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CAPITAL MISALLOCATION AND ECONOMIC DEVELOPMENT IN A DYNAMIC OPEN ECONOMY

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JEL Codes: F12, F43, O10, O19, O41, O47.

Keywords: Misallocation, Open Economy Growth Models, Capital Accumulation, Technology Adoption.

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Capital Misallocation and Economic Development in a Dynamic Open Economy *

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September 27, 2023

Abstract

Some countries such as Canada, Italy, and Mexico have experienced a higher growth rate of capital per worker but a lower growth rate for GDP per worker when compared to the United States. This paper tries to reconcile this apparent contradiction in a dynamic open economy model. In the model, capital accumulation and exogenous technology adoption jointly generate output growth. In this environment, sectors with higher import participation have, ceteris paribus, a lower markup over production costs that in equilibrium implies a higher production level. Furthermore, when either sectoral import participation or sectoral productivity changes, capital allocation across sectors is affected, altering the actual rate of return on capital and triggering capital accumulation at a rate that differs from the long-run rate of technology adoption. We calibrate the model for the Mexican economy for 1995-2011. The results show that sectors with a reduction in TFP (total factor productivity) increased capital participation in the aggregate capital formation from 93.5% to 95.7% in the period. Furthermore, if the sectoral productivities had remained constant at the initial level in a counterfactual exercise, the aggregate output would be higher than its initial level, with capital accumulation increasing 74% and driving the rise in GDP.

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1 Introduction

During the 1990s, a set of macroeconomic policy recommendations known as the "Washington Consensus" became widespread. Among other things, those recommendations prescribed market-oriented policies such as fiscal discipline, trade liberalization, and privatization, primarily spurring reforms that promote growth (Rodrik, 2006; Estevadeordal and Taylor, 2013). The following decades experienced improvements in many dimensions, for instance, the frequencies of extreme inflation, black market premiums, and extremely low trade shares (Easterly, 2019). However, some countries that have deployed these recommendations have shown sluggish growth in output per worker after the 1990s. Indeed, one intriguing fact is that countries such as Canada, Italy, and Mexico have presented a higher growth rate of capital per worker but a lower growth rate for GDP per worker when compared to the United States.[1]

The aim of this article is to reconcile this apparent contradiction in a dynamic open economy model. To do that, we build a model where monopolistic competitive firms face a wedge over the price of their differentiated sectoral products along the lines of Hsieh and Klenow (2009). The growth mechanisms considered here are capital accumulation, resulting from consumer saving decisions and sectoral firms' demand for capital input, and exogenous technology adoption coming from international trade in intermediate varieties inputs. In the balanced growth path (BGP), the world economy grows at the exogenous technology adoption rate given by the growth rate of the mass of varieties produced in each country. In this environment, sectors with higher import participation have, ceteris paribus, a lower markup over production costs that in equilibrium implies a higher production level. Furthermore, when either sectoral import participation or the sectoral productivity changes, capital allocation across sectors is affected, altering the actual rate of return on capital (that is equalized across countries in the world BGP) and triggering capital accumulation at a rate that differs from the long-run rate of technology adoption.

Therefore, in our model economic growth is affected through two channels: capital accumulation and exogenous technology adoption. The real rate of return on capital (which measures the market incentives) determines the capital accumulation. The exogenous technology adoption is given by the openness of the country to the world in the sense that international trade allows the economy to be exposed to the expansion of the technological frontier and increases the number of tradable varieties that can be produced domestically. With these ingredients, we use our model to analyze how the

[1] In Section 2 we discuss in more detail these stylized facts.

capital allocation among sectors could affect growth in a dynamic open economy. We assume that an open economy is in a BGP in the initial and final periods and analyze the transition dynamics of capital allocation and growth between these two periods.

The model embeds the theoretical framework hypothesized by Kehoe and Ruhl (2010) and Kehoe and Meza (2011) without presenting the actual model. Their theory indicates a constant growth in the stock of knowledge (interpreted as the U.S. long-run growth of GDP per capita) that can be adopted at some cost. Without any policy or institutional reforms, the country would grow at the same rate as frontier knowledge. Yet, convergence in the output per worker can be achieved through reforms in these policies and institutions to trigger a transition to an income level closer to that of the leading country. After institutional and policy changes cease and capital adjusts, the country returns to the long-run growth of the stock of available knowledge. As hypothesized by Kehoe and Ruhl (2010), countries with a poor set of policies and institutions leading to considerable distortions can still grow faster than countries closer to the leading economy as long as they are far behind. This is exactly what our model implies: capital accumulation works as a short- to medium-run growth mechanism that responds to the profile of the institutional environment.

We use Mexican sectoral data from the World Input-Output Database and calibrate the model for the initial (1995) and final (2011) sample years as the initial and final BGP, respectively. The model reproduces well statics related to sectoral import participation, sectoral output participation into GDP, output-capital ratio, and the real rate of return. The model could be calibrated to some developed economies, like Canada and Italy, or to developing countries, like Mexico, or to underdeveloped realities, like Belize or the Central African Republic. After the 1990s, these economies experienced puzzling performances; they showed a catch-up process relative to the U.S. economy in terms of capital accumulation but sluggish growth in output per worker. Canada and Mexico especially are examples of the implementation of the macro reforms recommended by the Washington Consensus but without much success in terms of economic growth response.[2]

The Mexican economy is often considered an interesting case since it experienced an impressive convergence growth up to the early 1980s and then stagnated. For example, in terms of foreign policy Mexico joined the General Agreement on Trade and Tariffs in 1986 and reinforced its commitment with an open and competitive market by signing the North America Free Trade Agreement (NAFTA) in 1994 (Hanson, 2010) and joined the World Trade Organization on January 1, 1995. In fact, the participation of trade in goods and services in total GDP for the Mexican economy increased by 20 percentage

[2] See, for example, Algazi (2020).

point in the 1994–95 period, after joining NAFTA (Kehoe and Ruhl, 2010). As a consequence of all the reforming efforts put in place through almost 15 years, Mexico joined the Organization for Economic Cooperation and Development (OECD) in 1994 –an organization formed primarily by rich countries (Hanson, 2010). Nevertheless, growth remained sluggish thereafter.[3] And analyzing the Mexican economy through a trade approach helps us understand the causes of the stagnation experienced by the country after 1995. Indeed, the trade data help us identify the possible distortions across production sectors faced by firms in the economy, as explained in the calibration section. [4]

According to the balanced growth path equilibrium calibrated to the Mexican economy, between 1995 and 2011, the aggregate output relative to the United States decreased around 23%. However, aggregate capital increased by approximately 1%. It is important to highlight that we use the output-capital ratio as a target, but the level of both aggregate output and capital does not exogenously discipline our model. This result is explained by capital misallocation: sectors that had a reduction in their TFP (total factor productivity) increased their capital participation in the aggregate capital formation from 93.5% to 95.7%. Furthermore, if the sectoral productivities had remained constant at the initial level in a counterfactual exercise, the aggregate output would be higher than its initial level, with capital accumulation increasing 74% and driving the rise in GDP.

The paper is related to several branches of the literature. The direct link is the literature that investigate the aggregate effects of resource misallocation across heterogeneous producers generated by distortions that prevent the marginal products of inputs to be equalized (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009, 2014). Among other sources, the tax system in a country, size-dependent policies, institutions, and regulations are the main examples of such distortions. A complete review of potential sources of distortions and their quantitative importance can be found in Restuccia and Rogerson (2017) and Hopenhayn (2014). In line with this literature, the model presented here assumes theoretical exogenous wedges as primitives and assesses the impact of such wedges on aggregate outcomes. This branch of the literature has been termed the "indirect approach". This article departs from this literature by focusing on both the static and dynamic effects of sectoral distortions, reflected on the short-run aggregate productivity effect and the long-run BGP equilibrium effect.

[3] For more details about the Mexican economy see Kehoe and Meza (2011), Estevadeordal and Taylor (2013), and Algazi (2020).

[4] See Section 4.

Closer in spirit are two main papers, Bento and Restuccia (2017) and Jovanovic (2014), that are worth mentioning. Bento and Restuccia (2017) extend the basic factor misallocation model to allow for entry investment and life-cycle productivity investment, implying an endogenous distribution of productivities. They show that the effect of correlated distortions on aggregate TFP is strongly driven by a reduction of the establishment-level entry investment, while the decrease in life-cycle productivity offsets the factor misallocation through the increased entry that squeezes the productivity distribution. Although Bento and Restuccia's paper focuses on the dynamic effects of the distortions, it does not address the transition as does this paper. Moreover, the growth mechanisms are quite different. The model in this paper focuses on the more neoclassical capital accumulation and exogenous technology adoption instead of productivity investments.

In turn, Jovanovic (2014) features both the transition and the steady-state effects of misallocation. He focus on the dynamics of the labor market matching between generations to produce output in a complementary production function. In an overlapping generation model, the quality of assignment between members of the two generations (old and young) determines the evolution of human capital formation and the total output. He interprets misallocation as a departure from the ideal matching that results from the increase in the signal-to-noise ratio. Better signals induce better assignment, more human capital formation, higher growth. He also look at the transition when adding more structure (Cobb-Douglas production function, log normal distribution of skills) showing that an improvement in the quality of signals induces better assignments, an increase in growth, and inequality toward the new BGP values. In contrast, this paper takes a broader view of the potential sources of misallocation across different sectors and focuses on different growth mechanisms.

There is also a set of papers that belongs to the direct approach that focuses on specific sources of resource misallocation (Buera and Shin, 2017; Midrigan and Xu, 2014; Moll, 2014). They basically address the common issue of financial frictions that is not the specific goal of this paper. Lastly, Jones (2011) shows how the input-output structure of the economy can amplify the effects of shocks in the TFP that reflect the empirically observed differences in output per worker across countries. Jones includes distortions to measure their impact on TFP. In contrast, although this paper features sectoral intermediates tradable varieties, the multiplier here is only the standard capital multiplier as in the neoclassical model. Our focus is to measure both the static and dynamic effects of reforms that change the distortions, not only the steady-state TFP effects.

