UNIVERSITAT DE BARCELONA

Essays on Political Economy of Public Intergenerational Transfers

Gianko Michailidis

PhD in Economics

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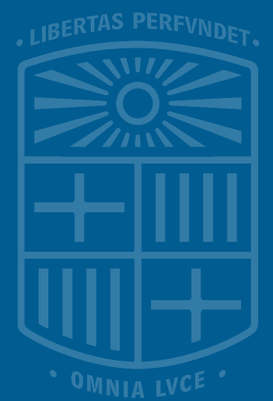

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Essays on Political Economy of Public Intergenerational Transfers

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In memory of my father, to my family and my beloved Rima

“Επιστήμη ποιητική ευδαιμονίας”
— Πλάτων

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Barcelona, 16^{th} of May, 2019

Sincerely,
Gianko Michailidis

Contents

List of Figures

List of Tables

1 Introduction

The economic life cycle is a fundamental feature of all societies and it refers to the patterns of consumption and earnings that people have throughout their life (United Nations, 2013). During the economic life cycle there are two periods – childhood and retirement – when people find themselves in a state of dependence. In both periods, there is a mismatch between the material needs and the ability to satisfy them. Middle-aged generations finance this mismatch – between productive capacity and consumption of young and elderly (called "life cycle deficit") – to a considerable extent out of their life cycle "surplus" through intergenerational transfers. In the past, these transfers towards both sides of dependence were arranged privately within families. However, in developed economies, the state has taken over the role of the main provider for the young and especially for the elderly. Nowadays, two of the main intergenerational transfers directed towards children and elderly come in the form of public education and pensions, respectively. This Ph.D. dissertation is devoted to the study of the interplay between the public finance of pensions and education and the demographic transition within a political economy framework.

Most of the developed countries have been experiencing a significant demographic transition in the last few decades. Low fertility and mortality rates combined with the retirement of the generation of "baby boomers" have accelerated the process of population ageing putting considerable pressure on public welfare states.[1] The implications of population ageing have a direct impact on the size and the allocation of public funds between pensions and education.[2]

[1]The main forces behind low fertility are the higher increase in female wages with respect to household income – and hence the increasing opportunity cost for women of having children (Galor and Weil, 1996) – and the increase in human capital investment per child or quantity-quality trade-off (Becker et al., 1990; Galor and Weil, 2000). The increased life expectancy is a result of better quality services due to technological progress in the healthcare system.

[2]See, Casamatta and Batté (2016) for a detailed review of the literature on political econ-

There is a large strand of literature on political economy of social security that analyses the effect of population ageing on public pensions.[3] In this literature, there are two opposite effects on public pensions. The "fiscal leakage" hypothesis argues that the increasing number of retirees decreases the expected profitability of the public pay-as-you-go (henceforth, PAYG) pension system for the working-age generation, thereby inducing them to vote in favour of lower current pensions. (Breyer and Stolte, 2001; Razin et al., 2002; Razin and Sadka, 2007). However, according to the "political power of elderly" hypothesis, population ageing makes the median voter older and hence more inclined to vote for policies that favour higher spending on pensions (Mulligan and Sala-i Martin, 1999; Tabellini, 2000; Disney, 2007; Shelton, 2008).[4]

The effect of population ageing on education spending is directly linked to the idea of increasing political power of elderly. Part of the theoretical literature on political economy of public education argues that there is an "intergenerational conflict" over the allocation of public resources between public pensions and education. As the electorate becomes older, there is an increasing political influence of the elderly over government budget and the allocation of public funds. As a result, there is a significant shift directing public resources towards pensions rather than education (Browning, 1975).

The empirical literature shows mixed results regarding the intergenerational conflict hypothesis. Poterba (1997) presents some evidence from the U. S. in favour of this hypothesis. Ladd and Murray (2001) challenge the robustness of the outcome arguing that the use of local-level instead of state-level data might weaken Poterba's findings. Harris et al. (2001) reconciling this dispute over which data to use, find only weak support of the intergenerational conflict. More recently, examining OECD countries Krieger and Ruhose (2013) show some evidence in favour of this hypothesis.

Other theoretical studies show that population ageing can have a positive effect on education spending. According to Pogue and Sgontz (1977) the design of the PAYG pension system – pay "now" and receive "tomorrow" – generates the appropriate incentives for the working aged generation to invest in public education and creates an "intergenerational link" between pen-

omy of ageing.

[3] See Galasso and Profeta (2002) for a detailed literature review.

