UNIVERSITAT DE BARCELONA

Essays on the roles of agriculture in the economic growth process: Contrasting theory and evidence, the Peruvian case

Jackeline Raquel Velazco Portocarrero

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A thesis presented for the degree of PhD in Economic History

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Departament d’Història Econòmica

Universitat de Barcelona

Spain 2024

“La República es un simulacro”

José María de Arce, parlamentario peruano, Lima 1823

Mencionado por Carmen Mc Evoy, historiadora peruana, en el programa “Mesa compartida”, emitido el 26 de setiembre 2023. Link de acceso: (20+) Facebook

"No forman el verdadero Perú las agrupaciones de criollos y extranjeros que habitan la faja de tierra situada entre el Pacífico y los Andes; **la Nación está formada por las muchedumbres de indios** diseminados en la banda oriental de la cordillera."

Manuel González Prada, *Discurso en el Politeama* (Lima, 1888) en Sobrevilla (2009: 239-240). (El énfasis es mío).

¿Qué habría pasado en la última década para que el Perú hubiera entrado en esa guerra fratricida que cada día dejaba un montón de muertos? ¿Por qué Sendero Luminoso se tomaba los pueblitos perdidos en las montañas o hacía estallar bombas en las ciudades de la sierra, o incluso en Lima, si todas sus víctimas eran peruanas? ¿En qué momento el país se había fracturado y roto por completo, separando la sierra de la costa y a un hermano de otro hermano?

Reflexiones de Toño Azpilcueta, personaje de la novela de Mario Vargas Llosa (2023), “Le dedico mi silencio”. Barcelona: Penguin Random House, pp. 113-14

Acknowledgements

This thesis marks a significant milestone in my endeavour to comprehend, from a long-term perspective, the role of agriculture in Peru's economic growth process. Having dedicated my academic efforts to studying agrarian family units through a microeconomic and contemporary lens, I embarked on doctoral studies in economic history with the intention of understanding the reasons behind the persistence of backwardness and poverty in family and peasant agriculture, whose production is primarily geared towards the domestic market. This thesis has afforded me multiple perspectives on the Peruvian agrarian issue, proving to be a fascinating and enriching journey. I was fortunate to find, in my thesis advisor, Professor Vicente Pinilla, an attentive and incisive interlocutor, consistently posing pertinent questions that spurred me to further explore and refine ideas and potential answers. I extend my heartfelt thanks to Vicente for his support, guidance, and boundless patience.

Preliminary drafts of the chapters comprising this dissertation have been disseminated through seminars and conferences held in Peru, Spain, the USA, and the UK. I am particularly indebted to the commentators and participants of the Doctoral Students Seminars at the University of Barcelona for their perceptive feedback and constructive suggestions. Their insights were eagerly awaited and greatly appreciated. Additionally, I am grateful to Yolanda Blasco for her dedication to ensuring the completion of this thesis within the established deadlines.

In the pursuit of Peruvian literature, particularly from the 19th and early 20th centuries, the services of the libraries at the University of Girona and the Pontifical Catholic University of Peru in Lima have been invaluable. I greatly appreciate their dedication and willingness to procure the requested bibliographic materials.

I wish to extend a special, in memoriam, thanks to two professors from the Pontifical Catholic University of Peru who accompanied me during my formative years as a researcher. One of them was Adolfo Figueroa, the first Peruvian economist to conduct exhaustive studies on peasant economy, who once recommended that I delve into agricultural productivity studies. I now understand the reason for his concern. The second mentor was Marcel Valcárcel, a rural sociologist, from whom I learned to comprehend the mechanisms of agrarian mobilizations, the significance of agrarian structure, and its relationship with the State. I recall that during one of my final presentations in Lima, when discussing household rural income diversification strategies, Marcel emphasized considering participation in activities outside the law (such as illegal mining, coca production for narcotics trafficking, among others), which could constitute significant income sources for certain rural households.

During my trips to Lima, I consistently found Patricia Fuertes, Norma Puican, and Julia Velazco willing to listen to my research progress. We share a mutual interest in understanding the country's reality, and I greatly value their feedback and suggestions for improvement.

I wish to express my gratitude to Adam Slaughter, who, taking advantage of our weekly English classes, has reviewed several chapters of this thesis. I also extend my gratitude to Jorge Quispe for his guidance in the econometric aspect and for always being attentive to resolving my queries.

Lastly, my family, dispersed between Girona and Lima, has been a fundamental pillar throughout this research journey. Their unwavering support and unconditional love provided me with the final strength to conclude this phase of my research. To Luis Walter, who entered our lives after I had commenced the thesis; to Ramon, my companion on this journey; and to my family in Lima, particularly those who have passed away, I dedicate this thesis.

Dedication

To mamá Quelita, tía Juanita and Tatiana, in memoriam

To papá Luchito

To Luis Walter, my Inti (Quechua word), mi Sol

To Ramon, for always standing by my side

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ABSTRACT

The discourse surrounding the contribution of agriculture to the process of economic growth and development has recently garnered renewed and vigorous attention. Factors such as climate change, the food price crises of 2007-2008 and 2011, challenges in achieving the Sustainable Development Goals, as well as economic, financial, and health crises have compelled international organisations, donors, and scholars to reconsider how agriculture can more efficiently address these significant issues.

Throughout its history, Peru, being a small and open economy, has undergone cycles of crises and recoveries often linked to fluctuations in the international market. A prominent characteristic of the Peruvian economy has been its profile as an exporter of primary goods and an importer of manufactured products. Development strategy paradigms have ranged from models focusing on diversification of primary exports to industrialization and promotion of non-traditional exports. Broadly speaking, these development models can be categorised since the late 19th century as follows: a) primary export diversification until 1962 and from 1975-1990, b) import substitution industrialization strategy during 1962-1975, and c) promotion of non-traditional exports since 1990.

Against this backdrop, the objective of this thesis is to examine the extent to which agriculture has influenced economic growth in Peru. Specifically, the thesis poses the following research question: What roles does agriculture play in the process of economic growth in Peru? The hypothesis posits that the role assigned to agriculture has been shaped by the stage of development (factor endowment, productivity, and trade openness) and implemented development strategies (roles of elites and other groups in defining macroeconomic and sectoral policies). Thus, from a long-term perspective, multiple roles of agriculture could be identified, where in some instances it may serve as the central driver of accumulation and growth while in other contexts it may be a sector subordinate to the expansion of others. Moreover, there may exist feedback relationships between sectors in certain cases.

To address the research question, the thesis is structured into five essays. The first essay establishes the general context and stylized facts of Peruvian agriculture, the development strategies implemented since the late 19th century, and the public policies that have influenced the sector's performance. The second essay provides a long-term perspective, from the late 19th century to the early 21st century, on the relationship between agricultural GDP and non-agricultural GDP (mining, industry, and services). Through cointegration analysis, the nature of the relationship between these sectors is elucidated. Furthermore, the essay analyses the export-led growth and import-led hypotheses. The third essay focuses on agricultural productivity analysis. Total factor productivity (TFP) is estimated for the period 1950-2010, and the determinants of TFP are explored, including the influence of GDP per capita, trade openness, human capital, and a structural reform index. The fourth essay aims to explain the factors behind the agricultural boom identified since the 1990s. Two dominant forms of production in Peruvian agriculture are examined: export-oriented agro-industrial complexes and family farming. The essay develops theoretical models for each production unit and discusses empirical evidence based on secondary sources to discern how the implementation of a non-traditional export promotion model has influenced their microeconomic performance.

The fifth essay discusses how public policies have been geared towards the expansion of non-traditional agricultural exports since the 1990s, becoming a state policy. In this context, the sector negatively affected or marginally served is agriculture for the domestic market (primarily family farming), leading to tensions in agrarian policy. Evidence suggests that this outcome is due to mechanisms reflecting the capture of the state by agrarian economic elites, as manifested through revolving doors and lobbying in Parliament. This result also highlights the limited political representation and support in Parliament for the producers comprising agriculture for the domestic market.

Returning to the research question regarding the role of agriculture in the Peruvian growth process, it can be affirmed, based on the presented evidence, that Peru exhibits a history of two types of agriculture according to destination markets: domestic and external. Regional components also gain significance in this analysis. The coastal region housed cotton and sugar production, which were part of the traditional export model from the late 19th century to the mid-20th century. Additionally, since 1990, agro-industrial complexes have been promoted by the state as part of the new non-traditional agro-export model, focusing on exporting vegetables and fruits. In this scenario, coastal agriculture has played the role of foreign exchange provider, crucial for sustaining economic growth as a significant portion of inputs and capital goods required by the economy need to be imported.

On the other hand, agriculture destined for the domestic market, predominantly located in the Sierra, with a growing presence in the Coast and Amazon regions, has been the source of food for local and regional markets. This agriculture has lacked state support, with the absence of a state policy for its development being the norm in Peru's economic history since the late 19th century, as analysed in this thesis. The predominant form of organisation in this agriculture is family farming, characterised by carried out an income diversification strategy, enabling its linkage with non-agricultural and urban economies, as evidenced by the feedback relationship between agriculture and other sectors.

The thesis provides a triple contribution. Firstly, it offers the inaugural long-term analysis of the proposed subject within Peruvian historiography, synthesising the interplay between economic sectors, agricultural productivity, the economic behaviour of production units, and the political economy in shaping agrarian policy. Secondly, it scrutinises the political economy underpinning the execution of agrarian policies, discerning both the beneficiaries and the marginalized groups. Thirdly, the microeconomic model elucidating the response of agro-industrial complexes to agrarian policies enacted since 1990 stands as a distinct contribution by the author.

Regarding sources, a variety of information sources are harnessed, encompassing time series, data gleaned from agricultural censuses, and nationwide household surveys.

In terms of the thesis's limitations, one constraint pertains to the availability of information, specifically the lack of data on productive factors at the regional level, which led to estimating only the Total Factor Productivity (TFP) at the national level. Another notable limitation is the absence of factor prices, hindering the estimation of alternative models to the Cobb-Douglas function used in Chapter 4. Furthermore, there is a scarcity of literature on agricultural performance from the 19th century to the mid-20th century. Ultimately, the estimation of GDP does not account for the presence of illegal activities such as drug trafficking, deforestation, and illegal mining. There is no official record of the income generated by these activities, so it is important to bear this limitation in mind.

CHAPTER 1: INTRODUCTION

1.1 Motivation

The debate on the role of agriculture in the process of economic growth and development is currently experiencing renewed and vigorous interest. Climate change, the crisis of food prices during 2007-2008, the difficulties facing the achievement of the Sustainable Development Goals, contexts of economic and health crisis, are forcing international organizations, donors and scholars to rethink how agriculture can contribute in a more efficient way to solve these serious problems.

The agricultural sector has played an important role in the process of economic growth. Federico (2005: XIII) concludes, after an exhaustive empirical analysis, that, "agriculture has been an outstanding, and somewhat neglected, success story. In the past two centuries, it has succeeded in feeding a much greater population with a greater variety of products at falling prices, while releasing a growing number of workers to the rest of the economy". The 2008 Banco Mundial report (Banco Mundial, 2008) highlights a new dimension to the issue when it argues that agriculture is a vital development tool for reducing the rate of population suffering from hunger and extreme poverty. So, sustainable development and poverty reduction are the explicit roles assigned to agriculture in the 21st century. As expected, the agriculture-for-development agenda will depend on the level of development reached by countries, which are broadly classified as agriculture-based, transforming and urbanized countries.

The analysis of the proposed issue in the case of Peru is of significant importance. Peru presents an intriguing case study due to its resemblance to other developing nations, having undergone a profound socioeconomic transformation throughout the 20th century. By 1940, as indicated by the earliest census of the century, the majority of Peru's population resided in rural areas (65%) and predominantly in the Sierra region (63%). However, by 2007, urban areas had become the primary places of residence for the majority of the population (77%), with the Coast emerging as the predominant region for settlement (55%) (INEI, 2008).

Peru, characterized as a small and open economy, has encountered cycles of crises and recoveries often linked to fluctuations in the international market. A notable aspect of the

Peruvian economy is its profile as an exporter of primary goods and importer of manufactured products. Over time, various development strategy models have been adopted, ranging from primary export diversification to industrialization to the promotion of non-traditional exports. Broadly speaking, these developmental models can be categorized since the late 19th century as follows: a) primary export diversification from the late 19th century until 1962 and from 1975-1990, b) import substitution industrialization strategy during 1962-1975, and c) promotion of non-traditional exports since 1990.

Furthermore, the agricultural landscape in Peru exhibits heterogeneity, manifesting in its diverse articulation with markets and varying levels of profitability and sustainability. This diversity is evidenced by the coexistence of modern, technologically advanced agricultural practices alongside small-scale family farms supplying to both local and international markets. The linking between small-scale agriculture and the export-oriented agro-industry is facilitated through market mechanisms, whereby agricultural produce serves as raw materials for agribusiness, land rental arrangements, and participation in the labour market (Figueroa, 1996).

The chapter is structured into four sections. The subsequent section introduces the aim, hypothesis, and proposed analytical framework. The third section outlines basic characteristics of Peru and identifies the most significant events from 1840 to 2020, while the fourth section provides an overview of the dissertation.

1.2 Aim, hypothesis and analytical framework

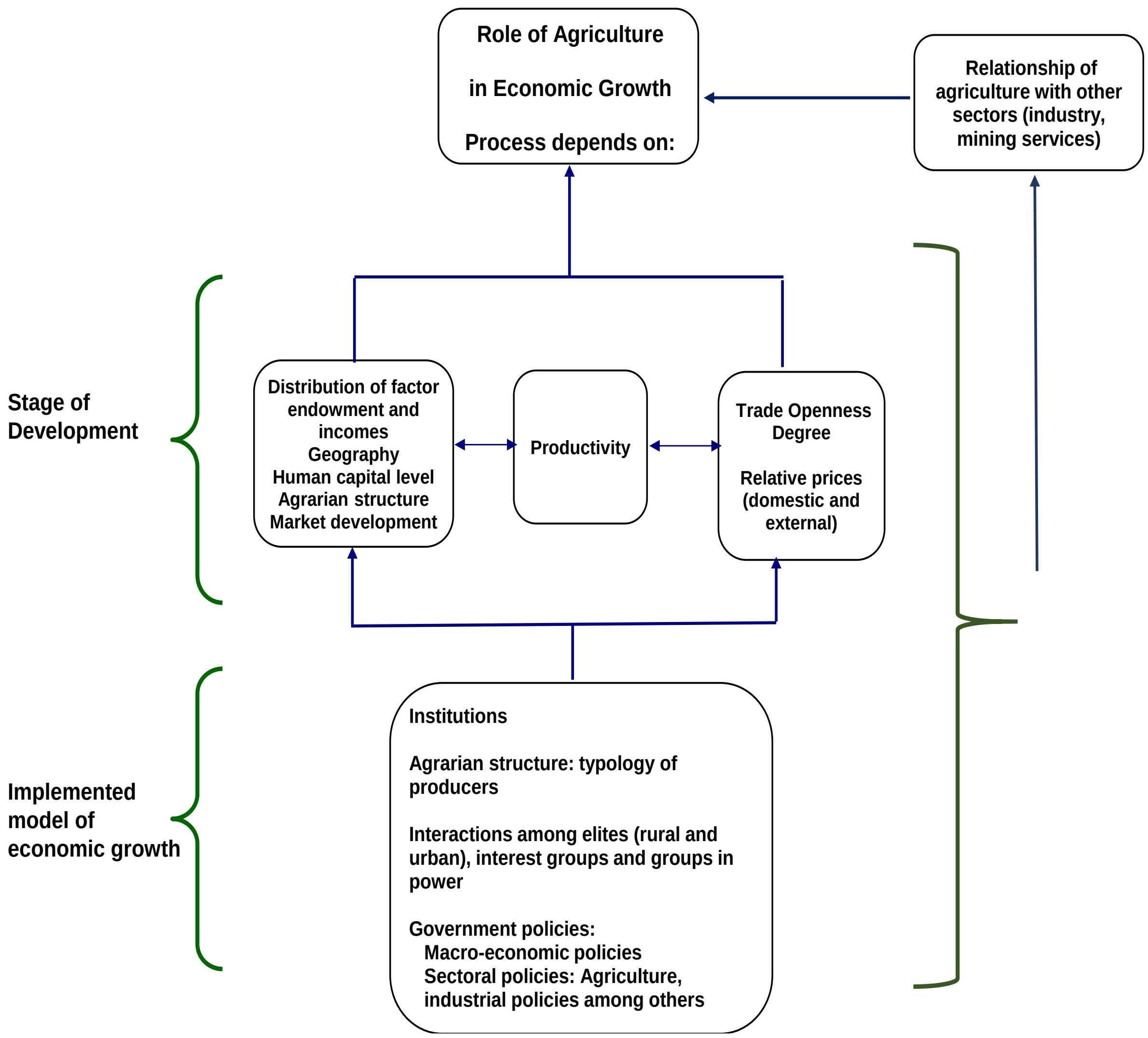
Given the aforementioned context, the objective of this thesis is to examine the influence of agriculture on economic growth in Peru during the period 1896-2012. Specifically, the research question posed by the thesis is: What roles does agriculture play in the process of economic growth in Peru? The hypothesis suggests that the role attributed to agriculture has been shaped by factors such as stage of development (including factor endowment, productivity, and trade openness) and the implementation of development strategies (including the roles of elites and other groups in defining macroeconomic and sectoral policies). Thus, taking a long-term perspective, various roles of agriculture could be identified, where it may act as a primary driver of accumulation and growth in some instances, while in others, it may be subordinate to the expansion of other sectors. Additionally, there may be feedback relationships between sectors in certain cases.

Figure 1.1 summarises the analytical framework proposed for analysing the research question. The analysis of the role of agriculture in the economic growth process necessitates considering two components simultaneously: the level of development achieved, and the growth model implemented. Concerning the latter, sectors that are intended to drive growth are delineated based on macroeconomic and sectoral policies. In the specific case of agriculture, it becomes crucial to identify how agricultural producers interact with political power to benefit from agricultural policy decisions, or alternatively, to recognise which groups are marginalized or receive limited attention from the state. The agrarian structure and the institutions representing various farmers (for example, those destined for the domestic or external market, or those organized by products) will be indispensable at this level of analysis.

The other component to consider is the developmental state of a country. Recognising the complexity of capturing it with a single variable, agricultural productivity can be assumed, for analytical simplicity, to be one of them, influenced by various circumstances or factors such as the endowment and distribution of productive factors and income, geography, level of human capital, agrarian structure, and market development. Another set of factors affecting productivity is reflected in the country's relationship with external markets, whether as an exporter or importer of agricultural and non-agricultural products. Other key variables in this component include relative prices, whether internal or external, as changes in these prices alter decisions regarding productive specialization and consumption.

It is expected that the interaction of these two components will define the role of agriculture in a specific context and time, and one of the ways in which it manifests is in the nature of the relationship between agriculture and other economic sectors such as industry, services, and mining.

Figure 1.1 Analytical Framework: Understanding the role of Agriculture in economic growth process



Source: Own elaboration

The selected study period commences with the consolidation of national recovery following the War of the Pacific (1879-1883), which left the country in ruins and amidst a protracted social and political crisis. Estimates of GDP by Bruno Seminario (2015) are being utilised, spanning the period from 1700 to 2012. Seminario's work represents a significant statistical and methodological endeavour, endorsed by the Central Reserve Bank of Peru. Notably, it has amalgamated existing literature on prior estimations for the first time in Peruvian economic history studies, employing a diverse array of primary and secondary sources associated with the economic sectors comprising the GDP. Therefore, for undertaking a long-term analysis, in this instance from the late 19th century to the first decade of the 21st century, Seminario's estimates serve as a pivotal source[1].

1.3 Setting the scene: The Peruvian case

In order to properly analyse agrarian issues in Peru, it is necessary to take into account its geographical features, which determine three natural regions: Coast, Sierra and Amazon (refer to the map of Peru according to natural regions in Figure 1.2). The Coast is the centre of the country's industrial, commercial and agricultural activity. Lima, the political and economic capital, is located here and has around one third of the total population. The *Sierra* or the Highlands consists of the Andes Mountain; high plateaus and valleys that cover 27% of the land area. The Amazon is the most extensive but least populated region of Peru. The Amazon covers an area equivalent to 60% of the national territory. Small holders are in the three regions, but they are prevalent in the Sierra, while commercial farmers are mainly in the Coast and Amazon regions.

[1] The link to the book containing all estimations and Excel databases is available at: https://historiaeconomicaperu.up.edu.pe/

Figure 1.2. Map of Peru by natural regions

Source: Web page of Minister of Agriculture (rrnn_mapa8regionnat.jpg (780×1118) (midagri.gob.pe))

To gain a comprehensive understanding of the key events in Peru, Table 1.1 analyses the evolution of political regimes in Peru from the 1840s to 2020, focusing on their economic, political, and social characteristics. The period under consideration witnessed significant transformations in Peru's political landscape, shaped by economic cycles, dominant raw materials, state alliances, and social dynamics (Crabtree and Durand, 2017).

During the Guano Republic (1840s-1879), Peru experienced an economic re-ordering driven by guano extraction, leading to a guano boom with strong comparative advantage in export. Guano, alongside cotton and sugar (Coast), and silver and wool (from Sierra region), dominated the export market. The state was patrimonial and elite-dominated, with the republican elite, both foreign and Peruvian, holding significant power. Elite-based liberal democracy emerged, replacing military-led regimes. However, social unrest persisted, with a mass population lacking rights.

Following the post-war reconstruction, prompted by the loss in the War of the Pacific, the period known as the Aristocratic Republic (1896-1919) commenced. Peru entered a new economic cycle stimulated by the second industrial revolution, diversifying its exports. British capital initially dominated, but US capital increasingly played a significant role. Modernisation efforts focused on sugar, cotton, mining, and commercial enterprises, with elite interests driving state policies. Attempts were made to suppress indigenous identity, but social movements emerged, advocating for labour rights and university reform.

The next period known as Extractive Authoritarianism (1919-30; 1930-62), witnessed continued demand for established raw materials and the emergence of new ones, coupled with increased commerce, investment, and borrowing. US capital displaced British influence, leading to the development of company towns and increased exports. Military and civilian dictatorships prevailed, promoting new exports and infrastructure development. Attempts to control democratisation were met with resistance from peasants, students, and workers, leading to social unrest and repression.

During the 1962-1990, a pendular Populism period took place. It was characterised by an alternation between democracy and authoritarian rule. From failed reformism under Belaunde to the Velasco military government and the return to democracy in 1980, Peru experienced a cycle marked by regional integration, import substitution industrialisation, and growing external indebtedness. State-led development and nationalism characterised this period, alongside the growth of mass parties and social movements. However, the crisis of the late 1980s saw the emergence of terrorist groups like *Sendero Luminoso* and MRTA (*Movimiento Revolucionario Túpac Amaru)*, leading to renewed authoritarianism and weakening of unions and mass parties.

Economic liberalization became firmly established in the late 1990s, heralding a return to a primary export-oriented economic model. The 1993 Constitution provided institutional and juridical backing for this extractive economic paradigm. This shift was accompanied by an export surge, buoyed by the promotion of non-traditional agro-exports, notably vegetables and fruits, alongside the participation of small-scale farmers in the export of coffee and cocoa. However, a notable aspect of this economic landscape is the limited presence of the state in significant areas of the country, resulting in the delegation of power and authority to extractive industries.

Consequently, this vacuum has facilitated the emergence of illicit activities, including drug trafficking, deforestation, and unregulated mining, particularly gold mining. Such developments can be traced back to the state reduction policies of the Fujimori era during the 1990s, which concurrently weakened state capacities. Furthermore, the influence over policymaking extends not only to business elites but also to criminal organizations, with corrupt practices permeating elite circles.

Despite attempts at decentralization, the hyper-centralization of the Peruvian state persists, compounded by instances of corruption at the sub-national government level. Moreover, the Fujimori government's adoption of a patrimonial social policy (access to social goods or services is contingent upon personal relationships or affiliations rather than being based on objective criteria or need) in the 1990s exacerbated existing inequalities. Nonetheless, the commodities super-cycle spanning from 2002 to 2014 contributed to poverty reduction, accompanied by a significant increase in government investment in physical and social infrastructure. This provided an opportunity to address entrenched social disparities. However, discontent has simmered, particularly in the Sierra and Amazon regions, where protests against extractive investments have escalated.

Overall, the evolution of political regimes in Peru from the 1840s to 2020 reflects the complex interplay between economic, political, and social factors, shaping the country's trajectory over time.

Table 1.1: Evolution of political regimes from the 1840s to 2020: economic, political and social characteristics

	Economic cycle	**Dominant raw materials and key types of economic unit**	**Dominant alliance within the state**	**Social situation, distribution and conflicts**
Guano Republic 1840s-1879 Economic re-ordering on the basis of guano extraction, until the War of the Pacific	Guano boom, with strong comparative advantage. But not the only export product responding to international demand,	Guano and (much less important) cotton and sugar (Coast), silver and wool (Sierra). Foreign and Peruvian consignees of guano: the first republican elite.	Patrimonial, elite-dominated state. Elite-based liberal democracy replaces military-led regimes with José Pardo y Lavalle and the *Civilista Party*. Rationalisation of the state and building of railways. Dreyfus contract.	Coolies and European migration. Abolition of slavery and attempts to eliminate indigenous tribute. Social outbursts. Mass of population without rights.
Aristocratic Republic 1896-1919 From post-war reconstruction to the crisis at the end of the First World War	New cycle stimulated by second industrial revolution dynamising wide range of exports. British capital predominates at the beginning. Opening of Panama Canal and increasing weight of US-capital.	Modernisation of sugar and cotton production. Mining and commercial company towns, (Cerro Corp., IPC, Grace). Wool and rubber integrate Sierra and Amazon to export chains managed by haciendas and rubber barons.	José Prado y Barreda; second *civilismo*; sugar, cotton and mining interests. Gendarme state. Promotion of highway investment. First mining code.	Attempt to supress indigenous identity. First trade unions and origins of mass parties. Struggle for eight-hour day and university reform. Social exclusion and repression of dissident.

	Economic cycle	Dominant raw materials and key types of economic unit	Dominant alliance within the state	Social situation, distribution and conflicts
Extractive authoritarianism 1919-30; 1930-62 From Leguía and the crisis of the early 1930s to "third wave" of anti-communist militarism	Continued buoyant demand for established raw materials and some new ones. Increased in commerce, investment and borrowing. US capital displaces British.	Displacement of British capital by US. Development of company towns, New open cast mining and increased fishing exports. Growth in manufacturing and new banks.	Military and civilian dictatorships. Repressive state. Promotion of new exports. 1950 mining code. Roadbuilding. Oligarchic pact with APRA (under Prado) and attempts to control democratisation.	Dictatorship closes political system, with pressure from peasants, students and workers. APRA and Socialists oscillates between revolutionary activity, conspiracies, politics and electoral participation. Some social conquests.
Pendular populism: alternation between democracy and authoritarian rule 1962-90 From Belaunde's failed reformism to the Velasco military government and on to return to democracy in 1980. Cycle finishes with debt crisis and Sendero Luminoso.	Regional integration and import substitutive industrialization (ISI), US, European, Japanese multinationals appear on the scene, State-led development and nationalism. Growing external indebtedness that eventually ruptures state-led development model.	Exports dwindle with nationalisation and ISI. Growth of public sector enterprise, with urban-based manufacturing. Failure of cooperatives in rural sector. Attempts to produce oil and building pipeline. Beginning of non-traditional exporting.	State-led development, and growth of mass parties (centre and left). Municipal elections (1963) and universal suffrage. Velasco liquidates rural oligarchy and attempts industrialisation with redistribution. Mass politics of the 1980s, and crisis of social market economy.	Urban migration and urbanisation. Growth of informal sector. Redistribution struggles led by left. Improvements in social policy. Mass parties weakened by crisis of late1980s. Appearance of SL and MRTA. Renewed authoritarian traits and weakening of unions and mass parties.

	Economic cycle	Dominant raw materials and key types of economic unit	Dominant alliance within the state	Social situation, distribution and conflicts
Economic liberalism: **transition to a free-market and extractive economy** Ongoing since the Fujimori regime (1990-2001) up to the present day. Given economic crisis, Washington Consensus measures were implemented	Economic liberalization took root in the end 1990s and the return to a model based on primary exports. 1993 Constitution provided the institutional and juridical underpinning for the extractive economic model.	2002-2014: export bonanza, super-cycle (minerals, timber and fish products). Promotion of non-traditional agro-export: vegetables and fruit (Coast region). Small farmers export coffee and cocoa. State lack a presence on the ground in large part of the country, ceding power and authority to extractive industries. Emergence of a range of illicit activities (drug trafficking, deforestation and unregulated mining, mainly gold).	State reduction policies of the Fujumori era in the 1990s. State capacities have been craped. State is swayed not only by business elite but also by criminal organizations and by elites that seek to influence through corrupt means. Strong influence of Peru's business elites over policy making. Policies of decentralization have not reversed the hyper centralization of the Peruvian State. Extent of corruption in sub-national government.	1990s: during Fujimori government patrimonial social policy. Commodities super-cycle (2002-2014) help reduce poverty. Large increase in government investment in physical and social infrastructure: opportunity to tackle some deep-rooted social inequalities. Protest again extractive investments has increased in the Sierra and Amazon regions.

Source: Crabtree and Durand (2017: 30 – 31).

1.4 Overview of the dissertation

1.4.1 Filling the gap and contributions

Although a significant body of research provides an account of Peruvian agriculture's performance and analyses the constraints hindering its stable development (such as macroeconomic and sectoral policies, technology, agrarian structure, among others)[2], it is noted that the proposed research topic has not received specific attention in studies of Peruvian agriculture. The majority of studies cover the period following the Agrarian Reform of the 1960s. This thesis seeks to address this knowledge gap and contribute to the study of the long-term relationship between agriculture and the broader economy. It aims to understand how this relationship has evolved under different prevailing development strategies from the late 19th century to the first decade of the 21st century.

The thesis provides a triple contribution. Firstly, it offers the inaugural long-term analysis of the proposed subject within Peruvian historiography, synthesising the interplay between economic sectors, agricultural productivity, the economic behaviour of production units, and the political economy in shaping agrarian policy. Secondly, it scrutinises the political economy underpinning the execution of agrarian policies, discerning both the beneficiaries and the marginalized groups. Thirdly, the microeconomic model elucidating the response of agro-industrial complexes to agrarian policies enacted since 1990 stands as a distinct contribution by the author.

1.4.2 Dissertation structure and limitations

The thesis is structured into 5 essays. The first essay (Chapter 2) provides a long-term perspective on the performance of agriculture and the agricultural policies implemented since the mid-19th century. The second essay (Chapter 3) analyses, using time series econometrics, two key themes. The first is the relationship of agriculture with industry, mining, and services for the period 1896-2012 and sub-periods. The second theme, recognizing the country's characteristics as a small and open economy, examines the relevance of the export-led growth hypothesis and import-led growth hypothesis. Furthermore, exports are classified into

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[2] Regarding this, the contributions of Caballero (1981), Hopkins (1981 and 1995) and Alvarez (1983) stand out for the analysis of agrarian policies since the mid-20th century, including the agrarian reform of 1969. The studies on peasant economy and technological change developed by Figueroa (1989), Cotlear (1989), and Gonzales de Olarte (1994) are noteworthy. In the analysis of the impact of macroeconomic policies on agricultural performance, the studies of Escobal (1989 and 1993) are highlighted.

agricultural exports and non-agricultural exports, thus enabling an evaluation of whether agriculture has played any role as a provider of foreign exchange.

The third essay (Chapter 4) studies the topic of Total Factor Productivity (TFP) for the period 1950-2010. TFP is estimated, and subsequently, its determinants are identified. Additionally, a causality analysis is conducted to determine whether the performance of TFP is linked to agriculture destined for the domestic market, external market, or the contribution of family farming.

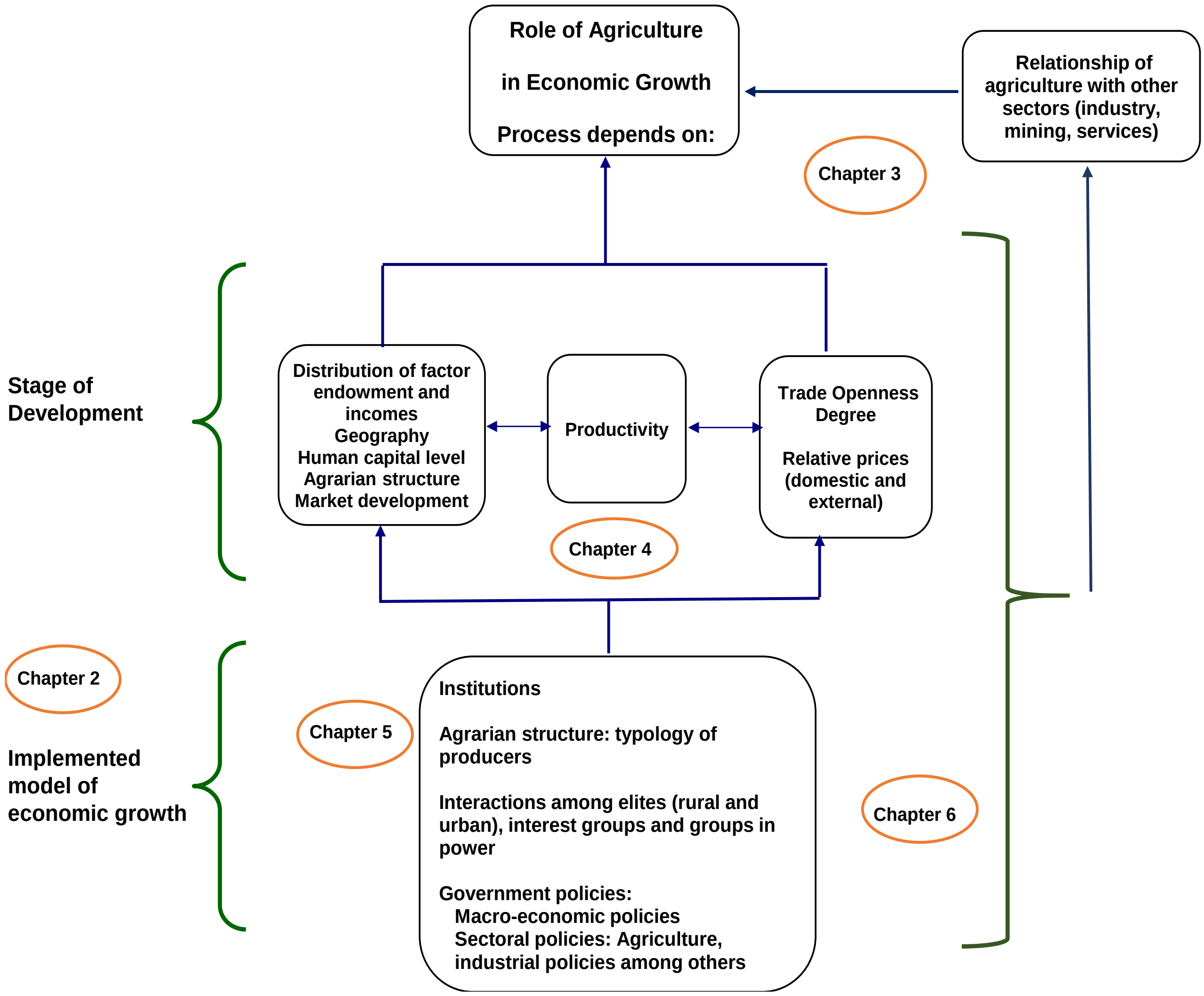
The fourth essay (Chapter 5) focuses on the microeconomics of the predominant agricultural production units in the country: agro-export complexes and family farming. For each type of agricultural unit, a behavior model is developed to explain the impact of policies aimed at incentivizing and promoting the new agro-export model since the 1990s. Furthermore, the essay discusses how the context of economic expansion and the gastronomic boom have impacted family farming.

The fifth essay (Chapter 6) deals with the political economy underlying the definition of agricultural policy. This involves a discussion of mechanisms of "state capture" by new agrarian economic groups and the strategies undertaken by producers destined for the domestic market to have their demands heard by the authorities responsible for the agricultural sector and the government.

Chapter 7 presents the conclusions and a discussion of the thesis results, taking into consideration the research question posed.

In Figure 1.3, the distribution of chapters is linked according to the analytical framework outlined.

Figure 1.3. Chapter distribution according to the analytical framework



In terms of the thesis's limitations, one constraint pertains to the availability of information, specifically the lack of data on productive factors at the regional level, which led to estimating only the Total Factor Productivity (TFP) at the national level. Another notable limitation is the absence of factor prices, hindering the estimation of alternative models to the Cobb-Douglas function used in Chapter 4. Furthermore, there is a scarcity of literature on agricultural performance from the 19th century to the mid-20th century.

From the 1980s onwards, the cultivation of coca leaves for cocaine production began, establishing connections with the narcotics trade. Consequently, the estimation of GDP does not account for the presence of illegal activities such as drug trafficking, deforestation, and illegal mining. There is no official record of the income generated by these activities, so it is important to bear this limitation in mind.

CHAPTER 2

DEVELOPMENT MODELS, AGRICULTURAL POLICIES, AND AGRICULTURAL GROWTH: PERU, 1824-2012

2.1 Introduction[3]

As this thesis concerns the role of agriculture in the Peruvian economic growth process, this chapter will provide evidence on the trends and noteworthy facts of agriculture for the period 1824-2012. While the study period focuses on 1896-2012, it is necessary to understand the conditions and characteristics of agriculture at the beginning of the Republic, after the end of the wars of independence in 1824. In this context, the objective of this chapter is to identify the salient characteristics of the development models and policies affecting Peruvian agriculture since the late 19th century, and to ascertain their impact on agricultural production. Clearly, it is not only economic development strategies that influence outcomes in the agricultural sector; changes in the international economy also play a significant role. Another aspect is to discuss the performance of agricultural production according to destination markets (export and domestic).

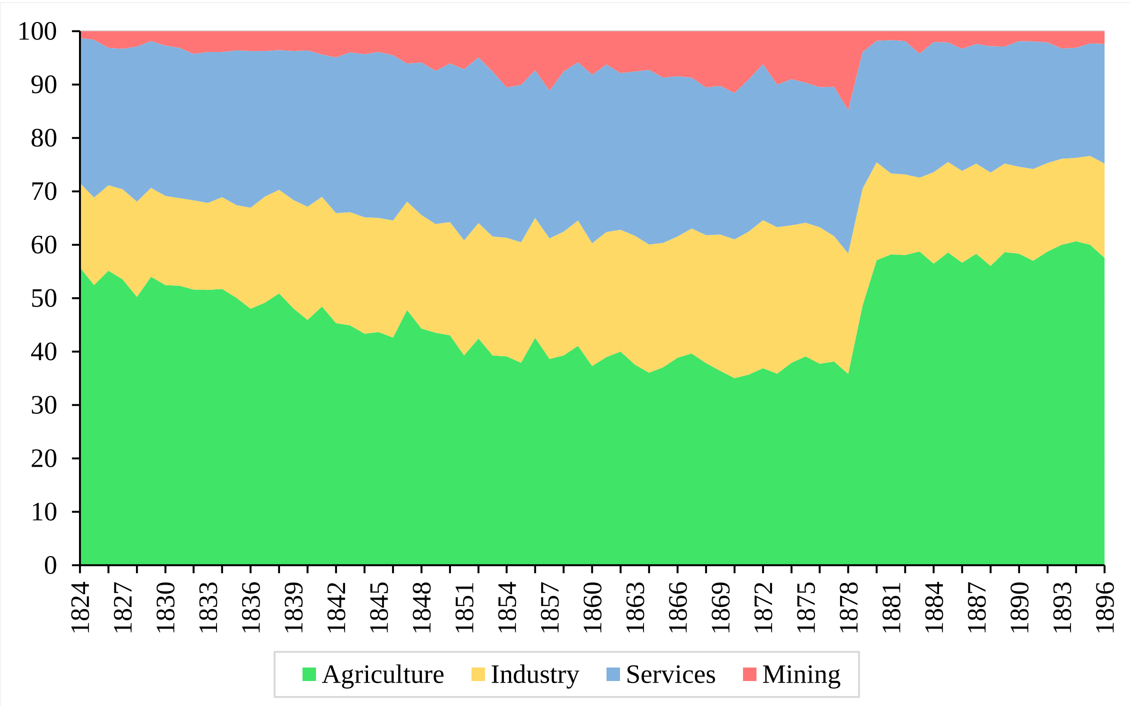
The chapter is structured into six sections. Section 2 addresses the general trends in agriculture during 1824-1896. Section 3 elaborates on the economic growth models implemented, with a particular focus on the export-led growth model (emphasizing the promotion of both traditional and non-traditional export products), and the import-substitution industrialization model. Agrarian reform policy and its effects on agrarian structure are discussed in Section 4. Trends in agricultural production are analysed in Section 5. Conclusions are summarised in Section 6.

[3] A substantial part of this chapter, particularly the analysis from 1950 onwards, has been published in the following book: (2018) Velazco, J. and Pinilla, V. Development models, agricultural policies, and agricultural growth: Peru, 1950-2010. In V. Pinilla and H. Willebald (Eds.), Agricultural development in the world periphery: A global economic history approach. Palgrave Macmillan, pp. 413-438.

2.2 General Trends in Agriculture during 1824 – 1896

In this section, an overview of Peru's economic performance for the period 1824-1896 is provided, spanning from the inception of the Republic to the beginning of the study period. Figure 2.1 illustrates the evolution of sectoral GDP participation. It is notable that during the initial period, agriculture slightly surpasses 50% of total production, maintaining a declining trend, reaching 40% before the War of the Pacific in 1879. As a result of the war, there is a sharp increase in its participation, reaching 60%. Additionally, services and industry are the sectors that follow in importance, with mining, an activity practically abandoned due to the War of Independence, showing the lowest contribution.

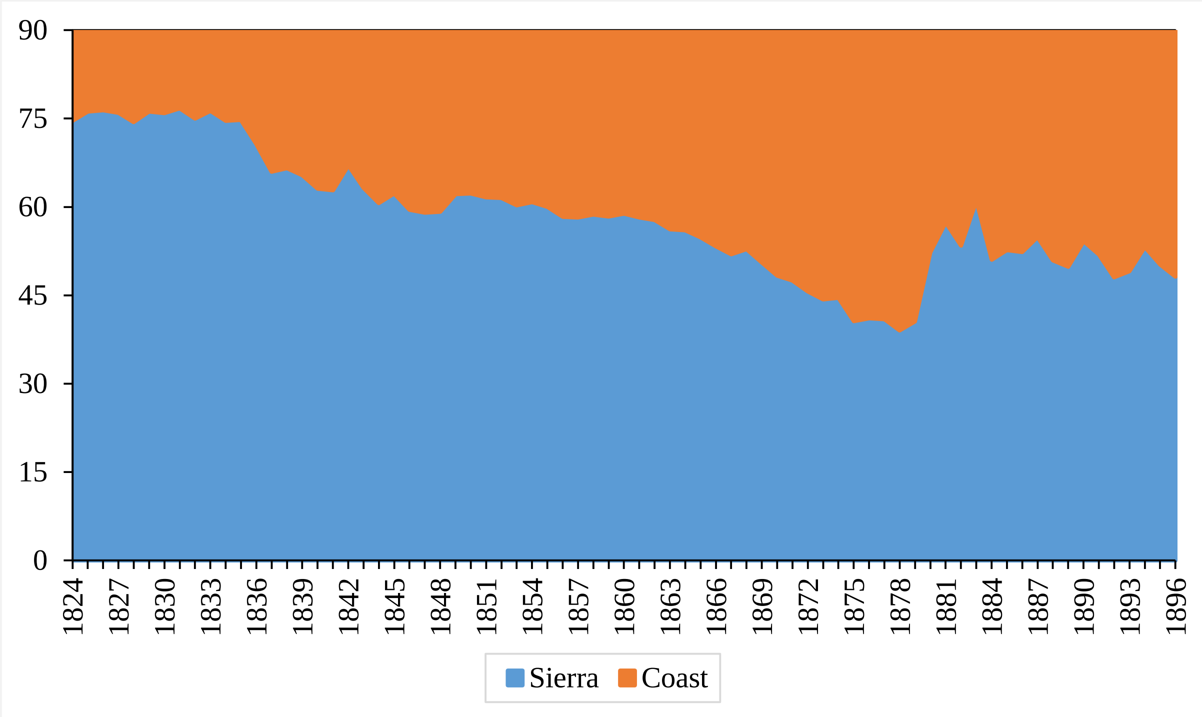
Figure 2.1. Evolution of GDP by sectors, 1825 - 1896 (in percentages)



Source: Author elaboration based on estimations by Seminario (2015). The original data are expressed in 1979 US dollars.

The Figure 2.2 depicts the evolution of agricultural GDP participation by regional origin, specifically whether it came from the Coastal or Sierra region. The greater weight of Sierra participation is observed, starting at 75% and showing a decreasing trend over the following decades. This trend reverses with the War of the Pacific between 1879-1884, only to later resume its lower participation trend, reaching 51% by the end of the period. In the Sierra region, the indigenous population is concentrated, engaging in agriculture organized within peasant units, utilizing rainfed lands of lower quality. Additionally, they serve as labourers or tenants on the neighbouring *haciendas* (Contreras, 2013).

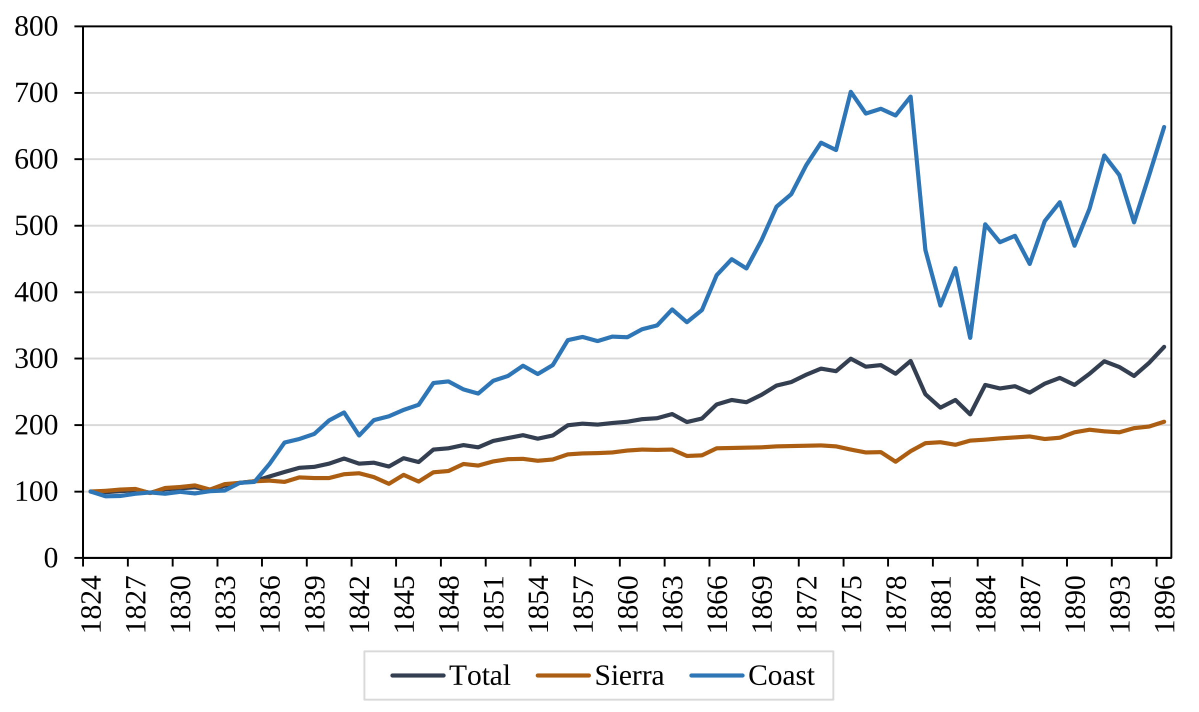
Figure 2.2. Evolution of Agriculture GDP by region of origin (in percentages)



Source: Author elaboration based on estimations by Seminario (2015). The original data are expressed in 1979 US dollars.

Figure 2.3 illustrates the evolution of the total agricultural GDP index and GDP generated in the Coastal and Sierra regions. Coastal production shows greater dynamism, interrupted during the war period and later resumed. However, Sierra agricultural production exhibits slow growth compared to that of the Coast.

Figure 2.3. Evolution of the Agriculture GDP index by region of origin (1824=100)



Source: Author elaboration based on estimations by Seminario (2015). The original data are expressed in 1979 US dollars.

Tables 2.1 and 2.2 present annual growth rates for various periods between 1824-1896, and additionally, Coastal production is divided according to destinations: domestic and external markets. The estimated growth rates confirm the trends previously indicated, namely, coastal agriculture leads the growth, supported by agriculture destined for the export market. Throughout the early decades of the Republic, Coastal export agriculture begins to gain importance in the overall production accounting for 5% of total agricultural GDP in the period 1824-1838, increasing to 36% in the period 1884-1896.

Table 2.1. Annual growth rates of Agriculture GDP by regions and market destinations

Period	Agriculture	Sierra Agriculture	Coastal Agriculture		
			Total	Export	Domestic
1824 – 1838	2.3	1.5	4.6	16.8	3.3
1839 – 1857	2.2	1.5	3.6	5.1	3.9
1858 – 1876	1.9	0.1	3.9	8.1	1.7
1877 – 1883	-3.7	1.7	-8.1	-3.5	-13.4
1884 – 1896	3.2	1.2	6.5	8.5	2.6

Source: Author elaboration based on estimations by Seminario (2015). The original data are expressed in 1979 US dollars.

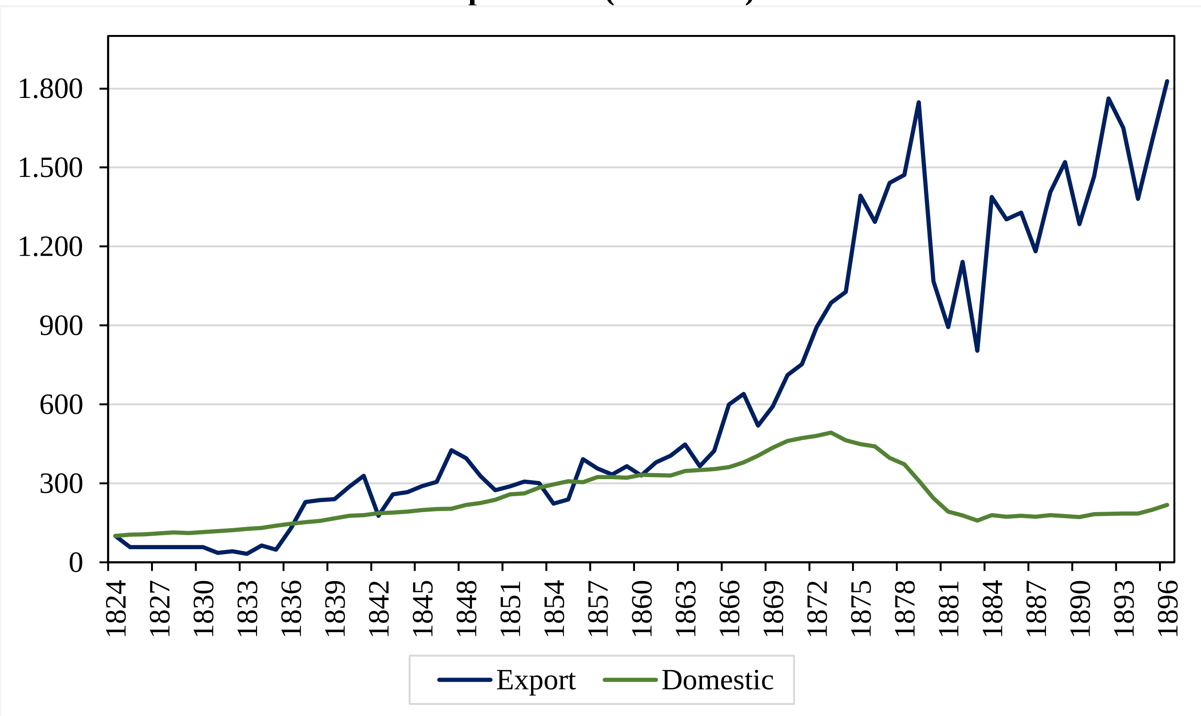
Table 2.2. Participation of Agriculture GDP by regions and market destinations.

Period	Agriculture	Sierra Agriculture	Coastal Agriculture		
			Total	Export	Domestic
1824 – 1838	100	74	26	5	21
1839 – 1857	100	61	39	13	26
1858 – 1876	100	52	48	18	30
1877 – 1883	100	49	51	32	19
1884 – 1896	100	51	49	36	13

Source: Author elaboration based on estimations by Seminario (2015). The original data are expressed in 1979 US dollars.

Figure 2.4 shows the evolution of the Coastal agricultural GDP index by destination markets, highlighting that by the late 1860s, Coastal exports demonstrate their greatest dynamism. Conversely, Coastal GDP destined for the domestic market grows at a slow pace, interrupted during the war and failing to recover thereafter.

Figure 2.4. Evolution of Coastal Agriculture GDP by market destination: domestic and exportation (1824=100)



Source: Author elaboration based on estimations by Seminario (2015). The original data are expressed in 1979 US dollars.

The first formative years of the Republic witnessed a sequence of highly unstable governments with serious difficulties in organizing the State and the functioning of the bureaucracy in the different regions of the country. The discovery of guano[4] (the dried excrement of sea birds) in the mid-nineteenth century and its massive export to Europe presented an opportunity to reorganise the State, with enormous income available for the initiation of infrastructure projects such as railways, which integrated the exporting zones of the central sierra (mining) and southern sierra (livestock) with the Pacific coast ports [5]. In addition, the guano revenues also supplied capital to the landowners of the Coast for the commercial-scale production of sugar and cotton[6]; however, it is worth mentioning that corruption and mismanagement of these extraordinary resources led to financial difficulties when the international demand for guano decreased and its reserves began to run out (Contreras, 2013).

Tantalean (1983) reviews the Memoirs of the Ministers of Finance for the period 1821-1879 with the aim of identifying the policies, diagnoses, techniques, and economic instruments of the State. Focusing on the case of the agricultural sector, Table 2.3 summarises the diagnosis of the problems affecting the sector and the measures proposed to overcome them. During the nineteenth century, Peru faced significant challenges in its agricultural sector, including labour shortages exacerbated by the abolition of slavery and the elimination of indigenous tribute, land constraints, capital limitations and production stagnation. To address these issues, public officials proposed measures such as the promotion of immigration, implementation of irrigation systems, provision of agricultural credit, and encouragement of export-oriented agriculture, aiming to stimulate agricultural growth. It is important to note that agricultural development was equated with the development of export agriculture, ignoring the promotion of agriculture destined for the domestic market. This position has been held since the formative stages of the Republican era.

The decades of the 1820s and 1830s, characterized by intense political upheaval and civil wars, prevented the implementation of an agricultural policy. Tantalean (1983) identifies a lack of correspondence between what appeared in the bureaucrats' diagnosis and the implementation of development policies oriented towards agriculture. It was only in the Memoir of the Minister of Finance of 1849 that the immigration of Europeans to

[4] To gain an understanding of the significance of guano exportation, Hunt (1985: 246) posits that "from 1840 till 1879 Peru was virtually a world monopolist in guano, and guano was the only commercial fertilizer available in the world's agriculture".
[5] For further discussion on the impact of the railway, see Zegarra (2020).
[6] Comprehensive analysis on the access to financial capital of agro-exporting elites during the 19th and 20th centuries can be found in Quiroz (1993), Tantaleán (1983) and Zegarra (2015 and 2022).

work in the fields was proposed. However, this measure did not yield the expected results, and the number of Europeans who accepted to come to Peru was insignificant. Consequently, the labour shortage was resolved with Chinese immigration, with thousands of workers arriving and being located, under conditions of forced labour, on the *haciendas* of the Coast and in the extraction of guano from the islands off the Coast of Lima. As observed, Asian labour was oriented towards the export sectors located in the Coastal region.

Table 2.3. The Nineteenth Century Agricultural Policy in Peru

Diagnosis	Policy measures
1) Deficiency and absence of labour force	1) Promotion of immigration
2) Insufficiency of agricultural land	2) Implementation of irrigation systems and colonization of new territories.
3) Shortage of capital.	3) Promotion of agricultural credit at reasonable rates
4) Stagnation of production	4) Encouragement of credit and expansion of export-oriented agriculture

Source: Tantalean (1983:87)

Having conducted this review of agriculture prior to the study period, the following sections will analyze the period from 1896 to 2012.

2.3 Economic development models in the twentieth century in Peru

Throughout its history, Peru, as a small open economy, has undergone cycles of crisis and recovery, usually linked to fluctuations in the international market. The Peruvian economy has always been an exporter of primary products and an importer of manufactured goods (Thorp and Bertram, 1978). Development strategy models have ranged from the diversification of primary exports (from the late 19th century until the late 1950s) to import-substitution industrialisation (1960-1975) and the promotion of non-traditional exports; this pattern has held since the early 1990s and is current today.

The economic history of Peru is marked by recurring export booms. Products such as guano, rubber, sugar, cotton, silver, gold, and others, have succeeded each other in dominating the export structure since the nineteenth century, reflecting the role of many countries on the periphery of the first globalisation, as suppliers of agricultural products and raw materials for the industrialised countries of Europe.

The political independence of the Spanish colonial government in the nineteenth century did not lead to a bourgeois transformation of the colonial structure, and the *hacienda* and peasant communities continued to be the predominant forms of Peruvian agrarian structures.

Capitalist development of agriculture took place in the twentieth century, with foreign capital playing an important part in this new process. As a result, the coastal *hacienda* evolved into a modern enterprise, leading to the consolidation of the larger *haciendas* and their sugar and cotton plantations. These were typically characterised by production for export, a high level of capital investment, centralised administration, and the use of modern technology (Byerlee and Viswanathan, 2017). The wage-labour system also became the norm in sugar-producing haciendas. Thus, agricultural development was driven by a growth model based on exports, in which the sugar sector was one of the leaders, its influence spreading over the northern highlands in areas such as Cajamarca, benefiting from its mainly peasant labour resources, and livestock farming.

Therefore, the agrarian development in Peru was largely driven by an export-led growth model, with the sugar sector playing a prominent role. Following the War of the Pacific (1879-84) and the subsequent recovery of the sugar industry, production experienced significant growth: 83% between 1889 and 1900, 77% from 1910 to 1920, and 18% from 1930 to 1940 (Thorp 1978:43). This growth was mirrored in the sugar industry's contribution to total exports, reaching a peak of 31.1% in 1890 and reaching its highest level in 1920 at 52.2% of total export revenues (Mejia,1992). During this period, sugar benefited from the flourishing commodity markets spurred by the First World War and the subsequent post-war years.

One way to assess the significance of agricultural exports within the overall context is illustrated in Table 2.4, which provides data for the years 1892 and 1920 (Piel, 1995). While sugar demonstrates notable performance during these years, it is important to highlight that the Sierra region and other coastal products such as cotton are also significant.

Table 2.4 illustrates that following the Pacific War, the Coast solidifies its position as the primary exporter, reaching 48% in 1892 and escalating to 71% by 1920. Conversely, the highlands witness a decrease in their share from 9% to 3%.

Table 2.4. Regions' contribution to agricultural exports and their share in total exports after the War of Pacific (in %)

Years	Agricultural Exports from the Sierra	Agricultural Exports from the Coast	Total Agricultural Exports
1892	9	48	57
1920	3	71	74

Source: Piel (1995:243).

However, the prosperous situation for the sugar sector took a drastic turn in the 1920s when external prices began to decline due to global oversupply. The high prices of previous years had incentivised substantial investments in the sugar industry, which began to bear fruit in the 1920s. The resurgence of European beet sugar production further contributed to the increase in global supply. Faced with this scenario, small and medium-sized sugar producers opted for crop diversification, while larger northern sugar *haciendas* intensified their production efforts to maintain revenue levels. Consequently, the number of *haciendas* decreased from 33 in 1922 to 14 in 1937 (Albert, 1988).

Albert (1988) suggests that during the interwar period, the industry's endurance was mainly attributed to increased labour productivity and reduced production costs. Technological improvements in both field and mill sectors, coupled with wage reductions, contributed to the latter.

One notable aspect of sugar *haciendas* expansion was their regional concentration in the North Coast[7]. In 1894, 49.9% of sugar production was concentrated in the North Coast, 41.5% in the Central Coast, 5.8% in the South Coast, and 2.8% in the Sierra. By 1941, the North Coast accounted for 90% of sugar production, the Central Coast 5.7%, the South Coast 1.7%, and the Sierra 2.6% (Albert, 1988). Consequently, the North Coast emerged as the agrarian region with the most significant capitalist development in the country, closely linked to international and domestic markets, and with a substantial section of proletarian labour[8]. This transformation had a profound impact on the traditional agrarian society of the region, leading to the formation of a rural proletariat centred around the large *haciendas*.

[7]/ The North Coast encompasses Piura, Lambayeque, La Libertad, and Ancash. The Central Coast extends to Lima, while the South Coast comprises Ica, Arequipa, Moquegua, and Tacna. The Sierra region includes highland production (Thorp, 1978).

[8]/ The expansion of the sugar industry led to significant concentration in the North Coast region. This set it apart from the Central Sierra, which had close ties to the mining export sector and external markets, as well as a presence of peasant economy and development of cattle-ranching. The South Sierra, on the other hand, lagged behind with low levels of capitalization, limited market development, and a predominantly peasant labour force.

The expansion of sugar *haciendas* also led to the coercive and legal incorporation of lands belonging to small-scale farmers and peasants. Furthermore, it altered regional trade patterns, directly impacting the economic foundation of local traders. In response to these changes, the "*Aprista*"[9] movement emerged, uniting the affected interests of sugar workers, displaced individual farmers, local entrepreneurs, and members of the emerging middle class[10].

The context of price stagnation that characterised the 1930s was disrupted by the Second World War, leading to sugar shortages in the free international market. This situation proved favourable for Peruvian producers, opening up new avenues for selling sugar in the USA, Great Britain, and other Latin American countries. However, the end of the Korean War in 1952 resulted in a resurgence of global oversupply. Peruvian producers, unable to gain access to protected high-price markets, were compelled to sell in free market areas, primarily Chile and, increasingly, Japan (Alberts, 1988). This structure underwent further change following the Cuban revolution of 1959, whereupon Cuba lost its USA quota, which was subsequently allocated among pro-US producers, including Peru.

Until the late 1950s, agriculture was a key sector of the Peruvian economy, and could be described as the sector leading growth (Escobal, 1993). Agriculture was an axis of accumulation for the economy in the context of the model of primary exports of agricultural products (cotton and sugar) and minerals. However, it is important to specify that it is coastal agriculture that fulfils this function. While Sierra agriculture continues to be a provider of food, it did not enjoy the same fortune and dynamism as coastal agriculture. Most of the food production for the domestic market was offered by the traditional sector in the Sierra. However, as the urban coastal population grew, commercial farmers from the Coast became specialised in basic food crops. Production conditions were not favourable in the Sierra, as Thorp and Bertram (1978: 274) conclude, "historically the traditional sector has grown slowly, being deprived of resources, discriminated against in policy measures and obliged to operate on the country's less-productive land resources".

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[9] APRA (Aprismo), Peruvian political party (Alianza Popular Revolucionaria Americana), founded in the 1920s by Víctor Raúl Haya de la Torre.

[10] An important observation is the profound dislocation effect of modernizing the sugar industry on the region's economic, political, and social fabric. This impact can be seen at two levels. Firstly, it resulted in the creation or exacerbation of regional disparities. Secondly, it brought about a profound transformation in the sugar-producing regions, accompanied by a certain level of political organization among affected sectors.
In the case of Peru, Klaren (1976) provides a similar analysis, noting that comparable patterns in the interplay between the modernization of the sugar industry, changes in traditional society, and radical political responses can be observed in other Latin American countries such as Mexico, Cuba, Argentina, and Brazil.

Romero (2006) presents a similar diagnosis when assessing the performance of agriculture in the Sierra during the early decades of the 20th century. The author concludes that the region remained neglected, devoid of agrarian promotion, technical support, or capital assistance. Consequently, the Sierra lagged behind in comparison to coastal agriculture. This line of inquiry is corroborated by Hopkins (1995) when analysing agrarian policy for the period 1950-1968, concluding that it is grounded in the principles of economic liberalism wherein the market plays a central role and the state minimises its interventions, focusing instead on supporting the development of export-oriented agriculture through large-scale irrigation projects on the Coast and colonization initiatives in the Amazon.

Resuming the changes occurring in the mid-20th century, the export-led model underwent transformation in the late 1950s. as in many other Latin American countries, with a turn toward models based on import-substitution industrialisation (ISI) (Bulmer-Thomas, 1994). The growth of agriculture then became dependent on the expansion of industry; it went from generating to demanding foreign currency, with food being imported to meet the growing domestic demand. The pace of growth of agricultural production for the internal market was not fast enough to meet the increased demand for food caused by population growth and rising incomes. This meant that Peru became a net importer of the food products that made up the urban diet (Rojas, 1993).

Table 2.5 presents the evolution of the food import dependency ratio for selected years within the period 1943-2015. It confirms the high dependency on imported wheat. In 1960, the country imported 70% of the wheat[11] it consumed, 10% of rice, and 22% of the dairy products. In 2015, the ratio attained 90% for wheat, and 61% for maize-sorghum.

[11] A discussion on the onset of wheat dependency in the 17th century is found in Sánchez (2015). The Lima elite took advantage of the consequences of the 1687 earthquake to cease wheat production. Instead, they began importing wheat from Chile, which became the capital's main supplier. In return, Chile purchased sugar from the Lima valleys. After the conclusion of the War of Independence in 1824, Chilean wheat began to be replaced by wheat flour from the USA.

Table 2.5. Food import dependency ratio in Peru 1943-2015 (percentage)

Product	1943	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2015
Maize-sorghum	n.a	5.9	3.1	0.4	52	28	27	43	57	41	51	61
Wheat	49	70	76	84	86	92	90	87	91	87	89	90
Barley	2	6	10	10	32	28	32	18	27	23	29	29
Rice	10	10	32	0	12	34	0	20	14	3	5	7
Beef*	2	4	6.3	8.7	3.6	3	4	4	5	2	2	2
Milk	3	22	22	35	41	31	21	25	35	25	10	17

Source: Data from 1943 to 1975 obtained from Lajo (1979). Since 1980, the ratio was computed using data from FAO, SUNAT, MIDAGRI, and INEI.
* From 1980 onwards, only fresh meat (excluding offal) is considered.
Note: Import dependence ratio (IDR) = [imports/(production + imports – exports)]*100
The Import Dependency Ratio (IDR) measures the percentage by which a country depends on imports of agricultural goods to meet its needs.

During the 1960s, there were major economic, political, and social changes in Peru. In economics, there was an attempt to reduce the vulnerability of growth driven by exports, by promoting industrialisation[12]. Although the economy's dependence on metal exports as the main source of growth remained substantial (its weight in the export structure went from 48.4% in 1970 to 40.2% in 1989), there was a transformation in the export structure. Agricultural products were overtaken by fuels and by manufactured products, and minerals continued to be the main source of foreign revenue.

In the ISI implementation scenario, from 1960 to 1975, the macro-economic policy to promote industrial growth created conditions that were hostile to agricultural development. Tax and price-control policies had a negative effect on the sector's profitability and growth. In this context of support for national industry, there were two main elements of agricultural policy during the military government of 1969-1979: implementing agrarian reform (promoting the creation of cooperatives) and guaranteeing the low cost of the food basket (Álvarez, 1983). According to Alberts (1983), agricultural policies were extremely biased in favour of urban consumers. Price-control policies and

[12] Concern over industrialisation is part of an old debate in the economic history of Peru. The subject arose in the political arena every time there was a crisis in the export sector. These periods can be identified in the 1880s, after the War of the Pacific; in the Great Depression; and in the Second World War.

the overvalued exchange rate discriminated against agricultural exports and incentivised food imports.

During the 1980s, alongside the return to democratic governance and the end of military rule, there occurred an agrarian counter-reform, characterized by the disappearance of collective forms of agricultural production and the expansion of small-scale farming. This coincided with the emergence of politically-motivated violence in rural areas, subsequently spreading to coastal cities, a situation that was eventually brought under control in the early 1990s. Two terrorist groups stood out during this period: *Sendero Luminoso* and *Movimiento Revolucionario Túpac Amaru.*

The macro-economic scenario was characterised by the effects of the external debt crisis and the application of orthodox policies, driving a change to a market-based strategy centred on privatisation and private investment, trade liberalisation, and the rerouting of state investments into economic infrastructure to support private enterprise. The orthodox programme failed due to difficulties and inconsistencies in its application, and to external factors (deterioration in the terms of trade, external credit being cut off, and adverse weather conditions caused by El Niño) (Wise and Pastor, 1992). Given this scenario, 1985 saw the rise to power of APRA, a political party that implemented a heterodox policy rooted in the Latin American structuralism tradition.

The APRA government diagnosed the agricultural problem as one of low profitability and implemented a set of measures to raise agricultural prices, lower costs, and increase productivity. Substantial injections of cash were used to subsidise loans and basic inputs, such as fertilisers and pesticides (Escobal, 1989). The results were positive until 1987, reflected in increased production. The main beneficiaries of this policy were the modern farms in the coastal and amazon regions.

The populist policies of the ARPA government under García, from 1985 to 1990, increased aggregate demand and imports, leading to a fiscal deficit in 1988/89 and a balance of payments crisis, which led in turn to hyperinflation and recession. In mid-1990, Fujimori launched a stabilisation programme in order to control inflation, with basic elements including restricting monetary variables, price adjustments, and public tariffs. Other measures included the elimination of subsidies, increased tax pressure, lower public expenditure, and free-floating exchange and interest rates. These measures were complemented by a set of structural reforms intended to manage resources efficiently through deregulation and market liberalisation, along with the reduction of the business role of the government through privatisations and the closure of state companies[13] (León, 1994).

The sectoral measures affecting the performance of agriculture were the elimination of subsidies and price controls on agricultural products and inputs, and free trade with the external market. In the case of imports, these measures took the form of variable import tariffs that, to some extent, provided protection from the subsidies of the main exporter countries and the overvaluing of the local currency against the dollar. [14]

On the financial market side, the interest rate was liberalised, and credit for the sector was reduced drastically when the *Banco Agrario* (Agricultural Bank, BAP) was liquidated. Alongside this, the main institutional measures were the liberalisation of the land and water markets and the end of the State monopoly on the purchase of agricultural inputs and products.

The Banco Agrario began reducing the cultivated hectares from the 1988/89 cropping season, when it helped finance 800,000 hectares, and the previous one where its coverage reached 1,200,000 hectares (Escobal, 1989). This situation was exacerbated by the disappearance of the *Banca de Fomento* (Development Bank) and increased interest rates. To identify the groups that were the most negatively affected by these measures, it is enough to remember that BAP funding tended to favour coastal products. For example, in the 1980-1988 period, funding for cotton was 22.6% of the total, and for rice, 32.2% of the allocated funds (Banco Agrario, annual reports) [15].

The 1990s were a period of far-reaching changes in the economic performance of agriculture (von Hesse, 2000; Escobal, 1999; Valcárcel, 2002). The implementation of the stabilisation programme and the State's structural reforms changed the institutional environment and the conditions of participation in market relationships for farmers. A key point, in the context of those reforms, was the explicit policy of encouraging investment in the sector by declaring the development of agro-industry to be in the national interest. The role of the State changed with this new approach; its functions were redefined and its participation in promoting and guiding economic development was limited. The State

[13] For a detailed analysis of the stabilisation policy and macroeconomic performance of agriculture, see León (1994) and Dancourt and Mendoza (1994).
[14] Dancourt and Mendoza (1994) discuss the implications and effectiveness of import tariffs on agricultural products.
[15] Despite these trends, it should be borne in mind that the BAP's coverage did not reach all farms, and this was most noticeable in small-scale agriculture. Data from the National Survey of Rural Households (Encuesta Nacional de Hogares Rurales; Portocarrero, 1987) show that in 1984, only 7.6% of farms had access to loans from the BAP. This information is crucial when considering the importance of alternative, informal sources of agricultural credit and the impact on interest rates.

assumed a regulatory and subsidiary role, and private enterprise became a fundamental driver of development (von Hesse, 2000; Eguren, 2003).

However, the bias favouring the promotion of export agriculture meant that small-scale agriculture and the peasant economy were excluded from the development agenda, unless they were able, with non-governmental support, to successfully insert themselves into the export agriculture production chain (Eguren, 2003)

According to Kay (1994), from a Latin American perspective, the link between agriculture and the world market was strengthened after the 1980s, with the change from an import-substitution strategy to a more export-oriented approach. This trend was consolidated with the introduction of structural adjustment programmes, as the expansion of export agriculture was prioritised as an alternative solution to the permanent shortage of foreign currency. Thus, as part of the economic globalisation process, transnational agricultural corporations and local investors became the predominant players on the Latin American scene. With the use of new technology enabling improvements in storage, agro-industrial processing, preservation, transport, communications, and industrial organisation, these companies achieved advantages in the production of fruit, vegetables, and flowers. Peru is no exception to this process. The structural reforms of the 1990s, particularly the policies promoting the development of agro-industry, created favourable conditions for non-traditional export agriculture to expand and consolidate[16]. The positive impact of measures favouring agro-industry can be seen in the levels of exports and employment in the productive regions.

Over the last 20 years, there have been significant changes in the mix of crops at the national level, explained by internal factors (higher income of the population, changes in consumption patterns, new regulations favouring investment in agriculture, greater openness to trade) and by external factors (a growing world population with higher incomes, and an increasing consumer preference for healthy and organic food). Crops for the internal market represent 45% of farmland, with an average annual growth rate of 3.7%. The proportion of farmland devoted to traditional Andean crops for regional

[16] This expansion of the agricultural export sector can be related to the trends identified in Latin America, as well as the ways capitalism can expand into agriculture, as described by de Janvry (1981), when considering commercial and contract farming as the predominant modes in the region. This subject has yet to be researched in the context of Peruvian agriculture. Some initial thoughts and hypotheses on this process can be found in Eguren (2003) and Valcárcel (2002).

and local markets fell by 3.9 percentage points in the 1990-2009 period. Industrial crops represented 16.1% of farmland and showed moderate growth in the 1990-2009 period (Velazco and Velazco, 2012).

Export-oriented crops represent the greatest dynamism in terms of farmland use. Coffee, cocoa, asparagus, mango, beans, plantain, grapes, artichoke, and paprika were the crops with the greatest expansion in farmland. The increase in farmland allocated to non-traditional crops for export is due to increased international demand; new laws favouring the sector such as the *Ley de Promoción del Sector Agrario* (Law of Promotion of the Agrarian Sector), which offer incentives for companies; optimal environmental conditions for cultivating these crops; the ability to supply goods while production is decreasing elsewhere in the world; the development of transport infrastructure that delivers products in better condition; and the implementation of Free Trade Agreements (FTAs) between Peru and the rest of the world, including FTAs with the United States, Thailand, Singapore, and China (PROINVERSIÓN, 2007). The output for export is not only provided by large companies - small, medium, and large farmers have all established individual arrangements for dealing with major corporations, and some companies are vertically integrated with their suppliers through contracts establishing their supervision of farming activities, financing, and conditions of sale (the quantity and quality of the product, prices, place of delivery, and penalties).

The expansion of agricultural frontiers based on irrigation in coastal areas creates the opportunity for greater growth of exportable production and employment, but this brings with it environmental problems and questions as to the sustainability of agricultural activity, as in the case of the exhaustion of groundwater in Ica, a situation which may threaten the availability of water for human consumption (RedGE, 2012).

Another problem to take into account, and which the 2007-2008 financial crisis made evident, was the heavy dependency of exports on the economic cycles of the importing countries. It is expected that the demand for fruit and vegetables among high-income segments of the population will not fall significantly when there are negative income shocks. Based on agricultural labour employment records and information on exports in 2009-2011, Gamero (2012) concludes that the loss of employment in Peru due to the impact of the 2007-2008 economic crisis is elastic in relation to exports. In other words, registered agricultural jobs fell more than exports. However, during the recovery phase, 2010-2011, employment appears to be inelastic to rising exports. This situation shows that employment is the adjustment variable when there are changes in the international market and reveals vulnerability and a lack of protection for wage labourers when adverse changes arise in external demand.

In the 1960s, more than half of the economically active population was engaged in agriculture, so access to land was an important factor in the performance of the Peruvian economy. Consequently, the following section will briefly discuss the main characteristics of the agrarian reform implemented in 1969, as well as its effects on the distribution of land and the agrarian structure.

2.4 1969 Agrarian reform and its impact on land ownership

The military government of General Velasco (1969-1975) implemented an extensive programme of agrarian reform in 1969[17]. The attempted reforms of earlier governments were limited in scope. An international context dominated by the Cold War and the Cuban revolution, and an internal front with a growing peasant movement in the 1950s and 1960s, put agrarian reform back on the government's agenda (de Janvry, 1994). The priority was the formation of agricultural cooperatives and associations: *Cooperativas Agrarias de Producción* (CAP), *Cooperativas Comunales*, *Sociedades Agrarias de Interés Social* (SAIS), and others (Bourque and Palmer, 1975). The main beneficiaries were wage labourers in the large *haciendas* that were in the process of being expropriated[18]. According to Alberts (Figueroa 1990:6, Alberts 1981), the bias can be explained by three factors. The first is political: by implementing this agrarian reform, the government expected to immediately dismantle the power of the Peruvian oligarchy,

[17] The diagnosis of the military government on the agrarian problem, associating it with the presence of latifundia and servile relationships, is related to Mariátegui's approach (1928) when he highlighted that the problem of the indigenous people was land and latifundia. José Carlos Mariátegui was a self-taught intellectual and founder in 1928 of the Peruvian Socialist Party, one of the first leftist parties in Peru. In contrast to the diagnosis of political elites associating the indigenous problem with education, religion, and culture; Mariátegui identified the agrarian problem in Peru as the problem of the indigenous people and their access to land and relationship with latifundia. Mariátgui pointed out: "There are two expressions of feudalism that survive: the latifundium and servitude. Inseparable and of the same substance, their analysis leads us to the conclusion that the servitude oppressing the indigenous race cannot be abolished unless the latifundium is abolished". In this regard, it is important to note that the indigenous people are associated with peasants. This identity will be key when discussing, in chapter 6, the topic of the relationship between the indigenous population, primarily agricultural producers for the domestic market, and the State.

[18] The agrarian reform was executed mainly on the coast and in the highlands, the two regions with greater rural population and greater areas of agricultural use. Between June 1969 and June 1979, 15,826 properties and more than 9 million hectares were expropriated. Most of this area was transferred to 370,000 beneficiaries (Eguren, 2006).

and the expropriation of these *haciendas*, and transferring them to the wage labourers who worked on them, was an effective way to do so. The second factor is connected to the motto "*la tierra es para quien la trabaja*" – "the land to the tiller" – based on the exploitative nature of the worker-owner relationship and making the point that exorbitant rents were being extracted from the peasants (Alberts, 1983). The third and last factor relates to administrative convenience: it was easier to strip power from the large landowners by handing their land directly to the wage labourers, and reorganising the rural population's access to the land later.

From the economic point of view, the Agrarian Reform was considered a measure for developing the internal market and supporting the industrialisation process. Thus, it was assumed that eliminating the former oligarchy would allow the peasants to integrate more fully in the national economy, and the surpluses generated in the modern agricultural sector could be funnelled into industrial investment and expansion (Valderrama, 1976).

Peru's agrarian problem in the 1950s and 1960s was defined by highly-concentrated land ownership. The agrarian reform implemented in 1969, characterised by changes in ownership structure, did not significantly alter the original agricultural structure. The haciendas were transformed into agricultural cooperatives and SAIS, with that becoming the dominant form of organisation in Peruvian agriculture until they were gradually dissolved in the 1980s. Only a small part of the expropriated land was directly allocated to private family farms (Kay, 2002). This is confirmed when we compare the agricultural censuses for 1961 and 1972. In 1961, small farms - under 5 hectares - comprised 83.2% of the total number of farms, corresponding to 5.7% of the land. In 1972, farms under 5 hectares comprised 78% of agricultural units, but were only 6.6% of the land. Mid-sized farms - 20 to 100 hectares - now had a larger share than before. This sector represented 2.9% of agricultural farm units and owned 5.3% of all farmland in 1961. After the agrarian reform, this group constituted 6.3% of all farms and held 11.7% of the land (INEI, 2009).

In the 1980s, the organisation and functions of the CAPs and SAIS collapsed, due to problems in their administration and their internal management, while their members were working less and production costs were rising, making the companies economically unviable[19]. The coastal CAPs, except for the sugar-producing cooperatives, decided to dissolve the companies and distribute the land among their members. In the highlands, most lands owned by SAIS associations were taken over by peasant communities (Burneo, 2011). As a result of this process, which was accelerated by land transfers through inheritance, farmland was fragmented and smallholdings became the most numerous group. Farmers were more interested in concentrating their efforts on their own land and pressed for the recognition of their individual deeds of ownership (Binswanger-Mkhize et al., 2009).

Table 2.6, based on the farming censuses of 1961, 1972, 1994, and 2012, shows the distribution of farms by number and size (hectares). At the national level, in 1961 farms under 5 hectares represented 83% of all farms but had access to only 5.7% of farmland. The results of the 2012 census confirm the predominance of very small farms, which nevertheless represent a tiny proportion of farmland. The first phase of the agrarian reform produced a small reduction in the concentration of land, with the Gini coefficient passing from 0.94 in 1961 to 0.88 in 1972. In 1994, the coefficient reached 0.5 because of the land distribution process (Zegarra, 1999). Estimates seem to indicate a pattern of greater equality in land distribution (Velazco, 2001). From 1961 to 1994, we can also see declining numbers of large farms and the growth of mid-sized holdings (INEI, 2013). However, when comparing the results of the 2012 farm census, processes of fragmentation and concentration of land are identified. The first process leads to the predominance of small-scale units, while the second refers to the fact that land has been acquired by a few agents (either for productive or speculative purposes). A more dynamic land market has enhanced land transactions.

Since the 1990s, the central government, in coordination with certain sub-national governments, has promoted and financed irrigation projects on the Coast. These new lands were auctioned off and transferred to economic groups specializing in export agriculture (Escobedo, 2015). The regional analysis of the land concentration based on the Gini coefficient for the 2012 census allows us to distinguish a more pronounced

[19] Mejía (1982) provides some examples of the problems faced by these companies. A study carried out in 1977 by a High-Level Commission of the Ministry of Agriculture clearly revealed this fact. Of 1,388 existing companies at that time, 955 (68%) had no manager and 659 (47%) lacked accounting. At the same time, the problems of lack of human resources were classified as serious in 1,088 cases (78%); lack of training in 941 cases (68%); and lack of business organization in 633 cases (48%).

dynamic on the Coast than in the Sierra and Amazon. Therefore, the Gini is 0.75 for the Coast, 0.68 for the Sierra, and 0.53 for the Am*azon* (Bourliaud and Eresue, 2015).

Table 2.6. Peru: Number and Size of Farming Units according to 1961, 1972, 1994 and 2012 Farming Surveys

	1961		1972		1994		2012	
	Number of farms (%)	Size (area) (%)	Number of farms (%)	Size (area) (%)	Number of farms (%)	Size (area) (%)	Number of farms (%)	Size (area) (%)
Under 1 Ha.	34.1	0.7	34.7	0.8	24.2	0.5	37.6	0.8
1 - 5 Ha.	49.1	5.0	43.2	5.8	46.1	5.3	41.7	5.1
5 - 20 Ha.	12.6	4.7	16.7	8.7	22.2	9.6	15.2	7.6
20 - 100 Ha.	2.9	5.3	4.3	9.3	6.3	11.7	4.5	9.5
100 - 500 Ha.	0.9	8.7	0.8	9.1	1.1	10.4	0.8	8.4
500 - 1000 Ha.	0.2	5.7	0.1	4.6	0.1	5.0	0.1	4.3
1000 - 2500 Ha.	0.1	8.9	0.1	7.4	0.1	8.4	0.1	7.3
Over 2500 Ha.	0.1	61.0	0.1	54.3	0.1	49.1	0.1	57.0
Total (%)	100	100	100	100	100	100	100	100
Total (absolute value)	851.957	18,604,500	1,390,877	23,545,147	1,745,773	35,381,808	2,213,506	38,742,465

Source: 1st, 2nd, 3rd and 4th National Farming Survey, 1961, 1972, 1994 and 2012 (INEI).

Returning to the discussion of the agriculture output performance, the next section deals with the trend in agricultural production.