This paper is also related to the literature on the growth effects of trade (Acemoglu and Ventura, 2002; Ventura, 1997). The model here is based on Acemoglu and Ventura (2002) but has different goals. Acemoglu and Ventura (2002) show how trade can generate a steady-state world equilibrium to an otherwise diverging set of AK economies. Finally, this paper is related to the literature on the lack of growth in the Mexican economy (Kehoe and Meza, 2011; Kehoe and Ruhl, 2010; Hanson, 2010; Arias, Azuara, Bernal, Heckman, and Villarreal, 2010). Most of the literature focuses on a more descriptive approach of the economy. We postpone further discussion of this literature to Section 2 where we present the motivation.

The paper proceeds as follows. Section 2 provides the cross-country evidence of the relationship between distortions and the rate of return on capital as possible explanation for the lack of economic growth although the capital accumulation is in place. Section 2 also provides a background for the Mexican development experience. Section 3 presents the open economy growth model with sectoral distortions. Section 4 presents the data and the calibration strategy. Section 5 presents the main results and the counterfactuals. Finally, Section 6 concludes.

2 Empirical Facts

This section explores the behavior of some developed and developing economies since the 1950s and 1980s that motivates this paper. in particular, the well-known impressive convergence growth and the following stagnation faced by some economies in recent decades. Figure 1 shows the real GDP per worker in Canada, Italy, Mexico, Belize, the Central African Republic, and the Uinted States measured in purchasing power parity (PPP). The resulting picture is striking. Mexico and Italy managed to grow faster than the United States over 30 years. Between 1950 and 1980, Canada, Italy, and Mexico showed an average GDP per worker growth rate of 2.60%, 5.81%, and 3.35%, respectively, whereas the average growth in the United States figured around 2.0% per year.

However, since the sovereign debt crisis in the early 1980s, growth has been lame for Mexico. From 1980 to 1995, the GDP per worker growth rate shrank at an average rate of 1.83% per year, whereas U.S. growth kept pace. Although growth resumed from 1995 to 2017, it continued at a moderate pace, around 1.3% per year, well below that of the United States. For Italy, after growing -0.80% annually at the beginning of the 1980s, the economy grew 3.46% per year up to 2000. Between 1980 and 2000, Canada witnessed an average growth of 1.65%, very close to the U.S. growth rate of around 1.82%. But after 2000 the Canadian and Italian economies started to experience stagnation, as shown in Figure 1. The GDP per worker grew in Canada and Italy by 0.69% and 0.43%, respectively, while the United States experienced a growth rate of 1.31%. Even underdeveloped countries such as Belize and the Central Africa showed relative stagnation compared to the United States in the past decades.

In Figure 2, we present the cross-country real GDP and capital per worker starting at the same base of 1995. For all countries shown in Figure 2, the GDP per worker has diverged from that of the United States since 1995. For example, the real GDP per worker in Belize and the Central African Republic has been shrinking at an average rate of -1.92% and -0.38%, respectively. However, Belize and the Central African Republic have shown a convergent trajectory for the capital per worker compared to that for the United States. A similar trend can be observed for Mexico, Italy, and Canada. They also managed to accumulate physical capital at a greater rate than the North American economy. But all economies could not do the catch-up process in terms of GDP per worker relative to that for the United States since 1995.

During the 1980s and 1990s, the macroeconomic literature prescribed policy measures to tackle the lack of growth in some economies. Among other things, the policy prescriptions included opening the economy to international trade and foreign direct

Figure 1: Output-Side Real GDP per worker

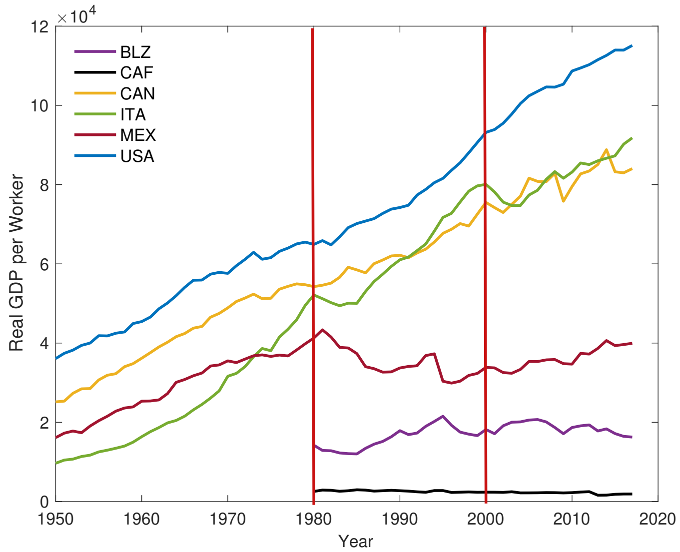
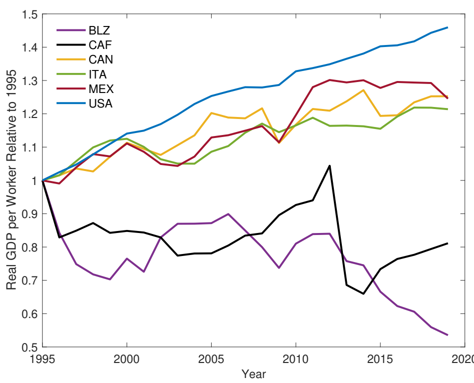
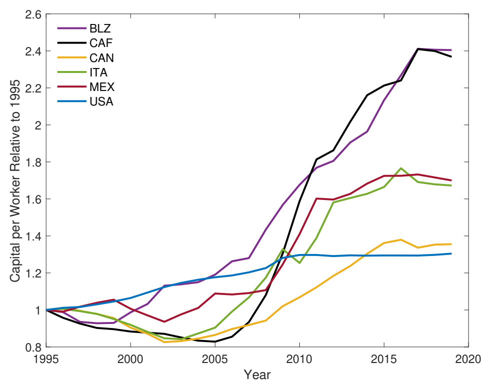


Figure 2: Cross Country Real GDP and Capital per Worker Relative to 1995



(a) Real GDP per Worker



(b) Capital per Worker

investment (FDI), control of public spending, and monetary policy restricting inflation and privatization. Although aggregate capital increased in some countries, the lack of GDP growth response to these policy reforms led to widespread doubts about the value of such reforms.[5]

The set of potential explanations for the stagnation has centered on policies and institutions that may generate perverse incentives and distort allocative decisions causing

[5]See, for example, Easterly (2019).

aggregate productivity to decline. Possible explanations are inefficient financial systems, lack of contract enforcement, and rigidities in the labor market as cited by Kehoe and Ruhl (2010). For example, one major consequence of an inefficient financial market is failing to channel enough investment to high-return productive sectors while low-return sectors continue to receive too much investment, generating a capital misallocation into the economy.

In light of these specific misallocation arguments for the stagnation of some economies, we sought to build a general equilibrium growth model that could encompass in a general framework the impacts of heterogeneous capital allocations among productive sectors on economic growth. In the model, capital accumulation and exogenous technology adoption affect growth. While the former is a result of the market incentives summarized in the real rate of return on capital, the latter is exogenously induced by the increase in the measure of traded varieties domestically produced. International trade allows countries to be exposed to the expansion of the world's technological frontier and to learn from it. This technology adoption process that ultimately increases the number of tradable varieties internally produced constitutes the long-term growth mechanism. Thus, complementary to the misallocation literature,[6] we analyze in a dynamic open economy how the capital allocation among sectors could affect growth.

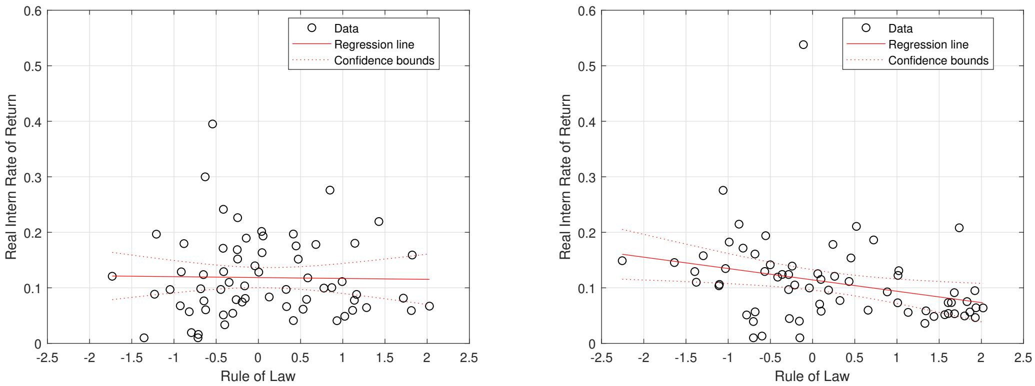
The key prediction of the model is that in the balanced growth path, in which all countries grow at the same rate, the profile of sectoral distortions in the economy determines the equilibrium rate of return on capital. Moreover, countries with fewer overall distortions will face a lower rate of return in the long run after the capital adjustment and, consequently, will have higher output per worker. Figure 3 depicts the real internal rate of return for all countries in the Penn World Table 9.1 in 2017 against the Worldwide Governance Indicator of "Rule of Law" calculated by the World Bank,[7] as a rough measure of misallocation. This indicator was chosen because it reflects the notion of the type of institutions and policies that may distort decision-making, as previously discussed. Countries with below-median GDP per worker growth rate in 2017 show a negative relationship between the real internal rate of return and the misallocation measure, suggesting that the model prediction might find empirical support. In addition,

[6] For comprehensive surveys on the topic, the reader is referred to Hopenhayn (2014) and Restuccia and Rogerson (2017).