[4] The median voter theorem states that governments implement the policy that is most preferred by the median voter (Downs, 1957).

sions and education. Working-age generations are willing to support public education because in the near future they are entitled to appropriate – by design of the pensions system – all the benefits in terms of higher, taxable income (Konrad, 1995), social security contributions (Kemnitz, 2000) and higher returns on savings (by complementarity between human and physical capital, Boldrin, 1992; Gradstein and Kaganovich, 2004). As Lancia and Russo (2016) argue, working age adults invest in public education because they can extract the political rent in form of pensions. This positive link between generations seems to be reinforced with population ageing, as middle-aged individuals understand the strategic role of the human capital for their pensions. Hence, the strategic role of human capital is even more important when there is faster population ageing and expected deterioration of pensions. Kemnitz (2000) shows that the demographic transition achieves higher allocation of public resources for pensions and education.

Therefore, population ageing is expected to have two antithetical effects on education spending, a direct and an indirect effect. The direct effect concerns the generation of retirees and their negative impact on education described by the intergenerational conflict hypothesis. In contrast, the indirect effect refers to the middle-aged generation who foresee the prolonged longevity and the decreasing expected profitability of the PAYG system. Expecting those demographic trends – and their effect on the public finance of pension systems – the middle aged react by investing in public education pursuing to "reap" the benefits of the aforementioned intergenerational link.

In the political economy context, this Ph.D. thesis contributes to the understanding of the effect of population ageing on the public finance of pensions and education. The main purpose of the second chapter is to conduct an empirical investigation on the effect of current (direct effect) and future population ageing (indirect effect) on education spending taking into account the strategic intergenerational link that exists in a system with a PAYG pension structure. Taking into account this positive intergenerational link and the indirect effect, the third chapter aims to evaluate whether a system of public intergenerational transfers – both to the elderly (e.g. pensions) and to the young (e.g. education) – can be politically sustained when we consider both current and projected demographic trends. In the fourth chapter, we develop an overlapping generations model with heterogeneous agents – in regard to their position in the income distribution –, endogenous fertility and proba-

bilistic voting to investigate how the size of public pensions and education is decided and how it is affected by both population ageing and income inequality.

The second chapter of this Ph.D. thesis, titled *"Do Pensions Foster Education? An Empirical Perspective"*, is a joint work with Concepció Patxot and Meritxell Solé. In this chapter, we investigate the opposing theoretical claims stemming from the aforementioned literature. On the one hand, the direct effect – of population ageing on education spending – indicates that population ageing has induced a significant raise in the political power of elderly that is expected to transform the allocation of public resources. As a result, more resources shift towards the older cohorts (e.g. for pensions) and fewer to the younger ones (e.g. for education). In the context of a limited fiscal budget, this reallocation of public funds triggers a "struggle" for public resources between the young and the elderly (intergenerational conflict). On the other hand, the indirect effect points out that the specific design of the PAYG pension system – pay "now" and receive "tomorrow" – provides the appropriate incentives to invest in public education. The working age generations are willing to pay for public education only if they can "reap" gains from higher (human capital) productivity in the future, in terms of higher taxable income, social security contributions and/or higher returns on savings. Therefore, it is expected that forward looking adults support a growth oriented public education policy as they are democratically entitled to claim share of the produced human capital of future generations (Lancia and Russo, 2016).

The empirical evidence derived from the application of a fixed effects approach to panel data for 31 OECD countries shows that the direct effect of the increasing share of elderly people on both total and per student education spending depends on the level of pensions and it is negative only beyond a certain level of total pension spending. This indicates a certain degree of intergenerational conflict. Nevertheless, we find that future population ageing (indirect effect), which reinforces the mechanism linking public education and pensions, affects positively the total and the per education spending. Furthermore, by disaggregating total education expenditure by educational levels, we observe that this effect is driven by levels of non-compulsory education (tertiary and pre-primary), probably as a reflection of the direct connection to labour productivity. Finally, future population ageing does not seem to affect significantly the education spending on primary and secondary

education (mandatory schooling).

The third chapter starts from the conclusion of the previous one. In a joint system of public pensions and education where generations are connected through a PAYG pension scheme, the intergenerational link plays a crucial role for the anticipation of the future population ageing. In such a setting, the projected population ageing can boost the investment in public education in order to increase the financial sustainability of a public system of pensions and education.

From the perspective of political economy another important aspect of a joint system of intergenerational transfers like pensions and education is its political sustainability given the life cycle dimension of those policies. This crucial aspect is examined in the third chapter of the thesis, titled *"Political Viability of Public Pensions and Education: An Empirical Application"*, which is a joint work with Concepció Patxot.

The question about the political sustainability of pensions and education is directly connected with the aforementioned literature. In this context, Rangel (2003) develops a model in order to analyse the possibility of non-market institutions to sustain a joint system of public intergenerational transfers directed towards young and elderly. In this model, non-altruistic agents live for three periods, and when adult they decide on the size of intergenerational transfers through a repeated voting setting. Employing the concept of a subgame perfect equilibrium with simple trigger strategies, Rangel derives the main conditions under which it is possible to have a sustained system of intergenerational transfers. Overall, this study underlines the crucial role of backward transfers – i.e. public pensions – in sustaining investment in forward transfers – i.e. public education. Moreover, this model shows that population ageing reinforces the investment in the public education system.