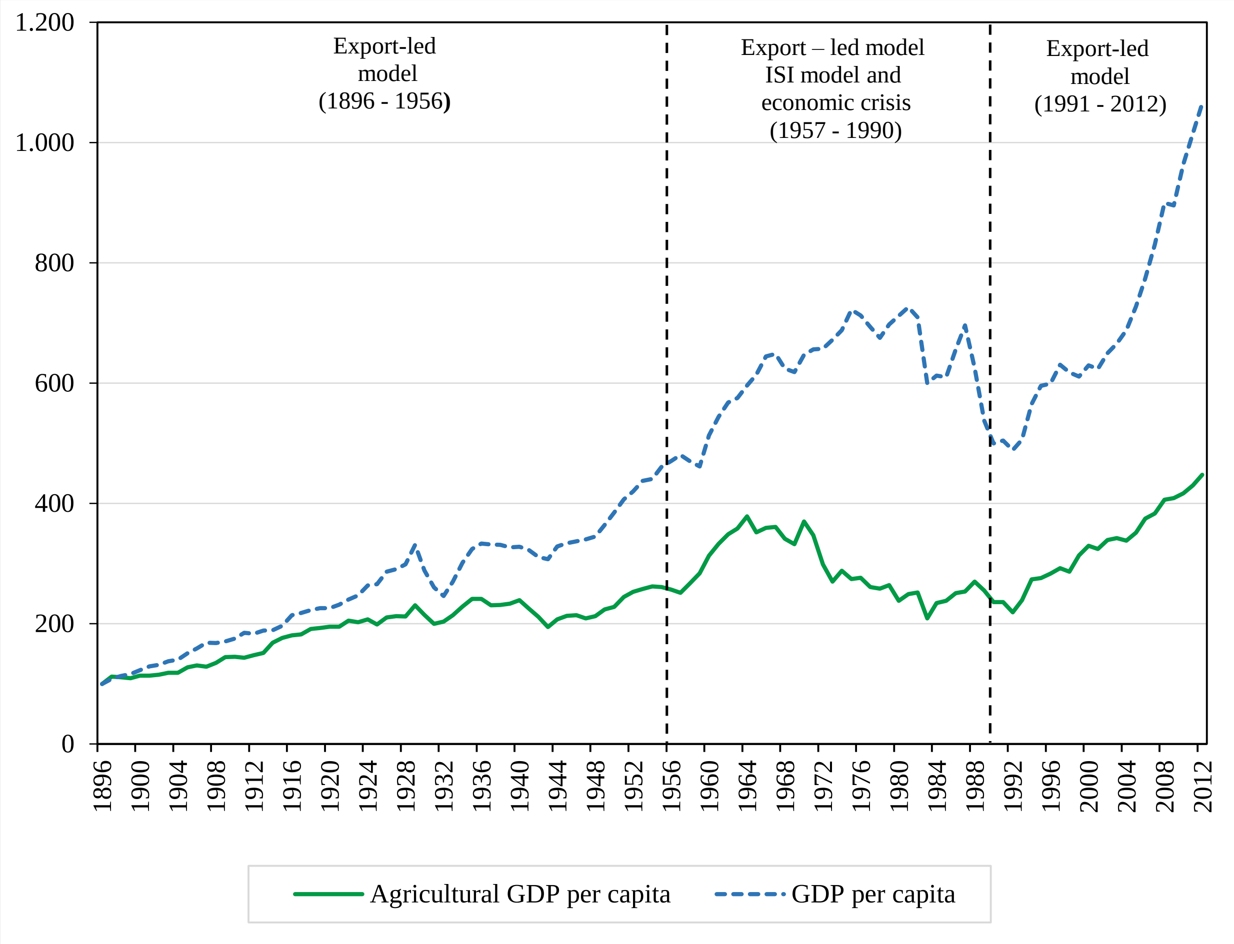
2.5. Trends in agricultural production

2.5.1 Comparison of total GDP and Agricultural GDP

To conduct the comparison, three stages are considered: a) the export-led model (1896–1956), b) The second period spans from 1957-1990 and encompasses the export-led model, as well as the initial phase of import substitution industrialization (ISI) and episodes of almost recurrent economic crises since 1975, culminating in the hyperinflation of the late 1980s, and c) the export-led model initiated under the framework of macroeconomic adjustment policies and structural reforms in the early 1990s, which has been in effect since then.

Figure 2.5 depicts the evolution of GDP per capita and agricultural GDP per capita. In the initial period, although both indices follow a similar trend, a greater divergence is identified from the mid-1920s onwards, with GDP per capita being higher, and this situation characterizes the subsequent periods. Agricultural GDP per capita shows irregular growth until the 1950s, then it increases until the mid-1960s, followed by a declining trend that lasts approximately 30 years. It is at the beginning of the 1990s that the downward trend reverses, marking a turning point until the end of the period. The intermediate stage is considered a period of crisis in Peruvian agriculture, defined in terms of agricultural output growing more slowly than domestic demand (Escobal, 1993). On the other hand, GDP per capita grows, except for the period of the Great Depression, until the mid-1970s, then it declines in the contexts of successive economic crises, and the trend changes at the beginning of the 1990s. GDP also clearly indicates Peru's unfavourable economic situation in the intermediate period, when it was unable to recover the 1977 level of GDP per capita until 2005.

Figure 2.5. Evolution of GDP per capita and agricultural GDP per capita, 1896 - 2012 (at constant 1979 US dollar, index number 100=1896)



Source: Author elaboration based on estimations by Seminario (2015).

2.5.2 Evolution according to destination markets

When we analyse the growth in agricultural production (Table 2.7), it is observed that the periods of greatest growth are at the beginning and end of the study period: 1950-70 and 1991-2007. Fast growth coincides with the end of the export agriculture era around 1960 and the first decade of the ISI, and again when the model changed to greater liberalisation and opening up to outside trade in 1991, and the subsequent economic expansion. The most critical period coincides with the economic crisis of the 1970s and the "lost decade" of Latin America in the 1980s.

Table 2.7. Annual average growth rates of agricultural production by destination markets (at constant US 1979 dollars)

Periods	Agricultural GDP			% External Market in Agricultural GDP
	Total	Domestic market	External Market	
1896 – 1899	4.4	3.6	8.1	19
1900 – 1910	3.6	3.0	6.0	22
1911 – 1920	4.2	3.0	7.3	29
1921 – 1930	2.7	1.8	4.5	34
1931 – 1940	3.0	3.2	2.7	37
1941 – 1950	1.5	2.3	-0.6	31
1951 – 1960	5.9	3.2	7.7	33
1961 – 1970	5.1	4.9	0.3	26
1971 – 1980	-1.5	0.2	0.4	25
1981 – 1990	2.5	2.9	0.5	22
1991 – 2000	5.4	6.8	2.6	14
2001 – 2012	3.9	4.5	2.9	13

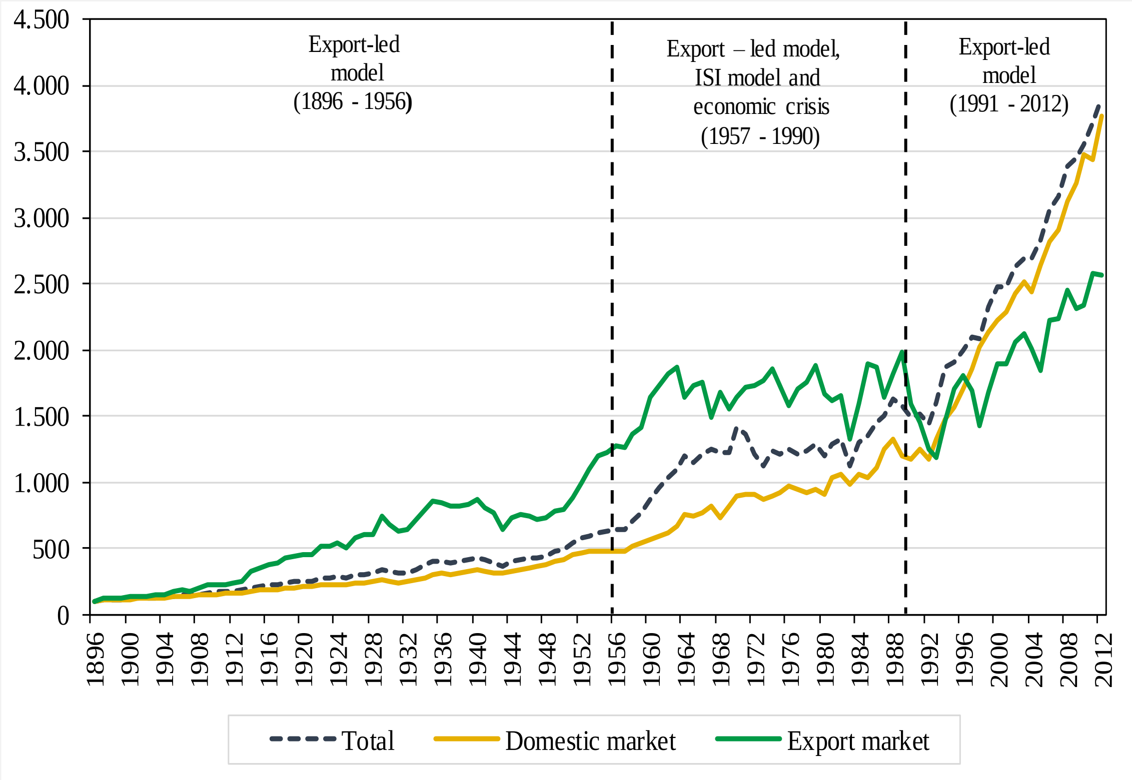
Source: Author elaboration based on estimations by Seminario (2015). The original data are expressed in 1979 US dollars.

The breakdown of agricultural production by destination market, whether domestic or export, and the share of exports in total production, also show which market has been the main driver of growth in agricultural GDP. The strong growth of the first two decades was based on the external market in the 1950s (when the export agriculture model was still current) and on the internal market in the 1960s, after the switch to ISI. This change in policy had a notable effect on agricultural exports, which were much less dynamic from 1961 and 1991, due to the reduced profitability of the sector, lower levels of investment, and a decline in the terms of trade[20]. Also, ecological limits appear on the exploitation of raw materials such as sugar and cotton (Rojas, 1993).

The return to rapid growth of agricultural GDP from 1991 rested equally on the external and internal markets, although exports had a much lower weight in the total agricultural GDP than at the end of the export agriculture period.

[20] Regarding the terms of term (ratio of export prices to import prices), a correlation coefficient between the terms of trade and an openness trade ratio (agricultural exports to agricultural GDP) for the period 1950-2010 is 0.61, suggesting a significant and positive relationship.

Figure 2.6. Evolution of Agricultural GDP by Destination Markets: Domestic and Export, 1896 - 2012 (at constant 1979 US dollar, index number 100=1896)



Source: Author elaboration based on estimations by Seminario (2015).

Identified trends at aggregate level and by market destinations raise the question of performance across regions. Table 2.8 illustrates the progression of the gross agricultural value (GAV) according to destination markets in 1964 and 1985. In 1964, 54% of the GAV was produced in the Coast, 34% in the Sierra, and 12% in the Amazon. By 1985, the Amazon's share had doubled, reaching 25%. Both the Sierra and Coast saw declines to 29% and 46%, respectively. Concerning destination markets, the Coast dominated exports and the food industry in 1964.

Two decades later, the Amazon region exhibited a significant increase in its share across export, urban, and food industry markets. Collectively, alongside the Coast region, it emerged as a principal contributor to these markets, while the Sierra region maintained its pivotal role as the primary food supplier for the local market. Hopkins (1981) approximated that the local market contributed 48.5% of the GAV during the period spanning from 1948 to 1952. However, this share dwindled to 27% by 1976, signifying a decline in the significance of peasants as food providers. Significantly, the potato, a fundamental crop produced by peasants, began to be primarily sourced from the Coastal region (Maletta, 1980).

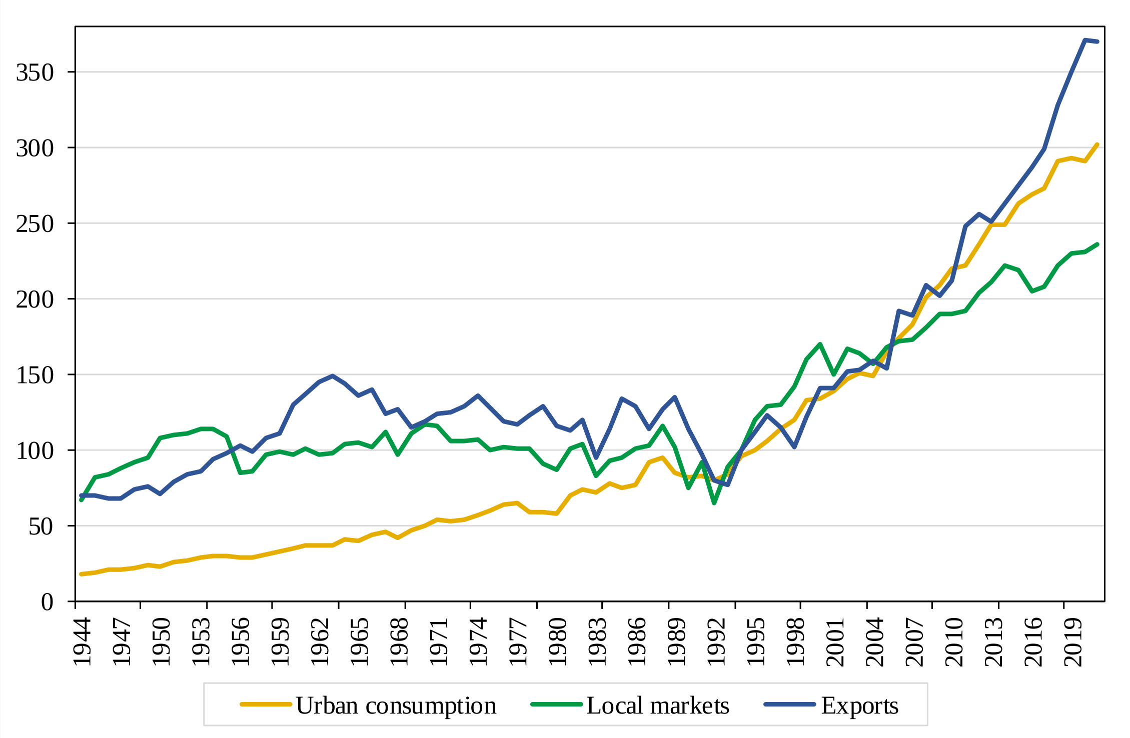
Table 2.8. Peru, Gross Agricultural Value by Destination Markets and Regions in 1964 and 1985 (Millions of 1960 Soles and in percentage)

Destination Markets (Soles)	Coast		Sierra		Amazon	
	1964	1985	1964	1985	1964	1985
Export	2,419.4	475.5	53.5	20.4	521.1	646.3
Urban	744.6	1,191.6	22.4	68.8	151	758.2
Food industry	1,191.2	2,579.8	12.4	15.3	116.1	806.5
Local consumption	89.8	35.4	2,671.8	2610.6	204.6	128.3
Total	4,434	4,282.3	2760.1	2715.1	992.8	2,339.3
Destination Markets (%)	**Coast**		**Sierra**		**Amazon**	
	1964	**1985**	**1964**	**1985**	**1964**	**1985**
Export	54	11	2	1	52	28
Urban	17	28	1	3	15	32
Food industry	27	60	0	1	12	34
Local market	2	1	97	96	21	5
Total	100	100	100	100	100	100

Source: Webb and Lamas (1987: 77)

In light of the preceding analysis, Figure 2.7 illustrates the trend of agricultural product quantity indices classified according to the reviewed destination markets in the preceding table. The distinction lies in considering export, urban (encompassing the food industry), and local market indices. These indices cover the period from 1944 to 2021. Concerning urban consumption, the trend shows growth from the onset of the period, with a decline in the late 1980s attributed to economic crises and the impacts of climatic phenomena such as El Niño. Growth, at an accelerated pace, resumed in the 1990s. Conversely, the local market quantity index demonstrates a relative stagnation from the mid-1950s to the late 1990s. This period coincided with the implementation of agrarian reform, which did not significantly affect production in this agricultural market. Additionally, in the 1980s, the terrorist actions of *Sendero Luminoso* commenced, primarily concentrated in Sierra *departmentos*, resulting in the loss of lives among peasants, destruction of capital stock and livestock, and triggering forced migration to nearby or distant locations from the affected departments (Velazco, 2014). However, this situation began to reverse with the cessation of terrorist activities and the onset of economic recovery from the 1990s onwards. The growth trend indicates a notable turning point, suggesting that after several decades of stagnation, this production increasingly meets the demands of the domestic market. Lastly, the index of production destined for the external market grew until the early 1960s, followed by a period of crisis extending into the early 1990s. Undoubtedly, this decade marked a radical shift in the performance of agricultural products for all three market types. This theme, scrutinised from a microeconomic perspective of agricultural units geared towards export and the domestic market, will be examined in further detail in Chapter 5.

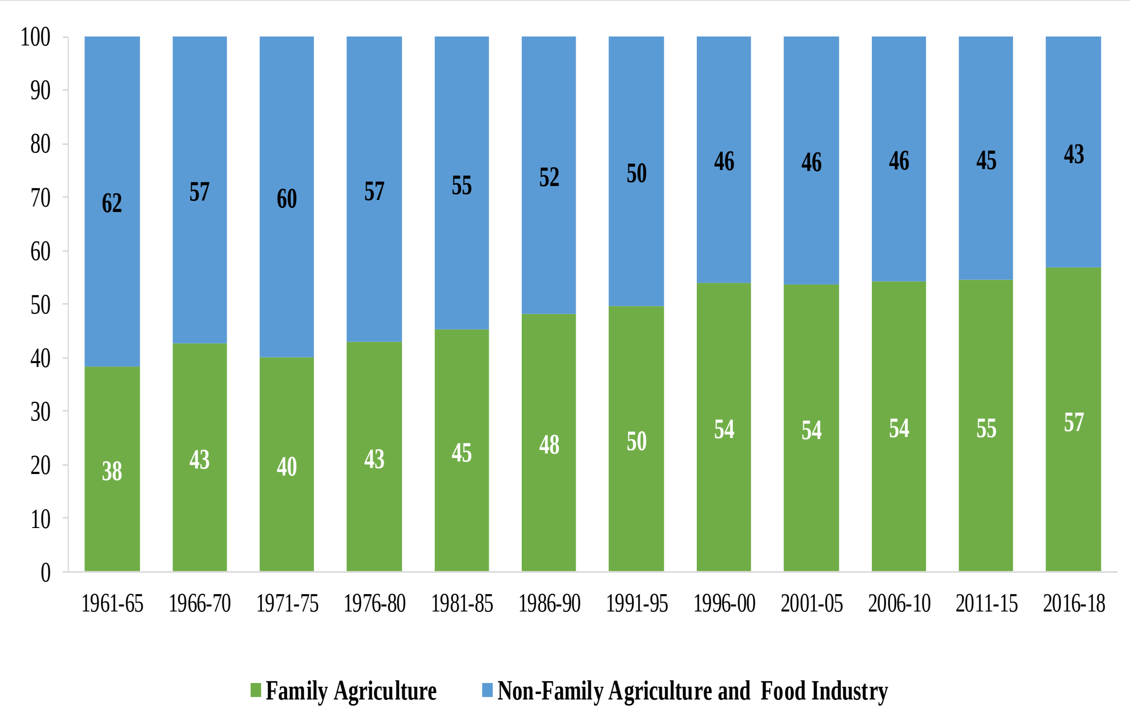
Figure 2.7. Quantity index of food production by market orientation 1944-2021 (1994=100)



Note: Quantity index was estimated using the Fisher index (values in current soles). The estimation represents a revision of the research conducted by Hopkins (1995). Main products are considered based on market orientation. For the period 1991-2021, new products have been added, particularly those that have gained importance in exports such as avocado, grape, mango, among others.
Source: Alvarez, Velazco and Pintado (2023) based on data from FAOSTAT, INEI, and MIDAGRI.

Pintado (2022) classifies family farming as agricultural units of less than 10 hectares standardized. The author finds that family farming in 2018 is responsible for producing approximately 57% of the national food supply. Although part of the supply is also sourced from imports of wheat, dairy, beef, and oil, Pintado's data shows that before the agrarian reform, it was medium and large-scale agriculture that produced the bulk of the food supply in the country. In a long-term perspective, considering the period 1961-2018, their estimations show that the proportion of the food supply in Peru produced by family agriculture has been increasing (Alvarez, et. al., 2023). For instance, this participation was 36% in 1961, 45% in 1970, 46% in 1980, 47% in 1990, 56% in 2000, and 57% in 2018, as shown in Figure 2.8.

Figure 2.8. Evolution of Family farming participation in the total Food Supply, 1961-2018



Source: Alvarez, Velazco and Pintado (2023), based on estimations from Pintado (2022). The original information is in metric tonnes. The source is FAOSTAT

2.5.3 Trends in use of land and performance of selected crops

This section illustrates trends in the number of agricultural holdings and land use, drawing information from agricultural censuses. Additionally, the evolution of selected crops is presented.

Table 2.9 depicts the evolution of the number of agricultural holdings between the censuses of 1961 and 2012. During this period, the number of holdings multiplied by 2.5. Geographically, around 80% were located in the Sierra, followed by the Coast and the Jungle. In the 2012 census, the Sierra continued to concentrate the majority of holdings at 64%, while the Amazon surpassed the Coast, accounting for 20% of the holdings.

Table 2.9. Distribution of Agricultural Holdings by Natural Regions, 1961 and 2012

	Coast	**Sierra**	**Amazon**	**Total**
1961 – In numbers	94,369	694,518	81,058	869,945
In percentage	11%	80%	9%	100%
2012 – In numbers	357,561	1,444,530	458,882	2,260,973
In percentage	16%	64%	20%	100%

Source: The information for 2012 is from the agricultural census of the same year, conducted by INEI (2013). Data for 1961 were estimated by the author as only information on the distribution of agricultural units by provinces was available. Using INEI's information on the classification of provinces into natural regions (Coast, Sierra, and Amazon), it was possible to generate the data for 1961.

Table 2.10 provides information on the hectares allocated to agricultural land, crop land, the number of holdings, and the average size of agricultural holdings across the agricultural censuses of 1961, 1972, 1994, and 2012. The land classified as agricultural land increases by 119% between census periods, while crop land hectares increase by 83%. The number of holdings rises by 257%. With these trends, the average size per holding, based on crop land as a trend, decreases.

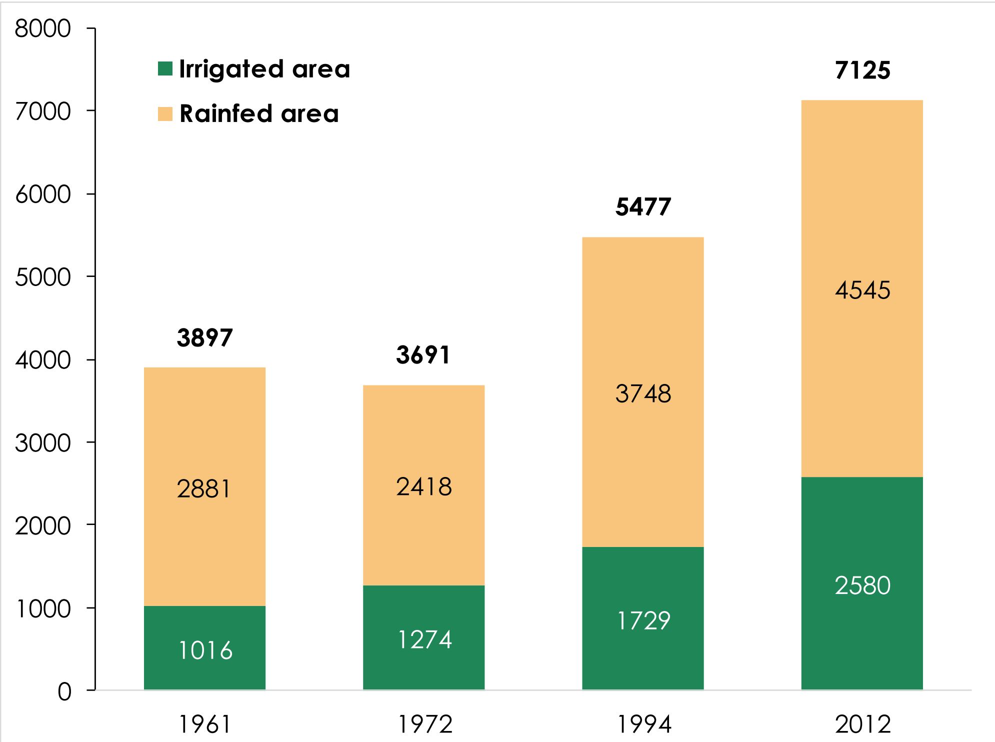
Table 2.10. Area (in thousands of hectares) of holdings classified by land use groups

	1961	**1972**	**1994**	**2012**
Agricultural land	17,722	23,545	35,382	38,742
Crop land	3,897	3,691	5,477	7,125
Number of holdings	879,432	1,390,877	1,764,667	2,260,973
Average size of agricultural holdings (Ha)*	4.43	2.65	3.10	3.15

Source: Own elaboration based on INEI – Agricultural censuses of 1961, 1972, 1994 and 2012.
*Average size based on use of crop land.

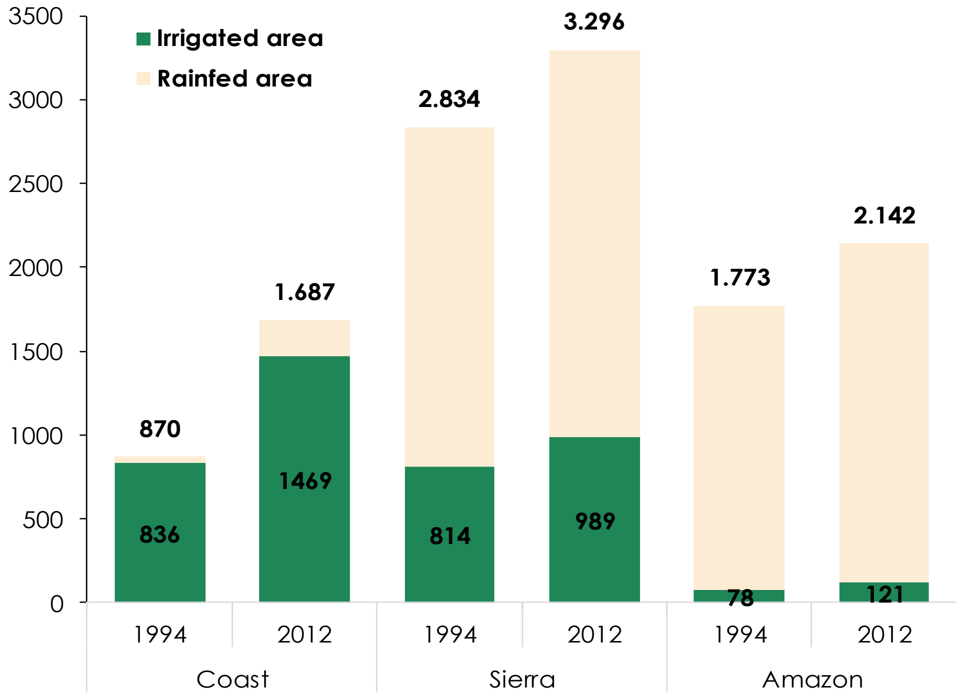
Figure 2.9 illustrates the distribution of crop land based on whether the area is irrigated or rainfed. A gradual increase in irrigated area is observed, reaching 26% in 1961, 35% in 1972, 32% in 1994, and 36% in 2012. Figure 2.10 provides regional-level information for the years 1994 and 2012. Notably, the Coastal region exhibits the highest percentage of irrigated land, at 95% in 1994 and 87% in 2012. In the case of the Sierra, the shares are 29% and 30% for the respective years, while in the Amazon, they are 4.5% and 6%.

Figure 2.9. Crop land according to irrigation (in thousands of hectares)



Source: Own elaboration based on INEI – Agricultural censuses of 1961, 1972, 1994 and 2012.

Figure 2.10 Crop land according to irrigation and natural region (in thousands of hectares)



Source: Own elaboration based on INEI – Agricultural censuses of 1961, 1972, 1994 and 2012.

Table 2.11 shows production, surface and yields of selected crops, including exportable goods such as cotton, sugar and asparagus, imported items such as rice and yellow flint maize and non-tradable crops such as potato and soft maize, which are both mainly produced on family farming in the Sierra region.

Traditional export products such as sugar and cotton exhibit a certain decline when compared to the dynamism of one of the shining stars of the new agro-export boom, such as asparagus. Remarkable growth rates in production, area cultivated, and yield are evident in the latter. This situation contrasts with a declining cotton production, with both production and cultivated area showing downward trends over periods. In the case of sugar, a lower yield per period stands out, contrasting with its emergence as one of the most modern sectors of Peruvian agriculture since the late 19th century.

As for products competing with imports, like rice and yellow flint maize, they demonstrate good performance, particularly in annual production growth rates.

Potatoes and soft maize, non-tradable products primarily cultivated in the Sierra region, though potatoes are also grown in the Coast, exhibited the poorest productivity performance during the 1970-1990 period, a trend identified earlier in the aggregated analysis of agricultural production. However, this trend reversed in the subsequent period, 1991-2012. This outcome coincides with the inflection point found in previous sections. It indicates a positive response from these sectors linked to supplying local markets, particularly from the production offered by the peasant economy of the Sierra, as well as regional markets (coming from both commercial agricultures in the Coast and Sierra).

Table 2.11. Production, surface and yields of selected crops between 1950 and 2020 (surface in 1,000 hectares; production in 1,000 metric tons; yield in kg/hectare)

	1950 - 1969		1970 - 1990		1991 - 2020		1950 - 2020	
	Annual average value	**Annual average growth rates**	**Annual average value**	**Annual average growth rates**	**Annual average value**	**Annual average growth rates**	**Annual average value**	**Annual average growth rates**
Rice								
Production	298	11.2	728	6.5	2,282	5.2	1,263	7.2
Surface	75	6.7	159	4.3	325	3.3	205	4.5
Yield	3,948	3.1	4,494	1.4	6,809	1.6	5,318	2.0
Potato								
Production	1,362	2.3	1,670	-1.3	3,430	6.3	2,327	2.9
Surface	242	1.7	231	-2.9	268	3.4	250	1.0
Yield	5,608	0.5	7,365	1.4	12,370	2.6	8,985	1.7
Sugar								
Production	6,463	3.3	7,257	0.2	8,166	2.5	7,417	2.0
Surface	42	2.3	50	0.6	69	2.3	56	1.8
Yield	152,044	1.2	144,980	-0.4	116,130	0.3	134,780	0.3
Cotton								
Production	309	2.0	236	4.1	127	-0.7	210	1.5
Surface	213	1.5	133	1.3	65	-3.8	127	-0.8
Yield	1,449	0.7	1,768	2.2	2,171	2.3	1,849	1.8
Yellow Flint maize								
Production	288	8.5	479	2.8	1,000	4	704	4.1
Surface	121	6.2	174	1.8	249	1	203	2.3
Yield	2,340	2.2	2,738	0.6	3,917	2	3,253	1.5
Soft Maize								
Production	167	2.7	214	-0.7	255	3.9	220	2.2
Surface	177	2.7	209	-1.4	201	1.5	197	0.9
Yield	944	-0.1	1,025	0.3	1,262	1.8	1,107	0.9
Asparagus								
Production	5	-8.4	12	18.4	248	7.0	140	10.6
Surface	1	-7.3	3	13.7	24	5.1	14	7.8
Yield	4,420	-1.8	4,943	4.7	9,798	2.7	7,553	3.2

Note: Data for asparagus is available from 1966 onwards, yellow flint maize from 1960 onwards, and soft maize from 1952 onwards.
Source: Own elaboration using data from INEI and MIDAGRI.

2.6. Conclusions

This chapter, based on gathering and analysing secondary sources, examines the performance of the agricultural sector for the period 1824-2012. Additionally, it discusses the consequences of diverse growth models and agrarian policies for Peruvian agricultural production from 1896 to 2012.

A long-term perspective, spanning from 1896 to 2012, of total GDP per capita and agricultural GDP per capita enables us to compare the growth dynamics of overall and sectoral output in relation to the demand component of population growth. Considering Peru's historical growth patterns over the long term, it becomes apparent that the latest accelerated GDP growth is, in essence, a return to the growth trends of past decades. A prolonged period has been identified during which agricultural production remained stagnant, trailing behind population growth. However, this trend shifted in the early 1990s, and since then, agriculture has experienced steady growth. And this trend becomes evident when analysing agricultural production indices according to destination market (urban consumption, local, and external); a turning point is identified for all markets at the beginning of the 1990s.

Throughout its history, Peru, as a small open economy, has undergone cycles of crisis and recovery, typically associated with fluctuations in the international market. The Peruvian economy has consistently been an exporter of primary products and an importer of manufactured goods (Thorp and Bertram, 1978). Development strategy models have varied from primary export diversification to import-substitution industrialisation, and currently, to the promotion of non-traditional exports. These strategies have shaped the outcome for agriculture. The sector served as a focal point of accumulation for the economy within the framework of the primary export model of agricultural products (cotton and sugar) and minerals. This dynamic changed significantly in the late 1950s with the promotion of import-substitution industrialisation (ISI). This marked a pivotal moment when agricultural growth became reliant on industrial expansion.

Efforts to implement ISI did not achieve their objectives, and the industry continued to depend on imported inputs and capital goods. The onset of the economic crisis in 1975 marked the end of this industrialisation experiment, prompting a return to the export-led growth model. After stabilising the economy and overcoming the hyperinflationary and recessive process of the late 1980s, a radical shift began. The state-led development embodied by the military regime of 1968-1980 gave way, once again, to a market-led development, with the external sector gaining importance in state policy priorities. It is within this context that the new agro-export model centred on non-traditional products such as vegetables and fruits began to take shape in the 1990s. In this new stage, the coastal region regained hegemony as in previous versions of the export-led growth model.

Regarding agricultural policy, the evidence presented has demonstrated that, since the formative stage of the Republic, agriculture was not a priority of the nascent state. Continuous internal conflicts, rebellions, and coups did not foster the appropriate context for defining and implementing policies aimed at economic growth. The exploitation of guano from the islands (*guano de las islas*) and its transformation into the main export product in the 19th century generated income for sugarcane producers to initiate investments and respond to the demand of the global market. Furthermore, agricultural policy was geared towards addressing the pressing issues of coastal agriculture: the lack of workers, capital, and water. This stance of the Peruvian state, its emphasis on export-oriented agriculture, has been a consistent state strategy that persists to this day. In doing so, it has inadequately addressed the growth needs of agriculture destined for the domestic market, predominantly located in the Sierra, during the 19th century, and has expanded its involvement to the Coast and Amazon since the 20th century.

The forthcoming chapter will examine the interconnections between the agricultural sector and other sectors of the economy spanning the period from 1896 to 2012. Additionally, it will discuss to what extent exports, categorized into agricultural and non-agricultural sectors, have impacted Peru's economic growth.

CHAPTER 3

IDENTIFYING THE ROLES OF AGRICULTURE IN THE ECONOMIC GROWTH PROCESS: THE PERUVIAN CASE FOR THE PERIOD 1896-2012

3.1 Introduction

This chapter aims to address, from a long-term perspective, the question of the role of agriculture in Peru's growth process for the period 1896-2012. To achieve this, two analyses will be conducted. The first aims to identify the relationship between agricultural GDP, industrial GDP, mining GDP, and other sectors, including services and energy. It is assumed that these sectors represent the state of urban development, and it is of interest to understand their level of interaction with agriculture.

The second analysis aims to empirically verify the export-led growth (ELG) hypothesis and the import-led growth hypothesis (ILG). To do so, exports are classified into agricultural and non-agricultural categories, allowing for an assessment of whether a positive relationship exists in the long term between GDP and agricultural exports.

This chapter is structured as follows. The second section describes some long-term characteristics of the Peruvian economy. The third section develops the relevant theoretical framework for each analysis to be conducted. The fourth section explains the empirical model to be applied. The fifth section is dedicated to the long-term analysis of economic sectors such as agriculture, mining, industry, and other sectors (services and energy). The sixth section presents the results of the analysis related to the testing of the export-led growth and import-led growth hypotheses. The seventh section discusses, collectively, the findings of both empirical approaches and attempts to interpret them in light of the information provided by Peruvian historiography. The final section presents the conclusions.

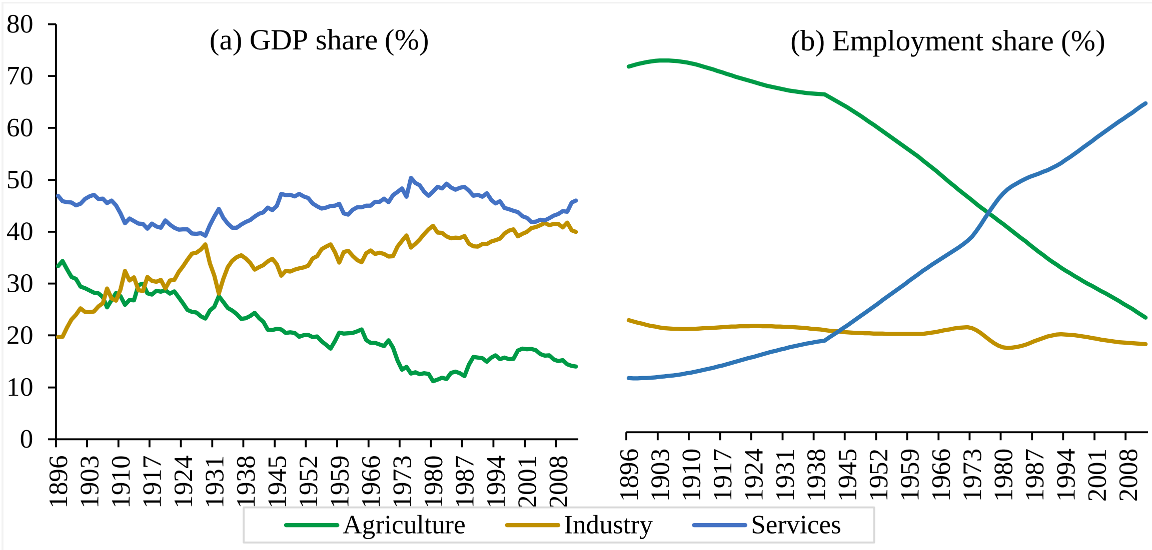
3.2. Stylised Facts of the Peruvian Economy

This section discusses the long-term trends of the variables that will be the subject of study, namely GDP and its components, as well as international trade variables such as exports and imports.

3.2.1 Sectoral Evolution of GDP

Figure 3.1 illustrates, in the left panel, the evolution, spanning the period 1896-2012, of the sectoral composition of GDP grouped into three sectors: agriculture, industry (encompassing manufacturing and mining), and services. A decreasing trend in agriculture, a growing trend in industry, and a certain stability in the services sector are observed. In the right panel, the evolution of employment participation is depicted. The trends are highly pronounced regarding the decline in the participation of the agricultural workforce in the total, compensated by an increase in the services sector, which has been the primary employer since the 1980s, with the employment participation in the industrial sector remaining largely unchanged. These graphs facilitate the observation of the transition from an agrarian economy to a service-oriented one, in terms of employment, over the study period.

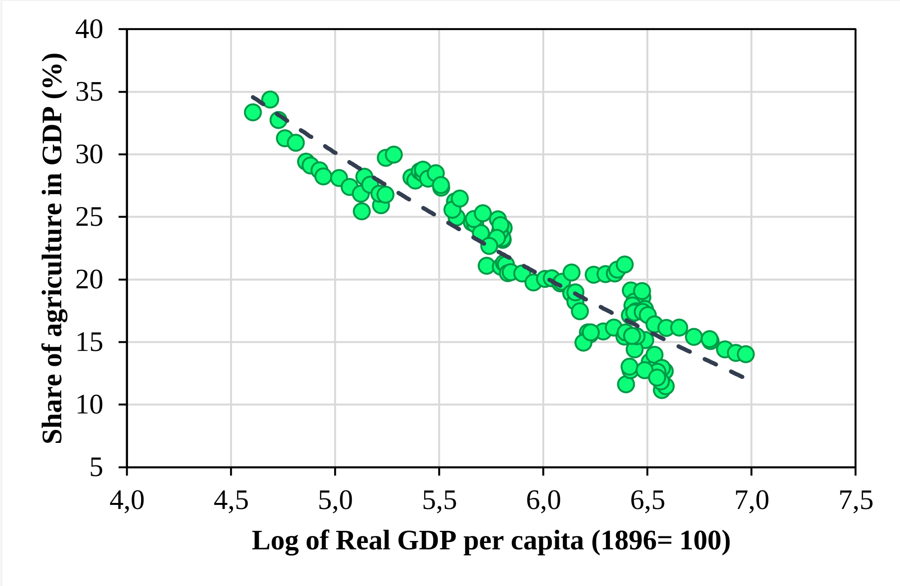
Figure 3.1. Sectoral composition of GDP and employment, 1896-2012



Source: Author elaboration based on estimations by Seminario (2015). The original data are expressed in 1979 US dollars.
Note: Within the category of industry, manufacturing and mining are considered.

Figure 3.2 depicts the evolution of agriculture's contribution to the total GDP as per capita income increases, serving as an indicator of economic growth. Over the study period, a declining trend is observed, a behavior anticipated during the transition from an agrarian economy to an industrial or service-based one

Figure 3.2. Agriculture as a share of GDP versus GDP per capita, 1896-2012



Source: Author elaboration based on estimations by Seminario (2015).
The original data are expressed in 1979 US dollars.

3.2.2 The evolution of exports and imports

The information presented in this section pertains to variables associated with the country's involvement in global markets. Table 3.1 illustrates a relatively diversified export basket within the realm of primary products, with agricultural commodities such as sugar and cotton notably prominent since the early 20th century. In the first decade, agricultural products constitute 40% of total revenue among the top 5 exports, followed by the subsequent decade (1911 to 1920), which represents one of the highest contributions at 47%, slightly surpassed in the 1940s. Thereafter, agricultural exports diminish in significance due to the increased prominence of mineral products, only to reappear among the top 5 in the first decade of the 21st century.

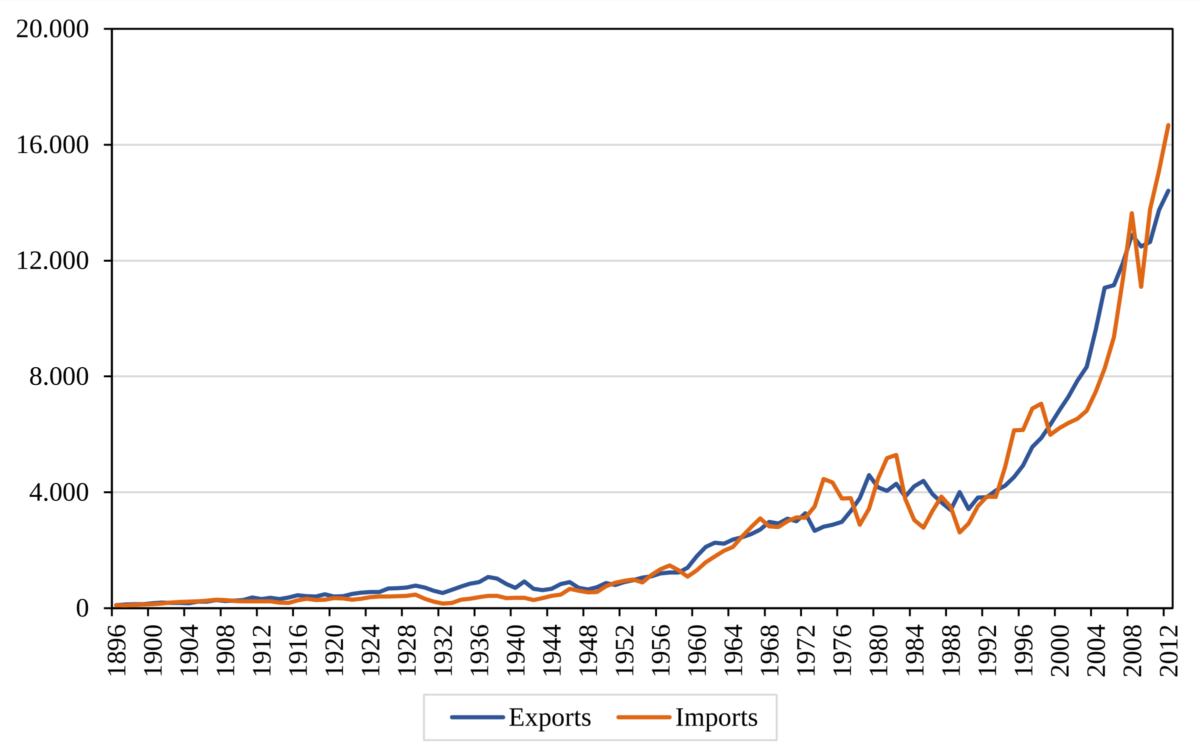
Table 3.1: Main Peruvian exports by percentage share, by decades since 1901

Decades	1st	2nd	3rd	4th	5th	Sum of the five
1901-10	Sugar 20.6	Copper 14.5	Rubber 12.6	Wool 6.6	Silver 6.4	63.9
1911-20	Sugar 27.6	Copper 22.6	Cotton 19.4	Silver 7.5	Petroleum 7.4	84.2
1921-30	Petroleum 25.1	Cotton 23.3	Copper 18.4	Sugar 17.5	Silver 10.2	94.5
1931-40	Petroleum 33.5	Cotton 22.1	Copper 15.2	Sugar 10.0	Silver 8.6	89.4
1941-50	Cotton 27.2	Sugar 20.9	Petroleum 14.5	Copper 8.4	Lead 7.3	78.3
1951-60	Copper 30.7	Cotton 23.1	Lead 13.1	Sugar 11.7	Silver 5.8	84.4
1961-70	Fishmeal 24.5	Copper 23.5	Cotton 9.8	Sugar 7.9	Iron 7.6	73.3
1971-80	Copper 20.4	Fishmeal 11.0	Petroleum 10.1	Lead 8.5	Zinc 7.7	57.7
1981-90	Copper 17.9	Petroleum 14.4	Zinc 10.1	Textiles 8.7	Fishmeal 7.3	58.4
1991-2000	Copper 16.9	Fishmeal 12.4	Gold 11.3	Textiles 9.0	Zinc 7.4	57.0
2001-10	Copper 22.4	Gold 19.4	Petroleum 7.6	Textiles 6.0	Zinc 5.8	61.2
2011-20	Copper 25.5	Gold 19.0	Petroleum 9.2	Fruits 4.2	Zinc 4.0	62.4

Source: Contreras (2021: 309, 379 and 440).

The figure 3.3 delineates the evolution of imports and exports for the period 1896-2012. A growing trend is identified, and periods of trade deficits are associated with economic crises in the country. Table 3.2 illustrates the evolution of import composition. Throughout all the periods considered, the same pattern repeats itself; between 71% and 78% of total imports are concentrated in the categories of capital goods and inputs. This fact already underscores the importance of imports for the country's growth and its dependency on imported inputs and capital goods, rendering it vulnerable to negative fluctuations in international markets.

Figure 3.3 Evolution of exports and imports in Peru, 1896-2012
(in millions of 1979 US dollars)



Source: Author elaboration based on estimations by Seminario (2015). The original data are expressed in 1979 US dollars.

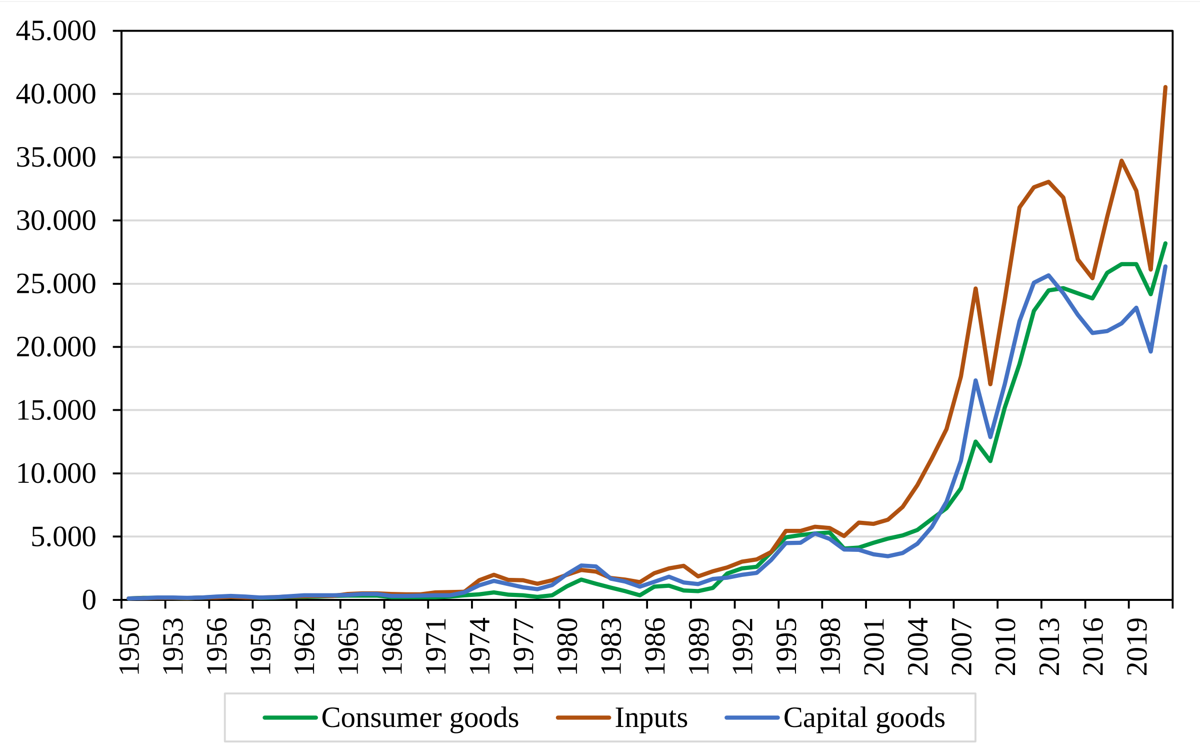
Table 3.2. Annual average growth rate of imports and their composition. 1950-2020

Period	Total	Composition by type (%)			
		Consumer goods	Inputs	Capital goods	Other goods
1950-1959	9.3	23	37	38	1
1960-1969	9.8	17	38	33	12
1970-1979	14.5	9	45	29	18
1980-1989	5.2	12	43	32	12
1990-1999	12.7	22	43	30	6
2000-2020	9.5	21	49	29	1

Source: Own elaboration based on BCRP data.

Figure 3.4 demonstrates the growing trend of import components for the period 1950-2020. Finally, Table 3.3 presents the average growth rates per periods of the variables of interest in this chapter: GDP and its components, as well as exports and imports. It is not surprising that the highest rates coincide with periods of relative stability, such as the first and third sub-periods, followed by a decline in the growth rate of variables for the period associated with less dynamism in the external sector and economic crises, as was the case during the period 1957-1990. Regarding the weight of imports in GDP, it oscillates between 18% and 27%, with a growing tendency. On the other hand, exports, although with a fluctuating trend, have a participation rate in the range of 23% to 30%. It increases during expansion periods and decreases during economic crises.

Figure 3.4. Evolution of import components in millions of US dollars, 1950-2020



Source: Own elaboration based on BCRP data.

Table 3.3 Annual average growth rates and shares of GDP components, imports, and exports

	1896-1956	1957-1990	1991-2012	1896-2012
(% annual average)				
GDP	4.3	3.1	5.1	4.1
Agriculture	3.2	2.2	5.0	3.2
Mining	8.5	3.5	4.3	6.3
Industry	5.1	3.2	6.1	4.7
Services	4.2	3.4	5.0	4.1
(In shares, %)				
GDP	100	100	100	100
Agriculture	25	13	14	20
Mining	12	13	13	13
Industry	18	23	25	21
Services	44	48	46	45
Exports growth (% annual average)				
Total	5.2	3.7	6.8	5.1
Agrarian	4.7	1.2	2.8	3.3
Non-agrarian	5.9	4.5	7.3	5.8
Total exports as % GDP (anual average)	27	23	30	27
Imports growth (% annual average)	5.9	3.5	8.9	5.8
Total imports as % GDP (anual average)	18	21	27	20

Source: Author elaboration based on estimations from Seminario (2015). The original data are expressed in 1979 US dollars.

3.3. Literature Review

3.3.1 Approaches of the roles of agriculture in development

This section briefly summarises the main roles, from an economic perspective, of agriculture in development.[21]

What is known about the theoretical relationship between agriculture and growth? The economic debate on the relationship between agriculture and industry has a long history: more than 200 years of discussions that have not been free of political positions and advocacy for specific groups of interest.

In accordance with this, Martin (1991:43) suggests that:

> "In political economics, the relations between industry and agriculture have been debated intermittently for well over 200 years. Hence, I think that at least a brief historical reminder is appropriate. In 1767, Sir James Stewart sharply attacked the rural bias of the then dominant French school of Physiocrats and for the sake of a 'proper' balance between agriculture and industry advocated a shift to the latter. Adam Smith took a similar line a little later. He was followed by Ricardo who attacked the British landed aristocracy for trying to block and sabotage industrial progress. In our time, and based on specific up-to date evidence, some authors have found reasons for much the same attacks on the rural elites."

Adam Smith pondered how improvements in agricultural productivity would mean an increasingly smaller number of farming families would be necessary to sustain the same population. This situation would lead the released labour to engage in other activities and thus expand the production and consumption of goods. "Thus Smith asserts a significant relationship between productivity improvements in agriculture and the wealth of nations. He argued that such improvements are a necessary condition for increasing the wealth of nations – not simply that there is a relationship between agriculture and general or overall productivity of the economy" (Johnson, 1997:2).

Drawing upon the contributions of economic growth theory developed since the mid-20th century, the role of agriculture in economic growth is conceptualized through three primary theoretical frameworks. Firstly, there are theories that emphasize the passive role of agriculture as a mere supplier of resources to the economy. Secondly, there are theories that underscore the active role of agriculture in driving economic growth through inter-sectoral linkages. Thirdly, there are theories that highlight agriculture's potential to promote sustainable economic growth.

[21] A comprehensive discussion of the evolution of economists' perception of the agricultural sector from the 18th to the 20th centuries is found in Throsby (1986). Gollin (2010) reviews theoretical arguments and empirical evidence for the hypothesis that agricultural productivity improvement leads to economic growth in developing countries.

The first theoretical approach is rooted in a dualistic perspective inherited from classical economic thought. It portrays agriculture as a sector lagging behind, while industry is depicted as modern and advanced. Technical backwardness within agriculture, attributed to institutional and social constraints, leads to productivity and income differentials among sectors, consequently relegating agriculture to a subordinate position in economic growth dynamics (Lewis, 1954; Fei and Ranis, 1961; Jorgenson, 1961). Agriculture generates a surplus that must be integrated into the broader economy, comprising food and primary goods, labour force, and capital and foreign exchange.

This approach is predicated on several hypotheses, including the assumption that agriculture consistently produces surplus relative to its internal needs, and that there exists non-productive labour within agriculture that can freely migrate to other sectors. Farmers, under this framework, are considered capable of saving and thus contributing to the economy, while agriculture produces goods with international tradability. Furthermore, a 'weak' variant of this approach suggests that while agriculture may produce surplus in theory, traditional agricultural practices may not always be conducive to surplus generation, necessitating modernization efforts. The modernization of agriculture, entailing resource transfers from the economy to agriculture, aims to enhance resource productivity, introduce technical innovations, and align production with market demands.

The second theoretical approach, building upon a dualistic view of the economy, advocates for the modernization of agriculture as a prerequisite for surplus creation, with public intervention deemed necessary to facilitate this transformation (Schultz, 1964; Gollin et al., 2002). The active role approach posits that agriculture, like other sectors, is embedded in a network of inter-sectoral linkages crucial for economic development (Mellor, 1976). Public interventions aimed at modernizing agriculture, such as the Green Revolution in India, are seen as catalysts for stimulating rural economies through increased incomes, expanded consumption, and the growth of local industries. A balanced and sustainable growth trajectory, according to this perspective, hinges on the development of rural industries, which absorb surplus labour from agriculture, alleviate urban pressures, capitalize on traditional skills, and leverage rural cost advantages. However, the modernization of agriculture has introduced its own set of challenges, including environmental degradation, social upheaval, and economic vulnerabilities. Despite its potential benefits, agricultural modernization can exacerbate inequalities, rural-urban migration, and informal sector expansion.

The empirical work investigating whether agricultural growth has a positive feedback effect on the rural non-farm sector are of two types: i) econometric estimates of the relationship between growth in agricultural income and growth in employment or income in the rural non-farm sector; and ii) the use of social accounting matrices (SAM) to calculate growth multipliers from structural relationships among agents in the economy[22] (Lanjouw and Lanjouw, 2001).

Lastly, the third theoretical approach reconceptualizes agriculture as a multifunctional system with social, economic, and spatial dimensions. Beyond its role as a surplus provider, agriculture contributes to collective welfare through diverse economic and non-economic functions, such as income generation, poverty reduction, natural resource management, and cultural preservation. Recognizing agriculture's multifaceted contributions, both conventional and unconventional, is essential for fostering sustainable economic growth, as these roles often transcend market valuations and encompass broader societal and environmental considerations (FAO, 2000). Timmer (1995) underscores the significance of indirect non-market linkages that enhance labour quality. The author posits that agriculture's indirect impact on economic growth lies in its supply of calories for the poor, bolstering food accessibility, influencing food pricing dynamics, and poverty reduction.

Along the lines of this approach, Byerlee et al. (2009:16) claim that "globalization, integrated value chains, rapid technological and institutional innovation, and environmental constraints have rapidly changed the context for agriculture's role." The authors claim that a new paradigm considering the multiple roles of agriculture for development is required. Such roles include triggering economic growth, reducing poverty, narrowing income disparities, providing food security and delivering environmental services.

Regarding poverty reduction, historically, agricultural growth has been the way out of poverty for developed countries. More recently, this has been confirmed by experiences in China and in India where agriculture-led economic growth has reduced poverty. The World Development Report (World Bank, 2008) argues that GDP growth generated in agriculture is at least twice as effective in reducing poverty as growth generated by other sectors.

There is a growing literature showing the close linkage between agricultural expansion and poverty reduction. A paper by Christiaensen et al. (2011), using world-wide empirical evidence about the role of agriculture in development, argues that agriculture is at least 5 times more effective in reducing poverty when it comes to the poorest of the poor and up to 3.2 times better at reducing $1/day headcount poverty (including in sub-Saharan Africa). Hence,

[22] For a review of empirical studies, see Islam (1997) and Lanjouw and Lanjouw (2001). For a critique on this issue, see Dunham (1991).

increasing investment in agriculture appears to be a crucial instrument for tackling poverty and food insecurity.

A key message drawn from the literature review is that contrasting views of the roles of agriculture emerge, and different policy implications could be realised and implemented. So, agriculture exhibits changing and multiple roles throughout the process of economic growth.

Regarding empirical studies, mainly in developing countries, have made a useful contribution to understanding the linkage between the agricultural sector and economic growth as well as the importance of intersectoral linkages for agricultural growth (Kanwar, 2000; Chaudhuri and Rao, 2004; Yao, 1994, 1996, 2000; Katircioglu, 2006; Tiffin and Irz, 2006; Chebbi and Lachaad, 2007; Gemmell et al., 2000; Verner, 2001; Blunch and Verner, 2006, among others). These papers have determined the existence of a long-term relationship between the different sectors of the economy and establishing the direction of causality. As the summary of selected studies in Table 3.4 shows, because the findings are country-specific, they cannot be generalised to other countries to make inferences.

Table 3.4. Summary of selected time-series empirical studies on sectoral linkages in developing countries

Authors	Country/period	Methodology	Main results	
			Cointegration	Direction of causality
Yao (1994)	China/1952-92	Cointegrated VAR	Cointegrated	Agriculture →Industry; Transportation, Construction; Services
Yao (1996)	China/1952-78 1979-92	Cointegrated VAR/VECM	Cointegrated	1952-78: same as Yao (1994) 1979-92:Agriculture→Industry; Transportation, Construction; Services Industry→(-)Agriculture; Transportation; Construction; Services →(+)Agriculture
Yao (2000)	China/1952-96	Cointegrated VAR/VECM	Cointegrated	Agriculture → Industry; Transportation; Construction; Services
Gemmell et al. (2000)	Malaysia/1965-91; 1970-91	Cointegrated VAR	Cointegrated	Manufacturing output → (+) Agricultural output. Services output → (-) Agricultural output. Manufacturing/services productivity→(+)Agricultural productivity
Kanwar (2000)	India /1950/1-1992/3	Cointegrated VAR	Cointegrated	Agricultural;Infrastructure, Services→Manufacturing Agricultural;Infrastructure, Services→Construction
Chaudhuri and Rao (2004)	India/ 1960-2000	Cointegrated VAR/VECM	Cointegrated	Agriculture→Industry Industry→Agriculture
Fiess and Verner (2001)	Ecuador/1965-98. Quarterly data.	Cointegrated VAR	Cointegrated only after 1990	Agriculture→Industry/Services Industry→Agriculture/Services Services→Agriculture/Industry
Blunch and Verner (1999)	Côte d'Ivoire, Ghana and Zimbabwe/1965-97	Cointegrated VAR impulse response analysis	Cointegrated	Agriculture→Industry

Source: Based on Gilson and Simões (2014). The symbol → represents the direction of causality found between sectors.

3.3.2 Export-led growth and import-led growth models

Agriculture serves as a significant contributor to foreign exchange earnings for numerous countries, particularly through exports, "especially primary exports, which are capable of providing underdeveloped countries with a satisfactory basis for economic development" (Myint, 1991: 277). The role of agriculture in total exports tends to be substantial in developing nations (Faridi, 2012). Johnston and Mellor (1961) assert that the expansion of agricultural exports stands as one of the most promising avenues for enhancing a country's income and foreign exchange reserves.

Furthermore, within the framework of globalization, agricultural exports possess the potential to stimulate agricultural production and demand, thereby fostering overall economic growth (Mamba and Ali, 2022). Agricultural growth can be influenced by agricultural exports through market expansion, facilitating access to a broad international market and consequent increases in demand and agricultural output. However, it is noteworthy that agricultural exports are susceptible to price fluctuations. Hence, Ojo, Awe, and Ogunjobi (2014) highlight that the rise in agricultural exports can directly spur production as an integral component of global production and indirectly by promoting efficient resource allocation, enhancing capacity utilization, exploiting economies of scale, and encouraging technological advancements through competition in international markets.

The empirical literature on the subject is extensive; a selection of works will be presented. Dawson (2005) undertakes an analysis of the contribution of agricultural exports to the economic growth of least developed countries. This investigation employs panel data from 62 countries spanning the period from 1974 to 1995. The theoretical framework adopted is a basic aggregate production function incorporating agricultural and non-agricultural exports as additional variables. The findings reveal structural disparities in economic growth among low-income, medium-low-income, and medium-high-income countries. Moreover, the study indicates that the expansion of the agricultural export subsector exerts a statistically equivalent impact on economic growth compared to the expansion of the non-agricultural export subsector.

Awokuse (2008) examines the relationship between trade and economic growth in Argentina, Colombia, and Peru. Granger causality tests and impulse response functions are employed to assess whether trade growth stimulates economic growth. Quarterly time series data covering the periods from 1993:1 to 2002:4 for Argentina, 1994:1 to 2002:4 for Colombia, and 1990:1 to 2002:4 for Peru are utilized for the study. The results suggest that while there is some empirical support for export-led growth, the evidence favouring the import-led growth hypothesis is stronger. Additionally, causality from GDP growth to exports and imports is observed.

Sanjuán-López and Dawson (2010) conduct research aimed at quantifying the contribution of agricultural exports to economic growth in 42 countries. The chosen theoretical model is Export-led Growth, with panel data spanning from 1970 to 2004. The countries are classified into 13 low-income, 22 medium-low-income, and 7 medium-high-income categories. The findings indicate long-term relationships between GDP and agricultural and non-agricultural exports for the entire set of 42 developing countries and each income group subset.

In the case of Peru, Urriola, Aquino, and Baral (2018) conducted a study covering the period from 2000 to 2016, with a specific focus on the application of Vector Autoregression (VAR) models. Their investigation primarily revolved around the influence of agricultural exports, differentiating between traditional and non-traditional agricultural exports. The results indicated that traditional agricultural exports demonstrated a positive albeit statistically insignificant impact. Conversely, non-traditional agricultural exports were found to exert a positive and statistically significant influence.

3.4. Methodology: Cointegration analysis

The two empirical approaches to be analysed, namely the relationship of GDP components and the testing of the import-led growth and export-led growth hypotheses, require the use of time series techniques, particularly the cointegration method.

Before the model is estimated, it must be tested for order of data integration. Confirming that the time series data is stationary in first differences, the model is estimated using the cointegration method suggested by Johansen and Juselius (1990), which distinguishes between the short and the long run. The method consists of a maximum likelihood procedure. With this methodology, two or more variables can be considered to be in long-term equilibrium if they move closely and in parallel over time, even though they may, in the short run, move in opposite directions. For this reason, the technique is particularly useful to identify the relationship between agriculture and the other economic activities, as well as the export-led model and the import-led model. The long-term relationship is known as the cointegration vector.

The econometric model to be tested for multivariate cointegration corresponds to a VAR model of *k*-dimensional time series vector Yt reparametrised as a vector error-correction model (VECM):

$$\boldsymbol{\Delta Y_t = \mu D_t + \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-1} + \varepsilon_t} \qquad (1)$$

Where:

Y_t = a (kX1) column vector of the endogenous variables.

D_t = a vector of deterministic variables (intercept, trend, etc.).

μ = the matrix of parameters associated with D_t.

Γ = (kXk) matrices of short-run parameters (i= 1,…..,p-1) where p is the number of lags.

Π = a (kXk) matrix of long-run parameters.

$\boldsymbol{\varepsilon}$ = the vector of disturbances assumed to be normal, independent and identically distributed.

Yt is cointegrated if the following rank conditions are met: Hr : $\Pi = \alpha\beta'$ of rank $0 < r < k$, where α and β are matrices of dimension (kXr). β is a matrix representing the cointegrating vectors which are interpreted as long-run equilibrium relations between the Yt variables, while α gives the weights of the cointegration relationships in the error-correction model equations

(Green, 2003 and Wooldridge, 2009). Before following the previous procedure, the lag length for the VAR model must be determined using Akaike's information criterion.

The following sections present the results of applying cointegration analysis. The investigation begins with the examination of the relationship between agriculture and other sectors, subsequently concluding with the hypotheses of the export-led model and import-led model.

3.5 The relationship between agricultural and non-agricultural sectors, 1896-2012

3.5.1 Data and stationarity properties

The empirical analysis primarily relies on the estimates provided by Seminario (2015) regarding the Gross Domestic Product (GDP) and its components. Table 3.5 describes the database used, based on the following sectoral aggregation: agriculture, industry, mining and the other economic sectors consisting of non-manufacturing industry (water, electricity) and services. The rationale behind incorporating these latter sectors is that they represent the level of urban development achieved by the country. This would allow for an analysis of how the agricultural sector is linked with an expanding urban and modern sector. All variables are in constant 1979 US dollars and transformed to logarithms.

Table 3.5. Description of database

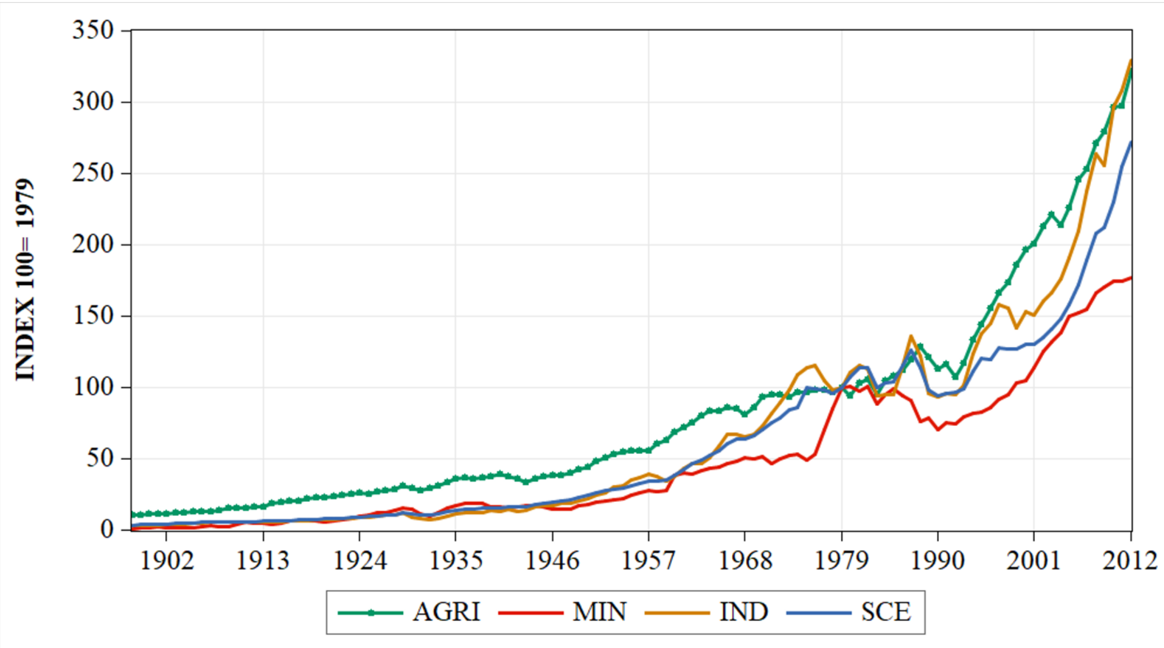
Variable	Nomenclature	Source
Gross Domestic Product of agricultural sector in millions of 1979 US dollars	AGRI	Seminario (2015)
Gross Domestic Product of industry sector in millions of 1979 US dollars	IND	
Gross Domestic Product of mining sector in in millions of 1979 US dollars	MIN	
Gross Domestic Product of other sectors (energy and services) in millions of 1979 US dollars	SCE	

Table 3.6 presents the descriptive statistics of the variables, while Figure 3.5 illustrates the four selected variables exhibiting a trend moving together over time.

Table 3.6. Descriptive Statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
L_AGRI	117	3.532122	2.709075	.0256678	6.858565
L_MIN	117	3.269923	2.431756	.0363319	6.624065
L_IND	117	3.352229	2.292782	.0563803	6.816736
L_SCE	117	3.049889	2.308516	.013903	6.850126

Figure 3.5. Trends of the indexed series (1979=100)



Source: Author elaboration based on estimations by Seminario (2015).

Graphs of the series in logarithms and first differences are presented in Appendix 3.1. Before the model is estimated, it must be tested for order of data integration. All the time series were tested for unit root after log-transformation. Augmented Dickey-Fuller (ADF) tests and Phillips-Perron tests were used for the series in levels. Tables in the Appendix 3.2 show the results of the above-mentioned tests for the series both in level (in log values) and in first differences, respectively. It can be observed, according to the stationary test, that the variable in levels are integrated in single order, I(1), was not rejected. Moreover, the null hypothesis that the first differences have unit roots was rejected.

3.5.2. Cointegration analysis: Long-run relationship analysis

Confirming that the time series data was stationary in first differences, the model was estimated.

Cointegration tests

Tables 3.7 and 3.8 show the cointegration tests. The Trace test indicated one cointegration vector using the maximum characteristic value test. Furthermore, both tests specify one integrating equation at both 5 percent and 1 percent levels.

Table 3.7. Johansen-Juselius cointegration tests: Trace statistic

Period 1896-2012				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.310	77.923	54.079	0.000
At most 1*	0.181	35.931	35.193	0.042
At most 2	0.095	13.411	20.262	0.332
At most 3	0.019	2.120	9.165	0.754
Period 1896-1956				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.370	32.264	24.276	0.004
At most 1	0.098	5.928	12.321	0.445
At most 2	0.001	0.078	4.130	0.818
Period 1957-1990				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.650	76.439	54.079	0.000
At most 1*	0.558	42.827	35.193	0.006
At most 2	0.328	16.725	20.262	0.143
At most 3	0.118	4.026	9.165	0.408
Period 1991-2012				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.887	72.117	55.246	0.001
At most 1	0.545	28.469	35.011	0.211
At most 2	0.460	12.701	18.398	0.260
At most 3	0.019	0.389	3.841	0.533

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Trend assumption: No deterministic trend and restricted constant.
Source: Eviews output.

Table 3.8. Johansen-Juselius cointegration tests: Max-Eigen statistic

Period 1896-2012				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.310	41.993	28.588	0.001
At most 1*	0.181	22.520	22.300	0.047
At most 2	0.095	11.291	15.892	0.231
At most 3	0.019	2.120	9.165	0.754
Period 1896-1956				
Hypothesised Number of CE(s)	Eigenvalue	Max-Eigen Statistic	5 percent critical value	1 percent critical value
None*	0.370	26.337	17.797	0.002
At most 1	0.098	5.849	11.225	0.367
At most 2	0.001	0.078	4.130	0.818
Period 1957-1990				
Hypothesised Number of CE(s)	Eigenvalue	Max-Eigen Statistic	5 percent critical value	1 percent critical value
None**	0.650	33.612	28.588	0.010
At most 1	0.558	26.102	22.300	0.014
At most 2	0.328	12.700	15.892	0.149
At most 3	0.118	4.026	9.165	0.408
Period 1991-2012				
Hypothesised Number of CE(s)	Eigenvalue	Max-Eigen Statistic	5 percent critical value	1 percent critical value
None*	0.887	43.648	30.815	0.001
At most 1	0.545	15.768	24.252	0.432
At most 2	0.460	12.312	17.148	0.221
At most 3	0.019	0.389	3.841	0.533

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Trend assumption: No deterministic trend and restricted constant.
Source: Eviews output.

The normalised cointegrations vectors (the β vector) are shown in Table 3.9.

Table 3.9. Normalised cointegration vector

	1898-2012		**1898-1956**	**1957-1990**	**1991-2012**
Sectors	Vector 1	Vector 2	Vector 3	Vector 4	Vector 5
LN_AGRI(-1)	1		1	1	1
LN_MIN (-1)		1			-0.5636 (0.0958) [-5.8811]
LN_IND (-1)	4.322 (1.756) [2.4606]	9.539 (2.595) [3.6766]	2.5181 (1.1182) [2.2517)	-0.3807 (0.1897) [-2.0063]	0.2262 (0.2188) [1.0336]
LN_SCE (-1)	-5.4395 (1.9007) [-2.8618]	-11.4041 (2.8076) [-4.0619]	-3.2787 (0.9686) [-3.3851]	0.07889 (0.1943) [0.4060]	-0.7531 (0.3020) [-2.4937]
Constant	6.7028 (2.6847) [2.4967]	17.2711 (3.9656) [4.3552]			

Note: The figure in the parenthesis denotes the standard error. The figure in the square brackets represents the t-statistic. Note: The signs of the coefficients are reversed in the long-run.

Serial correlation in residuals of the selected models was checked using the ADF and the LM tests. In all cases, the null hypothesis was rejected, implying the existence of cointegration. Furthermore, according to the Jarque Bera test, the residuals are normally distributed. The selected vector error correction model is presented in Appendix 3.3.

Cointegration results suggest that, in general, in the long run, agriculture is positively related to mining and the other sectors. On the other hand, agriculture is negatively related to industry (with the exception of the period 1957-1990.)

3.5.3. Granger non-causality analysis

To the extent that a cointegration relationship has been found between the variables, the next step is to investigate the direction of causality. In order to do this, a VECM derived from the long-term cointegration relation will be estimated. The following causality test will be carried out: short-run Granger non-causality, long-run weak exogeneity and overall strong exogeneity tests. Thus, the VECM can be written as follows (Eddine, 2010):

$\Delta LN\_Agri = \mu_{1+}\alpha_{11}ECT_{1,t-1} + \sum_{i=1}^{k}\theta_{1i}\Delta LN\_Agri_{t-i} + \sum_{i=1}^{k}\beta_{1i}\Delta LN\_Min_{t-i} + \sum_{i=1}^{k}\sigma_{1i}\Delta LN\_Ind_{t-i} + \sum_{i=1}^{k}\delta_{1i}\Delta LN\_Sce_{t-i} + \varepsilon_{1t}$ (2)

$\Delta LN\_Min = \mu_{2+}\alpha_{21}ECT_{1,t-1} + \sum_{i=1}^{k}\theta_{2i}\Delta LN\_Agri_{t-i} + \sum_{i=1}^{k}\beta_{2i}\Delta LN\_Min_{t-i} + \sum_{i=1}^{k}\sigma_{2i}\Delta LN\_Ind_{t-i} + \sum_{i=1}^{k}\delta_{2i}\Delta LN\_Sce_{t-i} + \varepsilon_{2t}$ (3)

$\Delta LN\_Ind = \mu_{3+}\alpha_{31}ECT_{1,t-1} + \sum_{i=1}^{k}\theta_{3i}\Delta LN\_Agri_{t-i} + \sum_{i=1}^{k}\beta_{3i}\Delta LN\_Min_{t-i} + \sum_{i=1}^{k}\sigma_{3i}\Delta LN\_Ind_{t-i} + \sum_{i=1}^{k}\delta_{3i}\Delta LN\_Sce_{t-i} + \varepsilon_{3t}$ (4)

$\Delta LN\_Sce = \mu_{4+}\alpha_{41}ECT_{1,t-1} + \sum_{i=1}^{k}\theta_{4i}\Delta LN\_Agri_{t-i} + \sum_{i=1}^{k}\beta_{4i}\Delta LN\_Min_{t-i} + \sum_{i=1}^{k}\sigma_{4i}\Delta LN\_Ind_{t-i} + \sum_{i=1}^{k}\delta_{4i}\Delta LN\_Sce_{t-i} + \varepsilon_{4t}$ (5)

The variable ECT is the lagged error-correction term obtained from the long-run cointegration vector. ε is a serially independent random error with mean zero and finite covariance matrix. For illustrative purposes from equation (2), testing if ΔLN_Min does not cause ΔLN_Agri implies carrying out the following steps:

a) Short-run Granger non-causality requires evaluating the statistical significance of the lagged dynamics terms using the Wald test by testing Ho: all $\beta_{1i} = 0$. Non-rejection of the null hypothesis implies mining does not Granger-cause agriculture in the short run.

b) The variable is said to be weakly exogenous if it is not affected by deviation from the long-run relationship. Thus, the statistical significance of the coefficients corresponding to ECT provide evidence of an error-correction mechanism that returns the variables to their long-run relationship. In (2), it requires satisfying Ho: $\alpha_{11} = 0$ for non-causality for long-run equilibrium deviation to mining.

c) Finally, overall strong exogeneity occurs when both short-run Granger non-causality and weak exogeneity are satisfied. From equation (2), ΔLN_Min does not cause ΔLN_Agri implies satisfying the joint hypothesis: Ho: all $\beta_{1i} = 0$ and $\alpha_{11} = 0$.

Table 3.10 and Table 3.11 show the results of non-causality tests.

Table 3.10. Results of non-causality tests between agricultural and non-agricultural sectors

Period 1896-2012						
Hypothesis of causality (Ho)	**Short-run Granger non-causality**		**Long-run weak exogeneity**		**Overall strong exogeneity**	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_MIN does not cause LN_AGRI	0.12	0.73	20.37	0.00	20.44	0.00
LN_AGRI does not cause LN_MIN	0.29	0.59	12.34	0.00	15.25	0.00
LN_IND does not cause LN_AGRI	1.45	0.23	20.37	0.00	20.44	0.00
LN_AGRI does not cause LN_IND	1.98	0.16	24.62	0.00	24.69	0.00
LN_SCE does not cause LN_AGRI	0.02	0.89	20.37	0.00	25.75	0.00
LN_AGRI does not cause LN_SCE	2.02	0.15	29.42	0.00	29.52	0.00
Period 1896-1956						
Hypothesis of causality (Ho)	**Short-run Granger non-causality**		**Long-run weak exogeneity**		**Overall strong exogeneity**	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_IND does not cause LN_AGRI	4.65	0.03	14.37	0.00	14.98	0.00
LN_AGRI does not cause LN_IND	0.05	0.82	6.19	0.01	6.21	0.04
LN_SCE does not cause LN_AGRI	1.76	0.18	14.37	0.00	15.57	0.00
LN_AGRI does not cause LN_SCE	0.03	0.85	19.54	0.00	19.54	0.00
Period 1957-1990						
Hypothesis of causality (Ho)	**Short-run Granger non-causality**		**Long-run weak exogeneity**		**Overall strong exogeneity**	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_MIN does not cause LN_AGRI	0.07	0.79	12.75	0.00	13.15	0.00
LN_AGRI does not cause LN_MIN	0.37	0.54	12.49	0.01	12.54	0.01
LN_IND does not cause LN_AGRI	5.72	0.02	12.75	0.00	12.78	0.01
LN_AGRI does not cause LN_IND	1.37	0.24	8.73	0.01	10.00	0.02
LN_SCE does not cause LN_AGRI	2.64	0.10	12.75	0.00	14.12	0.00
LN_AGRI does not cause LN_SCE	0.02	0.88	7.11	0.03	7.76	0.05
Period 1991-2012						
Hypothesis of causality (Ho)	**Short-run Granger non-causality**		**Long-run weak exogeneity**		**Overall strong exogeneity**	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_MIN does not cause LN_AGRI	0.34	0.56	11.51	0.00	11.74	0.00
LN_AGRI does not cause LN_MIN	10.80	0.00	7.99	0.00	14.74	0.00
LN_IND does not cause LN_AGRI	0.01	0.94	11.51	0.00	11.57	0.00
LN_AGRI does not cause LN_IND	2.11	0.15	7.98	0.00	8.45	0.01
LN_SCE does not cause LN_AGRI	1.25	0.26	11.51	0.00	11.51	0.00
LN_AGRI does not cause LN_SCE	0.28	0.60	3.75	0.05	3.75	0.15

Table 3.11. Direction of Causality

Causality				
Period 1896-2012				
Causality				
From	To	Long-run	Short-run	Direction of causality
ΔLN_MIN ΔLN_AGRI	ΔLN_AGRI ΔLN_MIN	Yes Yes	No No	Feedback
ΔLN_IND ΔLN_AGRI	ΔLN_AGRI ΔLN_IND	Yes Yes	No No	Feedback
ΔLN_SCE ΔLN_AGRI	ΔLN_AGRI ΔLN_SCE	Yes Yes	No No	Feedback
Period 1896-1956				
Causality				
From	To	Long-run	Short-run	Direction of causality
ΔLN_IND ΔLN_AGRI	ΔLN_AGRI ΔLN_IND	Yes Yes	Yes No	Feedback
ΔLN_SCE ΔLN_AGRI	ΔLN_AGRI ΔLN_SCE	Yes Yes	No No	Feedback
Period 1957-1990				
Causality				
From	To	Long-run	Short-run	Direction of causality
ΔLN_MIN ΔLN_AGRI	ΔLN_AGRI ΔLN_MIN	Yes Yes	No No	Feedback
ΔLN_IND ΔLN_AGRI	ΔLN_AGRI ΔLN_IND	Yes Yes	Yes No	Feedback
ΔLN_SCE ΔLN_AGRI	ΔLN_AGRI ΔLN_SCE	Yes Yes	No No	Feedback
Period 1991-2012				
Causality				
From	To	Long-run	Short-run	Direction of causality
ΔLN_MIN ΔLN_AGRI	ΔLN_AGRI ΔLN_MIN	Yes Yes	No Yes	Feedback
ΔLN_IND ΔLN_AGRI	ΔLN_AGRI ΔLN_IND	Yes Yes	No No	Feedback
ΔLN_SCE ΔLN_AGRI	ΔLN_AGRI ΔLN_SCE	Yes Yes	No No	Feedback

The results indicate that in the long term, there exists a complementary relationship between agriculture, mining, industry, and other sectors (services and energy).

Further exploration on the relationship between agriculture and SCE sector was carried out. Tables 3.12 and 3.13 show the Johansen-Juselius cointegration tests regarding the Trace statistic and th Max-Eigen statistic. Both tests confirm the existence of a singular cointegration vector for the entire analysis period and for the sub-periods.

Table 3.12. Johansen-Juselius cointegration tests: Trace statistic

Hypothesised Number of CE(s)	Eigenvalue	Trace Statistic	5 percent critical value	1 percent critical value
Period 1896-2012				
None*	0.138	21.302	20.262	0.049
At most 1	0.042	4.799	9.165	0.907
Period 1896-1956				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.462	24.078	20.262	0.014
At most 1	0.124	4.244	9.165	0.377
Period 1957-1990				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.843	42.776	20.262	0.000
At most 1	0.251	5.770	9.165	0.209
Period 1991-2012				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.843	42.776	20.262	0.000
At most 1	0.251	5.770	9.165	0.209

* denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Trend assumption: No deterministic trend and restricted constant.
Source: Eviews output.

Table 3.13. Johansen-Juselius cointegration tests: Max-Eigen statistic

Hypothesised Number of CE(s)	Eigenvalue	Max-Eigen Statistic	5 percent critical value	1 percent critical value
Period 1896-2012				
None*	0.138	16.503	15.892	0.040
At most 1	0.042	4.799	9.165	0.306
Period 1896-1956				
Hypothesised Number of CE(s)	Eigenvalue	Max-Eigen Statistic	5 percent critical value	1 percent critical value
None*	0.462	29.337	15.892	0.000
At most 1	0.124	2.320	9.165	0.714
Period 1957-1990				
Hypothesised Number of CE(s)	Eigenvalue	Max-Eigen Statistic	5 percent critical value	1 percent critical value
None*	0.843	19.834	15.892	0.011
At most 1	0.251	4.244	9.165	0.377
Period 1991-2012				
Hypothesised Number of CE(s)	Eigenvalue	Max-Eigen Statistic	5 percent critical value	1 percent critical value
None*	0.843	37.007	15.892	0.000
At most 1	0.251	5.770	9.165	0.209

* denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations..
Source: Eviews output

The normalised cointegrations vectors (the β vector) are shown in Table 3.14.