[7] These indicators are constructed based on several survey sources that reflect the views of the citizens, entrepreneurs, and pundits in public, private, and nongovernmental organizations regarding governance issues. We focus on the Rule of Law aggregate indicator that includes individual indicators, filling in the following definition: *Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence* (Kehoe and Meza (2011)).

it is important to highlight that the absence of relation among high-growth countries is not against the model predictions since the negative relationship implied by the model is based on the balanced growth path equilibrium, that is, the long-run behavior and not during the transition that might be the case for the above-median growth countries. Nevertheless, Appendix A Figure 11 depicts the same relationship between the real rate of return and misallocation by GDP per capita growth rate, which shows a negative relationship for both groups of countries.

Figure 3: Cross Country Real Internal Rate of Return and Misallocation in 2017 (by real GDP per worker growth rate)



(a) Above Median-Growth (b) Bellow Median-Growth

3 Model

This section outlines the open economy growth model with static distortions across the sectoral goods market. In each economy, there is a monopolistic competition between differentiated sectors that supply inputs to the homogeneous final good producers. Producers in each sector face specific distortions over their output prices that may affect the general equilibrium rate of return on capital accumulation, consequently changing growth incentives and leading to aggregate total factor productivity (TFP) losses.

3.1 Preferences and Technology

3.1.1 Demographics and Preferences

Time is continuous. The world economy is populated by a continuum of countries $n \sim G(n)$. With a slight abuse of notation, n measures the mass of tradable intermediate varieties produced by a given country. Along with the assumption that each variety is produced by only one country, n is interpreted as the *degree of technological development*, in the sense that it reflects the differential technological capabilities between countries.

The representative household of country n supplies labor inelastically ($L_n = 1, \forall n$) and has preferences given by: (dropped the n subscript)

$$\int_0^\infty \exp(-\rho t) \log C(t) dt \tag{1}$$

The budget constrain is, in turn, given by: (dropped the t subscript)

$$p^Y \left(C + \dot{\bar{K}} + \delta \bar{K} \right) = r\bar{K} + w + \bar{\Pi} \tag{2}$$

where C is household consumption; $\bar{K}$ is household total capital holdings, which is the sum of capital across sectors; $\bar{\Pi}$ is total profits accruing from intermediate firms, which is the sum of profits across sectors; r and w are the rate of return on capital and the labor wage rate, respectively.

The transversality condition can be written as:

$$\lim_{t\to\infty} \bar{K}(t) \exp\left(-\int_0^t \left(\frac{r(v)}{p^Y(v)} - \delta \right) dv \right) = 0 \tag{3}$$

3.1.2 Technology

For each country n, there is a perfectly competitive final good market that uses differentiated products from S sectors as inputs, according to the following constant elasticity of substitution (CES) technology:

$$Y = \left(\sum_{s=1}^{S} y_s^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \tag{4}$$

where $\sigma > 1$ is the elasticity of substitution between goods of different sectors. Also, firms in the final good market face prices p_s^y of inputs. Neither the final good nor the sectoral inputs are traded.

In each sector S, a differentiated product is produced by monopolistic competitive firms using capital and tradable intermediates in a Cobb-Douglas production function of the form:

$$y_s = z_s \chi K_s^{\alpha} X_s^{1-\alpha} \tag{5}$$

where z_s is the productivity in sector s, K_s is the demand for capital in sector s and X_s is the demand for tradable intermediate varieties. In turn, the tradable intermediate varieties are combined in a CES bundle given by:

$$X_s = \left(\int_0^N x_s(\nu)^{\frac{\epsilon-1}{\epsilon}} d\nu \right)^{\frac{\epsilon}{\epsilon-1}} \tag{6}$$

where $x_s(\nu)$ is the demand for variety ν in sector s, $\epsilon > 1$ is the elasticity of substitution between intermediate varieties, and N is the total mass of varieties. Therefore, if we sum up all the measures of tradable varieties across countries, we obtain N, that is, $\int n dG(n) = N$. Additionally, competitive firms hire labor in order to produce tradable intermediate varieties with a linear production function $x_s(\nu) = l_s(\nu)$. Finally, the constant χ is introduced for normalization.

Overall, growth in the above model is the result of two main mechanisms. The first is capital accumulation, resulting from savings decision of households and the demand for capital by firms in the differentiated products sectors. The second is the exogenous technology adoption that comes through trade. There is exogenous growth in the total mass of varieties at a rate given by $\dot{N}/N = \lambda > 0$. Trade between countries allows them to be exposed to frontier knowledge spillovers, in the sense that the mass of tradable intermediate varieties produced by each country also grows at the same rate as the technology frontier, that is, $\dot{n}/n = \dot{N}/N = \lambda$. Finally, there is no capital flow between countries, which implies the trade balance must hold in all periods.

3.2 Households' and Firms' Behaviour

Let us start with the final good producers decision. Since final good firms do not face any distortions in both input and output markets, their profit maximization problem yields the standard demand for sectoral products and the ideal price index given by:

$$y_s = \left(\frac{p^Y}{p_s^y}\right)^{\sigma} Y, \qquad p^Y = \left(\sum (p_s^y)^{1-\sigma}\right)^{\frac{1}{1-\sigma}} \tag{7}$$

In turn, the cost minimization problem for the differentiated products' firms given the technology (equations 5 and 6) implies the following unit cost function:

$$c_s(r, \tilde{P}) = \frac{1}{z_s} r^{\alpha} \tilde{P}^{1-\alpha} \tag{8}$$

where $\tilde{P}$ is the ideal price index of the tradable intermediate varieties, defined as:

$$\tilde{P} \equiv \left(\int_0^N p(\nu)^{1-\epsilon} d\nu\right)^{\frac{1}{1-\epsilon}} \tag{9}$$

The ideal price index is the numeraire in this world economy, consequently, it is normalized to one. Therefore, the unit cost function can be rewritten as $c_s(r) \equiv c_s(r, 1)$. Also, all values in the model can be interpreted as measured in units of the bundle of tradable intermediate varieties.

The differentiated products firms face the key decision in the model. Firms in each sector S face a distortion τ_s over their output price. Taking as given their unit cost function and specific distortion, they choose price in order to maximize profits given by:

$$\pi_s = \left[(1 - \tau_s) p_s^y - c_s(r)\right] y_s \tag{10}$$

Profit maximization implies the standard optimal price, set as a markup over marginal cost:

$$p_s^y = \frac{\sigma}{\sigma - 1} \frac{c_s(r)}{(1 - \tau_s)} \tag{11}$$

Recall that from equations 8 and 11 we have that revenue TFP (as it is called by Hsieh and Klenow (2009) and Foster, Haltiwanger, and Syverson (2008)), $p_s^y z_s$, is the same across sectors except for the distortion.

Equations 7 and 11 combined imply that the output in each sector is a fraction of the total output in the economy where the fraction is determined by the interaction between the sectoral productivity profile and distortions in a given economy. Thus:

$$y_s = \left(\frac{z_s(1-\tau_s)}{\left[\sum_{s'} \left(z_{s'}(1-\tau_{s'})\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}}} \right)^{\sigma} Y. \tag{12}$$

Since firms producing the tradable intermediate varieties have a linear production function in labor and both their input and output markets are competitive, intermediate prices equal wages, $p(\nu) = w, \forall \nu \in n$.

It is useful to anticipate the market-clearing conditions for exposition purposes. Since there is no capital flow, there must be a trade balance in each period. Hence, one can derive the trade balance in the economy as:

$$\bar{X}_n = np_n^{1-\epsilon} \int \bar{X}_{n'} dG(n') \tag{13}$$

where $\bar{X}_n = \sum_s X_{s,n}$ and $p_n = p(\nu) = w, \forall \nu \in n$ (see Appendix B.1 for the derivation). The trade balance condition can be interpreted as follows. Since each country is small in the world economy, the total sectoral demand for varieties is composed of the total sectoral imports in the economy. Summing up across sectors, we obtain the total imports for country n, the left-hand side of the previous equation. The total exports, in the right-hand side, require a more cumbersome derivation. Nevertheless, heuristic description is in place. The country n's exports are made up of the world's total demand for the intermediate varieties that are produced by the country, which is a fraction n of the world total expenditure in intermediate varieties divided by its price, taking into account the substitutability between varieties as summarized by ϵ.

The final market-clearing condition is the labor market. By definition, the total inelastic supply of labor (normalized to one) equals total demand for labor. The demand for labor also results from the world demand for intermediate varieties produced in a given country n, due to the linearity of its production function. Accordingly, one can derive the labor market clearing as the following (see Appendix B.1 for the derivation):

$$1 = np_n^{-\epsilon} \int \bar{X}_{n'} dG(n') \tag{14}$$

In parallel with the trade balance reasoning, the above equation expresses world total demand for labor as a fraction n of the world total expenditure in intermediates divided by its labor price.

Now let us turn to the representative agent decision: to maximize 1 subject to 2 and 3. The maximization problem yields a slightly different version of the traditional Euler equation given by:

$$\frac{\dot{C}}{C} = \frac{r}{p^Y} - \delta - \rho \tag{15}$$

The new element is the presence of the final good price p^Y that appears normalizing the rate of return to capital accumulation. This formulation is quite natural because the numeraire in the model is no longer the final good price, as in the standard neoclassical model; instead, it is the ideal price index of the tradable intermediate varieties bundle. It is worth noting that this form is key to the world balanced growth path (to be defined) with distortions that are country specific.

3.3 Equilibrium and Aggregation

The equilibrium in the world economy is defined as quantities and prices for each country such that firms maximize profits, consumers maximize utility and markets clear. Let us focus on the balanced growth path equilibrium for the world economy, defined as an equilibrium in which consumption and consequently output grow at the same rate for each country n. The key challenge is that the Euler equation in standard neoclassical models would imply the same rate of return across countries in the BGP. However, countries with different configurations of distortions between sectors would, ultimately, have different rates of return on capital; consequently, there would be no BGP equilibrium. Therefore, the formulation in equation 15 allows for the possibility of the world BGP equilibrium while implying that differences in distortions across countries reflect differences in the rate of return to capital and the final good price.