Our main contribution is to empirically examine the political sustainability of the public system of backward (i.e. pensions) and forward (i.e. education) intergenerational transfers. We achieve this by determining a particular voting outcome when the decision to reallocate economic resources *per se* is put to the vote. For this purpose, we conduct an empirical exercise based on the political economy application derived by Rangel (2003). This application considers a realistic demographic structure, where agents live in the first two decades as children, in the next five as working age adults and in the last two as retirees. All the decisions regarding the size and the directions

of public transfers are made through a majority rule. In this context, certain conditions under which it is possible to have a politically sustainable system of intergenerational transfers must be satisfied. More specifically, the majority of the voting cohorts must have a positive continuation value – which is a present value of all benefits received minus taxes paid – for the joint system of pensions and education. In order to calculate the continuation values we exploit the data from the National Transfer Accounts (NTA project) which provides us with detailed accounting of the direction and the magnitude of public intergenerational transfers for each age group coherent with National Accounts. Specifically, this method measures how the aforementioned "life cycle deficit" (consumption minus labour income) of children and the elderly is financed through the capital market or private or public transfers coming from the corresponding "life cycle surplus" of the working population. This particular nature of the data enables us to calculate the continuation value for every voting cohort of the countries included in our sample in order to assess the political support for public pensions and public education if such a vote would take place.

Our findings indicate that countries with a developed system of public intergenerational transfers (i.e. a big welfare state) and "greying" population structure would vote in favour of a joint system of pensions and education if such a vote would take place. In contrast, countries with relatively young populations where public intergenerational transfers are still dominated by private arrangements would vote down such a system as they have less political incentives to support it. In line with the theoretical predictions derived in Rangel (2003) we show that future population ageing would reinforce political support and strengthen political viability of a joint system of public transfers for pensions and education.

Parallel to populations ageing and the intergenerational conflict, an increasing income inequality constitutes another major trend in developed countries. This trend aggravates the intragenerational conflict between "poor" and "rich" segments of the population over the redistribution and the size of the welfare state. The existing literature studies the intergenerational conflict (Kaganovich and Zilcha, 2012; Naito, 2012; Ono and Uchida, 2016; Lancia and Russo, 2016) and the intragenerational conflict (Glomm and Ravikumar, 1992; Levy, 2005; De La Croix and Doepke, 2009) mostly in isolation. However, in determining the spending on a public system of pensions and

education it is of great importance to consider both conflicts simultaneously.

This is what I endeavour with Niclas Poitiers in the fourth chapter of the thesis, titled *"Inequality and Education Spending in a Greying Society"*. This chapter investigates the effect of population ageing and income inequality on education and pension spending taking into account simultaneously both political conflicts that arise, within (intragenerational conflict) and between (intergenerational conflict) generations. The former conflict is over taxation between poor and rich. The latter conflict is over the allocation of the resources between elderly (i.e. pensions) and young (i.e. education). The increase in income inequality directly affects the former whereas the population ageing directly affects the latter. We examine how voters of different age and income status decide their preferred levels of pensions and education per retiree and student, respectively. For this, we develop an overlapping generations model based on De La Croix and Doepke (2009), with public and private education, a PAYG pension system, endogenous fertility, and probabilistic voting à la Lindbeck and Weibull (1987) on the level of pensions and education spending. The main contribution to this literature is to incorporate the dimension of pensions in the model of De La Croix and Doepke (2009), and specifically a PAYG pension design. This allows us to consider the two political conflicts together and investigate the effect of income inequality and population ageing on education and pension spending. Moreover, the specific structure of pensions that we consider in this study enables us to internalize the intergenerational link or the incentives for adults to support public education according to the mechanism described in the second chapter.

In this model, an increase in income inequality increases public education and pension spending per enrolled student and retiree, respectively, and decreases the participation in public education and fertility. An increase in the share of retirees in the economy decreases per student spending on public education and pensions, while decreasing the participation in public education and the fertility rate. The effect of an increasing income inequality operates through the channel of decreasing public education participation due to the substitution of public by private schooling, freeing public resources for higher per student spending. At the same time, some of the resources that are not used any more for public schooling are used in order to finance more generous pensions. The effect of an increasing population ageing works directly via the budget constraint. The increased proportion of elderly burdens

the government's budget inducing cuts in the expenditure on pensions and education per beneficiary. The negative impact of the increasing number of elderly on education spending is driven by the direct effect – i.e. intergenerational conflict– which in our model is stronger than the indirect effect – i.e. intergenerational link.