Table 3.14. Normalised cointegration vector

	1896-2012	**1898-1956**	**1957-1990**	**1991-2012**
Sectors	Vector 1	Vector 2	Vector 3	Vector 4
LN_AGRI (-1)	1	1	1	1
LN_SCE (-1)	-0.8585 (0.0437) [-19.6389]	-0.7741 (0.0877) [-8.8177]	-0.3335 (0.1061) [-3.1436]	-0.9047 (0.1217) [-7.4336]
Constant	-1.8950 (0.6777) [-2.7962]	-1.4651 (0.5777) [-2.5361]	-4.7108 (0.9048) [-5.2064]	-0.1501 (1.1189) [-0.1342]

Note: The figure in the parenthesis denotes the standard error. The figure in the square brackets represents the t-statistic. The signs of the coefficients are reversed in the long-run.

Serial correlation in residuals of the selected model was checked using the ADF and the LM tests. In all cases, the null hypothesis was rejected, implying the existence of cointegration. Furthermore, according to the Jarque Bera test, the residuals are normally distributed and the models are stable. The selected vector error correction model is presented in Appendix 3.4. Table 3.15 and Table 3.16 show the results of non-causality tests.

Table 3.15. Results of non-causality tests between agricultural and non-agricultural sectors

Period 1896-2012						
Hypothesis of causality (Ho)	**Short-run Granger non-causality**		**Long-run weak exogeneity**		**Overall strong exogeneity**	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_SCE does not cause LN_AGRI	4.07	0.25	11.32	0.00	16.15	0.00
LN_AGRI does not cause LN_SCE	0.57	0.90	0.47	0.49	0.99	0.91
Period 1896-1956						
Hypothesis of causality (Ho)	**Short-run Granger non-causality**		**Long-run weak exogeneity**		**Overall strong exogeneity**	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_SCE does not cause LN_AGRI	0.00	0.98	30.96	0.00	47.57	0.00
LN_AGRI does not cause LN_SCE	0.04	0.84	21.53	0.00	21.54	0.00
Period 1957-1990						
Hypothesis of causality (Ho)	**Short-run Granger non-causality**		**Long-run weak exogeneity**		**Overall strong exogeneity**	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_SCE does not cause LN_AGRI	1.21	0.27	19.51	0.00	27.59	0.00
LN_AGRI does not cause LN_SCE	0.37	0.54	9.20	0.00	9.29	0.01
Period 1991-2012						
Hypothesis of causality (Ho)	**Short-run Granger non-causality**		**Long-run weak exogeneity**		**Overall strong exogeneity**	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_SCE does not cause LN_AGRI	3.42	0.06	67.10	0.00	82.11	0.00
LN_AGRI does not cause LN_SCE	0.86	0.35	8.94	0.00	11.54	0.00

Table 3.16. Direction of Causality

Causality				
Period 1896-2012				
From	To	Long-run	Short-run	Direction of causality
ΔLN_SCE ΔLN_AGRI	ΔLN_AGRI ΔLN_SCE	Yes No	No No	SCE causes AGRI
Period 1896-1956				
From	To	Long-run	Short-run	Direction of causality
ΔLN_SCE ΔLN_AGRI	ΔLN_AGRI ΔLN_SCE	Yes Yes	No No	Feedback
Period 1957-1990				
From	To	Long-run	Short-run	Direction of causality
ΔLN_SCE ΔLN_AGRI	ΔLN_AGRI ΔLN_SCE	Yes Yes	No No	Feedback
Period 1991-2012				
From	To	Long-run	Short-run	Direction of causality
ΔLN_SCE ΔLN_AGRI	ΔLN_AGRI ΔLN_SCE	Yes Yes	Yes No	Feedback

The findings suggest that for the entire period sample, the relationship is unidirectional, from the SCE sector towards agriculture. However, results for sub-periods indicate a complementary relationship between both sectors.

3.6 Exports, imports and economic growth: The Peruvian case, 1896-2012

3.6.1 Empirical model

Hwa (1988) advanced a methodology, employing the estimation of a production function, which enables the quantification of agriculture's contribution to economic growth through its effect on total factor productivity. This approach is utilised when testing the hypotheses of both the import-led model and the export-led model. In this scenario, the variables influencing productivity, and consequently impacting growth, are exports and imports. On the export side, a distinction is made between agricultural exports and non-agricultural exports. This approach aims to ascertain whether a long-term relationship exists between agricultural exports, non-agricultural exports, and total imports with GDP. Following to Awokuse (2008), an augmented version of the Solow-Swan neoclassical growth model is used. Assuming a constant-return to scale aggregate production function:

$$Y_t = K_t^{\alpha} L_t^{\beta} B_t \tag{6}$$

Where Y is the national production, K is the capital stock and L is labour. The variable B captures the changes in technology, being considered as proxies for changes in productivity. Instead of looking to "B" as a residual of Equation (6), it is assumed that "B" explicitly includes factors that affect change in productivity. For the purpose of this research, it is assumed that "B" is positively affected by agricultural exports (AX), no-agricultural exports (NAX), imports (M), terms of trade (TOT) and negatively by inflation (INF). Equation (7) depicts this relationship:

$$B = F(AX, NAX, TOT, M, INF) = (AX)^{\theta}_{t}(NAX)^{\lambda}_{t}(M)^{\rho}_{t}(TOT)^{\eta}_{t}(INF)^{\delta}_{t} + \mu_t \quad (7)$$

Where μ is a randomly distributed error term. Substituting Equation (7) into (6), the following Equation is obtained:

$$Y_t = K^{\alpha}_{t}L^{\beta}_{t}(AX)^{\theta}_{t}(NAX)^{\lambda}_{t}(M)^{\rho}_{t}(TOT)^{\eta}_{t}(INF)^{\delta}_{t} + \mu_t \quad (8)$$

By taking natural logs of Equation (8), the following Equation is defined:

$$LnY_t = \alpha LnK_t + \beta LnL_t + \theta LnAX_t + \lambda LnNAX_t + \rho LnM_t + \eta LnTOT_t + \delta LnINF_t + \varepsilon_t \quad (9)$$

Equation (9) is the one that will be estimated using time series models.

3.6.2 Data and stationarity properties

The empirical analysis primarily relies on the estimates provided by Seminario (2015). Table 3.17 describes the variables used.

Table 3.17. Description of selected variables

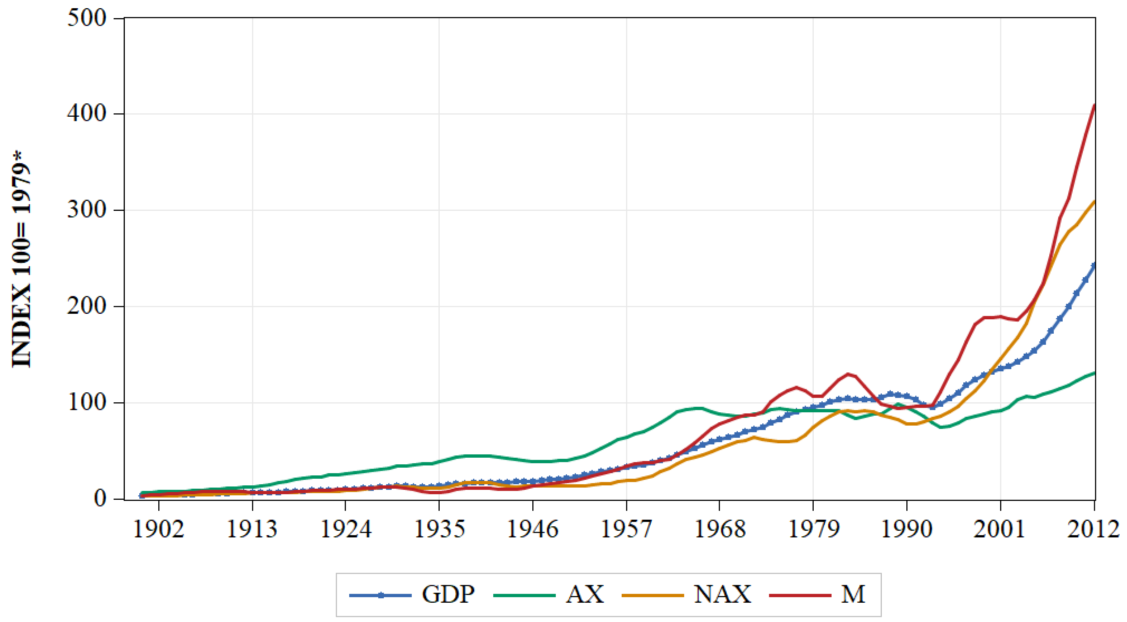
Variable	Nomenclature	Source
Gross Domestic Product of agricultural sector in in millions of 1979 US dollars	LN_GDP	Seminario (2015)
Agricultural export in millions of 1979 US dollars	LN_AX	
Non-agricultural export in millions of 1979 US dollars	LA_NAX	
Total imports in millions of 1979 US dollars	LN_M	
Labour (Economic Active Population)	L_L	
Capital stock in millions of 1979 US dollars	LN_K	
Inflation rate	INF	
Terms of trade (international)	L_TOT	

Table 3.18 presents the descriptive statistics of the variables, while Figure 3.6 illustrates the four selected variables (GDP, imports, agricultural exports and non-agricultural exports) exhibiting a trend moving together over time.

Table 3.18. Descriptive Statistics of variables

Variable	Observations	Mean	Std. Dev.	Min	Max
LN_GDP	117	8.489621	1.271729	6.140514	10.67148
LN_AX	117	5.45983	.8668282	3.314259	6.566049
LN_NAX	117	6.902577	1.353824	4.194009	9.458155
LN_M	117	6.854571	1.414027	4.401217	9.576292
LN_L	117	15.24925	.8406116	14.16906	16.59587
LN_K	117	9.640309	1.437135	7.197379	11.89518
INF	117	1.196816	7.636132	-.19	76.496
L_TOT	117	3.994613	.2660841	3.530452	4.71913

Figure 3.6. Trends of the indexed series (1979=100)



Source: Author elaboration based on estimations by Seminario (2015).

3.6.3 Cointegration analysis

Graphs of the series in logarithms and first differences are presented in Appendix 3.5. Before the model is estimated, it must be tested for order of data integration. All the time series were tested for unit root after log-transformation. Augmented Dickey-Fuller (ADF) tests and Phillips-Perron tests were used for the series in levels. Tables in the Appendix 3.6 show the results of the above-mentioned tests for the series both in level (in log values) and in first differences, respectively. It can be observed, according to the stationary test, that the variable in levels are integrated in single order, I(1), was not rejected. Moreover, the null hypothesis that the first differences have unit roots was rejected.

Confirming that the time series data was stationary in first differences, the model was estimated.

Cointegration tests

Tables 3.19 and 3.20 show the cointegration tests. The Trace test indicated one cointegration vector using the maximum characteristic value test. Furthermore, both tests specify one integrating equation at both 5 percent and 1 percent levels.

Table 3.19. Johansen-Juselius cointegration tests: Trace statistic

Period 1896-2012				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.370	32.264	24.276	0.004
At most 1	0.098	5.928	12.321	0.445
At most 2	0.001	0.078	4.130	0.818

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Trend assumption: No deterministic trend and restricted constant.
Source: Eviews output.

Table 3.20. Johansen-Juselius cointegration tests: Max-Eigen statistic

Period 1896-2012				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None*	0.370	26.337	17.797	0.002
At most 1	0.098	5.849	11.225	0.367
At most 2	0.001	0.078	4.130	0.818

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Trend assumption: No deterministic trend and restricted constant.
Source: Eviews output.

The normalised cointegration vector (the β vector) is shown in Table 3.21. All coefficients exhibit a significance level of 1%. Findings show that in the long run, capital, labour, imports, agricultural exports, non-agricultural exports, and terms of trade have a positive impact on GDP. However, as expected, inflation has a negative impact.

Table 3.21. Normalised cointegration vector

Sectors	**1900-2012**
LN_GDP	1
LN_K (-1)	-0.2178 (0.0793) [-2.7455]
LN_L (-1)	-0.4497 (0.1139) [-3.9457]
LN_AX (-1)	-0.2302 (0.0345) [-6.6737]
LN_NAX (-1)	-0.1111 (0.0311) [-3.5644]
LN_M (-1)	-0.1203 (0.0347) [-3.463]
L_TOT (-1)	-0.2538 (0.0391) [-6.4898]
INF (-1)	0.0131 (0.0011) [11.2011]

The figure in the parenthesis denotes the standard error.
The figure in the square brackets represents the t-statistic.
Note: The signs of the coefficients are reversed in the long-run.

Serial correlation in residuals of the selected model was checked using the ADF and the LM tests. In all cases, the null hypothesis was rejected, implying the existence of cointegration. Furthermore, according to the Jarque Bera test, the residuals are normally distributed and the models are stable. The selected vector error correction model is presented in Appendix 3.7.

3.6.4 Granger non-causality analysis

If the analysis is focused on the four variables of interest, namely agricultural and non-agricultural exports, imports, and GDP, the following system of equations is generated to facilitate the causality analysis.

$$\Delta LN\_Gdp = \mu_{1+}\alpha_{11}ECT_{1,t-1} + \sum_{i=1}^{k}\theta_{1i}\Delta LN\_Gdp_{t-i} + \sum_{i=1}^{k}\beta_{1i}\Delta LN\_Ax_{t-i} + \sum_{i=1}^{k}\sigma_{1i}\Delta LN\_Nax_{t-i} + \sum_{i=1}^{k}\delta_{1i}\Delta LN\_M_{t-i} + \varepsilon_{1t} \quad (10)$$

$$\Delta LN\_Ax = \mu_{2+}\alpha_{21}ECT_{1,t-1} + \sum_{i=1}^{k}\theta_{2i}\Delta LN\_Gdp_{t-i} + \sum_{i=1}^{k}\beta_{2i}\Delta LN\_Ax_{t-i} + \sum_{i=1}^{k}\sigma_{2i}\Delta LN\_Nax_{t-i} + \sum_{i=1}^{k}\delta_{2i}\Delta LN\_M_{t-i} + \varepsilon_{2t} \quad (11)$$

$$\Delta LN\_Nax = \mu_{3+}\alpha_{31}ECT_{1,t-1} + \sum_{i=1}^{k}\theta_{3i}\Delta LN\_Gdp_{t-i} + \sum_{i=1}^{k}\beta_{3i}\Delta LN\_Ax_{t-i} + \sum_{i=1}^{k}\sigma_{3i}\Delta LN\_Nax_{t-i} + \sum_{i=1}^{k}\delta_{3i}\Delta LN\_M_{t-i} + \varepsilon_{3t} \quad (12)$$

$$\Delta LN\_M = \mu_{4+}\alpha_{41}ECT_{1,t-1} + \sum_{i=1}^{k}\theta_{4i}\Delta LN\_Gdp_{t-i} + \sum_{i=1}^{k}\beta_{4i}\Delta LN\_Ax_{t-i} + \sum_{i=1}^{k}\sigma_{4i}\Delta LN\_Nax_{t-i} + \sum_{i=1}^{k}\delta_{4i}\Delta LN\_M_{t-i} + \varepsilon_{4t} \quad (13)$$

For illustrative purposes from equation (10), testing if ΔLN_Ax does not cause ΔLN_Gdp implies carrying out the following steps:

a) Short-run Granger non-causality requires evaluating the statistical significance of the lagged dynamics terms using the Wald test by testing Ho: all $\beta_{1i} = 0$. Non-rejection of the null hypothesis implies agricultural export does not Granger-cause GDP in the short run.

b) The variable is said to be weakly exogenous if it is not affected by deviation from the long-run relationship. Thus, the statistical significance of the coefficients corresponding to ECT provide evidence of an error-correction mechanism that returns the variables to their long-run relationship. In (10), it requires satisfying Ho: $\alpha_{11}= 0$ for non-causality for long-run equilibrium deviation to agricultural export.

c) Finally, overall strong exogeneity occurs when both short-run Granger non-causality and weak exogeneity are satisfied. From equation (10), ΔLN_Ax does not cause ΔGdp implies satisfying the joint hypothesis: Ho: all $\beta_{1i} = 0$ and $\alpha_{11}= 0$.

Table 3.22 shows the results of non-causality tests.

Table 3.22. Results of non-causality tests between agricultural and non-agricultural sectors

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_K does not cause LN_GDP	2.84	0.09	5.77	0.02	7.79	0.02
LN_GDP does not cause LN_K	3.31	0.07	0.01	0.94	3.32	0.19
LN_L does not cause LN_GDP	2.76	0.10	5.77	0.02	9.59	0.01
LN_GDP does not cause LN_L	0.68	0.41	0.39	0.53	1.07	0.59
LN_AX does not cause LN_GDP	2.67	0.10	5.77	0.02	6.98	0.03
LN_GDP does not cause LN_AX	4.48	0.03	3.24	0.07	7.79	0.02
LN_NAX does not cause LN_GDP	0.54	0.46	5.77	0.02	5.94	0.05
LN_GDP does not cause LN_NAX	2.93	0.09	0.94	0.33	3.85	0.15
LN_M does not cause LN_GDP	3.08	0.08	5.77	0.02	8.89	0.01
LN_GDP does not cause LN_M	9.69	0.00	0.00	0.97	9.69	0.01
LN_TOT does not cause LN_GDP	0.02	0.90	5.77	0.02	6.13	0.05
LN_GDP does not cause LN_TOT	1.85	0.17	6.45	0.01	8.24	0.02
LN_INF does not cause LN_GDP	4.40	0.04	5.77	0.02	6.24	0.04
LN_GDP does not cause LN_INF	2.73	0.10	36.26	0.00	38.83	0.00

Table 3.23 presents the findings regarding the relationship between GDP, agricultural exports, non-agricultural exports, and imports. Based on the results in the far-right column, the final outcome regarding the nature of the relationship between the selected variables and GDP is identified. It is justified to focus on these relationships as the second objective of the chapter is to test whether the export-led growth hypothesis, the import-led growth hypothesis, and particularly to identify if agricultural exports have a positive impact on long-term growth in Peru.

Having established in the cointegration vector of Table 3.21 that there exists a positive long-term relationship, for the period 1892-2012, between GDP, agricultural exports, non-agricultural exports, and total imports, what is expected is to ascertain the nature of causality. The results indicate there is a complementary, feedback relationship between agricultural exports and GDP, as well as between total imports and GDP. This would suggest that the agricultural export-led growth hypothesis, the growth-led agricultural export hypothesis, the import-led growth hypothesis, as well as the growth-led import hypothesis are fulfilled for the study period. Additionally, the non-agricultural-led growth hypothesis is fulfilled. These findings align with those by Awokuse (2008) for the case of Peru using quarterly data from 1990 to 2002.

Table 3.23. Direction of Causality

Period 1991-2012				
Causality		Long-run	Short-run	Direction of causality
From	To			
ΔLN_AX ΔLN_GDP	ΔLN_GDP ΔLN_AX	Yes No	No Yes	Feedback
ΔLN_NAX ΔLN_GDP	ΔLN_GDP ΔLN_NAX	Yes No	No No	NAX causes GDP
ΔLN_M ΔLN_GDP	ΔLN_GDP ΔLN_M	Yes No	No Yes	Feedback

3.7 Interpretation of the econometric results

Once the econometric results have been presented in the preceding sections, the discussion will proceed to examine the findings. To achieve this, historical evidence will be employed, as it is crucial to acknowledge the conditions preceding the analysis period and to unravel the events that may underpin the long-term relationships identified in the empirical section.

In the early 17th century, Spain achieved more effective control over its conquered lands, establishing strong commercial ties with Europe and laying the groundwork for a market economy to develop. Within this context, silver production from Peru and the Alto Peru (primarily Potosí) served as a vital source of capital, leading to the subsequent expansion of a diversified regional economy within the colonial space. Agriculture, livestock farming, and manufacturing emerged as privileged activities, propelled by mining as a key economic activity in the Spanish colonies. Thus, mining acted as the engine of growth during the colonial period, articulating a series of activities that connected various spaces within the colonial territory. Based on the mining expansion, the creation of the labor market and urbanization, an internal market was consolidated, supported by a regional specialization process in which the role played by merchants was essential in connecting nearby and distant spaces (Andrien, 1985). For example, starting from the subsistence goods demand for Potosí in 1603, 89% of the total subsistence supply came from the domestic market. For instance, Quito, Tucumán, and Cuzco provided textiles and food; Chile, copper and wheat; Cochabamba, soap and textiles; Charcas, sugar and cocoa; Moquegua, oil, fish, wine, and leather; from the Peruvian coast, Potosí received luxury goods, wine, brandy, fish, and fruits (Assadourian, 1978).

The war of independence and the beginning of the republic changed the economic structure inherited from the colonial period, and with mining in retreat, regional and local economies experienced stagnation. However, with the new opportunities offered by participation in the world market and British industrialization, Peru had new export products coming from the Coast (guano, sugar, and cotton), the Sierra (silver and wool), and the

Amazon (rubber). In other words, regional economies adapted to the export cycle of the prevailing product. And in doing so, agriculture, livestock farming, regional trade, and mining were reactivated.

Peruvian historiography is ample in studies on regional economy and *hacienda* functioning, spanning both the Coast and the Sierra regions, with a temporal scope dating back to the 16th century (Burga, 1976; Glave and Remy, 1983; Peloso, 2013; Jacobsen, 2013; Manrique, 1987; Montoya, 1970 and 1980; Luna and Quiroz, 2019, O'Phelan and Saint-Geours, 1998; Urrutia, 2019; Schlüpmann 2022; Bonilla, 2014; Guillén, 1989, among others)[23].

For instance, Urrutia (2019) delves into the production and circulation of goods within regional spaces and the interplay between capitalist economy and peasant production. In this regard, the author scrutinizes the mercantile networks linking Lima-based traders, Huamanga muleteers, and rural community peasants, thereby constructing the *arriero* routes and fair circuits that bridged capitalist production with the rural economy.

Burga (1976) conducts a study of the rural history of a valley in the northern coast of Peru spanning four centuries, from the 16th to the 20th century. This study explores the economic and social history of the Jequetepeque valley, from colonial encomienda to capitalist hacienda. Specifically, for the period 1860-1960, it elucidates the emergence of capitalist haciendas in the region, spanning from 1860 to 1904. The breakdown of the old structures occurred with the guano boom, marked by the presence of merchant capital and the development of export agriculture in sugar and cotton. Burga analyses the decomposition of the peasantry, the spread of the monetary economy, and the emergence of Sunday markets in the valley[24].

Burga and Reátegui (1981) examine the dynamics and changes brought about by the export of wool in the southern Andean region for the period 1895-1935. One conclusion of interest for the analysis in this chapter is the increased integration into the market experienced by peasant communities, as evidenced by changes in the fairs. Originally held annually for the sale of wool and purchase of necessary goods by the peasants, these fairs transitioned to weekly occurrences. The construction of the railway, which reached Puno in 1876, Sicuani in 1891, and Cusco in 1908, radically transformed the economic organization of the villages along its route, creating new commercial circuits and revitalizing urban centers.

[23] In recent years, the Instituto de Estudios Peruano (IEP) and the Banco Central de Reserva have released four studies on the regional economies of the southern, northern, central, and eastern areas. These represent the most current references on the subject: Monsalve (2019), Lossio and Molina (2023), Contreras and Hernández (2017), and Contreras (2022).

[24] References to the significance of markets and cities in the history of Andean societies can be found in the studies conducted by Larson and Harris (1995) and Kingman (1992).

In 1877, Martinet (1977) authored a study on Peruvian agriculture, identifying one of the key issues in the Sierra as its rugged geography, which hindered the transportation of people and goods. The author reflects on this matter, stating (Martinet, 1977:88): "These poor roads are an almost insurmountable cause of agricultural production paralysis throughout the fertile Sierra region. Indeed, why produce more than what consumption demands when there is no outlet?" It can be assumed that access to the railway would alter this situation.

Access to markets was not restricted solely to goods, but also encompassed labour migration, which led rural inhabitants to traverse various territories in search of monetary incomes. In this regard, Deere (1992) analyses the process of labour migration that enabled the sugar industry in the Northern Coast to access peasant workers from Cajamarca, a department in the Northern Sierra, for the period 1900-1980. The labour force in the sector comprised three distinct groups: Afro-Peruvian population from the North, originating from slavery; Chinese coolie labourers who replaced the former; and peasants from the Sierra de Cajamarca who had been contracted via the system of enganches (advance payments to cover expenses, which ultimately led to the worker's continuity on the hacienda). This scenario resulted in seasonal migrations associated with the agricultural cycle of peasant production becoming permanent (Zapata, 2021).

Gonzales (2016) analyzes, for the period 1860-1933, the case of the sugar hacienda in Cayaltí, located in the northern department of Lambayeque. The author finds that from the 1880s onwards, the haciendas of the northern Coast began to replace the aging Chinese coolies with workers from the Sierra. However, this labour market, with a massive Andean presence, was not exclusive to the sugar production sector. Peloso (2013) analyzes the case of cotton production in the coastal department of Ica and finds the same ethnic group composition in the sector's workforce, highlighting the presence of Sierra peasants migrating to work in cotton haciendas. In some cases, it involves seasonal migration that allows them to generate income for the purchase of their means of subsistence or inputs for their activities in the agricultural unit.

However, it was not only agricultural activity that demanded and employed Sierra labour but extended to mining activity, mainly located in the Central Sierra, which hired peasant labour from neighboring *departmentos* to the mines. Long and Roberts (2001) study this process for the case of the central Sierra and find that migrations to the mines are often permanent, with women assuming responsibility for agriculture, animal husbandry, and household care. This hints at the long-standing practice of migration and diversification of income sources.

One way to capture the bi-directional relationship between the rural and urban sectors specifically, the complementary relationship between agriculture and the variable representing urban development, as evidenced by the econometric results, is to consider, by way of illustration, the relationship between Lima and its rural surroundings during the period 1840-1860.

Velazco (1996) investigated the characteristics of this relationship using the diaries of European travelers and a review of *El Comercio* newspaper for the mentioned period. It was found that the city's population growth demanded a continuous flow of significant quantities of provisions. The supply specialized in the valleys near the capital, as well as in coastal and mountain regions, and even from neighbouring countries. However, the commercial circuit between Lima and its supplying agricultural areas extended beyond the exchange of products and provisions. Labour migration was also constant. Blacks and indigenous people went to work in the city every day and return to their areas of origin in the evening. This was also true for Andean peasants and miners who participated in Lima's markets. They contributed the rural component, constantly moving spatially and well integrated into the urban economy. Lima provided the rural areas with supplies, seeds, agricultural machinery and tools, experienced professionals, as well as political power, which was established in the city.

The evidence presented thus far accounts for a relationship between rural and urban agents in goods and services as well as labour markets. Moreover, these transactions are facilitated by the policy of road and highway construction as part of public policies aimed at the rural area during the 1920s. Roads were opened to connect *departmento* capitals with provinces and districts (Asensio, 2023). This policy was also present in what is termed the Developmental State (1957-1968) and has continued in subsequent decades (Orihuela, 2017). In other words, the material conditions were already in place to facilitate these exchanges and expect greater integration of rural and urban markets.

Delving into the discussion on the feedback relationship between agriculture and the SCE variable (services and energy), it can be understood that the agricultural sector, dedicated to the domestic market, provides food to the city, but the city also offers opportunities to generate income as part of the rural household's income diversification strategy.

With respect to the labour market interaction of rural households, it is important to point out the livelihood diversification strategy (farm and non-farm activities) carried out by rural households. The labour market is one channel in which the double relationship between agriculture and the rest of the sectors occurs. In Latin America, the non-farm rural sector is particularly important because of its effect on employment and productivity of rural economies.

Table 3.24 summarises some studies carried out with peasant households in the Peruvian Sierra between 1968-1993. These case studies provide an indication of the quantitative importance of non-farm income for peasant families. One salient feature of the peasant economy is the diversification of their activities; that is, not only do they work in agriculture and cattle breeding, but also participate in manufacturing, trading and wage employment. Figueroa (1989) found that, in the most traditional communities of the Southern Sierra, half of the monetary income originates from non-agricultural sources.

Table 3.24. Income Portfolios in Rural Peruvian Sierra Based on Peasant Household Surveys

Research Zone	**Junin/Lima[1]**	**Cajamarca[2]**	**Cusco[3]**	**South Sierra[4]**	**Bambamarca[5]**
Year	1968/1969	1972/1973	1977	1978/1979	1992/1993
Sample size	2,827	1,622	280	306	60
Income Source (In %)					
Farm	9.3	14.1	35.9	11.1	20.2
Livestock	18.6	13.3	26.6	18.7	38.0
Manufacturing	nd	5.8	4.7	18.9*	37.5
Trading	nd	11.5	nd	nd	nd
Wage income	48.4	41.3	30.1	32	4.3
Rent	20.7	3.9	0.1	0.6	nd
Remittances	nd	6.6	2.6	8.9	nd
Others	3	3.5	nd	9.8	nd
Total	100	100	100	100	100

Sources: Elaborated by author based on:
1.Amat and Leon (1977, Table 9 and 16 of Statistic Annex) cited by Caballero, J.M. (1981) in *Economía Agraria de la Sierra Peruana. Antes de la Reforma Agraria de 1969.* Lima: IEP. (Table 36, pp. 215-216)
2. CRIAN (1974, Table 4), cited by Caballero, J. M. (1981). in *Economía Agraria de la Sierra Peruana. Antes de la Reforma Agraria de 1969*. Lima: IEP. (Table 36, pp.215-216)
3.Gonzales de Olarte, E. (1994) *En las Fronteras del Mercado. Economía Política del Campesinado en el Perú*. Lima: IEP. (Table 2.3, p.124).
4. Figueroa, A. (1989). *La Economía Campesina de la Sierra del Perú*. Lima: PUCP, Fondo Editorial, Cuarta Edición. (Table IV.5, p. 79)
5. Gonzales de Olarte, E. (1996). *El Ajuste Estructural y los Campesinos*. Lima: IEP, colección mínima 33. (Table 19, p.52)
nd: Not determined
*Includes trade income

An analysis of the evolution of complementary income-generating activities between the 1994 and 2012 farm censuses by Velazco and Fuertes (2017) shows the scale of productive diversification that has taken place. In 1994, 25.7% of total agricultural producers carried out paid activity off the farm. By 2012, according to the farm census of that year, this participation had increased to 40.7%. In general, farmers have significantly increased their participation in the sectors of trade, processed products, construction, agriculture (off-farm), transport and communications.

To illustrate the significance of rural households' involvement in various markets (goods, inputs, and labour), Velazco (2001) conducted fieldwork in 1998 and 2000 in two regions of the Sierra, one in the central part, in Ayacucho, and the other in the north, in Cajamarca. Table 3.25 summarises the types of transactions they engage in across markets, identifying products and exchange locations. It is observed that families actively participate in goods, services, and factor markets, with the labour market standing out. For both study areas, the nearest city, Bambamarca for Cajamarca and Huanta for Ayacucho, emerge as the most frequented urban centres for purchasing goods and services for household consumption, such as processed foods, agricultural products, industrial goods, agricultural inputs, livestock, and handicrafts, as well as access to various services, including education and healthcare. Conversely, families' participation in labour markets—both agricultural and non-agricultural—leads them to traverse regional markets, incorporating departments of the Coast, particularly for families from Cajamarca, and the Amazon, in the case of Ayacucho.

Table 3.25. Commercial Circuits in rural Cajamarca (2000) and rural Ayacucho (1998)

Markets	Supply		Demand	
	Cajamarca	Ayacucho	Cajamarca	Ayacucho
Consumer goods	Agricultural and processed products. Small animals Cattle and sheep. Handcrafted products and straw hats. Milk, fresh cheese, and cheeses. Location: Community and Bambamarca	Agricultural and processed products. Location: Local fair, community, and Huanta.	Industrial Goods. Purchase of agricultural products. Breeding animals. Construction materials. Location: Local fair, community, and Huanta	Industrial Goods. Barter and purchase of agricultural products (net buyer). Location: Local fair, community, and Huanta
Services	------	------	Education Healthcare Transportation	Education Healthcare Transportation
Factors/inputs	Labor: agricultural laborer, street vendor, construction worker, and domestic worker. Location: Bambamarca, Cajamarca, Trujillo, Lima, and the Selva.	Labor: agricultural laborer, street vendor, and domestic worker. Location: Huanta, Lima, and the Selva.	Agricultural inputs and equipment. Wool/straw for hat weaving. Oxen rental. Hiring laborers. Location: Community and Bambamarca	Agricultural inputs and equipment. Credits from non-governmental organizations. Location: Huanta and Huamanga. .

Source: Velazco (2001) based on fieldwork in Cajamarca and Ayacucho.

Using the National Household Surveys (ENAHO) for the years 1997, 2004, and from 2006 to 2010, a study by the Banco Mundial (2017) estimates the various sources of income for rural households. Table 3.26 demonstrates that in the 21st century, the trends discussed for previous periods persist. That is to say, income diversification remains a characteristic of rural households, and the participation of wage incomes, both agricultural and non-agricultural, exhibits an increasing trend.

Table 3.26. Sources of household income, rural households, Peru, 1997-2010

	1997	2004	2006	2007	2008	2009	2010
Agricultural income	55.7	61.0	60.4	55.6	57.7	58.4	56.4
• Wage	6.7	14.3	15.1	12.8	12.3	12.4	11.2
• Non-wage income	49.0	46.7	45.3	42.8	45.4	46.0	45.2
Non-agricultural income	44.3	39.0	39.6	44.4	42.3	41.6	43.6
• Wage	14.6	23.1	22.2	25.4	25.1	25.4	25.8
• Non-wage income	29.7	15.8	17.4	19.0	17.2	16.2	17.8

Source: Banco Mundial (2017: 14), estimations based on National Household Surveys (ENAHO)

The cointegration results suggest a relationship between agriculture and mining, indicating that mining expansion creates employment opportunities and local product demand, which may stimulate agricultural production. In his study of silver mining during the 19th and early 20th centuries in the central Sierra region, Contreras (1988) examines the relationship between mining and agriculture. The author observes that well into the 20th century, miners maintained a dual status as both peasants and mine workers, alternating between periods of agricultural work in fields or pastures and employment in mines. Contreras concludes that this unique relationship made mining the primary link between the modern sector and the traditional agricultural sector of Andean economies, identifying an articulation between both modes of production. The pivotal components of this link were the markets for goods and labour.

Furthermore, econometric findings pointed out a negative relationship between agriculture and industry. This outcome could be related to the effects of the ISI policies that undermined the expansion options of agriculture. This conflicting association could embody an obstacle for a sustainable and stable process of economic growth. The trade-off or growth trap between agriculture and industry has been shaped by the nature of the development strategies implemented in Peru. In the ISI execution scenario, from 1960 to 1975, the macroeconomic policy to promote industrial growth created conditions that were hostile to agricultural development. Tax and price control policies had a negative effect on the sector's profitability and growth. According to Alberts (1983), agricultural policies were extremely biased in favour of urban consumers. Price control policies and the overvalued exchange rate discriminated against agricultural exports and incentivised food imports.

The ISI policies did not achieve the expected results. They were a failure as a model of development. Jiménez (2017) describes them as spurious industrialisation that deepened the structural imbalances that made the continuity of the model unviable. The author identifies the following "perverse" elements that originated the processes of spurious industrialisation.

First, the disarticulation of agriculture and industry. Agriculture is unable to sustainably generate foreign exchange and wage goods required to support industrial modernisation, while industry was unable to supply the demand for labour, the market for agricultural products, the inputs and capital goods needed to modernise agriculture and rural production. Second, the growth of industry was unbalanced, with the branches producing durable goods having hegemony, while the production of capital goods and some intermediate goods were practically non-existent. Third, poverty levels increased, and peasants and urban dwellers were marginalised from the benefits of growth. Fourth, spurious substitute industrialisation did not eliminate the constraint of the external sector. Thus, the industrial structure was unable to generate foreign exchange to sustain growth in terms of imports and payments to external factors.

Furthermore, liberalisation policies of the 1990s created the conditions for a process of deindustrialisation, with a significant reduction of industry's participation in the total GDP as well as its participation in total employment. This trend identified by CEPAL (2014) for South America is also applicable to Peru. This means that the export-led growth model applied since the 1990s is mainly a resource-based model (agriculture, mining and the primary product processing industry), characterised by the re-primarisation of the economy.

Gonzales (2015) carried out a comparative analysis of the input-output tables of 1950, 1955, 1969, 1973, 1979, 1994 and 2007. His results are key to understanding the nature of the relationship between sectors according to the causality tests performed previously. Analysing the period 1950-2013, the author identified a long-lasting economic cycle initiated in the 1950s, with a boom in 1975, that ended with a deep crisis towards 1990, and whose economic model was the primary exporter and semi-industrial dependent (PESID). After 1990, structural adjustment and its institutional reforms generated a new long-term cycle and a new economic model: the primary exporter and services model (PESER).

In 1950, the Peruvian economy was characterised as: 1) having low levels of integration between economic sectors; 2) being an open economy with a primary export sector and dependent on imports of inputs and final goods; and 3) having a government with limited intervention in the economy.

Agriculture and mining did not exchange inputs. Mining barely connected with the industrial and commercial sector and services were too poorly developed to provide inputs to other sectors. Agriculture was the most important sector, producing 34% of the inputs and 29% of the gross value of production. The Peruvian economy had an export sector made up of agricultural and mining goods that constituted 62% of exports. The main point was that Peru was a primary export economy based on two sectors with different characteristics. The mining sector did not generate an internal economic dynamic in its own regions, due to its poor coordination with other sectors and the limited use of labour. On the other hand, the agricultural sector did have greater sectoral integration and generated more employment, but it had a modern export sector and a traditional sector with low productivity. However, the most articulated sector by supply and demand was the industrial sector, although it had very little articulation with mining.

The analysis of the input-output tables indicates that articulation has increased since 1950. The most striking features are, first, that the economy in 2007 has more intrasectoral articulation, especially industry, while the intersectoral articulation has been oscillating. Secondly, Peru is an open economy, in which the export axis of the 1950s and 1960s was an agricultural and mining combination that became, over the years, more important in mining exports, although non-primary exports have increased in recent years. The transition from one export sector to another has had repercussions on internal articulation: the agro-export economy is more articulated with other sectors, especially industry, while the exporting mining sector is less (Gonzales, 2015).

3.8. Conclusions

The objective of this chapter was to examine the role of agriculture in economic growth for the period of 1896-2012 and sub-periods. Time-series co-integration techniques were employed for this purpose. Two themes were investigated: a) the relationship between agriculture, mining, industry, and an aggregate of sectors representing the level of urban development (services and energy); and b) the export-led growth and import-led growth hypotheses were tested.

Concerning the first objective, a feedback relationship was found between agriculture and the other sectors. This indicates that agriculture provides food to the city, and the city, in turn, offers employment opportunities, with migratory processes and the labour market being significant transmission chanel.

Additionally, the chapter identified the role of export (agriculture and non-agriculture) and imports in economic growth. For this purpose, and using a Cobb-Douglas function, the relevance of the agricultural export-led growth model, non-agricultural export-led model, and import-led growth model for the entire sample was analysed. The empirical analysis also corroborated the existence of an export-led growth model, where both agricultural and non-agricultural exports were relevant. Additionally, the existence of an import-led growth model was verified. The composition of imports, mostly concentrated in inputs and capital goods, explained this result. In this regard, it can be suggested that the Peruvian case is one of an economy that must export (both agricultural and non-agricultural goods) to import, and by purchasing inputs and capital goods, it creates the conditions to stimulate economic growth. This explains the feedback relationship between exports, imports, and growth.

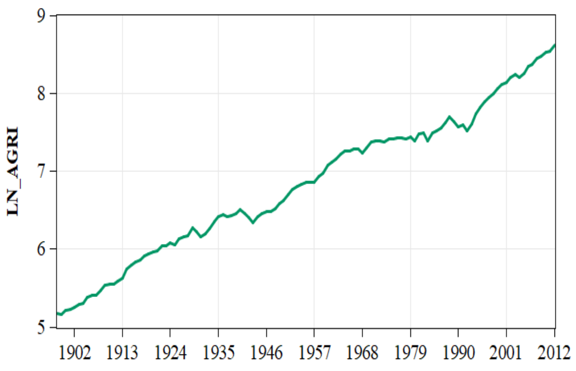
Having identified the roles of agriculture in the growth process, the next chapter will investigate the sources that enable growth in Peruvian agriculture.

APPENDICES CHAPTER 3

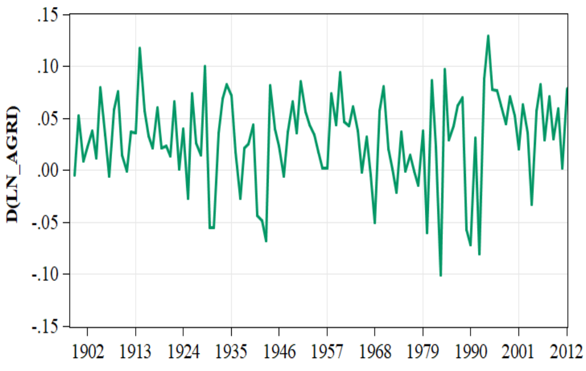
Appendix 3.1

Selected variables for the empirical analysis, 1896-2012

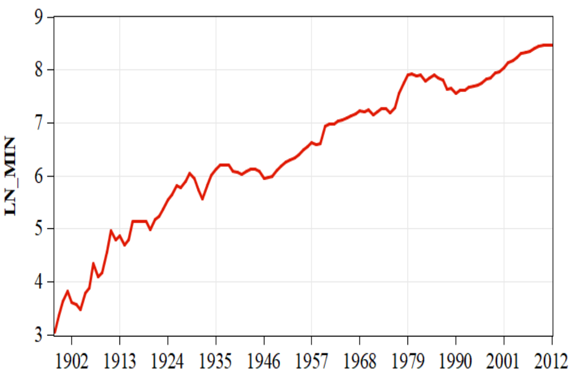
Agriculture GDP in logarithms



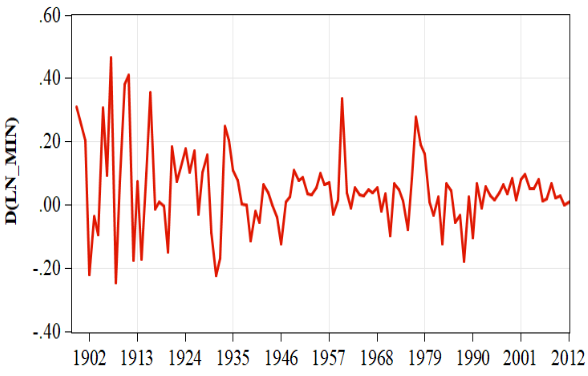
Agriculture GDP in first differences



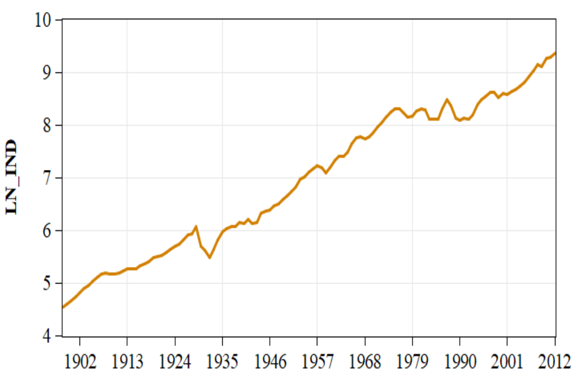
Mining GDP in logarithms



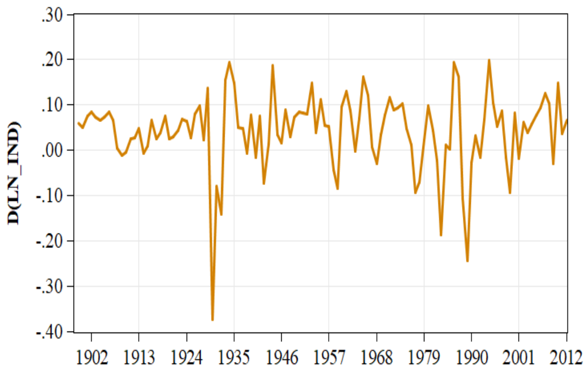
Mining GDP in first differences



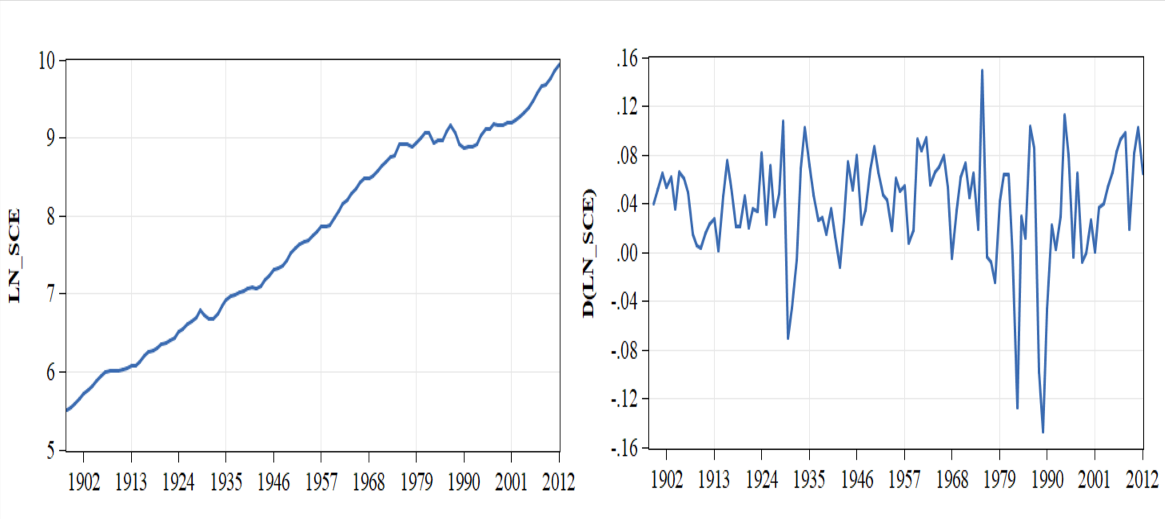
Industry GDP in logarithms



Industry GDP in first differences



Service GDP in logarithms **Service GDP in first differences**



Appendix 3.2

Results from unit root tests with ADF (in levels)

1898-2012				1898-1956			
ADF				ADF			
Levels (in logs)	Lags	Test	p-values*/ (Decision)	Levels (in logs)	Lags	Test	p-values*/ (Decision)
LN_AGRI				**LN_AGRI**			
NINT	0	7.27	1.00 (NS)	NINT	0	5.48	1.00 (NS)
INT	0	0.20	0.97 (NS)	INT	0	-0.86	0.79 (NS)
IT	0	-1.83	0.68 (NS)	IT	0	-1.79	0.70 (NS)
LN_MIN				**LN_MIN**			
NINT	0	3.33	1.00 (NS)	NINT	0	2.41	1.00 (NS)
INT	0	-2.57	0.10 (NS)	INT	0	-2.36	0.16 (NS)
IT	1	-3.04	0.13 (NS)	IT	0	-2.19	0.48 (NS)
LN_IND				**LN_IND**			
NINT	1	3.49	1.00 (NS)	NINT	0	4.27	1.00 (NS)
INT	1	-0.39	0.91 (NS)	INT	0	0.24	0.97 (NS)
IT	1	-2.83	0.19 (NS)	IT	0	-1.60	0.78 (NS)
LN_SCE				**LN_SCE**			
NINT	1	4.55	1.00 (NS)	NINT	0	9.41	1.00 (NS)
INT	1	-0.30	0.92 (NS)	INT	0	0.33	0.98 (NS)
IT	1	-2.07	0.55 (NS)	IT	1	-2.85	0.19 (NS)

Results from unit root tests with ADF ((in first difference)

1898-2012				1898-1956			
ADF				ADF			
In first differences	Lags	Test	p-values*/ (Decision)	In first differences	Lags	Test	p-values*/ (Decision)
LN_AGRI				**LN_AGRI**			
NINT	0	-7.02	0.00 (S)	NINT	0	-4.65	0.00 (S)
INT	0	-9.69	0.00 (S)	INT	0	-6.56	0.00 (S)
IT	0	-9.65	0.00 (S)	IT	0	-6.56	0.00 (S)
LN_MIN				**LN_MIN**			
NINT	0	-8.76	0.00 (S)	NINT	0	-6.41	0.00 (S)
INT	0	-9.66	0.00 (S)	INT	0	-7.04	0.00 (S)
IT	0	-9.78	0.00 (S)	IT	1	-5.83	0.00 (S)
LN_IND				**LN_IND**			
NINT	0	-6.92	0.00 (S)	NINT	0	-5.25	0.00 (S)
INT	0	-8.17	0.00 (S)	INT	0	-6.47	0.00 (S)
IT	0	-8.14	0.00 (S)	IT	0	-6.46	0.00 (S)
LN_SCE				**LN_SCE**			
NINT	0	-4.98	0.00 (S)	NINT	0	-2.96	0.00 (S)
INT	0	-7.22	0.00 (S)	INT	0	-5.42	0.00 (S)
IT	0	-7.19	0.00 (S)	IT	0	-5.39	0.00 (S)

*MacKinnon (1996) one-sided p-values.

NS is non-stationary. Lag length based on SIC (Schwarz information criterion).

IT: Intercept and trend

NINT: No intercept and no trend

NIT: No intercept and trend

Results from unit root tests with ADF (in levels)

1957-1990				1991-2012			
ADF				ADF			
Levels (in logs)	Lags	Test	p-values*/ (Decision)	Levels (in logs)	Lags	Test	p-values*/ (Decision)
LN_AGRI				**LN_AGRI**			
NINT	0	2.39	1.00 (NS)	NINT	0	4.88	1.00 (NS)
INT	0	-2.79	0.07 (NS)	INT	0	-0.57	0.86 (NS)
IT	0	-3.06	0.13 (NS)	IT	0	-1.90	0.62 (NS)
LN_MIN				**LN_MIN**			
NINT	0	1.46	0.96 (NS)	NINT	0	6.07	1.00 (NS)
INT	0	-1.85	0.35 (NS)	INT	0	-0.59	0.85 (NS)
IT	0	-0.78	0.96 (NS)	IT	0	-1.13	0.90 (NS)
LN_IND				**LN_IND**			
NINT	2	2.22	0.99 (NS)	NINT	0	4.04	1.00 (NS)
INT	3	-2.46	0.14 (NS)	INT	0	-0.06	0.94 (NS)
IT	3	-0.54	0.98 (NS)	IT	0	-1.56	0.77 (NS)
LN_SCE				**LN_SCE**			
NINT	6	-0.52	0.48 (NS)	NINT	0	5.99	1.00 (NS)
INT	3	-3.62	0.01 (S)	INT	0	1.80	1.00 (NS)
IT	4	0.78	1.00 (NS)	IT	0	-0.40	0.98 (NS)

Results from unit root tests with ADF ((in first difference)

1957-1990				1991-2012			
ADF				ADF			
In first differences	Lags	Test	p-values*/ (Decision)	In first differences	Lags	Test	p-values*/ (Decision)
LN_AGRI				**LN_AGRI**			
NINT	0	-4.75	0.00 (S)	NINT	0	-2.29	0.05 (S)
INT	0	-5.34	0.00 (S)	INT	0	-5.81	0.00 (S)
IT	0	-5.66	0.00 (S)	IT	0	-6.51	0.00 (S)
LN_MIN				**LN_MIN**			
NINT	0	-4.04	0.00 (S)	NINT	0	-2.30	0.05 (S)
INT	0	-4.23	0.00 (S)	INT	0	-4.39	0.00 (S)
IT	0	-4.62	0.00 (S)	IT	0	-4.47	0.01 (S)
LN_IND				**LN_IND**			
NINT	1	-4.66	0.00 (S)	NINT	0	-2.61	0.10 (S)
INT	1	-5.55	0.00 (S)	INT	0	-4.25	0.00 (S)
IT	2	-5.38	0.00 (S)	IT	0	-4.11	0.02 (S)
LN_SCE				**LN_SCE**			
NINT	0	-3.27	0.00 (S)	NINT	0	-1.60	0.10 (S)
INT	0	-4.36	0.00 (S)	INT	0	-3.31	0.03 (S)
IT	3	-5.71	0.00 (S)	IT	0	-3.51	0.07 (S)

*MacKinnon (1996) one-sided p-values.

NS is non-stationary. Lag length based on SIC (Schwarz information criterion).

IT: Intercept and trend

NINT: No intercept and no trend

NIT: No intercept and trend

Results from unit root tests with Phillips-Perron (in levels)

1898-2012			1898-1956		
Phillips-Perron			Phillips-Perron		
Levels (in logs)	Test	p-values*/ (Decision)	Levels (in logs)	Test	p-values*/ (Decision)
LN_AGRI			**LN_AGRI**		
NINT	7.11	1.00 (NS)	NINT	5.55	1.00 (NS)
INT	0.19	0.97 (NS)	INT	-0.87	0.79 (NS)
IT	-2.01	0.59 (NS)	IT	-1.82	0.68 (NS)
LN_MIN			**LN_MIN**		
NINT	3.21	1.00 (NS)	NINT	2.51	1.00 (NS)
INT	-3.15	0.03 (S)	INT	-4.64	0.00 (S)
IT	-3.40	0.06 (NS)	IT	-2.33	0.41 (NS)
LN_IND			**LN_IND**		
NINT	5.25	1.00 (NS)	NINT	3.87	1.00 (NS)
INT	-0.32	0.92 (NS)	INT	0.12	0.96 (NS)
IT	-2.24	0.46 (NS)	IT	-1.60	0.78 (NS)
LN_SCE			**LN_SCE**		
NINT	7.62	1.00 (NS)	NINT	8.75	1.00 (NS)
INT	-0.31	0.92 (NS)	INT	0.28	0.97 (NS)
IT	-1.65	0.76 (NS)	IT	-2.13	0.52 (NS)

Results from unit root tests with Phillips-Perron (in first differences)

1898-2012			1898-1956		
Phillips-Perron			Phillips-Perron		
In first differences	Test	p-values*/ (Decision)	In first differences	Test	p-values*/ (Decision)
LN_AGRI			**LN_AGRI**		
NINT	-7.42	0.00 (S)	NINT	-4.60	0.00 (S)
INT	-9.65	0.00 (S)	INT	-6.50	0.00 (S)
IT	-9.61	0.00 (S)	IT	-6.54	0.00 (S)
LN_MIN			**LN_MIN**		
NINT	-8.73	0.00 (S)	NINT	-6.40	0.00 (S)
INT	-9.70	0.00 (S)	INT	-7.16	0.00 (S)
IT	-10.30	0.00 (S)	IT	-13.10	0.00 (S)
LN_IND			**LN_IND**		
NINT	-6.86	0.00 (S)	NINT	-5.17	0.00 (S)
INT	-7.91	0.00 (S)	INT	-6.43	0.00 (S)
IT	-7.86	0.00 (S)	IT	-6.38	0.00 (S)
LN_SCE			**LN_SCE**		
NINT	-4.80	0.00 (S)	NINT	-2.68	0.01 (S)
INT	-7.15	0.00 (S)	INT	-5.12	0.00 (S)
IT	-7.11	0.00 (S)	IT	-5.08	0.00 (S)

*MacKinnon (1996) one-sided p-values.
NS is non-stationary. Lag length based on SIC (Schwarz information criterion).
IT: Intercept and trend
NINT: No intercept and no trend
NIT: No intercept and trend

Results from unit root tests with Phillips-Perron (in levels)

1957-1990 Phillips-Perron		
Levels (in logs)	Test	p-values*/ (Decision)
LN_AGRI		
NINT	2.50	1.00 (NS)
INT	-2.79	0.07 (NS)
IT	-3.04	0.14 (NS)
LN_MIN		
NINT	1.31	0.95 (NS)
INT	-1.82	0.36 (NS)
IT	-1.03	0.93 (NS)
LN_IND		
NINT	1.32	0.95 (NS)
INT	-2.02	0.28 (NS)
IT	0.91	1.00 (NS)
LN_SCE		
NINT	2.10	0.99 (NS)
INT	-2.79	0.07 (NS)
IT	3.93	1.00 (NS)

1991-2012 Phillips-Perron		
Levels (in logs)	Test	p-values*/ (Decision)
LN_AGRI		
NINT	5.76	1.00 (NS)
INT	-0.59	0.86 (NS)
IT	-1.96	0.59 (NS)
LN_MIN		
NINT	6.07	1.00 (NS)
INT	-0.59	0.85 (NS)
IT	-1.28	0.87 (NS)
LN_IND		
NINT	4.04	1.00 (NS)
INT	-0.06	0.94 (NS)
IT	-1.67	0.73 (NS)
LN_SCE		
NINT	5.34	1.00 (NS)
INT	1.80	1.00 (NS)
IT	-0.57	0.97 (NS)

Results from unit root tests with Phillips-Perron (in first differences)

1957-1990 Phillips-Perron		
In first differences	Test	p-values*/ (Decision)
LN_AGRI		
NINT	-4.76	0.00 (S)
INT	-5.34	0.00 (S)
IT	-5.66	0.00 (S)
LN_MIN		
NINT	-4.03	0.00 (S)
INT	-4.23	0.00 (S)
IT	-4.62	0.00 (S)
LN_IND		
NINT	-3.48	0.00 (S)
INT	-3.17	0.03 (S)
IT	-4.36	0.01 (S)
LN_SCE		
NINT	-3.07	0.00 (S)
INT	-3.53	0.00 (S)
IT	-5.69	0.01 (S)

1991-2012 Phillips-Perron		
In first differences	Test	p-values*/ (Decision)
LN_AGRI		
NINT	-2.25	0.03 (S)
INT	-5.67	0.00 (S)
IT	-6.51	0.00 (S)
LN_MIN		
NINT	-1.61	0.10 (S)
INT	-4.39	0.00 (S)
IT	-4.47	0.01 (S)
LN_IND		
NINT	-2.43	0.02 (S)
INT	-4.25	0.00 (S)
IT	-4.11	0.02 (S)
LN_SCE		
NINT	-1.67	0.10 (S)
INT	-3.31	0.03 (S)
IT	-3.51	0.07 (S)

*MacKinnon (1996) one-sided p-values.
NS is non-stationary. Lag length based on SIC (Schwarz information criterion).
IT: Intercept and trend
NINT: No intercept and no trend
NIT: No intercept and trend

Appendix 3.3

Vector Error Correction models and Post – Estimation Diagnostic Tests

1) Period 1898-2012

Vector Error Correction Estimates
Date: 10/29/23 Time: 23:50
Sample (adjusted): 1900 2012
Included observations: 113 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2		
LN_AGRI(-1)	1.000000	0.000000		
LN_MIN(-1)	0.000000	1.000000		
LN_IND(-1)	4.321887	9.538999		
	(1.75646)	(2.59452)		
	[2.46056]	[3.67659]		
LN_SCE(-1)	-5.439468	-11.40409		
	(1.90071)	(2.80759)		
	[-2.86181]	[-4.06187]		
C	6.702829	17.27108		
	(2.68468)	(3.96562)		
	[2.49670]	[4.35520]		
Error Correction:	**D(LN_AGRI)**	**D(LN_MIN)**	**D(LN_IND)**	**D(LN_SCE)**
CointEq1	0.049321	0.138535	0.142859	0.066060
	(0.01678)	(0.04688)	(0.02891)	(0.01583)
	[2.93934]	[2.95539]	[4.94143]	[4.17403]
CointEq2	-0.023799	-0.081146	-0.099224	-0.036249
	(0.01241)	(0.03466)	(0.02138)	(0.01170)
	[-1.91818]	[-2.34115]	[-4.64159]	[-3.09758]
D(LN_AGRI(-1))	-0.057533	0.163521	-0.263876	-0.146187
	(0.10895)	(0.30436)	(0.18772)	(0.10276)
	[-0.52807]	[0.53725]	[-1.40571]	[-1.42257]
D(LN_MIN(-1))	-0.012003	0.140489	0.102641	0.040027
	(0.03420)	(0.09554)	(0.05893)	(0.03226)
	[-0.35096]	[1.47042]	[1.74185]	[1.24083]
D(LN_IND(-1))	0.102371	0.028881	0.169874	0.131560
	(0.08504)	(0.23758)	(0.14653)	(0.08021)
	[1.20375]	[0.12156]	[1.15934]	[1.64013]
D(LN_SCE(-1))	0.022877	-0.348634	0.374730	0.174230
	(0.15846)	(0.44268)	(0.27302)	(0.14946)
	[0.14437]	[-0.78755]	[1.37252]	[1.16572]
DUMMY	-0.010774	-0.022745	-0.024738	-0.010965
	(0.00855)	(0.02390)	(0.01474)	(0.00807)
	[-1.25942]	[-0.95177]	[-1.67844]	[-1.35901]
R-squared	0.063423	0.088755	0.235442	0.206966
Adj. R-squared	0.010409	0.037175	0.192165	0.162077
Sum sq. resids	0.203650	1.589312	0.604544	0.181172
S.E. equation	0.043832	0.122448	0.075520	0.041342
F-statistic	1.196349	1.720721	5.440366	4.610646
Log likelihood	196.6687	80.58085	135.1927	203.2768
Akaike AIC	-3.356969	-1.302316	-2.268897	-3.473926
Schwarz SC	-3.188016	-1.133363	-2.099944	-3.304973
Mean dependent	0.030502	0.045271	0.042107	0.038827
S.D. dependent	0.044062	0.124789	0.084023	0.045164

Determinant resid covariance (dof adj.)	8.51E-11
Determinant resid covariance	6.59E-11
Log likelihood	683.1664
Akaike information criterion	-11.41887
Schwarz criterion	-10.50170
Number of coefficients	38

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	247.5323	0.0000	Heteroscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	15.7306	0.4719	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	0.9858	0.4721	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	13.9293	0.9739	Zero Serial Correlation
VEC Residual Normality Test (Kurtosis)	Join test (Chi-sq)	106.3619	0.0000	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

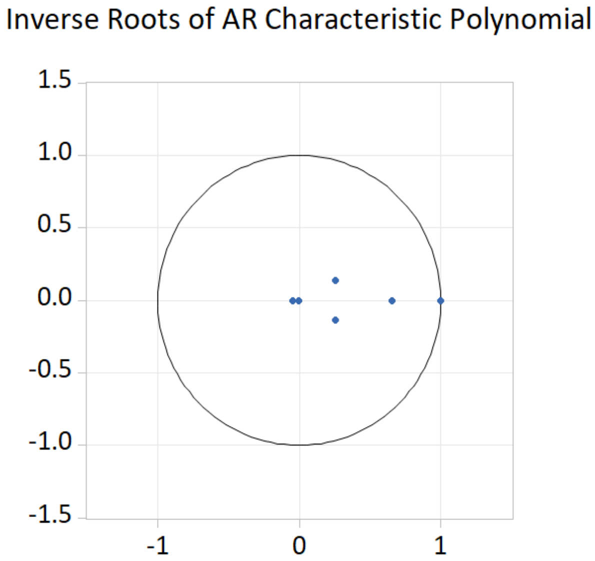
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_AGRI LN_MIN LN_IND LN_SCE
Exogenous variables: DUMMY
Lag specification: 1 1
Date: 03/04/24 Time: 15:15

Root	Modulus
1.000000	1.000000
1.000000	1.000000
0.995738	0.995738
0.655648	0.655648
0.258517 - 0.133287i	0.290855
0.258517 + 0.133287i	0.290855
-0.047653	0.047653
-0.000548	0.000548

VEC specification imposes 2 unit root(s).



2) Period 1898-1956

Vector Error Correction Estimates
Date: 11/14/23 Time: 21:06
Sample (adjusted): 1900 1956
Included observations: 57 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1		
LN_AGRI(-1)	1.000000		
LN_IND(-1)	2.518118		
	(1.11827)		
	[2.25179]		
LN_SCE(-1)	-3.278696		
	(0.96858)		
	[-3.38506]		
Error Correction:	**D(LN_AGRI)**	**D(LN_IND)**	**D(LN_SCE)**
CointEq1	-0.028399	-0.039004	-0.026529
	(0.00749)	(0.01568)	(0.00600)
	[-3.79124]	[-2.48711]	[-4.42070]
D(LN_AGRI(-1))	0.109922	-0.074507	-0.022866
	(0.15440)	(0.32325)	(0.12369)
	[0.71194]	[-0.23049]	[-0.18486]
D(LN_IND(-1))	0.221656	0.068822	0.124861
	(0.10279)	(0.21519)	(0.08235)
	[2.15650]	[0.31982]	[1.51631]
D(LN_SCE(-1))	-0.362913	0.315620	0.105309
	(0.27335)	(0.57229)	(0.21899)
	[-1.32765]	[0.55151]	[0.48088]
DUMMY	-0.005455	-0.027808	-0.001389
	(0.01007)	(0.02108)	(0.00807)
	[-0.54188]	[-1.31932]	[-0.17221]
R-squared	0.123936	0.100136	0.157055
Adj. R-squared	0.056547	0.030916	0.092213
Sum sq. resids	0.076541	0.335493	0.049126
S.E. equation	0.038366	0.080323	0.030736
F-statistic	1.839099	1.446625	2.422125
Log likelihood	107.5904	65.47387	120.2285
Akaike AIC	-3.599664	-2.121890	-4.043106
Schwarz SC	-3.420449	-1.942675	-3.863891
Mean dependent	0.029652	0.045045	0.039602
S.D. dependent	0.039499	0.081594	0.032260
Determinant resid covariance (dof adj.)		2.81E-09	
Determinant resid covariance		2.13E-09	
Log likelihood		326.4183	
Akaike information criterion		-10.82170	
Schwarz criterion		-10.17652	
Number of coefficients		18	

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	93.6107	0.0007	Heteroscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	12.1425	0.2054	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	1.3789	0.2057	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	12.8632	0.6129	Zero Serial Correlation
VEC Residual Normality Test (Kurtosis)	Join test (Chi-sq)	222.2404	0.0000	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

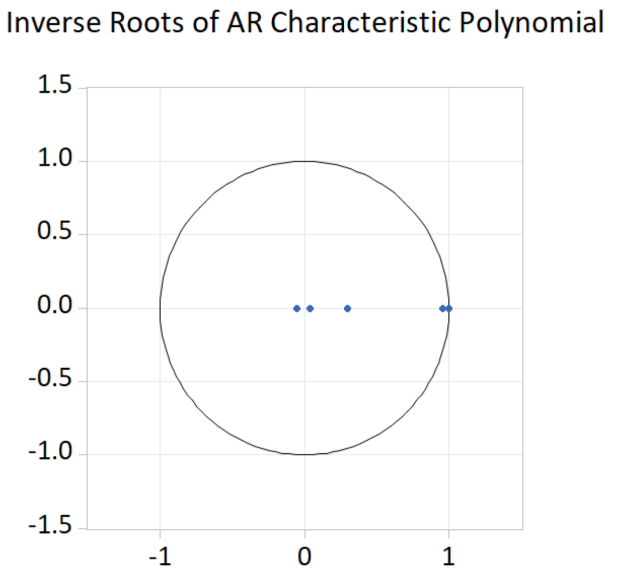
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN AGRI LN IND LN SCE
Exogenous variables: DUMMY
Lag specification: 1 1
Date: 03/04/24 Time: 15:23

Root	Modulus
1.000000 - 3.89e-16i	1.000000
1.000000 + 3.89e-16i	1.000000
0.957925	0.957925
0.295643	0.295643
-0.050471	0.050471
0.041321	0.041321

VEC specification imposes 2 unit root(s).



3) Period 1957-1990

Vector Error Correction Estimates
Date: 11/14/23 Time: 09:54
Sample (adjusted): 1959 1990
Included observations: 32 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2		
LN_AGRI(-1)	1.000000	0.000000		
LN_MIN(-1)	0.000000	1.000000		
LN_IND(-1)	-0.380674	3.245666		
	(0.18974)	(0.28702)		
	[-2.00630]	[11.3081]		
LN_SCE(-1)	0.078894	-4.251639		
	(0.19431)	(0.29394)		
	[0.40601]	[-14.4642]		
C	-5.084988	3.704372		
	(0.34881)	(0.52765)		
	[-14.5781]	[7.02051]		
Error Correction:	**D(LN_AGRI)**	**D(LN_MIN)**	**D(LN_IND)**	**D(LN_SCE)**
CointEq1	-0.408224	-0.897265	-0.362969	-0.459322
	(0.12459)	(0.25513)	(0.24411)	(0.17384)
	[-3.27645]	[-3.51683]	[-1.48690]	[-2.64216]
CointEq2	-0.225396	-0.338261	-0.443463	-0.182731
	(0.07666)	(0.15699)	(0.15020)	(0.10697)
	[-2.94009]	[-2.15473]	[-2.95244]	[-1.70830]
D(LN_AGRI(-1))	-0.094642	0.236012	-0.432093	-0.040708
	(0.18832)	(0.38562)	(0.36896)	(0.26276)
	[-0.50257]	[0.61203]	[-1.17110]	[-0.15493]
D(LN_MIN(-1))	-0.020782	0.182026	0.352961	0.175595
	(0.07888)	(0.16152)	(0.15455)	(0.11006)
	[-0.26347]	[1.12692]	[2.28387]	[1.59545]
D(LN_IND(-1))	0.508821	-0.028601	1.005181	0.622174
	(0.21269)	(0.43554)	(0.41672)	(0.29677)
	[2.39229]	[-0.06567]	[2.41214]	[2.09651]
D(LN_SCE(-1))	-0.533960	-0.430715	-0.515353	-0.561222
	(0.32840)	(0.67249)	(0.64343)	(0.45822)
	[-1.62592]	[-0.64048]	[-0.80095]	[-1.22479]
DUMMY	0.008228	-0.030602	-0.011533	-0.005223
	(0.01225)	(0.02508)	(0.02400)	(0.01709)
	[0.67180]	[-1.22022]	[-0.48064]	[-0.30565]
R-squared	0.428043	0.459903	0.459544	0.366935
Adj. R-squared	0.290774	0.330280	0.329834	0.214999
Sum sq. resids	0.043633	0.182963	0.167493	0.084945
S.E. equation	0.041777	0.085548	0.081852	0.058291
F-statistic	3.118268	3.547995	3.542870	2.415067
Log likelihood	60.15684	37.22130	38.63474	49.49768
Akaike AIC	-3.322303	-1.888831	-1.977171	-2.656105
Schwarz SC	-3.001673	-1.568201	-1.656542	-2.335475
Mean dependent	0.019734	0.030135	0.028651	0.031369
S.D. dependent	0.049607	0.104536	0.099986	0.065791
Determinant resid covariance (dof adj.)		3.91E-11		
Determinant resid covariance		1.46E-11		
Log likelihood		217.5941		
Akaike information criterion		-11.22463		
Schwarz criterion		-9.484068		
Number of coefficients		38		

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	133.5575	0.3975	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	14.7755	0.5411	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	0.9251	0.5465	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	16.6453	0.9194	Zero Serial Correlation
VEC Residual Normality Test (Kurtosis)	Join test (Chi-sq)	25.6054	0.0012	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

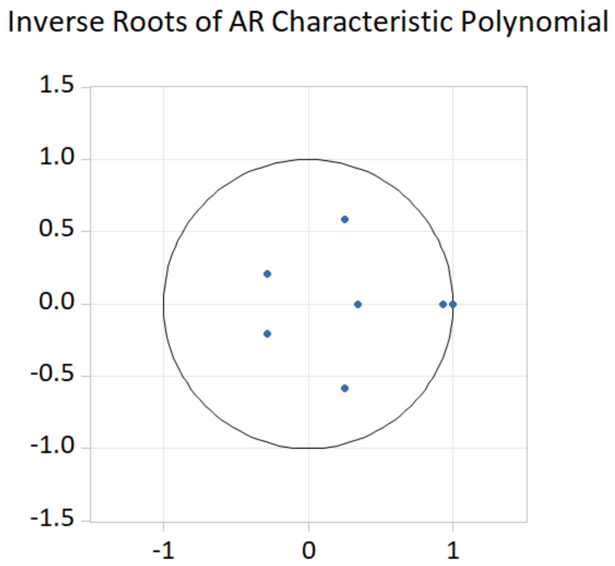
The stability test of long and short run estimates is tested by using the inverse roots of

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_AGRI LN_MIN LN_IND LN_SCE
Exogenous variables: DUMMY
Lag specification: 1 1
Date: 03/04/24 Time: 15:33

Root	Modulus
1.000000	1.000000
1.000000	1.000000
0.932153	0.932153
0.256141 - 0.585468i	0.639047
0.256141 + 0.585468i	0.639047
-0.279943 - 0.208933i	0.349315
-0.279943 + 0.208933i	0.349315
0.339818	0.339818

VEC specification imposes 2 unit root(s).



4) Period 1991-2012

Vector Error Correction Estimates
Date: 11/19/23 Time: 12:57
Sample (adjusted): 1993 2012
Included observations: 20 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_AGRI(-1)	1.000000
LN_MIN(-1)	-0.563683 (0.09585) [-5.88110]
LN_IND(-1)	0.226187 (0.21882) [1.03366]
LN_SCE(-1)	-0.753166 (0.30202) [-2.49372]
C	1.471786

Error Correction:	D(LN_AGRI)	D(LN_MIN)	D(LN_IND)	D(LN_SCE)
CointEq1	-0.359578 (0.10598) [-3.39285]	0.193066 (0.06830) [2.82685]	-0.568503 (0.20130) [-2.82422]	-0.266343 (0.13750) [-1.93711]
D(LN_AGRI(-1))	0.226658 (0.19147) [1.18380]	-0.405407 (0.12339) [-3.28567]	0.528379 (0.36366) [1.45294]	0.131834 (0.24840) [0.53073]
D(LN_MIN(-1))	0.153980 (0.26356) [0.58422]	-0.038730 (0.16985) [-0.22803]	0.288515 (0.50060) [0.57634]	0.187896 (0.34194) [0.54951]
D(LN_IND(-1))	-0.013436 (0.17675) [-0.07601]	0.280931 (0.11390) [2.46636]	-0.085733 (0.33572) [-0.25537]	0.144414 (0.22931) [0.62977]
D(LN_SCE(-1))	-0.327084 (0.29264) [-1.11771]	-0.495625 (0.18858) [-2.62814]	-0.160936 (0.55582) [-0.28955]	-0.087821 (0.37965) [-0.23132]
C	0.060700 (0.01550) [3.91550]	0.073632 (0.00999) [7.37030]	0.056924 (0.02944) [1.93324]	0.039038 (0.02011) [1.94101]
DUMMY	-0.020575 (0.01455) [-1.41405]	-0.006700 (0.00938) [-0.71449]	-0.061861 (0.02764) [-2.23832]	-0.017601 (0.01888) [-0.93237]
R-squared	0.530165	0.709044	0.523598	0.342155
Adj. R-squared	0.313318	0.574757	0.303721	0.038534
Sum sq. resids	0.010897	0.004526	0.039313	0.018342
S.E. equation	0.028953	0.018658	0.054991	0.037562
F-statistic	2.444878	5.280056	2.381316	1.126914
Log likelihood	46.77099	55.55878	33.94065	41.56437
Akaike AIC	-3.977099	-4.855878	-2.694065	-3.456437
Schwarz SC	-3.628593	-4.507372	-2.345558	-3.107931
Mean dependent	0.054885	0.043121	0.062455	0.051986
S.D. dependent	0.034939	0.028612	0.065903	0.038307

Determinant resid covariance (dof adj.)	3.11E-13
Determinant resid covariance	5.55E-14
Log likelihood	191.7011
Akaike information criterion	-15.97011
Schwarz criterion	-14.37694
Number of coefficients	32

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	100.7433	0.7248	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	20.1762	0.2124	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	1.3928	0.2433	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	19.9412	0.8666	Zero Serial Correlation
VEC Residual Normality Test (Kurtosis)	Join test (Chi-sq)	4.9625	0.7616	Normality

*Edgeworth expansion corrected likelihood ratio statistic.

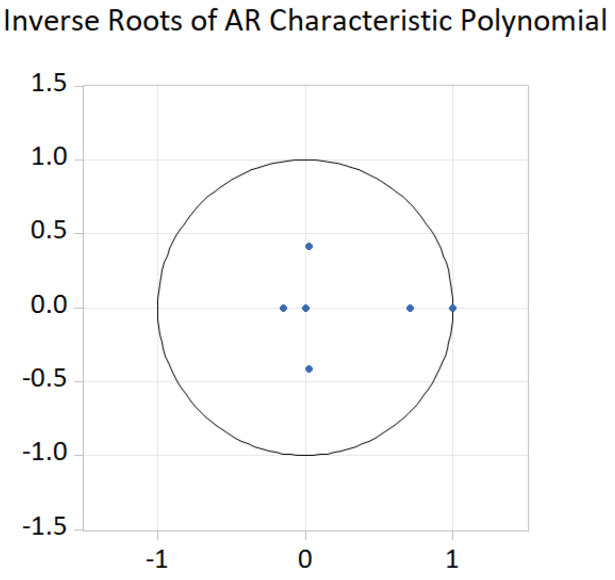
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN AGRI LN MIN LN IND LN SCE
Exogenous variables: DUMMY
Lag specification: 1 1
Date: 03/04/24 Time: 15:41

Root	Modulus
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
0.710524	0.710524
0.027590 - 0.415430i	0.416345
0.027590 + 0.415430i	0.416345
-0.149415	0.149415
0.001692	0.001692

VEC specification imposes 3 unit root(s).



Appendix 3.4

1) AGRI and SCE (Full period)

Vector Error Correction Estimates
Date: 04/06/24 Time: 18:03
Sample (adjusted): 1902 2012
Included observations: 111 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN AGRI(-1)	1.000000
LN SCE(-1)	-0.858578 (0.04372) [-19.6388]
C	-1.895018 (0.67770) [-2.79627]

Error Correction:	D(LN AGRI)	D(LN SCE)
CointEq1	-0.077224 (0.02295) [-3.36493]	0.016505 (0.02406) [0.68609]
D(LN AGRI(-1))	0.054188 (0.09571) [0.56616]	-0.070903 (0.10033) [-0.70672]
D(LN AGRI(-2))	-0.003943 (0.09632) [-0.04093]	0.030936 (0.10096) [0.30642]
D(LN AGRI(-3))	0.131002 (0.09590) [1.36600]	-0.000835 (0.10053) [-0.00831]
D(LN SCE(-1))	0.094756 (0.09952) [0.95213]	0.381397 (0.10432) [3.65607]
D(LN SCE(-2))	-0.031556 (0.10720) [-0.29435]	-0.134571 (0.11237) [-1.19753]
D(LN SCE(-3))	-0.158077 (0.10205) [-1.54900]	-0.164997 (0.10697) [-1.54244]
LN TI	-0.020823 (0.00956) [-2.17920]	0.018012 (0.01002) [1.79833]
DUMMY2	-0.058183 (0.01019) [-5.70916]	-0.022585 (0.01068) [-2.11419]
R-squared	0.274352	0.241537
Adj. R-squared	0.217439	0.182050
Sum sq. resids	0.157108	0.172623
S.E. equation	0.039246	0.041139
F-statistic	4.820513	4.060316
Log likelihood	206.5973	201.3707
Akaike AIC	-3.560311	-3.466138
Schwarz SC	-3.340620	-3.246447
Mean dependent	0.030503	0.038479
S.D. dependent	0.044365	0.045487

Determinant resid covariance (dof adj.)	2.18E-06
Determinant resid covariance	1.84E-06
Log likelihood	417.9249
Akaike information criterion	-7.151800
Schwarz criterion	-6.639186
Number of coefficients	21

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	60.0718	0.1801	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 4	4.5251	0.3396	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 4	1.1385	0.3396	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 4	5.4424	0.6061	Zero Serial Correlation
VEC Residual Normality Test (Jarque - Bera)	Join test (Chi-sq)	75.0661	0.0000	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

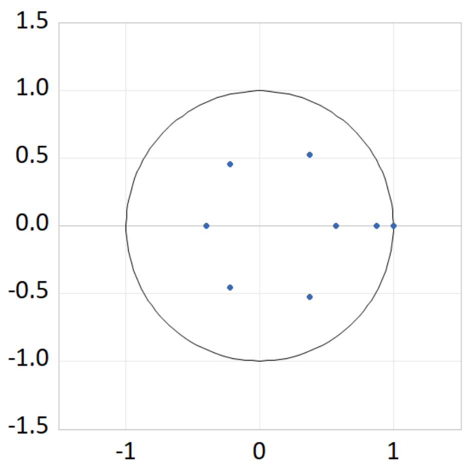
Stability Test (remark: the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_AGRI LN_SCE
Exogenous variables: LN_TI DUMMY2
Lag specification: 1 3
Date: 04/06/24 Time: 17:28

Root	Modulus
1.000000	1.000000
0.873399	0.873399
0.373429 - 0.529028i	0.647549
0.373429 + 0.529028i	0.647549
0.573637	0.573637
-0.223869 - 0.455416i	0.507465
-0.223869 + 0.455416i	0.507465
-0.401968	0.401968

VEC specification imposes 1 unit root(s).

Inverse Roots of AR Characteristic Polynomial



2) AGRI and SCE (1896-1956)

Vector Error Correction Estimates
Date: 04/06/24 Time: 19:02
Sample (adjusted): 1900 1956
Included observations: 57 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_AGRI(-1)	1.000000
LN_SCE(-1)	-0.774102 (0.08779) [-8.81773]
C	-1.465077 (0.57769) [-2.53612]

Error Correction:	D(LN_AGRI)	D(LN_SCE)
CointEq1	-0.077036 (0.01385) [-5.56396]	-0.060712 (0.01308) [-4.63984]
D(LN_AGRI(-1))	0.094305 (0.13077) [0.72115]	-0.024860 (0.12359) [-0.20115]
D(LN_SCE(-1))	0.004830 (0.16449) [0.02936]	0.313180 (0.15546) [2.01460]
DUMMY2	-0.048635 (0.00961) [-5.06295]	-0.016540 (0.00908) [-1.82185]
R-squared	0.359330	0.142146
Adj. R-squared	0.323066	0.093588
Sum sq. resids	0.055975	0.049995
S.E. equation	0.032498	0.030713
F-statistic	9.908647	2.927348
Log likelihood	116.5088	119.7288
Akaike AIC	-3.947677	-4.060661
Schwarz SC	-3.804305	-3.917289
Mean dependent	0.029652	0.039602
S.D. dependent	0.039499	0.032260

Determinant resid covariance (dof adj.)	7.52E-07
Determinant resid covariance	6.51E-07
Log likelihood	244.2359
Akaike information criterion	-8.183715
Schwarz criterion	-7.789442
Number of coefficients	11

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	23.9404	0.2960	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	5.6136	0.2299	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	1.4289	0.2300	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	6.2228	0.5140	Zero Serial Correlation
VEC Residual Normality Test (Jarque - Bera)	Join test (Chi-sq)	44.3381	0.0000	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

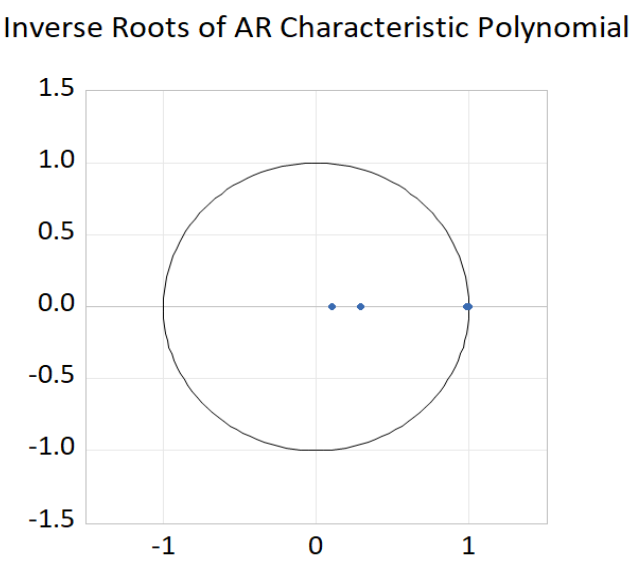
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (remark: the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_AGRI LN_SCE
Exogenous variables: DUMMY2
Lag specification: 1 1
Date: 04/06/24 Time: 19:03

Root	Modulus
1.000000	1.000000
0.980873	0.980873
0.293602	0.293602
0.102972	0.102972

VEC specification imposes 1 unit root(s).