The next proposition shows the growth rate of consumption in the BGP world equilibrium. Let g_x be the growth rate of variable x in the BGP. Hence, we have the following result:

Proposition 1. *Consider the above described open economy neoclassical model with capital accumulation, exogenous technology adoption, and the presence of sectoral static distortions. The long-run growth rate of total output, capital stock, and intermediate bundle in the balanced growth path is given by:*

$$g_Y = g_{\bar{K}} = g_{\bar{X}} = \frac{1}{\epsilon - 1}\lambda \quad \forall\, n$$

Proof. See Appendix B.3. □

The result shown in the above proposition is quite natural: in the neoclassical growth models, long-run growth is usually driven by the exogenous growth rate of the world technological frontier captured by the parameter λ. Additionally, as in Acemoglu and Ventura (2002), the substitutability between varieties, ϵ, plays an important role in determining long-run growth but for different reasons. In the Acemoglu and Ventura's model, ϵ determines the extent to which changes in relative income in a given country affect its terms of trade, which, in turn, is related to the rate of return to capital. Therefore, in their world of AK economies, a higher level of ϵ would imply a higher output growth rate needed to bring down the rate of return to capital through terms of trade and to ensure a common steady-state growth rate for the world economy. In contrast, in the model presented here, the substitutability parameter determines the degree of trade between countries and, as a result, the extent of technology adoption. In this sense, higher values of ϵ mean that all countries' varieties are highly substitutable and there is less need for trade and less opportunity of technology adoption that comes through international trade interactions. In the limit, $\epsilon \to \infty$, there is no long-run growth.

Now we are able to discuss how the sectoral distortions affect growth in this model. As it is clear from Proposition 1, the output growth rate in the balanced growth path is not affected by the distortions. However, both the transition and the long-run rate of return on capital are determined by them. The way to see this result is the following. From Proposition 1 and the Euler equation 15, it is straightforward to see that the long-run ratio between the rate of return to capital and final good price is constant. Let us call this long-run ratio by the *actual rate of return* and denote its value by $(r/p^y)^*$. From equations 7, 8, and 11, we obtain the actual rate of return as:

$$\frac{r}{p^Y} = \frac{\sigma - 1}{\sigma} \mathcal{B} r^{1-\alpha}, \tag{16}$$

where $\mathcal{B} \equiv \left[\sum_s (z_s(1-\tau_s))^{\sigma-1}\right]^{\frac{1}{\sigma-1}}$. The above equation shows that the BGP rate of return, r^*, is determined by the long-run actual rate of return as well as the aggregator of the profile of productivities and distortions across sectors. Accordingly, any increases in the aggregator would translate into decreases in r^*. Thus, assuming that the distortions are positive and less than one –as it is the case in the calibration –higher values for the sectoral distortions would distance the economy from the actual profile of productivities, decreasing $\mathcal{B}$ and increasing the rate of return in the BGP. This is one of the interesting features of the model, the ability to generate cross-country differences in the rate of return in the BGP, as seen in the data, explained by differences in the sectoral distortions faced by countries.

Another important implication of the model is how the sectoral distortions combine to affect the TFP in the economy. As we show in Appendix B.4, total output in each country n is given by:

$$Y = \frac{1}{\alpha}\mathcal{A}r^{1-\alpha}\bar{K} \tag{17}$$

where

$$\mathcal{A} \equiv \frac{\left[\sum_s \left(z_s(1-\tau_s)\right)^{\sigma-1}\right]^{\frac{\sigma}{\sigma-1}}}{\sum_s z_s^{\sigma-1}(1-\tau_s)^{\sigma}} \tag{18}$$

Equation 18 presents two main implications of the model regarding the effect of the sectoral distortions on aggregate TFP. First, the sectoral distortions aggregate in a more intricate way, having a nonlinear effect on TFP. Second, while the average distortion has no effect on TFP, its variance is important to determine the effect on aggregate productivity. In order to see that, suppose an increase in all distortions by a factor of $\gamma > 1$. This increase in the average distortion would have no impact on $\mathcal{A}$, although the BGP rate of return would be affected. Guided by this relationship between distortions and the aggregate TFP, the counterfactuals implemented in Section 5 are to maintain the sectoral distortions and the productivities constant at their level in 1995, to assess the impacts on the aggregate output and on the incentives to accumulate capital relative to the adoption of technology in the economy. More details on the counterfacuals are given in Section 5.

4 Data and Calibration

In this section, we explain the calibration procedure, which is carried out in two stages. First, we define a set of parameters calibrated either directly from the data or the literature, which we call externally calibrated. Then, the second set of parameters is endogenously calibrated, considering the equilibrium in our model.

The main data used is the World Input-Output Tables Release 2013, which provides a panel of 40 countries and a "rest of the world" additional country from 1995 to 2011 disaggregated into 35 sectors. The Input-Output Tables allow measuring the linkages between sectors within and between countries. Moreover, they are constructed based on the official national Input-Output Tables and information on national accounts. Release 2013 has a higher length of the period covered –17 years as opposed to 15 years in Release 2016 –and the starting year of 1995, which is closer to the beginning of reforms in Mexico after the economic crisis during the 1980s. Another data source is the Penn World Table (PWT).

The first set of parameters $\{\delta, \epsilon, \lambda, \sigma\}$ is externally calibrated. The annual depreciation rate is set to $\delta = 0.05$ as is standard in the literature. The elasticity of substitution between varieties, ϵ, and the growth rate of the technological frontier λ are set to match the U.S. hundred years annual GDP per capita growth rate of 1.8%, as the world technological frontier, taking values of $\epsilon = 2$ and $\lambda = 0.018$.[8] Note that the parameter ϵ has no effect on either the aggregate productivity or the BGP rate of return on capital, rendering this normalization innocuous. The elasticity of substitution between sectors is set to $\sigma = 3$ following Hsieh and Klenow (2009).

Table 1: Externally Calibrated parameters

Definition	Parameter	Value	Source
Depreciation rate	δ	0.05	Standard
Elast. of subst. (varty)	ϵ	2.00	Estimate from data
Tech. front. growth rate	λ	0.018	Estimate from data
Elast. of subst. (sector)	σ	3.00	Hsieh and Klenow (2009)

Notes: The elasticity of substitution between varieties and the growth rate of the total mass of varieties are set to match the long-run annual growth rate of GDP per capita for the United States.

Some parameters could not be adjusted directly from data or estimations from other studies. The approach adopted here was to jointly calibrate them to match some model

[8] See equation 16.

moments with data. We define the vector of parameters to be calibrated as

$$\boldsymbol{\Theta} = \{\{\tau_s^{1995}\}_{s=1}^{S}, \{\tau_s^{2011}\}_{s=1}^{S}, \{z_s^{1995}\}_{s=1}^{S}, \{z_s^{2011}\}_{s=1}^{S}, \rho, \alpha\}^\top$$

where S is the total number of sectors.

Let $\mathbf{m}_d$ be a vector of moments obtained from data, and let $\mathbf{m}(\boldsymbol{\Theta})$ be the model moments counterparts for $\mathbf{m}_d$. The optimal calibrated parameters vector, $\boldsymbol{\Theta}^*$, as follows:

$$\boldsymbol{\Theta}^* = \underset{\Theta}{\operatorname{argmin}} \left[\mathbf{m}(\boldsymbol{\Theta}) - \mathbf{m}_d\right]^\top \mathbf{W} \left[\mathbf{m}(\boldsymbol{\Theta}) - \mathbf{m}_d\right]. \tag{19}$$

Since all selected moments are positive, we minimize the sum of relative squared errors, meaning the weight matrix used is a diagonal matrix where the typical element is $W_{i,i} = 1/\mathbf{m}_i^2$.

The moments selected as targets for the calibration are the following:

1. The ratio of sectoral import participation: $\frac{X_s/p_s^y y_s}{X_{s'}/p_{s'}^y y_{s'}}$, where s' is the sector with the highest import participation;
2. The sectoral share in total production $\frac{p_s^y y_s}{p^Y Y}$;
3. The geometric mean of the real internal rate of return between 1979–1995;
4. The real internal rate of return in 2011;
5. The mean aggregate output to capital ratio between 1979–1995;
6. The aggregate output to capital ratio in 2011.

The data counterparts of the sectoral participation discipline all 34 (S = 34) sectoral productivities in both the initial and final years.[9] The sectoral demand for import and the sectoral share in total production allows for separately identifying the TFP and distortions. However, as we only have $(S-1)$ statistics related to the ratio of sectoral import participation, we use the BGP rate of return to capital to calibrate the remaining distortion. Thus, the geometric mean of the real internal rate of return over a previous period of the same length (1979–1995) is used to capture the long-run behavior of the rate of return on capital and discipline the parameter in the initial year. Analogously, the highest participation distortion in the last year is disciplined by the real internal rate of return in 2011. Now, the elasticity parameter, α, is disciplined by the mean aggregate

[9] The sector c35 "Private Households with Employed Persons" is excluded from the analysis because its import participation is nearly zero.

output to capital ratio over a previous period of the same length (1979–1995). Finally, the intertemporal rate of substitution, ρ, is disciplined by the final year aggregate output to capital ratio, which indirectly reflects the long-run equilibrium in the economy.

Table 2 summarizes the internally calibrated parameters for the Mexican economy.[10] The value of the elasticity parameter, α, is close to half, which seems reasonable since profits in the model accrue from the monopolistic competition in the sectoral production, as opposed to standard calibrations of the parameter that only take into account wage and capital share in total GDP. Moreover, the intertemporal substitution parameter, ρ, is calibrated to an annual value of 0.3, which is higher than the usual figures. It seems reasonable to conjecture that this value is related to the method used to guarantee the convergence of the transition simulation that is explained later.

As pointed out at the beginning of this section, $(S-1)$ distortions are calibrated to fit the sectoral import participation ratio. The distortion of the sector with the highest import participation in the initial year 1995 (it is also the highest import participation throughout the sample period) is calibrated to match the real rate of return. Thus, the distortion for the sector with the highest import participation is 0.3 in the first period, and its value decreases to less than half (0.14) in 2011. Although this decrease does not affect aggregate productivity, it does affect the economy-wide interest rate in the BGP, implying a drop in the output price and, consequently, an increase in the actual rate of return, inducing capital accumulation and a later decrease in the interest rate.