Empirical evidence from 34 OECD countries seem to support the main theoretical claims of the model. The obtained findings are mixed concerning the effect on income inequality on public education spending. An increase in income inequality increases the spending per student in primary public education but in regards to secondary education the effect is inconclusive. Moreover, an increase in the share of retirees in the economy decreases the primary and secondary education spending but the effect depends on the level of pension spending per retiree. This effect is in line with the empirical findings from the second chapter, when we consider the effect of the current rather than the future population ageing on total and per student public education spending.

The rest of this Ph.D. thesis is structured as follows: In the next two chapters, we investigate the theoretical predictions regarding the intergenerational conflict between old and young and the theoretical claims about the positive intergenerational link that exists in a system with PAYG pension design. The fourth chapter augments the existing theoretical models that examine the intergenerational conflict by adding the dimension of the intragenerational conflict between rich and poor that take place within generations and it refers to the size and the allocation of public resources between public pensions and education. The final chapter provides the concluding remarks of this doctoral dissertation.

2 Do Pensions Foster Education? An Empirical Perspective[§]

2.1 Introduction

The welfare state has gradually extended its action from mere monetary transfers for poverty reduction to broader welfare programs, including the provision of basic social goods (education and health), and to income substitution programs, including pensions, with a high insurance component. Interestingly, this process can be said to have led to the gradual substitution of private intergenerational transfers from the public sphere. Indeed, in such instances, government intervention extends beyond intra-generational redistribution to constitute intergenerational redistribution. Today, two of the main policies of OECD countries are public education and pensions, two polices that directly impact the extremes of dependency (children and the elderly). More specifically, the size of public pensions in OECD countries in 2012 stood at 7.6% of GDP, while expenditure on public education represented on average 5.5% of GDP.[1]

Parallel to this, we have seen the unfolding of the demographic transition. Population ageing has become an issue of growing concern, especially as the generation of "baby boomers" reach retirement age, putting considerable pressure on current pay-as-you-go (PAYG) pension systems. In 2012, the average old-age dependency ratio (ODR) – population over 65 years old as a precent of the working age population (15-64) – for the OECD countries was 22.4%, but this figure is expected to rise to 43.4% by 2040. The forces behind population ageing are declining fertility rates – following on from the post-war "baby boom" – and increased life expectancy. Among other things, the

[§]The paper in this chapter is coauthored with Concepció Patxot and Meritxell Solé (Michailidis et al., 2019)

[1]For data definitions and sources, see Table 2.9 in the Appendix 2.8.2.

latter is a result of better quality services due to technological progress in the healthcare system, while the former results from the increasing opportunity cost for women of having children in developed economies.[2]

Both processes – demographic change and the extension of the welfare state – seem to be related, as shown by the convergence of both strands of the literature. This relationship between economic and demographic variables is mediated either by a household's reactions to exogenous changes and/or changes in preferences and social norms.[3] Hence, the study of intergenerational transfers means considering, more or less explicitly, hypotheses about the motives for private transfers and government intervention, which can range from forward (towards the young) and backward (towards the elderly) altruism to strategic behavior or, in line with recent studies of endogenous preferences, they can be due to reciprocity.[4] The political economy literature also converges with the literature on intergenerational transfers and population change by investigating the link between forward and backward intergenerational transfers (henceforth, FITs and BITs, respectively) in the absence of altruism. This link is quite intuitively present in the family but to a lesser extent in government action.

Scholars have previously examined the existence of a link between public FITs (e.g. education) and BITs (e.g. pensions) by addressing the question as to why selfish generations choose to transfer public resources to future generations. The main reason seems to lie in the fact that markets and intra-family reallocations are failing to achieve certain important social goals by providing non-optimal investments in human capital for the young and pensions for the old Becker and Murphy (1988). Hence, governments have to step in and correct that failure by creating a social contract between generations. According to the terms of which, the older generations invest economic resources in the younger generations in expectation of future benefits. Public intergenera-

[2] According to Galor and Weil (1996), this is brought about by the higher increase in female wages with respect to household income. Other potential channels include the increase in human capital investment per child and the quantity-quality trade-off à la Becker (Becker et al., 1990; Galor and Weil, 2000).

[3] Doepke and Tertilt (2016) recognize the need to incorporate changes in family structure in dynamic macroeconomic models.