3) AGRI and SCE (1959-1990)

Vector Error Correction Estimates
Date: 04/06/24 Time: 18:11
Sample (adjusted): 1959 1990
Included observations: 32 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LN_AGRI(-1)	1.000000	
LN_SCE(-1)	-0.333478 (0.10608) [-3.14368]	
C	-4.710854 (0.90482) [-5.20638]	
Error Correction:	**D(LN_AGRI)**	**D(LN_SCE)**
CointEq1	-0.185275 (0.04195) [-4.41650]	-0.186191 (0.06139) [-3.03270]
D(LN_AGRI(-1))	-0.098659 (0.16006) [-0.61637]	-0.142062 (0.23425) [-0.60644]
D(LN_SCE(-1))	0.137668 (0.12535) [1.09825]	0.349750 (0.18345) [1.90650]
DUMMY2	-0.045224 (0.01227) [-3.68603]	-0.035998 (0.01796) [-2.00482]
R-squared	0.434363	0.311221
Adj. R-squared	0.373759	0.237423
Sum sq. resids	0.043151	0.092421
S.E. equation	0.039257	0.057452
F-statistic	7.167236	4.217217
Log likelihood	60.33461	48.14813
Akaike AIC	-3.520913	-2.759258
Schwarz SC	-3.337696	-2.576041
Mean dependent	0.019734	0.031369
S.D. dependent	0.049607	0.065791
Determinant resid covariance (dof adj.)		4.85E-06
Determinant resid covariance		3.71E-06
Log likelihood		109.2466
Akaike information criterion		-6.140414
Schwarz criterion		-5.636567
Number of coefficients		11

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	16.8377	0.7209	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	1.4935	0.8278	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	0.3715	0.8279	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	3.0590	0.8795	Zero Serial Correlation
VEC Residual Normality Test (Jarque - Bera)	Join test (Chi-sq)	2.4065	0.6615	Normality

*Edgeworth expansion corrected likelihood ratio statistic.

The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

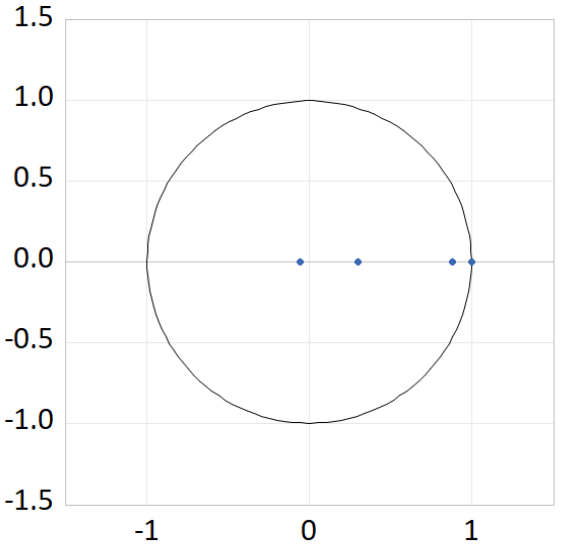
Stability Test (remark: the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_AGRI LN_SCE
Exogenous variables: DUMMY2
Lag specification: 1 1
Date: 04/06/24 Time: 18:12

Root	Modulus
1.000000	1.000000
0.882510	0.882510
0.301566	0.301566
-0.056170	0.056170

VEC specification imposes 1 unit root(s).

Inverse Roots of AR Characteristic Polynomial



4) AGRI and SCE

Vector Error Correction Estimates
Date: 04/05/24 Time: 03:31
Sample (adjusted): 1993 2012
Included observations: 20 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_AGRI(-1)	1.000000
LN_SCE(-1)	-0.904419
	(0.12167)
	[-7.43336]
C	-0.150100
	(1.11884)
	[-0.13416]

Error Correction:	D(LN_AGRI)	D(LN_SCE)
CointEq1	-0.169717	-0.096233
	(0.02072)	(0.03219)
	[-8.19116]	[-2.98976]
D(LN_AGRI(-1))	0.084286	0.179340
	(0.12466)	(0.19365)
	[0.67615]	[0.92610]
D(LN_SCE(-1))	-0.269684	0.199900
	(0.14582)	(0.22654)
	[-1.84938]	[0.88242]
DUMMY2	-0.033511	-0.035515
	(0.01110)	(0.01725)
	[-3.01847]	[-2.05923]
R-squared	0.620679	0.238481
Adj. R-squared	0.549556	0.095696
Sum sq. resids	0.008798	0.021232
S.E. equation	0.023449	0.036428
F-statistic	8.726871	1.670210
Log likelihood	48.91098	40.10091
Akaike AIC	-4.491098	-3.610091
Schwarz SC	-4.291952	-3.410945
Mean dependent	0.054885	0.051986
S.D. dependent	0.034939	0.038307

Determinant resid covariance (dof adj.)	7.12E-07
Determinant resid covariance	4.56E-07
Log likelihood	89.25946
Akaike information criterion	-7.825946
Schwarz criterion	-7.278293
Number of coefficients	11

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	19.8386	0.5315	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	1.2827	0.8643	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	0.3163	0.8645	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	3.9685	0.7834	Zero Serial Correlation
VEC Residual Normality Test (Jarque - Bera)	Join test (Chi-sq)	1.8453	0.7642	Normality

*Edgeworth expansion corrected likelihood ratio statistic.

The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

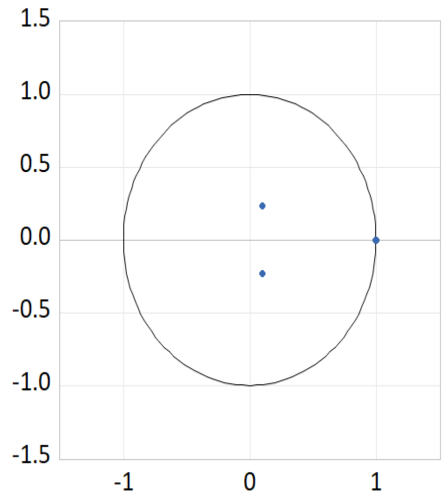
Stability Test (remark: the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN AGRI LN SCE
Exogenous variables: DUMMY2
Lag specification: 1 1
Date: 04/06/24 Time: 18:25

Root	Modulus
1.000000	1.000000
0.996967	0.996967
0.102268 - 0.234422i	0.255758
0.102268 + 0.234422i	0.255758

VEC specification imposes 1 unit root(s).

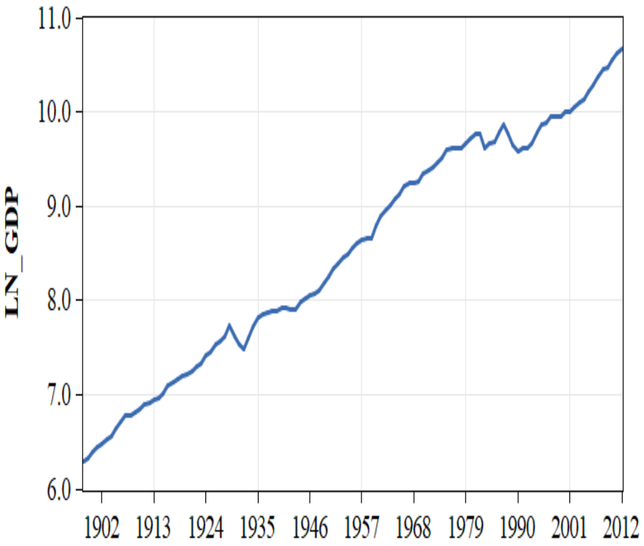
Inverse Roots of AR Characteristic Polynomial



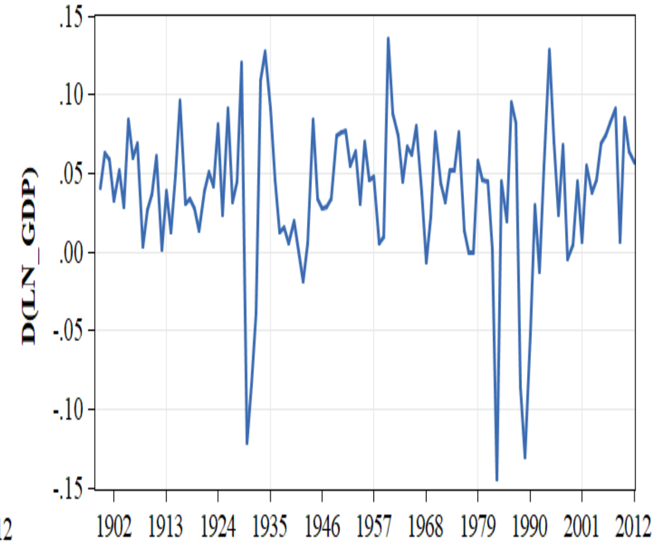
Appendix 3.5

Selected variables for the empirical analysis, 1896-2012

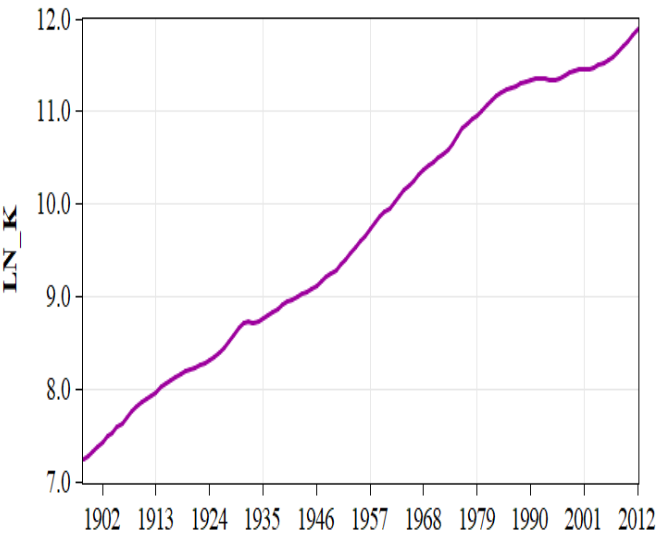
GDP in logarithms



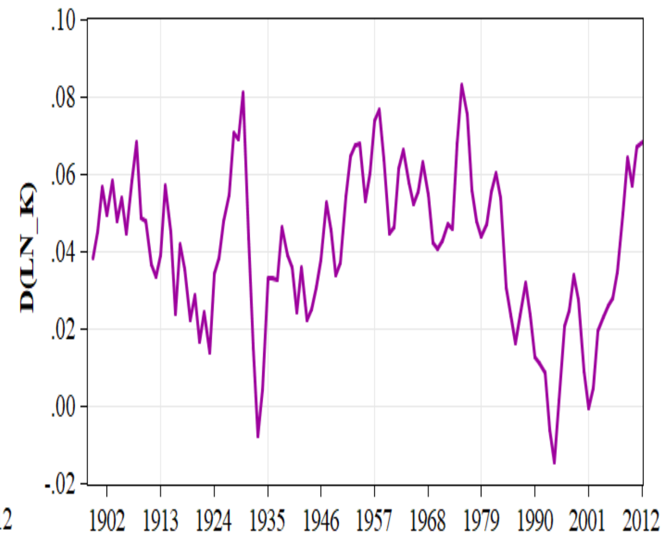
GDP in first differences



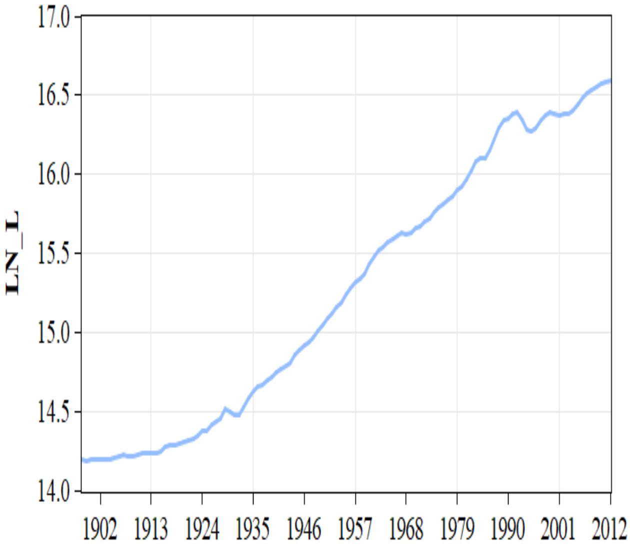
Capital stock in logarithms



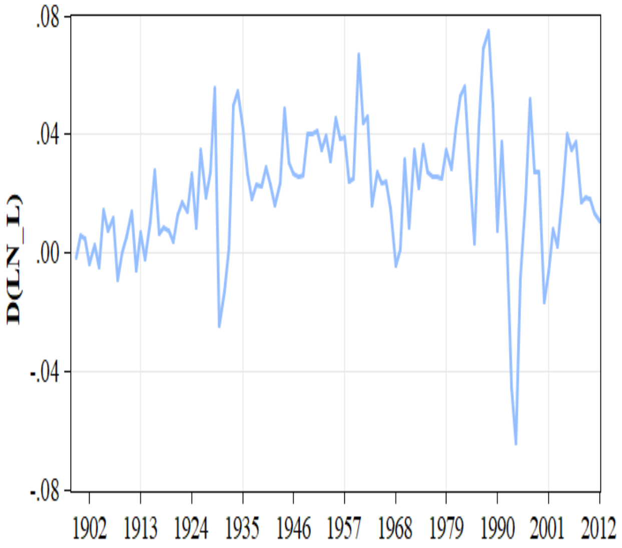
Capital stock in first differences



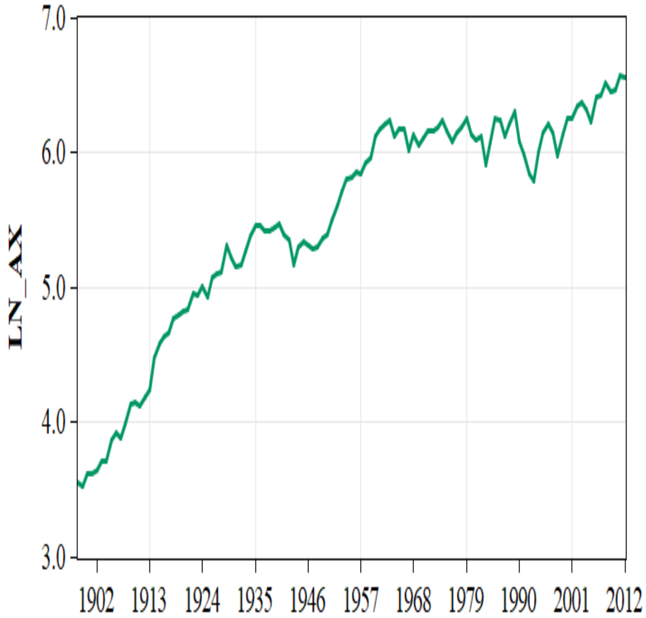
Labour in logarithms



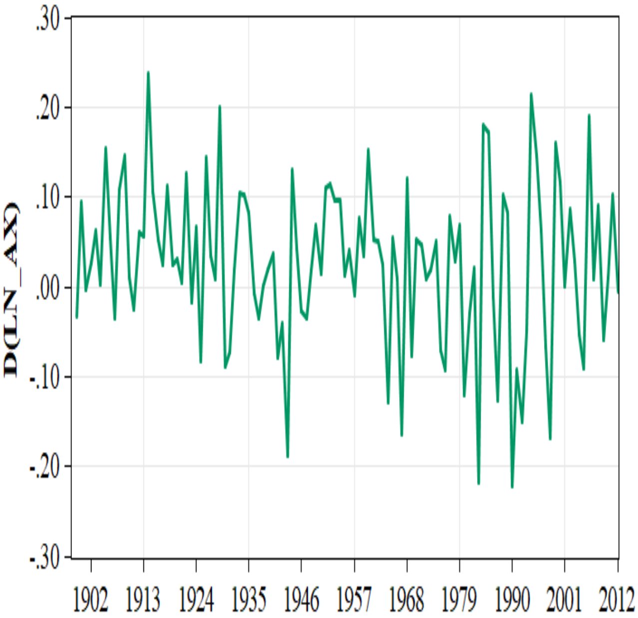
Labour in first differences



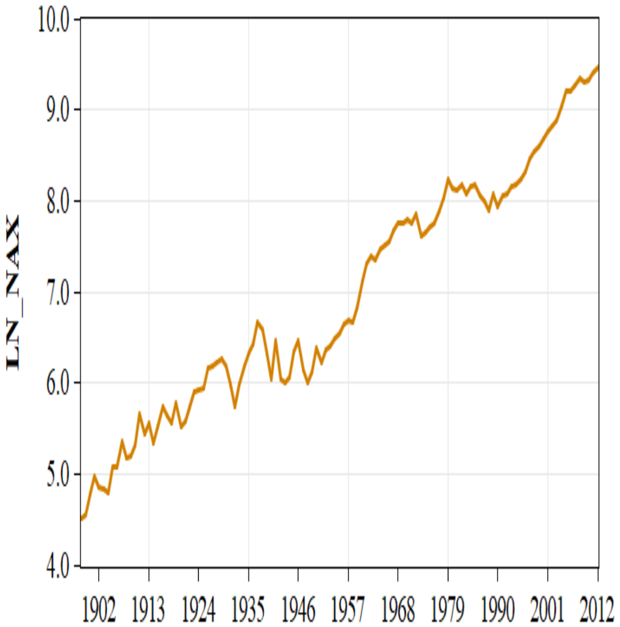
Agricultural exports in logarithms



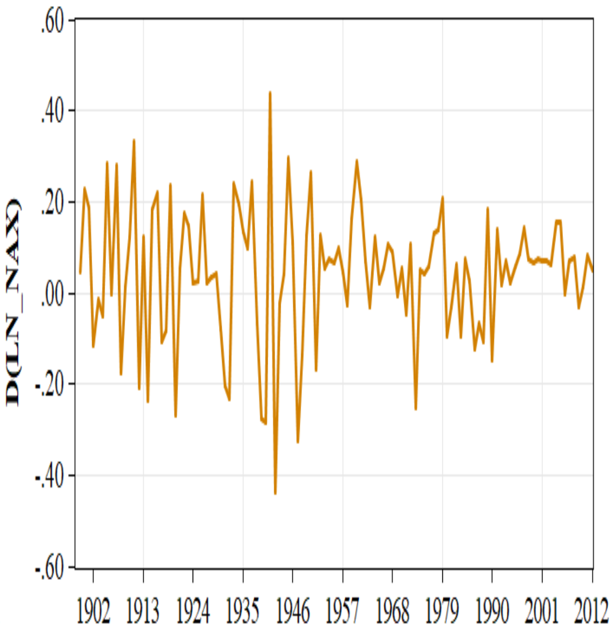
Agricultural exports in first differences



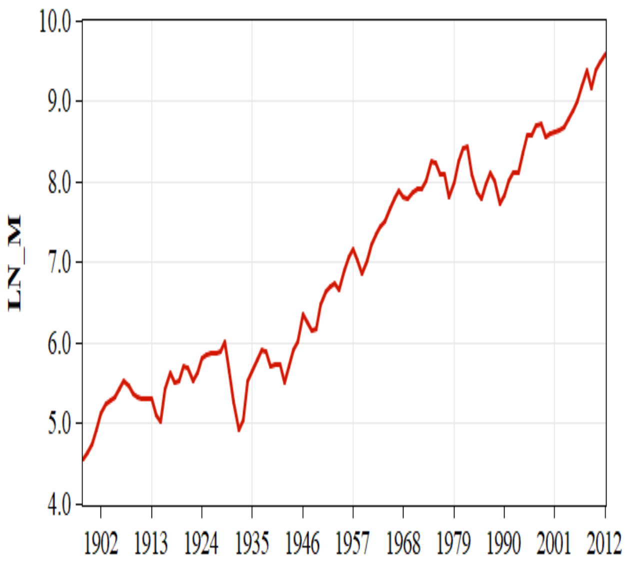
Non-agricultural exports in logarithms



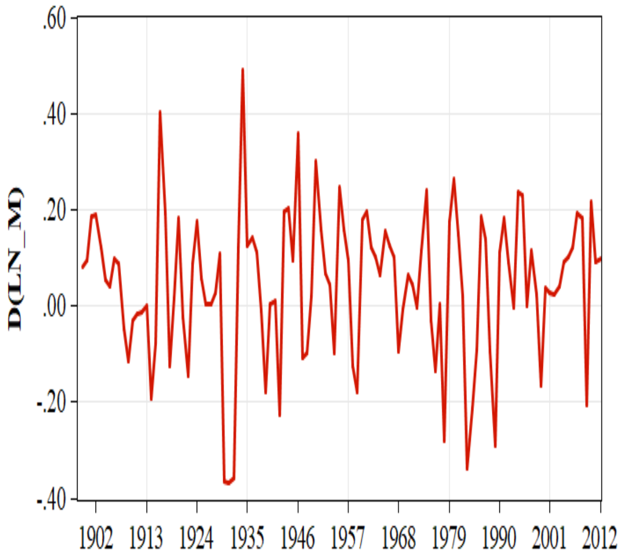
Non-agricultural exports in first differences



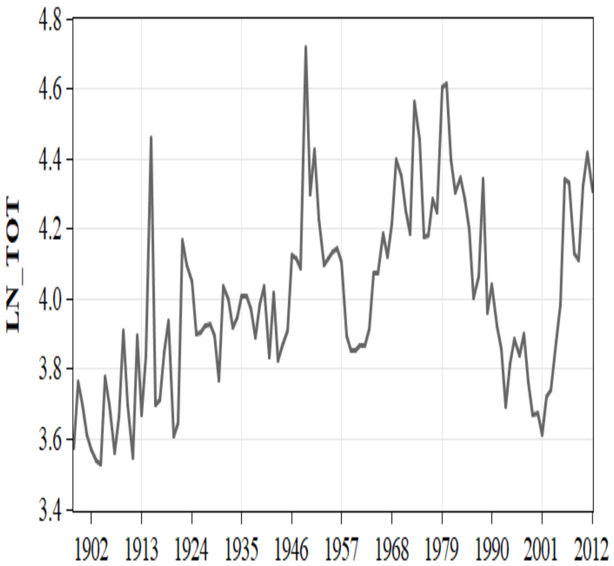
Imports in logarithms



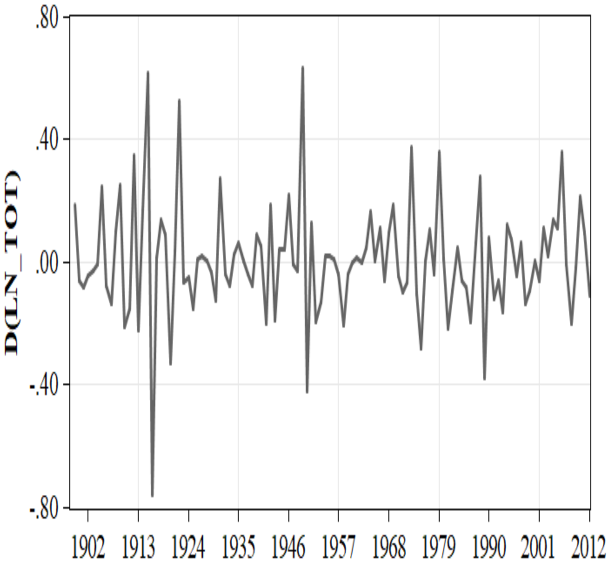
Imports in first differences



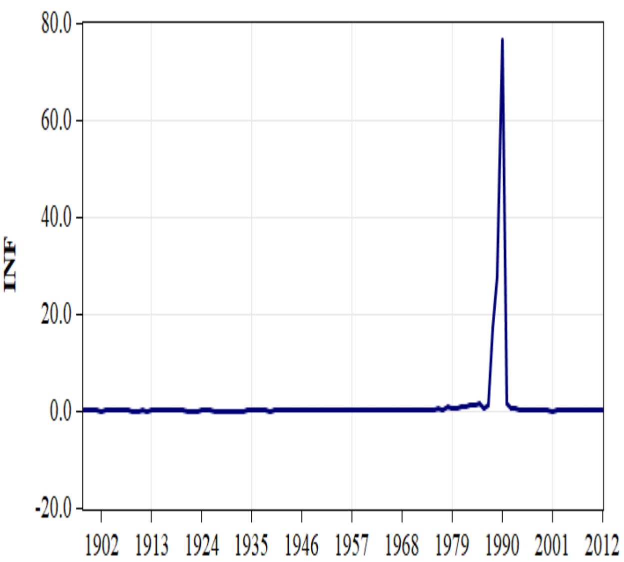
Terms of trade in logarithms



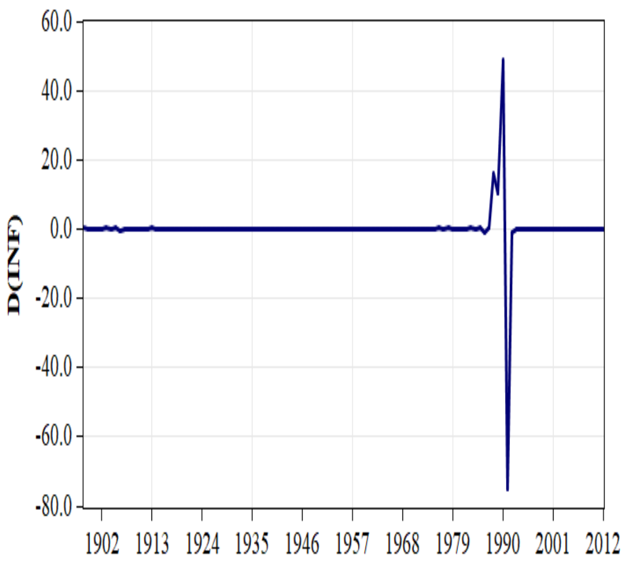
Terms of trade in first differences



Inflation in logarithms



Inflation in first differences



Appendix 3.6

Results from unit root tests with ADF and PP in levels

ADF				Phillips-Perron	
Levels (in logs)	Lags	Test	p-values*/ (Decision)	Test	p-values*/ (Decision)
LN_GDP					
NINT	1	4.6	1.00 (NS)	7.2	1.00 (NS)
INT	1	-0.5	0.88 (NS)	-0.5	0.88 (NS)
IT	1	-2.5	0.35 (NS)	-2.0	0.58 (NS)
LN_K					
NINT	2	3.2	1.00 (NS)	8.2	1.00 (NS)
INT	2	-0.7	0.85 (NS)	-1.0	0.74 (NS)
IT	2	-1.8	0.72 (NS)	-1.2	0.90 (NS)
LN_L					
NINT	1	3.9	1.00 (NS)	6.9	1.00 (NS)
INT	1	0.4	0.98 (NS)	0.8	0.99 (NS)
IT	1	-2.6	0.27 (NS)	-2.7	0.23 (NS)
LN_AX					
NINT	0	2.7	1.00 (NS)	2.8	1.00 (NS)
INT	0	-2.3	0.18 (NS)	-2.6	0.09 (NS)
IT	0	-2.1	0.56 (NS)	-2.0	0.61 (NS)
LN_NAX					
NINT	0	3.0	1.00 (NS)	3.2	1.00 (NS)
INT	0	-0.5	0.88 (NS)	-0.5	0.88 (NS)
IT	0	-3.1	0.11 (NS)	-3.1	0.11 (NS)
LN_M					
NINT	2	2.7	1.00 (NS)	3.7	1.00 (NS)
INT	2	-0.1	0.94 (NS)	0.0	0.95 (NS)
IT	2	-2.4	0.38 (NS)	-2.3	0.41 (NS)
LN_TOT					
NINT	2	0.5	0.81(NS)	0.5	0.82 (NS)
INT	0	-4.2	0.00 (S)	-4.1	0.00 (S)
IT	0	-4.6	0.00 (S)	-4.7	0.00 (S)
INF					
NINT	0	-7.0	0.00 (S)	-7.0	0.00 (S)
INT	0	-7.1	0.00 (S)	-7.2	0.00 (S)
IT	0	-7.2	0.00 (S)	-7.2	0.00 (S)

*MacKinnon (1996) one-sided p-values. S is stationary

NS is non-stationary. Lag length based on SIC (Schwarz information criterion).

IT: Intercept and trend

NINT: No intercept and no trend

NIT: No intercept and trend

Unit Root Tests for Selected Variables (in first difference)

	ADF			Phillips-Perron	
LN_GDP					
NINT	0	-5.3	0.00 (S)	-5.2	0.00 (S)
INT	0	-7.5	0.00 (S)	-7.2	0.00 (S)
IT	0	-7.5	0.00 (S)	-7.2	0.00 (S)
LN_K					
NINT					
INT	1	-3.9	0.00 (S)	-3.0	0.04 (S)
IT	1	-3.9	0.01 (S)	-3.2	0.10 (S)
LN_L					
NINT	0	-3.6	0.00 (S)	-3.6	0.00 (S)
INT	0	-5.5	0.00 (S)	-5.4	0.00 (S)
IT	0	-5.5	0.00 (S)	-5.4	0.00 (S)
LN_AX					
NINT	0	-9.7	0.00 (S)	-9.7	0.00 (S)
INT	0	-10.5	0.00 (S)	-10.5	0.00 (S)
IT	0	-10.7	0.00 (S)	-10.8	0.00 (S)
LN_NAX					
NINT	0	-11.0	0.00 (S)	-11.0	0.00 (S)
INT	0	-12.0	0.00 (S)	-12.0	0.00 (S)
IT	0	-11.9	0.00 (S)	-11.9	0.00 (S)
LN_M					
NINT	1	-7.8	0.00 (S)	-7.4	0.00 (S)
INT	1	-8.5	0.00 (S)	-8.0	0.00 (S)
IT	1	-8.5	0.00 (S)	-8.1	0.00 (S)
LN_TOT					
NINT	1	-11.7	0.00 (S)	-15.4	0.00 (S)
INT	1	-11.7	0.00 (S)	-15.4	0.00 (S)
IT	1	-11.6	0.00 (S)	-15.3	0.00 (S)
INF					
NINT	0	-15.3	0.00 (S)	-69.1	0.00 (S)
INT	0	-15.3	0.00 (S)	-68.6	0.00 (S)
IT	0	-15.2	0.00 (S)	-68.9	0.00 (S)

*MacKinnon (1996) one-sided p-values. S is stationary

NS is non-stationary. Lag length based on SIC (Schwarz information criterion).

IT: Intercept and trend

NINT: No intercept and no trend

NIT: No intercept and trend

Appendix 3.7

Vector Error Correction Model

Vector Error Correction Estimates
Date: 12/04/23 Time: 20:44
Sample (adjusted): 1900 2012
Included observations: 113 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN GDP(-1)	1.000000
LN K(-1)	-0.217832
	(0.07934)
	[-2.74556]
LN L(-1)	-0.449702
	(0.11397)
	[-3.94579]
LN AX(-1)	-0.230249
	(0.03450)
	[-6.67373]
LN NAX(-1)	-0.111192
	(0.03119)
	[-3.56446]
LN M(-1)	-0.120360
	(0.03475)
	[-3.46343]
LN TOT(-1)	-0.253890
	(0.03912)
	[-6.48986]
INF(-1)	0.013141
	(0.00117)
	[11.2011]
@TREND(96)	-0.001570
	(0.00228)
	[-0.68734]
C	4.407237

Error Correction:	D(LN GDP)	D(LN K)	D(LN L)	D(LN AX)	D(LN NAX)	D(LN M)	D(LN TOT)	D(INF)
CointEq1	-0.139164	0.000888	0.015931	-0.238496	0.204007	-0.007244	0.642083	-58.07657
	(0.05795)	(0.01144)	(0.02546)	(0.13243)	(0.21011)	(0.19842)	(0.25277)	(9.64423)
	[-2.40127]	[0.07768]	[0.62562]	[-1.80098]	[0.97093]	[-0.03651]	[2.54018]	[-6.02190]
D(LN GDP(-1))	0.561880	0.047234	0.047784	0.636132	0.816318	1.401281	0.779161	-36.15495
	(0.13150)	(0.02595)	(0.05778)	(0.30047)	(0.47674)	(0.45020)	(0.57352)	(21.8823)
	[4.27300]	[1.82022]	[0.82705]	[2.11715]	[1.71230]	[3.11261]	[1.35855]	[-1.65225]
D(LN K(-1))	-0.331359	0.897235	-0.046629	-0.259286	-0.609355	-2.261837	0.096618	-25.95790
	(0.19656)	(0.03879)	(0.08637)	(0.44915)	(0.71264)	(0.67296)	(0.85732)	(32.7102)
	[-1.68577]	[23.1307]	[-0.53990]	[-0.57729]	[-0.85507]	[-3.36101]	[0.11270]	[-0.79357]
D(LN L(-1))	-0.314223	0.048481	0.615080	-0.547867	0.608587	0.198476	-1.570072	107.4667
	(0.18923)	(0.03734)	(0.08314)	(0.43238)	(0.68605)	(0.64785)	(0.82532)	(31.4894)
	[-1.66056]	[1.29830]	[7.39795]	[-1.26709]	[0.88710]	[0.30636]	[-1.90238]	[3.41279]
D(LN AX(-1))	-0.080297	0.006399	-0.015715	-0.150162	0.188267	-0.111500	-0.121969	17.60308
	(0.04912)	(0.00969)	(0.02158)	(0.11223)	(0.17807)	(0.16815)	(0.21422)	(8.17329)
	[-1.63487]	[0.66017]	[-0.72822]	[-1.33801]	[1.05728]	[-0.66308]	[-0.56937]	[2.15373]
D(LN NAX(-1))	-0.020752	0.005212	-0.025580	-0.011320	-0.174353	0.084957	0.095098	1.525729
	(0.02821)	(0.00557)	(0.01240)	(0.06446)	(0.10228)	(0.09658)	(0.12304)	(4.69460)
	[-0.73560]	[0.93614]	[-2.06367]	[-0.17561]	[-1.70468]	[0.87961]	[0.77288]	[0.32500]
D(LN M(-1))	-0.065031	0.041002	-0.003990	-0.145825	-0.167571	-0.089439	-0.315507	-6.859091
	(0.03706)	(0.00731)	(0.01628)	(0.08469)	(0.13437)	(0.12689)	(0.16165)	(6.16755)
	[-1.75464]	[5.60608]	[-0.24505]	[-1.72193]	[-1.24709]	[-0.70486]	[-1.95181]	[-1.11213]
D(LN TOT(-1))	-0.002715	-0.001173	0.010687	-0.044956	0.157682	0.145495	-0.234951	-12.33639
	(0.02172)	(0.00429)	(0.00954)	(0.04962)	(0.07873)	(0.07435)	(0.09472)	(3.61384)
	[-0.12503]	[-0.27365]	[1.12004]	[-0.90596]	[2.00274]	[1.95691]	[-2.48056]	[-3.41365]
D(INF(-1))	0.001229	0.000107	0.000226	0.002640	-0.000569	0.001082	-0.004366	0.027764
	(0.00059)	(0.00012)	(0.00026)	(0.00134)	(0.00212)	(0.00201)	(0.00256)	(0.09750)
	[2.09742]	[0.92812]	[0.87890]	[1.97228]	[-0.26796]	[0.53958]	[-1.70865]	[0.28477]
C	0.046953	-0.000598	0.010210	0.036992	0.039561	0.088384	0.008347	-0.085151
	(0.00934)	(0.00184)	(0.00410)	(0.02134)	(0.03385)	(0.03197)	(0.04073)	(1.55386)
	[5.02840]	[-0.32465]	[2.48874]	[1.73376]	[1.16859]	[2.76473]	[0.20495]	[-0.05480]
DUMMY	-0.075983	0.000587	-0.004872	-0.021831	-0.130961	-0.162953	0.199472	1.908178
	(0.01720)	(0.00339)	(0.00756)	(0.03931)	(0.06237)	(0.05889)	(0.07503)	(2.86265)
	[-4.41702]	[0.17297]	[-0.64455]	[-0.55539]	[-2.09983]	[-2.76684]	[2.65861]	[0.66658]
R-squared	0.368373	0.867271	0.401232	0.103885	0.157180	0.325018	0.240105	0.472562
Adj. R-squared	0.306449	0.854259	0.342529	0.016030	0.074551	0.258843	0.165605	0.420852
Sum sq. resids	0.159789	0.006223	0.030848	0.834293	2.100325	1.872959	3.039677	4424.969
S.E. equation	0.039580	0.007811	0.017390	0.090440	0.143497	0.135508	0.172629	6.586505
F-statistic	5.948782	66.64851	6.834978	1.182466	1.902227	4.911512	3.222899	9.138750
Log likelihood	210.3727	393.7520	303.3037	116.9935	64.82916	71.30249	43.94340	-367.5612
Akaike AIC	-3.528720	-6.774372	-5.173518	-1.875991	-0.952729	-1.067301	-0.583069	6.700198
Schwarz SC	-3.263222	-6.508874	-4.908020	-1.610493	-0.687231	-0.801803	-0.317571	6.965696
Mean dependent	0.038431	0.040868	0.021299	0.026878	0.043366	0.043668	0.004832	-0.000620
S.D. dependent	0.047526	0.020460	0.021447	0.091173	0.149165	0.157402	0.188985	8.654863

Determinant resid covariance (dof adj.)	2.57E-17
Determinant resid covariance	1.13E-17
Log likelihood	921.7683
Akaike information criterion	-14.59767
Schwarz criterion	-12.25646
Number of coefficients	97

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	1401.9640	0.0031	Heteroscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 3	69.5262	0.2968	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 3	1.0934	0.2998	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 3	112.7631	0.6911	Zero Serial Correlation
VEC Residual Normality Test (Kurtosis)	Join test (Chi-sq)	977.8329	0.0000	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

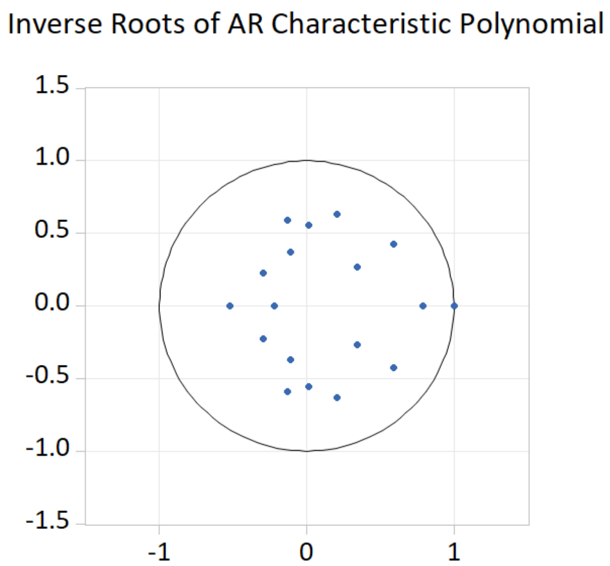
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (remark: the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN GDP LN K LN L LN AX LN NAX LN M LN TOT INF
Exogenous variables: DUMMY1
Lag specification: 1 2
Date: 03/04/24 Time: 21:12

Root	Modulus
1.000000	1.000000
1.000000 - 3.42e-16i	1.000000
1.000000 + 3.42e-16i	1.000000
1.000000	1.000000
1.000000 - 2.39e-15i	1.000000
1.000000 + 2.39e-15i	1.000000
1.000000	1.000000
0.788489	0.788489
0.591140 + 0.428078i	0.729861
0.591140 - 0.428078i	0.729861
0.206012 - 0.628542i	0.661442
0.206012 + 0.628542i	0.661442
-0.129208 - 0.592593i	0.606515
-0.129208 + 0.592593i	0.606515
0.012938 - 0.557684i	0.557834
0.012938 + 0.557684i	0.557834
-0.524472	0.524472
0.341508 - 0.270497i	0.435656
0.341508 + 0.270497i	0.435656
-0.112302 - 0.372032i	0.388613
-0.112302 + 0.372032i	0.388613
-0.296391 - 0.229172i	0.374656
-0.296391 + 0.229172i	0.374656
-0.220912	0.220912

VEC specification imposes 7 unit root(s).



CHAPTER 4

TOTAL FACTOR PRODUCTIVITY AND SOURCES OF GROWTH IN PERUVIAN AGRICULTURE (1950 – 2010)[25]

> "Productivity is not everything, but in the long run it is almost everything"
> (Paul Krugman, 1994)

4.1. Introduction

Total Factor Productivity (TFP) serves as a crucial indicator for evaluating agricultural efficiency and productivity. It measures the overall effectiveness of all inputs utilised in agricultural production, encompassing labour, capital, land, and technology, in relation to the quantity of output generated. Moreover, enhancements in agricultural productivity have the potential to drive broader economic growth, encompassing poverty alleviation, enhanced food security, and rural development (Gollin, 2010).

This chapter undertakes an analysis of the factors contributing to the growth dynamics within Peruvian agriculture from 1950 to 2010. The chapter pursues three primary objectives. Firstly, it aims to estimate Total Factor Productivity (TFP). Secondly, it seeks to identify the determinants influencing TFP. Finally, the third objective is to ascertain the causal relationship between TFP and agricultural production by destination (domestic and external), as well as the contribution of family agriculture to the overall food supply.

Regarding the first aim, the sources of growth of agricultural output are identified in terms of the contribution of inputs and changes in productivity. In doing this, a Cobb-Douglas production function with constant returns to scale is assumed. The inputs considered are labour, land, machinery (number of tractors), livestock and fertiliser. Data was obtained from national statistical sources (INEI), FAOSTAT, Groningen Growth and Development Center 10-industry database and the International Fertiliser Industry Association.

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[25]The section presenting the estimations and discussion of results of the TFP have been published in the following chapter: (2018) Velazco, J. and Pinilla, V. Development models, agricultural policies, and agricultural growth: Peru, 1950-2010. In V. Pinilla and H. Willebald (Eds.), Agricultural development in the world periphery: A global economic history approach. Palgrave Macmillan, pp. 413-438. Additionally, the discussion on the methodological limitations of the TFP and some reflections on the new agro-export model in Peru have been published in the following article: (2022) Martín-Retortillo, M., Pinilla, V., Velazco, J., and Willebald, H. Is there a Latin American agricultural growth pattern? Factor endowment and productivity in the second half of the 20th century. *Revista de Historia Económica – Journal of Iberian and Latin American Economic History.* Vol. 40, Número 1, pp 99-134.

Five sub-periods, which coincide with major economic policy measures undertaken during the study period, are considered for the analysis of the TFP trend. The selected sub-periods are 1950-1959, 1960-1975, 1976-1990, 1991-2000 and 2001-2010. Findings show a poor TFP performance during the first sub-period, followed by a recovery during the second and third periods and an outstanding performance since the 1990s.

With respect to the second aim of the chapter, the estimation of the determinants of TFP, time series econometric techniques are used. Following the literature on the subject, among the determinants of TFP are trade openness, human capital (school enrollment ratio), GDP per-capita, and institutional factors captured by a Structural Reform index.

For the third objective, estimations of agricultural GDP by destination (external and domestic) from Seminario (2015) and the estimation by Pintado (2021) regarding the participation of family agriculture in total food supply are utilized. These data were previously presented in Chapter 2. Findings indicate a feedback relationship, suggesting that the expansion of Total Factor Productivity (TFP), since 1990, has encompassed all types of agriculture, including family farming.

Acknowledging that data availability often poses limitations in long-term analysis, this chapter makes two contributions to the existing literature. Firstly, it extends the analysis period beyond the 1950s. This extension enables us to elucidate the long-term Total Factor Productivity (TFP) patterns in light of specific macroeconomic events and government policies. Secondly, to the best of our knowledge, this is the first endeavour to estimate the determinants of TFP in Peruvian agriculture within a long-term perspective.

The structure of this chapter is as follows. Section two delineates the principal trends in labour and land productivity within Peruvian agriculture. Section three elucidates the methodology for estimating total factor productivity. Section four addresses the identification of the determinants influencing total factor productivity. Section five analyses the causality between total factor productivity indices and agricultural product destination markets. Finally, section six provides concluding remarks.

4.2. An Overview of land and labour productivity in Agriculture

Table 4.1 shows the distribution of real GDP and employment according to economic sectors. In 1961, agriculture represented 12.3% of total GDP but its share fell to 9.2% in 2007. Nevertheless, the sector is still an important source of employment, being engaged around 25% of total employment.

Table 4.1. Peru: Distribution of GDP, at 1994 Nuevos Soles constant prices, and employment by sector (%)

	1961	1972	1981	1993	2007
Agriculture	12.3	9.2	7.5	9.1	9.2
Mining	4.2	3.2	4.8	5.2	6.5
Manufacturing	19.3	19.9	19.1	17.1	17.3
Electricity	0.8	1.0	1.6	2.1	2.3
Construction	4.4	4.0	4.5	5.1	6.2
Commerce	16.4	18.1	18.1	15.7	16.2
Services	42.5	44.5	44.4	45.7	42.4
Distribution of employment by sector (%)					
Agriculture	51.9	43.1	38.5	30,6	24,7
Mining	2.2	1.5	2.0	1,2	1,4
Manufacturing	13.7	13.8	11.8	12,9	9,6
Electricity	0.3	0.2	0.4	0,4	0,2
Construction	3.5	4.9	4.2	4,2	5,7
Commerce	9.4	11.4	13.4	19,3	18,9
Services	19.0	25.1	29.7	31,5	39,5

Source: GDP data from El Banco Central de Reserva and employment data from the Population and Housing National Census (INEI) from 1961, 1972, 1981, 1993 and 2007.

Studies on sectoral labour productivity offer the same conclusion. Agriculture in Peru is the sector with the lowest productivity (Jurado, 2001; Garcia 2004; Chacaltana, 2005; Chacaltana and Yamada, 2009; Banco Mundial, 2010). Table 4.2 shows an estimation of labour productivity from 1961 to 2007. Agricultural labour productivity grew by 118%. Most noteworthy is the gap between labour productivity in agriculture and the economy as a whole, which shows a convergence, albeit still modest, from the 1990s (Velazco and Pinilla, 2018).

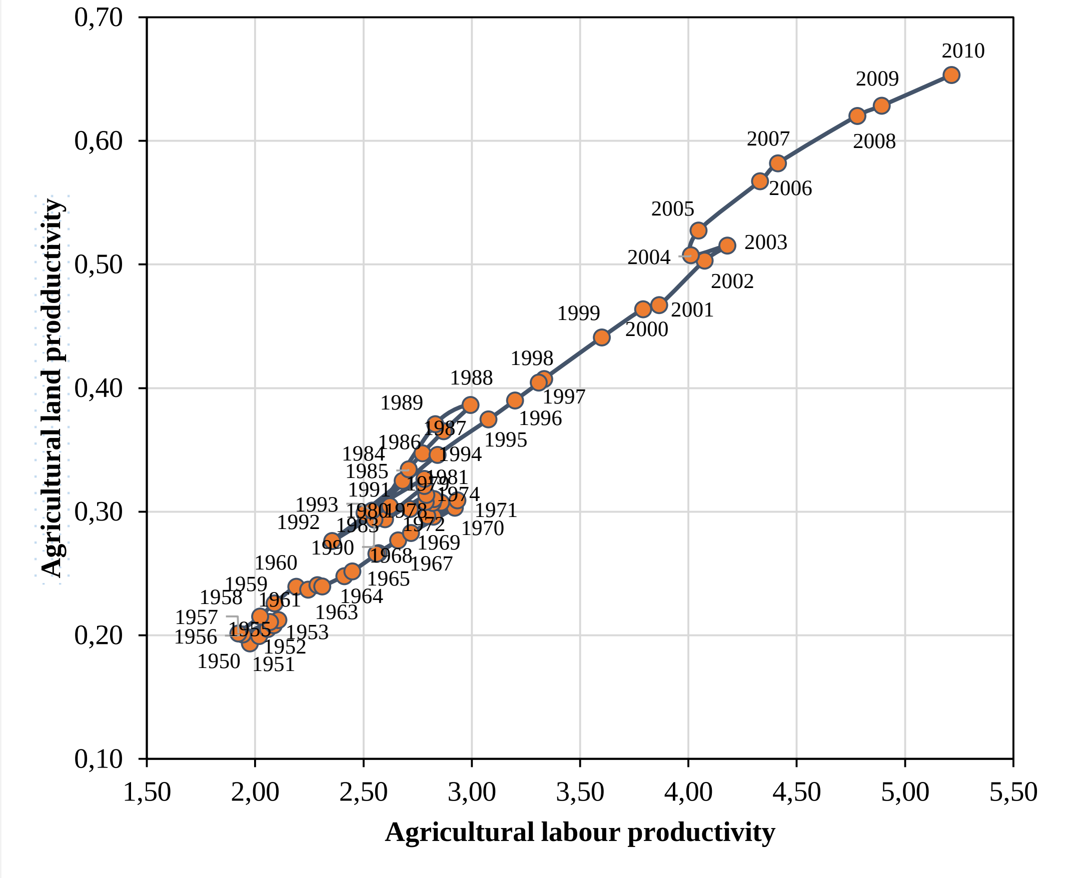
Table 4.2. Estimated labour productivity (at constant 1994 Soles) (index number 100=1961 and % of productivity for the economy as a whole)

	1961	1972	1981	1993	2007
Agriculture	100	136	124	128	218
Agriculture/Total	23.8	21.4	19.4	29.8	37.4

Source: By the author, based on statistics from the Central Reserve Bank of Peru and the National Population and Housing Census (INEI) of 1961, 1972, 1981, 1993, and 2007.

Figure 4.1 depicts a positive association between land productivity and labour productivity for the period 1950-2010. However, it is possible to identify two distinct periods based on the pace of expansion. The first period, from 1950 until the late 1980s, exhibits slow progress with setbacks, followed by an acceleration in the early 1990s.

Figure 4.1. Agriculture: Relationship between land and labour productivity, 1950-2010



Source: Own elaboration, see Appendix 4.1 for data sources.

4.3. Estimating Total Factor Productivity in Peruvian Agriculture

The results of the estimation of total factor productivity (TFP) of Peruvian agriculture for 1950-2010 are presented in this section. The objective of this approach is to identify the sources of growth of the agricultural product based on the contribution of factors and changes in productivity.

4.3.1 Measuring TFP

TFP is defined as the ratio between the total output (Y) and total inputs (X). Thus, TFP can be represented as:

$$TFP = Y/X \qquad (1)$$

TFP changes over time are estimated by comparing the rate of change of the output with the rate of change of inputs. Equation (1) in logarithm is expressed as:

$$\frac{d\ln(TFP)}{dt} = \frac{d\ln(Y)}{dt} - \frac{d\ln(X)}{dt} \qquad (2)$$

Assuming a Cobb-Douglas production function with constant returns to scale, equation (2) becomes:

$$\ln\left(\frac{TFP_t}{TFP_{t-1}}\right) = \sum_J R_j \ln\left(\frac{Y_t}{Y_{t-1}}\right) - \sum_j S_j \ln\left(\frac{X_{j,t}}{X_{j,t-1}}\right) \qquad (3)$$

Where Sj is the cost structure of the input j.

Equation (3) shows TFP as a Solow residual in a growth accounting approach. The residual is assumed as a disembodied, exogenous and Hicks-neutral technological change. According to Jorgenson and Griliches (1967), output can grow as a result of improvements in the quality of inputs (specific to physical capital or labour). If inputs are not adjusted by quality, improvements to inputs would be part of the TFP growth estimate. As Chen pointed out (1997:24, 26):

> "In this case, the residual is no longer disembodied technological change but includes also embodied techological change and other quality improvements. The more quality improvement adjustments are made to the factor inputs, the less will be left for the residual or TFP. Thus, to a large extent, the TFP in a given estimation depends on the extent and scope of quality improvements which are included in the measurement of factor inputs (…). If we assume that all quality improvements are embodied techological change and that technological change is made up of disembodied and embodied technological change, then techological change consists of quality improvement in factor inputs plus the residual or TFP (…). If one does not make any adjustment to the measurement of capital and labour inputs, all the quality improvements and measurement errors will show in the residual or TFP".

The above argument emphasises the complexities involved in the TFP estimation and caution should be taken when interpreting the empirical findings. The lack of data precludes carrying out the suggested input adjustments, with the exception of the standardization adjustment made to the land (refer to the description in Appendix 4.1). Therefore, TFP estimates would capture, to some extent, input quality improvements.

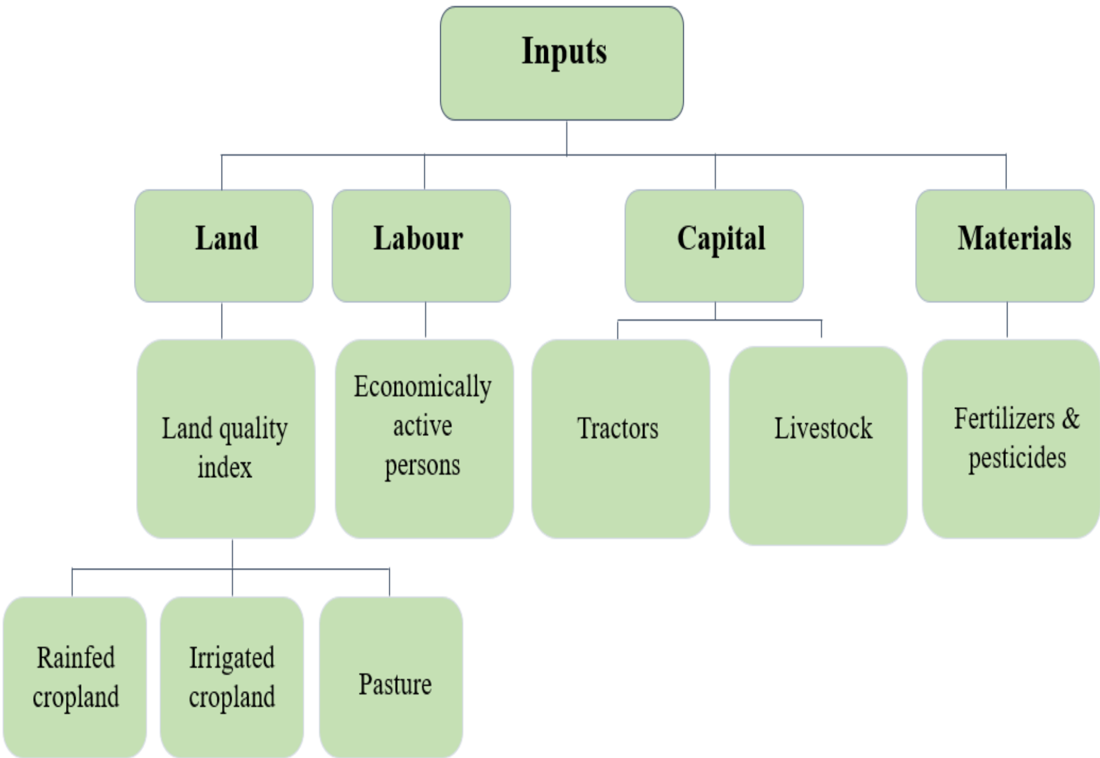
It is essential to recognize that the proposed methodology is not exempt from certain methodological and theoretical problems[26]. In the process of estimating the TFP it can be identified three key issues. First, the specification of the relationship between the inputs and the output, that is, the production function that underlies this relationship. Second, the adequate measurement of the inputs and production factors (capital, land, fertilizers, natural resources, and livestock, among others). Third, the allocation of weights to inputs when

[26] For references on TFP limitations, see Cohen and Harcourt (2003), Felipe and McCombie (2014) and Nelson (1981).

aggregation is performed (Chen, 1997). That said, it is considered that, taking into account the constraints of the methodology and interpreting the estimates with great care and caution, the empirical analysis carried out in the chapter does, indeed, contribute to the understanding of the evolution of Peruvian agricultural productivity in recent decades.

The inputs considered are labour, land, machinery, stock of cattle and fertiliser. A description of the variables is found in the Appendix 4.1. The Hodrick-Prescott filter was used with the purpose of eliminating from the output series the effect of short-term fluctuations due to weather or other events. Figure A1, in the Appendix 4.1 compares the series with original data and the resulting series after applying the filter. Figure 4.2 illustrates the components of TFP utilized in the analysis.

Figure 4.2. Components of the TFP index



Source: Author adaptation from Fuglie (2012).

Although there are informational shortcomings in, for example, the summation of fertiliser variables, the calculation of agricultural EAP[27] and the failure to allow for machinery depreciation, the estimated functions do give an indication of the relative importance of these factors in agricultural production.

[27] An ideal variable for labour is the working hours of farm labourers. Due to the lack of survey data, the labour input is defined as the number of workers engaged in agricultural activities.

In order to assess the robustness of the estimates, two scenarios are taken into account. The first one consists of assuming constant input shares for the whole period of analysis. The weights correspond to the case of Brazil reported by Avila and Evenson (1995). The weights are 0.43 for labour; 0.22 for the land; 0.14 for the stock of cattle; 0.14 for machinery and 0.07 for fertilisers. On the other hand, the second alternative corresponds to variable input shares by decades. Input shares were calculated from the Brazilian Agricultural Census' 1970, 1985, 1996 and 2006 and reported by Fuglie (2012). Velazco (2001) estimated, using a Cobb-Douglas funcion, the shares of land, labour, machinery and fertiliser for the period 1970-1995. The relative importance of those input shares is similar to the Brazilian weights, these being the prefered ones for the application to the Peruvian case. Table 4.3 shows the factor shares used for the variable input share scenario.

Table 4.3. Variable Input Shares

Input	Factor shares				
	1950-70	1971-80	1981-90	1991-00	2001-10
Labour	0.434	0.434	0.443	0.415	0.373
Land	0.342	0.342	0.159	0.115	0.083
Livestock	0.126	0.126	0.168	0.181	0.129
Tractor	0.071	0.071	0.110	0.177	0.160
Fertiliser	0.027	0.027	0.120	0.112	0.255

Source: Fuglie (2012)

Regarding the evolution of production and use of productive factors, Table 4.4 summarises the annual average growth rate of inputs and output according to sub-periods of analysis. Five sub-periods, which coincide with major economic policy measures undertaken during the study period, were considered for the analysis of the TFP trend. The selected sub-periods are 1950-1959, 1960-1975, 1976-1990, 1991-2000 and 2001-2010. Export-oriented economic policies were carried out in the first sub-period. The second period is characterised by the implementation of the Import Substitution Industrialisation (ISI) policies. The third period was a transition towards neoliberal policies, seeking to dismantle the protectionist policies and encouraging trade liberalisation (Rojas, 1997). Furthermore, it coincided with the external debt crisis, the expansion of political violence and the failure of the populist government of Garcia (1985-1990), ending in hyperinflation and recession. The next period covered the implementation of the stabilisation programme and structural reforms aimed at reducing the role of government in the economy. The last period is related to a scenario of steady economic expansion[28].

[28] In order to confirm the selected periods of analysis, the test of structural change, proposed by Bai and Perron (2003), was performed to the agricultural production series. Outcomes identify structural breaks in 1960, 1993 and 2002.

As expected, the lowest output growth rate was for the economic crisis period, 1976-1990, showing an increasing dynamism after that. Regarding the input trends, the higher growth rates were associated with arable land and permanent crops (2.09% for the entire period), fertiliser use (4.3%), and use of agricultural tractors (2.97%). On the other hand, the lowest rate of growth corresponds to the number of the economically active population in agriculture (1.01%) and livestock units (0.86%).

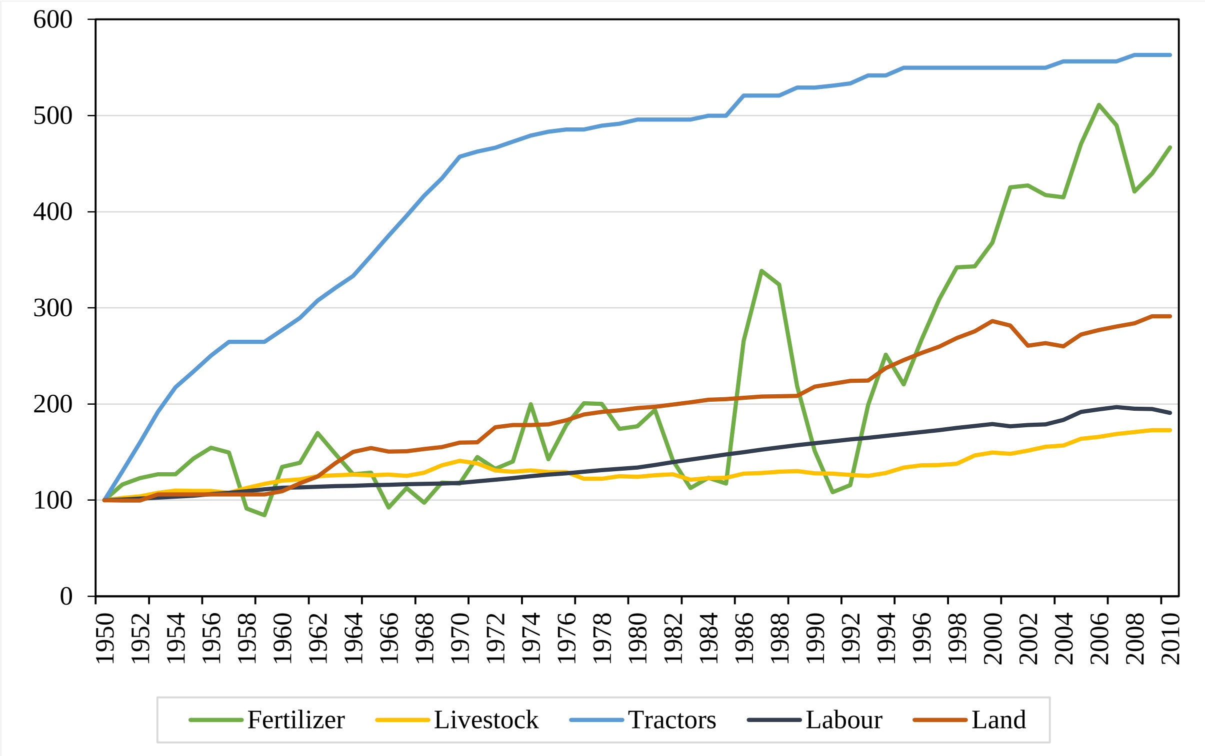
Figure 4.4 depicts the evolution of input indices over the study period. Notably, there is a significant growth and dynamism in tractor usage. While the demand for fertilizers is on the rise, it exhibits erratic behaviour, possibly attributed to the fact that a significant portion of this input is imported, and its demand may have declined during periods of crisis. The livestock index shows almost stagnant input, labour experiences slight growth from around 1970 onwards, and land begins a slow increase from 1960 onwards.

Table 4.4 Agricultural ouput and inputs growth by periods, 1950-2010

Periods	**Agricultural Net Production, 1994 New Soles (in Millions)**		**Arable Land and Permanent Crops**		**Active Population in Agriculture**		**Livestock Units**		**Agricultural Tractors**		**Fertilizers use**	
	Average period	Annual growth rate	Thousand hectares	%	Thousand people	%	Thousand LU	%	Units	%	Thousand tonnes	%
1950-1959	3,358	1.87	1,692	0.83	1,655	1.19	11,895	1.78	4,985	11.84	84.61	-.042
1960-1975	4,845	2.52	2,661	4.01	1,861	0.76	14,187	0.52	9,490	3.80	93.25	2.85
1976-1990	6,187	0.99	3,642	1.26	2,252	1.57	13,857	-0.05	12,090	0.62	135.33	3.85
1991-2001	8,501	5.11	4,633	2.78	2,694	0.94	14,983	1.53	13,081	0.34	186.50	16.35
2002-2010	13,288	4.06	5,084	1.51	2,989	0.88	18,098	1.67	13,368	0.30	313.78	1.45
1950-2010	6,836	2.53	3,456	2.09	2,240	1.01	14,450	0.86	10,611	2.97	151.53	4.34

Source: Author' own elaboration

Figure 4.3 evolution of input indices (1950=100)



Source: Own elaboration, see Appendix 4.1 for data description.

4.3.2. Estimation of TFP for Peruvian Agriculture in previous studies

There is significant empirical literature on agricultural TFP estimates made at the level of various regions, groups of countries and individual countries. In the case of Latin America, although there are few studies for individual countries, estimates were carried out for Chile (Olavaria, et al., 2004), Argentina (Lema, 2015), Mexico (Fernandez-Cornejo and Shumway, 1997), Uruguay (Arancet and Calvete, 2003), Colombia (Jiménez et al, 2018), Brazil (Helfand, et al, 2015; Gasques et al, 2010 and 2012, among others), Honduras and Panama (Ebata, 2011). These studies estimate, using annual and aggregated data, the contribution of productive factors and TFP in explaining the performance of agricultural output. The discussion on the evolution of TFP is often framed in decades, periods of government or development strategies implemented in the country.

In general, studies have considered Peru as part of a sample of countries to estimate TFP. Main findings, in terms of methods, period of analysis and estimates of the TFP growth rate, are summarised in Table 4.5. Different approaches were implemented, such as translog production function, the stochastic frontier analysis, the Data Envelopment Analysis (DEA), among others. The review reveals that methods, measures of variables and model specifications used to estimate productivity growth could affect its estimation. As can be seen, the average annual TFP growth derived from these studies varies between -0.99 and 3.46.

While the focus lies on estimating TFP using time series data, there are studies that have estimated PTF for Peru using cross-sectional data. Notable among them are Galarza and Díaz (2015), Tello (2016), and the Banco Mundial (2017).

Table 4.5. Estimation of TFP in Peruvian Agriculture using time series

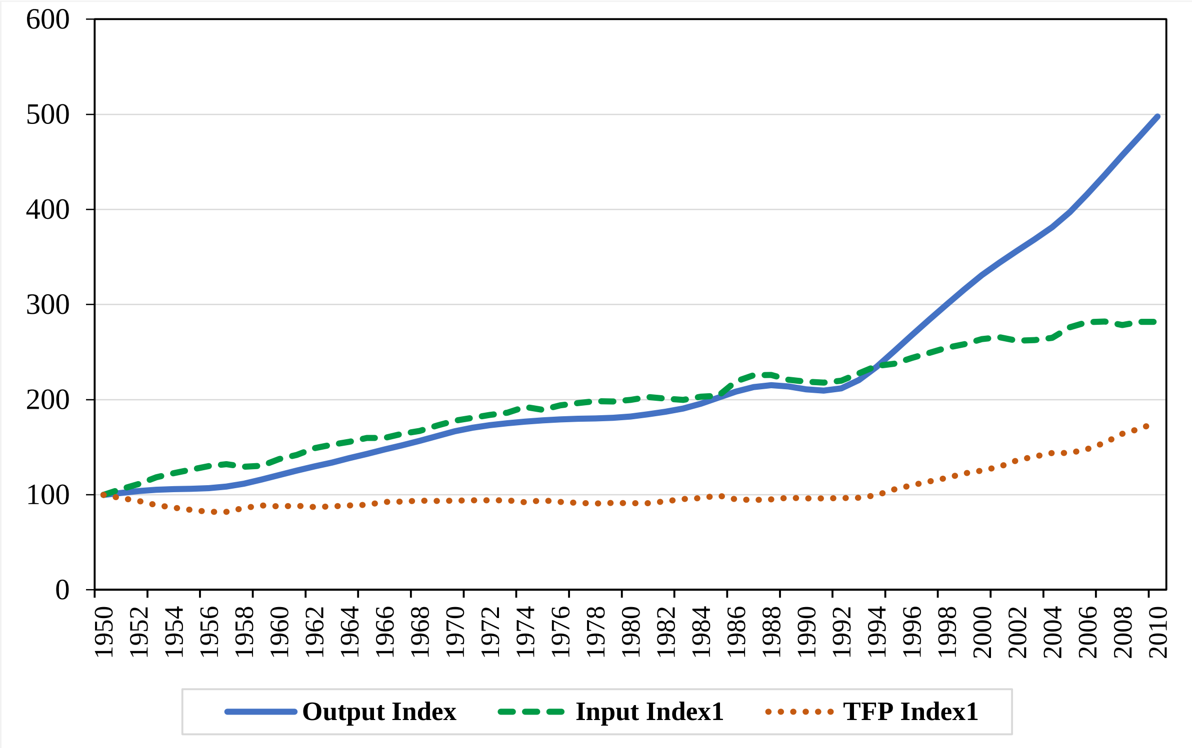
Authors	Methodology	Period	TFP growth rate
Martín-Retortillo et al. (2022)	Cobb-Douglas Production function	1950-1973 1974-1993 1994-2008 1950-2008	-0.33 0.98 3.61 1.14
Fuglie (2012)	Cobb-Douglas Production function	1961-1970 1971-1980 1981-1990 1991-2000 2001-2009	0.85 -0.99 -0.02 3.11 3.46
Avila et al. (2010)	Tornqvist-Theil	1961-2001	1.17
Ludena (2010)	Malmquist – DEA*	1961-2007	1.2
Headey et al. (2010)	Stochastic Frontier Analysis	1970-1985 1986-2001	1.8 2.5
Nin-Pratt y Yu (2009)	Malmquist	1984-2003	2.55
Coello y Rao (2005)	DEA	1980-2001	1.02
Bravo-Ortega y Lederman (2004)	Translog production function	1961-2000	1.36
Pfeiffer (2003)	Stochastic Frontier Malmquist	1972-2000 1972-2000	2.79 1.40

DEA: Data envelopment analysis. Author’s own elaboration

4.3.3 Findings

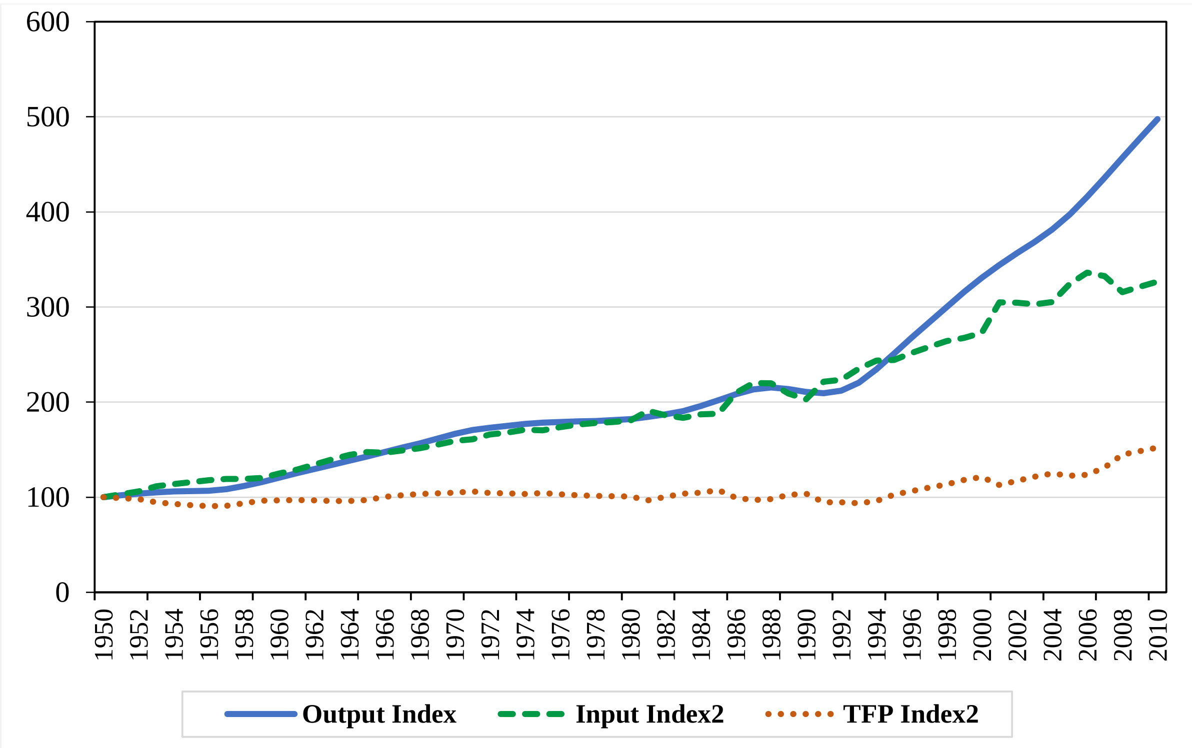
Figures 4.4 and 4.5 shows the evolution of the output index, input index and TFP index for Peruvian agriculture for the period 1950-2010. It is noted that the expansion of production until the early 1990s was accompanied by greater dynamism of the factors of production. Thereafter, TFP shows a trend closer to the output.

Figure 4.4. Evolution of Output Index, Input Index and TFP Index in Peruvian Agriculture, 1950-2010
(Assuming constant input shares)



Source: Author own elaboration

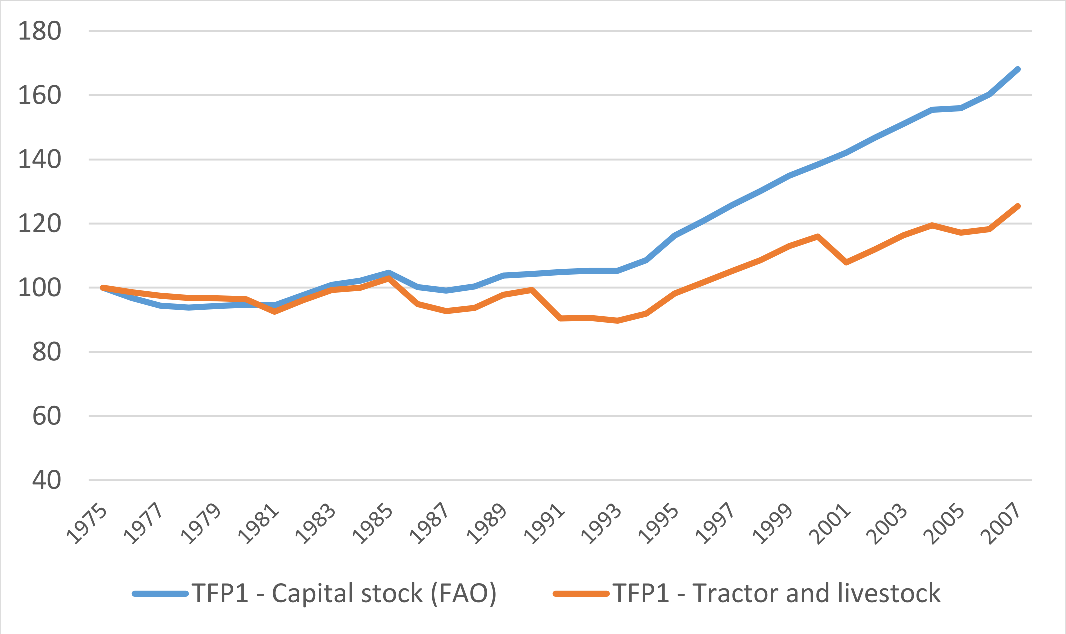
Figure 4.5. Evolution of Output Index, Input Index and TFP Index in the Peruvian Agriculture, 1950-2010
(Assuming variable input shares)



Source: Author own elaboration.

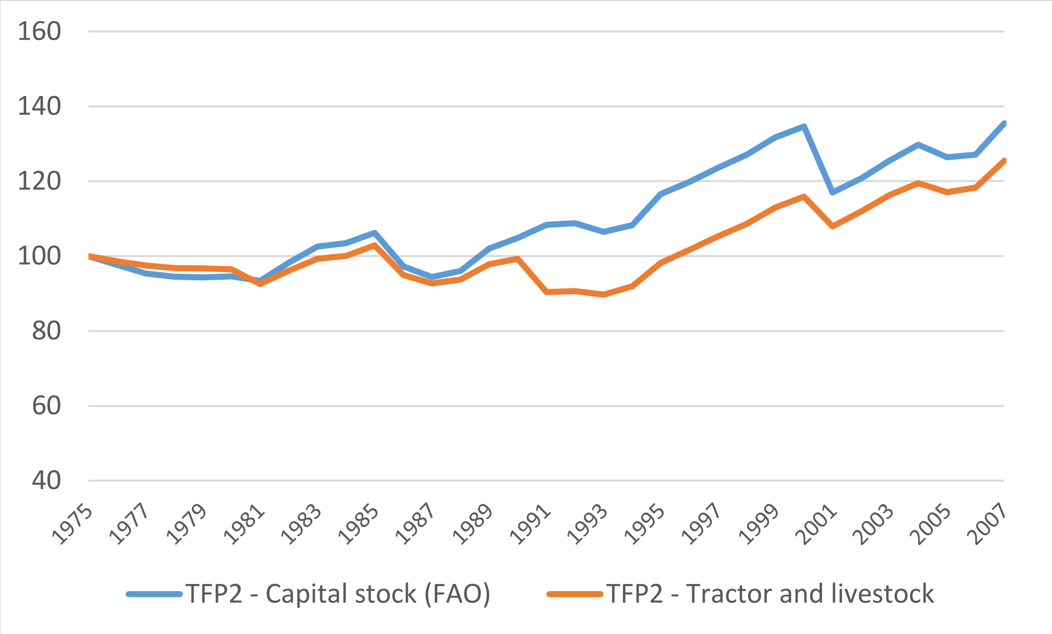
It is important to acknowledge that one of the critical issues with measuring production factors, as previously indicated, is the estimation of capital. The analysis undertaken considers the number of tractors and the livestock as two components of the capital stock. In 2011, the FAO produced estimates of capital stock in agriculture based on the physical inventory approach (Daidone and Anriquez, 2011) for the period 1975-2008. The dataset is generated under the assumption that agricultural capital comprises three distinct elements that necessitate separate computation: 1) livestock, 2) physical capital, and 3) orchard stock, representing the value of planted permanent crops. With the aim of conducting a kind of robustness analysis of the estimated indices, they are compared with the capital stock variable estimated by the FAO for the period 1975-2008. Figures 4.6 and 4.7 depict the comparison of TFP indices with the two capital options. The indices exhibit a similar trend until the mid-1980s, after which the index with FAO capital stock diverges and surpasses the other indicator. The correlation coefficients for TFP1 and TFP2 are 0.92 and 0.85, respectively. While the trends are very similar in both cases, it can be concluded that using tractors and livestock as proxies for capital stock would lead to an underestimation of TFP performance. In other words, TFP performance from the 1990s onwards could be greater than the presented estimates suggest.

Figure 4.6: Comparison of TFP1 with two options of capital stock



Source: Author own elaboration.

Figure 4.7: Comparison of TFP2 with two options of capital stock



Source: Author own elaboration.

Table 4.6 and Table 4.7 show the sources of agricultural growth for the periods of analysis. The contribution of the TFP index and the input index (land, livestock, labour, machinery and fertilisers) is estimated. Outcomes with constant input shares and variable input shares provide similar trends, showing some discrepancy only in the 1976-1990 period. In general, results denote that the TFP exhibits a poor performance during 1950-1959, output being explained largely by input accumulation. The ISI period, 1960-1975, was characterised by a recovery in the TFP contribution to output growth, ranging from 13.19% to 19.05%. During the next sub-period, 1976-1990, external debt crisis and economic crisis expressed in hyperinflation, undermined the output growth. This was mainly explained by input accumulation, being 88% according to the constant input share scenario and 100% for the variable input shares scenario. The following two-subperiods witnessed remarkable output growth. From the 1990s, productivity in Peruvian agriculture recovered significantly, growing at an annual average growth rate of 2.81% and 3.51% during the fourth and fifth sub-periods respectively for the constant input share context and 0.76% and 3.36% for the variable input share scenario. In terms of the inputs that most explain growth, the order of importance is as follows: fertilisers, tractors, and land.

It is noteworthy that, when viewed through the lens of Latin American comparison, Martín-Retortillo et al. (2022) undertake an estimation of Total Factor Productivity (TFP) across ten countries spanning the period 1950-2008. Their findings correspond with the results of the Peru case study, suggesting a notable increase in the significance of Total Factor Productivity (TFP) in relation to agricultural output, especially since the 1990s.

Table 4.6. Factor Accumulation and Productivity Contributions to Output Growth, 1950-2010 (annual average growth rate in percent)
(With constant input shares)

Periods	National context	Output growth (%)	Input growth (%)	TFP growth (%)	TPF relative to output
1950-1959	Export oriented policies	1.67	3.03	-1.36	-81.60
1960-1975	ISI policies	2.73	2.37	0.36	13.19
1976-1990	Internal/debt crisis	1.13	0.99	0.14	12.10
1991-2001	Stabilisation programme and structural reforms	4.58	1.77	2.81	61.35
2002-2010	Economic expansion	4.18	0.67	3.51	83.97
All period 1950-2010		2.73	1.76	0.97	35.40

Source: Author' calculations

Table 4.7. Factor Accumulation and Productivity Contributions to Output Growth, 1950-2010 (annual average growth rate in percent)
(With variable input shares)

Periods	National context	Output growth (%)	Input growth (%)	TFP growth (%)	TPF relative to output
1950-1959	Export oriented policies	1.67	2.08	-0.41	-24.55
1960-1975	ISI policies	2.73	2.21	0.52	19.05
1976-1990	Internal/debt crisis	1.13	1.24	-0.11	-9.73
1991-2001	Stabilisation programme and structural reforms	4.58	3.82	0.76	16.60
2002-2010	Economic expansion	4.18	0.82	3.36	80.40
All period 1950-2010		2.73	2.04	0.69	25.30

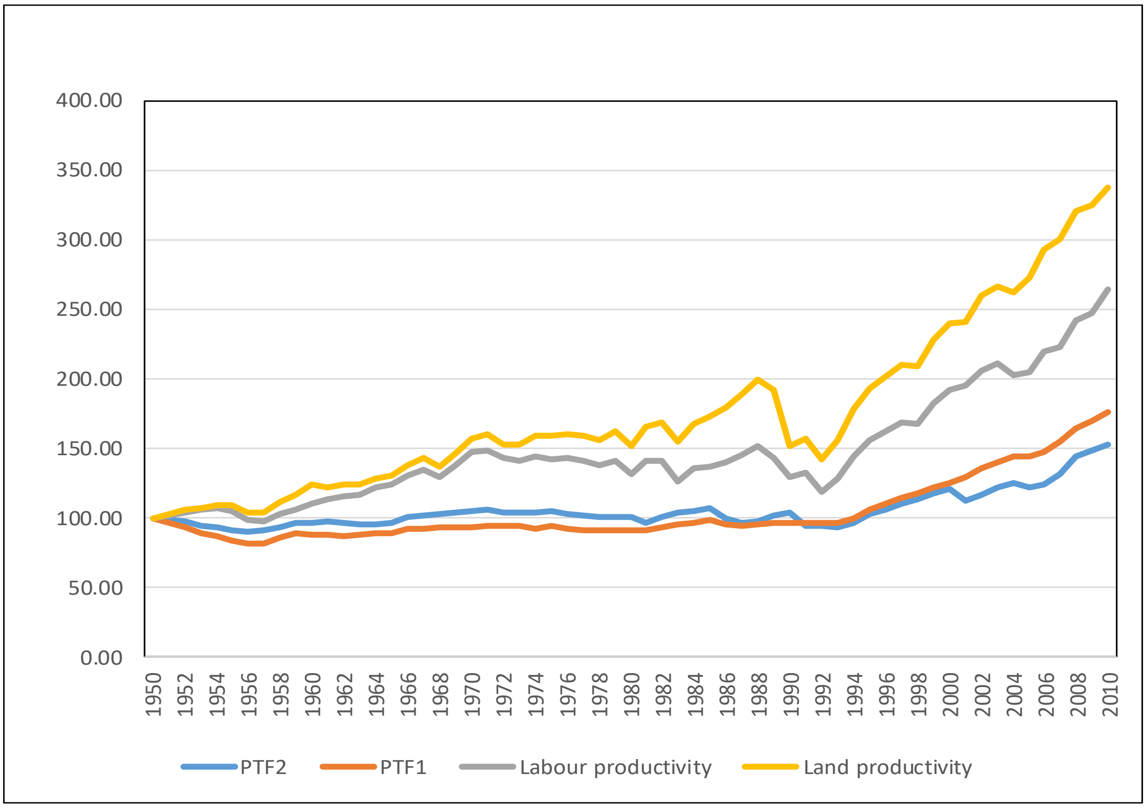
Source: Author' calculations

Consequently, important changes have taken place in Peruvian agriculture in the last two decades. These have been due to the increasing openness to international markets (currently the country has free trade agreements with various countries). Other factors are related to the growing international demand for healthy food quality, the incorporation of new land for farming, the growing interest in bio-fuels, the increased income of Peruvians who demand a more varied and quality food supply and the expansion of private investment in agriculture, among other factors (Velazco and Velazco, 2012).

The 1990s marked a period of significant transformation in agricultural performance. The State's implementation of stabilization programmes and structural reforms altered the institutional landscape and the parameters within which agricultural producers engage in market activities. A notable aspect arising from these reforms is the explicit policy stance aimed at fostering investment in the sector, declaring the advancement of agribusiness as a matter of national interest. Within this new context, the government's role underwent a shift, assuming a regulatory stance in promoting and directing economic endeavours. Consequently, the State assumes a subsidiary role, with private initiative deemed essential for driving development (von Hesse, 2000; Eguren, 2003). Policies directly benefiting the agricultural sector included the liberalization of trade in agricultural goods and production factors, as well as the divestment of state monopolies. Additionally, measures such as the deregulation of factor markets (water, land, labour, inputs, credit), reductions in income taxes, tariff reductions on imports, and the expansion of new export markets through the signing of bilateral free trade agreements, among others, were implemented (Velazco and Velazco, 2012).

Figure 4.8 compares the three productivity indicators: partial (land and labor) and total factor productivity (TFP) in both versions. It is observed that TFP remains almost stagnant until 1990, after which it undergoes a radical change in trend. Conversely, the partial productivities exhibit similar trends, with land productivity showing greater dynamism.