Table 2: Structural Parameters Calibrated Values for the Mexican Economy

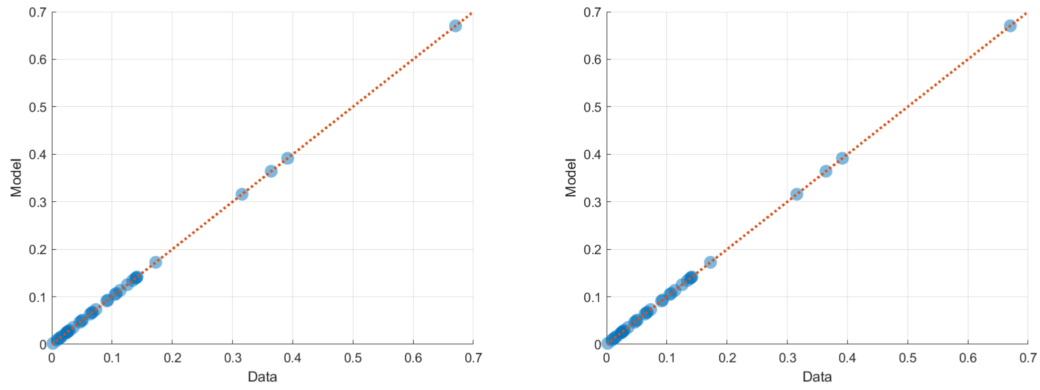
Internally Calibrated					
Definition	Parameter	Value	Target	Data	Model
Share parameter	α	0.4652	Output-capital ratio (1979–95)	0.3067	0.3464
Intertemporal discount	ρ	0.3000	Output-capital ratio (2011)	0.2706	0.2706
Distortion 1995 (s = max import)	$\tau_{s_{MAX}}^{1995}$	0.3000	Real rate of return (1979–1995)	0.1509	0.1366
Distortion 2011 (s = max import)	$\tau_{s_{MAX}}^{2011}$	0.1361	Real rate of return (2011)	0.1344	0.1358
Other Distortions	$\{\tau_s^t\}_s^t$	Figure 6	Sectoral import participation	Figure 4	Figure 4
Sectoral productivity	$\{z_s^t\}_s^t$	Figure 6	Sectoral participation in GDP	Figure 5	Figure 5

Table 2 shows the model's fit to the real rate of return and the output-capital ratio. The model somewhat overestimates the output-capital ratio, whereas it moderately underestimates the observed real internal rate of return in 1995. Furthermore, Figures 4 and 5 shows the model's fit for import share and sectoral participation in total GDP in

[10] See Appendix C for more details on productivities parameters.

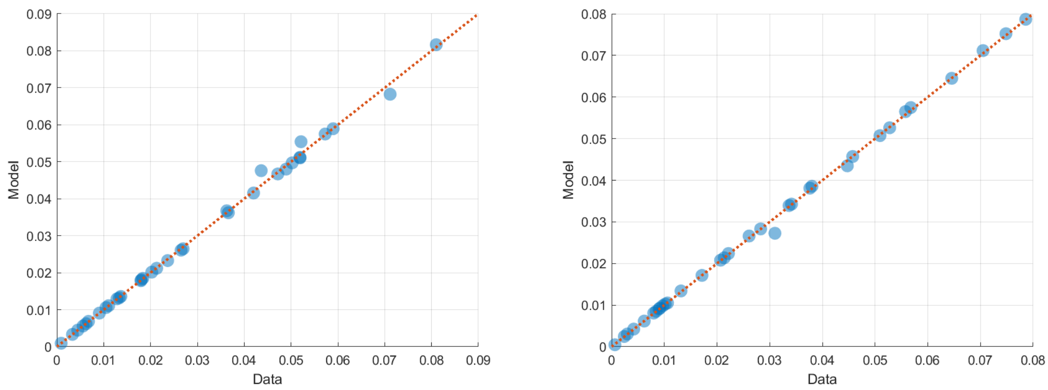
both the initial and final calibrated years. Overall, the model can replicate fairly well the main targeted features of the Mexican economy in the period analyzed.

Figure 4: Model Fit –Ratio of Sectoral Import Participation



(a) Model versus Data –1995 (b) Model versus Data –2011

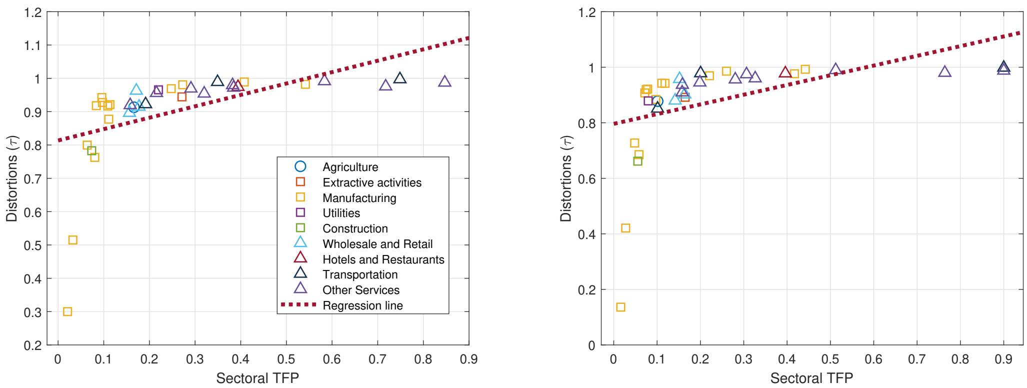
Figure 5: Model Fit –Sectoral Share in Total Production



(a) Model versus Data –1995 (b) Model versus Data –2011

One important issue in the misallocation literature is the correlation between sectoral productivities and sectoral distortions. For instance, Restuccia and Rogerson (2008) consider the case of correlated idiosyncratic distortions when assessing the static effects of changes in the distortions, and Bento and Restuccia (2017) highlight the dynamic effects of changes in the empirically observed correlation between productivities and distortions on the productivity distribution. To gauge the correlation between the calibrated sectoral productivities and distortions, Figure 6 depicts the scatter plot of the sectoral distortions against the sectoral productivities in both the initial and final BGP calibrated equilibria. Both years show a positive correlation between sectoral productivities and distortions in the Mexican economy. In particular, the calculated correlation is considerable, around 0.5119 in 1995, decreasing to 0.4587 in 2011. As it will be clear in the counterfactuals, the decrease in the overall sectoral distortions is responsible for the increase in the price composite of sectoral productivities, which induces capital accumulation more than technology adoption. Nevertheless, the correlation between productivities and distortions does not change much, which results in a lower aggregate TFP in the final BGP.

Figure 6: Correlation between Sectoral Productivities and Distortions

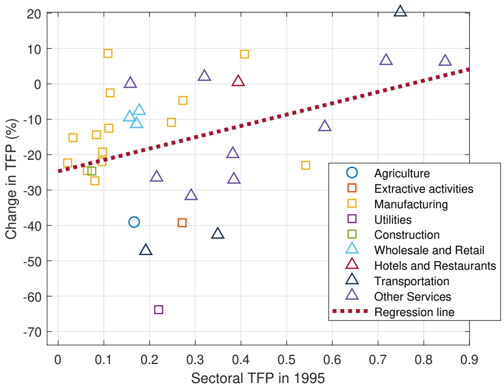


(a) Correlation in 1995

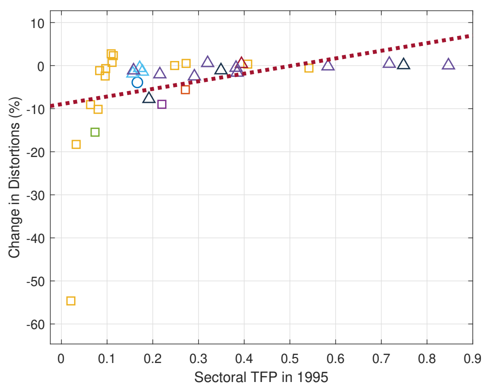
(b) Correlation in 2011

The changes in the profile of sectoral productivities and distortions between the initial and final BGP equilibria were considerably heterogeneous. Figure 7 depicts three main correlations that help visualize the heterogeneous sectoral variation between the BGPs: the first two panels, Panel 7a and Panel 7b, depict the correlation between initial productivities and the change in productivities and distortions, respectively, and Panel 7c shows the correlation between changes in productivities and changes in distortions. The vast majority of the sectors experienced a decline in calibrated productivities between 1995 and 2011. Also, sectors with low initial productivities experienced a stronger decline in productivity, whereas the initially high-productivity sectors experienced an increase in productivity. However, the change in distortions did not substantially decreased the correlation between productivities and distortions. As Panel 7b shows, the sectors with low initial productivity (which had the strongest decline in productivity) also experienced the strongest decrease in sectoral distortions. Although most of the sectoral distortions fell during the period, there is a positive relationship between initial productivity and changes in the distortions, preserving the level of correlated distortions. The last panel makes this point clear by showing a positive correlation between changes in sectoral distortions and changes in sectoral productivities. Overall, the sectoral productivities and distortions declined between the initial and final BGPs in a way that preserved the correlated distortions as roughly the same in the Mexican economy.