[4] See Michel et al. (2006) for a survey on forward and backward altruism in the context of neoclassical growth models; Laferrère and Wolff (2006) for a survey on the motives for private transfers; and Fehr and Schmidt (2006) for a detailed survey on altruism and endogenous preferences (i.e. other-regarding preferences).

tional contracts, in which generations link FITs (e.g. education) to BITs (e.g. pensions) can achieve an optimal and sustainable allocation of economic resources (Rangel, 2003; Boldrin and Montes, 2005).[5] More specifically, the design of the PAYG pension system – pay "now" and receive "tomorrow" – creates the appropriate incentives to invest in public education Pogue and Sgontz (1977). The working age generations are willing to pay for public education only if they can "reap" gains of higher productivity in the future in terms of higher, taxable income Konrad (1995), social security contributions (Kemnitz, 2000) and higher returns on savings (Boldrin, 1992; Gradstein and Kaganovich, 2004).[6]

However, the demographic transition is predicted to have a significant impact on the aforementioned intergenerational contract and, hence, on the link between pensions and education.[7] According to the median voter theorem, governments implement the distribution of public funds that is preferred by the median voter Downs (1957) and as the median voter becomes older – due to population ageing – the political clout of the elderly seems set to grow. In turn, the increasing political power of the elderly transforms the allocation of public resources, shifting more resources towards the older cohorts (e.g. for pensions) and fewer to the younger cohorts (e.g. for education) Browning (1975).[8] In the context of a limited fiscal budget, this reallocation of public

[5]Rangel (2003) examines the possibility of sustaining a system of public FITs and BITs using sub-game perfect equilibrium in seeking to determine the ability of non-market intergenerational arrangements to invest optimally in FITs and BITs. With the help of simple trigger strategies in a repeated voting setting, he concludes that the provision of education for the younger cohort is optimal and sustained only when it is linked to sufficiently large transfers to the older cohort. This theory is tested empirically in Michailidis and Patxot (2018). Also, Boldrin and Montes (2005) stress that only financing public education is not sufficient to restore economic efficiency, because in order to do so an additional intergenerational trade arrangement is needed.

[6]The main incentives for investing in education are more closely related to the middle-aged generation. Nevertheless, the elderly might choose to reallocate public resources towards the education of the young because of the positive impact that the quality of schooling might have on property values (housing prices) (Poterba, 1998; Harris et al., 2001; Brunner and Balsdon, 2004)

[7]Moreover, according to previous findings, the impact of ageing on economic growth is sensitive to the forms of the social transmission of human capital (Choi and Shin, 2015). The authors find that the decrease in GDP and per-capita GDP in Korea would have been more severe if there were no increase in the investment in human capital.

[8]In this context, Jäger and Schmidt (2016) find that population ageing reduces the overall support for public investment. The authors relate this finding to differences in discount rates by age groups (the elderly discount future payoffs more heavily than working-age people).

funds might trigger a "struggle" for fiscal resources between the young and elderly, the so-called "intergenerational conflict" hypothesis.

Despite this, a number of theoretical studies show that a positive link between public pensions and education is actually strengthened as a population ages. Lancia and Russo (2016) argue that adults support education only if they can ensure that they will be able to extract political rent in form of pensions in the future. Hence, the strategic role of human capital is stronger when the political power of elderly is larger and the forward looking adults support public education policy as they are democratically entitled to claim a share of the produced human capital of future generations. Kemnitz (2000), using an overlapping generations model – in which the determination of intergenerational transfers is decided in a context of representative democracy – shows that the demographic transition achieves a better backward (pensions) and forward (education) redistribution of public funds.[9] This study highlights the impact that the political influence of the working population has on the political power of retirees. As a result, population ageing, accompanied by the specific structure of the PAYG pension system, stimulates the working generation to invest in education so as to provide future pension benefits for themselves.

Gradstein and Kaganovich (2004) reach similar conclusions, albeit based on a slightly different intuition. They state that as the elderly population grows there should be two antithetical effects (direct and indirect) on public education expenditure: on the one hand, the direct effect of the aforementioned intergenerational conflict; and, on the other, the fact that there are working-age agents who foresee that they are going to live longer because of the increase in longevity. These agents also realize that the increased number of retirees makes the PAYG pension system less generous in terms of spending per retiree. Having anticipated these outcomes, they react by investing more in education in the current period in order to take advantage of the future higher productivity of these young people (i.e. an indirect effect).[10] In this way, working-age agents pursue an increase in future tax revenues and endeavour to ensure a higher return on their savings in order to deal with the

[9] As shown in Figure 2.4 in the Appendix 2.8.2, parallel to population ageing, there is an increasing trend for education and pension spending per student and retiree, respectively.

[10] This mechanism finds some empirical confirmation in Cattaneo and Wolter (2009). The authors suggest that those aged between 30 and 50 are more likely to support an increase in education expenditure than are those above the age of 60.

increased fiscal needs of a prolonged retirement. The authors find that, even in the absence of altruistic linkages, the indirect effect is stronger than the direct and that, therefore, the ageing process might have a positive impact on the amount spent on education.