Figure 4.8. Labour productivity, land productivity and TFP, 1950-2010



Source: Own elaboration, see Appendix 4.1 for data description

4.4. Explaining TFP Growth in Peruvian Agriculture

Empirical studies estimate the determinants of TFP highlighting significant variables, such as investment in agricultural research, public investment, infrastructure, education, labour quality, irrigation, international technology transfer, macroeconomic stability and trade liberalisation (Griliches, 1963; Hayami and Ruttan,1970; Antle, 1983; Appleton and Balihuta, 1996; Rao et al., 2004; Chen et al., 2008; Fuglie, 2010; Fernandez-Cornejo and Shumway, 1997; Arancet and Calvete, 2003; Headey et al., 2010; Dias Avila et al., 2010, among others). The econometric analysis consists of estimating an equation for TFP based on the following set of variables that comprise both supply side variables and demand-side variables[29]:

a) Human capital (HC) expressed as a labour quality index, computed according to the methodology applied by Céspedes and Ramírez-Roldán (2014) for the estimation of the TFP in Peru. The index is defined as:

$$H = \sum_{j} W_j E_j$$

H is the weighted average of the shares of population, E, with educational level j, where W_j is a weight defined as the social return to educational level j. This variable is taken from Psacharopoulos (1994) for the following seven educational levels: no education, incomplete primary education, completed primary education, incomplete secondary education, completed secondary education, incomplete college education and completed college education. The variable E, available since 1950, is obtained from Barro and Lee (2010). In spite of the fact that this variable is not specific to agricultural workers, it is a good proxy for the estimation aim, bearing in mind that the average schooling of agricultural workers is lower than the average schooling for all workers.

b) Trade openness is measured as the ratio of (imports + exports) to GDP (OPEN). The index was computed using data from the on-line database of the Central Bank of Peru (www.bcrp.gob.pe).

c) Public investment allocated to the agricultural sector (API) in Nuevos Soles (1994 base year). This series was created using diverse sources: Elias (1981) reports information from 1950- 1980, Velazco (2001) from 1970 – 1994 and the Central Bank of Peru Annual Report from 1995 - 2010. It is expected that higher levels of this expenditure will be associated with improved availability of productivity enhancing infrastructure, research and education.

[29] For a detailed literature review on the determinants of TFP, see Isaksson (2007).

d) Expenditure on research and development in agriculture (AR&D) is considered. Estimates from Gomez (2019) for the period 1962-2010 are utilized. It is anticipated that there will be a positive impact on Total Factor Productivity (TFP), as demonstrated by Evenson (2001) and Alston et al. (2000).
e) Public investment in gross fixed capital (PGFCF) in Nuevos Soles (1994 base year) obtained from the Central Bank of Peru website (www.bcrp.org.pe). It is expected that this variable might capture technology that is embodied in fixed capital.
f) The Gini land index (GINI) data are derived from the estimates provided by Zegarra (2018). These indices are calculated using data from agricultural censuses (1961, 1972, 1994, and 2012). In order to complete the series, intercensal growth rates are estimated. A negative relationship with TFP is anticipated, as equitable land distribution is expected to encourage small farmers to invest in sustainable farming practices and adopt modern technologies, consequently enhancing TFP (Deininger and Jin, 2003).

g) GDP per capita (GDPpc) in Nuevos Soles is expressed in real terms (1994 base year). Data obtained from the Central Bank of Peru database. This is the only variable representing the demand-side pressures, underlying that strong aggregate demand enhances investment and technological change and causes technological adoption (Isaksson, 2007). Furthermore, this variable also encapsulates a supply-side component insofar as increased income leads to higher fiscal revenue, which can be allocated towards infrastructure development within the sector.
h) A Structural reforms index (SRI) is a set of indexes that attempt to measure how favourable trade, financial, tax, privatisation and labour policies are for the free working of the market. Escaith and Paunovic (2004) computed the indexes for the period 1970-2000. Lora (2012) estimated a similar index for 1985-2009. Escaith and Paunovic's index was updated to 2010 using the rate of growth of Lora's index. Given that the index begins in 1970, it was necessary to resort to a literature review regarding the nature of policies in force during the period 1950-1970 (Zegarra, 2014). It was found that governments continued to implement measures facilitating trade openness during 1950-1960, alongside initiatives initiated in the mid-1960s aimed at promoting the development of the domestic industry. To facilitate the expansion of the index for the period 1950-1969, it is assumed that its growth during the 1950s-1960s is greater than that of the subsequent decade, thus connecting the value with the year 1970. This approach yields the Structural Reform Index variable for the entire period. Additionally, to assess the robustness of econometric results, regressions are estimated

using the index covering the period 1950-2010 and others considering the period 1970-2010.

Thus, the following equation to be estimated is:

$$TFP = \beta_o + \beta_1 HumanCapital + \beta_2 TradeOpeness + \beta_3 Agro\_Investment + \beta_4 R\&D + \beta_5 GDPpc + \beta_6 Fixed\_Capital\_Public\_Investment + \beta_7 Structural\_Reform + \beta_8 Land\_Gini + \mu \quad (4)$$

Where μ is the error term.

It is anticipated a priori that all variables, except the land Gini coefficient, will have a positive impact on Total Factor Productivity (TFP).

Equation (4) will be estimated using cointegration analysis. The proposed methodology mirrors that applied in Chapter 3, hence the procedure will involve identifying the presence of unit roots in the series, checking for stationarity of variables in first differences, and verifying cointegration using the Trace statistic and the Max statistic. If cointegration is confirmed, the cointegration vector along with its respective Vector Error Correction (VEC) model will be estimated, followed by conducting the Granger non-causality test.

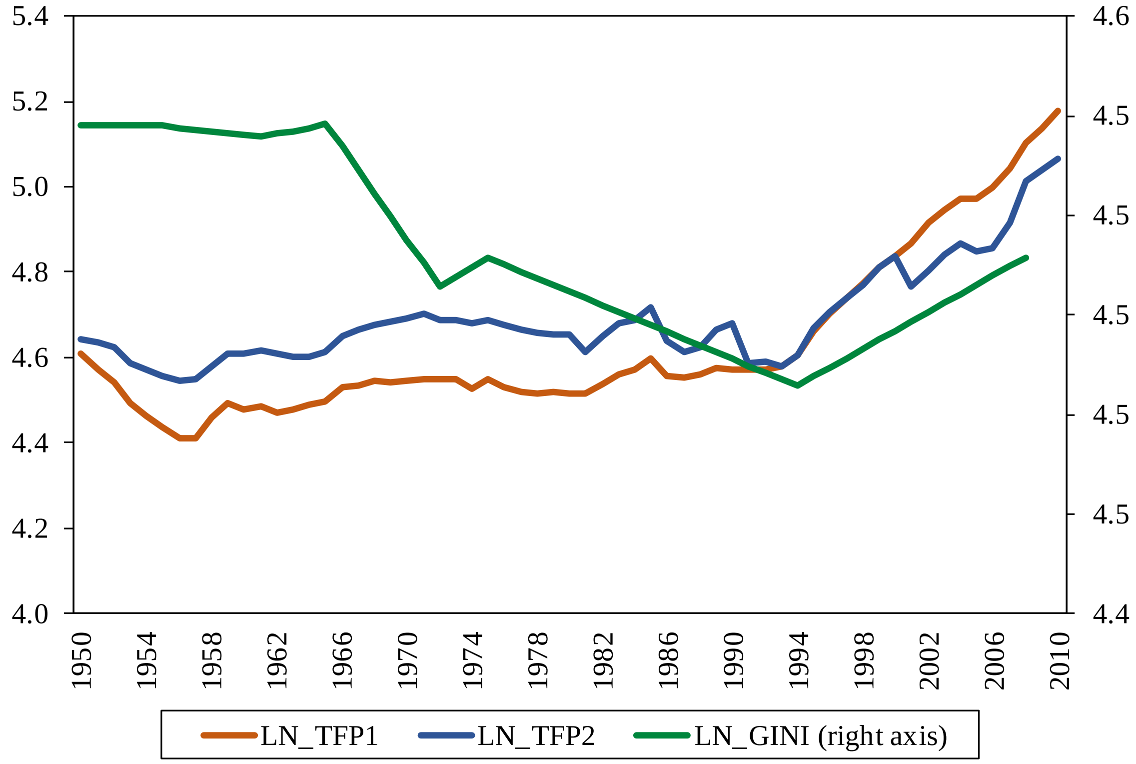
After testing the relationship proposed in equation (4), the following variables do not exhibit a long-term relationship with the TFP1 and TFP2 indices: all public investment variables and the land Gini indicator (See Figures 4.9 and 4.10). This implies that the remaining variables, having established a long-term relationship with TFP, include human capital, trade openness index, GDP per capita, and Structural Reform index.

The land Gini coefficient, public expenditure on R&D in agriculture, public investment allocated to the agricultural sector and public investments in gross physical capital (proxy for public infrastructure) do not show a long-term relationship with TFP indices, a situation that diverges from the international literature (Hayami and Ruttan, 1970; Antle, 1983; Rao et al., 2004; Alauddin et al., 2005; Teruel and Koruda, 2005; Chen et al., 2008; Fare et al., 2008; Headey, Allaudin and Rao, 2010). This finding can be interpreted as evidence of the absence of a long-term public policy (both macro and sectoral) aimed at improving the productivity of the economy and, specifically, the agricultural sector.

For instance, a demonstration of underinvestment in Research and Development (R&D) is evident in the evolution of the percentage of this expenditure within the agricultural Gross Domestic Product (GDP) in Peru. This figure declined from 1.5% during the period 1964-1975 to 1.2% in 1976-1990, and further plummeted to 0.3% in 1991-2011 (Gómez, 2019). However, agricultural policy, which has remained stable since the mid-19th century, is to support the development of export agriculture, mainly located on the Coast, prioritizing spending on irrigation (this leads to expanding land rather than necessarily TFP).

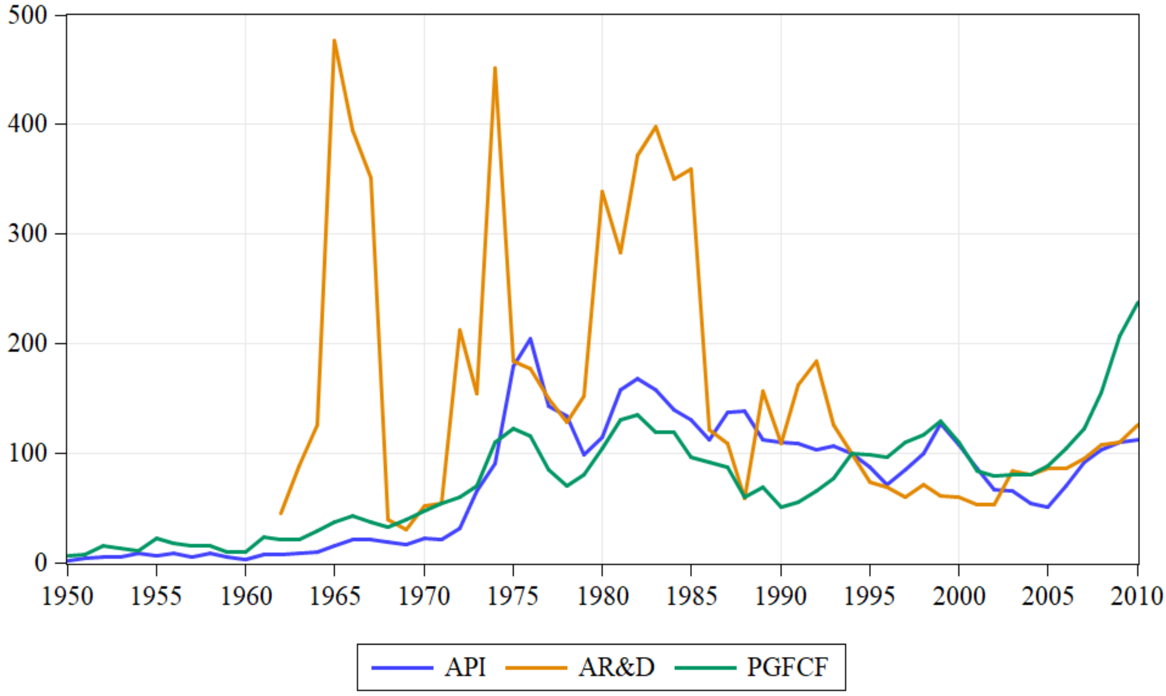
Regarding the land Gini coefficient, it can be interpreted that in agricultural performance, especially during an expansion phase, episodes of land concentration may occur, thereby increasing the Gini coefficient. Furthermore, the increase in the Gini coefficient from the 1990s onwards would be associated with processes of land concentration facilitated by the new Land Law that removes limits on the size of new agricultural units. This situation was observed in the existence of agro-industrial complexes dedicated to the export of non-traditional products. In other words, it can be suggested that the functioning of the land market, supported by legislation, stimulates and generates these processes of land concentration.

Figure 4.9. Evolution of Total Factor Productivity (TFP) indices and land Gini coefficient



Source: Own elaboration, see Appendix 4.1 for data description

Figure 4.10. Evolution of public investment in agriculture (API), research and development (R&D), and public investments in gross physical capital (PGFCF) (1994= 100)



Source: Own elaboration based on BCRP data for API and PGFCF and from Gómez (2019) for AR&D.

Appendix 4.2 shows the variables in their original values, in log and in first differences. Descriptive statistics of selected variables are shown in Table 4.8

Table 4.8. Descriptive Statistics of variables

Variable	Obs	Mean	Std. Dev.	Min	Max
LN_TFP1	61	4.629604	.193657	4.411602	5.177908
LN_TFP2	61	4.691113	.1161665	4.544838	5.065009
LN_HC	61	5.767912	.3317931	5.279476	6.285666
LN_Open	61	3.715702	.1898185	3.300434	4.033632
LN_SRI	61	-.4883226	.3519427	-.9519179	-.0632447
LN_GDPpc	61	8.417065	.1962039	7.963112	8.872347

Source: Own elaboration, see Appendix 4.1 for data description

4.4.1 Unit Root Tests for selected Variables

Conventional tests of Augmented Dickey-Fuller (ADF) and Phillips-Perron were considered[30]. In Appendix 4.3, the results of the aforementioned tests for the series are presented, both in levels and first differences. It can be observed, according to the stationary test, that the variable levels integrated in single order, I(1), were not rejected. Moreover, the null hypothesis that the first differences have unit roots was rejected.

Confirming that the time series data was stationary in first differences, the TFP determinants were estimated using the cointegration method suggested by Johansen (1988). Under this methodology, two or more variables can be considered to be in long-term equilibrium if they move closely and in parallel over time, even though they may in the short-run move in opposite directions. For this reason, the technique is particularly useful to identify the determining factors of the TFP. The long-term relationship is known as the cointegration vector. After testing different model options, three sets of models were the preferred estimations for each TFP index.

4.4.2 Cointegration tests and Determinants of TFP

The Trace test indicated one cointegration vector using Johansen and Juselius' (1990) criterion and one cointegration vector using the maximum characteristic value test. The results from this analysis, for the TFP considering either constant or variable input shares, are presented from Tables 4.9 to 4.14.

[30] Additionally, the Clemente-Montañés-Reyes tests for unit roots allowing for structural change were also carried out, providing similar results.

Table 4.9. Johansen-Juselius cointegration tests: TFP1, Human capital and GDpc

Trace statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None *	0.395	47.191	29.797	0.000
At most 1 *	0.202	19.574	15.495	0.012
At most 2	0.122	7.184	3.841	0.007
Max-Eigen statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.395	27.618	21.132	0.005
At most 1	0.202	12.389	14.265	0.097
At most 2	0.122	7.184	3.841	0.007

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Source: Eviews output.

Table 4.10. Johansen-Juselius cointegration tests: TFP2, Human capital and GDpc

Trace statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.371	37.296	29.797	0.006
At most 1	0.165	11.805	15.495	0.167
At most 2	0.034	1.890	3.841	0.169
Max-Eigen statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.371	25.491	21.132	0.011
At most 1	0.165	9.915	14.265	0.218
At most 2	0.034	1.890	3.841	0.169

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Source: Eviews output.

Table 4.11. Johansen-Juselius cointegration tests: TFP1 and trade openness

Trace statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.225	16.729	15.495	0.032
At most 1	0.028	1.682	3.841	0.195
Max-Eigen statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.225	15.047	14.265	0.038
At most 1	0.028	1.682	3.841	0.195

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Source: Eviews output.

Table 4.12. Johansen-Juselius cointegration tests: TFP2 and trade openness

Trace statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.291	20.765	15.495	0.007
At most 1	0.008	0.477	3.841	0.490
Max-Eigen statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.291	20.288	14.265	0.005
At most 1	0.008	0.477	3.841	0.490

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Source: Eviews output.

Table 4.13. Johansen-Juselius cointegration tests: TFP1, GDPpc and Structural Reform index

Trace statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.360	32.170	29.797	0.026
At most 1	0.093	5.855	15.495	0.713
At most 2	0.002	0.096	3.841	0.757
Max-Eigen statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.360	26.314	21.132	0.009
At most 1	0.093	5.760	14.265	0.644
At most 2	0.002	0.096	3.841	0.757

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Source: Eviews output.

Table 4.14. Johansen-Juselius cointegration tests: TFP2, GDPpc and Structural Reform index

Trace statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.321	34.438	29.797	0.014
At most 1	0.178	11.570	15.495	0.179
At most 2	0.000	0.020	3.841	0.887
Max-Eigen statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.321	22.868	21.132	0.028
At most 1	0.178	11.550	14.265	0.129
At most 2	0.000	0.020	3.841	0.887

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Source: Eviews output.

Knowing that there exists a cointegration vector for each model, Table 4.15 presents the normalised cointegration vectors for the two TFP indices. The same models are replicated for each index as a robustness test of the results. All coefficients exhibit a significance level of 1%.

Table 4.15. Normalised cointegration vector

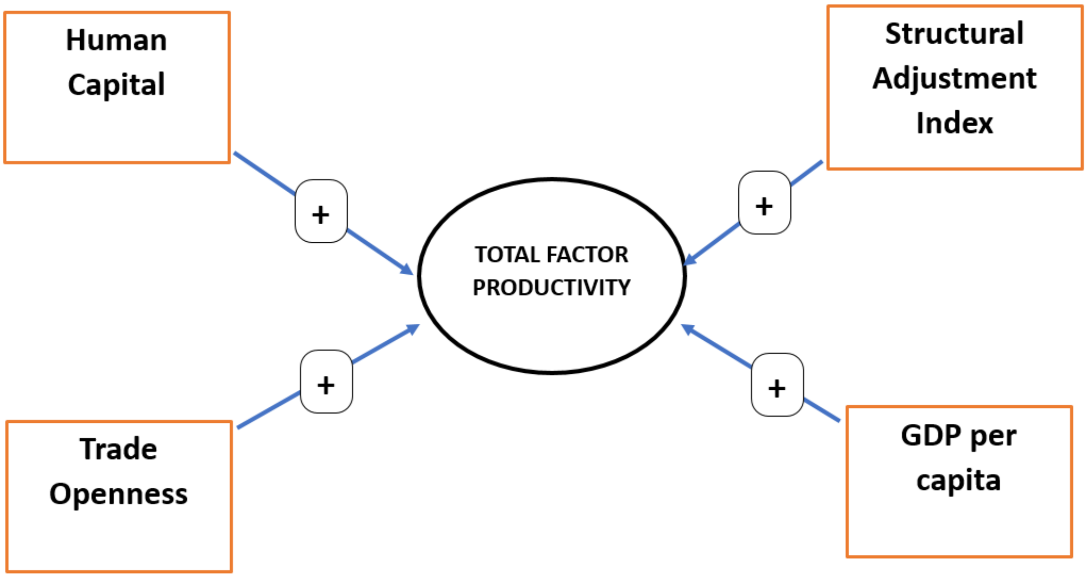
Variables	TFP1			TFP2		
LN_TFP1 (-1)	1	1	1	1	1	1
LN_TFP2 (-1)						
LN_HC (-1)	-0.6405 (0.1088) [-5.8856]			-0.2569 (0.0426) [-6.0377]		
LN_Open (-1)		-1.6885 (0.2727) [-6.1914]			-1.0370 (0.1497) [-6.9281]	
LN_SRI1 (-1)			-0.9426 (0.1161) [-8.1205]			-0.2076 (0.0443) [-5.9461]
LN_GDPpc (-1)	-0.5670 (0.1970) [-2.8774]		-0.4920 (0.1566) [-3.1423]	-0.3136 (0.0896) [-3.5002]		-0.4220 (0.0443) [-4.6844]
Constant	3.8748	1.3612	-1.0560	-0.5529	-1.0118	-1.2606

The figure in the parenthesis denotes the standard error.
The figure in the square brackets represents the t-statistic.
Note: The signs of the coefficients are reversed in the long-run.

The resulting normalised cointegration vectors provide an estimate of the relative contribution of the selected variables to Peru's agricultural TFP. Serial correlations in the residuals of the selected models were checked using the ADF and the LM tests. In all cases, the nill hypothesis was rejected, implying the existence of cointegration. Furthermore, according to the Jarque Bera tests, the residuals are normally distribuited, homoscedasticity is fullfied and stability condition is satisfied using the roots of characteristics polynomial. The post diagnostic tests and the selected vector error correction models are presented in Appendix 4.4.

Figure 4.11 summarises the long-term relationships identified through cointegration analysis. In other words, in the long run, human capital, structural adjustment policies, trade openness, and GDP per capita have a positive impact on Total Factor Productivity (TFP).

Figure 4.11. Long-term relationships between TFP, human capital, trade openness, structural adjustment index and GDp per capita

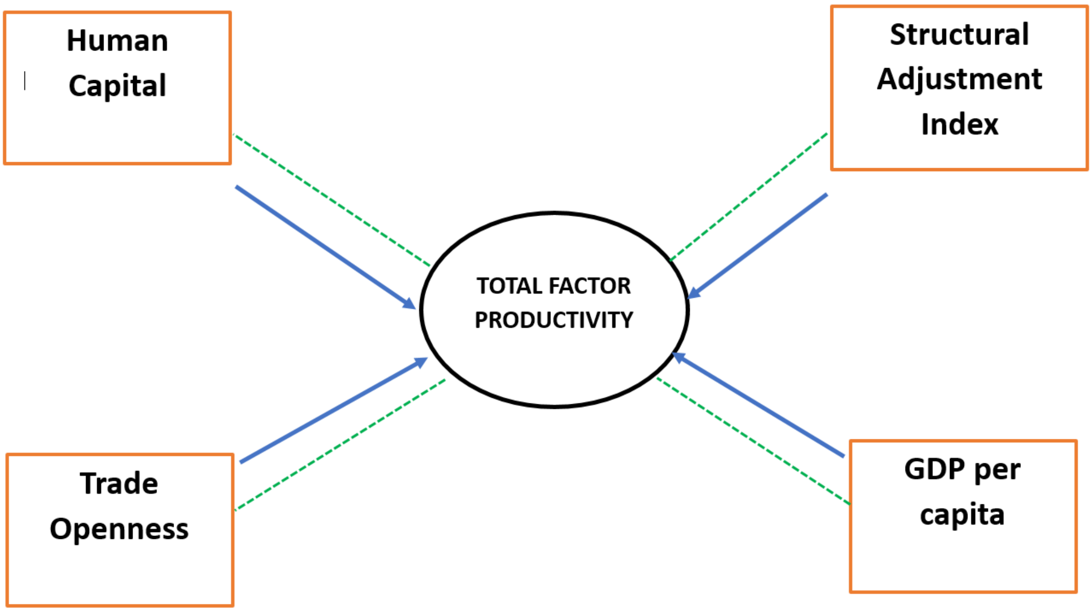


Source: Relationships are derived from Table 4.15

4.4.3 Granger non-causality analysis

The outcomes of non-causality tests are located in Appendix 4.4. The findings derived from the Granger causality tests are outlined in Figure 4.12. Long-term relationships and signs are confirmed as in the previous figure. The Granger test indicates a long-term causality running from the selected variables to the Total Factor Productivity (TFP) and furthermore, suggests the absence of short-term causality.

Figure 4.12. Short-term relationships between TFP, human capital, trade openness, structural adjustment index and GDp per capita



Legend:
Uni-directional long-term Granger causality
No short-term Granger causality
Source: Relationships are derived from Tables in Appendix 4.4

Overall, these results, suggest that TFP is positively determined by human capital, GDP per capita, trade openness and the structural reforms index.

Turning to the human capital variable, the literature on the determinants of agricultural innovation emphasise socio-economic factors, such as farm size, risk, human capital, availability of labour, credit and form of land tenure[31] (Feder, Just and Zilberman, 1982; Feder, 1982; Feder and Slade, 1984). In the southern highlands of Peru, Figueroa (1986) and Cotlear (1989) identify education as a key factor behind the adoption of new technologies. Studies were carried out on the factors influencing adoption of technologies, and innovation and technological capacity in Peruvian agriculture based on a comparative analysis of the 1994 and 2012 Farm Census. Findings corroborate the key role played by farmer's education as well as farm size, access to credit and distance to the markets (Tello, 2016; and Kim, 2015).

The 1972, 1994 and 2012 Peru Farm Census report that the percentage of farmers without education decreased as farm size increased. Furthermore, the proportion of uneducated farmers accounted for 27.48 % of farms in 1972, 20.4 % in 1994 and 15.1% in 2012. In spite of the fact that the percentage of farmers with secondary and higher education

[31] A review on the benefits from agricultural research and development, innovation, and productivity growth was carried out by Alston (2010).

have increased across the census, the share of farmers having only a primary education is still high, reaching 51.8% in 2012. This fact can be seen as an obstacle to the delivery of extension programmes and technology transfer, which require specialised knowledge on the part of the farmer.

With regard to innovation of selected crops, considerable progress was made in the research and generation of improved varieties[32]. During the 1980s, The Agricultural University of La Molina (UNALM), the National Institute of Agricultural Research (INIA) and the International Potato Centre (CIP) were all actively engaged in improving existing technologies and adapting them to national agricultural conditions (Velazco, 2001). However, there are still important technological bottlenecks. One problem restricting innovation potential is inadequate government spending on research and technology transfer. According to the Farm Census, farmers access to technical assistance and training reached only 3.41% of total farmers in 1972, 9.33% in 1994 and 7.3% in 2012 (Velazco, 2001; INEI, 2012). As a result of the stabilisation and structural programmes implemented in the 1990s, public expenditure in agricultural research experienced sharp cuts. Private sector agencies emerged as the main providers of technical assistance and engagement in agricultural research, resulting in a partial dismantling of the public agricultural extension service. At the beginning of the 1990s, the Peruvian government concentrated its direct involvement in agricultural innovation to that of agricultural research only. Therefore, technology diffusion was left to the private sector and civil society.

Focusing on the lack of a long-term relationship between public investment in agriculture and TFP, it is important to note that public investment in Peru has targeted the agricultural sector since the mid-19th century. This is because the mainstay of economic growth was export-based agriculture in the coastal region. The primary concern was to make sure that this region received sufficient water, thus removing a constraint to expanding the area under cultivation. Therefore, public investment in irrigation in 1905 accounted for 8.7% of the total, reaching 18.62% in 1912, a trend that continued in the 1920s. This investment was financed by fiscal revenue from a progressive income tax and taxation on mineral export earnings. Another important source was the policy of external debt (Portocarrero et al, 1988).

In general, the largest share of public investment in agriculture was directed towards irrigation in the coastal region. Between 1950 and 1980, 90 percent of irrigation investment

[32] A review of certified seed production for rice, cotton, wheat, barley, beans, and maize from the 1970s to 2004, predominantly conducted by public agencies, is documented in Iguíñiz (2006). Regarding seed usage, the author concludes that the seed sector represents one of the most significant innovations in the country, explaining the improvement in agricultural yields. It is noted that despite the challenges encountered by public agricultural research, they have managed to generate a significant supply of certified seeds.

was directed to the coastal region and the rest to the Sierra. Some 76% of investment in the coastal region between 1978 and 1982 was concentrated on three major irrigation projects at Majes, Chira-Piura and Tinajones (Guerra, 1986). Public agricultural investment has been a key policy instrument employed to promote the expansion of area under cultivation and to establish and maintain agricultural infrastructure. Analysis of the allocation of public investment from 1971 to 1995 indicates that, on average, 75.8% of funds were used to expand area under cultivation and that investment in technology transfer and agricultural development was limited and piecemeal (IICA, 1990; and MAG, 1992).

The above-mentioned could justify that the relationship between public investment and TFP in agriculture is more related to the expansion of the agricultural frontier, increased land input, and not with any sigificant impact on TFP. It could be suggested that the composition of public investment really matters for defining any potential impact on TFP. Taking into account that TFP is the difference between output growth and input growth, public investment allocated massively to expand one input, land in the Peruvian case, is expected to lead to an increase in factor accumulation rather than changes in productivity. However, the effect of public investment on TFP can occur through other mechanisms. Velazco (2001) found, using the method of Granger causality, a complementarity relationship between public and private investment in agriculture for the period 1970-1995. More precisely, support was found for the existence of causality from public investment to private investment. That is, greater public investment or subsidy, in this case concentrated on irrigation, creates conditions for the expansion of private investment.

This scenario can be extrapolated to what happened in agriculture since the 1990s. That is, the government creates the conditions for the private sector to expand the irrigation infrastructure for new export products and provide farmers with measures that brought about a reduction in production costs (labour, inputs, taxes, tariffs). It also facilitates access to new export markets through the implementation of various free trade agreements. This means that producers need to make improvements in their production techniques and business management that allows them to compete in international markets. It can be suggested that the combined effect of these measures have caused a significant increase in TFP since the 1990s. As will be discussed in more detail in Chapter 5, these improvements are not limited to export agriculture; data from agricultural censuses indicate that family farming has made advancements in technology (Kim, 2015). The following section will analyse whether there exists a long-term relationship between Total Factor Productivity (TFP) and agricultural production by destination (external and domestic markets) and the contribution of family farming.

With respect to the GDP per capita variable, it is observed that this is positively associated with TFP. This fact suggests that the interaction and complementarity between agriculture and the whole economy are crucial for defining the perfomance of total factor productivity in agriculture. In general, it could be assumed that a scenario of economic expansion would have two main effects related to the demand and the supply aspect.

Regarding the supply side effects, a higher level of economic growth would be related to the provision of services, inputs, financial resources, technology transfer, infraestructure and other factors that enhance the growth of TFP. This result is in line with Martín-Retortillo and Pinilla (2014), where the determinants of labour productivity in Europe were analysed for the period 1950-2005.

On the other hand, as a demand side effect, a growing domestic market is expected and also an increasing middle class, experiencing changes in consumer preferences. This could imply that new food products are demanded or traditional food (Andean cereals such as potatoes, *quinua* and *maca*) are recoverered for urban consumption. As a result of this, farmers would have the incentive to improve seed varieties and introduce improvements in the technology used, augmenting the contribution of TFP to output growth.

Trade openness or globalisation in general could affect TFP in different ways. The flow of knowledge across national borders is enhanced. Producers are facing potential larger markets in spite of increasing competition from abroad. More integration boosts specialisation according to comparative advantage and affects the incentives for technological diffusion (Grossman and Helpman, 2015). Trade openness exhibits a positive relationship with TFP. It seems that more market integration means more opportunities for accessing new markets and offering a more diversified supply of commodities. Furthermore, it could have a positive impact on the diffusion of technology and, therefore, on TFP.

The positive exports-productivity relationship could imply learning effects from exporting as opposed to the opinion that firms need to be productive to enter export markets (Isaksson, 2007). Freund and Pierola (2010) provide evidence supporting the importance of learning effects for the non-traditional agricultural sector in Peru, which grew seven-fold from 1994-2007. Learning effects are relevant when the firms start exporting with small trials and there is significant entry, exit and reentry because the entry into exporting involves low initial fixed cost. Although it has more difficulties, a similar pattern applies to firms entering into new markets. However, when a firm exports a new product, not consumed domestically, pioneers are mainly large experienced exporters facing higher sunk costs.

The importance of macro-growth dimensions of agricultural development has been recognised by scholars. In particular, the structural adjustment in the 1980s and the 1990s showed the strong relationship of agriculture to the macroeconomy and world market (Barrer et al., 2010; Staatz and Eicher, 1998). The implementation of the "free market-free trade paradigm" meant a turning point with respect to the import-substitution-based strategy of industrialisation of the previous decades (de Janvry et al., 1997). Regarding the Latin American experience in the 1980s and 1990s, Staatz and Eicher (1998: 24) emphasised that:

> "Massive currency devaluation and other structural reforms allowed agriculture to play a leading role in the economic growth of a number of Latin American countries during this period. But, de Janvry, Key and Sadoulet (1997), Valdés (1986) and the FAO (1988) point out that some of these countries were blessed with favourable domestic and international demand, available technology, and responsive agricultural institutions to induce the required supply response."

In line with the above discussion and focusing on the structural reforms index[33], the positive impact on TFP performance suggest that reforms implemented during the 1990s, and in particular policies to promote agribusiness development, created favourable conditions for the expansion and consolidation of non-traditional agricultural exports[34]. Moreover, the Coast region, due to climatic conditions, access to better land, proximity to markets and infrastructure, was the leading growth region.

4.5 Causality between Total Factor Productivity (TFP) and output

In this section, the nature of the long-term relationship between estimated TFP indices and agricultural GDP destined for both domestic and external markets for the period 1950-2010 will be explored. Furthermore, the relationship between TFP and the contribution of family farming to the total food supply for the period 1965-2010 will be considered. The fundamental question guiding this analysis is to ascertain the type of agriculture that can be associated with the long-term performance of TFP.

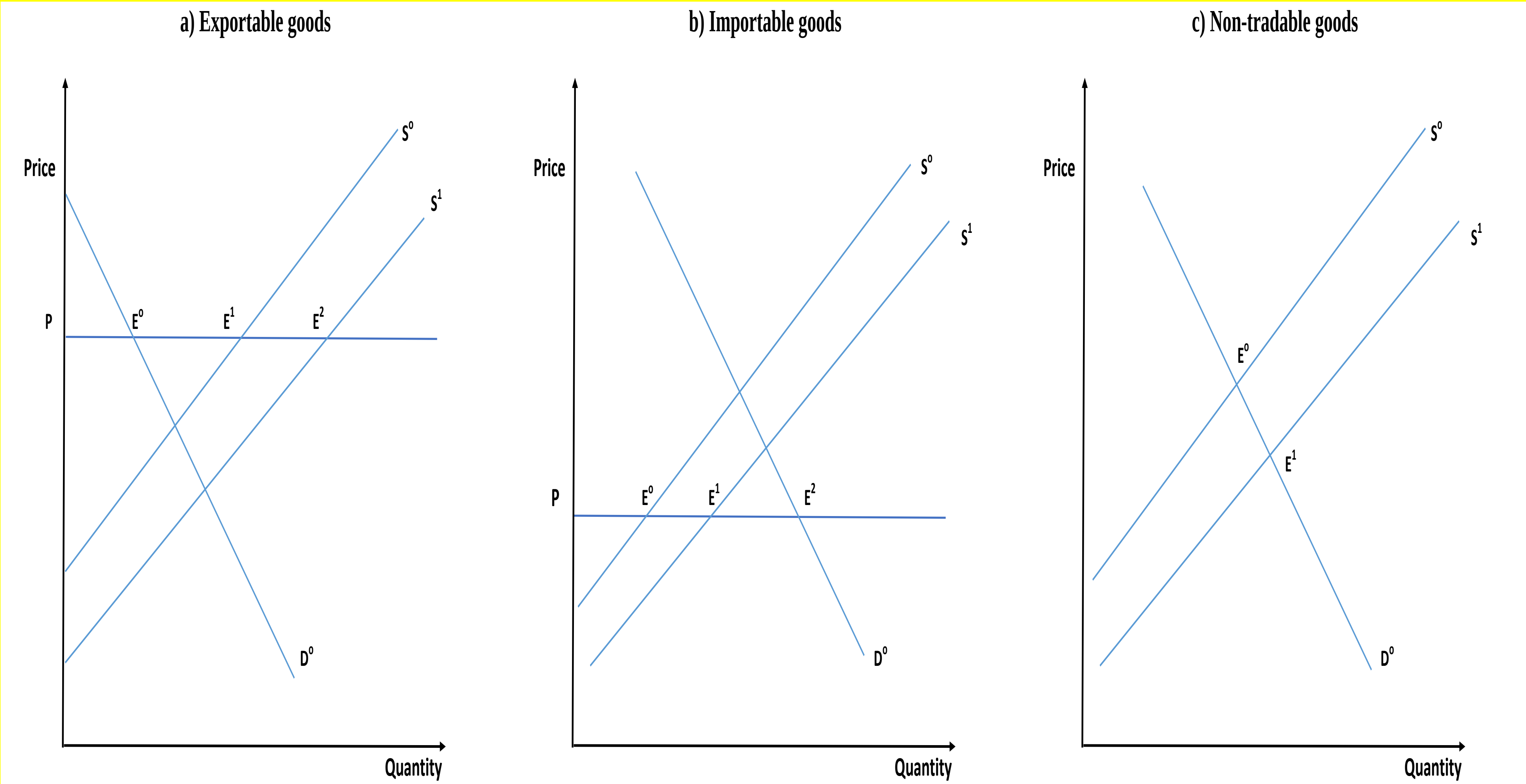
The database corresponds to estimates of agricultural GDP and destination markets (domestic and export) made by Seminario (2015). The estimation of the contribution of family agriculture to the total food supply comes from Pintado (2021). In order to support the expected relationships, the types of agricultural markets existing in Peru will be considered. To this end, and drawing on the theoretical contributions of Dancourt (1986), Mendoza (1993), and Hopkins (1995), three types of agricultural goods markets are assumed: a) tradable goods, classified as importable and exportable, and b) non-tradable goods market.

[33] Estimations using the structural reform index for the period 1970-2010 are available in Appendix 4.4. The findings are akin to those reported in Table 4.15.

[34] Loayza (2008) underscored the significance of structural reforms in shaping the trajectory of the Peruvian economy. The author discerned that the economic expansion experienced by Peru throughout the 1990s was predominantly attributable to the implementation of structural reforms alongside stabilization measures. This viewpoint is echoed by Mendoza (2021 and 2023). Conversely, dissenting perspectives are articulated by Gonzales de Olarte (2023) and Jiménez (2016).

Figure 4.13 illustrates the partial equilibrium of the three mentioned markets, under the assumption of perfect competition and a small country in the world market. That is, once participating in the world market, either as an exporter, panel a), or importer, panel b), the world price governs in the domestic economy, and this price defines consumption and production decisions. Thus, an initial equilibrium situation in the three markets occurs when at price "p", the country exports E^0E^1 and imports E^0E^2. On the other hand, equilibrium for the market with non-tradable goods is production at the level of E^0. In this scenario, an improvement in productivity means a shift to the right of the supply function, from S^0 to S^1, and international prices do not change, but local production increases for exportable goods to E^2 and for importable goods to E^1. Additionally, production for the non-tradable market also increases to E^1. This simple theoretical exercise shows that an increase in productivity has resulted in an increase in the production of all types of agricultural goods. The aim is to apply this idea to TFP data and agricultural production by destination, to identify if there is a positive relationship between TFP and all the agricultural markets considered.

Figure 4.13. Productivity and exports for a price-taking exporter, imports for a price-taking importer and a non-tradable producer



4.5.1 Empirical findings

In Appendix 4.5, graphs illustrating the evolution of variables in logarithms and first differences are presented. The results of unit root tests demonstrating that the variables are stationary in first differences are found in Appendix 4.3, The Vector Error Correction (VEC) model, post-diagnostic tests, and the analysis of non-causality are available in Appedix 4.4.

From Table 4.16 to 4.18, the results of the Trace statistic and Max-Eigen statistics tests are presented, and in all cases, it is concluded that there exists a unique cointegration vector for each relationship proposed.

Table 4.16. TFP and agriculture GDP for domestic market (DAGRI)

Trace statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.333	30.101	20.262	0.002
At most 1	0.099	6.175	9.165	0.178
Max-Eigen statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.333	23.926	15.892	0.002
At most 1	0.099	6.175	9.165	0.178

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Source: Eviews output.

Table 4.17. TFP and agriculture GDP for external market (EAGRI)

Trace statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.290	20.909	15.495	0.007
At most 1	0.012	0.705	3.841	0.401
Max-Eigen statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.290	20.205	14.265	0.005
At most 1	0.012	0.705	3.841	0.401

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Source: Eviews output.

Table 4.18. TFP and family farming participation in food supply (FAMGRI)

Trace statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Trace Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.316	22.242	20.262	0.026
At most 1	0.098	4.744	9.165	0.313
Max-Eigen statistic				
Hypothesised Number of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**5 percent critical value**	**1 percent critical value**
None**	0.316	17.498	15.892	0.028
At most 1	0.098	4.744	9.165	0.313

*(**) denotes rejection of the hypothesis at the 5 percent and 1 percent level. CE(s) are cointegration equations.
Source: Eviews output.

Once the existence of a single cointegration vector has been confirmed, Table 4.19 presents the results of the three estimated vectors, and Tables 4.20 to 4.22 display the results of the non-causality test.

Table 4.19. Normalised cointegration vector

Sectors	Domestic market	Export market	Family farming
LN_TFP2	1	1	1
LN_DAGRI	-0.2962 (0.11354) [-5.5933]		
LN_EAGRI		-0.9985 (0.1651) [-6.0331]	
LN_FAMGRI			-0.3917 (0.1673) [-2.3409]
Constant	-2.7406	1.4142	-3-2270

The figure in the parenthesis denotes the standard error.
The figure in the square brackets represents the t-statistic.
Note: The signs of the coefficients are reversed in the long-run.

Table 4.20. Non-causality test for Domestic agriculture and TFP2

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_DAGRI does not cause LN_TFP2	5.73	0.02	4.35	0.04	23.02	0.00
LN_TFP2 does not cause LN_DAGRI	0.15	0.70	15.92	0.00	18.28	0.00

Source: Eviews output.

Table 4.21. Non-causality test for Export agriculture and TFP2

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_EAGRI does not cause LN_TFP2	0.82	0.36	5.39	0.02	6.67	0.04
LN_TFP2 does not cause LN_EAGRI	0.14	0.71	11.45	0.00	12.13	0.00

Source: Eviews output.

Table 4.22. Non-causality test for Family Farming and TFP2

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_FAMAGRI does not cause LN_TFP2	1.72	0.19	10.01	0.00	15.33	0.00
LN_TFP2 does not cause LN_FAMAGRI	5.51	0.02	7.98	0.00	17.55	0.00

Source: Eviews output.

4.5.2 Discussion

A cointegration analysis was conducted to ascertain whether there exists a long-term relationship between Total Factor Productivity (TFP), with TFP2 being deemed the most suitable, and the components of agricultural GDP destined for the domestic and external markets, along with the share of family agriculture in the total food supply. The findings of Table 4.19 suggest a positive long-term relationship between TFP2 and the agricultural output variables. Additionally, the results of the short-run and long-run non-causality tests confirm the existence of a complementary relationship between TFP and each of the considered variables. Thus, based on the conducted analysis, it can be inferred that the performance of TFP and agricultural output destined for both domestic and external markets, as well as the share of family agriculture, mutually reinforce each other.

4.6. Conclusions

The aim of the chapter was to analyse the factors behind the growth dynamics in Peruvian agriculture during 1950-2010. Three related analysis were carried out. The first consisted of the estimation of the total factor productivity. The second was the identification of its determinants. The third objective was to analyse the causal relationship between Total Factor Productivity (TFP) and agricultural production destined for the domestic and external markets, as well as the contribution of family agriculture to the total food supply.

Five sub-periods, which coincide with major economic policy measures undertaken during the study period, were considered for the analysis of the TFP trend. The selected sub-periods were 1950-1959, 1960-1975, 1976-1990, 1991-2000 and 2001-2010.

Regarding the first aim, the sources of growth of agricultural output were identified in terms of the contribution of inputs and changes in productivity. In doing this, a Cobb-Douglas production function with constant returns to scale was assumed. The inputs considered were labour, land, machinery (number of tractors), livestock and fertiliser. Findings showed a poor TFP performance during 1950 – 1975. This situation changed after the 1990s, when productivity in Peruvian agriculture recovered significantly. With respect to the second aim of the chapter, the estimation of the determinants of TFP, time series econometric techniques were used. The estimated cointegration vectors showed that trade openness, GDP per capita, human capital (school enrolment ratio) and structural reform index showed a positive effect on TFP.

The causality analysis between Total Factor Productivity (TFP) index and agricultural production indicates that individually, agriculture destined for both external and domestic markets, as well as the contribution of family agriculture, exhibit a positive complementary relationship with TFP. In other words, a feedback relationship between TFP and each of these variables is observed. This finding supports the assumption that the improvement in TFP since 1990 has occurred across all segments of agriculture.

The evidence discussed, particularly the increasing trend in agricultural labour productivity, land productivity, and TFP performance, appears to suggest that there was a turning point in the performance of agricultural productivity indicators in Peru during the 1990s. The next chapter will discuss, from a microeconomic perspective, the actors involved in this performance.

APPENDICES CHAPTER 4

Appendix 4.1

Sources of Data for estimating TFP (1950-2010)

Labour
It is the number of people employed in the agricultural sector. The source is the database of the Groningen Growth and Development Center 10-industry for the period 1960-2010. database, available on the web: www.ggdc.net.

Livestock
The data for the number of head of cattle on farms is available in the FAO online -database, FAOSTAT (www.fao.org), and FAO yearbooks for the 1950s. Different types of animals have been aggregated in livestock units following conversions suggested by Hayami and Ruttan (1985:450). The aggregation weights used are: camels, 1.1; buffaloes, horses and mules, 1.0; cattle and donkeys, 0.8; pigs, 0.2; sheep and goats, 0.1; poultry, 0.01.

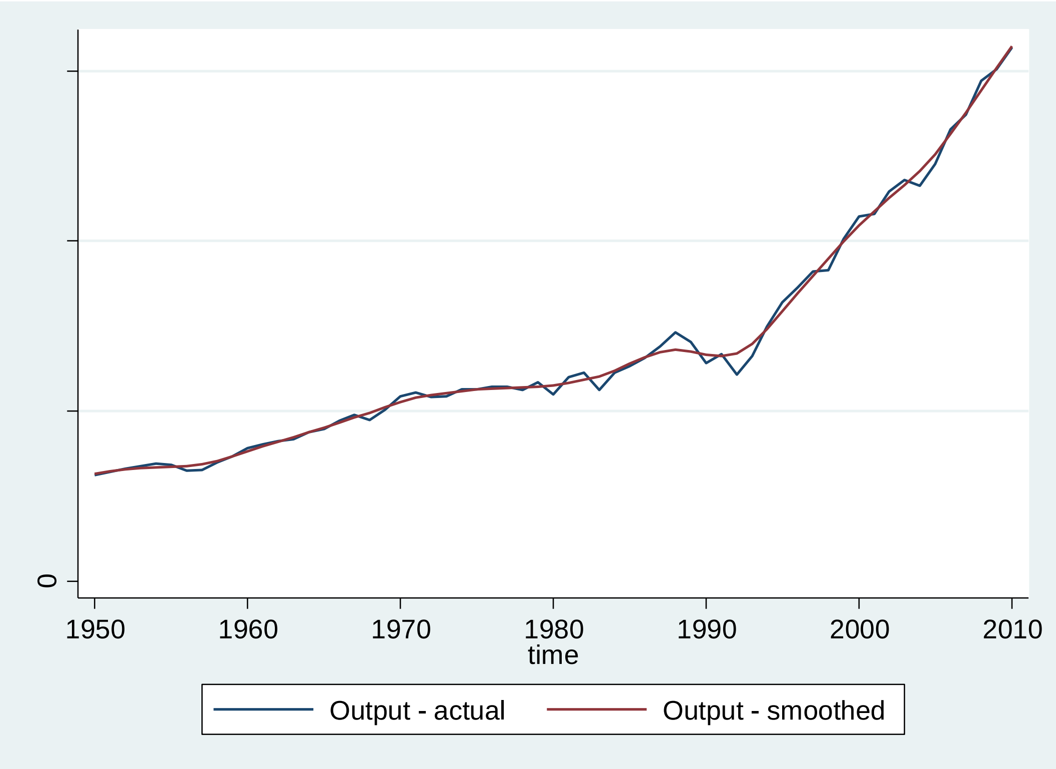
Tractors
It is the number of tractors in use in farming. The source is the FAOSTAT database. The information is available for Peru until 2003. To project values up to 2010, the average annual growth rate was estimated using the following equation: Ln (tractors) = a + b (Time). The estimated value of the coefficient b is 0.012.

Fertilisers
Information on fertiliser consumption for 1961-2010 was obtained from The International Fertilizer Industry Association (IFA). All IFADATA statistics are available in metric tonnes of three nutrients, nitrogen (N), phosphate (P2O5) and potassium (K2O). The IFA database contains historical statistics of consumption, production and sales at regional and country level. Data for 1950-1960 is from Hopkins (1981).

Land
Information on hectares of agricultural land comes from FAOSTAT and FAO yearbooks for the 1950s. It considers the following types of land: rainfed cropland, irrigated land and permanent pasture. In order to account for differences in land quality, the approach proposed by Fuglie (2008) was followed. Hence, a land quality index adjusted by “rainfed cropland equivalents” was computed by aggregating the three land types. The quality weights were based on type of land productivity. Estimates for the Latin American regions were used.

Agricultural output
The information is the net value of agricultural production in 1994 Peruvian Nuevos Soles, in millions. It was obtained from the INEI on-line database (www.inei.gob.pe). In order to eliminate from the ouput series the effects of short-term fluctuations due to weather or other events, the Hodrick-Prescott filter was used. Figure 1 compares the series with original data and the resulting data after applying the filter.

Figure A1. The Effects of Smoothing on Net Agriculture Output Measure (in Millions of constant 1994 Peruvian Soles)

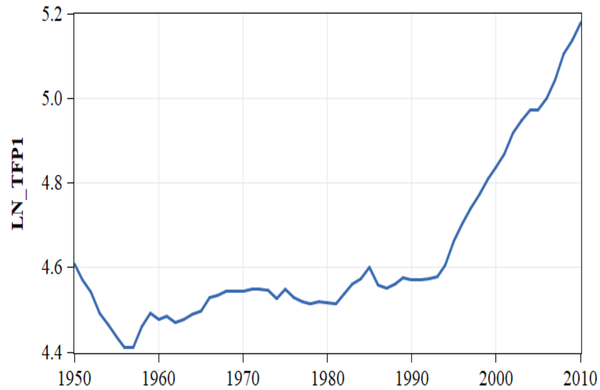


Source: Own elaboration using INEI dataset.

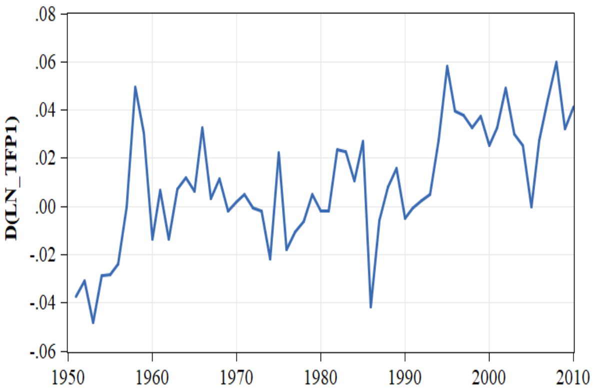
Appendix 4.2

Selected variables for the analysis of the TFP determinants, 1950-2010

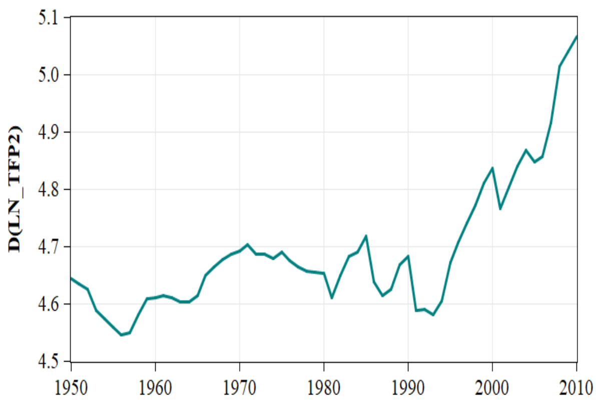
TFP1 in logarithms



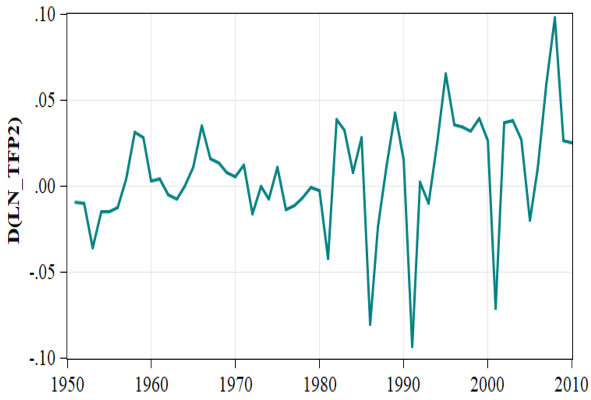
TFP1 in first differences



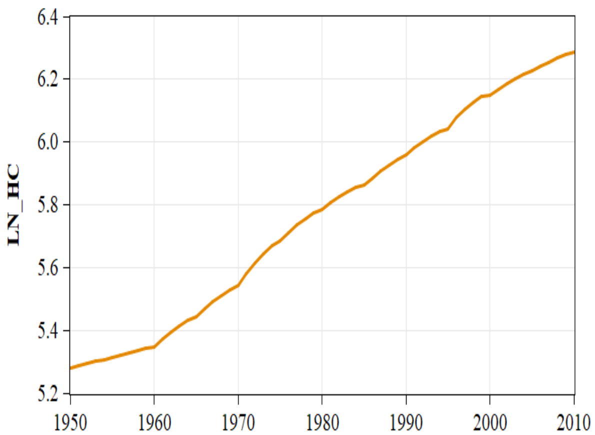
TFP2 in logarithms



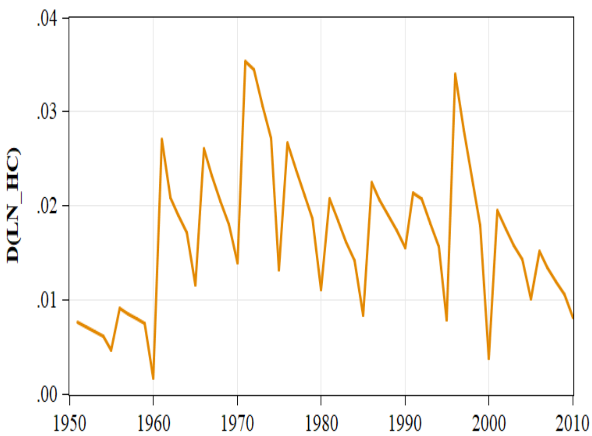
TFP2 in first differences



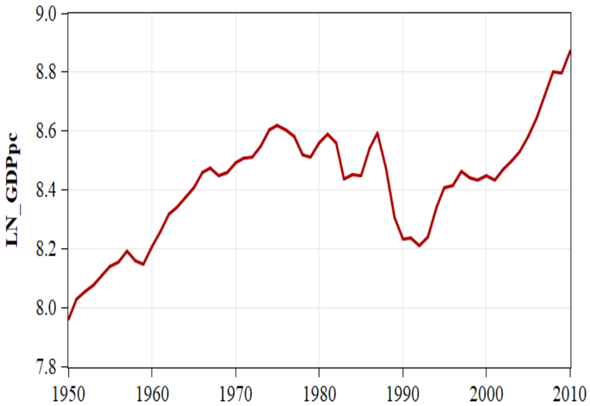
Human capital in logarithms



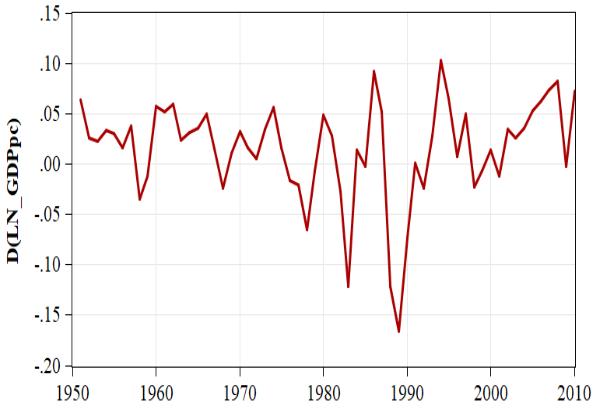
Human capital in first differences



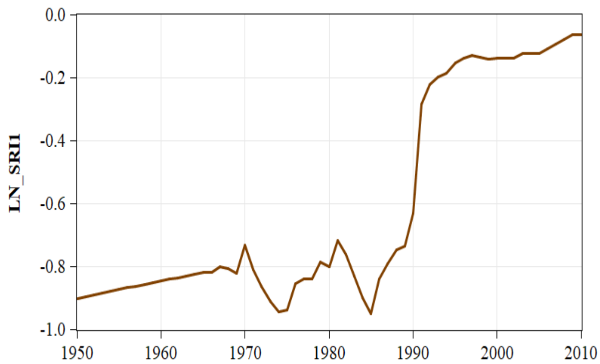
GDP per capita in logarithms



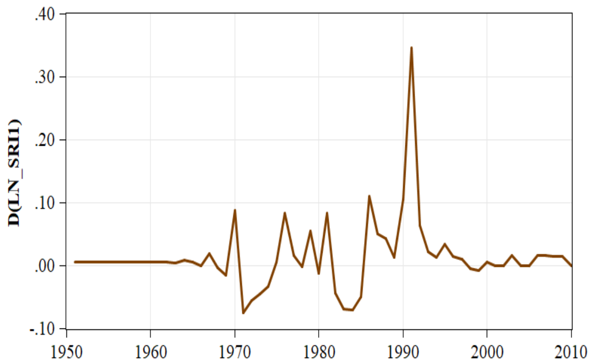
GDP per capita in first differences



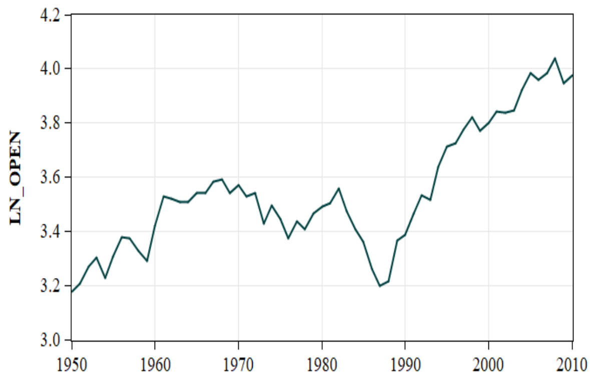
Structural reform index in logarithms



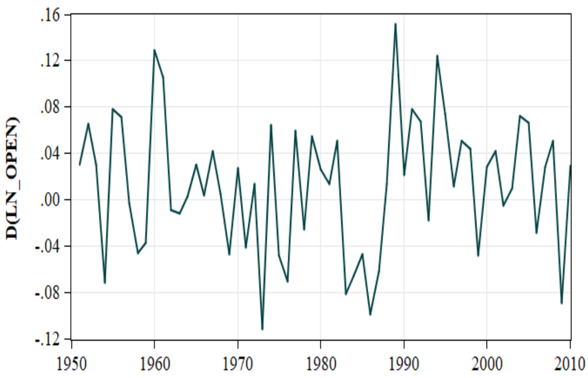
Structural reform index in first differences



Trade openess in logarithms



Trade openess in first differences



Appendix 4.3

Table 1. Unit Root Tests for Selected Variables (in levels)

ADF				Phillips-Perron	
Levels (in logs)	Lags	Test	p-values*/ (Decision)	Test	p-values*/ (Decision)
LN_TFP1					
NINT	1	1.87	0.98 (NS)	1.78	0.98 (NS)
INT	0	4.44	1.00 (NS)	2.92	1.00 (NS)
IT	0	-0.06	0.99 (NS)	-0.46	0.98 (NS)
LN_TFP2					
NINT	0	1.72	0.98 (NS)	1.54	0.97 (NS)
INT	0	1.51	1.00 (NS)	1.66	1.00 (NS)
IT	0	-0.31	0.99 (NS)	-0.41	0.98 (NS)
LN_HC					
NINT	6	1.94	0.99 (NS)	10.88	1.00 (NS)
INT	6	-1.41	0.57 (NS)	0.35	0.97 (NS)
IT	6	-2.13	0.52 (NS)	-2.48	0.34 (NS)
LN_GDPpc					
NINT	1	1.26	0.95 (NS)	1.92	0.99 (NS)
INT	1	-1.19	0.67 (NS)	-1.22	0.66 (NS)
IT	1	-1.85	0.67 (NS)	-1.59	0.78 (NS)
LN_OPEN					
NINT	0	1.72	0.98 (NS)	1.58	0.97 (NS)
INT	0	-0.73	0.83 (NS)	-0.87	0.79 (NS)
IT	0	-1.41	0.85 (NS)	-1.62	0.77 (NS)
LN_DGRI					
NINT	0	5.01	1.00 (NS)	5.50	1.00 (NS)
INT	0	0.67	0.99 (NS)	0.81	0.99 (NS)
IT	0	-1.34	0.87 (NS)	-1.33	0.87 (NS)
LN_EAGRI					
NINT	0	1.26	0.95 (NS)	1.55	0.97 (NS)
INT					
IT	0	-3.42	0.06 (NS)	-3.41	0.06 (NS)
LN_FAMAGRI					
NINT	0	2.90	1.00 (NS)	3.20	1.00 (NS)
INT	0	-0.27	0.92 (NS)	-0.18	0.93 (NS)
IT	0	-2.11	0.52 (NS)	-2.22	0.46 (NS)
LN_SRI					
NINT	1	-1.48	0.13 (NS)	-1.24	0.19 (NS)
INT	1	-0.82	0.80 (NS)	-0.44	0.89 (NS)
IT	1	-2.27	0.44 (NS)	-2.35	0.40 (NS)

*MacKinnon (1996) one-sided p-values.

NS is non-stationary. S is stationary. Lag length based on SIC (Schwarz information criterion). NINT: No intercept and no trend. INT: Intercept and no trend.

IT: Intercept and trend

Table 2. Unit Root Tests for Selected Variables (in first difference)

ADF				Phillips-Perron	
First difference	Lags	Test	p-values*/ (Decision)	Test	p-values*/ (Decision)
ΔLN_TFP1					
NINT	1	-2.40	0.02 (S)	-3.34	0.00 (S)
INT	1	-2.93	0.05 (S)	-3.68	0.01 (S)
IT	0	-5.01	0.00 (S)	-5.00	0.00 (S)
ΔLN_TFP2					
NINT	0	-5.69	0.00 (S)	-5.60	0.00 (S)
INT	0	-5.89	0.00 (S)	-5.80	0.00 (S)
IT	0	-6.29	0.00 (S)	-6.16	0.00 (S)
ΔLN_HC					
NINT	0	-1.65	0.10(S)		
INT	0	-4.48	0.00 (S)	-4.48	0.00 (S)
IT	0	-4.43	0.00 (S)	-4.40	0.00 (S)
ΔLN_GDPpc					
NINT	0	-4.37	0.00 (S)	-4.17	0.00 (S)
INT	0	-4.58	0.00 (S)	-4.34	0.00 (S)
IT	0	-4.53	0.00 (S)	-4.28	0.00 (S)
ΔLN_OPEN					
NINT	0	-6.71	0.00 (S)	-6.75	0.00 (S)
INT	0	-6.96	0.00 (S)	-6.97	0.00 (S)
IT	0	-6.91	0.00 (S)	-6.92	0.00 (S)
ΔLN_DGRI					
NINT	2	-2.23	0.03 (S)	-6.22	0.00 (S)
INT	0	-7.89	0.00 (S)	-7.90	0.00 (S)
IT	0	-8.00	0.00 (S)	-8.04	0.00 (S)
ΔLN_EAGRI					
NINT	0	-7.36	0.00 (S)	-7.46	0.00 (S)
INT	0	-7.48	0.00 (S)	-7.71	0.00 (S)
IT	0	-7.46	0.00 (S)	-7.69	0.00 (S)
ΔLN_FAMAGRI					
NINT	0	-6.68	0.00 (S)	-6.76	0.00 (S)
INT	0	-7.90	0.00 (S)	-7.89	0.00 (S)
IT	0	-7.84	0.00 (S)	-7.83	0.00 (S)
ΔLN_SRI					
NINT	0	-4.06	0.00 (S)	-4.04	0.00 (S)
INT	0	-4.26	0.00 (S)	-4.18	0.00 (S)
IT	0	-4.17	0.01 (S)	-4.09	0.01 (S)

*MacKinnon (1996) one-sided p-values.
NS is non-stationary. S is stationary. Lag length based on SIC (Schwarz information criterion). NINT: No intercept and no trend. INT: Intercept and no trend.
IT: Intercept and trend

APPENDIX 4.4

Vector Error Correction Models, post estimation diagnostic tests and non-causality tests

1) TFP1, HC and GDPpc

Vector Error Correction Estimates
Date: 12/16/23 Time: 19:02
Sample (adjusted): 1956 2010
Included observations: 55 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_TFP1(-1)	1.000000
LN_HC(-1)	-0.640512
	(0.10883)
	[-5.88556]
LN_GDPPC(-1)	-0.566999
	(0.19705)
	[-2.87748]
C	3.874764

Error Correction:	D(LN_TFP1)	D(LN_HC)	D(LN_GDP...
CointEq1	-0.065656	0.021474	0.189651
	(0.02875)	(0.00751)	(0.06485)
	[-2.28374]	[2.85828]	[2.92432]
D(LN_TFP1(-1))	0.369536	-0.036309	0.057010
	(0.14964)	(0.03910)	(0.33755)
	[2.46954]	[-0.92855]	[0.16889]
D(LN_TFP1(-2))	0.091683	0.018615	0.847867
	(0.16850)	(0.04403)	(0.38011)
	[0.54410]	[0.42276]	[2.23059]
D(LN_TFP1(-3))	-0.201510	0.062415	-0.161555
	(0.17728)	(0.04633)	(0.39991)
	[-1.13666]	[1.34727]	[-0.40398]
D(LN_TFP1(-4))	0.196667	-0.084031	-0.069404
	(0.17544)	(0.04585)	(0.39576)
	[1.12097]	[-1.83289]	[-0.17537]
D(LN_TFP1(-5))	0.004043	0.036703	0.309079
	(0.15789)	(0.04126)	(0.35617)
	[0.02561]	[0.88957]	[0.86779]
D(LN_HC(-1))	-0.180730	0.334967	0.644585
	(0.43222)	(0.11295)	(0.97499)
	[-0.41815]	[2.96574]	[0.66112]
D(LN_HC(-2))	-0.586182	0.154922	-1.273228
	(0.45211)	(0.11814)	(1.01987)
	[-1.29654]	[1.31129]	[-1.24842]
D(LN_HC(-3))	-0.165846	0.017076	2.472636
	(0.43086)	(0.11259)	(0.97193)
	[-0.38492]	[0.15166]	[2.54404]
D(LN_HC(-4))	-0.285341	-0.056437	0.006066
	(0.44845)	(0.11719)	(1.01160)
	[-0.63629]	[-0.48160]	[0.00600]
D(LN_HC(-5))	-0.273613	0.692339	-0.106606
	(0.43726)	(0.11426)	(0.98636)
	[-0.62575]	[6.05922]	[-0.10808]
D(LN_GDPPC(-1))	0.100464	0.011229	0.535845
	(0.07140)	(0.01866)	(0.16107)
	[1.40700]	[0.60183]	[3.32677]
D(LN_GDPPC(-2))	-0.046555	0.045855	-0.145425
	(0.08928)	(0.02333)	(0.20139)
	[-0.52145]	[1.96552]	[-0.72210]
D(LN_GDPPC(-3))	0.030932	-0.027185	-0.223366
	(0.09983)	(0.02609)	(0.22518)
	[0.30986]	[-1.04214]	[-0.99193]
D(LN_GDPPC(-4))	0.103260	0.003394	0.006436
	(0.08877)	(0.02320)	(0.20025)
	[1.16323]	[0.14632]	[0.03214]
D(LN_GDPPC(-5))	-0.045273	-0.000611	-0.194772
	(0.07383)	(0.01929)	(0.16655)
	[-0.61320]	[-0.03165]	[-1.16948]
C	0.037204	-0.004823	-0.031572
	(0.01314)	(0.00343)	(0.02965)
	[2.83052]	[-1.40425]	[-1.06483]
DUMMYA	-0.014847	0.007409	0.013934
	(0.00619)	(0.00162)	(0.01397)
	[-2.39769]	[4.57844]	[0.99752]
R-squared	0.516108	0.723265	0.562252
Adj. R-squared	0.293779	0.596117	0.361124
Sum sq. resids	0.012410	0.000847	0.063151
S.E. equation	0.018314	0.004786	0.041313
F-statistic	2.321373	5.688350	2.795499
Log likelihood	152.8638	226.6750	108.1213
Akaike AIC	-4.904137	-7.588183	-3.277139
Schwarz SC	-4.247192	-6.931237	-2.620194
Mean dependent	0.013491	0.017709	0.013326
S.D. dependent	0.021793	0.007531	0.051687

Determinant resid covariance (dof adj.)	1.26E-11
Determinant resid covariance	3.83E-12
Log likelihood	488.8318
Akaike information criterion	-15.70297
Schwarz criterion	-13.62265
Number of coefficients	57

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	195.9875	0.5271	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 6	3.3776	0.9474	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 6	0.3667	0.9475	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 6	18.7426	0.2256	Zero Serial Correlation
VEC Residual Normality Test (Kurtosis)	Join test (Chi-sq)	3.516408	0.3186	Normality

*Edgeworth expansion corrected likelihood ratio statistic.

The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

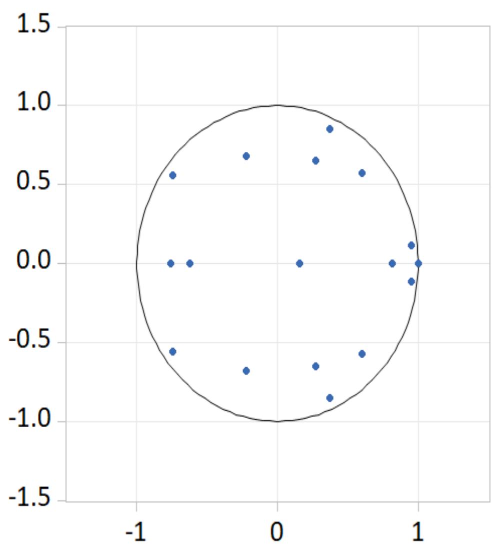
Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN TFP1 LN HC LN GDPPC
Exogenous variables: DUMMYA
Lag specification: 1 5
Date: 12/17/23 Time: 08:49

Root	Modulus
1.000000	1.000000
1.000000	1.000000
0.950220 - 0.116060i	0.957281
0.950220 + 0.116060i	0.957281
0.372529 + 0.853345i	0.931116
0.372529 - 0.853345i	0.931116
-0.743533 + 0.560304i	0.931011
-0.743533 - 0.560304i	0.931011
0.600681 - 0.575739i	0.832041
0.600681 + 0.575739i	0.832041
0.818017	0.818017
-0.759565	0.759565
-0.223982 - 0.678090i	0.714125
-0.223982 + 0.678090i	0.714125
0.272656 + 0.649917i	0.704793
0.272656 - 0.649917i	0.704793
-0.621247	0.621247
0.159062	0.159062

VEC specification imposes 2 unit root(s).

Inverse Roots of AR Characteristic Polynomial



Results of non-causality tests

TFP_1

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_HC does not cause LN_TFP1	3.00	0.70	7.62	0.01	13.02	0.04
LN_TFP1 does not cause LN_HC	4.40	0.49	1.48	0.22	6.34	0.39
LN_GDPpc does not cause LN_TFP1	10.64	0.06	7.62	0.01	13.74	0.03
LN_TFP1 does not cause LN_GDPpc	9.54	0.09	10.13	0.00	19.45	0.00

2) TFP2, HC and GDPpc

Vector Error Correction Estimates
Date: 12/17/23 Time: 09:09
Sample (adjusted): 1956 2010
Included observations: 55 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_TFP2(-1)	1.000000
LN_HC(-1)	-0.256953
	(0.04256)
	[-6.03770]
LN_GDPPC(-1)	-0.313618
	(0.08960)
	[-3.50029]
C	-0.552953

Error Correction:	D(LN_TFP2)	D(LN_HC)	D(LN_GDP...
CointEq1	-0.269029	0.017103	0.406092
	(0.08798)	(0.01888)	(0.13883)
	[-3.05773]	[0.90590]	[2.92503]
D(LN_TFP2(-1))	0.161705	0.009326	0.039614
	(0.13956)	(0.02995)	(0.22022)
	[1.15865]	[0.31141]	[0.17988]
D(LN_TFP2(-2))	0.012614	-0.009261	0.373032
	(0.14211)	(0.03049)	(0.22424)
	[0.08876]	[-0.30368]	[1.66352]
D(LN_TFP2(-3))	0.018220	-0.018217	-0.042831
	(0.14578)	(0.03128)	(0.23004)
	[0.12498]	[-0.58233]	[-0.18619]
D(LN_TFP2(-4))	0.016043	0.005706	0.245015
	(0.14694)	(0.03153)	(0.23186)
	[0.10918]	[0.18097]	[1.05674]
D(LN_TFP2(-5))	0.349569	-0.077707	-0.031910
	(0.14752)	(0.03165)	(0.23277)
	[2.36969]	[-2.45483]	[-0.13709]
D(LN_HC(-1))	-0.203124	0.417500	0.468072
	(0.61489)	(0.13195)	(0.97027)
	[-0.33034]	[3.16416]	[0.48241]
D(LN_HC(-2))	-0.438978	0.060954	-1.490970
	(0.66340)	(0.14236)	(1.04681)
	[-0.66171]	[0.42818]	[-1.42430]
D(LN_HC(-3))	-0.742680	0.070834	2.123016
	(0.67585)	(0.14503)	(1.06646)
	[-1.09888]	[0.48842]	[1.99071]
D(LN_HC(-4))	-0.477083	-0.104067	0.125637
	(0.66864)	(0.14348)	(1.05508)
	[-0.71351]	[-0.72531]	[0.11908]
D(LN_HC(-5))	-0.663879	0.545248	-0.456568
	(0.60972)	(0.13084)	(0.96211)
	[-1.08883]	[4.16741]	[-0.47455]
D(LN_GDPPC(-1))	0.053528	0.023936	0.510374
	(0.10104)	(0.02168)	(0.15943)
	[0.52979]	[1.10402]	[3.20125]
D(LN_GDPPC(-2))	0.044673	0.020402	-0.264480
	(0.11864)	(0.02546)	(0.18721)
	[0.37653]	[0.80137]	[-1.41273]
D(LN_GDPPC(-3))	0.197367	-0.010701	-0.113546
	(0.13254)	(0.02844)	(0.20914)
	[1.48911]	[-0.37625]	[-0.54291]
D(LN_GDPPC(-4))	0.024932	0.000658	-0.121437
	(0.12638)	(0.02712)	(0.19942)
	[0.19728]	[0.02427]	[-0.60894]
D(LN_GDPPC(-5))	0.182089	-0.006809	-0.370741
	(0.11435)	(0.02454)	(0.18044)
	[1.59236]	[-0.27750]	[-2.05463]
C	0.050699	-0.001030	0.003022
	(0.01587)	(0.00341)	(0.02504)
	[3.19469]	[-0.30251]	[0.12069]
DUMMYB	-0.020733	0.004736	-0.009818
	(0.00930)	(0.00199)	(0.01467)
	[-2.23046]	[2.37437]	[-0.66937]
R-squared	0.560752	0.620895	0.564842
Adj. R-squared	0.358935	0.446712	0.364904
Sum sq. resids	0.025213	0.001161	0.062777
S.E. equation	0.026104	0.005602	0.041191
F-statistic	2.778523	3.564610	2.825089
Log likelihood	133.3714	218.0193	108.2845
Akaike AIC	-4.195325	-7.273431	-3.283073
Schwarz SC	-3.538379	-6.616485	-2.626127
Mean dependent	0.009222	0.017709	0.013326
S.D. dependent	0.032603	0.007531	0.051687

Determinant resid covariance (dof adj.)	3.55E-11
Determinant resid covariance	1.08E-11
Log likelihood	460.2987
Akaike information criterion	-14.66541
Schwarz criterion	-12.58508
Number of coefficients	57

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	202.8887	0.3908	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 6	6.552437	0.6836	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 6	0.725560	0.6841	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 6	22.12192	0.1046	Zero Serial Correlation
VEC Residual Normality Test (Kurtosis)	Join test (Chi-sq)	6.16586	0.1038	Normality

*Edgeworth expansion corrected likelihood ratio statistic.

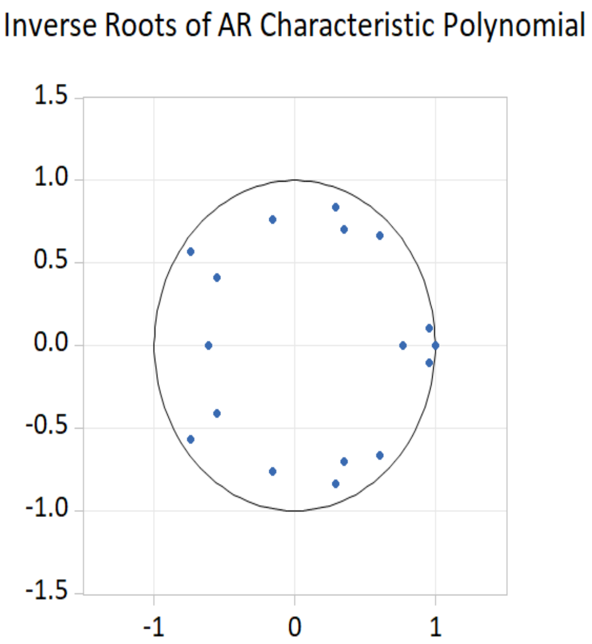
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (th model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP2 LN_HC LN_GDPPC
Exogenous variables: DUMMYB
Lag specification: 1 5
Date: 12/17/23 Time: 09:13

Root	Modulus
1.000000	1.000000
1.000000	1.000000
0.961215 - 0.107465i	0.967204
0.961215 + 0.107465i	0.967204
-0.738702 + 0.565881i	0.930539
-0.738702 - 0.565881i	0.930539
0.604037 - 0.664563i	0.898056
0.604037 + 0.664563i	0.898056
0.293116 + 0.837615i	0.887421
0.293116 - 0.837615i	0.887421
0.351413 - 0.703901i	0.786746
0.351413 + 0.703901i	0.786746
-0.153699 - 0.760278i	0.775658
-0.153699 + 0.760278i	0.775658
0.771066	0.771066
-0.551645 - 0.414119i	0.689787
-0.551645 + 0.414119i	0.689787
-0.613740	0.613740

VEC specification imposes 2 unit root(s).



Results of non-causality tests

TFP_2

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_HC does not cause LN_TFP2	9.15	0.10	9.35	0.00	12.00	0.06
LN_TFP2 does not cause LN_HC	6.46	0.26	0.82	0.37	6.97	0.32
LN_GDPpc does not cause LN_TFP2	9.79	0.08	9.35	0.00	15.10	0.02
LN_TFP2 does not cause LN_GDPpc	4.07	0.54	8.56	0.00	16.79	0.01

3) TFP1 and OPEN

Vector Error Correction Estimates
Date: 12/25/23 Time: 22:16
Sample (adjusted): 1952 2010
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_TFP1(-1)	1.000000
LN_OPEN(-1)	-1.688526 (0.27272) [-6.19149]
C	1.361254

Error Correction:	D(LN_TFP1)	D(LN_OPEN)
CointEq1	-0.043021 (0.01284) [-3.34977]	0.078828 (0.04462) [1.76670]
D(LN_TFP1(-1))	0.355551 (0.11487) [3.09516]	0.335291 (0.39909) [0.84014]
D(LN_OPEN(-1))	-0.024170 (0.04024) [-0.60060]	0.118169 (0.13981) [0.84521]
C	0.009700 (0.00270) [3.59091]	0.013117 (0.00938) [1.39778]
DUMMYO	-0.015019 (0.00633) [-2.37288]	-0.030069 (0.02199) [-1.36743]
R-squared	0.556518	0.082157
Adj. R-squared	0.523668	0.014169
Sum sq. resids	0.015221	0.183714
S.E. equation	0.016789	0.058328
F-statistic	16.94093	1.208399
Log likelihood	160.0302	86.55409
Akaike AIC	-5.255261	-2.764546
Schwarz SC	-5.079199	-2.588483
Mean dependent	0.010271	0.013074
S.D. dependent	0.024326	0.058745

Determinant resid covariance (dof adj.)	9.49E-07
Determinant resid covariance	7.95E-07
Log likelihood	246.8828
Akaike information criterion	-7.962129
Schwarz criterion	-7.539579
Number of coefficients	12

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	27.5834	0.1524	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	6.8876	0.1420	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	1.7635	0.1420	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	7.7894	0.2539	Zero Serial Correlation
VEC Residual Normality Test (Jarque – Bera)	Join test (Chi-sq)	5.6849	0.2239	Normality

*Edgeworth expansion corrected likelihood ratio statistic.

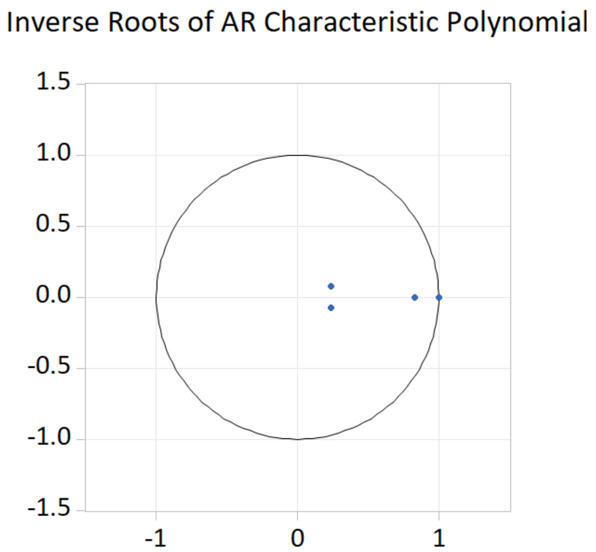
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP1 LN_OPEN
Exogenous variables: DUMMYO
Lag specification: 1 1
Date: 12/25/23 Time: 22:18

Root	Modulus
1.000000	1.000000
0.828871	0.828871
0.234363 - 0.074436i	0.245900
0.234363 + 0.074436i	0.245900

VEC specification imposes 1 unit root(s).



Results of non-causality tests

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_OPEN does not cause LN_TFP1	0.36	0.55	11.22	0.00	11.36	0.00
LN_TFP1 does not cause LN_OPEN	0.71	0.40	3.12	0.08	3.25	0.20

4) TFP2 and OPEN

Vector Error Correction Estimates
Date: 12/25/23 Time: 22:47
Sample (adjusted): 1952 2010
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LN_TFP2(-1)	1.000000	
LN_OPEN(-1)	-1.036996 (0.14968) [-6.92811]	
C	-1.011822	
Error Correction:	**D(LN_TFP2)**	**D(LN_OPEN)**
CointEq1	-0.105091 (0.02385) [-4.40689]	0.036705 (0.05767) [0.63650]
D(LN_TFP2(-1))	-0.064991 (0.11240) [-0.57822]	0.042041 (0.27180) [0.15467]
D(LN_OPEN(-1))	-0.069410 (0.05919) [-1.17271]	0.127720 (0.14312) [0.89236]
C	0.015197 (0.00387) [3.92991]	0.008424 (0.00935) [0.90088]
DUMMYM	-0.042976 (0.00965) [-4.45193]	0.017682 (0.02334) [0.75748]
R-squared	0.451457	0.025380
Adj. R-squared	0.410824	-0.046814
Sum sq. resids	0.033361	0.195078
S.E. equation	0.024855	0.060105
F-statistic	11.11066	0.351558
Log likelihood	136.8812	84.78348
Akaike AIC	-4.470549	-2.704525
Schwarz SC	-4.294486	-2.528462
Mean dependent	0.007297	0.013074
S.D. dependent	0.032382	0.058745
Determinant resid covariance (dof adj.)		2.12E-06
Determinant resid covariance		1.78E-06
Log likelihood		223.1532
Akaike information criterion		-7.157734
Schwarz criterion		-6.735184
Number of coefficients		12

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	28.2305	0.1337	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	6.8792	0.1424	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	1.7613	0.1424	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	7.1223	0.3097	Zero Serial Correlation
VEC Residual Normality Test (Jarque – Bera)	Join test (Chi-sq)	1.8078	0.7710	Normality

*Edgeworth expansion corrected likelihood ratio statistic.