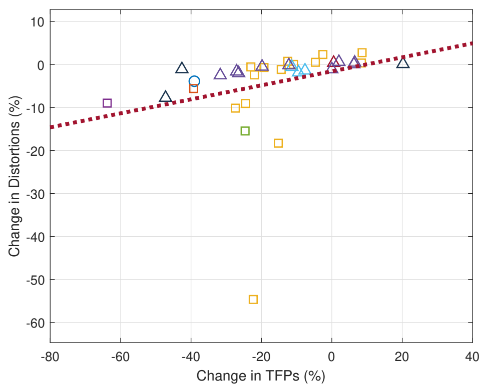
Figure 7: Initial Sectoral Productivities and Change in Productivities and Distortions in 1995 and 2011



(a) Change in Productivities



(b) Change in Distortions



(c) Change in Productivities and Distortions

5 Results

This section describes the main results of the study. The primary goal of this section is to measure the capital allocation among sectors over time and understand its impact on total GDP. It begins by presenting the benchmark calibration results for the long-run equilibrium and the transition starting from the initial calibrated BGP toward the final BGP equilibrium, in which sectoral productivities and distortions vary simultaneously. Next, the subsection dedicated to the counterfactual analysis outlines a series of exercises that keep sectoral productivity or distortions constant.

5.1 Long-run and Transition Effects

The first result compares the aggregate endogenous variables in the balanced growth path equilibrium calibrated for the Mexican economy in 1995 and 2011. The final BGP calibrated equilibrium considers the long-run effects of changes in the profile of distortions and productivities in each sector on the incentives for capital accumulation relative to technology adoption. These effects are summarized in Table 3.

Table 3: Normalized Endogenous Variables for the Mexican Economy

Benchmark BGP Relative to 1995		
	1995	2011
Aggregate output	1.0000	0.7692
Aggregate capital	1.0000	1.0058
Consumption	1.0000	0.7672
Output-capital ratio	0.3464	0.2649
Output price, p^Y	1.0000	0.9942
Internal rate of return	0.1366	0.1358
Aggregate import share	0.0509	0.0665
$\mathcal{A}$	1.0000	0.7671
$\mathcal{B}$	1.0000	1.0031

Notes: The table shows the value of the normalized endogenous variables in the benchmark calibration's balanced growth path. Each endogenous variable is normalized by the total imports, rendering them stationary in equilibrium. A value equal to one in the initial year means the value of the variables relative to their BGP equilibrium in 1995.

In the BGP, all aggregate variables grow at the same rate given by Proposition 1.

Hence, the aggregate output, capital, and consumption were normalized by the total country imports, rendering them stationary in equilibrium. For the variables with a value equal to one in the initial year, Table 3 shows the endogenous variables in 2011 relative to the initial BGP equilibrium in 1995.

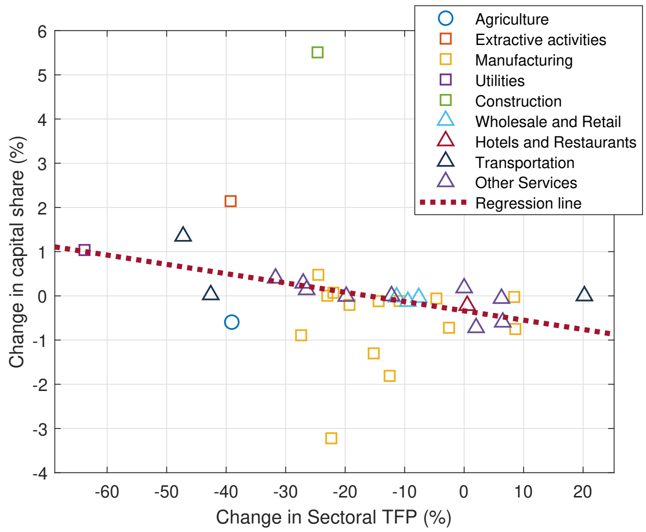
The benchmark calibration implies a drop in the normalized aggregate output and consumption of roughly 23% with a slightly higher decrease in consumption, but aggregate capital increases. Therefore, the output-capital ratio decreases from 34% to 26%. This differential response of capital relative to output has its roots in the differential effect of changes in the profile of sectoral distortions on the aggregate TFP, $\mathcal{A}$, compared to its effect on the price composite of productivities and distortions $\mathcal{B}$. While the former drops roughly the same as the aggregate output, the latter slightly increases.

To clarify the implications of these differential movements of sectoral productivities and distortions composites, let us go back to some of the model equations. Recall from equation 17 that changes in the sectoral profile of distortions and productivities directly affect the aggregate output of the economy. Thus, a change in the sectoral distortions and productivities that combined generates a decrease in the aggregate TFP would lead to a drop in the aggregate output even if total capital remains constant. This effect is well documented in the misallocation literature (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009). However, another impact of changes in sectoral distortions and productivities has dynamic implications. Equation 16 implies that these changes have a potentially different effect on the actual rate of return. Indeed, in the benchmark calibration the price composite slightly increases, inducing capital accumulation at a rate higher than the technology adoption that counteracts the initial drop in the aggregate output.

This is the key result of the model and contrasts it with the standard neoclassical growth models. In those models, the aggregate TFP impacts the aggregate output and the economy-wide interest rate in the same direction. Therefore, the static and the dynamic effects are qualitatively similar. In the model presented in this paper, these effects are potentially disconnected because the profile of sectoral distortions affects the final output prices in a different direction than it affects the aggregate TFP. As Table 3 shows, changes in the profile of sectoral productivities and distortions lead to an increase in the price composite, which implies a mild decrease in the output price. Since the dynamics of the model are also driven by the Euler equation (equation 15), the increase in the actual rate of return triggers capital accumulation to a greater extent relative to the technology adoption despite the decrease in the aggregate TFP.

The result shows a misallocation of capital among sectors over time. Sectors that increased their productivity reduced their participation in aggregate capital. In contrast, sectors that reduced their productivity increased their participation in capital. Indeed, 26 of the 34 sectors showed a drop in productivity between 1995 and 2011. Furthermore, participation in the aggregate capital of these sectors increased from 93.5% to 95.7%. Figure 8 presents the result for all sectors of the change in capital participation according to the percentage change in productivity. As can be seen, on average, sectors with an increase in capital participation showed a decline in TFP.

Figure 8: Capital Misallocation Among Sectors



This differential impact of changes in the profile of sectoral distortions on the aggregate TFP and prices, which ultimately impacts the growth mechanisms, has important policy implications. If some of these changes in distortions are policy-driven decisions by the government, they could lead to a misguided impression of success. The way to see this is by interpreting the normalized aggregate output as measured relative to the leading country's aggregate output, since the imports grow at the same rate as the stock of frontier knowledge –here it is calibrated to the U.S. long-run growth rate. Once the policy-driven changes in the distortions hit the economy, the price responses to the policy could generate capital accumulation that surpasses the technology adoption even if it increases the sectoral distortions in the economy and lowers the aggregate TFP. This would trigger growth in the aggregate output through time that would be lower than if distortions were mitigated instead.

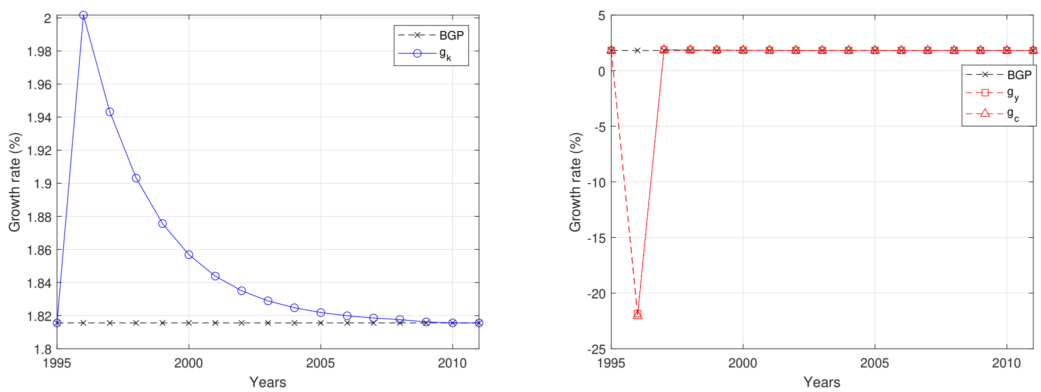
Next, the model's transition is investigated through a simulation of a shock in the profile of sectoral productivities and distortions between the initial calibrated BGP in

1995 and the final calibrated BGP in 2011. It is assumed that the economy begins at the initial BGP equilibrium in 1995 and then faces a permanent shock in the sectoral productivities and distortions in the following period.

Figure 9 shows the behavior of the growth rate for the aggregate output, aggregate capital, consumption, and total imports. After the shock, the growth rate of aggregate output and consumption dropped significantly by roughly the same magnitude. It then increased to a value slightly higher than the growth rate of the technology adoption reflected in the total imports growth rate. The differential impact of the shock in the profile of sectoral productivities and distortions in the aggregate TFP (the static effect) and the actual rate of return (the dynamic effect) gives rise to an increase in the capital accumulation rate that exceeds the rate of technology adoption despite the decrease in productivity. As already mentioned, this price response leads to a relatively small compensatory increase in the aggregate output through time that is not driven by productivity increases. Thus, the output-capital ratio decreases along with the economy's interest rate.

The qualitative differences in the static versus the dynamic effect of the shocks in the sectoral profile of productivities and distortions generate new implications for the total effect on the aggregate variables and constitute the central message of the model. It is also important to ask how the responses would change if either sectoral productivities or distortions remained constant. Although this question is postponed to the next subsection, it is clear from equation 18 that the aggregate TFP, $\mathcal{A}$, would equal the price composite, $\mathcal{B}$, in the absence of sectoral distortions. Hence, sectoral distortions are crucial to give rise to differential static versus dynamic effects.

Figure 9: Transition Growth Rates for the Benchmark Final BGP



(a) Agregate Capital

(b) GDP and Consumption

5.2 Counterfactual Productivities and Distortions

In this section, we assess the isolated effect of changes in either sectoral productivities or distortions. Two main counterfactual exercises are conducted. In the first one, the sectoral distortions remain constant at their level in 1995. The second counterfactual maintains the sectoral productivities constant at the initial period level.