The main objective of this chapter is to undertake an empirical examination of both the direct and indirect effects of demographic change on current public education spending. To the best of our knowledge, no empirical study has yet to test for the two effects proposed by the aforementioned theoretical studies (Kemnitz, 2000; Gradstein and Kaganovich, 2004). This is what we attempt here, and what can be considered as this study's value added to the existing literature.

In the existing empirical literature, most studies focus on testing the direct effect (intergenerational conflict) and rely on data from a single country. In the case of the U. S. , Poterba (1997) argues that the effect of gerontocracy on education outlay per child is negative. However, Ladd and Murray (2001) question the approach of Poterba (1997) on the grounds that the use of local government as opposed to state-level data may weaken the negative effect of the share of the elderly on education spending per student or even make it insignificant. Harris et al. (2001) try to reconcile these two studies using a panel data set at the school district level. While they find a negative effect of a growing elderly population, the magnitude of the impact is far more moderate than that reported for the state-level model of Poterba (1997). Subsequently, Grob and Wolter (2007) and Borge and Rattsø (2008) have used state-level data for the Swiss Cantons and local governments in Denmark, respectively. Both studies find evidence in favour of the intergenerational conflict hypothesis.[11] However, as Krieger and Ruhose (2013) show, there is only partial evidence for this when the hypothesis is examined using the panel data of OECD countries.[12]

Using an enhanced panel data set for OECD countries, we examine the effects of the demographic transition on education spending: that is, the di-

[11] In the case of the Swiss Cantons, these results are reinforced by Cattaneo and Wolter (2009). According to their survey-based evidence, the elderly are less willing to support an increase in education expenditure or an increase in taxes to finance education. Similar findings on the negative preferences of elderly on education spending are obtained by Sørensen (2013) and Hess et al. (2017) using data on several OECD and EU countries, respectively.

[12] Busemeyer (2007) and Morales et al. (2013) also conduct a cross-national study, although their analysis is focused on the main determinants of education expenditure rather than on the impact of the demographic transition.

rect effect caused by intergenerational conflict and the indirect effect caused by the positive link between pensions and education. Our results show that current population ageing appears to be negatively related to education expenditure, although it seems to be dependent on the level of total pension spending, indicating a "struggle" for public resources – between generations – in times of fiscal scarcity. However, we obtain a positive impact on both the size (total spending) and generosity (spending per student) of the education system, when we consider projected population ageing. Finally, decomposing total education spending by level of education, we find that only the non-mandatory educational levels benefit from future population ageing. This could be due primarily to the fact that there is space for political intervention in favour of enhancing future labour productivity.

The remainder of this chapter proceeds as follows. Section 2.2 presents the data and methodology. Section 2.3 is devoted to a replication of past studies. In section 2.4 we revisit the intergenerational conflict hypothesis. Section 2.5 and 2.6 analyse the impact of projected population ageing on total education expenditure and on spending per level of education, respectively. In the last section 2.7 we provide our conclusions, discuss some possible policy implications and suggest topics for future research.

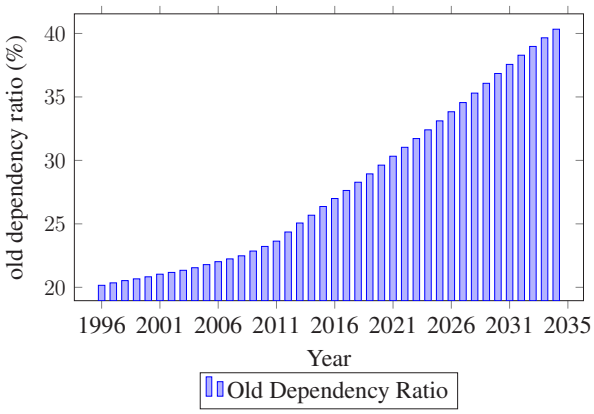
2.2 Data and Methodology

2.2.1 Data

We use panel data for 31 OECD countries and yearly observations over the period 1996-2015.[13] The choice of the annual base analysis is partially justified by the empirical evidence provided in Figure 2.5 in the Appendix 2.8.2. This figure shows that education spending fluctuates on a yearly basis in contrast with pensions that vary over a longer period, which is necessary for pension reform. Also, according to De La Croix and Doepke (2009) is a common sense to think of a government that adjusts education budget on a yearly basis. In addition, the choice of the time period of our sample, apart

[13] Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, S. Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, U. K. , U. S. .

Figure 2.1: *Current and Future Population Ageing*



NOTE: *This figure shows the current and future population ageing measured – on average of 31 OECD countries – by the old dependency ratio (1996–2017) and the projected old dependency ratio (2018–2035), respectively.*

from the current population ageing (1996-2017)[14], also allows us to capture the retirement of the "baby boomers" (2016–2035) – generations born from 1946–1964 – when we use as a proxy variable the future old dependency ratio that is projected 18 years in the future (2018–2035), see Figure 2.1.