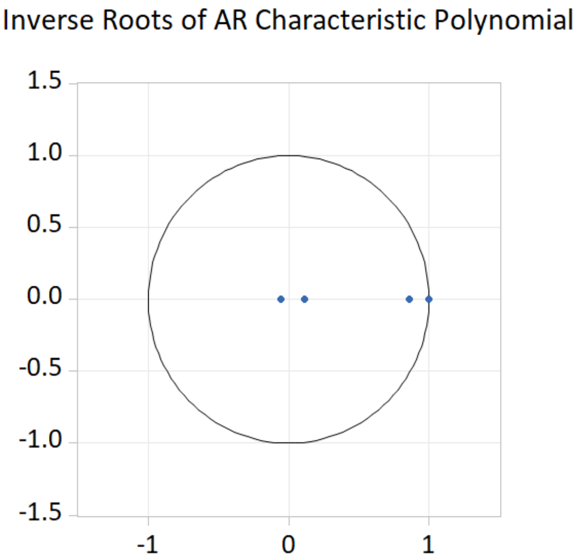
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP2
LN_OPEN
Exogenous variables: DUMMYM
Lag specification: 1 1
Date: 12/25/23 Time: 22:48

Root	Modulus
1.000000	1.000000
0.860771	0.860771
0.113769	0.113769
-0.054965	0.054965

VEC specification imposes 1 unit root(s).



Results of non-causality tests

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_OPEN does not cause LN_TFP2	1.38	0.24	19.42	0.00	19.45	0.00
LN_TFP2 does not cause LN_OPEN	0.02	0.88	0.41	0.52	0.41	0.82

5) TFP1, GDPpc and SRI1

Vector Error Correction Estimates
Date: 03/04/24 Time: 11:39
Sample (adjusted): 1952 2010
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_TFP1(-1)	1.000000
LN_GDPPC(-1)	-0.491985 (0.15657) [-3.14234]
LN_SRI1(-1)	-0.942647 (0.11608) [-8.12052]
C	-1.056022

Error Correction:	D(LN_TFP1)	D(LN_GDP...	D(LN_SRI1)
CointEq1	-0.079704 (0.01466) [-5.43551]	0.018400 (0.04013) [0.45850]	0.047144 (0.05344) [0.88226]
D(LN_TFP1(-1))	0.194622 (0.11542) [1.68621]	0.190237 (0.31587) [0.60226]	0.181432 (0.42060) [0.43136]
D(LN_GDPPC(-1))	0.061267 (0.04314) [1.42018]	0.364875 (0.11806) [3.09053]	-0.214298 (0.15721) [-1.36314]
D(LN_SRI1(-1))	-0.068156 (0.03994) [-1.70665]	-0.102300 (0.10929) [-0.93603]	0.375411 (0.14553) [2.57962]
C	0.005735 (0.00280) [2.04636]	0.019770 (0.00767) [2.57758]	0.013186 (0.01021) [1.29108]
DUMMYY	0.011393 (0.00494) [2.30565]	-0.042750 (0.01352) [-3.16122]	-0.011751 (0.01801) [-0.65256]
R-squared	0.636548	0.356286	0.151676
Adj. R-squared	0.602260	0.295558	0.071645
Sum sq. resids	0.012474	0.093425	0.165650
S.E. equation	0.015341	0.041985	0.055906
F-statistic	18.56481	5.866928	1.895224
Log likelihood	165.9010	106.5024	89.60736
Akaike AIC	-5.420373	-3.406862	-2.834148
Schwarz SC	-5.209098	-3.195587	-2.622873
Mean dependent	0.010271	0.014320	0.014120
S.D. dependent	0.024326	0.050023	0.058023

Determinant resid covariance (dof adj.)	1.24E-09
Determinant resid covariance	9.00E-10
Log likelihood	363.2866
Akaike information criterion	-11.60293
Schwarz criterion	-10.86347
Number of coefficients	21

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	66.3655	0.1205	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	13.6858	0.1340	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	1.5636	0.1342	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	13.8176	0.5394	Zero Serial Correlation
VEC Residual Normality Test (Jarque – Bera)	Join test (Chi-sq)	374.0508	0.0000	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

Stability Test (the model is stable)

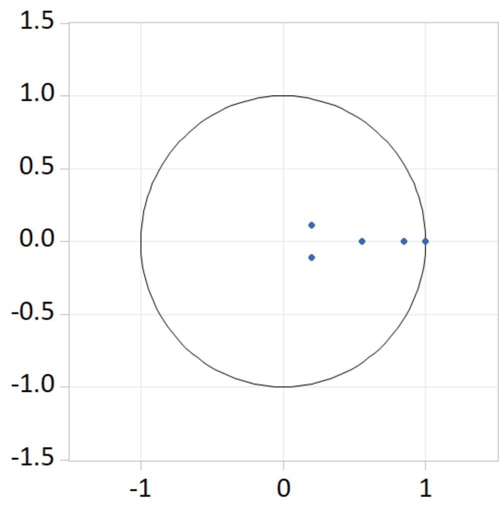
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP1 LN_GDPPC LN_SRI1
Exogenous variables: DUMMYY
Lag specification: 1 1
Date: 03/04/24 Time: 11:40

Root	Modulus
1.000000	1.000000
1.000000	1.000000
0.851008	0.851008
0.551862	0.551862
0.199421 - 0.108152i	0.226860
0.199421 + 0.108152i	0.226860

VEC specification imposes 2 unit root(s).

Inverse Roots of AR Characteristic Polynomial



Results of non-causality tests

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_GDPpc does not cause LN_TFP1	2.08	0.15	29.63	0.00	35.15	0.00
LN_TFP1 does not cause LN_GDPpc	0.37	0.55	0.17	0.68	0.37	0.83
LN_SRI1 does not cause LN_TFP1	3.17	0.07	29.63	0.00	30.59	0.00
LN_TFP1 does not cause LN_SRI1	0.18	0.67	0.72	0.40	0.78	0.68

6) TPF2, GDPpc and SRI1

Vector Error Correction Estimates
Date: 02/05/24 Time: 11:33
Sample (adjusted): 1952 2010
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_TFP2(-1)	1.000000
LN_GDPPC(-1)	-0.421989 (0.07097) [-5.94606]
LN_SRI1(-1)	-0.207616 (0.04432) [-4.68446]
C	-1.260621

Error Correction:	D(LN_TFP2)	D(LN_GDP...	D(LN_SRI1)
CointEq1	-0.260868 (0.05719) [-4.56108]	0.198943 (0.09626) [2.06677]	0.211002 (0.11621) [1.81567]
D(LN_TFP2(-1))	0.320039 (0.11944) [2.67952]	-0.094202 (0.20102) [-0.46863]	0.220991 (0.24268) [0.91061]
D(LN_GDPPC(-1))	0.022366 (0.07140) [0.31323]	0.487852 (0.12017) [4.05956]	-0.118859 (0.14508) [-0.81924]
D(LN_SRI1(-1))	-0.040523 (0.06939) [-0.58398]	-0.084949 (0.11679) [-0.72738]	0.453966 (0.14100) [3.21973]
C	0.012010 (0.00450) [2.67038]	0.008811 (0.00757) [1.16413]	0.000289 (0.00914) [0.03165]
DUMMYZ	-0.025960 (0.00809) [-3.20813]	0.001705 (0.01362) [0.12516]	0.029814 (0.01644) [1.81328]
R-squared	0.404117	0.292736	0.233792
Adj. R-squared	0.347901	0.226013	0.161509
Sum sq. resids	0.036240	0.102649	0.149615
S.E. equation	0.026149	0.044009	0.053131
F-statistic	7.188719	4.387322	3.234370
Log likelihood	134.4392	103.7250	92.61075
Akaike AIC	-4.353871	-3.312712	-2.935958
Schwarz SC	-4.142596	-3.101437	-2.724683
Mean dependent	0.007297	0.014320	0.014120
S.D. dependent	0.032382	0.050023	0.058023

Determinant resid covariance (dof adj.)	2.99E-09
Determinant resid covariance	2.17E-09
Log likelihood	337.3274
Akaike information criterion	-10.72296
Schwarz criterion	-9.983501
Number of coefficients	21

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	66.6783	0.1153	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	10.2204	0.3329	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	1.1507	0.3333	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	11.4222	0.7221	Zero Serial Correlation
VEC Residual Normality Test (Jarque – Bera)	Join test (Chi-sq)	61.9993	0.0000	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

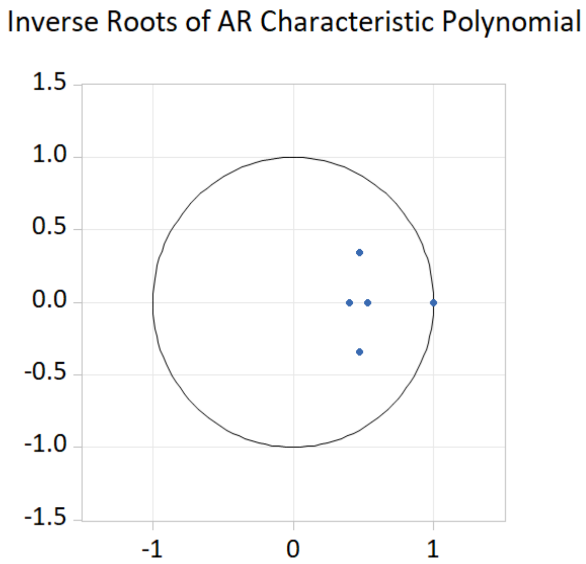
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP2 LN_GDPPC LN_SRI1
Exogenous variables: DUMMYZ
Lag specification: 1 1
Date: 02/05/24 Time: 11:35

Root	Modulus
1.000000	1.000000
1.000000	1.000000
0.471980 - 0.344045i	0.584065
0.471980 + 0.344045i	0.584065
0.531971	0.531971
0.397299	0.397299

VEC specification imposes 2 unit root(s).



Results of non-causality tests

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_GDPpc does not cause LN_TFP2	0.10	0.75	20.80	0.00	21.75	0.00
LN_TFP2 does not cause LN_GDPpc	0.22	0.64	4.27	0.04	4.48	0.11
LN_SRI1 does not cause LN_TFP2	0.34	0.56	20.80	0.00	21.43	0.00
LN_TFP2 does not cause LN_SRI1	0.83	0.36	3.30	0.07	4.15	0.13

7) TFP1 and SRI

Vector Error Correction Estimates
Date: 12/16/23 Time: 23:19
Sample (adjusted): 1972 2010
Included observations: 39 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_TFP1(-1)	1.000000
LN_SRI(-1)	-2.678549
	(0.38366)
	[-6.98155]
C	-6.005997

Error Correction:	D(LN_TFP1)	D(LN_SRI)
CointEq1	-0.022689	0.020254
	(0.00392)	(0.01703)
	[-5.78987]	[1.18961]
D(LN_TFP1(-1))	-0.014906	0.358359
	(0.14026)	(0.60941)
	[-0.10627]	[0.58805]
D(LN_SRI(-1))	-0.078377	0.449853
	(0.03586)	(0.15578)
	[-2.18592]	[2.88774]
C	0.021239	-0.008069
	(0.00341)	(0.01482)
	[6.22670]	[-0.54446]
DUMMYG	-0.023162	0.091228
	(0.00576)	(0.02504)
	[-4.01917]	[3.64365]
R-squared	0.710372	0.396217
Adj. R-squared	0.676299	0.325184
Sum sq. resids	0.005704	0.107666
S.E. equation	0.012952	0.056273
F-statistic	20.84803	5.577904
Log likelihood	116.8502	59.56096
Akaike AIC	-5.735908	-2.797998
Schwarz SC	-5.522631	-2.584721
Mean dependent	0.016101	0.019139
S.D. dependent	0.022765	0.068503

Determinant resid covariance (dof adj.)	5.29E-07
Determinant resid covariance	4.02E-07
Log likelihood	176.4884
Akaike information criterion	-8.435301
Schwarz criterion	-7.923436
Number of coefficients	12

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	31.2975	0.0688	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	4.3845	0.3565	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	1.1172	0.3566	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	5.7325	0.4538	Zero Serial Correlation
VEC Residual Normality Test (Jarque – Bera)	Join test (Chi-sq)	45.4168	0.0000	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

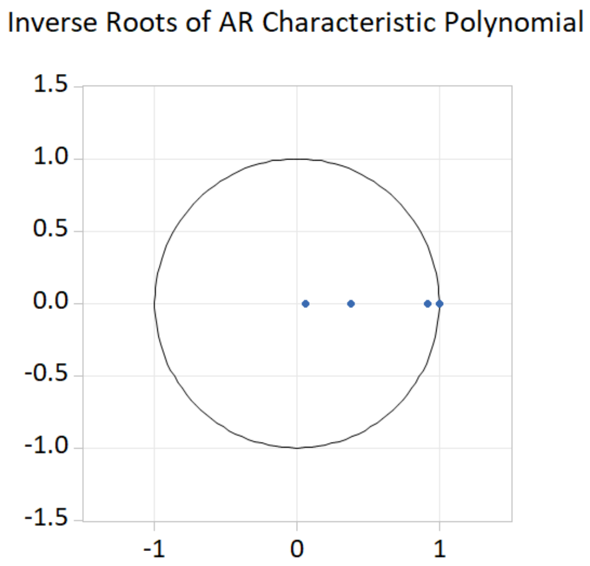
Stability Test (the model is stable)

The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP1 LN_SRI
Exogenous variables: DUMMYG
Lag specification: 1 1
Date: 03/04/24 Time: 11:54

Root	Modulus
1.000000	1.000000
0.918950	0.918950
0.377407	0.377407
0.061651	0.061651

VEC specification imposes 1 unit root(s).



Results of non-causality tests

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_SRI does not cause LN_TFP1	4.78	0.03	33.52	0.00	34.26	0.00
LN_TFP1 does not cause LN_SRI	0.35	0.56	1.42	0.23	1.57	0.46

8) TFP2 and SRI

Vector Error Correction Estimates
Date: 12/16/23 Time: 23:22
Sample (adjusted): 1972 2010
Included observations: 39 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_TFP2(-1)	1.000000
LN_SRI(-1)	-1.000865 (0.29357) [-3.40933]
C	-5.651194 (0.19222) [-29.3997]

Error Correction:	D(LN_TFP2)	D(LN_SRI)
CointEq1	-0.040834 (0.00854) [-4.78095]	0.019007 (0.01890) [1.00571]
D(LN_TFP2(-1))	0.132506 (0.12028) [1.10167]	0.370150 (0.26615) [1.39077]
D(LN_SRI(-1))	-0.057338 (0.06613) [-0.86711]	0.512190 (0.14632) [3.50047]
DUMMYH	-0.085585 (0.01147) [-7.46115]	0.128463 (0.02538) [5.06116]
R-squared	0.677505	0.515884
Adj. R-squared	0.649863	0.474388
Sum sq. resids	0.017631	0.086327
S.E. equation	0.022444	0.049664
F-statistic	24.50966	12.43225
Log likelihood	94.84390	63.86833
Akaike AIC	-4.658661	-3.070171
Schwarz SC	-4.488040	-2.899549
Mean dependent	0.009293	0.019139
S.D. dependent	0.037930	0.068503

Determinant resid covariance (dof adj.)	1.22E-06
Determinant resid covariance	9.85E-07
Log likelihood	159.0165
Akaike information criterion	-7.590590
Schwarz criterion	-7.121380
Number of coefficients	11

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	30.5863	0.0808	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	3.6482	0.4557	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	0.9237	0.4558	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	5.6678	0.5790	Zero Serial Correlation
VEC Residual Normality Test (Jarque – Bera)	Join test (Chi-sq)	20.3279	0.0004	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

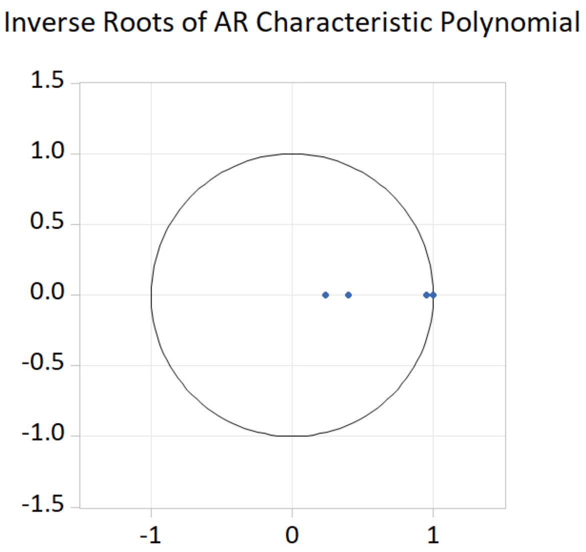
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP2 LN_SRI
Exogenous variables: DUMMYH
Lag specification: 1 1
Date: 03/04/24 Time: 12:03

Root	Modulus
1.000000	1.000000
0.951356	0.951356
0.398458	0.398458
0.235025	0.235025

VEC specification imposes 1 unit root(s).



Results of non-causality tests

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_SRI does not cause LN_TFP2	0.75	0.39	22.86	0.00	27.00	0.00
LN_TFP2 does not cause LN_SRI	1.93	0.16	1.01	0.31	2.06	0.36

9) TFP2 and EAGRI

Vector Error Correction Estimates
Date: 12/18/23 Time: 09:42
Sample (adjusted): 1952 2010
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LN_TFP2(-1)	1.000000
LN_EAGRI(-1)	-0.998533 (0.16551) [-6.03308]
C	1.414255

Error Correction:	D(LN_TFP2)	D(LN_EAGRI)
CointEq1	-0.057982 (0.02498) [-2.32132]	0.285531 (0.08439) [3.38337]
D(LN_TFP2(-1))	0.115868 (0.11436) [1.01323]	-0.145399 (0.38637) [-0.37632]
D(LN_EAGRI(-1))	0.032196 (0.03547) [0.90775]	0.068724 (0.11983) [0.57349]
C	0.016015 (0.00433) [3.70227]	0.026523 (0.01462) [1.81475]
DUMMYK	-0.039642 (0.00857) [-4.62550]	-0.040664 (0.02896) [-1.40433]
R-squared	0.345619	0.247928
Adj. R-squared	0.297146	0.192219
Sum sq. resids	0.039797	0.454308
S.E. equation	0.027148	0.091723
F-statistic	7.130175	4.450406
Log likelihood	131.6766	59.84487
Akaike AIC	-4.294124	-1.859148
Schwarz SC	-4.118061	-1.683085
Mean dependent	0.007297	0.016455
S.D. dependent	0.032382	0.102054

Determinant resid covariance (dof adj.)	5.82E-06
Determinant resid covariance	4.88E-06
Log likelihood	193.3740
Akaike information criterion	-6.148272
Schwarz criterion	-5.725722
Number of coefficients	12

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	23.1139	0.3379	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	7.8296	0.0980	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	2.0140	0.0981	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	7.2998	0.2940	Zero Serial Correlation
VEC Residual Normality Test (Jarque – Bera)	Join test (Chi-sq)	5.6485	0.2270	Normality

*Edgeworth expansion corrected likelihood ratio statistic.

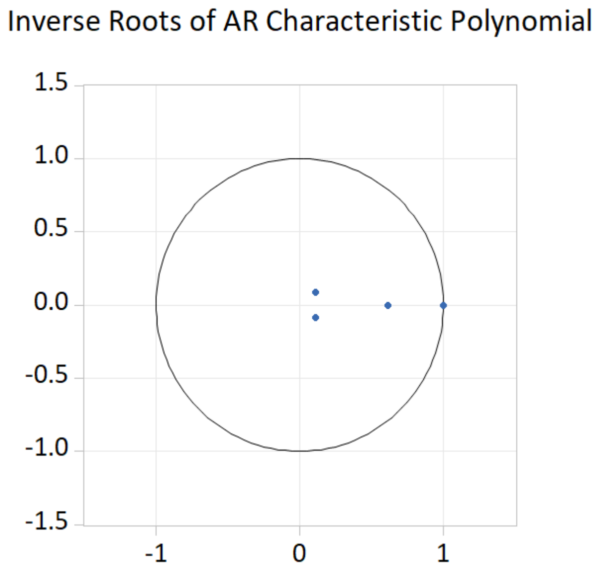
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP2 LN_EAGRI
Exogenous variables: DUMMYK
Lag specification: 1 1
Date: 03/04/24 Time: 12:22

Root	Modulus
1.000000	1.000000
0.615981	0.615981
0.112758 - 0.088388i	0.143272
0.112758 + 0.088388i	0.143272

VEC specification imposes 1 unit root(s).



Results of non-causality tests

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_EAGRI does not cause LN_TFP2	0.82	0.36	5.39	0.02	6.67	0.04
LN_TFP2 does not cause LN_EAGRI	0.14	0.71	11.45	0.00	12.13	0.00

10) TFP2 and DAGRI

Vector Error Correction Estimates
Date: 12/18/23 Time: 11:04
Sample (adjusted): 1952 2010
Included observations: 59 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LN_TFP2(-1)	1.000000	
LN_DAGRI(-1)	-0.296235	
	(0.06219)	
	[-4.76369]	
C	-2.740600	
	(0.44358)	
	[-6.17840]	
Error Correction:	**D(LN_TFP2)**	**D(LN_DAGRI)**
CointEq1	-0.045593	-0.164729
	(0.01829)	(0.04482)
	[-2.49332]	[-3.67508]
D(LN_TFP2(-1))	0.274626	0.170927
	(0.09564)	(0.23445)
	[2.87131]	[0.72906]
D(LN_DAGRI(-1))	0.134995	-0.054002
	(0.05745)	(0.14083)
	[2.34973]	[-0.38346]
DUMMYL	-0.062856	-0.019922
	(0.01092)	(0.02676)
	[-5.75755]	[-0.74447]
R-squared	0.503991	-0.015081
Adj. R-squared	0.476936	-0.070449
Sum sq. resids	0.030166	0.181252
S.E. equation	0.023419	0.057406
F-statistic	18.62834	-0.272384
Log likelihood	139.8510	86.95211
Akaike AIC	-4.605117	-2.811936
Schwarz SC	-4.464267	-2.671086
Mean dependent	0.007297	0.034683
S.D. dependent	0.032382	0.055485
Determinant resid covariance (dof adj.)		1.65E-06
Determinant resid covariance		1.43E-06
Log likelihood		229.4794
Akaike information criterion		-7.406080
Schwarz criterion		-7.018743
Number of coefficients		11

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	24.5349	0.2679	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	5.5842	0.2324	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	1.4202	0.2325	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	6.7810	0.4520	Zero Serial Correlation
VEC Residual Normality Test (Jarque – Bera)	Join test (Chi-sq)	35.2112	0.0000	No normality

*Edgeworth expansion corrected likelihood ratio statistic.

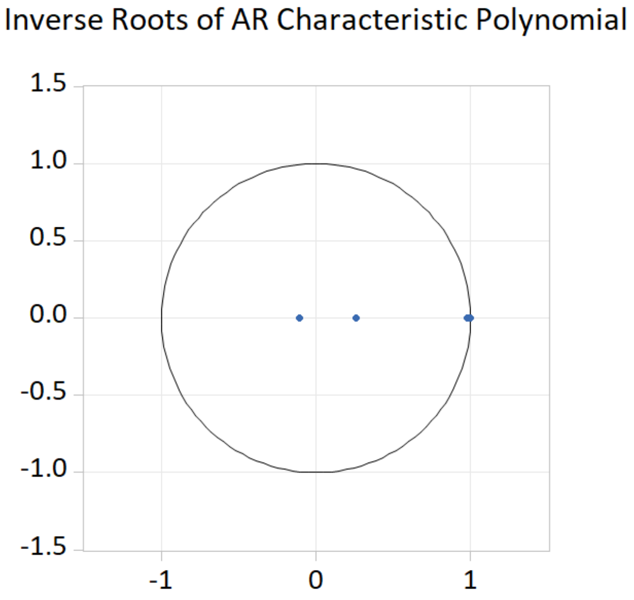
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP2 LN_DAGRI
Exogenous variables: DUMMYL
Lag specification: 1 1
Date: 12/18/23 Time: 11:05

Root	Modulus
1.000000	1.000000
0.952711	0.952711
0.376728	0.376728
-0.105609	0.105609

VEC specification imposes 1 unit root(s).



Results of non-causality tests

Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_DAGRI does not cause LN_TFP2	5.73	0.02	4.35	0.04	23.02	0.00
LN_TFP2 does not cause LN_DAGRI	0.15	0.70	15.92	0.00	18.28	0.00

11) TFP2 and FAMGRI

Vector Error Correction Estimates
Date: 12/18/23 Time: 10:14
Sample (adjusted): 1965 2010
Included observations: 46 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	
LN_TFP2(-1)	1.000000	
LN_FAMAGRI(-1)	-0.391680	
	(0.16732)	
	[-2.34086]	
C	-3.227009	
	(0.74860)	
	[-4.31074]	
Error Correction:	**D(LN_TFP2)**	**D(LN_FAMAGRI)**
CointEq1	-0.062797	-0.110739
	(0.01985)	(0.03920)
	[-3.16324]	[-2.82471]
D(LN_TFP2(-1))	0.081295	0.612457
	(0.13216)	(0.26099)
	[0.61512]	[2.34671]
D(LN_FAMAGRI(-1))	0.093977	-0.175730
	(0.07172)	(0.14164)
	[1.31025]	[-1.24069]
DUMMYJ	-0.038932	-0.036870
	(0.01113)	(0.02198)
	[-3.49766]	[-1.67735]
R-squared	0.291219	0.175554
Adj. R-squared	0.240592	0.116665
Sum sq. resids	0.039264	0.153119
S.E. equation	0.030576	0.060380
F-statistic	5.752234	2.981106
Log likelihood	97.24870	65.94794
Akaike AIC	-4.054291	-2.693389
Schwarz SC	-3.895279	-2.534376
Mean dependent	0.010060	0.026770
S.D. dependent	0.035086	0.064243
Determinant resid covariance (dof adj.)		3.39E-06
Determinant resid covariance		2.83E-06
Log likelihood		163.3273
Akaike information criterion		-6.622924
Schwarz criterion		-6.185641
Number of coefficients		11

Post – Estimation Diagnostic Tests

Tests	Type	Test statistics	Prob.	Remarks
VEC Residual Heteroscedasticity Test	Join test (Chi-sq)	22.9260	0.3479	Homoscedasticity
VEC Residual Serial Correlation LM Test	LRE* stat at lag 2	2.6790	0.6129	Zero Serial Correlation
VEC Residual Serial Correlation LM Test	Rao F-stat at lag 2	0.6726	0.6129	Zero Serial Correlation
VEC Residual Serial Portmanteau Test	Q-Stat at lag 2	3.2047	0.8654	Zero Serial Correlation
VEC Residual Normality Test (Jarque – Bera)	Join test (Chi-sq)	4.1013	0.3925	Normality

*Edgeworth expansion corrected likelihood ratio statistic.

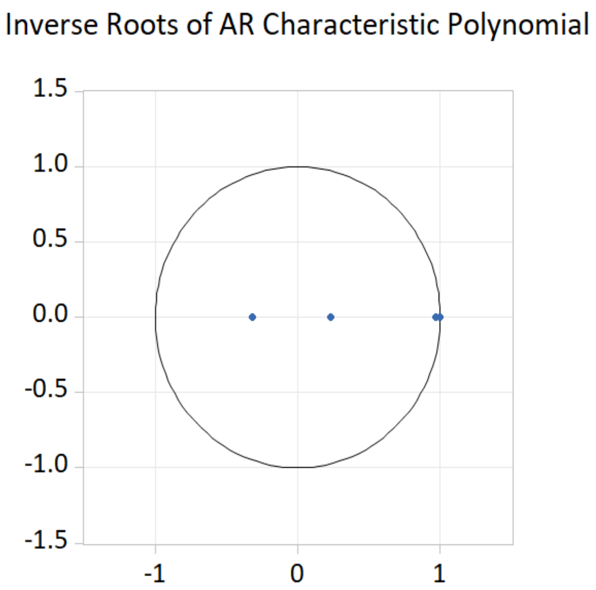
The stability test of long and short run estimates is tested by using the inverse roots of AR characteristics polynomial.

Stability Test (the model is stable)

Roots of Characteristic Polynomial
Endogenous variables: LN_TFP2 LN_FAMAGRI
Exogenous variables: DUMMYJ
Lag specification: 1 1
Date: 03/04/24 Time: 12:50

Root	Modulus
1.000000	1.000000
0.970988	0.970988
-0.317721	0.317721
0.232875	0.232875

VEC specification imposes 1 unit root(s).

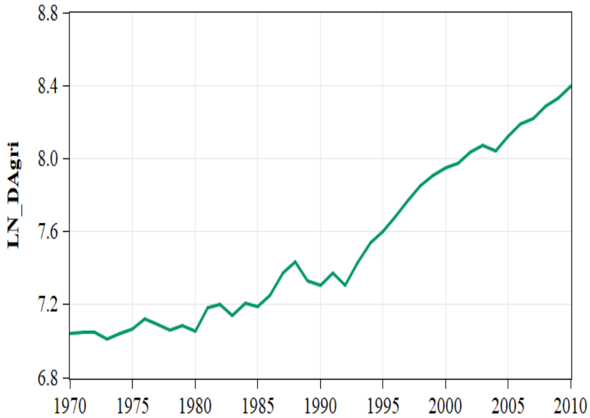


Results of non-causality tests

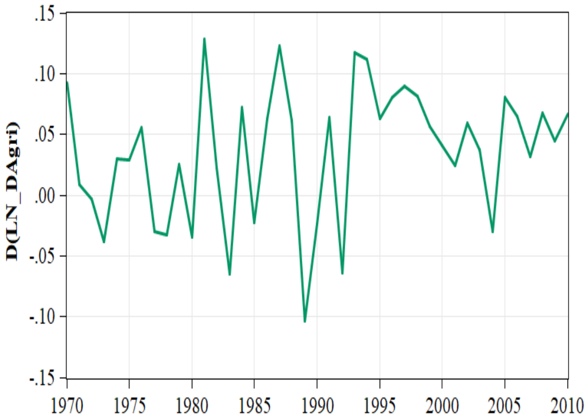
Hypothesis of causality (Ho)	Short-run Granger non-causality		Long-run weak exogeneity		Overall strong exogeneity	
	Chi-square	Prob.	Chi-square	Prob.	Chi-square	Prob.
LN_FAMAGRI does not cause LN_TFP2	1.72	0.19	10.01	0.00	15.33	0.00
LN_TFP2 does not cause LN_FAMAGRI	5.51	0.02	7.98	0.00	17.55	0.00

APPENDIX 4.5

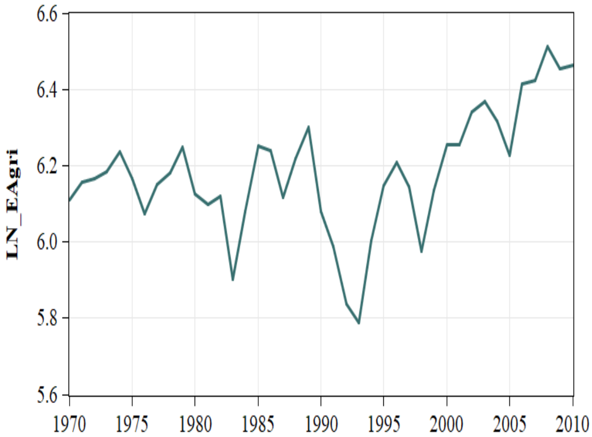
Domestic Agriculture GDP in logarithms



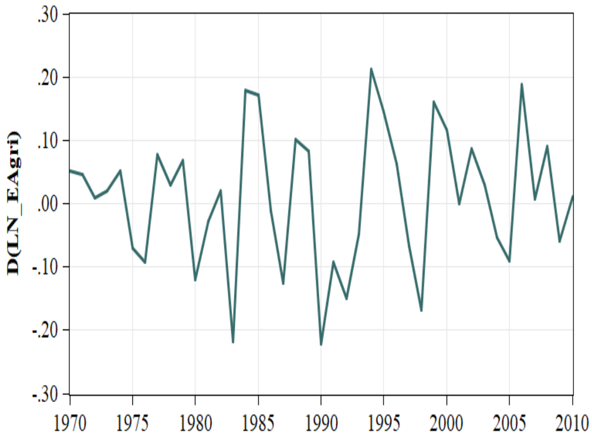
Domestic Agriculture GDP in first differences



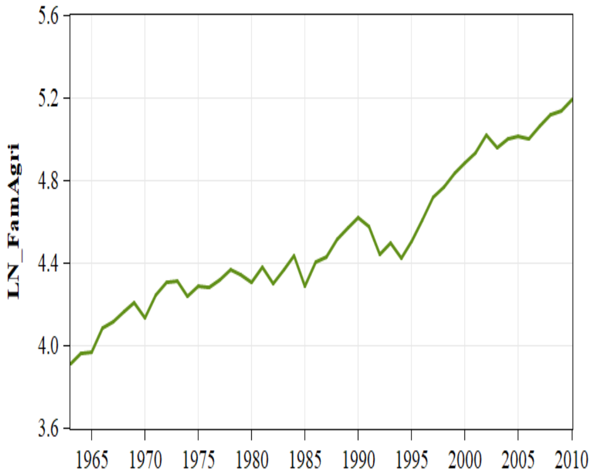
Export Agriculture GDP in logarithms



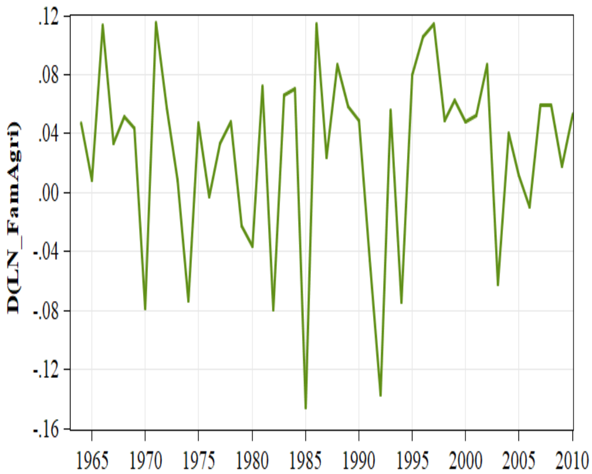
Export Agriculture GDP in first differences



Family farming in logarithms



Family farming in first differences



CHAPTER 5

THE NEW AGRO-EXPORT MODEL AND FAMILY FARMING: INSIGHTS FROM THE PERUVIAN CASE (1990-2015)

5.1. Introduction

The evaluation of labour productivity and total factor productivity (TFP), as discussed in the preceding chapter, confirms the existence of a turning point in the 1990s. Bearing this fact in mind, the objective of this chapter is to analyse the economic performance of the most representative agricultural units in the country. To do so, it is necessary to adopt a microeconomic analytical approach. This will enable us to identify events, circumstances, and public policies that may have impacted the economic decisions of agricultural units and thus explain the identified increase in TFP from the 1990s onwards.

There are two dominant forms of production in Peruvian agriculture: export-oriented agro-industrial complexes (which vertically integrate the field phase and factory/processing) and family farming. Therefore, to fulfill the objective of this chapter, analyzing the performance of these two types of agricultural units, theoretical models are developed for each type of agrarian unit. Based on the analysis of comparative statics and using empirical evidence from agrarian censuses, national surveys and studies on the subject, the transmission mechanisms are identified. Through these mechanisms, the implementation of the new model of agro exports in the 1990s, public policies, the gastronomic boom and the context of economic expansion (caused by the mining boom at the beginning of the 21st century) have shaped the economic performance of agro-industrial complexes and family farming.

It is estimated that, in both developed and developing countries of the world, "family farming represents the predominant form of food production" (FAO, 2014). In Latin America and the Caribbean, family agriculture leads more than 80% of the sector's production, while its contribution to agricultural GDP in the region is between 30% and 40% (FAO-IDB, 2007). Family farming units contribute to markets and domestic consumption and to international markets. In countries such as Peru, the production of exportable coffee and mango is in the hands of small family farms organised in cooperatives (Sotomayor and Linares, 2013).

According to FAO (2014:23), “Family Farming is a means of organizing agricultural, forestry, fisheries, pastoral and aquaculture production which is managed and operated by a family and predominantly reliant on family labour, both women’s and men’s”. Furthermore, the Ministry of Agriculture and Irrigation of Peru (MINAGRI), through its National Family Agriculture Strategy (ENAF 2015-2021), highlights that family farming is mainly characterised by the predominant use of family labour and limited access to resources, land, water, forests and capital. Family farms carry out income diversification strategies (on-farm and off-farm sources) and are heterogeneous (MINAGRI, 2015).

Regarding heterogeneity, MINAGRI (2015) differentiates family farming units according to accumulation levels and classifies them into three categories: a) subsistence or simple reproduction units (which produce mainly for self-consumption); b) intermediate accumulation units (that surpass the subsistence level); and c) consolidated units (that manage to accumulate and grow). Maletta (2018) distinguishes three family-farm size categories, measured in terms of standard hectares: small (below 10 ha), medium-sized (10-99 ha) and large (over 100 ha). Based on the 2012 farm census, small family farms account for 58% of all crop area measured in terms of standardised hectares. This share corresponds with 13% and 20% for medium and large family farms, respectively. Furthermore, corporate farms cover less than 9% of the total standardised crop area. Focusing on the total number of farms, data from the 1994 and 2012 farm censuses indicate that there were about 1.8 million in 1994 and 2.3 million in 2012. In both census years, small family farm represented 97% of total farms.

The chapter added value is two-fold. First, the development of a theoretical framework that explain the expansion of agro-industry. Secondly, it fills a gap in knowledge by providing a comprehensive view of the different causes affecting the microeconomic performance of agricultural family units. The use of farm censuses (1994 and 2012), representative household surveys at national and regional levels as well as case studies allow us to identify changes in migration patterns, household farm consumption, technological innovation, as well as in income diversification and livelihood strategies.

This chapter is organised into six sections. Section 2 summarises some relevant characteristics of the new agro-export model. Section 3 explains the analytical framework for transmission channels. The model and empirical evidence for the expansion of export agro-industry are developed in Section 4. A household model and evidence that identifies changes in family farming are presented in Section 5. Conclusions are outlined in Section 6.

5.2. The new agro-export model

The dynamics of capitalist accumulation on the Peruvian coast have undergone significant transformations over time, reflecting shifts in global economic structures and local socio-political contexts. This section aims to compare and contrast the old and new models of agrarian accumulation, focusing on key aspects such as the role of the state, economic policies, forms of productive organization, crops, land tenure, market orientation, importance of foreign exchange, and social classes. Valcárcel (2003) provides a pertinent reflection on both models, with their key characteristics succinctly summarised in Table 5.1.

The original context of the old model of agrarian accumulation in the 19th century was shaped by the forces of the first wave of globalization, urbanization, and industrialization processes in developed countries. At this time, the Peruvian coast saw the dominance of an oligarchic system, with agrarian classes intricately linked to political power. Economic policies were characterized by a laissez-faire approach, facilitating the consolidation of large agro-industrial plantations and estates, predominantly cultivating traditional crops such as sugar and cotton. Land ownership was concentrated in the hands of a few, with medium and large estates dominating the landscape. The market orientation was primarily external, with significant reliance on foreign exchange, which constituted a substantial portion of the national and agricultural totals. Social classes were sharply divided between the wealthy sugar and cotton barons and the working class, comprising both permanent and occasional proletariat.

In contrast, the new model of agrarian accumulation emerged in the wake of globalization in the 1980s, accompanied by an expansion of consumption capacities in developed countries and the adoption of new dietary habits. The role of the state shifted towards a weaker, more liberal stance, increasingly subject to the influence of international organizations such as the World Bank and the International Monetary Fund, framing economic policies within the context of Structural Adjustment Programs. Productive organization witnessed a transition towards the dominance of transnational agri-food companies, agro-industrial chains, contract farming arrangements, and the involvement of non-governmental organizations (NGOs). This restructuring also led to a diversification of crops, with a shift towards non-traditional products like fruits and vegetables. Land tenure patterns became more varied, encompassing small, medium, and large agricultural properties. Despite a continued reliance on external markets, there was a notable decrease in the contribution of foreign exchange to the national economy, although it remained significant in the agricultural sector. Social classes evolved, with a rise in the prominence of small and medium-scale farmers alongside the emergence of a native and transnational agro-industrial bourgeoisie, alongside an increasingly feminized occasional proletariat.

In conclusion, the evolution of capitalist accumulation models on the Peruvian coast reflects broader global economic trends and local socio-political dynamics. From the oligarchic structures of the past to the neoliberal reforms of the present, the transformation of agrarian systems has profoundly impacted land ownership, production relations, market dynamics, and social hierarchies.

Table 5.1. Capitalist accumulation models on the Peruvian Coast

	Old model of agrarian accumulation	**New model of agrarian accumulation**
Original context	19th century. First globalization. Urbanization and industrialization processes in developed countries.	Globalization initiated in the 1980s. Expansion of the consumption capacity of developed country populations. New dietary habits.
State	Oligarchic, agrarian classes articulated to political power.	Weak liberal state subject to international organizations (World Bank and International Monetary Fund).
Economic policies	Liberal (laissez-faire laissez-passer).	Liberals framed within Structural Adjustment.
Form of productive organization	Large agro-industrial plantations, estates with *yanaconas*.	Transnational agri-food companies, agro-industrial chains, contract farming, and NGOs.
Crops	Traditional: sugar and cotton	Non-traditional: fruits and vegetables
Land tenure	Medium and large estates.	Small, medium, and large agricultural properties.
Market Foreign exchange	Primarily external 50% of the national total, 90% of the agricultural total	Primarily external 15% of the national total, 86% of the agricultural total.
Social classes	Sugar and cotton barons. Permanent and, above all, occasional proletariat.	Small and medium farmers. Native and transnational agro-industrial bourgeoisie, increasingly female occasional proletariat.

Source: Valcárcel (2003:130).

As part of the new agro-export model, non-traditional export crops have increased their acreage due to increased international demand and the promotion of laws for the sector, such as the Law for Promotion of the Agricultural Sector, which offers a range of incentives to firms. Furthermore, environmental conditions have been optimal for crop expansion, significant developments in transport infrastructure allow the transfer of products in the best conditions, and free trade agreements (FTA) have been implemented between Peru and other countries, including the United States, Thailand, Singapore and China (PROINVERSIÓN, 2007). The exportable supply is provided not only by large firms but also by small, medium and large producers who establish various forms of articulation with big agro-business. Some firms are vertically integrated with suppliers of crops through contracts that establish the monitoring of agricultural activities, financing and conditions of sale (quantity and quality of the product, price, place of delivery of the product and penalties). Confirming these changes, Table 5.2 shows the trend of a growing export share from non-traditional products. For example, the participation increased from 3.7% in 1990 to 12.8% in 2015.

Table 5.2. Exports according to traditional and non-traditional, 1950-2015 (FOB values in millions of US$ and percentage)

	1950	1960	1970	1980	1990	2000	2010	2015
1. Traditional products	**178**	**403**	**973**	**3051**	**2259**	**4804**	**27850**	**23291**
Fishing	6	42	342	195	345	955	1884	1449
Agricultural	107	153	160	228	174	249	975	704
Mineral	41	190	465	1854	1481	3220	21903	18836
Petroleum and derivatives	25	18	7	774	258	381	3088	2302
2. Non-traditional products	**20**	**41**	**61**	**845**	**949**	**2044**	**7699**	**10857**
Agriculture and livestock	n.a.	n.a.	8	72	119	394	2203	4387
Fishing	n.a.	n.a.	5	117	107	177	644	934
Textile	n.a.	n.a.	1	224	364	701	1561	1329
Timbers and papers	n.a.	n.a.	n.a.	n.a.	13	123	359	352
Chemical	n.a.	n.a.	6	90	90	212	1228	1402
Non-metallic minerals	n.a.	n.a.	n.a.	58	16	47	252	698
basic metal and jewellery	n.a.	n.a.	3	82	220	265	949	1080
Fabricated metal and machinery	n.a.	n.a.	1	58	43	97	393	525
Other non-traditional products	20	41	36	144	18	29	110	150
3. Total Exports	**198**	**444**	**1034**	**3896**	**3247**	**6848**	**35549**	**34148**
In percent of total (%)								
4. Traditional exports	**89.9**	**90.7**	**94.2**	**78.3**	**69.6**	**70.2**	**78.3**	**68.2**
Fishing	2.9	9.5	33.0	5.0	10.6	13.9	5.3	4.2
Agricultural	53.7	34.4	15.5	5.9	5.4	3.6	2.7	2.1
Mineral	20.6	42.8	45.0	47.6	45.6	47.0	61.6	55.2
Petroleum and derivatives	12.7	4.0	0.7	19.9	8.0	5.6	8.7	6.7
5. Non-traditional products	**10.1**	**9.3**	**5.8**	**21.7**	**30.4**	**29.8**	**21.7**	**31.8**
Agriculture and livestock	n.a.	n.a.	0.8	1.8	3.7	5.8	6.2	12.8
6. TOTAL (in %)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Author elaboration based on statistics from BCRP, SUNAT and Customs
n.a.: not available

The 1990s saw a period of fundamental changes in agricultural performance. The implementation of a stabilisation programme and the structural reforms by the state modified the institutional environment and the conditions in which agrarian producers participate in market relations. A key fact to note, in the context of the reforms, is the explicit policy of promoting investment in the sector when the development of agro-industry is declared to be of national interest. This was evidenced by the 2000 Law for the Promotion of the Agricultural Sector (Law 27360)[35]. The role of the state changes in this new approach, its functions are redefined and its participation in the promotion and orientation of economic development is limited. The state assumes a normative and subsidiary role and private action is fundamental to development (von Hesse, 2000; Eguren, 2003). Table 5.3 summarises the main policy measures implemented to provide incentives for the emergence and expansion of the non-traditional agro-export sector.

[35] Law 27360 includes individuals or legal entities that carry out agro-industrial activity, except for activities related to wheat, tobacco, oilseeds, oils and beer, provided they use mainly agricultural products, directly produced or acquired from people who develop crops and livestock in areas outside the province of Lima and the Constitutional Province of Callao. The minimum percentage of utilisation of agricultural inputs of national origin that must be included in the agro-industrial activities, covered by the Law, is 90%. This is calculated on the total value of the inputs necessary for the preparation of the goods, excluding the container (Decreto Supremo Nº 007-2002-AG).

Table 5.3. Peru: Main policies that affect the national agricultural sector since the 1990s

Laws and policies	Content	Effect
1993 Constitution	Eliminated the expression *agrarian reform* and reduced the protection of peasant community lands.	Legal security for potential investors
1995 Land Law	Eliminated restrictions on land ownership (size, concentration, indirect driving and destination of use).	Allow the concentration of large land holdings by agro-export companies.
2000 Law for the Promotion of the Agricultural Sector (Law 27360)	Reduced corporate income tax to agrarian firms (from 30% to 15%); reduced contributions to social security (from 9% to 4%); reduced workers' rights; made the agrarian labour regime more flexible.	Reduction of tax and labour costs
Investment policy	Large investments in irrigation works in the Coast region.	Expansion of the agricultural frontier for export crops. State subsidies via prices in the purchase of the new lands.
Trade policy	Liberalisation of foreign trade. Signing of bilateral and multilateral free trade agreements	Elimination of restrictions on import and export
Agrarian sanitary policy	Strengthening of the National Service of Agri-Food Health and Quality (SENASA).	Compliance with health regulations to access buyer countries
Liberal macroeconomic framework	Limited state intervention, except to promote agro-export production.	

Source: Pintado (2018:12)

However, the bias in favour of the promotion of agro-export activities left small-scale agriculture and the peasant economy out of the development agenda during the 1990s, unless they achieved – with non-governmental support – a successful insertion in the agro-export production chains (Eguren, 2003; Zegarra, 2018). This situation began to change when Law 28890 was enacted in 2006 to create the decentralised public authority *Sierra Exportadora*. According to the objective of this law, the promotion and development of the rural economic activities of the Sierra region were declared of national interest, with emphasis on agriculture, livestock, aquaculture, handicrafts, textiles, jewellery, reforestation, agroforestry and tourism, as well as the activities of transformation and industrialisation of products that are obtained from these activities. These activities are expected to allow the creation of national and export markets as tools to fight against poverty and generate productive employment (*Diario el Peruano*, 2006). Subsequently, in 2016, Law 30495 extended the area of execution of *Sierra Exportadora* to the zones of the Amazon region, with the purpose of constituting Andean-Amazonian corridors to generate competitiveness, added value, innovation and territorial development (*El Peruano*, 2016).

In addition to interacting directly with farmers, *Sierra y Selva Exportadora* also works with local authorities. From 2011 to 2015, over 280,000 small producers in 129 provinces were beneficiaries and export value was about $600 million. The main agricultural products promoted were quinoa, coffee, cocoa, Andean cheese, berries of various types, aquaculture (trout in Andean lakes), artichokes, processed products based on Andean grain and tuber crop varieties, and exotic products or specialties (Maletta, 2018).

Another new programme oriented towards providing support for smallholder projects is *Agrorural* (Agrarian Productive Development). Its main lines of action include providing assistance to create and run rural industry enterprises, training in financial management, price and market information. The programme is present in over 1,000 rural districts and has offices in 20 out of 25 regions (*departamentos*) of the country (Maleta, 2018). However, despite these public efforts aimed at family farming, their level of coverage and the available budget are insufficient. When Zegarra (2018) evaluated public policies aimed at family farming during the last decade, he concluded that the generalist type of policies still predominates, which, although they have implications for family farming, do not form a coherent and articulated set of policies that meet the demands and needs of family farmers. The author proposes the design of a specific policy for the development of family farming in a context characterised by high social and geographical heterogeneity.

The estimation of labour productivity and TFP discussed in the previous chapter corroborates the existence of significant changes in agriculture. Among the causes that explain these results is the growing openness towards international markets (Peru currently has free trade agreements with several countries). Other factors are related to the growing international demand for healthy and high quality food; the incorporation of new lands for agriculture; the growing interest in biofuels; the gastronomic boom that revalorises products of traditional agriculture; the increasing number of Peruvians who demand a more varied and higher quality food supply; and the expansion of private investment in agriculture (Velazco and Velazco, 2012).

Following the trend established as state policy since the late nineteenth century, since the 1990s the central government, in coordination with some sub-national governments, has promoted and financed irrigation projects in the Coast region. These new lands were auctioned and transferred to specialised economic groups in export agriculture (Escobedo, 2015). In terms of hectares for new lands or improvement of irrigation, the expected impact of the irrigation projects in the regions of Piura, La Libertad, Lambayeque, Ica and Arequipa, was 461 thousand hectares (Burneo, 2010). Eguren (2018) estimates, based on the information available and the importance of the irrigation projects in the Coast region, the amount of the fiscal subsidy for the projects. The projects analysed were Chavimochic, Chinecas, Chira-Piura, Jequetepeque-Zaña, Majes-Siguas, Olmos, Tinajones and Pasto Grande. The study shows that all the coastal irrigation projects analysed have been heavily subsidised with respect to the investment cost versus the income obtained from the sale, especially in auctions, the extension of new lands and the sale of services such as water and energy. All this income has managed to cover only 7% of the investment cost of the irrigation projects as a whole, which means a subsidy of 93%.

The regional analysis of land concentration based on the Gini coefficient for the 2012 census allows us to distinguish a more pronounced dynamic in the Coast region than in either the Sierra region or the Amazon region. Thus, the Gini is 0.75 for the Coast, 0.68 for the Sierra, and 0.53 for the Amazon (Bourliaud and Eresue, 2015). This process is associated with the expansion of non-traditional and large-scale export agriculture in the Coast region.

In order to disentangle how external events (expansion of agro-exports, economic expansion and gastronomic boom) have shaped the behaviour of family farming, the next section discuss some transmission channels.

5.3. Analytical framework for transmission channels

Table 5.4 summarises the different transmission channels through which the occurrence of agro-export promotion, economic expansion and gastronomic boom have impacted on the agro-export complex and family farming. It is assumed that the redistributive government policies aimed at improving access to public goods and services played an important role in improving agricultural productivity. Furthermore, targeted social programmes (unconditional cash transfers) were effective in reducing extreme rural poverty. Moreover, the expansion of non-traditional agricultural exports boosted labour market demand, employing members of rural households. Economic growth increased labour demand for non-agricultural sectors, enhancing higher net migration from the poorest rural areas (Sierra) to the more dynamic ones (Coast and Amazon). In addition, increased demand for food was expected due to economic expansion (consolidation of a middle class that demands fresh and healthier foods). Likewise, the boom in Peruvian gastronomy, which revalorised products of traditional agriculture (for example, potatoes and Andean cereals), also caused an increase in the demand for food and in prices. All the above-mentioned factors are expected to improve household incomes. Finally, it is important to highlight the key role of the labour market as a sphere that allows households to take advantage of economic expansion.

Table 5.4. Analytical framework for effects on the agro-export complex and family farming: Identifying transmission channels

Events/government policies	Expected effect on Agro-export complex	Expected effect on Family farming
Promotion of non-traditional agro-export goods (early 1990s) Laws and policy measures mainly for large firms (excluding family farming); free trade agreements	Increase in production; increase in labour demand; export and market diversification	Increase in family labour supply; limited participation in export value chains (through cooperatives or being farm input supplier to large companies)
Economic expansion (mining boom, since 2002) Public investment in rural areas; targeted social polices (extreme rural poor); higher food demand; higher labour demand from non-farm sectors (service, trade and construction)		Access to roads, markets, electricity, drinking water and small irrigation channels (higher labour productivity); exit poverty; increased farm production and prices; increased household labour supply (off-farm activities and rural-urban migration)
Gastronomic boom (late 1990s) Higher demand for Andean food		Increase in production and prices

Source: Author´s elaboration.

The following two sections will deal with the theory and empirical evidence regarding the agro-export complex and family farming.

5.4. The expansion of agro-export complex: theory and evidence

This section comprises two parts. The first part elaborates on the theoretical model, while the second part provides empirical evidence regarding the model's predictions.

5.4.1 Model

The model considers a salient characteristic of the agro-industrial complexes dedicated to the export of non-traditional agricultural products. That is, the control of field and factory activities. For this reason, it is assumed that the firm is responsible for producing the agrarian good, with access to its own land, and has a plant to process it. In many cases, the same firms assume the functions of packing and exporting the final product.

The agro-industrial complex requires labour for the agricultural activity (farm stage, L_f) and labour for the processing of the agricultural good (farm processing stage, L_p).

The production of the agricultural good (X) requires labour and it is assumed that the land size (T) and the technology are fixed in the short term. The firm is a price-taker both in factor and good markets. It is assumed that the firm produces an agro-industrial good with the following technology that involves the use of farming good and inputs (I) in fixed proportions (technologically pre-determined). This means that fixed proportions production function (Leontief production function) is considered, as expressed in equation (1):

$$Y = \text{Min}\ \{X\ (L_f),\ I\} \tag{1}$$

where:
Y = units of the agro-industrial good (final good)
X = units of the agrarian good
I = inputs for the farm processing stage
L_f = labour allocated to the production of farm goods.

The input I is considered as a composite input, adding a set of inputs including the labour of the factory stage. Thus, the following linear relationships can be established between the level of inputs used (In) and the labour demand (L_p) for the food processing stage:

$$L_p = \alpha I \quad \text{and} \quad In = (1-\alpha)I, \quad \alpha < 0 \tag{2}$$

Equation (2) means that once the level of composite input I is established, the corresponding labour demand (Lp) and input demand (In) are directly determined.

The factors of production for the farming stage are labour, land and fixed costs (fertilizers, water, extension services, etc.). For the farm stage, decreasing marginal returns are assumed in the use of labour, so that X '> 0 and X "<0.

Let P, P_{in}, w_f, w_p, t_0, and t_1 be the prices of agricultural goods, inputs, wage for the farm worker, wage for the food processing worker, wages tax (social security) and corporate income tax, respectively. When defining the maximisation condition, given the Leontief production function, the optimal condition is achieved when no productive resources are wasted:

$$Y = X(L_f) = I \quad (3)$$

The firm´s objective is to maximise a profit function (π) formed by the sale of agro-industrial production and the costs associated with labour demand in farming and processing phases, inputs and fixed costs (FC) as expressed in equation (4):

$$\pi = (1-t_1)PY - w_f(1+t_0)L_f - P_{in}I_n - w_p(1+t_0)L_p - FC \quad (4)$$

Upon considering equation (2), that is to say, substituting the use of inputs (In) and processing phase labour (L_p) in terms of composite input (I), the profit function undergoes transformation to:

$$\pi = (1-t_1)PY - w_f(1+t_0)L_f - P_{in}(1-\alpha)I - w_p(1+t_0)\alpha I - FC \quad (5)$$

By replacing condition (3) in (5), the profit function, in terms of the labour factor L_f, is described as:

$$\pi = (1-t_1)PX(L_f) - w_f(1+t_0)L_f - P_{in}(1-\alpha)X(L_f) - w_p(1+t_0)\alpha X(L_f) - FC \quad (6)$$

In order to obtain the condition of maximisation, the profit function is derived with respect to the labour hired in farm production:

$$\frac{\partial \pi}{\partial L_f} = (1-t_1)P\frac{\partial X}{\partial L_f} - w_f(1+t_0) - P_{in}(1-\alpha)\frac{\partial X}{\partial L_f} - w_p(1+t_0)\alpha\frac{\partial X}{\partial L_f} = 0 \quad (7)$$

By rearranging equation (7), the condition of maximisation is summarised as:

$$\frac{\partial X}{\partial L_f} = \frac{w_f(1+t_0)}{[P(1-t_1) - (P_{in}(1-\alpha) + w_p(1+t_0)\alpha)]} \quad (8)$$

Thus, the allocation of farm labour depends on the following exogenous variables: wages levels within both farm and processing stages, the price of the agro-industrial output, the input price, wages tax, corporate income tax and technology. Furthermore, the model solution, the endogenous variables, consists of the farm output, agro-industrial output, labour demand for the farming and processing stage and input demand.

Taking into account equation (8), a summary of the comparative static analysis is presented in Table 5.5. A positive sign indicates that there is a positive or direct relationship between the exogenous variable and the endogenous variable. A negative sign corresponds to an indirect relationship between these variables. For instance, a fall in the corporate income tax increases the level of each endogenous variable, denoting a negative or indirect relationship.

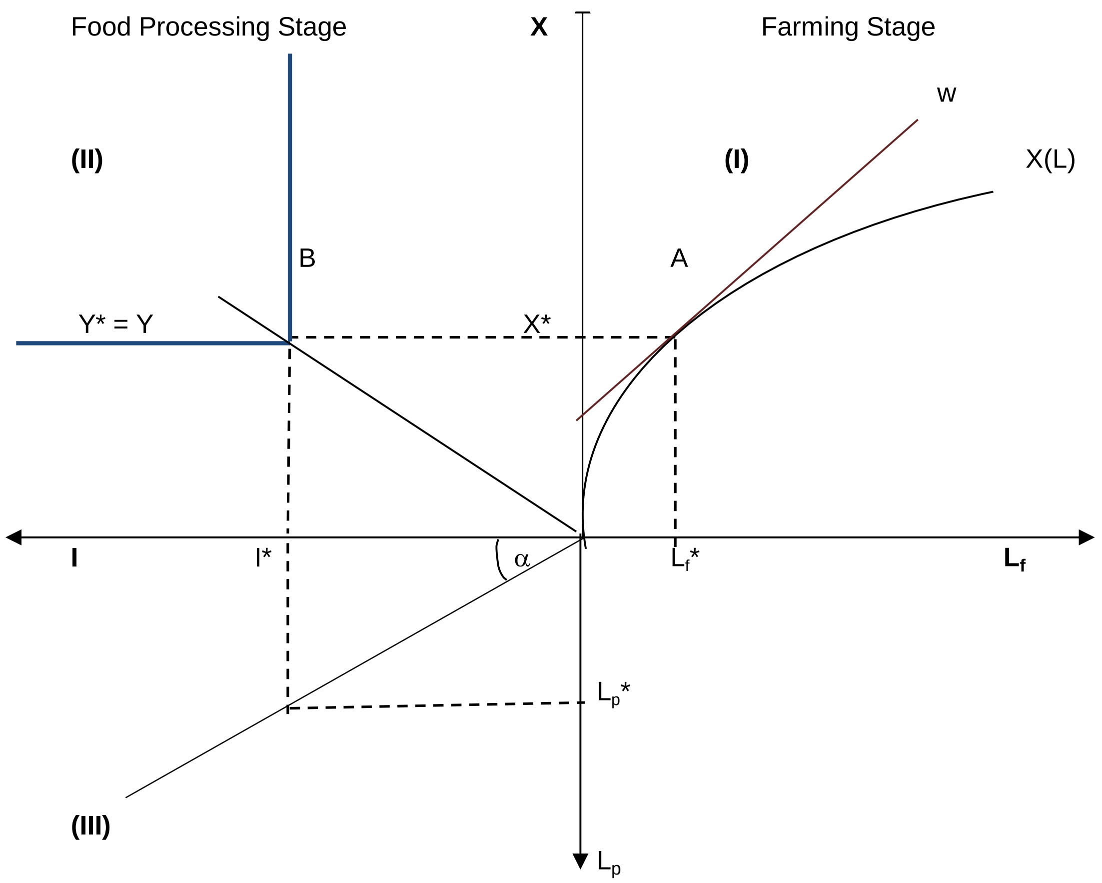
Table 5.5. Summary of effects of the comparative static analysis

Impact on (endogenous variables)	**Change on (exogenous variables)**				
	Corporate income tax (t_1)	Wage tax (t_0, Social Security)	Land size (T)	Final price (P)	Input price (P_{in})
X	(-)	(-)	(+)	(+)	(-)
L_f	(-)	(-)	(+)	(+)	(-)
Y	(-)	(-)	(+)	(+)	(-)
I	(-)	(-)	(+)	(+)	(-)
L_p	(-)	(-)	(+)	(+)	(-)

A graphic solution of the firm equilibrium is presented in Figure 5.1. Quadrant I represents the equilibrium in the farming stage. Given the initial levels of the exogenous variables, the slope of the line w represents the condition of maximisation of the equation (8). The production function $X(L_f)$ exhibits the presence of decreasing marginal returns of labour. The point of tangency of the line w at point A of the production function defines the optimum level of production of the agricultural good (X*) and the demand for labour (L_f*). The equilibrium of the processing stage is represented in quadrant II. Thus, the vertical axis represents the agricultural product (X) and the horizontal axis displays the composite input (I). Assuming a Leontief production function, it is determined that, given X* level of agrarian production, I* is defined as the demand of composite inputs that allows the optimal production of Y* units of the agro-industrial good. Once the demand for inputs I* is defined, the labour demand for the farm processing stage is determined in the third quadrant[36]. The line with α slope allows the labour demand associated with I* to be defined as L_p*.

[36] Within the components of the composite input, graphical interest is focused on the analysis of labour demand in the processing phase. By utilising equation (2), it is possible to discern the impact on the usage of other inputs (In).

Figure 5.1. Equilibrium at the agro-industrial complex



Source: Author´s elaboration.

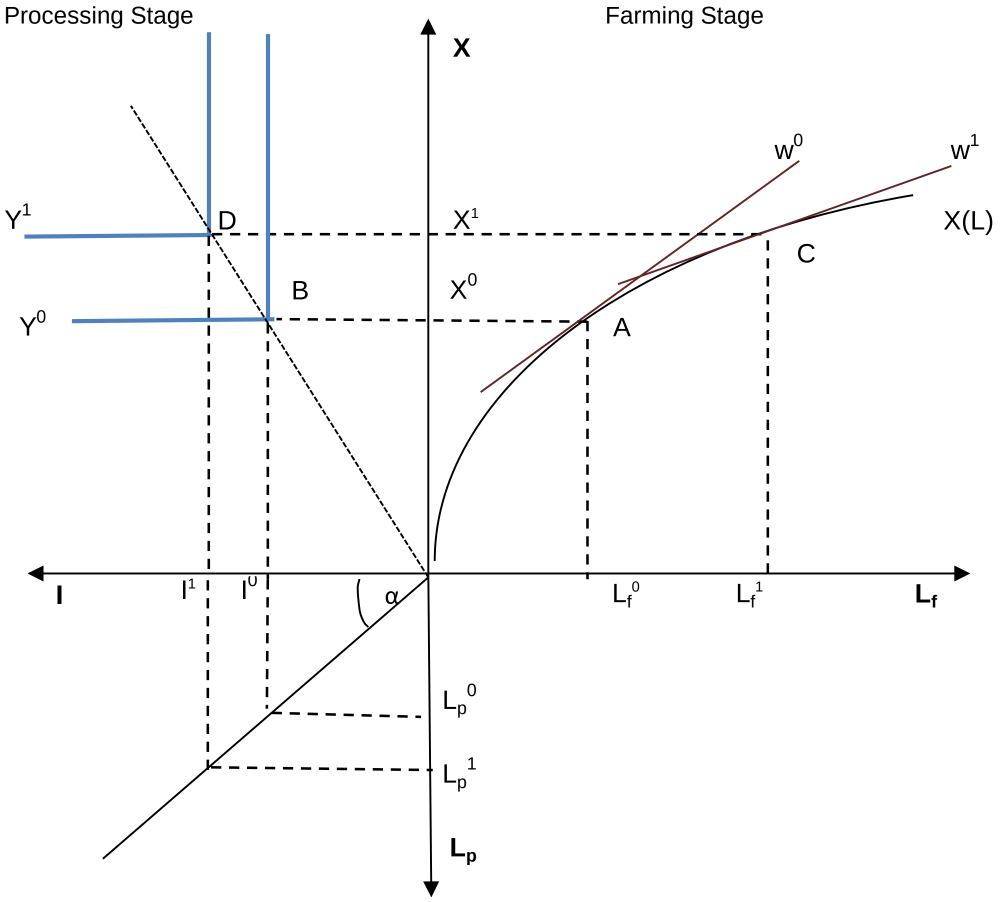
Table 5.3 summarises the main policies that have affected the national agricultural sector since the 1990s. The identification of the equilibrium discussed in the previous graph will allow a discussion of the expected impact of the policies implemented. There are two measures to analyse. First are those aimed at reducing production costs such as a flexible labour regime, the lower rate of social security (from 9% to 4%), the lower corporate income tax (from 30% to 15%), the elimination or reduction of tariffs on imports of inputs, as well as on the exports of final goods[37]. Secondly, it is interesting to discuss the expected effect of the investment policy in a large irrigation infrastructure in the Coast region. This latter measure translates into an expansion of the agricultural frontier and the security of access to water.

Figure 5.2 summarises the effect of the first type of measures. The initial situation is at point A, with line w^0, of the first quadrant and point B of the second quadrant. From

[37] Given that Y is a tradable good (exportable), trade and exchange policies can be considered in the following way: $P = eP^*(1-t_3)$, where e is the exchange rate, P* is the international price and t_3 is the export tariff. For instance, a tariff reduction due to a free trade agreement will cause an increase of domestic price, P.

these points, the equilibrium levels of the endogenous variables are obtained. The impact of the measures aimed at reducing production costs is captured by the lower slope of line w^1. This leads to a new point of tangency between the line w^1 and the production function at point C, defining higher levels of X and L_f. The expansion of X allows the firm to produce a greater quantity of Y, when passing to a higher isoquant curve, being $Y^1 > Y^0$. As a result, the labour demand for the processing stage increases. That is, these measures have led to an expansion of agro-export activity.

Figure 5.2. Agro-industrial complex: Effects of cost-reducing policies



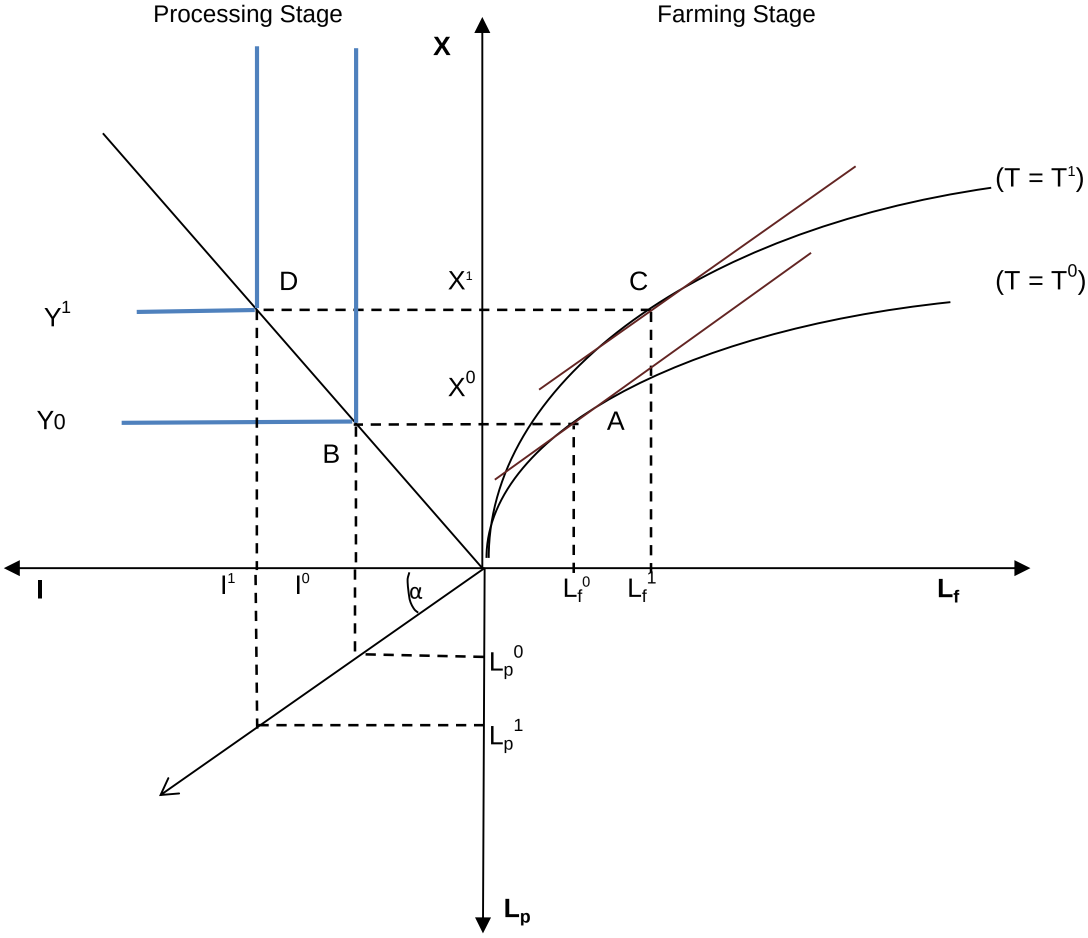
Source: Author´s elaboration.

The incorporation of thousands of hectares of the coastal desert to agricultural production has been accomplished through large irrigation works financed by the government. Following this tradition, initiated at the beginning of the 20th century, an important part of public investment in agriculture was used to expand the agricultural frontier for export. Bourliaud and Eresue (2015) identify 30 of the agribusinesses oriented to agro-exports in the Coast region that have more than 2,500 hectares and control

364,783 hectares. The agrarian groups have an average land size of 12,159 hectares. Overall, they represent 21.6% of the agricultural land of the region. Figure 5.3 shows the effect of this measure that affects, at first, the exogenous conditions of the farming stage, having assumed as a given the land size at T^0. Irrigation extends the agrarian frontier to T^1 and, assuming that the other exogenous variables remain constant, the initial equilibrium associated with points A and B goes to another scenario corresponding to points C and D. That is, the increase in the land size has led to an increase in agricultural production, in the labour demand in the farming stage, in the production of the agro-industrial good, in the demand for inputs and in the labour demand for processing farming.

If the simultaneous occurrence of the measures discussed in the two previous figures are taken into account, it can be concluded, from the analysis of comparative statics, that the measures aimed at promoting the non-traditional agro-export sector are positively reinforcing each other and have contributed to the expansion of the sector, reflected in the increase in production, labour demand and inputs.

Figure 5.3. Agro-industrial complex: Effects of agricultural frontier expansion



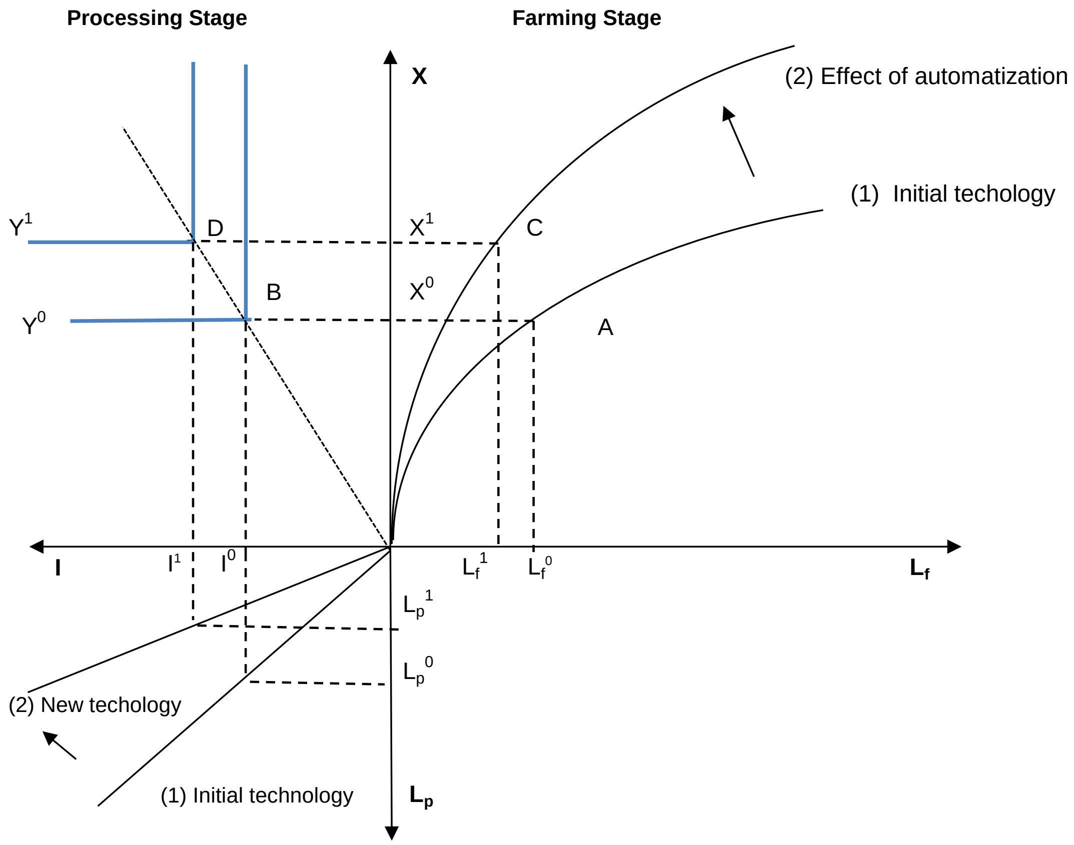
Source: Author´s elaboration.

Further discussion on current relevant issues.

The discussion presented so far has focused on the impact of public policies on the performance of the new agro-export model. However, there are a couple of issues that are gaining importance, such as the discussion of the effects of automation in productive processes and the impact of adverse climatic conditions associated with climate change. The discussion of these topics will be carried out solely based on the theoretical model developed, as there is still not enough information to provide robust empirical evidence.

Regarding the expected impact of the incorporation of automation in field and factory processes, Figure 5.4 shows how the initial conditions associated with point A in the farming stage and point B in the processing stage would change to a situation in which the agricultural production function shifts upwards, assuming labour-saving technology, reaching point C, with lower labour demand in the field and higher production of the agricultural good. Simultaneously, the incorporation of automation processes in the factory part implies a new relationship between composite inputs and labour, creating a reduction in demand, shifting from L_p^0 to L_p^1. What are the immediate implications for the labour markets associated with the agro-industry? Assuming it is a labour-intensive industry and operates as a source of income for rural and peri-urban households, this new scenario would result in increased rural unemployment and a decline in household incomes.

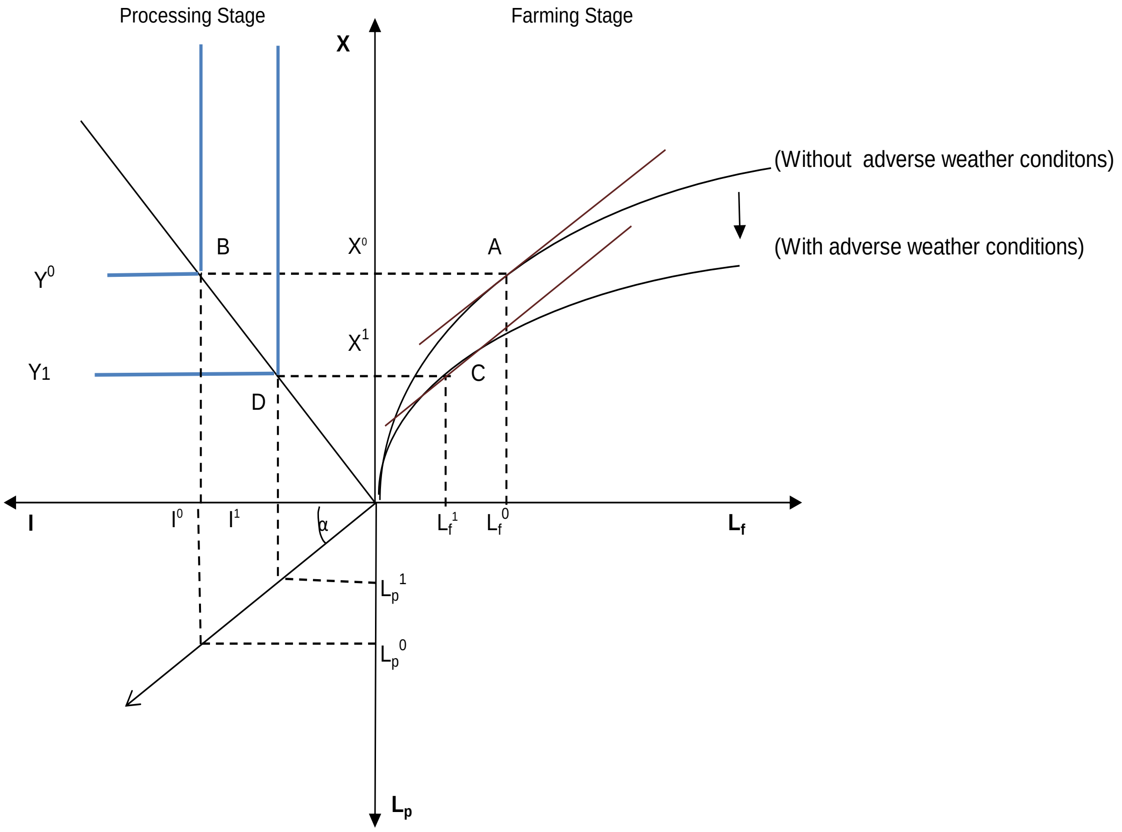
Figure 5.4. Effect of labour-saving technology in farming and processing stages



Source: Author´s elaboration.

Finally, the discussion of the potential effect of climate change on the agricultural sector would lead, as shown in Figure 5.5, to a decline in the production function, moving from point A to C, generating a lower level of agricultural production, demand for labour in both sectors, as well as composite input and processed goods (moving from Y^o to Y^1). It is expected that companies will adopt appropriate mitigation and prevention measures to minimize the effects of adverse climatic scenarios such as increased temperatures, excessive rainfall, or droughts.

Figure 5.5. Effect of adverse weather conditions associated to climate change



Source: Author´s elaboration.

5.4.2 Empirical evidence

In this section, empirical evidence is presented that confirms the predictions of the theoretical model. To achieve this, the following points will be developed: export trends and diversification and labour demand.

5.4.2.1 Export trends and diversification

The model developed has shown that the expected effects of the policy measures implemented since the mid-1990s would have increased production for agro-export and the demand for labour. Table 5.6 shows the evolution of the value of agricultural exports by five-year periods, from 1980 to 2015. Traditional export agriculture corresponds mainly to coffee, sugar and cotton. These products show an erratic trend until 2005, when a period of expansion begins. As expected, non-traditional exports show sustainable growth at very high rates. The share of these exports in the total has been increasing, from 25% in the early 1980s to about 78% for the period 2011-2015.

Table 5.6. Evolution of agricultural exports according to traditional and non-traditional products, 1980–2015 (in thousand USD, FOB)

	Total agricultural exports		Traditional agricultural exports		Non-traditional agricultural exports		Share of non-traditional exports (%)
Year	USD	Rate of growth (%)	USD	Rate of growth (%)	USD	Rate of growth (%)	
1980-1985	283.0		211.8		71.3		25.2
1986-1990	319.3	12.8	221.3	4.5	98.0	37.6	30.7
1991-1995	398.8	24.9	197.9	-10.6	200.9	104.9	50.4
1996-2000	677.5	69.9	324.5	64.0	353.0	75.7	52.1
2001-2005	944.5	39.4	260.8	-19.6	683.7	93.7	72.4
2006-2010	2400.9	154.2	665.9	155.3	1735.0	153.8	72.3
2011-2015	4628.6	92.8	1028.0	54.4	3600.5	107.5	77.8

Source: Author´s calculation based on statistics from the Central Reserve Bank of Peru, available at www.bcrp.gob.pe

Complementing the above, Table 5.7 shows the evolution of the main agricultural export products for the periods 1991-1993, 2001-2003 and 2011-2013. Coffee beans and products are by far the main export product, to which new coffee varieties are added as well as organic coffee. Additionally, the appearance of an increasing number of specialties, destined to specific market niches, is noted. As Maletta (2018) says:

> "Peru's farm-related exports comprised more than a hundred Custom Code second-order groups (*sub-partidas*), each comprising in turn several individual or grouped crops, many varieties of the crops, many processed products for each variety, and numerous specific product presentations. Only organic products (…) covered 24 crops or crop groups, each covering several species and many varieties of those species, exported in several specific processed forms, and various presentations." (Op. cit.: 2018:55)

Table 5.7. Major agricultural exports, 1991-1993 to 2011-2013

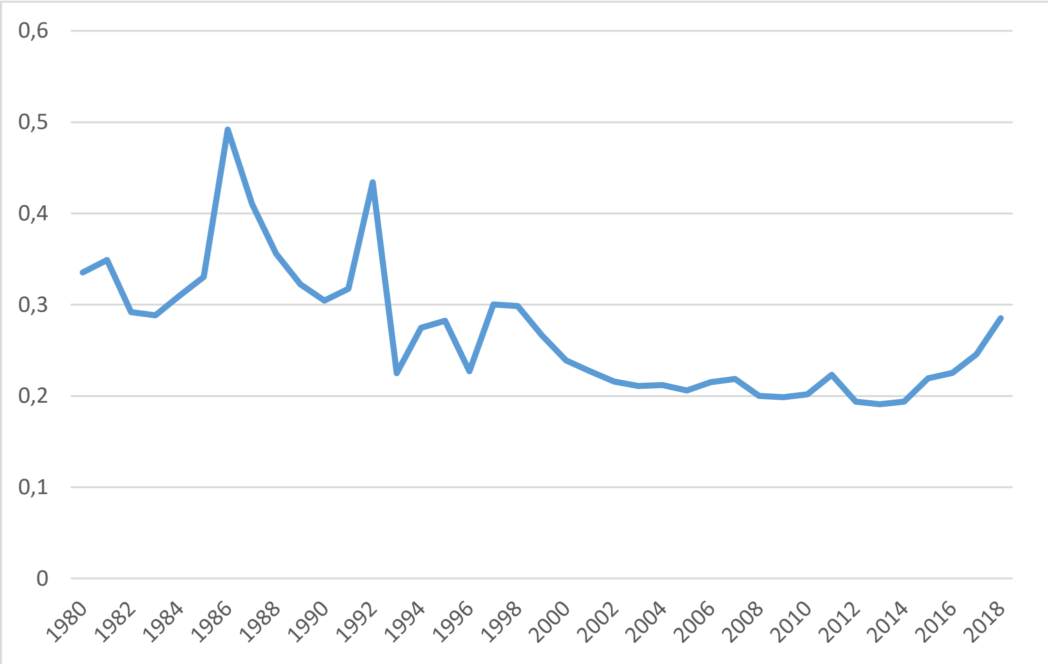
	Exports (in thousand USD, FOB)		
	1991-1993	2001-2003	2011-2013
Coffee beans and products	80,249	183,337	1,101,811
Vegetables, preserved	60,774	136,554	496,017
Grapes, fresh	517	19,005	372,029
Asparagus	10,920	85,842	348,619
Avocados	78	8,042	161,875
Cocoa beans and products	12,098	17,702	126,901
Mango	4,920	30,408	122,784
Chillies and peppers, dry	68	19,290	111,817
Citrus, fresh or processed	2,096	7,184	90,850
Plantains and bananas	62	5,293	81,743
Onions, dry	37	12,162	53,409
Tobacco, unmanufactured	101	508	8,199
Ginger	1	6	5,468

Source: Maletta (2018:56) using FAOSTAT data.

The Herfindahl-Hirschman (HH) product concentration index was estimated for the period 1980-2018[38]. This indicator is a measure of the dispersion of agricultural trade value across a set of products. The considered products include cotton, sugar, coffee, vegetables, fruit, cereals, tea, cacao and pulses. A country with a trade value concentrated in very few products will have an index value close to 1. Measured over time, a fall in the index is a sign of diversification in the exporter's trade profile. Figure 5.6 shows the evolution of the HH index for agricultural exports. While exports are composed of traditional exports – sugar, coffee and cotton – the index exhibits its highest values. That is, agricultural exports were less diversified. This situation changed in the 1990s, when non-traditional exports started to be promoted and new products began to have a greater share in the export basket, which has been expanding and diversifying ever since.