Table 4 presents two counterfactuals for the Mexican economy. The total imports normalize all the values of the endogenous variables as before. Also, the values are presented relative to their BGP level in the initial year. For convenience, the first two columns replicate the benchmark results of Table 3. Columns 3 and 4 show the results for the counterfactuals. In the former, the aggregate output would have declined around 21% in 2011, the aggregate capital roughly 28%, and consumption approximately 21%. Contrary to the benchmark calibration, the output-capital ratio would have instead increased. The reason is that the aggregate TFP and the price composite decline due to the drop in the sectoral productivities documented in the previous subsection. Thus, the output price increases and reduces the actual rate of return on capital, generating a decrease in capital accumulation relative to the technology adoption. In contrast to the final benchmark BGP, the import share declined.

In turn, Column 4 shows the counterfactual BGP equilibrium when the sectoral productivities remain constant. A completely opposite behavior of the endogenous variables comes out. As described in the previous section, most of the sectoral distortions decreased in the period. Consequently, the counterfactual aggregate output, the aggregate capital, and consumption increase significantly relative to the initial benchmark BGP. The aggregate capital increases by 74% while aggregate output and consumption increase around 32%. The output-capital ratio remains fairly constant. The reason for the increase in the aggregate output is twofold. First, there is a mild increase in the aggregate TFP of 2.35% that directly increases aggregate output (the static effect). Second, there is a substantial increase in the price composite (approximately 34%) that decreases final output prices, leading to an increase in the actual rate of return on capital that induces stronger capital accumulation relative to technology adoption, which, finally, amplifies the initial increase in output (the dynamic effect). Note, however, as the economy adjusts to the new BGP equilibrium, the economy-wide interest rate decreases substantially by almost 6 percentage points (p.p.) in the final BGP.

Figure 10 analyzes the transition for the first two counterfactuals. Figure 10a shows the effect on the growth rates when the distortions remain constant at their level in 1995. A decline in sectoral productivities in the period leads to a strong negative response in

Table 4: Normalized Endogenous Variables for the Mexican Economy

Counterfactual BGP Relative to 1995

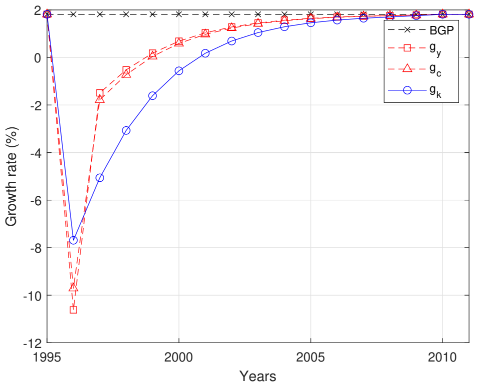
	1995	2011	τ_s init	z_s init
Aggregate output	1.0000	0.7692	0.7883	1.3273
Aggregate capital	1.0000	1.0058	0.7218	1.7486
Aggregate consumption	1.0000	0.7672	0.7888	1.3238
Output-capital ratio	0.3464	0.2649	0.3783	0.2630
Output price, p^Y	1.0000	0.9942	1.3855	0.5719
Internal rate of return	0.1366	0.1358	0.1892	0.0781
Aggregate import share	0.0509	0.0665	0.0466	0.0670
$\mathcal{A}$	1.0000	0.7671	0.9174	1.0235
$\mathcal{B}$	1.0000	1.0031	0.8400	1.3483

Notes: The table shows the value of the normalized endogenous variables in the balanced growth path for counterfactual exercises. Each endogenous variable is normalized by the total imports, rendering all stationary in equilibrium. Also, the table shows the calculated variables relative to the 1995 BGP for variables with a value equal to one in 1995. The first two columns replicate the results in Table 3. Columns 3 and 4 show the calculated counterfactual endogenous variables in the BGP keeping distortions constant and the calibrated productivities constant at the 1995 level, respectively.

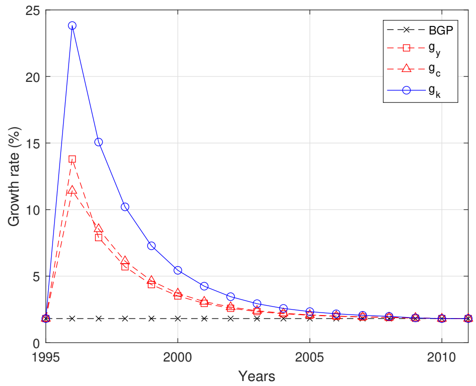
growth rates. However, note that the capital accumulation response is less severe than the response of aggregate output and consumption growth. In contrast, Figure 10b shows a completely different behavior of the growth rates. Since sectoral distortions declined in the period, the counterfactual growth rate of output shows a substantial increase relative to the growth rate of technology adoption, which is induced by the strong increase in the price composite. All aggregate outcomes exhibit the same qualitative positive response, though the magnitude of the capital accumulation response is higher.[11] Finally, the depicted growth rate responses to the unanticipated shocks are exactly those expected in the standard neoclassical model in which the aggregate TFP affects both the total output and the actual rate of return in the same direction.

[11] The magnitudes of the response are somewhat extreme. However, in this exercise, all the impacts of decade-long changes in sectoral productivities and distortions are concentrated in one year, which at least partially explains the magnitudes. Also, the model embeds only two out of a number of growth mechanisms in the data, which may force greater responses to account for the observed empirical behavior.

Figure 10: TRANSITION GROWTH RATES FOR THE COUNTERFACTUAL FINAL BGP



(a) Distortions Constant in 1995



(b) Productivities Constant in 1995

6 Conclusion

This paper addresses how an increase in capital accumulation per worker could happen even with a decrease in GDP per capita. The main motivating fact is that some countries such as Canada, Italy, and Mexico have presented a higher growth rate of capital per worker but a lower growth rate for GDP per worker when compared to the United States. The Mexican economy, especially, experienced sluggish growth since the debt crisis during the 1980s despite major macroeconomic reforms put in place. The lack of growth directed the policy debate from macro toward micro reforms that could tackle many distortions in the Mexican economy. Thus, increasing aggregate capital is not enough to boost economic development if this capital has been allocated to less efficient sectors.

We build a model where monopolistic competitive firms face a wedge over the price of their differentiated sectoral products. The growth mechanisms considered here are capital accumulation, resulting from consumer saving decisions and sectoral firms' demand for capital input, and exogenous technology adoption coming from international trade in intermediate varieties inputs.

According to the balanced growth path equilibrium calibrated to the Mexican economy, between 1995 and 2011, the aggregate output relative to the United States decreased around 23%. However, aggregate capital increased by approximately 1%. This result is explained by capital misallocation: sectors that had a reduction in their TFP increased their capital participation in the aggregate capital formation from 93.5% to 95.7%. Furthermore, if the sectoral productivities had remained constant at the initial level in a counterfactual exercise, the aggregate output would be higher than its initial level, with capital accumulation increasing 74% and driving the rise in GDP. It is important to highlight that, although an interesting case, the Mexican trajectory is far from the exception. Therefore, the analysis carried out in this paper would easily apply to other countries in developed or developing stages of gorwth, like Canada, Italy, and Belize.

Altogether, the results warn about policies that aim at triggering growth. They suggest that policies that incentivize capital accumulation in some specific sectors might backfire in terms of their effect on economic growth. They may generate the false impression of a successful intervention when they, in fact, decrease the productivity that they intended to promote. Although this paper does not address any specific reform, it could be viewed as a step toward improving our understanding of how microeconomic reforms could lead to economic growth.

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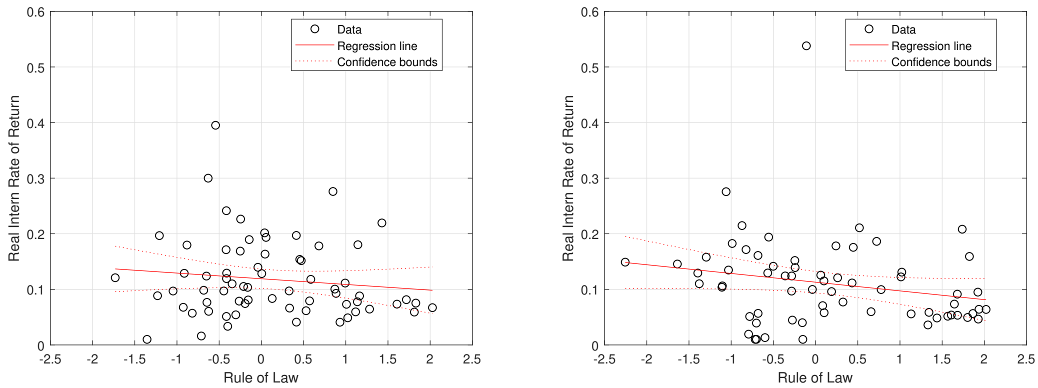
A Additional Cross-Country Evidence

Figure 11 depicts the relationship between the real internal rate of return (from the PWT9.1) and Worldwide Governance Indicator of "Rule of Law" calculated by the World Bank, as a rough measure of the level of distortions. In contrast to the relationship shown in the text, when the groups of countries are divided by the growth rate of GDP per capita, instead of the growth rate of GDP per worker, both groups display a negative relationship. It is worth emphasizing that the model predicts this negative correlation in the BGP. To the extent that countries with above-median growth might be enjoying the transition growth rates, the presence of the correlation for the high-growth group would be somewhat unexpected.