In Table 2.1, we summarize the main descriptive statistics of the variables that we use in our model.[15] The first two variables according to Table 2.1 are used as dependent variables and represent the total education spending or the size of the education system as a percentage of GDP (TES) and per student spending (ESPS) or the generosity of the education system, respectively.[16] A closer look at Table 2.1 and Table 2.8 shows that, for both total education and per-student spending, the differences between countries are bigger than the differences within countries (over years). The next two variables are the total (TPS) and per retiree pension spending (PSPR). We incorporate the pension outlays in order to check the potential link with education expenditure.

The demographic variables (PRODR, ODR, PopEduc, Fertility) describe the projected old dependency ratio 17 years in the future (2018–2035), the

[14]We use the observed data on ODR for 2016 and 2017 instead of using the projected one although there are no significant differences. Moreover, when we run the regressions using the projected data (for 2016 and 2017) there are no significant changes (results available upon request).

[15]Definitions and sources of the variables can be found in Table 2.9 in the Appendix 2.8.2.

[16]Total general (local, regional and central) government expenditure on education (current, capital, and transfers), expressed as a percentage of GDP. It includes expenditure funded by transfers from international sources to government.

Table 2.1: *Descriptive Statistics*

A. Education Spending-Dependent Variables

	N	mean	sd	min	max
TES: Total Education Spending (% of GDP)	609	5.371	1.1699	2.9887	8.8069
ESPS: Education Spending per Student	606	6.3954	3.2454	0.6691	19.3315
PPES: Pre-Primary Education Spending (% of GDP)	471	0.4445	0.2152	0.0291	1.3437
PES: Primary Education Spending (% of GDP)	473	1.4254	0.4419	0.5381	2.6816
SES: Secondary Education Spending (% of GDP)	479	2.0592	0.423	0.9617	3.0541
TERES: Tertiary Education Spending (% of GDP)	503	1.2487	0.4326	0.3059	2.6367

B. Retirement Spending Variables

	N	mean	sd	min	max
TPS: Total Pension Spending (% GDP)	554	6.8624	2.8467	0.5	13.72
PSPR: Pension Spending per Retiree	554	13.2055	5.7301	0.8376	32.3935

C. Demographic Variables

	N	mean	sd	min	max
PRODR: Projected Old Dependency Ratio	620	33.5752	7.8432	10.6217	58.9743
ODR: Old Dependency Ratio	620	22.36731	5.2894	7.9619	44.1976
PopEduc: Population of the Official Age for Education	619	9.7829	16.7128	0.0932	89.6784
Fertility rate	620	1.6626	0.3891	1.08	3.09
ppoap: Population of the official age for Pre-Primary Education	619	1.2114	2.2732	0.0124	12.333
poap: Population of the official age for Primary Education	619	2.6474	4.8474	0.0297	24.9838
soap: Population of the official age for Secondary Education	619	3.0619	5.023	0.0294	26.0222
toap: Population of the official age for Tertiary Education	618	2.4636	4.1050	0.0208	22.5103

D. Macroeconomic and Fiscal Variables

	N	mean	sd	min	max
GDPpc: GDP per capita	620	30.2911	11.2317	6.917	68.7794
RGDPgr: Real GDP per capita	620	2.5012	3.0155	-14.7	25.5572
TaxRev: Tax Revenues	620	34.3952	7.0032	13.754	49.508
TotSocExp: Total Social Expenditures	608	20.6103	5.6777	3.4	31.938
SocExp: Social Expenditures	554	13.5204	3.7088	2.4	21.9

E. Institutional and Political Variables

	N	mean	sd	min	max
MYS: Mean Years of Schooling	620	11.0259	1.5049	6.4723	14.1
GI: Globalization Index	620	80.6224	8.5111	54.3113	92.3716
VAI: Voice and Accountability Index	620	1.2119	0.3603	-0.0791	1.8263
EFI: Economic Freedom Index	620	70.0617	6.7921	50.4	83.1
Left	620	0.3983	0.4899	0	1

NOTE: *Data on Public Pensions is not available after 2013. PSPR, ESPS and GDPpc are measured in U. S. $1,000. PopEduc, ppoap, poap soap and toap are measured in U. S. $1,000,000. SocExp does not include pensions spending.*

current old dependency ratio (1996–2017), the population of official age for education and the fertility rate, respectively. First, the projected old dependency ratio is employed to examine the effect that future ageing has on current education expenditure. The underlying hypothesis here is that the working-age cohort, realizing the forthcoming demographic crisis, chooses to invest in education in order to preserve its pension benefits in the future. Therefore, it is expected that the effect of the projected old dependency ratio will have a positive effect on education spending. Second, the current old dependency ratio is used to test the hypothesis that there is a conflict over public resources between generations because of the increasing political power of the elderly. Third, the young population of official age for education is used to control for the size effect, namely that a larger proportion of pupils/students could mean a higher budget allocated to education. Finally, we have the fertility rate that is used as a proxy for the proportion of parents in the voting population. Parents are expected to push for more spending on public education as their children benefit directly from a higher quality of education services.[17]