[38] According to the OECD/WTO (2019:279): "The HH export product concentration index is calculated as the sum of squared product shares in a country's exports and then normalised to lie between zero and one. HH export concentration indices with scores close to zero indicate a diversified, i.e. equally distributed, product portfolio and scores close to one indicate high concentration on a few products".

Figure 5.6. The evolution of the Herfindhal-Hirschman product concentration index for agricultural exports, 1980-2018



Source: Author´s calculation based on statistics from the Central Reserve Bank of Peru, Available at www.bcrp.gob.pe

The expansion of agricultural frontiers thanks to irrigation in coastal areas has created the opportunity for the stronger growth of exportable production and employment. However, this brings with it environmental problems and doubts about the sustainability of agricultural activity, as in the case of the exhaustion of groundwater in Ica, a situation which may threaten the availability of water for human consumption (RedGE, 2012; Damonte and Boelens, 2019).

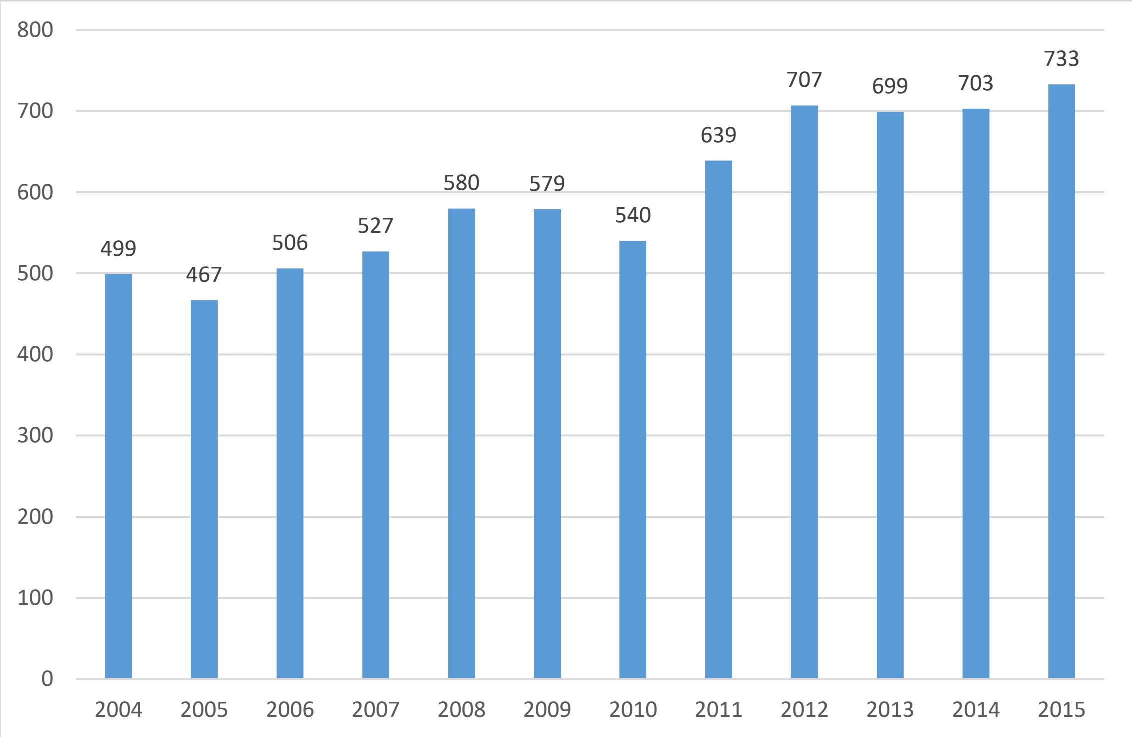
5.4.2.2 Labour demand

The positive impact of the measures in favour of agro-industry, which began in the 1990s, is evident in the levels of exports achieved and in the registered employment[39] in the producing regions. Chacaltana (2010) concludes that the novelty of the recent experience of economic expansion, and its correlation in employment, is that it is not concentrated in Lima, but has been produced in a significant way in those regions related to non-traditional export agriculture and labour-intensive agriculture, as in Ica and La Libertad.

[39] Registered employment is the total employment that private companies declare before the Ministry of Labour when they send their payroll annually.

Figure 5.7 exhibits the evolution of the formal employment in agriculture during the period 2004-2015. In line with the model predictions, an increasing labour demand is confirmed, growing at an annual rate of 3.6%.

Figure 5.7. Evolution of formal employment in agricultural activity, 2004-2015 (in thousands)

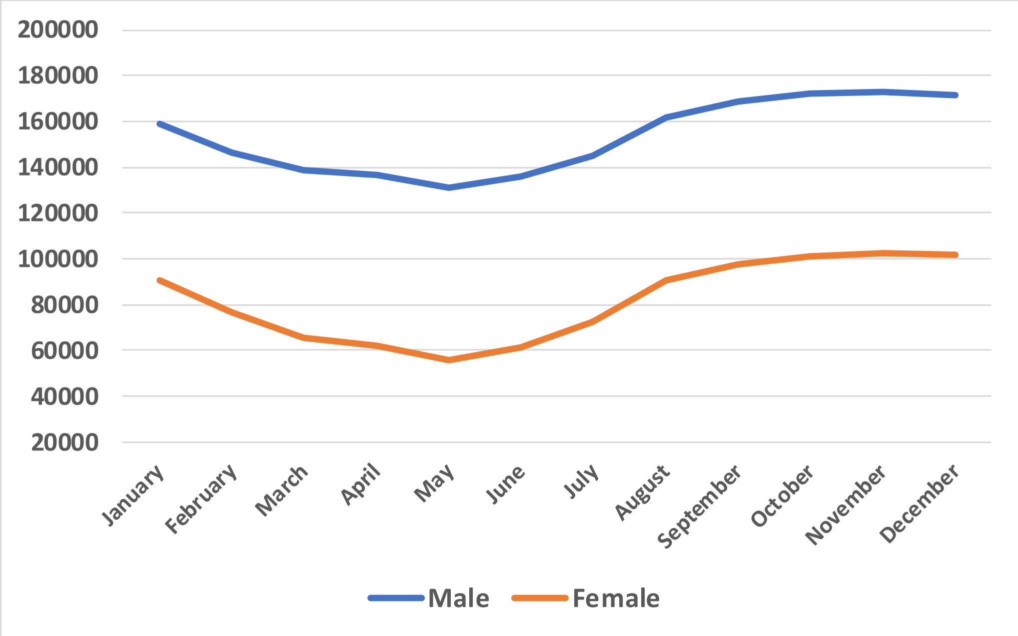


Source: Instituto Crecer (2017:19). Estimations based on ENAHO, various years.
Workers are defined as formal if they have a job contract.

Kay (1994) identifies four major changes in the composition of the agricultural labour force in Latin America: "a) the replacement of tenant labour by wage labour; b) within wage labour, the growth of temporary and seasonal labour; c) the increasing feminization of the agricultural labour force, and d) the 'urbanization' of rural workers" (Kay, 1994, p.12). The Peruvian case confirms these trends. Comparative information from the III and IV Farm Census show an increase in the participation of women in paid work, from 21.4% in 1994 to 27.1% in 2012 (Velazco and Velazco, 2012).

In Figure 5.8, the monthly distribution of workers by gender for the year 2015 is shown. It is found that in January, 36% of the total workers are women; this participation increases to 45% in June and to 59.4% in December. The information confirms the existence of a seasonal demand for labour throughout the year, with a downward trend from January to May and then an increase until the end of the year. Another noteworthy fact, as previously mentioned by Kay (1994), is the significant presence of women in the agro-industry.

Figure 5.8. Peru: Registered jobs in the private sector formed by the agrarian regime (Law 27360) by sex of workers, January 2015 - December 2015



Source: Author elaboration based on data provided by MTPE-DGPE-Dirección de Investigación Socio Económico Laboral (DISEL). MTPE-OGETIC-Oficina de Estadística-Planilla Electrónica (Plame y T-registro).

However, the expansion of employment in the modern sector of Latin American agriculture has not been accompanied by the generation of decent work, creating the conditions for an unequal distribution of income and the results of economic expansion. In a study, Soto and Klein (2012) document the employment status of temporary workers linked to the production of tobacco and lemons in Argentina, grapes and mangoes in Brazil and fruit in Chile.

In the agricultural labour market, León (2009) conducts a case study of employment in the modern sector of Peruvian agriculture. The study finds that the behaviour and dynamism in the generation of employment in the agroindustry has not been accompanied by a growth in wages and working conditions. The author highlights the effects differentiated by gender. The sector massively hired women in both the field and factory phases, and their health and integrity workers were compromised by the difficult working conditions. In the same line of research, Valcárcel (2009) argues that the presence of women in agricultural wage work is explained by the demand for them in agro-industrial companies due to their ability to treat products in fresh conditions. Ferm (2008) analyses the situation of female workers in the asparagus industry and discusses contracts and hours of work, wages, health and safety issues, maternity and unionisation.

The author concludes that labour reform, while reducing costs and increasing flexibility for employers, has worsened working conditions and wages (Velazco and Velazco, 2012).

5.5. Identifying changes in family farming: Theory and evidence

This section comprises two parts. The first part elaborates on the theoretical model, while the second part provides empirical evidence regarding the model's predictions.

5.5.1 Model

This section examines the determinants of farm and non-farm incomes from family farming. A simple household model shows how access to assets, prices, wages and non-labour income (transfers) explains the composition of income. The literature on household-farm modelling (e.g., Barnum and Squire, 1979; Singh, Squire and Strauss, 1986) is concerned with the effect of agricultural price policies on the marketed surplus of food production. These models consider the dual character of farm households: producers and consumers participating in markets with inputs and outputs. For the sake of simplicity, a simple model considering the household as only a unit of production will be developed[40]. The model explicitly explains how access to assets (public and private), fluctuations in farm prices, wages and public transfers shape the household income composition.

The model considers an income-maximising producer where households are price takers. Asset ownership by the rural poor is increasingly recognised as being essential to sustained and broad-based economic growth. Assets are related to activities as part of the income-generating strategies of the households. With respect to the definition of assets, it is important to point out that:

> "Assets are stocks of directly or indirectly productive factors that produce a stream of cash or in-kind returns. (…) Portfolio theory, on which much of the diversification literature depends, emphasizes assets as the subject of agent choice when trying to maximize expected income, minimize income variability, or some combination of the two. So assets are a logical subject of the study of diversification behaviour. Indeed, asset and income distributions are analytically inextricable from one another." (Barrett and Reardon, 2000:10).

[40] A more detailed discussion of the model and its empirical application to rural households in the Peruvian Sierra can be found in Velazco (2003).

The possibility of transforming assets into income depends on the access opportunities faced by each household. Social relations and the availability of public assets mediate those options. The appropriate way to deal with asset formation and accumulation requires the use of dynamic household models, where saving and investment decisions[41] are explicitly developed in an intertemporal framework. This approach is beyond the scope of this chapter.

In an analysis of poverty in Latin America, Attanasio and Székely (1999) proposed a simple framework for the study of the relationship between assets and poverty, and discussed the restrictions that the poor face on accumulating income-earning assets. For the Peruvian case, the authors confirm that assets play a crucial role in the probability of exiting poverty. A much better distribution of assets is associated with higher social mobility and better prospects for wider sectors of the population.

A broad classification of assets provided by Siegel and Alwang (1999) includes the following types: natural, human, physical, financial, social, location and infrastructure, and political and institutional.

It is assumed that assets are employed in farm and non-farm activities. Furthermore, assets are classified according to ownership or access, that is, assets may be held privately by individuals[42] or collectively, as public goods, without restriction on access. Government expenditure is assumed to have a greater role as the provider of the latter assets. A particular case is the extreme situation where no government expenditure has been allocated to create public assets in poor rural areas. In this context, the creation of public assets is expected to have a "pull effect", enhancing both farm and non-farm economic activities in terms of self-employment and wage employment. Furthermore, improvements in or access to water, sanitation, education, health and roads are expected to increase the quality of human assets, which, therefore, increase household labour productivity. It is important to note that human assets create a multiplier effect on labour productivity. In particular, location and infrastructure assets are included in this respect (Velazco, 2003).

[41] A literature review about the role of household consumption and savings in economic development is provided by Deaton (1997).

[42] Community level assets can also be part of household private assets. For a further development see Siegel and Alwang (1999).

Assets related to farm activity have a household component given by fixed factors and exogenous farm-specific characteristics, A_2, and a public component, such as infrastructure and the provision of public services (including marketplace, information systems, storage facilities and roads), A_p. The same classification is assumed for the non-farm activity, A_3, with the household-specific category also including fixed factors and exogenous non-farm specific characteristics, and a public component for infrastructure and public services, A_p.

It is also assumed that the amount of public assets in the short run can be increased by government expenditure, which is a decision external to the household model. Interactions may be generated between access to household assets and public assets. For instance, improvements in health and education services are expected to enhance health, nutrition, education and skills of household members. To simplify the analysis, these interactions are not modelled but it is assumed that access to public assets, by improving the current quality of human assets, can generate a positive impact on labour productivity.

Considering public assets is consistent with the growing number of empirical studies in rural Latin American and other regions that conclude that access to public services is a key determinant of rural household incomes (Ellis, 2000; Reardon et al., 2001; Escobal, 2001; Velazco, 2003; Escobal and Ponce, 2011). Furthermore, evidence is currently available to support the hypothesis that government investment has an important role in promoting farm and non-farm activities (Webb, 2013; Fort and Paredes, 2015).

In a typical rural household, members must undertake optimal decisions on production. The model captures the situation of a household engaged in farm activity (crop and livestock production), non-farm micro enterprise (e.g., producing crafts, rural tourism) and labour migration. The production process is assumed to be risk free. The factors used in farm production are land and labour. In the case of non-farm output, the factor required is labour. Farm output is either consumed on farm or sold in markets. Non-farm output is sold only in markets. The household has endowments of time, farm and non-farm assets.

The household is a price taker in all markets and faces no transaction costs there. It is constrained by its resource endowments, existing production technologies and the exogenous market price. The household maximises its income function with respect to production constraints. The solution to this maximisation problem gives the labour allocation among the different productive activities. The corresponding production levels are subsequently defined. As result, monetary income is generated. What is interesting at this level of analysis is the study of the income composition between farm and non-farm sources, which can be considered an outcome of this theoretical exercise. Thus, once the different monetary income sources are identified, it will be possible to know the determinant of total household income.

It is assumed that the household allocates total available labour, L, across farm work (l_a), non-farm work (l_z) and wage work (l_w):

$$L = l_a + l_z + l_w \tag{9}$$

Non-negativity constraints are imposed on farm, non-farm and market work:

$l_a \geq 0$, $l_z \geq 0$ and $l_w \geq 0$,

Farm output (Q_a) is produced by a vector of household members' farm labour (l_a), including hired labourers, who are perfect substitutes, and a set of exogenous variables that affect the efficiency of farm production (A_2). Among these exogenous variables are fixed factors, such as land and the stock of cattle, and farm-specific characteristics, such as the farmer's education, agricultural research and extension. Additionally, access to infrastructure and public services is considered (A_p).

$$Q_a = Q_a(l_a; A_2, A_p) \tag{10}$$

$$\partial Q_a / \partial l_a > 0$$

Non-farm output (Q_z) requires labour, which is supplied exclusively by household members (l_z), and a set of exogenous variables, such as fixed factors, non-farm specific characteristics (A_3), infrastructure and public services (A_p). Non-farm production technology is represented by the following production function:

$$Q_z = Q_Z(l_z; A_3, A_p) \tag{11}$$

$$\partial Q_z / \partial l_z > 0$$

It is assumed that both production functions are continuous, quasi-convex, non-decreasing in labour quantities.

P_a and P_z are the farm and non-farm price, respectively. The household total income (TI) can be expressed as:

$$TI = P_a Q_a + P_z Q_z + w l_w + \mathrm{R} \tag{12}$$

This consists of farm income, P_aQ_a, non-farm income, P_zQ_z, wage income, wl_w and non-labour income such as transfers or remittances (R). The former optimisation problem involves maximising incomes subject to the time and non-negativity constraints. The optimal solution is characterised by the Kuhn-Tucker conditions, which are the first order condition for maximising the Lagrange function:

$$\ell = P_aQ_a + P_zQ_z + wl_w + R + \lambda[L - l_a - l_z - l_w] \tag{13}$$

By placing equations (10) and (11) into (13), the following expression of the maximisation problem in terms of labour allocation variables is obtained:

$$\ell = P_aQ_a(l_a;A_2,A_p) + P_zQ_z(l_z;A_3,A_p) + wl_w + R + \lambda[L - l_a - l_z - l_w] \tag{14}$$

The farm work, non-farm work and wage work conditions are, respectively, a subset of Kuhn-Tucker conditions:

$$\frac{\partial \ell}{\partial l_a} = P_a \frac{\partial Q_a}{\partial l_a} \le \lambda \tag{15}$$

$$\frac{\partial \ell}{\partial l_z} = P_z \frac{\partial Q_z}{\partial l_z} \le \lambda \tag{16}$$

$$\frac{\partial \ell}{\partial l_w} = w \le \lambda$$

An internal solution takes place when the equality holds. Therefore,

$$P_a \frac{\partial Q_a}{\partial l_a} = P_z \frac{\partial Q_z}{\partial l_z} = w \tag{17}$$

Equation (17) implies that if an internal solution occurs for all choices, the value of labour productivity for both farm and non-farm work is equal to the market wage. The reduced-form solution for the total income equation has the form:

$$\begin{aligned} TI = {} & P_aQ_a(P_a, w; A_2, A_p) + P_zQ_z(P_z, w; A_3, A_p) \\ & + wl_w(P_a, P_z, w; A_2, A_3, A_p) + R \end{aligned} \tag{18}$$

In general, it can be concluded that, in the context of rural households, the total income composition of farm, non-farm, wage incomes and non-labour income depends on output prices and wages. It is also dependent on the access to a set of assets, broadly classified as farm assets, non-farm assets and public assets. Those assets may be natural, human, physical, financial, social, location and infrastructure and political and institutional. The next section discusses the effects on income composition of changes in farm assets, A_2, non-farm assets, A_3, public assets, A_p, wages, w, farm price, Pa, and transfers, R.

5.5.1.1 Change in farm household ownership assets

Equation (19) shows the total differentiation with respect to total income when there is an increase in farm assets. The following effects are discussed:

$$\frac{dTI}{dA_2} = P_a \frac{\partial Q_a}{\partial A_2} + w\left[\frac{\partial l_w}{\partial A_2}\right] \tag{19}$$

A positive impact on farm output, $\frac{\partial Q_a}{\partial A_2} > 0$, is assumed. Given fixed prices, farm income increases, so that the first term on the right-hand side is positive. An increase in farm output requires more labour, which may imply a re-allocation of labour from other activities. In order to cope with higher farm labour demand, the wage labour supply may be reduced and a fall in wage income occurs. However, since family labour and hired labour are perfect substitutes in farm activity, an increase in hired labour demand can fill the additional farm labour demand. Thus, the second term of the expression in brackets on the right-hand side has an undefined sign. It is important to bear in mind that the level of non-farm output remains unchanged since an expansion in farm related assets (A_2) has no effect on non-farm production.

5.5.1.2 Changes in non-farm household ownership assets

To analyse the impact of changes in non-farm assets on total household income, equation (20) shows the total differentiation expression:

$$\frac{dTI}{dA_3} = P_z \frac{\partial Q_z}{\partial A_3} + w\left[\frac{\partial l_w}{\partial A_3}\right] \tag{20}$$

An increase in the level of assets related to non-farm activities, such as equipment, tools, skills and experience in the activity, is associated with an increase in non-farm production, which may exclusively require a higher proportion of family labour. Apparently, there is a fall effect on wage labour. A new labour allocation may take place since more labour is employed in non-farm activities and the level of farm activities remains the same. This means that the second term of the expression in brackets on the right-hand side of equation (20) is negative. Thus, an expansion in non-farm assets will reduce wage labour.

5.5.1.3 Changes in public assets

The absence of government expenditure, $A_p = 0$, denotes that the level of production is represented as $Q_a = Q_a(l_a; A_2)$ and $Q_z = Q_z(l_z,; A_3)$ for farm output and non-farm output, respectively. Thus, the creation of public assets implies a positive impact on both farm and non-farm outputs. Consider, for example, the situation of low-income households located in a backward region where the initial condition is characterised by an absence or limited presence of public assets. Suppose that government expenditure is increased, for example, to improve roads, telephone service, electricity, drinking water, or job training.

Equation (21) decomposes the effect of changes in public assets on total income. For instance, assuming either an increase in the amount available of public assets or the creation of public assets, *ceteris paribus*, a "pull" effect can be considered: it is characterised by the enhancement of both farm and non-farm activities by the provision of public goods.

$$\frac{dTI}{dA_p} = P_a \frac{\partial Q_a}{\partial A_p} + P_z \frac{\partial Q_z}{\partial A_p} + w\left[\frac{\partial l_w}{\partial A_p}\right] \qquad (21)$$

As a result of the "pull" effect, all sources of income will increase, since farm and non-farm outputs increase and more labour are allocated to wage labour. Given that the total amount of family labour is fixed, the increment in farm and non-farm production could imply an increase in labour demand. However, the final impact is ambiguous since the provision of public assets could generate a multiplier effect on labour productivity in both sectors. For instance, increasing access to education, job-training programmes and schooling may improve the quality of labour, making workers more efficient in their performance of routine tasks and, in general, farm and non-farm management. Furthermore, as it was assumed, household and hired labour are perfect substitutes, and the additional labour requirement can be satisfied by using this type of labour for farm activity. In general, if the "pull" effect is strong enough, an increase in total income is expected.

It is important to bear in mind that the household model does not address a key issue: the possible interactions between activities via profitability. For instance, it remains unclear to what extent the creation or provision of public assets can affect the profitability of farm and non-farm and wage labour activities. For example, the provision of a highway and greater connectivity between small towns and intermediate or large cities can expand the options for finding better-paid wage employment. As a result of increased access to assets, households may be motivated to change their pattern of labour and, consequently, their income composition may change.

5.5.1.4 Changes in food prices

Equation (22) shows the total differentiation with respect to total income when there is an increase in food price. The following effects are discussed:

$$\frac{dTI}{dP_a} = Q_a(1+\varepsilon^s_{p_a}) + P_z\frac{\partial Q_z}{\partial P_a} + w\frac{\partial l_w}{\partial P_a} \qquad (22)$$

where $\varepsilon^s_{p_a}$ is the supply elasticity of farm output, $\varepsilon^s_{p_a} > 0$

The first component on the right side indicates the positive impact of an increase in the prices of agricultural goods on production. If there is a greater demand for agricultural work and a perfect substitution with hired labour, it can be expected that labour allocation will not be altered in non-farm activity (Qz) and wage labour (l_z). If that were not the case, falls in income from these activities could be expected.

5.5.1.5 Changes in wages

To analyse the impact of changes in wage on total household income, equation (23) shows the total differentiation expression:

$$\frac{dTI}{dw} = P_a\frac{\partial Q_a}{\partial w} + P_z\frac{\partial Q_z}{\partial w} + w\frac{\partial l_w}{\partial w} \qquad (23)$$

The case of an increase in wages is analysed, due, for example, for an economic expansion that increases labour demand in non-agricultural sectors. This leads to an increase in the third component on the right side. That is, rural households would allocate more labour to salaried activities. This would cause a reduction in the labour available for the other activities, affecting the income that might be generated.

5.5.1.6 Change in transfers

Given that non-labour income is not affecting labour decisions on farm, non-farm and wage work, an increase in R as a result, for instance, of receiving remittances, public transfers such as pensions or any cash transfer such as social programme benefits will directly increase the level of household income.

$$\frac{dTI}{dR} = \frac{\partial IT}{\partial R} \tag{24}$$

5.5.1.7 Summary of the comparative static analysis

In Table 5.8, the effects discussed in this section are summarized. The aim is to identify how changes in exogenous variables may impact the various sources of income in the model, namely farm income, non-farm income, wage income, and non-labour income. As can be observed, there is unanimity regarding the impact of increases in public assets and transfers on total incomes, while ambiguity exists in other cases. This ambiguity arises from the effects on labor allocation decisions that directly alter the several income sources, rendering the final effect indeterminate.

Table 5.8. Summary of effects

Impacts on	**Changes on**					
	Farm assets	Non-farm assets	Public assets	Food price	Wage	Transfers
Farm income	(+)	(0)	(+)	(+)	(?)	(0)
Non-farm income	(0)	(+)	(+)	(?)	(?)	(0)
Wage income	(?)	(?)	(+)	(?)	(+)	(0)
Non-labour income	(0)	(0)	(0)	(0)	(0)	(+)
Total income	(?)	(?)	(+)	(?)	(?)	(+)

5.5.2 Empirical evidence

In this section, empirical evidence will be presented regarding public rural investment, changes in farm household ownerships assets, importance of on-farm and off-farm activities, trends in terms of trade and welfare indicators.

5.5.2.1 Public rural investment: Change in public assets

Within the household model developed, the provision of public goods, (Ap), was crucial for the expansion of farm and non-farm activities and household income. To illustrate the role played by public investment, Figure 5.9 shows the trend of public investment in rural areas for the period 2002-2012. There is a remarkable growth in rural public investment. The amount of investment for 2012 is eight times that of 2002. This fact is a novelty in the Peruvian investment policy aimed at the rural sector. Since the beginning of the 20th century, it has been policy that the bulk of public investment in agriculture is directed towards irrigation works in the Coast region, leaving a smaller budget for infrastructure works in the traditional rural sector of the Sierra and Amazon regions (Portocarrero et al, 1988).

How can this change in public investment policy be explained? Two possible, mutually reinforcing reasons could be hypothesised. The first is the existence of important fiscal revenues caused by the mining boom and the subsequent economic expansion in Peru since the beginning of the 2000s. The second reason is related to the decision-making process on the allocation of public resources. In this regard, it is suggested that those responsible for the economic policy, the policy makers, chose to follow the guidelines of the National Agreement (*Acuerdo Nacional*) signed in 2002 between the political parties and civil society.[43] One of the development matrices considers investing in rural public infrastructure as a means to reduce poverty, integrate producers into the market and improve their competitiveness.[44]

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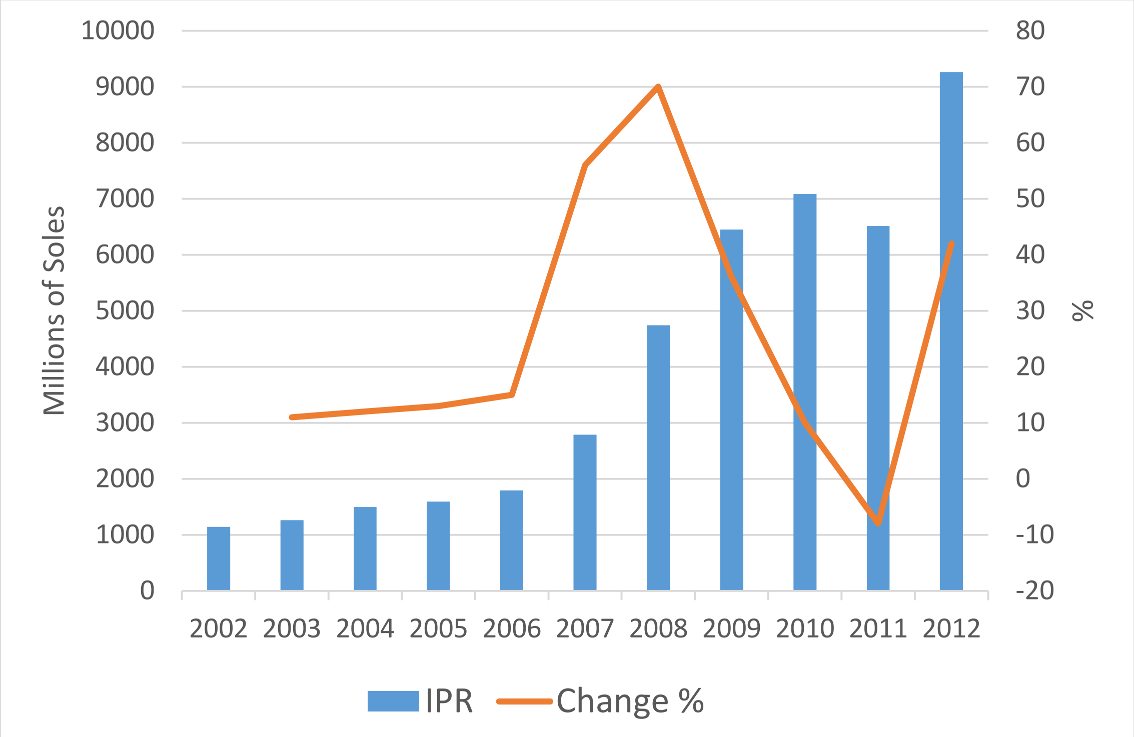
[43] The National Agreement is the set of state policies developed and approved on the basis of dialogue and consensus, after a process of workshops and consultations at the national level, in order to define a course for the sustainable development of the country and affirm its democratic governability. The signing of the National Agreement was carried out in a solemn ceremony at the Government Palace on July 22, 2002. (Source: www.acuerdonacional.pe).

[44]In relation to agricultural and rural development policies, the Agreement says: "We commit ourselves to promote the agrarian and rural development of the country, which includes agriculture, livestock, aquaculture, agro-industry and sustainable forestry exploitation, to promote the economic and social development of the sector. Within the subsidiary and regulatory role of the State, indicated in the Constitution, we will promote the profitability and the market expansion of agricultural activities, promoting its competitiveness with exporting vocation and seeking the social improvement of the rural population." (Source: www.acuerdonacional.pe).

Figure 5.9. Peru: Evolution of rural public investment, IPR, (in millions of soles and as percentage change), 2002-2012



Source: Fort and Paredes (2015:31)

Considering that this investment was not focused mainly on enhancing agricultural activities, direct and indirect effects on households' incomes and agricultural productivity could be expected. This investment consists of productive infrastructure (irrigation, roads, electrification, telecommunications, marketing infrastructure, water and sanitation), social infrastructure (education and health), direct producer support and social assistance (Fort, 2014). An evaluation of the impact of rural public investment from regional information for 2004-2012 was conducted by Fort (2014). The author finds improvements in agricultural productivity as a result of rural public investment in irrigation, roads, telecommunications and producer support. These outcomes also have had a significant effect on reducing rural poverty.

Meléndez and Huaroto (2014) analyse the complementarity of rural infrastructure projects such as the joint impact of investment in electrification and access to information technology and communication. The authors find that access to both infrastructure projects raises real annual household income, the rate of female employment and the effective rate of children's school attendance. Confirming the previous results, Webb (2013) reports two key findings from research carried out in 176 districts characterised by extreme poverty and high rurality. The first is the rapid growth of rural incomes since the 1990s. The second is related to the densification and improvement of the road network and other transport infrastructures, the growth of the vehicle fleet, the massification of cell phones and Internet access, and the reduction of dispersion due to migration from rural farms to rural villages, which now exceed the dynamism of cities. The increased accessibility has led to rapid market integration of rural producers. According to the author, these phenomena constitute a transformation of the rural economy in Peru.

5.5.2.2. Change in farm household ownership assets

This section presents some evidence of changes in farm household ownerships assets (A_2) mainly related to technological innovations. In order to identify any change in the adoption of farming technology, this section relies on the findings of Kim (2015). The author constructs a composite index, the technological level index (TLI), consisting of 23 variables relevant to agricultural production technology. The sources of information were the agrarian censuses of 1994 and 2012. Among these variables are different agricultural and livestock practices, use of energy and machinery, technified irrigation systems, access to credit and technical training or assistance. Table 5.9 shows the variables used in each category and the sub-indicators.

Table 5.9. The technological level index (TLI): Categories and sub-indicators

Agricultural practices index (API)	Use of chemical fertilizers
	Use of chemical insecticides
	Use of certified seeds and/or seedlings
	Use of herbicides
	Use of fungicides
Livestock practices index (LPI)	Use of vaccines for animals
	Farmer applies dosages
	Use of balanced food
	Use of artificial insemination
Technified irrigation index (TII)	Use of sprinkler irrigation
	Use of drip irrigation
	Use of exudation irrigation
Energy and machinery index (EMI)	Use of electric power
	Use of tractor
	Use of sprayer
	Use of gasoline/oil/electric pump for well
	Farmer owns truck/van
	Farmer owns cultivator
	Farmer owns food mixer
	Farmer owns mill for grains
	Farmer owns motor for pumping water
Technical training and information index (TTI)	Farmer received technical assistance/training
Credit index (CI)	Farmer received credit

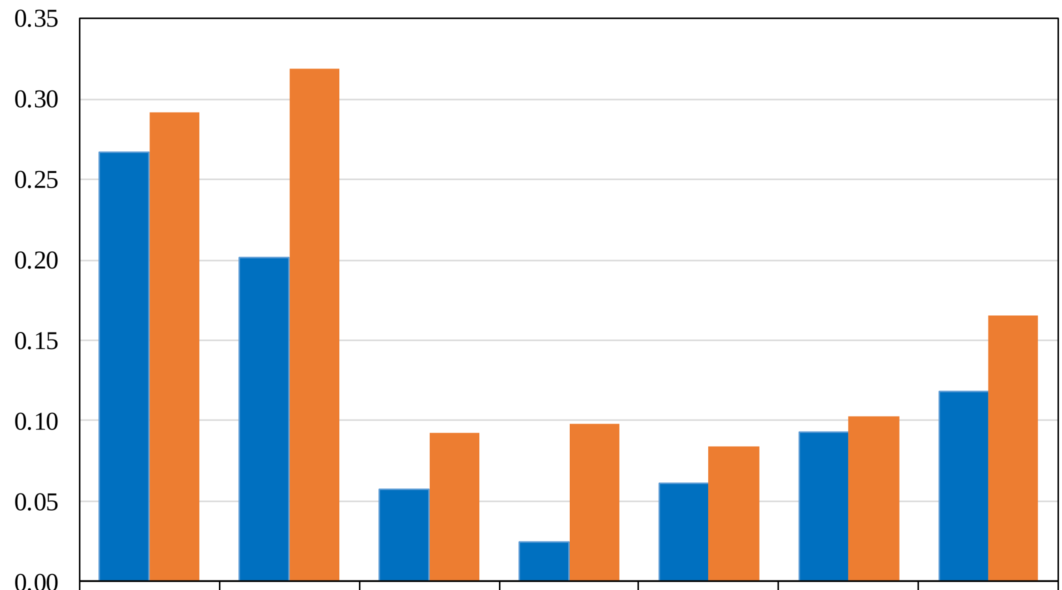
Source: Kim (2015:13)

The TLI is calculated using an arithmetic average of its subcomponents. The TLI corresponds to a number from 0 to 1, with 1 being the maximum technological level, in which all the agricultural units of a given territory (district, province or department) or group of producers use all the variables used to build the TLI. The higher the TLI, the greater the number of practices and techniques used by farmers in a given area, which implies a higher level of agricultural technology in the territory or group.

The national TLI and its sub-indicators for 1994 and 2012 are shown in Figure 5.10. It identifies an evolution in the inter-census period, increasing from 0.118 to 0.165, a growth rate of 39.8%. The indicator suggests, therefore, an increase in the adoption of technologies in agricultural production in Peru. The sub-indicators of TLI that show greater growth are the Energy and Machinery Index (EMI), the Livestock Practices Index (LPI) and the Technified Irrigation Index (TII). The sub-indicators with the least degree of dynamism are the Technical Training and Information Index (TTI) and the Agricultural

Practices Index (API). The advance of the use of technified irrigation was an important achievement in the inter-census period, denoting that the scarcity of water encouraged a more efficient use of this resource. The increased use of equipment and machinery also demonstrates a still incipient mechanisation trend for agricultural production in Peru (Kim, 2015).

Figure 5.10. The national technological level index (TLI) and sub-indicators (1994-2012)

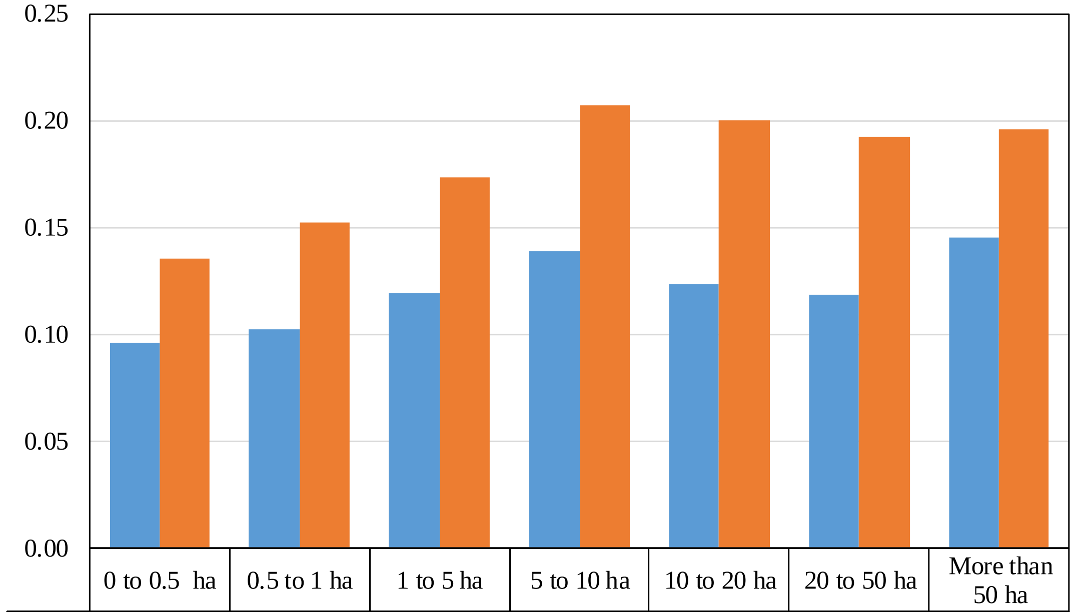


	API	LPI	EMI	TII	CI	TTI	TLI
1994	0.267	0.201	0.057	0.025	0.061	0.093	0.118
2012	0.292	0.319	0.092	0.098	0.084	0.103	0.165

Source: Kim (2015:28)

Figure 5.11 compares the evolution of the TLI according to the sizes of the agricultural units. It is found, in general, that the greater the extension of the agricultural unit, the greater the TLI. The inter-census comparison shows that the TLI has increased for all sizes analysed. The information in the index according to regions indicates that the Coast region has a TLI superior to that of the Sierra region and the Amazon region has the lowest value of the index. This situation is characteristic for the two census years and reflects the great challenge of closing technological innovation gaps. This indicates that the existence of regional heterogeneities at the technological level may explain the difference in productivities (total factor productivity) estimated by Fort (2017) for the period 2007-2015.

Figure 5.11. The national Technological Level Index (TLI) according to farm size (1994-2012)



	0 to 0.5 ha	0.5 to 1 ha	1 to 5 ha	5 to 10 ha	10 to 20 ha	20 to 50 ha	More than 50 ha
1994	0.096	0.102	0.119	0.139	0.123	0.118	0.145
2012	0.135	0.152	0.173	0.207	0.200	0.192	0.196

Source: Kim (2015:48)

In relation to the topic of farm household ownership assets, it is important to mention two facts: a) the underestimation of information from agricultural censuses to capture the productive assets of family farming, and b) the effects of political violence by terrorist groups such as the Shining Path and the Túpac Amaru Revolutionary Movement (MRTA) during the period 1983-1993.

Regarding investment decisions in family farming, Velazco and Zepeda (2001) conducted a survey to gather information on the 1996-97 crop year. The survey reveals that the majority of agricultural investments (69% by value) were not registered in the national agricultural census. Additionally, the survey highlights the significance of local funding for financing small producers' investments, with nearly three-quarters (71%) of investments being financed with family or communal funds. Infrastructure construction for public use, in particular, tends to be undertaken as a community investment. This includes activities such as reforestation, construction of ditches and channels, roads, bridges, nurseries, seedbeds, dipping tanks, and training courses. The survey findings underscore the importance of community organization in accessing public assets and improving agricultural infrastructure. In the same line of analysis, concerning the highlighting of the importance of communal institutions as drivers of collective action in favour of initiatives that promote growth and reduce poverty, Escobal and Ponce's study

(2011) is notable. The authors employ a panel dataset of rural households from the National Household Survey (ENAHO) for 2002 and 2006, and their findings support the hypothesis of complementarity between institutional thickness and public infrastructure, "given that gains from infrastructure in terms of welfare dynamics are higher for those immersed in institutional thick settings. More importantly, these complementarities are more important for the poorest households" (Op. cit.: 375-376). These results are pivotal as they confirm, based on the theoretical model discussed earlier, the significance of increasing the stock of public and private assets (for both farm and non-farm activities) to enhance total household income and foster pathways out of poverty.

Regarding the impact of political violence in rural areas of Peru, the Truth and Reconciliation Commission (2003) pointed out that the estimated cost in human lives was approximately 69,280 people, including both dead and missing individuals, with the majority being peasants from the Sierra region. Velazco (2013) conducted fieldwork in 1999 in two communities in Ayacucho, the region where the violence began in 1983. The author visited a community of "returnees," whose residents were forced to migrate due to political violence. In contrast, the other community, referred to as "resisters," chose to remain and, with the assistance of the army, confronted the actions of terrorist groups. The 1980s decade marked a loss of human, social, and productive capital for households. Following the pacification achieved in the early 1990s, households, with the support of the state and churches, particularly the evangelical church, initiated a series of projects and interventions to recover the lost productive and economic capital of households. Urban experience and the return of more educated and younger household members created incentives for change in products and investment, for example, in vegetables and greens to supply local and regional markets.

5.5.2.3 Importance of on-farm and off-farm activities

With respect to the labour market interaction of rural households, it is important to point out the livelihood diversification strategy (farm and non-farm activities) some of them carry out. The labour market is one channel in which agriculture and the rest of the sectors have a relationship. An analysis carried out by Velazco and Fuertes (2017) on the evolution of complementary income-generating activities between the 1994 and 2012 farm censuses shows the scale of productive diversification that has taken place. In 1994, 25.7 percent of total agricultural producers carried out paid activity off the farm. This participation increased to 40.7 percent according to the 2012 farm census. In general, farmers have significantly increased their participation in the sectors of trade, processed products, construction, agriculture (off-farm), transport and communications.

The strategy of income diversification of rural households involves transit between the city and the countryside. Spatial mobility is crucial for households to supplement or increase their income, and the information on migration sheds light on this process. Based on the population censuses of 1981, 1993 and 2007, the net migration rate by department is calculated and shown in Table 5.10. The Sierra region is the main population expeller. As most of the farmers reside in the Sierra region, they can be expected to represent an important part of this migration. During the 1988-1993 period, forced migrations occurred due to political violence. The actions of the Shining Path terrorist group, which began in 1983 and lasted for a decade, had as their starting point the rural areas of the *departmentos* located in the Sierra. In other periods, migration responds responded to economic incentives, such as the search for better income and conditions. In particular, for the period corresponding to the years 2002-2007, it can be speculated that the higher rate of net migration is due to the effects of economic expansion. In particular, a higher wage (w) in urban areas is causing a higher migration, suggesting that the share of non-farm income in total income could increase.

Table 5.10. Peru: Net migration rate by department, 1981-2007
(Recent migration, in %)

	1976-1981	1988-1993	2002-2007
COAST			
Tumbes	8.8	17.6	6,0
Piura	-2.5	-6,0	-6.1
Lambayeque	-2.6	-0.3	-2.6
La Libertad	-3.3	2.7	1.9
Ancash	-6.8	-10.8	-5.4
Ica	-5.6	-3.9	-1,0
Arequipa	3.4	5.3	3.3
Moquegua	5.4	7.9	4.5
Tacna	18.7	26.1	9.2
Lima	6.1	11.7	9.3
SIERRA			
Apurimac	-9.9	-14.3	-11.7
Ayacucho	-8.8	-2.15	-6.2
Cajamarca	-11,0	-13.9	-13.6
Cusco	-0.9	-5.3	-5.7
Huancavelica	-8.6	-24.4	-14.6
Huanuco	1.5	-6.1	-11.1
Junin	-1.9	-13.1	-8.1
Pasco	-3.2	-20.9	-9.1
Puno	-6.3	-10.7	-6.5
AMAZON			
Loreto	-2.8	-3.3	-5,0
Ucayali	8,0	13.2	1,0
Madre de Dios	41.4	18.7	1,0
Amazonas	0.2	-5.9	-15.1
San Martín	25.2	7.2	0.3

Source: INEI (2009)

In Chapter 3, when discussing the feedback relationship between agriculture and other sectors, evidence was presented regarding the income diversification strategy of rural households. Table 5.11 demonstrates the importance and relevance of diversification of activities and income, utilizing the Household Survey (ENAHO) from 2017. In this case, the sample has been classified into three types of households: poor, vulnerable, and non-vulnerable[45]. The overarching message underscores the significance of income

[45] The proposed typology is based on the risk of falling below the poverty line proposed by the INEI (S/. 330). According to the calculations of Cozzubo and Herrera (2016), once the per capita income exceeds 550 soles, the probability of a rural household falling below the poverty line in the following year is 10% or less. Based on these calculations, the sample was divided into three groups: (1) poor households, which

diversification for rural households across the three regions, regardless of their poverty or vulnerability status.

have a per capita income of 330 soles or less; (2) vulnerable households, which have a per capita income between 330 and 550 inclusive; and (3) non-vulnerable households, which have an income greater than 550 soles.

Table 5.11. Average Percentage of Each Source of Income in Total Household Income for Poor, Vulnerable, and Non-Vulnerable Households by Region, 2017

Types of Households	Poor Households			Vulnerable Households			Non-Vulnerable Households		
Region	Coast	Sierra	Amazon	Coast	Sierra	Amazon	Coast	Sierra	Amazon
Source of Income									
Wages	**48.05**	**31.52**	**33.20**	**56.38**	**41.01**	**46.13**	**42.45**	**45.78**	**45.52**
Agricultural production	**32.81**	**36.41**	**48.48**	**30.70**	**33.48**	**41.13**	**44.44**	**37.56**	**44.47**
Crop production	26.60	25.12	40.91	25.54	23.20	35.23	39.79	30.36	39.45
Forestry production	0.43	0.87	1.71	0.15	0.63	0.98	0.16	0.27	0.34
Livestock production	5.78	10.42	5.86	5.01	9.65	4.92	4.49	6.93	4.68
Non-agricultural rural production	**3.81**	**10.32**	**5.41**	**3.95**	**8.08**	**3.30**	**9.56**	**9.60**	**2.28**
Agricultural by-products	0.94	3.6	3.70	0.84	2.16	1.78	1.49	1.44	1.18
Livestock by-products	2.87	6.72	1.71	3.11	5.92	1.52	8.07	8.16	1.20
Transfers	**15.33**	**21.75**	**12.91**	**8.97**	**17.43**	**9.44**	**3.55**	**7.06**	**7.73**
Per Capita Income (2017 Soles)	**230.6**	**216.77**	**203.47**	**431.42**	**429.68**	**433.8**	**2325.07**	**1920.37**	**1224.85**
Diversification Index	**57.47**	**68.84**	**62.76**	**59.26**	**64.2**	**60.75**	**65.70**	**62.12**	**55.52**
Observations	4122			1226			988		

Source: Moncilla and Quiliche (2021).

5.5.2.4 Trends in terms of trade: Changes in prices and wages

In this section, three events that are expected to impact agricultural prices and wages received by family farming will be discussed. To achieve this, the evolution of terms of trade for the segment of local peasant agriculture located in the Sierra will be examined, along with the involvement of small farmers in international markets, and the anticipated impact of the gastronomic boom, which revalues Andean products, on the prices of food offered by family farming.

A) Terms of trade in small agriculture (peasant)

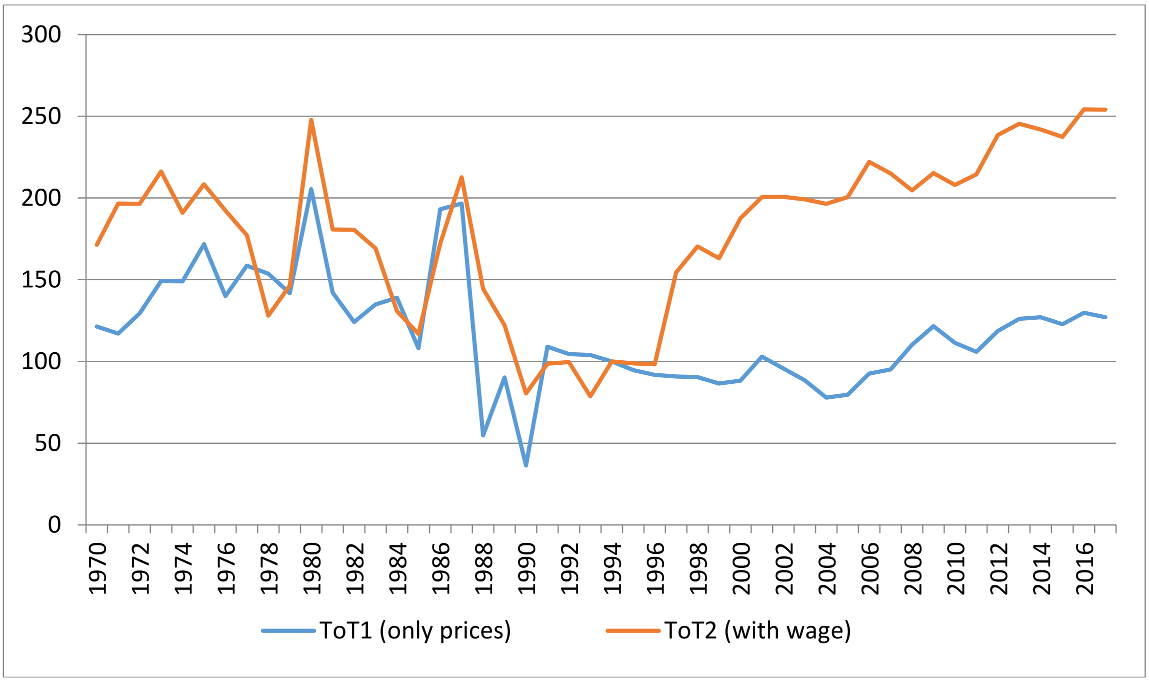
Although the theoretical model analyses the rural household in its facet as a producing unit, it is important to emphasise that the household is, at the same time, a unit of production and consumption. To assess how changes in prices and wages have affected the family farm, it is necessary to calculate the terms of trade. To this end, Figueroa's (1996) proposal to use the household expenditure and income structure of a sample of peasant families from the southern highlands of Peru was followed. Based on the availability of information for the series from 1970 to 2016, the following specification of the terms of exchange was used:

$$ToT = \frac{\frac{1}{4}\sum_1^5 Pm + \frac{1}{4}\sum_1^5 Pp + \frac{1}{4}\sum_1^5 Pt + \frac{1}{4}\sum_1^5 w}{\sum_1^6 \beta_j P_j} \qquad (25)$$

Generally, the numerator components are the sources of household income and the denominator prices are the expenses. The weighted sum of the prices of maize (Pm), potatoes (Pp) and wheat (Pt) is in the numerator in a sample of *departamentos* of the southern Sierra (Apurimac, Ayacucho, Cusco, Huancavelica and Puno). In addition, the legal minimum wage (w) is included as a proxy of the wage that the farmer can receive when he migrates to the city. All these prices have equal weight (1/4). The denominator includes goods such as oil, rice, noodles, bread, evaporated milk and beer, all with equal weight ($\beta = 1/6$). For comparison purposes, two indices of terms of trade were estimated. The first only considers the prices of agricultural goods in the numerator, with equal weighting. The second index considers both the prices and the wage in the numerator. The idea when comparing both indices is to evaluate the importance of each one of the numerator components in the performance of the terms of trade.

Figure 5.12 shows the evolution of both indices. Until the mid-1990s, both indices had the same tendency to fall. From then on, the index of only the prices of agricultural goods shows a slight increase while the other index grows at a higher rate. Different trajectories indicate that the evolution of wages has had greater weight when defining the tendency of growth of the terms of trade. Linking these findings with the model predictions suggests that the terms of trade became favourable for the peasant units and that both agricultural prices and wages have had a positive impact on improvements in their purchasing power and income. Improvements in agricultural prices during the period of economic expansion may have been due to the greater demand for food by urban consumers.

Figure 5.12. Terms of trade of small family farmers (peasants), 1970-2016



Source: Author´s calculations based on statistics from the INEI and Mendoza (2015)

B) Small family farming and export market participation

It is important to note that although family farming was not explicitly included as a beneficiary agent of the export promotion policies in the 1990s, successful cases of exports were achieved by small farmers. The participation of NGOs, international cooperation and public funds available since 2006, along with the creation of the *Sierra Exportadora* programme, have made it possible for farmers from the Coast, Sierra and Amazon regions to participate in the world market. Table 5.12 displays the number of small family producers and area planted for selected export crops in 1994 and 2012. The performance of crops such as coffee, cocoa, avocado, mango, grapes and artichoke is remarkable.

In some cases, farmers have had to abandon traditional crops and opt for new and more profitable products with growing demand in world markets. From the perspective of the model, this means that these households have faced a change in the pattern of crops in the expectation of a higher price. In any case, the participation of small-scale agriculture in export markets is still limited.

Table 5.12. Small family farms and selected export crops, 1994-2012

	Small family producers		Area planted (ha)	
	1994	2012	1994	2012
Coffee	105,157	219,185	197,836	404,001
Cocoa	28,867	87,542	48,143	137,118
Avocado	8,440	34,313	7,307	22,539
Quinoa	72,973	67,778	19,974	18,500
Mango	6,353	15,672	7,454	17,226
Grapes	9,148	17,008	7,061	10,574
Asparagus	2,555	2,587	7,992	5,988
Artichoke	500	1,244	285	2,050
Maca	1,260	631	507	886

Source: Maletta (2018:63) and FAOSTAT

C) Gastronomic boom and demand for traditional crops

Another source of increased demand for food is the development of Peruvian gastronomy. Peruvian cuisine has experienced a gastronomic boom in the last twenty years that has impacted its international recognition and is the main factor of cultural identity and national pride for Peruvians. Gastronomy shows potential as a new engine of sustainable and inclusive development and drives a value chain encompassing 6 million people (including cooks, waiters, farmers, fisherfolk, transporters, market traders and tourism operators). Furthermore, following the example of *Mistura*,[46] the international gastronomic fair of Lima, gastronomic festivals organised in various regions have sought to revalorise cuisines, flavours and regional flagship products (Valderrama, 2017). The main features related to the gastronomic boom are summarised in Table 5.13.

[46] According to Valderrama (2017:13), "One of the most important expressions of the boom is, undoubtedly, the *Mistura* gastronomic fair, which has been organized in Lima since 2008 and which in a short time was consolidated as the most outstanding in the region, attracting some 400 thousand visitors, including of 25 thousand foreign tourists. It is a 'sui generis' fair, since it brings together the different actors of the gastronomic chain. Mistura has become a fair of cuisine, culture and biodiversity, and is, according to a national survey of the agency Ipsos Peru conducted in July 2016, the brand that best represents Peruvianness".

Table 5.13. Some features of Peru's gastronomic boom

Feature	Description
Rescue of traditions associated with a cultural fusion	It doesn't break from the past, it builds on the homemade culinary tradition with contributions added from other cultures.
Movement gestated by a generation of emerging chefs	Young chefs organise the *Apega** collective and team up to promote Peruvian cuisine.
Greater visibility of the contribution of small agriculture to culinary excellence	The "Cook-Peasant Alliance" highlights the contribution of peasant families.
Mistura (gastronomic fair): meeting point of chefs, peasants, processors and suppliers	National forum that brings together varying tastes, visions, biases, experiences and desires.
Contribution to the rediscovery of Peru and products associated with its origins	Every town, however small and remote, has something of which to be proud, opportunities to include.
Natural ally of the Peru brand	Tourism, crafts, music, dance, biodiversity and everything that can be identified with the nation.
Stronger feeling of Peruvian identity and pride	Revalorise our culture, identity and belonging, the basis for building a country project.
Shift from being *limeño* (from Lima) to being regional, from being foreign to being Peruvian	Gastronomy as an ally of decentralisation and of national integration in a common cause.
Broad call to the entire gastronomic chain	Study establishes that Peruvian food generates 12% of the national GDP.
Development of an important message of inclusion and consensus	Spokespersons send messages that summon everyone to work on a common project.

Source: Ginocchio (2012:17)
* Peruvian Gastronomy Society

The development of Peruvian gastronomy and the fact that it is based on the revalorisation of regional cuisines has meant that agricultural products of more local or regional consumption are now in demand on the domestic and international markets. This is the case of quinoa and other Andean cereals, native varieties of potatoes and exotic fruits, among other products cultivated mainly by family farms. The internationalisation of Peruvian cuisine is reflected in the number of restaurants opened abroad and the demand for traditional agricultural products. In general, and in terms of the model developed in the previous section, the emergence of the gastronomic boom implies a greater demand for regional agricultural products. Table 5.14 lists some of them and their places of origin.

Table 5.14. Peru: Opportunities and gastronomic boom

Crop	Description	Production region
Olives	The growing international demand stimulates production and processing. It faces productivity and quality challenges to improve profitability.	Coast and Sierra
Chilli	Wide variety scattered throughout the country; small, medium and large producers; includes peppers; domestic demand and export.	Coast, Sierra and Amazon
Wheat and barley	Consolidated chain of sustainable agriculture; alternative to coca; growing exports and national market to be developed.	Sierra and Amazon
Organic cocoa	Great expectation for *criollo* qualities; alternative to coca, high demand for premium markets; agroindustry; national and export.	Coast and Amazon
Fruits	Cape gooseberry, organic bananas, *camu camu*, cherimoya or custard apple, date, passion fruit, soursop, *lucuma*, avocado, *pitahaya* or dragon fruit, elderberry, tree tomato, grapefruit and prickly pear.	Coast, Sierra and Amazon
Aromatic herbs	Includes colouring, aromatic species, anise, good grass, *huacatay*, oregano and rosemary.	Coast, Sierra and Amazon
Purple corn	Input for traditional drinks; potential for national market and, depending on research and innovation, for export.	Coast and Sierra
Dairy products	Varieties of high-priced cheese for domestic market and export.	Coast, Sierra and Amazon
Garlic and onion	Qualities and flavour concentrations essential for Peruvian cuisine; exporting potential towards gourmet markets.	Coast, Sierra and Amazon
Nuts and fruits dehydrated	Chestnuts and *sacha inchi* stand out as well as dehydrated fruits; increasing national and export demand.	Coast, Sierra and Amazon
Native potatoes and related	Generic term that includes varieties with different commercial potentials.	Sierra
Quinoa and Andean grains	High nutritional value; incipient agro-industrial development. Quinoas of colour, insufficient supply and export potential.	Sierra

Source: Ginocchio (2012:15)

5.5.2.5 Welfare indicators: The joint effect

The identification of changes in welfare indicators, such as income, poverty and consumption composition, is the outcome of considering the simultaneous effects of changes in access to public goods, farm-related assets, cash transfers, food prices and wages.

During the 1990s, along with the economic stabilisation programme and structural adjustments, emergency social protection programmes were implemented to deal with macroeconomic crises and with the impacts of stabilisation programmes themselves. The dominant approach to social policy was that economic growth was the primary mechanism for poverty reduction. Therefore, social policies focused on assisting the most vulnerable segments of the population (the poor, the elderly, children, the disabled), according to the principle of "targeting" and focusing, as opposed to universal access to social protection. With respect to the household model, if a household is beneficiary of a social programme, such as conditional cash programmes, this means that the household income will increase in R, the non-labour income.

Inchauste et al. (2012) estimated that the largest contribution to poverty reduction in Peru within the period 2002-2008 was associated with labour market factors, due to an increase in real wages and higher productivity. Increases in non-farm incomes were largely responsible for poverty reduction, while non-labour income (cash transfers, the R variable in the model) played an important role in reducing extreme poverty. Jaramillo and Sparrow (2013) have confirmed these findings, concluding that cash and in-kind targeted transfers have the highest incidence of poverty reduction in the short run. Furthermore, Yamada et al. (2012) found out that, from 2006 to 2010, 25% of poverty reduction responded to improvements in income distribution due to direct social programme transfers, while 75% responded to economic growth. In addition to this, other positive impacts were identified: increased food consumption, education and utilisation of medical services.

Studies using the National Household Surveys (ENAHO) to examine the impact on poverty in rural households offer different dynamics and responses of households to the context of economic expansion. This diversity of outcomes confirms the various scenarios pointed out by the theoretical model. That is, given a rural household with heterogeneous endowments of private assets, differentiated access to public goods, and diverse levels of human capital among household members, it is understandable that different pathways of income increases and exits from poverty are found. In this line, studies by Morley (2017), Flachsbarth et al. (2018), Trivelli and Urrutia (2018), and Aldana (2018) stand out. A common element is the observation that for vast majority of rural households, the pathway out of poverty is due to increases in labor income (whether as wage earners in urban areas or in rural areas that become dynamic due to economic growth or increased public investment), with a lesser extent of poverty reduction coming from transfer programs. Additionally, it is identified that individuals with higher human capital were able to take advantage of better employment opportunities in cities. Furthermore, it is found that households experience increases in their agricultural incomes because improved roads and greater connectivity create conditions for their products to receive higher prices. Additionally, this is supplemented by increased demand resulting from rising incomes among rural and urban consumers.

To discuss changes in welfare indicators, the FAO family farming classification (2017) will be used and the following groups considered:

a) Subsistence farms that produce mainly for domestic consumption and have an area of cultivated land of less than 1.5 ha and less than 10 livestock units.
b) Transition farms that use land for cash crops, but their total cultivated area is less than 5 ha and they have less than 10 livestock units.
c) Commercial farms that have more than 5 ha of cultivated land or 10 livestock units, or both, or are considered different from business operations because they are managed by families.

Table 5.15 presents welfare indicators estimated by FAO (2017) for Peru. Representative household surveys were used for the years 2005 and 2014. During the decade, the welfare levels of all types of Peruvian family farmers improved. Significant reductions in poverty were accompanied by improvements in household access to health services, computers and the Internet, ownership of goods such as cars and trucks, and increased per capita income.

Considering the composition of income, a significant increase in the share of income obtained from off-farm sources is identified. This is evidence of the growing role of non-farm income in improving well-being and reducing poverty, especially among small family farmers. Family labour has been moving towards non-agricultural activities (a fact already confirmed with census data). For example, in 2014, a third of the income of households on subsistence farms came from agricultural activities. This could indicate that the exit from poverty and income improvements are associated with a greater linkage of rural households with off-farm activities and with better jobs and income opportunities offered by the non-agricultural or urban sector.

Table 5.15. Welfare indicators by family farming type in Peru

Type of farm	Year	Poverty rate (%)	Per capita income (2014 US$)	Farm income/total income	With sanitary services (%)	With computer (%)	With car or truck (%)
Subsistence	2005	84.2	556	40.0	48.6	1.3	0.5
	2014	45.7	1377	33.8	78.7	5.8	2.0
Transition	2005	71.3	792	51.0	58.8	2.5	1.8
	2014	31.7	1887	44.4	81.4	11.4	5.6
Commercial	2005	66.3	914	61.3	59.0	3.3	5.7
	2014	25.8	2236	50.6	78.1	13.6	8.1

Source: FAO (2017:81).

Regarding changes in household consumption, Table 5.16 displays the consumption structure according to the first (lowest) and fifth (highest) income per capita quintile, based on national representative household surveys for the years 2005 and 2014, and in particular, the questionnaire module answered by farm producers. This means that the information presented corresponds to households having farming activity as their primary or secondary activity.

As expected, given the increase in household income between 2005 and 2014, changes in consumption composition were expected. The most salient fact is the fall in the share of food expenditure for the lowest quintile, implying that more income was allocated to other consumption groups such as furniture, health and transport and communication.

Table 5.16. Peru: Consumption composition of family farming, 2005 and 2014 (in %)

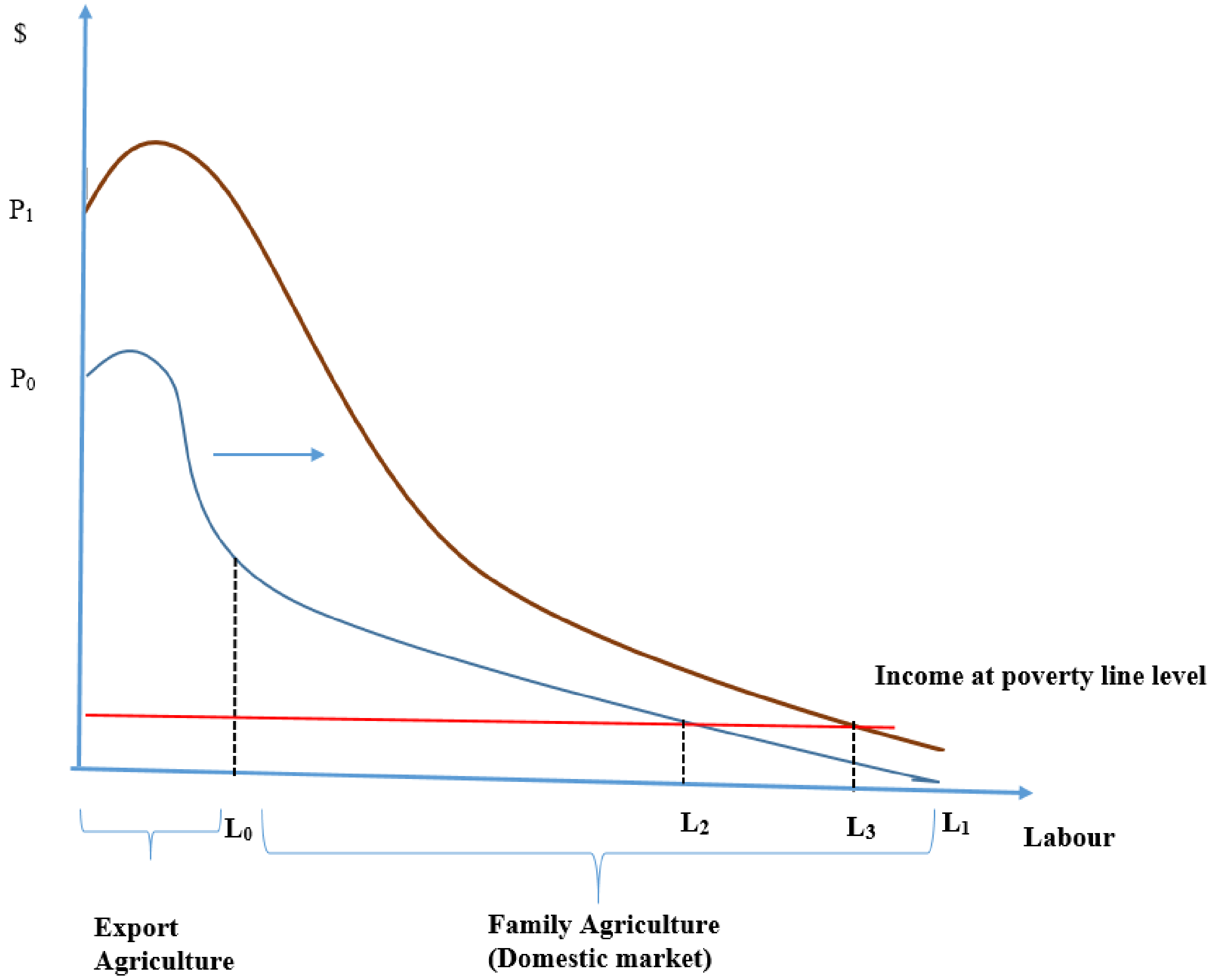
Consumption Groups	**2005**			**2014**		
	National level	Quintile 1 (lowest)	Quintile 5 (highest)	National level	Quintile 1 (lowest)	Quintile 5 (highest)
Food	63.7	67.4	53.8	56.4	59.2	48.8
Clothes and shoes	5.4	5.0	5.4	5.6	6.0	4.7
Housing and fuel	10.9	11.6	12.8	11.7	12.1	13.0
Furniture	4.5	4.7	5.0	5.6	5.4	6.2
Health expenses	5.4	3.9	8.6	6.9	5.3	10.2
Transport and communications	3.2	1.5	6.0	5.6	3.8	7.7
Education and entertainment	3.5	3.5	3.6	4.5	5.4	4.6
Other goods and services	3.3	2.3	4.8	3.6	2.9	4.8

Source: Author's calculation based on ENAHO 2005 and 2014.

To conclude this analysis, the results from Chapter 4 will be brought into consideration, where a bidirectional causal relationship was found between total factor productivity and the agricultural GDP allocated to export agriculture and domestic agriculture. Furthermore, the same relationship was found between TFP and an index of quantities of food supply from family agriculture. In an attempt to integrate these findings, Figure 5.13 is proposed, representing the curve of value added per worker in agriculture. The vertical axis denotes the monetary value of labour productivity, while the horizontal axis corresponds to the allocation of labour between export agriculture and family agriculture destined for the domestic market, with L_1 representing the labour endowment in agriculture. It is assumed an income fixed at the poverty line level.

The initial curve (P_oL_1) represents the situation prior to the 1990s, where segments of higher labour productivity are allocated to export agriculture and those of lower productivity to family agriculture. Thus, for the first period, L_o represents the allocation of labour to export agriculture and L_0-L_1 represents the labour for family agriculture. The initial situation indicates that given the poverty level income, the segment L_2-L_1 generates an income in agriculture below the poverty line, classifying this group of workers as monetary poor. However, assuming the events discussed in this chapter, such as the promotion of non-traditional exports, public investments in infrastructure and public assets, and increases in consumer incomes, among other events, an expansion of the value-added curve to level P_1 can be expected. This implies that, assuming the same allocation of labour between the two agricultures, poverty decreases and concentrates in segment L_3-L_1. This result is consistent with the trend in poverty reduction discussed in this chapter.

Figure 5.13. The Value Added per agricultural worker according to types of Agricultural Units (oriented towards both the domestic and external markets)



Source: Author own elaboration

5.6. Conclusions

The estimation of labour productivity and total factor productivity (TFP) in chapter 4 corroborates the existence of a turning point since the 1990s. Since agriculture is the main activity of rural households, this chapter studied the changes that have occurred in the microeconomic behaviour of agricultural units.

There are two dominant forms of production in Peruvian agriculture: export-oriented agro-industrial complexes (which vertically integrate the field phase and processing) and family farming. In order to meet the objective of the chapter, theoretical models were developed for each type of agrarian unit. In the case of the agro-export complex model, the discussion has focused on how government measures have assisted in shaping and consolidating the new agro-export model. To achieve this, evidence was presented on the impact on exports, their composition towards non-traditional products such as fruits and vegetables, as well as the impact on labour demand, which originates from family farming, urban, and peri-urban areas.

To comprehend the decisions regarding time allocation and production among agricultural, non-agricultural activities, and labour migration, a simple household model was introduced. Using comparative statics, the expected effects on total income due to changes in prices, wages, transfers, and assets (both public and allocated to farm and non-farm activities) were discussed. Empirical evidence was presented to identify to what extent situations of increased rural household income and their pathway out of poverty occurred. The analysed empirical evidence seems to suggest the following transmission mechanisms:

a) Redistributive government policies aimed at improving access to public assets and services, with increasing public investment and its new composition in rural areas playing an important role. Furthermore, targeted social programmes, carried out under the umbrella of the National Agreement, were effective in reducing extreme rural poverty.
b) The expansion of the agricultural non-traditional exports has boosted labour market demand, employing members of rural households.
c) Economic growth increased labour demand for non-agricultural sectors, enhancing higher net migration from the poorest rural areas (Sierra) to the more dynamic ones (Coast and Amazon).
d) Improvements in agricultural technology, which have occurred in all types of agricultural units, although regional disparities remain and there is a need to close the gaps.
e) In addition, increased demand for food was expected due to economic expansion (consolidation of a middle class that demands fresher and healthier foods). Likewise, the boom in Peruvian gastronomy, which revalorises products of traditional agriculture (for example, potatoes and Andean cereals), has also caused an increase in the demand for food and in prices.

It is important to note that all these improvements in the welfare conditions of rural families have been achieved despite the lack of an explicitly oriented agricultural policy towards the domestic market agriculture. After several decades of relative productive stagnation, the 1990s mark a turning point in the trend of agricultural production destined for the domestic market and the participation of family agriculture in total food production. As expressed throughout this thesis, the priority in agricultural policy has been, since the late 19th century, the promotion and support of export market-oriented agriculture. The next chapter will examine the political economy behind this state option in the context of the new agro-export model.

CHAPTER 6

AGRARIAN POLICY IN PERU IN THE CONTEXT OF THE NEW AGRO-EXPORT MODEL: HOW DO THE ELITES “CAPTURE” POWER? THE CONFLICT BETWEEN FAMILY FARMING AND AGRO-EXPORT COMPLEXES

6.1 Introduction

Since the onset of the republican era, the absence of an agrarian policy conducive to family farming, particularly one oriented towards the domestic market, has been a recurring phenomenon in Peruvian economic history. Family farming has flourished despite the state's apathy and neglect, indicating a longstanding discord. As an illustration, two events can be cited to underscore this reality and its significance, notwithstanding the century that separates them. The first occurred in 1919, when Agusto B. Leguía, then a presidential candidate, pledged in his platform to introduce a draft Agrarian Law to address the lingering feudal issues in Peru. However, his proposal was rebuffed by a majority of representatives, many of whom were *gamonales*, owners of extensive estates in the Sierra region (Tord, 2015).

The second event occurred in 2019, marked by a national agricultural strike which saw half a million agricultural producers take to the streets and occupy the main highways. In light of the scale of the mobilization, President Vizcarra recognized that "the Government acknowledges that the sector is neglected." In line with this sentiment, Clímaco Cárdenas from CONVEAGRO, one of the leaders of the agrarian unions organizing the strike, emphasized that "we must cease prioritizing large agro-exporters to the detriment of small and medium-sized agriculture" (Diario Perú21, 2019). Furthermore, Parliament felt compelled to convene an agrarian plenary session "for the first time in history [...] to enhance the livelihoods of millions of Peruvians," as stated by the president of the Legislative Assembly (Diario Perú21, 2019).

Having identified this situation, the aim of the chapter is to explore how the key actors in agriculture destined for both external and internal markets have interacted with the state to shape and influence, if possible, agricultural policies in their favour. To achieve this, the latest agro-export boom that began in the 1990s will be analyzed.

Within this context, the questions to be addressed are: Why has the Peruvian State not prioritized the implementation of agrarian policy in favor of family farming? How has the state's relationship with agriculture destined for the domestic market been manifested? The hypothesis posited is that, in terms of defining agrarian policy, the Peruvian State has been "captured" by agro-exporting elites and has not prioritized the development of family farming for the domestic market. To support this hypothesis, two mechanisms are suggested for the capture of agrarian policies by economic elites: a) The revolving doors, which facilitate the approval of legal or regulatory frameworks to obtain individual or group benefits. This mechanism occurs with the appointment of agriculture ministers with strong ties to agro-export businessmen; and b) The second mechanism is the practice of lobbying in parliament. Through this means, the approval of laws that favor the expansion and promotion of the agro-export sector is facilitated. Additionally, and to address the second question, the hypothesis posits that agricultural producers supplying the domestic market, perceiving themselves as marginalized from the advantages of agrarian policy and devoid of direct channels to political authority, be it executive or parliamentary, have resorted to confrontational tactics against the state. This is substantiated by instances of strikes and road blockades.

The chapter is structured into 6 sections. The second section provides information on the new economic groups in agriculture. The third section discusses how these groups interact with the state. The fourth section examines, from a long-term perspective, the ways in which the state has engaged with the indigenous population, heavily involved in market-oriented agriculture. Section five demonstrates the strategies employed by farmers directing their production towards the domestic market in their relationship with the State. The sixth section presents the conclusions.

6.2 Economic power groups in Peruvian agriculture in the context of the New-agro export model

First and foremost, it is imperative to delineate the concept of 'elite' that will be employed. Following Cárdenas (2020), an economic elite is construed as a select group of individuals distinguished by their economic prowess or accumulation power. They are further characterized by their lifestyles, consumption habits, and their capacity to influence political affairs, both individually and through business conglomerates. Additionally, they exhibit considerable associational and union capabilities, functioning cohesively as a collective entity and within networks.

In the Latin American context, approaches to economic elites as delineated by Lungo (2022) accentuate several key themes. Firstly, studies underscore historical processes, examining families, corporations, unions, and the intricate power dynamics therein, including marriage alliances and strategies for reproduction. A second strand of inquiry delves into the composition and internal structure of the elites, emphasizing the interplay between diverse economic sectors and organizational forms such as unions, associations, alliances, and power dynamics. Lastly, there exist studies probing into political influence at various levels—local, regional, or national.

In the Peruvian context, the investigations into elites spearheaded by Malpica (1976), Flores Galindo (1977), Miller (1982), Quiroz (1986), Gilbert (2017), Portocarrero (2017), Morenas (2020), Dargent (2018), and notably, the contributions of Durand (2014 and 2016), hold significance. In this regard, Durand's conceptual framework furnishes us with insights into the mechanisms of state capture by elites or economic factions.

In a study on entrepreneurship over the 200 years of republican life in Peru, Contreras and Monsalve (2022) conclude that a characteristic of the Peruvian economy is its ability to grow through diversified exploitation of natural resources. However, this situation changes when the economy faces periods of crisis caused by both internal and external factors. The process of recovering growth momentum is slow; it takes several lustres to regain what was lost. They attribute this situation to the institutional weakness of the state, which has shaped the strategies of business groups in the face of constant political and economic risk. In a long-term assessment, the authors conclude that the evolution of the economy has favoured the formation of diversified economic groups predominantly led by a single family, rather than the emergence of large corporations with diversified ownership. Another element highlighted by the authors in their long-term analysis is the concentration of financial and managerial activities in the city of Lima, resulting in highly unequal regional development.

Focusing on economic groups in agriculture, Durand (2014) identifies them using information sourced, among others, from Peru Top Publications, an annual publication providing a ranking of business groups in Peru and a range of indicators facilitating their analysis. By way of illustration, Table 6.1 shows the access to land by economic power groups in Peru linked to agriculture. In 2010, 10 of the economic power groups concentrated a total of 209,000 hectares planted in the best land in the country (Coast and Amazon). These lands acquired and agglomerated in the groups of economic power have two sources of origin: a) the old haciendas and b) new lands that are the result of irrigation or concessions in the Amazon region (Durand, 2014).

Table 6.1. Concentration of land by economic groups in 2010 (hectares planted)

Group	Hectares	Production	Location
Rodriguez group	64,445	Sugar	La Libertad and Ancash
Romero group	34,950	Sugar, fruits, cocoa and oil palm	Piura, Lima, San Martin
Camposol group/Dyer	31,621	Asparagus, mango, fruit	Piura and Lambayeque
Oviedo group	21,800	Sugar	Lambayeque
Wong group	17,200	Sugar	Lima and Arequipa
Manuelita group Bustamante group	12,889 7,600	Sugar Sugar, mago and lemmon	La Libertad Lambayeque and Lima
Huancaruno group	7,700	Sugar	Lambayeque and La Libertad
Maple group	13,500	Sugar	Piura
Chilmper group	4,435	Asparagus	Ica
Total	209,235		

Source: Durand (2014).

Using the same information source as Durand (2014), *Peru Top Publications: The Top 20,000 companies*, the composition of the main agro-industrial economic groups for the year 2022 has been updated. This information is presented in Table 6.2, where the groups are ordered based on their revenues. In this list, an attempt has been made to consider the groups listed in Table 6.1; therefore, the top 14 in the ranking are considered. Appendix 6 provides a detailed description of the top 20 economic groups linked to agriculture.

Table 6.2. Top Agro-industrial Economic Groups 2022

N°	Economic Group	Revenues – Agroindustry (millions of Peruvian soles)
1	Gloria	2,001
2	D&C (former Camposol)	1,487
3	Matta Exalmar	860
4	Romero	789
5	CFI	612
6	Drokasa (former Chilmper group)	525
7	La Calera	445
8	Layconsa	218
9	AIB	218
10	Rocio	212
11	Oviedo	204
12	Cervesur	170
13	Huancaruna	142
14	Wong	33

Source: Author elaboration based on Peru Top Publications.
The Top 20,000 companies.

These groups tend to diversify their activities across various economic sectors. Table 6.3 illustrates the number of companies owned by each group, as well as those belonging to the agro-industry sector. Of all, the Gloria group stands out, with 24 companies, 9 of which are engaged in agro-industrial activities. Additionally, information on workers is provided, with those associated with agro-industry, on average, accounting for 73% of the total workforce of these groups.

Table 6.3. Employees of the primary agro-industrial economic groups 2022 – Top 20,000 companies

N°	Economic Group	N° of companies		Employees		
		Total Group	Total Agroindustry	Total group (TG)	Total Agroindustry (TA)	TA/TG (%)
1	Gloria	24	9	23,495	15,667	67%
2	D&C	4	2	47,531	46,124	97%
3	Matta Exalmar	3	2	19,254	17,899	93%
4	Romero	27	4	21,417	6,159	29%
5	CFI	3	1	11,997	11,963	100%
6	Drokasa	3	1	10,655	9,283	87%
7	La Calera	3	1	5,744	2,127	37%
8	Layconsa	2	1	5,548	5,126	92%
9	AIB	1	1	2,910	2,910	100%
10	Rocio	4	2	4,704	2,856	61%
11	Oviedo	2	1	2,171	2,155	99%
12	Cervesur	5	1	9,479	6,346	67%
13	Huancaruna	4	2	4,946	4,450	90%
14	Wong	13	2	2,910	618	21%
Total		**98**	**31**	**172,761**	**133,065**	**73%**

Source: Author elaboration based on Peru Top Publications. The Top 20, 000 companies 2022 (PUCP-Lima).

In Table 6.4, the evolution of an index capturing the business strategy of the group is presented. An index has been estimated considering the revenues according to the different economic sectors in which each group participates (the classification of economic sectors is found in Appendix 6). The index is the sum of the squared shares of each economic sector in the total group revenues. Thus, if a group only has one company and therefore participates in only one economic sector, the index takes the value of 1. Conversely, if an economic group diversifies into multiple sectors, the index decreases in value. That is, a high value reflects a strategy of concentration/specialization of activities, while a low value indicates diversification. The table displays the index information for the years 2013 and 2022.

With the exception of the AIB Group, all have businesses in more than one economic sector, with Gloria, Romero, and Cervesur groups being particularly noteworthy. Overall, these groups tend to diversify their activities, and there is no clear pattern of change between the two years under consideration.

Table 6.4: Business strategy of the leading economic groups

N°	Economic Group	Number of economic sectors 2022	Business strategy index	
		Total Group	2013	2022
1	Gloria	6	0.5	0.6
2	D&C	3	0.8	0.6
3	Matta Exalmar	2	0.5	0.6
4	Romero	6	0.4	0.5
5	CFI	3	0.6	0.9
6	Drokasa	3	0.4	0.4
7	La Calera	3	0.5	0.5
8	Layconsa	2	0.5	0.6
9	AIB	1	1.0	1.0
10	Rocio	2	0.6	0.6
11	Oviedo	2	0.6	0.6
12	Cervesur	4	0.5	0.4
13	Huancaruna	2	0.8	0.8

Note: To estimate the business strategy index, only companies with revenue information for the years 2013 and 2022 have been considered.
Source: Author elaboration based on Peru Top Publications. The Top 20,000 companies 2022 (PUCP-Lima).

How significant are export revenues in the total income of each group? Table 6.5 provides an answer at the group and exporting company levels. Overall, 70% of the revenues of these groups come from exports, meaning they are part of the agro-export boom that the country has experienced in recent decades. Entre los grupos que lideran las exportaciones se encuentran D&C, Matta Exalmar, Gloria, CFI y Drokasa.