Figure 11: Appendix: Cross-Country Real Internal Rate of Return and Misallocation in 2017 (by real GDP per capita growth rate)



(a) Above Median Growth

(b) Bellow Median Growth

B Derivation of the Equilibrium and Aggregation

B.1 Derivation of Equation 13

The first-order conditions (FOC) for the cost minimization problem of the differentiated products firms given the technology, equations 5 and 6, imply the following firm-level exports (equal to the foreign firm-level demand for country's n varieties):

$$\begin{aligned}\int_{\nu\in n} p(\nu)x(\nu)d\nu &= \int_{\nu\in n} \left(p(\nu)X_{s,n'}\right)^{1-\epsilon}\left((1-\alpha)c_s(r_n,\tilde{P})y_{s,n'}\right)^{\epsilon} d\nu \\ &= \left((1-\alpha)c_s(r_n,\tilde{P})y_{s,n'}\right)^{\epsilon} X_{s,n'}^{1-\epsilon}\int_{\nu\in n} p(\nu)^{1-\epsilon}d\nu \\ &= \left(\tilde{P}X_{s,n'}\right)^{\epsilon} X_{s,n'}^{1-\epsilon} n p_n^{1-\epsilon} \\ &= n\left(\frac{p_n}{\tilde{P}}\right)^{1-\epsilon}\tilde{P}X_{s,n'}\end{aligned} \tag{20}$$

The first equality is obtained by substituting the FOC. The second reflect that only prices are indexed by varieties. The third substitutes the FOC again and uses the fact that $p(\nu) = p_n,\ \forall \nu \in n$. Summing over sectors and across countries, we obtain the right-hand side of equation 13.

B.2 Derivation of Equation 14

The total labor demand in country n is composed of the total demand for the intermediate tradable varieties of the country. Thus,

$$\begin{aligned}\int_{\nu\in n} \ell(\nu)d\nu &= \int_{\nu\in n} x(\nu)d\nu \\ &= \int_{\nu\in n}\left(\frac{p(\nu)}{\tilde{P}}\right)^{-\epsilon} X_{s,n'}d\nu \\ &= n\left(\frac{p_n}{\tilde{P}}\right)^{-\epsilon} X_{s,n'}\end{aligned} \tag{21}$$

Summing over sectors and across countries, we obtain the right-hand side of equation 14.

B.3 Proof of Proposition 1

Before we get to the proof of Proposition 1, it is helpful to begin by deriving the country n import participation in total trade, X_n^R (the R superscript stands for ratio). From labor market-clearing equation 14 we have:

$$\left(\frac{p_n}{\tilde{P}}\right)^{\epsilon} = \frac{n}{\tilde{P}} \underbrace{\int \tilde{P}\bar{X}_{n'} dG(n')}_{\equiv X^W}$$
$$\Rightarrow \frac{p_n}{\tilde{P}} = \left(\frac{nX^W}{\tilde{P}}\right)^{\frac{1}{\epsilon}} \tag{22}$$

Now, substituting the above equation into the ideal price index equation 9, we obtain:

$$\begin{aligned}
\tilde{P} &= \left(\int_0^N p(\nu)^{1-\epsilon} d\nu\right)^{\frac{1}{1-\epsilon}} \\
&= \left(\int n p_n^{1-\epsilon} dG(n)\right)^{\frac{1}{1-\epsilon}} \\
&= \left(\int n \left(\tilde{P}^{\frac{\epsilon-1}{\epsilon}} \left(nX^W\right)^{\frac{1}{\epsilon}}\right)^{1-\epsilon} dG(n)\right)^{\frac{1}{1-\epsilon}} \\
\Rightarrow X^W &= \left(\int n^{\frac{1}{\epsilon}} dG(n)\right)^{\frac{\epsilon}{\epsilon-1}}
\end{aligned} \tag{23}$$

Substituting the above equation and equation 22 into the trade balance equation 13, we obtain the country's n import participation in world trade:

$$\begin{aligned}
X_n^R \equiv \frac{\tilde{P}\bar{X}_n}{X^W} &= n\left(\frac{p_n}{\tilde{P}}\right)^{1-\epsilon} \\
&= n\left(\frac{nX^W}{\tilde{P}}\right)^{\frac{1-\epsilon}{\epsilon}} \\
&= \frac{n^{\frac{1}{\epsilon}}}{\int n^{\frac{1}{\epsilon}} dG(n)}
\end{aligned} \tag{24}$$

Now we are ready to prove Proposition 1. In the BGP, by definition, the consumption growth rate is the same across all countries. Let us define this common consumption growth rate as g_c. From the definition of the import participation we have that total imports are given by:

$$\bar{X}_n = X_n^R \frac{X^W}{\tilde{P}} = n^{\frac{1}{\epsilon}} \left(\int n^{\frac{1}{\epsilon}} dG(n) \right)^{\frac{1}{\epsilon-1}} \tag{25}$$

Since the mass of intermediate tradable varieties grows at the same rate as the total mass of varieties available in the world economy, we can define θ such that $n = \theta_n N$. Therefore, total imports are given by:

$$\begin{aligned}
\bar{X}_n &= N^{\frac{1}{\epsilon}} \theta_n^{\frac{1}{\epsilon}} N^{\frac{1}{\epsilon(\epsilon-1)}} \left(\int \theta_n^{\frac{1}{\epsilon}} dG(n) \right)^{\frac{1}{\epsilon-1}} \\
&= N^{\frac{1}{\epsilon-1}} \theta_n^{\frac{1}{\epsilon}} \left(\int \theta_n^{\frac{1}{\epsilon}} dG(n) \right)^{\frac{1}{\epsilon-1}} \\
&= N^{\frac{1}{\epsilon-1}} f(\theta_n) \\
\Rightarrow \frac{\dot{\bar{X}}}{\bar{X}} &= \frac{1}{\epsilon - 1} \lambda
\end{aligned} \tag{26}$$

Now it suffices to show that the aggregate output and capital grow at the same rate as the total imports. The Euler equation (equation 15) and the actual rate of return in equation 16 then imply that the rate of return is constant and given by:

$$r^* = \left(\frac{\sigma}{\sigma - 1} \frac{g_c + \delta + \rho}{\mathcal{B}} \right)^{\frac{1}{1-\alpha}} \tag{27}$$

The technical marginal rate of substitution then implies:

$$\begin{aligned}
\frac{\bar{K}}{\bar{X}} &= \frac{\alpha}{1 - \alpha} \frac{1}{r^*} \\
\Rightarrow \frac{\dot{\bar{K}}}{\bar{K}} &= \frac{\dot{\bar{X}}}{\bar{X}}
\end{aligned} \tag{28}$$

The aggregate output in each country, equation 17, implies that $\dot{Y}/Y = \dot{\bar{K}}/\bar{K}$. Finally, the consumer budget constraint, equation 2, implies that $g_c = \lambda/(\epsilon - 1)$.

B.4 Derivation of Equation 17

The first-order conditions (FOC) for the cost minimization imply:

$$\begin{aligned} K_{s,n} &= \alpha \left(\frac{\tilde{P}}{r_n}\right)^{1-\alpha} \frac{y_{s,n}}{z_{s,n}} \\ \Rightarrow \bar{K}_n &= \alpha \left(\frac{\tilde{P}}{r_n}\right)^{1-\alpha} \frac{Y_n}{\mathcal{A}_n}. \end{aligned} \tag{29}$$

The second equality follows substituting the optimal output in each sector, equation 12, and summing over sectors. Rearranging the expression we obtain equation 17.

C Sectoral Productivity Parameters

Table 5: APPENDIX: SECTORAL PRODUCTIVITY PARAMETERS CALIBRATED VALUES FOR THE MEXICAN ECONOMY

Internally Calibrated (Part 1)			
		Year	
Sector (total=34)	Parameter	1995	2011
Agriculture, Hunting, Forestry and Fishing	z_1	0.16623	0.10132
Mining and Quarrying	z_2	0.27127	0.1648
Food, Beverages and Tobacco	z_3	0.080331	0.058322
Textiles and Textile Products	z_4	0.11368	0.11079
Leather, Leather and Footwear	z_5	0.27287	0.26014
Wood and Products of Wood and Cork	z_6	0.40774	0.44204
Pulp, Paper, Printing and Publishing	z_7	0.10891	0.11828
Coke, Refined Petroleum and Nuclear Fuel	z_8	0.54165	0.41707
Chemicals and Chemical Products	z_9	0.11094	0.097056
Rubber and Plastics	z_{10}	0.096973	0.078286
Other Non-Metallic Mineral	z_{11}	0.24781	0.22089
Basic Metals and Fabricated Metal	z_{12}	0.063788	0.048154
Machinery, Nec	z_{13}	0.095845	0.074789
Electrical and Optical Equipment	z_{14}	0.02079	0.016148
Transport Equipment	z_{15}	0.032381	0.027461
Manufacturing, Nec; Recycling	z_{16}	0.083701	0.071669
Electricity, Gas and Water Supply	z_{17}	0.21988	0.07959

Notes: The table shows the internally calibrated sectoral productivity parameters for sectors 1-17. The sectoral participation in total GDP for the respective sector is targeted and discipline productivity parameters in the calibration for the Mexican economy. The sectoral participation in total GDP for the Mexican economy is calculated from the WIOT Release 2013.

Table 6: Appendix: Sectoral productivity parameters calibrated values for the Mexican economy

Internally Calibrated (Part 2 Final)			
		Year	
Sector (total=34)	Parameter	1995	2011
Construction	z_{18}	0.073632	0.055492
Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	z_{19}	0.17134	0.15189
Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles	z_{20}	0.15638	0.14159
Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods	z_{21}	0.17732	0.16379
Hotels and Restaurants	z_{22}	0.394	0.39603
Inland Transport	z_{23}	0.19162	0.10112
Water Transport	z_{24}	0.74868	0.9
Air Transport	z_{25}	0.34917	0.20046
Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies	z_{26}	0.58334	0.51215
Post and Telecommunications	z_{27}	0.29098	0.19875
Financial Intermediation	z_{28}	0.31998	0.32641
Real Estate Activities	z_{29}	0.71745	0.76403
Renting of M& Eq and Other Business Activities	z_{30}	0.15789	0.15789
Public Admin and Defence; Compulsory Social Security	z_{31}	0.3844	0.28042
Education	z_{32}	0.84686	0.9
Health and Social Work	z_{33}	0.21542	0.1584
Other Community, Social and Personal Services	z_{34}	0.38211	0.30641

Notes: The table shows the internally calibrated sectoral productivity parameters for sectors 18-34. The sectoral participation in total GDP for the respective sector is targeted and discipline productivity parameters in the calibration for the Mexican economy. The sectoral participation in total GDP for the Mexican economy is calculated from the WIOT Release 2013.