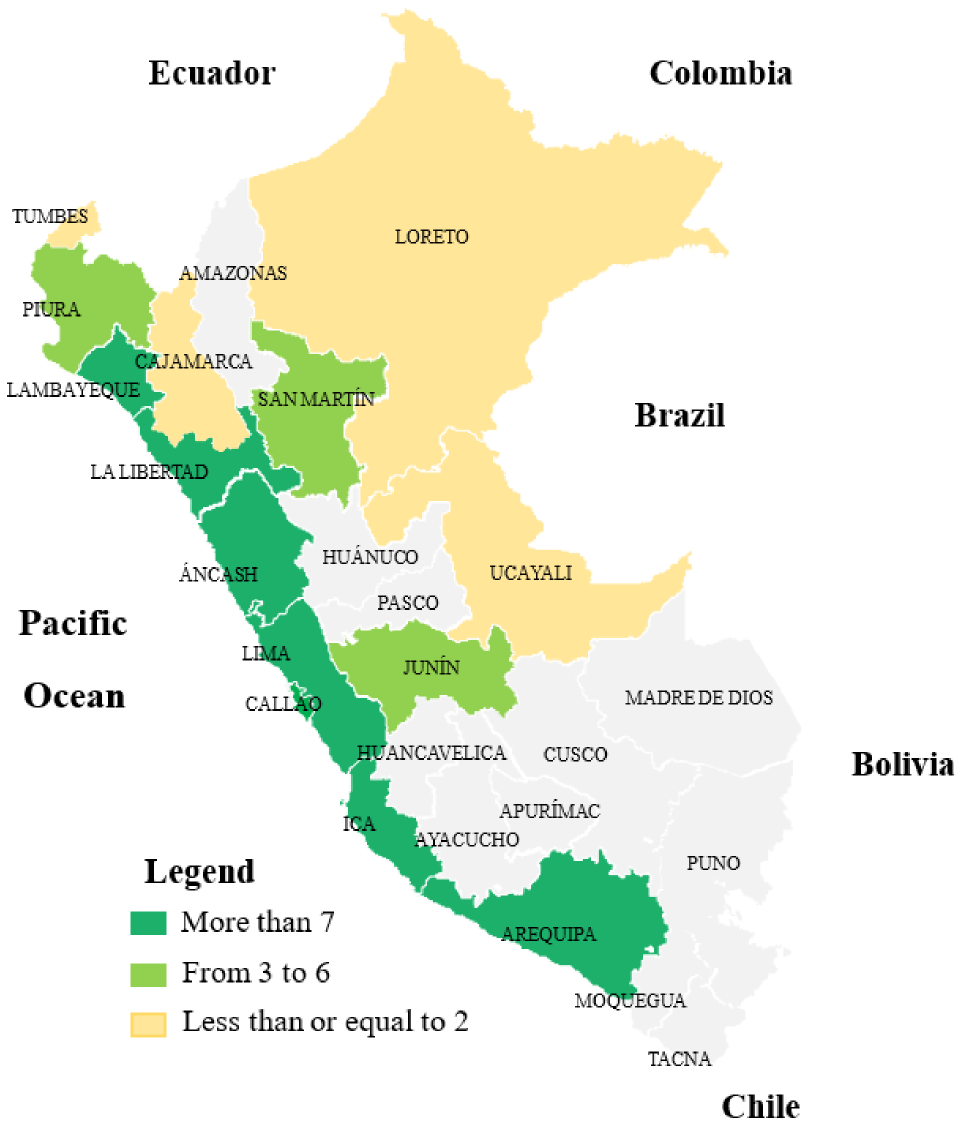
Table 6.5: Agro-industrial economic groups by exportation – 2022

N°	Economic Group	Company	Exports (millions of US$)	Exports (millions of Peruvian soles) *	Exports / Revenue (%)
1	D&C	Camposol S.A.	370	1,418	100
2	Matta Exalmar	Complejo Agroindustrial Beta S.A.	219	840	99
3	Gloria	Casa Grande S.A.A.	34	132	20
		Cartavio S.A.A.	24	90	20
		Agroindustrias San Jacinto S.A.A.	7	28	10
		Agroolmos S.A.	25	98	28
		Agrofutura Company S.A.C.	19	73	89
		Agrocasagrande S.A.C.	16	63	76
		Agrosanjacinto S.A.C.	3	12	50
4	CFI	Agrícola Cerro Prieto S.A.	140	538	88
5	Drokasa	Sociedad Agrícola Drokasa S.A.	121	464	88
6	La Calera	Procesadora Laran S.A.C.	113	433	97
7	AIB	Agroindustrias AIB S.A.	49	189	87
8	Cervesur	Procesos Agroindustriales S.A.	45	171	100
9	Layconsa	Agrícola Pampaa Baja S.A.C.	41	159	73
10	Rocio	Tal S.A.	36	138	81
11	Huancaruna	Empresa Agrícola San Juan S.A.	21	81	61
Total			**1,283**	**4,927**	**70**

Note: Only include companies with information available by group (see Appendix 6). */ The export value was converted from dollars to soles using the average annual interbank exchange rate for 2022 (Exchange Rate: 3.84).
Source: Own elaboration based on data from BCRP and Peru Top Publications. The Top 20,000 companies (PUCP).

Figure 6.1 illustrates the distribution of companies belonging to agricultural economic groups by *departmentos*. Notably, there is a concentration in the Coastal region, from Lambayeque to Arequipa, where companies are most frequently located, followed by Piura and Tumbes. In other natural regions, San Martín (Amanzon) and Cajamarca (Sierra) stand out, along with Junín (Sierra), with a lesser presence in two other Amazon *departmentos*, Loreto and Ucayali.

Figure 6.1. Location of companies belonging to an economic group by *departamentos*, 2022

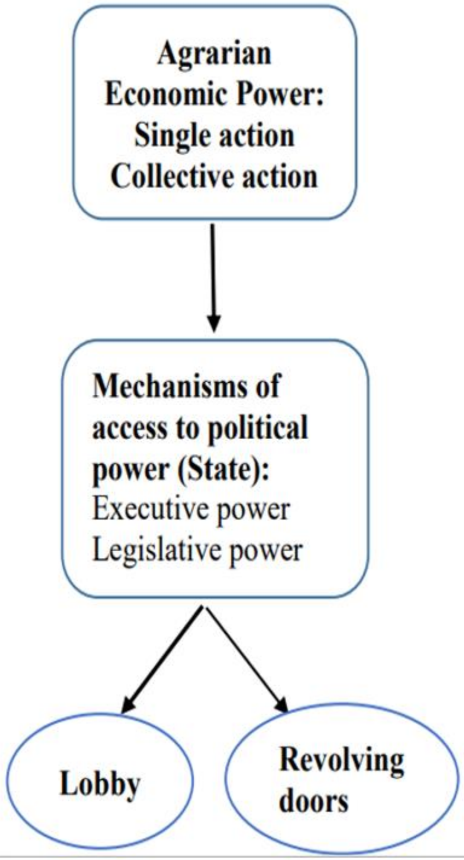


Source: Own elaboration based on Peru Top Publications. The Top 20, 000 companies 2022 (PUCP-Lima).
Note: To create the map, consideration has been given to the companies within the top 20 economic groups based on the 2022 revenue figures.

6.3 Mechanisms for capturing power by agrarian elites

Durand (2016) offers a conceptual framework that helps to identify the ways in which the elites or groups of economic power reach the State and achieve their objectives which allow them to consolidate their position. In diagram 6.2, it is identified that the economic power groups interact with the political power in a direct and individual or collective action or as a business association. There are two mechanisms that allow access to the State, whether they are the Executive Branch or the Parliament: a) the revolving doors that facilitate access to the Ministry of Agriculture and b) the lobbying actions in Parliament that are manifested in the approval of a series of legislative measures that help the development, expansion and consolidation of the new agro-export sector.

Figure 6.2. Powers of the agrarian economic elites and their projection towards the State



Source: Adapted from the author from Durand (2016:29).

6.3.1 Revolving doors

Morenas (2020) examines the profile of Ministers of Agriculture from 2000 to 2020. Among its key findings is the significant prevalence of agronomists with business backgrounds and presidents of agricultural associations, particularly notable in the first decade of the 2000s.

Another notable profile of agriculture ministers is that of business owners or executives within the agricultural sector, often with political affiliations. An illustrative example is the case of Minister of Agriculture, José Chlimper, who endorsed the Agrarian Promotion Law in 2000. He is a businessman, banker, and politician closely associated with the agricultural export sector. In 1995, he established his company, *Sociedad*

Agrícola Drokasa S.A., which currently exports avocados, grapes, asparagus, and blueberries.

Table 6.6 presents the list of agriculture ministers for the period 1990 to 2020. Over the course of these 30 years, there have been 27 ministers, indicating a relatively high turnover in the position. It is noted that 12 out of the 27 agriculture ministers from 1990 to 2020 have had confirmed ties to the large-scale agro-industry, comprising 44.4% of the total. This underscores the significant decision-making power in agricultural policy held by these authorities under the revolving door phenomenon. There are 10 cases where the existence of a link with the agro-industry is not known, suggesting that the involvement of ministers with the agro-industry may be even greater.

According to Damonte (2019), regarding the professional backgrounds of ministers associated with the agro-industry, whether as board members, presidents, or consultants for agricultural export firms, none of them originate from the family farming sector

Table 6.6. Relationship between Ministers of Agriculture and agroindustry: 1990-2020

Name	Links to agroindustry	President
Carlos Amat and León Chávez	No	Alberto Fujimori (1990-2000)
Enrique Rosal Link	Unknown	
Gustavo González Prieto	No	
Absalón Vásquez Villanueva	Unknown	
Rodolfo Muñante Sanguinetti	Unknown	
Belisario De las Casas	Yes	
José Chimper Ackerman	Yes	
Carlos Amat and León Chávez	No	
Álvaro Quijandría Salmón	Yes	Valentín Paniagua (2000-2001)
Francisco González García	Unknown	Alejandro Toledo (2001-2006)
José León Rivera	Yes	
Álvaro Quijandría Salmón	Yes	
Manuel Manrique Ugarte	Unknown	
Juan José Salazar García	Yes	
Ismael Benavides Ferreyros	Yes	Alan García (2006-2011)
Carlos Leyton Muñoz	No	
Adolfo De Córdova Vélez	Unknown	
Rafael Quevedo Flores	Yes	
Jorge Villsante Aranibar	Unknown	
Miguel Caillaux Zazzali	Yes	
Luis Ginocchio Balcázar	Yes	Ollanta Humala (2011-2016)
Milton von Hesse La Serna	Yes	
Juan Manuel Benítez Ramos	Unknown	
José Manuel Hernández	Yes	
José Arista Arbildo	Unknown	Pedro Pablo Kuczynski (2016-2018)
Gustavo Mostajo Ocola	Unknown	
Fabiola Muñoz Dodero	No	Martín Vizcarra (2018-2020)

Source: Damonte (2019: Table 1)

6.3.2 The lobby in Parliament

Table 6.7 presents an overview of legislative measures supporting both family farming and the agro-export sector spanning the period 1990-2021, considering various governments, predominantly democratic regimes.

In the era following the initial policies of the Alberto Fujimori government, from 1990 to 2000, significant laws were enacted that facilitated the emergence of the new non-traditional agro-export model. Commencing with the adoption of the new Constitution in 1993, this period saw the enactment of the Land Law in 1995 and the Agrarian Promotion Law in 2000. These legislative actions encountered minimal obstacles during approval. To achieve this, a strategy based on "*decretismo*" was embraced, wherein Parliament delegated legislative authority to the Executive to formulate regulations promoting agricultural exports. Integral to this strategy, the

Ministers of Economy and Agriculture played pivotal roles in crafting the new legislation. These laws fostered increased private investment, abolished restrictions on land extension for agricultural purposes, lowered agricultural labor costs, and reduced tax burdens. Additionally, concerted efforts were made to explore new markets following the signing of several free trade agreements.

Conversely, measures targeting family farming paint a contrasting picture. Despite existing legislation supporting family farming, successive governments have lacked the political resolve to implement the approved norms or laws. Compounding this issue is the weak organization of producers, which results in a lack of political representation in Parliament[47]. The absence of effective agrarian policies in support of family farming has compelled producer organizations to resort to drastic measures such as blocking major highways and staging general strikes to amplify their grievances and garner attention from the government or relevant authorities for resolution.

[47] For a thorough analysis of the causes explaining the weak political participation of the indigenous population in Peru since the 1970s, refer to Paredes (2011).

Table 6.7. Legislative measures in favour of export agriculture and family farming

President	Government years	Type of regimen	Legislative measures in favour of export agriculture	Legislative measures in favour of family farming
Alberto Fujimori	1990-2000	Democracy: 1990-1991 Dictatorship: 1992-2000	New Constitution (1993) Land Law (1995) Law of agrarian promotion (2000)	Specific programs (deforestation, small business, etc.)
Alejandro Toledo	2001-2006	Democracy	Free trade Agreement (FTA)	Specific programs
Alan García	2006-2011	Democracy	FTA	Specific programs and *Sierra Exportadora*
Ollanta Humala	2011-2016	Democracy	FTA	*Selva exportadora* Investment in rural infrastructure and social programs National Strategy of Family Farming (2015) Not implemented Law of Promotion and Development of Family Farming (2015) Not implemented
Pedro Pablo Kuczynski/ Martín Vizcarra	2016-2021	Democracy	FTA	National Plan of Family Farming 2019-2021. Not implemented
Pedro Castillo	2021- 2022	Democracy	FTA	Second Agrarian Reform. Not implemented.

Source: Author elaboration from diverse sources.

It is noteworthy that family farming has garnered visibility within agricultural policy, particularly concerning exports. Consequently, programs have been established to facilitate the export activities of farmers situated in the Sierra and Amazon regions. However, the vast majority of family farmers engaged in supplying the domestic market do not benefit from this preferential treatment.

Paniagua (1993) assesses the rural development strategies implemented in Peru since the 1960s. The author acknowledges that very little could be achieved during the dominance of the *hacienda* system; the landowners opposed these interventions, which remained on the margins of peasant communities. The period of agrarian reform was lacking in projects (*proyectos*, intermittent interventions within the productive sphere), and since the advent of democracy in 1980, three phases have been identified, representing a pendulum swing in approaches: liberalism (1980-85), populism (1985-1990), and liberalism (since 1990). The first period inaugurates the era of projects, namely the parceling out of development. This trend continues into the second period until political violence and economic crisis hinder the continuity of the approach. With the return to liberalism since 1990, there has been a shift towards neglecting the countryside and reducing projects. These back-and-forth shifts in approaches, stemming from the state, reveal a lack of direction and priorities concerning rural development, and consequently, agrarian issues tied to family farming. The author concludes that since 1970, the state has equated rural development with project implementation, and in carrying out these projects, it has encountered bureaucratic institutional barriers that hindered the achievement of project objectives.

Asensio (2023) undertakes an evaluation of public interventions in rural development spanning the period from 1900 to 1920. The study corroborates previous findings and underscores the inconsistencies of state interventions, the resource constraints encountered by the majority of them, and the significant urban bias evident in many of these interventions. However, a point highlighted by the author, which subsequently contributes to explaining the decline in rural poverty rates from the early 21st century onwards, is the social policy of conditional cash transfers targeted at impoverished rural families and the increase in rural public investment.

Regarding the weakness of agricultural organizations, Urteaga (2021) compares it with the Colombian case, highlighting the organization of producers at both the commodity level and the sectoral level, with the former being integrated with the latter. For the Peruvian case, the author concludes:

> "producers are highly fragmented and lack a sectoral association to represent their interests. Not all producers are organized, producers of a single commodity are often represented by competing associations, and there is no association integrating both agro-exporters and producers for the domestic market. The National Convention for Agricultural Producers, CONVEAGRO, falls short of being an encompassing association—it only groups small-scale producers, not agro-exporters. The commodity level associations are not integrated into CONVEAGRO. Since Peruvian farmers are poorly organized, their demands are unlikely to have an echo in the government".

A low level of agency among producers to organize themselves can be assumed, and it is important to acknowledge the vast heterogeneity among producers and the difficulty in reconciling such diverse interests.

6.3.3 Dilemma in the definition of agrarian policy: Identifying winners and excluded/losers

So far, it can be deduced that agricultural policy, within the framework of the new agro-export model, exhibits a bias towards export promotion. However, the persistent absence of a clear and defined policy favouring agriculture for the domestic market has been a recurring theme throughout Peru's republican history. During the formative periods of the republic in the 19th century, the primary focus of the political elites was to bolster export agriculture, primarily located in the Coastal region (Tantalean, 1983). Evidence supporting the continuation of this trend into the 20th century can be found in the examination of public budgets allocated to agricultural investment from 1905 to 1968 (Portocarrero et al., 1988). The authors confirm a bias in public investment towards export-oriented agriculture, particularly manifested in irrigation projects in the Coastal region. Despite investments in the Sierra and Amazon regions in recent decades, this reality has seen little change (Hopkins, 1995; Pintado, 2022).

As discussed in Chapter 2, when analyzing the state of agriculture during the 19th century, water scarcity along the coast was identified as one of the constraints hindering the development of export-oriented agriculture. In this context, it is unsurprising that one of the cornerstones of agricultural investment was directed towards addressing this pressing issue. Consequently, in 1902, Peru enacted its first Water Code, which transferred control and management of water resources to the State. As Oré (1986) concludes, this event marks a significant milestone in Peruvian agricultural history. Therefore, all efforts to expand and improve the irrigation system were driven by the State, with control and management of water resources entrusted to state officials. The table 6.8 presents data regarding the extent of irrigated agricultural land in hectares within the Coastal region from 1906 to 1964.

Table 6.8. Increase in irrigated agricultural land in the Coastal region during the period 1906-1964 (hectares)

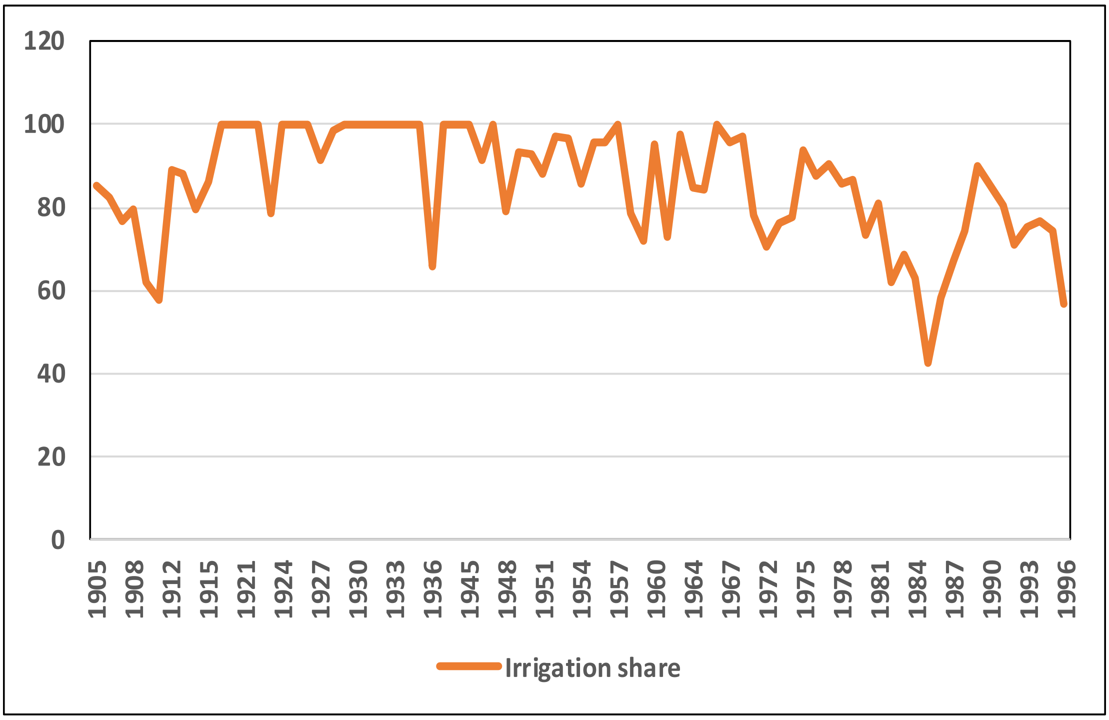
	New lands	Improved lands	Total
North Coast	61,245	93,500	154,745
Central Coast	37,749	84,600	122,349
South Coast	21,299	-	21,299
Total	120,293	178,100	298,393
Public investment	95,493	178,100	273,593
Private investment	24,800	-	24,800
Share of public investment (%)	79.4	100	91.7

Source: Apacclla et al. (1993)

It is observed that the distribution along the coast is 52% for the North Coast and 41% for the Central Coast. Moreover, 91.7% of the new lands and improved lands have been financed through public investment, with the remainder funded by private investment. To supplement the significance of investments in irrigation within the public budget allocated to agricultural investment, Figure 6.3 illustrates the evolution of the share of this investment in the total for the period 1905-1996.

At the onset of the period, participation fluctuated between 60-80%, subsequently persisting at the upper range of over 80% until the early 1970s. It then declined to its lowest level by the mid-1980s, before rebounding and reaching levels above 80%. Overall, the trend message is unequivocal; investment in irrigation has constituted the primary allocation of public investment in agriculture.

Figure 6.3. Evolution of the public investment participation in irrigation as a part of total agricultural public investment, 1905-1996 (In %)



Source: Author own elaboration based on Portocarrero et al. (1988) and Velazco (2001).

6.3.4. Public investment allocation: An analytical framework[48]

To elucidate the disparity in the allocation of public investment budget between agriculture targeted for domestic consumption and that aimed at foreign markets, this section presents a straightforward analytical framework for examining the identified issue. This involves undertaking both static and dynamic analyses. Assuming that the government possesses a budget denoted as B_0, which is to be allocated across the two categories of agriculture, equation (1) summarises the line that is formed by all potential combinations of allocations between the two groups.

$$B_0 = \text{Domestic agriculture} + \text{Export agriculture} \qquad (1)$$

The panel a) of Figure 6.5 depicts the budget line defined by equation (1). The vertical axis denotes the budget allocated to agriculture geared towards the domestic market, while the horizontal axis represents allocation for the export market. Along this budget line, several points can be identified, including C, D, and A, each indicating different budget allocations. The central inquiry pertains to the determinants of these

[48] This section represents a contribution by the author, who has employed the basic concept of budget constraint to apply it to the issue of expenditure allocation between the two agricultural types.

various positions along the straight line. Three explanations can be delineated: a) the role ascribed to agriculture within the growth model (whether it is geared towards generating foreign exchange or ensuring food security); b) the influence exerted by power factions (economic elites/agricultural unions); and c) the political determination to allocate resources to vulnerable segments within the agricultural domain.

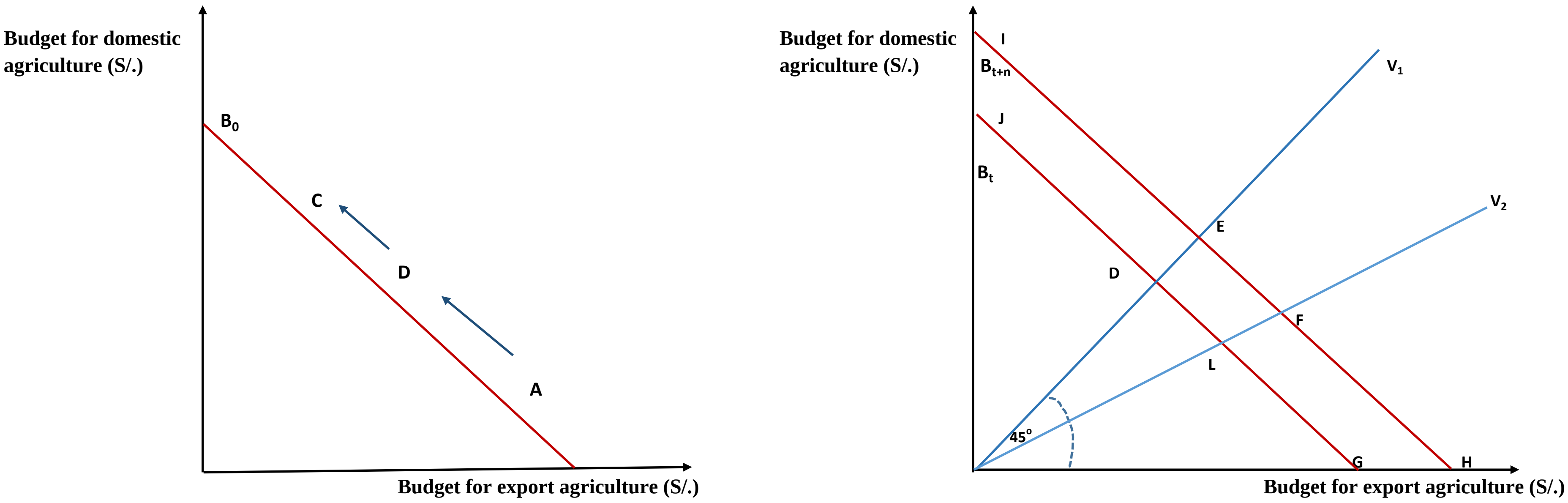
Point A exemplifies the state of Peruvian agriculture, wherein the growth model assigns the function of generating foreign exchange to the sector. Conversely, an ideal scenario advocating comprehensive support for agriculture targeted primarily at the domestic market, notably family farming, would necessitate positioning at points D or C. These points denote substantial shifts in public budget allocation, fundamentally reshaping the distributive dynamics within the agricultural sphere and favouring historically marginalized sectors.

Panel b) of Figure 6.4 approaches the same issue from a dynamic perspective, considering two budgets at different time points: B_t and B_{t+n}. It is assumed that the public investment budget increases between time periods t and t+n. Each budget engenders its own budget constraint; assuming a growth trajectory for the budget over time, the line moves away from the origin. The analysis incorporates vector V_1, oriented at a 45-degree angle, implying that various combinations of budget allocation for each type of agriculture along V_1 are of equal magnitude. This indicates that in combinations D and E, an equivalent budgetary allocation is made for both domestic and external markets, representing an equal distribution of resources. However, this is not the scenario observed in the Peruvian context. The scenario that best illustrates the analysed situation is represented by V_2. Along this vector, points L and F denote budget allocations where a larger portion of the budget is allocated to export-oriented agriculture.

Figure 6.4. Public budget allocation between export and domestic agriculture

a) Estatic analysis

b) Dynamic analysis



Source: Author elaboration

In Table 6.9, the results of the graphical analysis and their implications for the long term are summarised. It is important to highlight that the situation that best fits the Peruvian case is a bias towards export agriculture, which creates a scenario of underinvestment in agriculture intended for the domestic market. In the context of an open economy, and with expanding food demand driven by demographic growth and increasing consumer incomes, imports are opted for as a solution to meet domestic demand.

Table 6.9. Main outcomes of public budget allocated to agricultural investment

Budget allocation	Outcome in the long-run
Throughout vector V_1: D and E	Equal allocation between domestic and external agriculture
Any combination within the segments DG or EH	Export agriculture bias, public underinvestment in domestic agriculture
Any combination within the segments JD or IE	Domestic agriculture bias, public underinvestment in export agriculture

Source: Own author elaboration based on Figure 6.4.

Having analytically discussed the bias of agrarian investment policies against agriculture for the domestic market, and recognizing that these producers are predominantly organized as family or peasant agriculture and located in the Sierra region as previously mentioned in Chapter 2[49], the following section will present evidence regarding the nature of the relationship between family farming and the state.

6.4. The Relationship between Family farming and the State: A Long-Term Perspective

An inquiry arising from the analysis conducted thus far concerns explaining the republican state's attitude towards agriculture aimed at the domestic market. It is important to recall that during the colonial period, the agreement between the indigenous population and the colonial state was one of tutelage concerning access to communal land. Thus, indigenous communities would have access to land for their subsistence, and this situation ensured their role as tributaries to the Spanish crown through forced labour in

[49] According to data from the first agricultural census of 1961, 80% of agricultural units were located in the Sierra. It can be assumed that this share was significantly higher at the beginning of the 20th century.

mines, textile workshops (*obrajes*), haciendas, and payment of tributes in money. This agreement was disrupted from the onset of the republic, with the establishment of a liberal approach that theoretically considered indigenous people as citizens and individual landowners with the same rights as *criollos* and mestizos (Remy, 2014). However, the economic constraints of the nascent republic led to the reinstatement of indigenous tribute until 1854, when the substantial resources from guano exports provided significant fiscal relief.

The situation of the indigenous population regarding the maintenance of their rights to communal lands was seriously threatened. The expansion of haciendas, spurred by promising prospects in global markets for wool exports in the mid-19th century, prompted the *gamonales* (*hacienda* owners of the Sierra) to initiate a strategy of expansion through the usurpation of communal lands. Thus, the haciendas that survived the colonial period grew larger, and new haciendas emerged. This dark period between 1854, when the indigenous contribution was eliminated, and 1920, when the state recognized indigenous communities, saw continued expropriations and usurpations of communal lands in the absence of tutelage from the republican state (Remy, 2014). In this regard, Jacobsen (2013) illustrates the case of how indigenous pastoral communities in Azángaro, Puno (1780-1930), in the southern part of the country, interacted with the state and suffered losses of their lands due to the expansion of *gamonal haciendas*, which responded to a flourishing wool export market.

This section will discuss the situation of the indigenous population regarding access to civil rights, followed by the presentation of evidence regarding their access to economic and social assets.

6.4.1 Access to citizenship and relationship with the Republican state

To delineate the features of the Sierra region and its significance as a dwelling place for the indigenous population, the following text by Contreras (2014:15) is pertinent:

> "The Sierra region was until the mid-20th century the most populous, but it was mainly composed of indigenous people who, due to their poverty and isolation, had a very austere level of consumption. Consequently, their demand did not promote a solid local industry capable of creating a local accumulation sector. The Sierra remained as a kind of demographic and natural resource 'reserve' for the coastal population, who felt entitled to access these resources in exchange for the theoretical government services provided to them. Thus, regional inequality was added to cultural and economic inequality. The interplay between a white/mestizo coast, whose elite based in Lima controlled the government and ports of the

country, and a predominantly indigenous population in the Sierra, engaged in a peasant economy, with some white or mestizo mining enclaves, marked the social dynamics of Peruvian history until the mid-20th century." (The translation from Spanish is mine).

In order to gain insight into the relative importance of the indigenous population, Contreras (2015) provides statistical data showcasing the racial distribution of the population over various census years. Table 6.10 shows that towards the end of the 18th century, the indigenous populace comprised 57% of the total population, which increased to 62% by 1827. The census of 1876 indicates that over half of Peruvians (58%) were of indigenous descent. However, this percentage had declined to 46% by the time of the 1940 census, which was the last official measurement of ethnicity. Subsequent estimations from 1980 suggest that the indigenous population constituted between 38% and 40% of the overall population (Paredes, 2008).

Table 6.10. Racial distribution of the Peruvian population (1791-1940) (in %)

Races	1791	1827	1876	1940
White	13	-	14	
Mestizo	23	-	25	52
Indigenous	57	62	58	46
Black	6	-	2	1
Others	1	-	2	1

Source: Contreras, et al. (2015:37).

The Constitution of Cádiz of 1812, characterized by its reformist and liberal nature, marked the first formal attempt to confer citizenship upon the indigenous population. This entailed the abolition of the erstwhile legal system comprised of the "Republic of Spaniards" and the "Republic of Indians," which had been in force throughout the three centuries of the colonial period. Although the Constitution was annulled in 1814, leading to a return to absolutism, the landscapes of colonial America were forever altered. The opposition to reverting to an absolutist and centralizing regime set the stage for the emergence of liberating expeditions in the South American continent (RENIEC, 2019).[50]

[50] A comprehensive examination of the impact of the Constitution of Cádiz on the Viceroyalty of Peru can be found in Chiaramonti (2021). For an in-depth historical analysis of the evolution of the concept of citizenship based on the formation of electoral rolls in Peru from 1812 to 2019, refer to RENIEC (2019).

One approach to delving into the issue of indigenous population's access to citizenship is to trace the evolution of electoral legislation. Table 6.11 presents an overview of the evolution of voting rights as stipulated in the 19th and 20th-century Constitutions, spanning the years from 1839 to 1979.

Table 6.11. Voting rights in the 19th and 20th – century Constitutions, 1839-1979

Year	Article
1839	"All who know how to read and write, with the exception of indigenous and *mestizos*, until 1844, in the places where no school for primary instruction exist".
1856	"All citizens that know how to read and write or are heads of a *taller*, or have a fixed property or have been retired, according to law, after having served in the army".
1860	"All citizens who know how to read and write, or are head of a *taller*, or have a fixed property or pay to the Public Treasury any contribution. The exercise of this will be regulated by a law".
1896	"The right to suffrage is exercised by individuals aged 21 or older, or those who are married and have not reached that age. To qualify, individuals must possess literacy skills, be registered in the civic registry of their place of residence".
1933	"Citizens who possess the ability to read and write enjoy the right to suffrage; additionally, in municipal elections, adult Peruvian women, whether married or having reached the age of majority, also have this right."
1979	"Citizens are individuals aged eighteen or above in Peru. To exercise citizenship, registration in the Electoral Register is a prerequisite. All citizens in the enjoyment of their civil capacity have the right to vote. Voting is personal, equal, free, secret, and mandatory until the age of seventy, after which it becomes optional".

Source: Information from 1839 to 1860 from Paredes (2008). From 1896 to 1979, author elaboration using the web page of the Peruvian Congress: https://www.congreso.gob.pe/constitucionyreglamento/

The table summarises legislative articles pertaining to the requirements for citizens to exercise their suffrage rights. Liberal-origin constitutions purportedly advocated for juridical equality and citizenship rights for *criollos*, mestizos, and indigenous peoples, at least in theory. Until the legislation of 1860, there was an option for the indigenous population to exercise their right to vote, often through military service. Del Aguila (2013) demonstrates how between the period 1821-1896, a corporatist citizenship (*ciudadanía corporativa*) is formed to the extent that indigenous peoples had the right to participate in indirect elections, albeit not to be elected. However, starting with the constitution of 1896, literacy in Spanish became a prerequisite for voting. This requirement was reiterated in the constitutions of 1929 (Art. 66) and 1933 (Art. 86).

Consequently, the predominantly illiterate indigenous population was effectively disenfranchised. It wasn't until the constitution of 1979 that universal suffrage was established.

The denial of voting rights to illiterates in 1896 was a deliberate attempt by the Lima elites to exclude the indigenous population, whom they blamed for the defeat in the Pacific War. Regarding this matter, Paredes (2008: 5) concludes:

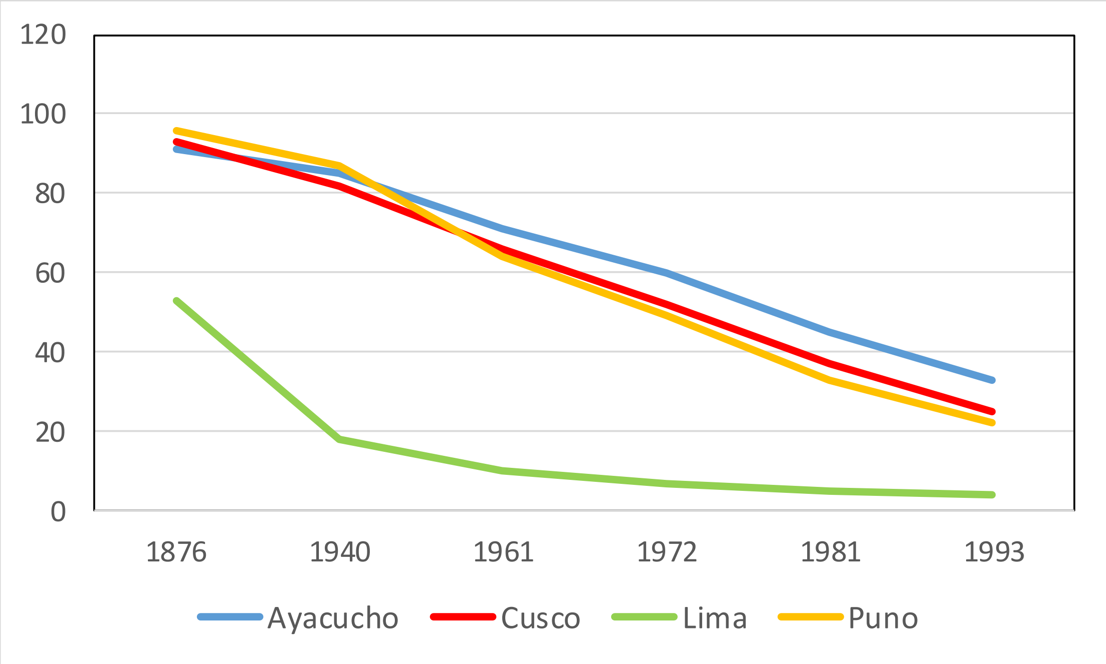
> “As noted above, in 1896, after the Pacific War, voting rights were restricted to the literate, thereby excluding indigenous people. The legislation seems to have been explicitly written to exclude indigenous people, and expresses the enormous disappointment of the Peruvian elite, particularly from Lima, with the pluri-ethnic nature of the country after the dramatic defeat by Chile. The elite blamed the indigenous for the loss of the war because they believed they lacked patriotic sentiments or civic virtues to fight for the nation”.

If literacy in Spanish was a condition for acquiring citizenship and exercising political rights, it is not surprising to identify that access to education was one of the priorities, alongside land, for indigenous communities once they achieved legal recognition under the constitution of 1920.

The magnitude of the extent of illiteracy problem in the Sierra *departmentos* from 1876 to 1993, considering the years of the censuses implemented during that period, is depicted in Figure 6.5. It compares the cases of Lima, the capital of the republic located on the Pacific coast, with the cases of Sierra *departmentos* such as Cusco, Puno, and Ayacucho. The census data from 1876 shows that the national illiteracy rate was 81%. However, a significant difference is found in the illiteracy rates between Lima, around 53%, and the other Sierra *departmentos* with an average of 93%.

Faced with this scenario, the *Civilista* party in power during 1899-1919, a period known as the Aristocratic Republic, initiated a program that considered access to education for the indigenous masses, comprising 57% of the total population of the country, as a strategy for national inclusion (Contreras, 1996). The results were not as anticipated, and the census of 1940 demonstrated that little progress had been made in closing the literacy gaps, prompting the implementation of another approach led by the group known as "*indigenistas*," who advocated for literacy in Spanish through the teaching of Quechua. The subsequent decades demonstrate an acceleration in the decline of the illiteracy rate, albeit a gap with Lima persists; nevertheless, there is a discernible tendency towards convergence[51].

Figure 6.5. Percentage of illiteracy by selected *departamentos* according to national censuses



Source: Contreras (1996:37).

Arroyo (2015) examines the limitations of educational policies during the period 1876-1940 and finds that despite the exclusion of illiterates from voting, the provision of public goods expands. In the case of education, there is an increase in literacy and schooling. However, power struggles between the national elites, with a centralist inclination, and the regional elites, advocating decentralization, led to an unequal distribution of public resources, as evidenced by regional disparities in access to education when comparing areas with high and low indigenous population presence. The author concludes that the restriction on indigenous population's access to suffrage results in suboptimal provision of public resources. Therefore, "the indigenous populations' participation in the political process was constrained and its voice muted" (2015:106).

In the face of this scenario of denial of their civil rights and citizenship, it is important to note that the indigenous population was not passive, and there are studies that make visible the strategies they implemented to adapt to their new circumstances. In one such study, Méndez (2014) presents, with all its complexity, the political experiences

[51] A discussion on the effectiveness of educational policies from the late 19th century to 1960 can be found in Contreras (1996).

of the population of Huanta, predominantly peasant and indigenous, from a coca-growing and Sierra region of Peru, during the early decades of independent life (1820-1850). The author highlights the participation and protagonism of the lower classes, thus challenging the traditional view that emphasizes the exclusive role of the elites in the construction of the State.

One of her main arguments is the idea of a "plebeian republic," in which the indigenous and mestizo communities of Huanta played a fundamental role in shaping state structures and resisting the imposition of power from Lima. Méndez argues that, far from being passive or subordinate, these communities played an active role in local and regional politics, articulating forms of resistance and autonomy in the face of central authorities. In this same line of thought, Thurner (2006) explores, from the perspective of postcolonial studies, how the indigenous population, an important part of the subaltern groups, adapted to the new context of the republic and established their strategies to connect and negotiate their rights with local authorities and elites.

Another study in line with this discussion is that of Guerrero (2022) when examines, for the decades from 1820 to 1870, the case of the indigenous Aymara population in the provinces of Arica and Tarapacá. The Lima elites promoted policies aimed at the destruction of the organizational and territorial system of these populations. They responded by deploying significant negotiating and adaptive capacity, allowing them to resist and, therefore, participate in the nation-building process. According to Guerrero (2022:15):

> "Such capacity was materialized through the instrumental use of republican rhetoric, the strategic appeal to the status of taxpayers, the establishment of complex alliances with local authorities, and the validation as indigenous landowners of communal lands since colonial times, constituted the means to make themselves heard and thus, plead for the defense of their lands, goods, and, above all, cultural specificity." (the translation from Spanish is mine)

The relationship between the state and indigenous communities has evolved over time, reflecting changing ideologies, policies, and societal norms. Díez (2022) provides a comparative analysis of the long-term perspectives of the state-indigenous community relationship, focusing on three distinct stages: Recognition (1920-1969), Developmentalism (1970-1990), and Neoliberalism (1990-2021). Each stage is examined in terms of the views and projects of the state, perspectives and demands of the communities, state-community pacts, and normative regulation. Table 6.12 summarises the most relevant components of each period.

During the Recognition Stage (1920-1969), the state focused on recognizing and protecting indigenous land rights, organizing communal institutions, and integrating indigenous communities into national society. The tutelary pact emphasized state tutelage and trust renewal. Normative instruments such as the Constitutions of 1920 and 1933 provided regulations for communal elections and recognition.

The developmentalist (1970 – 1990) era saw an emphasis on tutelary protection of collective land, communal legislation, and development programs. Indigenous communities sought recognition and development projects, including price safeguards. The Development Pact aimed to improve living conditions and promote rural development, supported by the Constitution of 1979 and the Law of Peasant Communities.

In the subsequent period from 1990 to 2021, neoliberal policies shifted towards privatization, titling programs, and anti-communal measures, leading to demands for consultation rights, resource claims, and the restoration of land tutelage. The absence of a formal pact reflected state disregard, prompting communal claims for state presence. Normative regulations included the Constitution of 1993, Land Law, Convention 169, and the Indigenous Consultation Law.

Table 6.12. Long run Perspectives of the State and Indigenous Communities Relationship and Normative Instruments

Stages	**Recognition 1920-1969**	**Developmentalism 1970-1990**	**Neoliberal 1990-2021**
Views and Projects of the State	Tutelary protection of indigenous land Organization of communal institutional structure Programs for integration into national society	Tutelary protection of collective land Communal legislation Development and productive extension programs	Emphasis on private property Titling programs Anti-communal policies Demand for public records
Perspectives and demands of the communities	Recognition Protection of land rights Legitimization of internal processes and agreements	Recognition Development programs and projects Price safeguards	Right to consultation Claiming rights over resources State intermediation Defense of rights Restoration of tutelary condition of the land and new Constitution
State-Community Pact	The tutelary pact Recognition, integration, and protection through the renewal of trust and state tutelage	Development Pact: Improvement of living conditions, production, and services in rural areas State investment for social purposes	Absence of a pact: State disregard and communal claims for state presence Subsidiary State in the economy
Normative regulation	Constitutions of 1920 and 1933 Regulations for recognition and communal elections	Constitution of 1979 Law of Peasant Communities and delimitation and titling	Constitution of 1993 Land Law Convention 169 Indigenous Consultation Law

Source: Díez (2022:135).

In conclusion, the state-indigenous community relationship in Peru has evolved through distinct stages, each characterized by unique perspectives, demands, pacts, and normative regulations. While the Recognition stage emphasized state tutelage and integration, Developmentalism focused on rural development and communal legislation. However, the neoliberal era witnessed tensions arising from privatization and anti-communal policies, leading to demands for consultation rights and the restoration of land tutelage.

6.4.2 Access to economic and social assets

In this section, the discourse will centre on the extent to which the republican state has managed to furnish citizens with access to a variety of social and economic resources, which can be construed as benchmarks for assessing the attained level of state capacity development. It is reasonable to infer that extensive coverage in the aforementioned indicators signifies a heightened level of population well-being.

Soifer (2016) analyses the characteristics of the state-building process in Latin America. Tables 6.13 and 6.14 display historical trend information for 2000 and 1900, respectively, regarding indicators associated with the level of state capacity reached for 11 Latin American countries. The first two columns of Table 6.13 present indicators of coercive capacity such as military mobilization (measured as the average share of the population in the armed forces and military spending per capita) and the homicide rate. The other two columns provide indicators of the provision of basic public goods, such as the literacy rate and the rate of immunizations for measles and DPT (diphtheria, tetanus and pertussis) among children under the age of one. The final indicator is road density, which reflects the ability of state agents to penetrate the territory within a country's borders. This data corresponds to the year 2000, and from the comparison with the 11 countries, it is observed that Peru, along with Paraguay and Bolivia, exhibits the poorest performances. Conversely, Uruguay and Chile emerge as the strongest states.

Comparing the ranking with information from Table 6.15 for the year 1900, the category of census implementation appears to account for the state's organizational capacity to reach the territory and obtain relevant information to define public policies. It is noted that Peru ranks last in the ranking (average value). Therefore, it can be concluded that in comparative terms, the capacity of the Peruvian state is limited. And no significant changes have occurred over the century that mediates the discussed information[52].

[52] A question arising from the reading of the preceding tables is why notable divergences have occurred in the level of state capacity in Latin American countries after they formed as republics in the second decade of the 19th century. While this topic exceeds the scope of this chapter, an analysis of the historical foundations of unequal state capacity in Latin America can be found in Kutz (2013), Saylor (2014), and Soifer (2015). A critical assessment of the approaches used by the mentioned authors is found in Urteaga (2017).

Table 6.13. State capacity rankings *c.2000*

	Military	Homicide rate	Literacy	Immunization	Road density	Average	St. Dev.
Argentina	6	3	2	5.5	8	5.42	2.27
Bolivia	8		11	9	11	9.67	1.53
Brazil	8	9	10	1	2	5.33	3.25
Chile	1.5	1	3	3	7	3.75	2.95
Colombia	6	10	5.5	7.5	5	6.50	1.50
Ecuador	5	5	7	11	4	6.00	2.65
Mexico	9	8	8	2	3	5.50	2.78
Paraguay	9	7	5.5	7.5	9	7.83	1.26
Peru	6	4	9	5.5	10	7.42	2.50
Uruguay	2	2	1	4	1	1.83	0.76
Venezuela	5.5	6	4	10	6	6.25	0.66

Source: Soifer (2016:13).

Table 6.14. State capacity rankings *c.1900*

	Military	Literacy	Road density	Census implementation	Average	St. Dev.
Argentina	2.5	2	3	7	3.625	2.29
Bolivia	9	11	8	5	8.25	2.50
Brazil	4	4	5	3	4.875	1.93
Chile	1	3	4	1	2.25	1.50
Colombia	10	5	10	7	8	2.45
Ecuador	6	6	11	11	8.5	2.89
Mexico	8	9	2	7	6.5	3.11
Paraguay	4.5	7	9	9.5	7.5	2.27
Peru	9.5	10	6	9.5	8.75	1.85
Uruguay	2.5	1	1	3	1.875	1.03
Venezuela	5.5	6	7	3	5.375	1.70

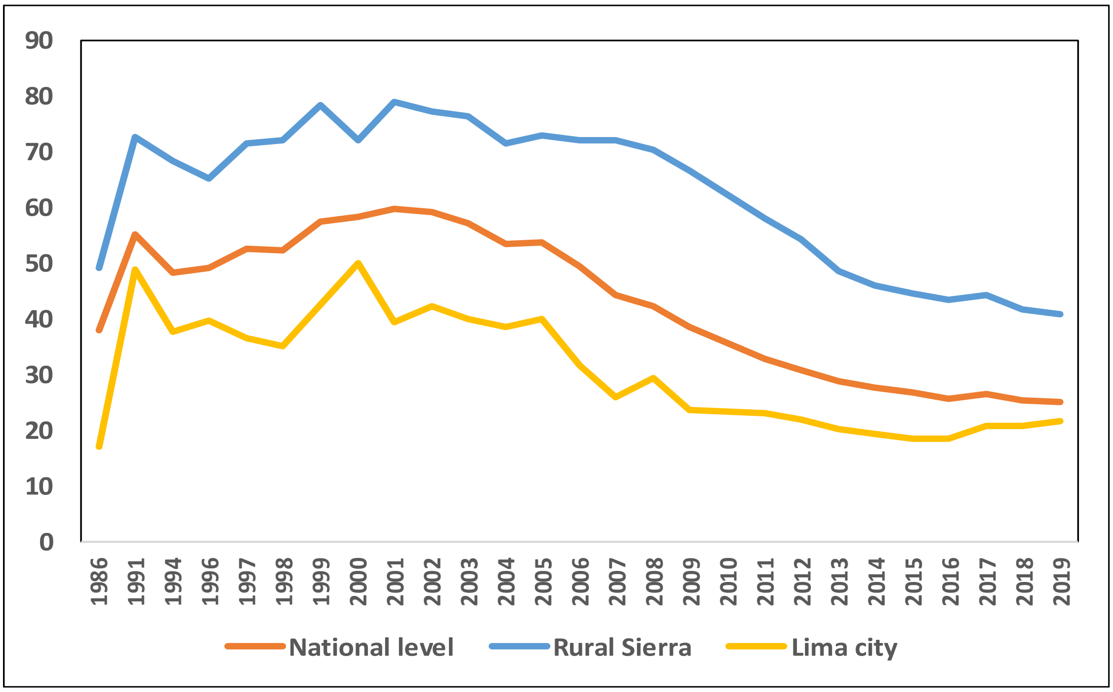
Source: Soifer (2016:12).

There is unanimity among researchers that the Peruvian state is absent, precarious, small, and weak (Incio and López, 2015; Grompone, 2017; González and Asensio, 2021, among others). In this regard, the issue of the capacity of the Peruvian state 200 years after independence is succinctly summarized by Zapata (2021:481-482), who states:

> "In these two hundred years, the State is the nation's main deficit. It is poorly organized, with overlapping functions occurring across different spheres, and there are no consensus mechanisms for conflict resolution. (...) But the primary ill of the State is the high level of corruption that corrodes it from top to bottom, with honorable exceptions. The State's last problem is its subsidiary nature in relation to the market. According to the current constitution, its capacity to intervene in the economy is limited, and it cannot be a driver of economic development. Therefore, in its current situation, the State is irrelevant, as well as corrupt and poorly organized." (The translation from Spanish is mine).

Faced with a performance indicating a low level of state capacity in Peru, it is not surprising that the assessment of the monetary poverty indicator shows high rates. Figure 6.6 also highlights gaps in poverty rates, which are higher in rural Sierra compared to the national average and the city of Lima. It is interesting to note the sustained decline from the beginning of the 21st century. Recalling the discussion in Chapter 5, which illustrates, in the context of the mining price boom and the onset of an expansive economic cycle, the state's decision to allocate its budget to social policies and rural investment. This implies, within the framework of the household model discussed then, that the increase in public assets creates incentives for income improvements in rural households and enables them to escape poverty.

Figure 6.6. The evolution of the monetary poverty rate at the national level, rural Sierra and Metropolitan Lima (In %), 1986-2019



Source: Gonzales de Olarte (2023:179). Estimates are based on national household surveys conducted by the National Institute of Statistics and Informatics and Cuanto Institute.

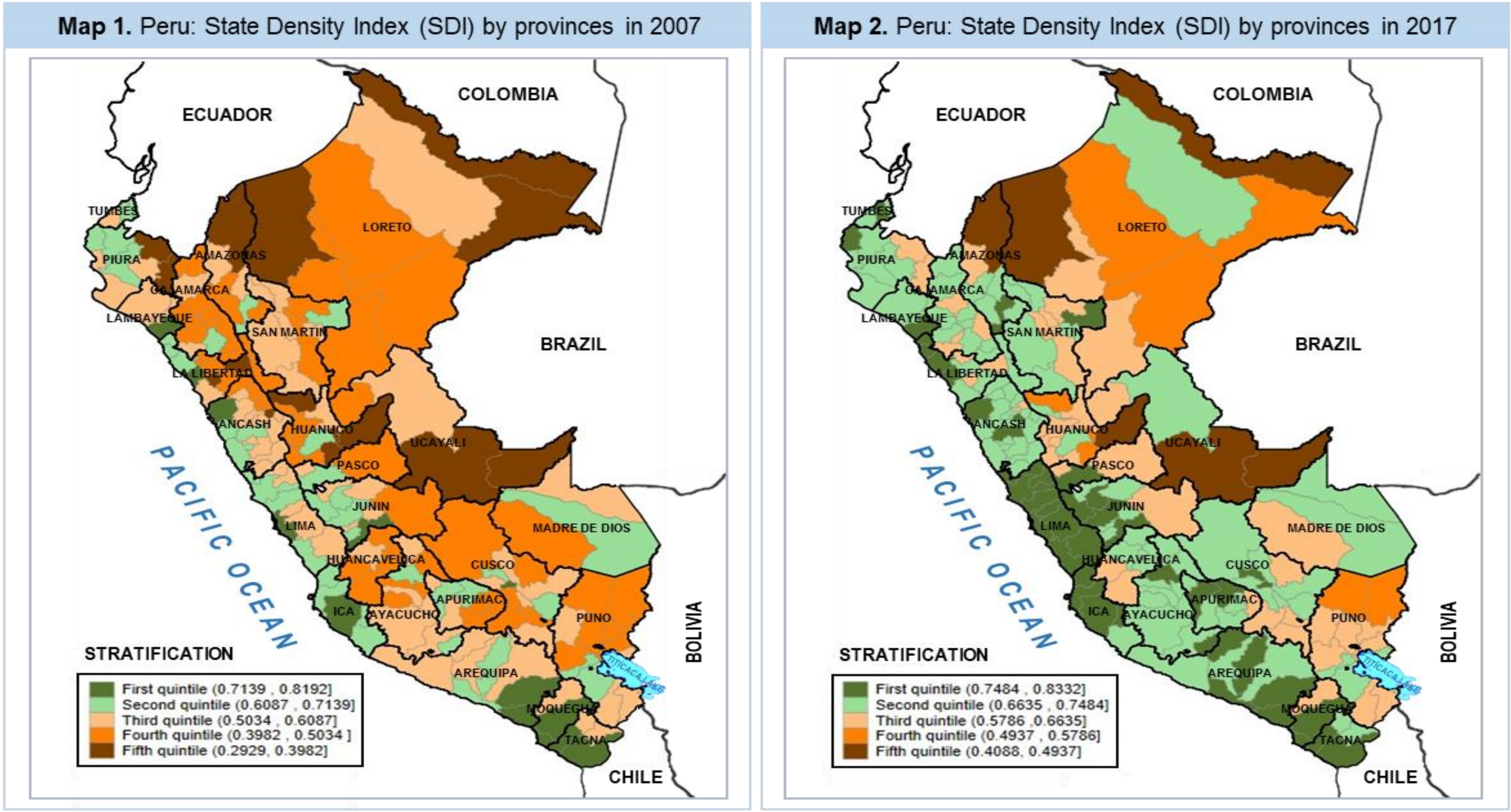
To assess the recent performance of the Peruvian state, the results of the State Density Index for the years 2007 and 2017 will be presented at the provincial level. Its formulation takes into account the findings of the population censuses conducted in the respective years.

The State Density Index proposed by UNDP (United Nation Development Program) is a synthetic indicator, measured at the provincial level, which allows evaluating the contribution of the state to human development. According to UNDP (2009: 27-28), "state density is conceived (...) in terms of the performance or functioning of the state at the moment of providing basic social services. The magnitude of state density in a given area will depend on the number and coverage of services that the state offers in it". In this context, the services considered are basic services (health, education, and sanitation), connectivity and integration (electricity), and citizenship (identity).

The indicators used for each dimension are, for health, the number of doctors per 10 thousand inhabitants. In education, it is the ratio of attendance to secondary school of the population aged 12 to 16 over the total population aged 12 to 16. The sanitation indicator is the ratio of households with water and sewage over the total number of households. Access to electricity is measured based on the rate of households with electricity over the total number of households. Finally, identity is measured based on the percentage of the population with possession of an identity document relative to the total population. Each indicator follows a standardization methodology, and these new indicators are used to define the state density index as the simple average index, with equal weight of 20% (UNDP, 2019).

In Figure 6.7, maps of Peru depicting the evolution of the index for the years 2007 and 2017 are presented. The green colour and its darker variations denote a higher intensity of the state, while the orange colour indicates lower density. For 2007, coastal provinces are in the first quintiles of the index, with most of the Sierra provinces ranging between the third and fifth quintiles. This situation changes ten years later, as central coastal provinces are now in the first quintile, and the rest of the coast is in the second quintile. There is progress in Sierra provinces, which now range between the second and third quintiles, while provinces in the Amazon are in the lowest quintiles. Although there have been improvements, regional disparities still exist and need to be addressed.

Figure 6.7. State Density Index by provinces in 2007 and 2017



Source: Population and Housing Census, 2007 and 2017. Elaborated by PNUD-Peru (2019).

6.5. Strategies from domestic agriculture' actors

In this section, the strategies implemented by family agriculture to engage with the state and voice their demands will be examined. From a long-term perspective, peasant rebellions and mobilizations have been a recurring phenomenon since the colonial period. O'Pheelan (2012), examining a dataset of 140 uprisings and rebellions that occurred in the eighteenth century in the Viceroyalty of Peru, including the Alto Peru region, identifies three distinct periods of social unrest. The first period occurred from 1724 to 1736, triggered by sharp fiscal policies involving revisions and adjustments to tribute and forced labor (*mita*). The second period occurred following the legalization of the distribution of goods by the *corregidor* between 1751 and 1756. The third period coincided with the implementation of Bourbon fiscal reforms starting in 1777. This era culminated in the significant rebellion led by José Gabriel Túpac Amaru II, which garnered substantial regional influence in the southern Andes, affecting the Cuzco-Potosi commercial circuit. The economic factor, delineated through tax burdens, forced labour, and mandatory purchases imposed by authorities, constitutes the foundational catalyst behind the mobilisations throughout the 18th century.

To attain a comprehensive overview of peasant movements from the 19th century to the mid-20th century, the classification proposed by Kapsoli (1987) is of particular interest. The author delineates five distinct periods: the antifiscal movements (1879-1896), millenarian movements (1919-1930), reformist movements (1945-1948), and revolutionary movements intertwined with struggles for land (1956-1965).

Focusing on agrarian mobilizations from the mid-20th century onwards, Table 6.15 summarises the main demands of agricultural producers for the periods 1956-1964, 1985-1989, and 2008-2022. As observed, the first period coincides with peasant struggles for land access, and demands against government measures and land issues become prominent. In subsequent decades, other factors drive agricultural producer mobilizations. For instance, from the 1980s onwards, demands revolve around agrarian policy measures such as prices, credit, access to technical assistance, and investments. These are components of agrarian policy that have been absent in the state's relationship with agriculture intended for the domestic market. These measures directly affect the profitability and viability of the sector. It can be suggested, without seeking to prove it conclusively in this chapter, that the income diversification strategy of family farming may be a mechanism that enables the continuity of agricultural activity despite being carried out under precarious conditions and lacking public support.

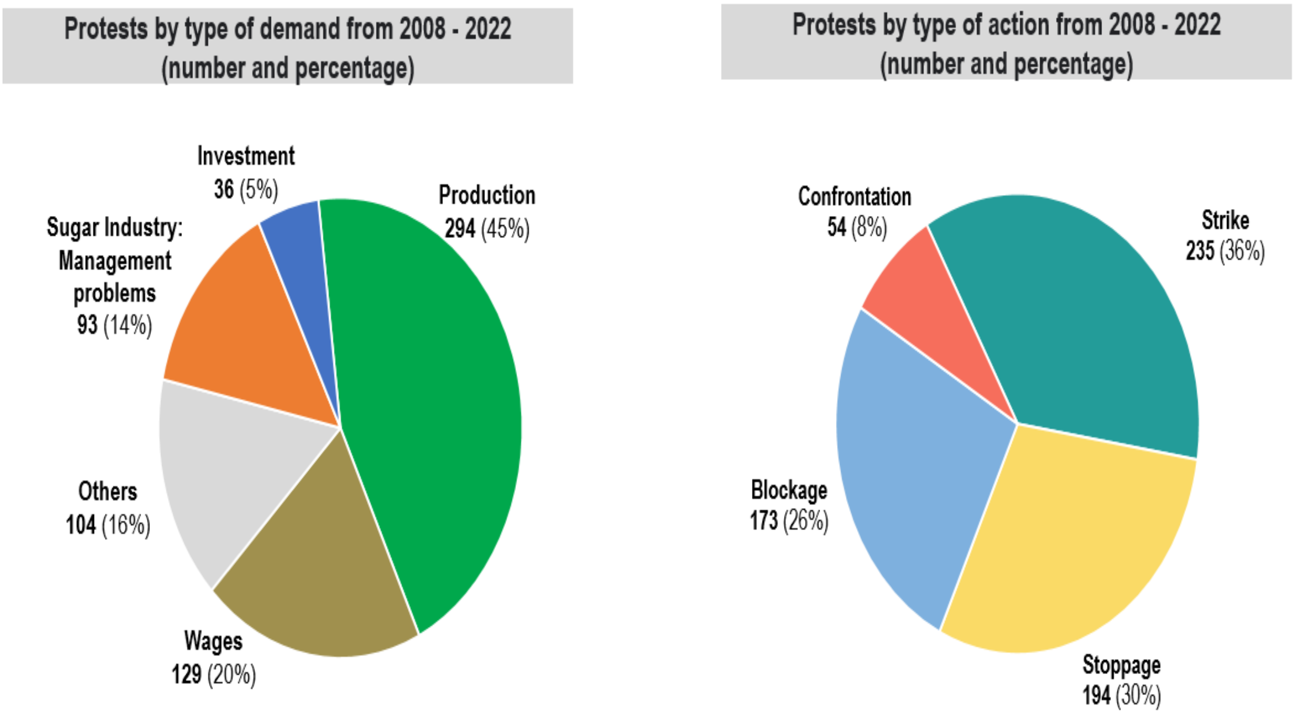
Table 6.15. Demands of agricultural producers during 1956-1964, 1985-1989 and 2008-2022

Demands	1956-1964		1985-1989		2008-2022	
	Number	%	Number	%	Number	%
Against State measures	254	29.6	21	14.8	--	--
Non-compliance with the National Agrarian Agreement	--	--	17	12	--	--
Land issues	330	38.5	15	10.6	--	--
Claims for fair prices, credit, access to technical assistance, investment	12	1.4	60	42.3	330	50
Labour relations (wages and working conditions)	151	17.6	--	--	129	20
Local power issues	68	7.9	--	--	--	--
Sugar industry (management problems)	--	--	--	--	93	14
Other issues	22	2.5	29	20.3	104	16
Total	858	100	142	100	656	100

Source: The data for 1956-1964 is obtained from Monge (1989), whereas that for 1985-1989 is derived from Velazco et al. (1990). For the years 2008-2022, access was granted to the social mobilization database prepared by the Office of the Ombudsman.

Figure 6.8 illustrates, for the mobilizations during the period 2008-2022, the agrarian demands categorized by type of demand and action. In the first scenario, 50% are associated with productivity-related aspects, while 20% correspond to calls for higher wages and improved working conditions. These mobilizations primarily involve wage laborers employed within agro-export complexes. Additionally, there is a 14% share of mobilizations linked to workers from former sugar cooperatives, established during the agrarian reform of 1969, who, amid privatization, struggle to address management issues.

Figure 6.8. Agrarian Protests by Type of Demand and Action, 2008-2022



Source: Author's elaboration using the database of the Office of the Ombudsman.

To conclude this section, Figure 6.9 depicts a map illustrating the geographical distribution of protests across *departmentos*. Protests are dispersed across nearly all *departmentos,* with a notable concentration in the coastal areas and the southern and central Sierra.

Figure 6.9
Geographical location of agrarian mobilizations and protests during 2008-2022 (numbers by *departamentos*)

Source: Author's elaboration using the database of the Office of the Ombudsman.

6.6 Conclusions

This essay focused on the political economy of agricultural policies since the 1990s when the new-agro export model was implemented and, following an old tradition in agrarian Peruvian history, a policy bias in favour of the expansion of the agro export sector is identified, undermining the options of development of agriculture oriented toward the domestic market, mainly based on family farming.

Since the 1990s, Peru has embarked on a shift in its agrarian development model. Structural reforms, particularly policies aimed at promoting agro-industrial development, have created conducive conditions for the expansion and consolidation of non-traditional agro-exportation. Notably, the Agricultural Sector Promotion Law stands out, offering a range of incentives to companies, primarily organized within large agro-industrial complexes. The role of the state transforms in this new approach, assuming a regulatory and subsidiary role, with private action proving pivotal in driving development. However, the bias towards promoting agro-export activities relegated policies aimed at the development of family farming, whose production is geared towards the domestic market—the predominant form of production organization—to a secondary and limited role. Given this backdrop, this chapter discussed the political economy characterizing the decision-making process in agricultural policy. In this regard, and following the approach of Durand (2016), forms are identified in which agrarian economic elites "capture" the state and exert control over the decision-making process. These include revolving doors and the presence of lobbying with ties to parliament.

In this scenario, the sector harmed or marginally served is agriculture for the domestic market (mainly family farming). This fact creates a tension in agrarian policy. This result also shows the little political representation and limited support in Parliament of the various producers that make up agriculture for the domestic market. In response to this context, these producers adopt a confrontational strategy with the state to address their demands and grievances.

The evidence presented, concerning the accessibility of political, social, and economic rights for the predominantly agrarian indigenous population residing in the Sierra, leads to the conclusion that during the nascent phase of the Peruvian republic, social, discriminatory, and hierarchical disparities inherited from the colonial era persisted.

Despite their significant engagement in agriculture, the indigenous populace did not attain full citizenship status. An analysis of state capacity indicators, comparing access to essential services during the 19th and 20th centuries across Latin America, consistently reveals Peru's lower regional ranking. Another crucial indicator was the right to universal suffrage, which was established as universal in the 1979 Constitution after being restricted to literate individuals since 1896, effectively excluding indigenous communities from citizenship.

In practice, these political and social exclusions manifested as a notable rural-urban divide, evidenced by comparisons of a State density indicator derived from population censuses conducted in 2007 and 2017, revealing a gradual reduction in disparities over time. In summation, from a long-term perspective, the republican State did not prioritise rural inhabitants as economic agents, nor did it formulate long-term strategies to enhance sector productivity or ensure equitable access to public services and citizen entitlements.

The analysis suggests that the concentration of family farming within a predominantly indigenous population could have contributed to the discriminatory treatment by the State in crafting agricultural policies that adequately consider the interests of these farmers. This leads to suggesting that the promise of the liberal Republic, citizens with equal opportunities and rights, was not fulfilled. And this situation evokes the relevance and pertinence of the statement made by the parliamentarian José María de Arce in 1823, who said: “La República es un simulacro”.

APPENDIX 6

Table A6.1Major Agro-industrial Economic Groups

N°	Economic Group	Legal Entity	Foundation	*Location of Facilities by Region*	Activity	2022		
						Workers	Revenue (S/ millions)	Ranking Top 20000
1	**Gloria**	CASA GRANDE S.A.A.	1970	La Libertad, Lambayeque, Áncash, Piura, San Martín, Arequipa, Junín and Lima	Sugar processing	3,302	669	282
2		CARTAVIO S.A.A.	1970	La Libertad, Lambayeque, Áncash, Piura, San Martín, Arequipa, Junín and Lima	Sugar processing	1,401	445	404
3		AGROINDUSTRIAS SAN JACINTO S.A.A.	1992	La Libertad, Áncash and Lima	Sugar processing	1,102	277	750
4		AGROLMOS S.A.	2012	La Libertad, Lambayeque, Áncash, Piura, San Martín, Arequipa, Junín and Lima	Sugar processing	748	345	531
5		AGROFUTURA COMPANY S.A.C.	1899	La Libertad, Piura, Áncash and Lima	Growing of fruits, nuts, and plants	2,217	82	2,183
6		AGROCASAGRANDE S.A.C.	2016	La Libertad, Áncash and Lima	Growing of fruits, nuts, and plants	6,015	82	2,132
7		EMPRESA AGRARIA CHIQUITOY S.A.	1992	La Libertad	Growing of cereals and other non-crop plants	297	51	3,236
8		EMPRESA AGRICOLA SINTUCO S.A.	1992	La Libertad	Growing of cereals and other non-crop plants	80	24	5,651
9		AGROSANJACINTO S.A.C.	1899	La Libertad, Áncash and Lima	Growing of fruits, nuts, and plants	505	24	5,755
10		AGROINDUSTRIAS SAN JUAN SAC	NA	La Libertad, Lambayeque, Áncash, Arequipa, Junín and Lima	Growing of cereals and other non-crop plants	NA	NA	NA
11	**D&C**	CAMPOSOL S.A.	1997	La Libertad, Lambayeque, Áncash, Piura, Lima, Callao, Arequipa and Junín	Growing of fruits, nuts, and plants	44,941	1,415	123
12		EMPACADORA DE FRUTOS TROPICALES S.A.C.	2000	Piura	Growing of cereals and other non-crop plants	1,183	72	2,374

13	**Matta Exalmar**	COMPLEJO AGROINDUSTRIAL BETA S.A.	1995	Ica, Lambayeque, Piura and Lima	Growing of cereals and other non-crop plants	17,710	850	229
14		ALPINE PERU S.A.C.	2003	Ica	Growing of cereals and other non-crop plants	189	10	15,380
15		AGROCITRICOS S.A.C.	2002	Ica	Growing of fruits, nuts, and plants	NA	NA	NA
16	**Romero**	AGRICOLA DEL CHIRA S.A.	2006	Piura, La Libertad, Lambayeque, Lima and Callao	Growing of cereals and other n.c.p.	1,431	325	590
17		PALMAS DEL ESPINO S.A.	1979	Ucayali, San Martín, Loreto, Lima and Callao	Growing of cereals and other n.c.p.	2,018	218	901
18		PALMAS DEL SHANUSI S.A.	2006	San Martín, Loreto, Lima and Callao	Growing of cereals and other n.c.p.	2,290	204	944
19		PALMAS DEL ORIENTE S.A.	2006	San Martín y Lima	Growing of cereals and other n.c.p.	420	42	3,686
20		FRUTAS DEL CHIRA S.A.	NA	NA	Growing of fruits, nuts, and plants	NA	NA	NA
21		ISLANDIA ENERGY S.A.	NA	NA	Growing of cereals and other n.c.p.	NA	NA	NA
22		PALMAS DEL AMAZONAS S.A.	NA	NA	Growing of cereals and other n.c.p.	NA	NA	NA
23	**CFI**	AGRICOLA CERRO PRIETO S.A.	2000	La Libertad, Lambayeque and Arequipa	Growing of fruits, nuts, and plants	11,963	612	342
24	**Drokasa**	SOCIEDAD AGRICOLA DROKASA S.A.	1997	Ica and Lima	Growing of fruits, nuts, and plants	9,283	525	364
25		AGRICOLA LOS ANDENES II S.A.C.	NA	NA	Growing of fruits, nuts, and plants	NA	NA	NA
26		AGRICOLA LOS ANDENES III S.A.C.	NA	NA	Growing of fruits, nuts, and plants	NA	NA	NA
27		AGRICOLA LOS ANDENES S.A.C.	NA	NA	Growing of fruits, nuts, and plants	NA	NA	NA
28	**La Calera**	PROCESADORA LARAN S.A.C.	2000	Ica and Lima	Growing of fruits, nuts, and plants	2,127	445	436

29	**Layconsa**	AGRICOLA PAMPA BAJA S.A.C.	1998	Arequipa, Lambayeque and Lima	Crop cultivation combined with animal husbandry (mixed farming)	5,126	218	868
30	**AIB**	AGROINDUSTRIAS AIB S.A.	1990	Lambayeque, Ica, Piura, Lima and Callao	Crop cultivation combined with animal husbandry (mixed farming)	2,910	218	857
31	**Rocio**	TAL S.A.	1989	La Libertad, Lambayeque, Junín and Lima	Cultivation of vegetables and legumes,	2,276	170	1,223
32		AVO PERU S.A.C.	2004	La Libertad and Lima	Growing of fruits, nuts, and plants	580	42	3,993
33	**Oviedo**	EMPRESA AGROINDUSTRIAL POMALCA S.A.A.	1970	Lambayeque	Sugar processing	2,155	204	903
34		EMPRESA AGROINDUSTRIAL TUMAN S.A.A.	1970	Lambayeque	Sugar processing	NA	NA	NA
35	**Cervesur**	PROCESOS AGROINDUSTRIALES S.A.	1990	Ica and Piura	Growing of fruits, nuts, and plants	6,346	170	1,010
36	**Huancaruna**	EMPRESA AGRICOLA SAN JUAN S.A.	1972	Lambayeque y Callao	Growing of fruits, nuts, and plants	2,971	134	1,499
37		AGROPUCALA S.A.A.	1970	Lambayeque	Growing of cereals and other n.c.p.	1,479	8	18,543
38	**Wong**	EMPRESA AGRARIA AZUCARERA ANDAHUASI S.A.A.	1970	NA	Sugar processing	474	23	6,482
39		INDUSTRIAL ANDAHUASI S.A.C.	1998	NA	Sugar processing	144	11	12,051
40		EMPRESA AGRARIA ANDAHUASI MANCO CAPAC S.A.	NA	NA	NA	NA	NA	NA
41		RIO PATIVILCA S.A.	NA	NA	NA	NA	NA	NA
42	**GEA**	COOP. AGRARIA CAFETALERA LA PROSPERIDAD DE CHIRINOS	1968	Cajamarca	Activities of agricultural and livestock services excluding veterinary activities	24	72	2,497

43	**San Fernando**	AGROPECUARIA CAMPO VERDE S.A.	2003	Ucayali and Lima	Crop cultivation combined with animal husbandry (mixed farming)	39	17	8,412
44		MAI S.A.	1984	Tumbes	Growing of cereals and other n.c.p.	236	17	9,806
45	**Inca**	AGROINCA PRODUCTOS PERUANOS DE EXPORTACION S.A.	1997	Arequipa	Crop cultivation combined with animal husbandry (mixed farming)	228	28	5,505
46	**Ajegroup**	AJEPROCESOS S.A.C.	2009	Lima	Preparation and preservation of fruits, vegetables, and legumes	47	17	8,612
47	**Wiese**	AGROEMPAQUES S.A.	2003	Callao	Preparation and preservation of fruits, vegetables, and legumes	143	15	10,242
48	**CA CHUCARAPI - PAMPA BLANCA**	CENTRAL AZUCARERA CHUCARAPI PAMPA BLANCA S.A.	1993	Arequipa	Sugar processing	292	11	12,682

Note. Not available (NA). Not Classified Previously (n.c.p.).

Source: Own elaboration using the Peru Top Publications database. The Top 20,000 companies 2022 (accessed through the PUCP-Lima library).

Table A6.2. Economic Sectors

N°	Economic Sector
1	Agroindustry
2	Forestry and Silviculture
3	Livestock Farming
4	Fishing
5	Mining
6	Hydrocarbons
7	Energy and Water
8	Manufacturing
9	Construction
10	Commerce
11	Services

Note: For the classification of sectors, it was based on the definition provided by the National Institute of Statistics and Informatics (INEI).
The services sector includes Real Estate activities, Tourism, Financial Intermediation, Telecommunications, Transportation, Public Administration, Research and Development, Legal Services, Consulting Services, Postal Services, Tanning, Publishing, Education, Entertainment, Printing, Information Technology, and other services. (Own elaboration).

Table A6.3 Agro-industry sector by activity

CIIU 3	DESCRIPTION
111	Crop cultivation of cereals and other unspecified crops.
112	Cultivation of vegetables and legumes, horticultural specialties, and nursery products.
113	Cultivation of fruits, nuts, plants whose leaves are used to prepare beverages, and spices.
130	Combined cultivation of agricultural products with animal husbandry (mixed farming).
140	Agricultural and livestock service activities except for veterinary activities.
1513	Processing and preservation of fruits, legumes, and vegetables.
1542	Sugar processing.

Own elaboration

CHAPTER 7

CONCLUSIONS

The aim of this thesis was to identify the various roles that Peruvian agriculture has played in the process of economic growth. Specifically, the research question posed was: What roles did agriculture play in the process of economic growth in Peru during 1896-2012? The hypothesis proposed that the role assigned to agriculture has been influenced by the stage of development (factor endowment, productivity, and trade openness) and implemented development strategies (roles of elites and other groups in defining macroeconomic and sectoral policies). Thus, over the long term, multiple roles of agriculture could be discerned, where it may serve as the central driver of accumulation and growth in some instances, while in others, it may be a sector subordinate to the expansion of others. Moreover, there may exist feedback relationships between sectors in certain cases.

To address the research question, the thesis was organised into five essays (from Chapter 2 to 6). By employing time series data and appropriate econometric models, it has been possible to identify these diverse roles played by agriculture during the 20th century and beginning of the 21th century. In both the traditional export promotion models (until the middle of the 20th century) and the non-traditional export promotion model (starting in the 1990s), agriculture appears as a provider of foreign exchange. Furthermore, with the urbanization process, a close relationship with the tertiary sector of the economy is found. The demand linkage shows the greatest relevance, as demonstrated by the feedback effect between these sectors. Additionally, the demand linkage is also present with migrations from the countryside to the city, as part of the income generation strategy of rural households. These are the transmission channels or mechanisms that allow the transference of the impacts of public policies and the effects of market expansion in a context of economic growth that characterized Peru, for example, during the first decade of the 21st century.

Turning to the chapter results, the second chapter of the thesis, stylized facts of Peruvian agriculture from 1824-2012, offered a long-term perspective on the regional distribution of agricultural production for the period 1824-1896, and on the distribution by market destinations, domestic and external, for 1896-2012. This latter separation was fundamental for articulating the analysis of the rest of the chapters. Additionally, the main characteristics of agricultural policies were identified. In general, it is concluded that the state's focus on supporting export agriculture appears from the 19th century, leaving preferential attention to agriculture destined for the domestic market unattended, located massively in the Sierra and organized as family farming.

The third chapter focused on the long-term relationship between agriculture, industry, mining, and services. The analysis was conducted for the entire period (1896-2012) and for 3 sub-periods associated with development strategies and macroeconomic crisis situations (1896-1956; 1957-1990 and 1991-2012). Additionally, the chapter has another section on identifying the role of export (agriculture and non-agriculture) and imports in economic growth. For this purpose, and using a Cobb-Douglas function, the relevance of the agricultural export-led growth model, non-agricultural export-led model, and import-led growth model for the entire sample and the mentioned sub-periods were analysed. The empirical analysis also corroborates the existence of an export-led growth model, where both agricultural and non-agricultural exports were relevant. Additionally, the existence of an import-led growth model was verified. The composition of imports, mostly concentrated in inputs and capital goods, explained this result.

The fourth chapter, also with time series models, focused on the determinants of TFP (1950-2010). The following variables show long-term relationship with TFP indices (there are two for sensitivity analysis, one with fixed shares and others that vary by decades): human capital, GDP per capita, trade openness index, and structural reforms index. The land Gini coefficient, public expenditure on R&D in agriculture, and public investments in gross physical capital (proxy for public infrastructure) do not show a long-term relationship with TFP indices, a situation that diverges from the international literature. This finding can be interpreted as evidence of the absence of a long-term public policy (both macro and sectoral) aimed at improving the productivity of the economy. Agricultural policy, which has remained stable since the mid-19th century, is to support the development of export agriculture, mainly located on the Coast, prioritizing spending on irrigation (this leads to expanding land rather than necessarily TFP). Regarding the Gini coefficient, it can be interpreted that in agricultural performance, especially during an expansion phase, episodes of land concentration may occur, thereby increasing the Gini coefficient. Furthermore, the increase in the Gini coefficient from the 1990s onwards would be associated with processes of land concentration facilitated by the new Land Law that removes limits on the size of new agricultural units. This situation was observed in the existence of agro-industrial complexes dedicated to the export of non-traditional products. In other words, it can be suggested that the functioning of the land market, supported by legislation, stimulates and generates these processes of land concentration.

The chapter concluded with the analysis of the long-term relationship between TFP indices and agricultural output by destination (domestic and external) and the contribution of family farming. A positive long-term relationship was found. This result would indicate that agents linked to agricultural production, including family farming, have made decisions that have led to improvements in productivity, particularly since the 1990s.

The fifth chapter developed the microeconomics of agriculture since 1990 (export agro-industrial complex model and family farming). Theoretical models were developed for each type of agrarian unit. Since agriculture is the main activity of rural households, the changes that have taken place in the microeconomic behaviour of agricultural units were studied. Thus, it was explored the transmission mechanisms through which the expansion in non-traditional exports, the gastronomic boom and continued economic growth have shaped the microeconomic behaviour of family farming in Peru. The analysed empirical evidence seems to suggest the following transmission mechanisms: a) Redistributive government policies aimed at improving access to public goods and services, with increasing public investment and its new composition in rural areas playing an important role. Furthermore, targeted social programmes, carried out under the umbrella of the National Agreement, were effective in reducing extreme rural poverty. b) The expansion of the agricultural non-traditional exports has boosted labour market demand, employing members of rural households. c) Economic growth increased labour demand for non-agricultural sectors, enhancing higher net migration from the poorest rural areas (Sierra) to the more dynamic ones (Coast and Amazon). d) Improvements in agricultural technology, which have occurred in all types of agricultural units, although regional disparities remain and there is a need to close the gaps. e) In addition, increased demand for food was expected due to economic expansion (consolidation of a middle class that demands fresher and healthier foods). Likewise, the boom in Peruvian gastronomy, which revalorises products of traditional agriculture (for example, potatoes and Andean cereals), has also caused an increase in the demand for food and in prices. All the above-mentioned factors have improved farm incomes and are the driving forces behind the declining trend in rural poverty. As a final point, it is important to highlight the key role of the labour market as a sphere that allows households to take advantage of a context of economic expansion.

Finally, the sixth chapter allowed us to understand the absence of an agricultural policy oriented towards family farming and the domestic market. The examination of the dynamics of the relationship between export-oriented agricultural producers and smallholder family farmers with the State forms the central focus of the issue under discussion. For this purpose, two mechanisms of capture were analysed: laws passed in the legislature in favour of the expansion of agro-exports and revolving doors (agriculture ministers linked to agro-export companies). 44% of agriculture ministers, since 1990, have had ties to this sector. On the other hand, strategies of family farming to obtain attention from the government and responsible authorities in the sector focused on mechanisms of direct confrontation with the State through strikes, protests, and roadblocks. How can this differentiated link of the State with the two agricultures (export and domestic market) be explained? To attempt to answer this question, studies on state-building in Latin America and in the Peruvian case were consulted. The evidence presented, regarding access to political, social, and economic rights of the indigenous population located massively in the Sierra and dedicated to agriculture, leads to the conclusion that during the formative stage of the Peruvian republic, social, discriminatory, and hierarchical gaps inherited from the colony were not eliminated. The indigenous population, massively engaged in agriculture, did not achieve full citizenship status. The best way to approach this was through quantitative indicators of State presence/intensity comparing access to basic services in the 19th and 20th centuries in Latin America, and Peru was one of those that appears in the lower ranks regionally. Another indicator was access to the universal suffrage right, which became universal in the 1979 Constitution after suffrage had been restricted to literate individuals from 1896, excluding the indigenous population from citizenship. In practice, these political and social exclusions are expressed in a significant rural-urban gap that, according to comparisons of a State density indicator using population censuses from 2007 and 2017, showed a slow closing of gaps. In conclusion, from a long-term perspective, the republican State did not prioritize rural dwellers as economic agents, neither having a long-term policy to improve the sector's productivity nor concerned with the provision and access to public services and citizen rights. Based on the analysis conducted, there may be indications to suggest that the concentration of family farming within a predominantly indigenous population could account for the discriminatory treatment by the State in formulating an agricultural policy that takes into account the interests of these farmers.

Returning to the research question regarding the role of agriculture in the Peruvian growth process, it can be affirmed, based on the presented evidence, that Peru exhibits a history of two types of agriculture according to destination markets: domestic and external. Regional components also gain significance in this analysis. The coastal region housed cotton and sugar production, which were part of the traditional export model from the late 19th century to the mid-20th century. Additionally, since 1990, agro-industrial complexes have been promoted by the state as part of the new non-traditional agro-export model, focusing on exporting vegetables and fruits. In this scenario, coastal agriculture has played the role of foreign exchange provider, crucial for sustaining economic growth as a significant portion of inputs and capital goods required by the economy need to be imported. On the other hand, agriculture destined for the domestic market, predominantly located in the Sierra, with a growing presence in the Coast and Amazon regions, has been the source of food for local and regional markets. This agriculture has lacked state support, with the absence of a state policy for its development being the norm in Peru's economic history since the late 19th century, as analysed in this thesis. The predominant form of organisation in this agriculture is family farming, characterised by carrying out an income diversification strategy, enabling its linkage with non-agricultural and urban economies, as evidenced by the feedback relationship between agriculture and other sectors.

Further Research

The dissertation concludes by highlighting important areas for further research. It is suggested that the empirical analysis conducted to study the Peruvian case can be replicated and extended to other countries in Latin America. The availability of time series data on total and sectoral GDP, as well as information on international trade (exports, imports, prices, among other variables), would make this comparative approach more feasible.

At the Peruvian level, it would be of interest to explore the regional dimension from a long-term perspective, tracing back to the beginnings of the Republic in the 19th century. An initial phase of this exploration could involve conducting a comprehensive review of studies on haciendas and identifying any missing information that needs to be collected through the analysis of primary sources located in the regions.

The topic addressed in Chapter 6 regarding the continuity during the Republic of a state behaviour that denies or minimizes economic, social, and political rights to the indigenous population requires a study of racism from a more comprehensive perspective. Similarly, studying the strategies carried out by those groups of the population, mainly indigenous, to overcome or minimize the exclusionary impact of state measures is indispensable. In particular, an area of interest is the study of informal, illegal, or even criminal economies that may have emerged and persisted over time due to the state's failure to address significant segments of the Peruvian population suffering from centuries-old inequality of opportunities. This requires a multidisciplinary effort to understand the causes of state weakness and the failure of the state-building process in the Peruvian case.

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