The macroeconomic variables GDP per capita (GDPpc) and real GDP growth (RGDPgr) are used as control variables. The former variable is an indicator of the level of economic development in a country and the latter is used as a control for the business cycle. In addition, we include two fiscal variables, tax revenues (TaxRev), total social expenditure (TotSocExp) and social expenditure not including retirement spending (SocExp), in order to control for the size of the government and the generosity of the welfare state. Tax receipts include taxes on income, profits and capital gains and social security contributions. Respectively, social expenditure includes survivors and incapacity-related benefits, health, family, active labour market programmes, unemployment, housing and other social policy areas.

The variable MYS (Mean Years of Schooling) illustrates the average number of years of education received by people aged 25 and older. This variable tries to capture the quality of the educational system as referred in Morales et al. (2013). It is assumed that the more you study the better your educational level. In addition, we use three institutional variables, globalization index (GI), index of voice and accountability (VAI) and index of economic freedom (EFI). The first one shows how globalised a country is at the political, economic, cultural and social level. The underlying hypothesis is that

[17]The fertility rate variable appears only in the per-student model specifications.

the more open the economy is, the more countries are engaged in the "race to the bottom", reducing their spending and taxes in order to be more competitive *vis-a-vis* the rest of the world. The second index captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media; in general, the variable captures the level of democracy in a country. It is expected that a higher level of democracy will lead to higher education spending. Finally, the last index includes assessments on commercial policy, government tax load, government intervention in the economy, monetary policy, foreign investment and capital flow, foreign activity, financial activity, salary and price control, property rights, and black market regulation and activity. Here too, it is expected that a higher degree of economic freedom leads to a larger amount spent on education policy.

Furthermore, we include in our model a dummy variable (Left) that accounts for the political ideology of the governing party. The dummy variable takes 1 when the government is either left-wing or social-democratic and 0 otherwise. It is predicted that left-wing governments are more fervent toward redistribution through social policies and education in order to favour their electoral base that lies among poorer social layers (Castles, 1989; Busemeyer, 2007). In addition, as it is shown empirically, left-wing governments favour more generous spending packages on social policies and therefore on education Roubini and Sachs (1989).

Finally, we show in Table 2.1 the descriptive statistics of pre-primary (PPES), primary (PES), secondary (SES) and tertiary (TERES) education spending and the population of the official age (ppoap, poap, soap, toap) for these levels of education, respectively. These variables are used in order to investigate the effect of projected ageing per level of education (see Table 2.5).

2.2.2 Methodology

Our empirical approach complements the existing evidence on the determinants of public education spending at a cross-national level (Castles, 1989; Busemeyer, 2007; Morales et al., 2013; Krieger and Ruhose, 2013). These studies identify a set of variables that explains most of the variation in public education expenditure. Nevertheless, we extend the literature by focusing on the demographic transition and adding into the model variables that capture

the current and future demographic features, such as current, projected old dependency ratio and fertility rate.

In order to choose our estimation strategy we conduct some diagnostic tests. Primarily, we have to decide between pooled OLS – which takes into account both between and within variation – and Random Effects (RE) which consider that the differences across countries have a significant influence on the dependent variable. In order to decide, we use the adjusted instead of the simple Breusch and Pagan (1980) Lagrange multiplier (LM) test. It might be the case that, in the presence of first-order serial correlation, the simple LM test by Breusch-Pagan too often rejects the correct null hypothesis (H_0): *no random effects*. Therefore, we have to conduct some complementary tests: the Baltagi and Li (1991) test for first-order serial correlation and the Baltagi and Li (1995) joint test for serial correlation and random effects.[18] According to the outcome of these tests, the null hypothesis (H_0): *the variance of the random effect is zero* or that there are no individual effects in the model is rejected. Therefore, in the presence of country-specific characteristics (individual) heterogeneity, we have to decide between using random or fixed effects. Thus, we apply the test introduced by Hausman (1978), which leads us to a strong rejection of the null hypothesis (H_0): *random effects provide consistent estimates* or that there is no correlation between the error term and the independent variables. Therefore, the test indicates use of the fixed effects method that produces a consistent estimator. This method takes into account the within variation (over time)[19] and controls for the unobserved characteristics that remain constant over the years and that might affect public expenditure on education, like culture heritage or religion, etc.[20]

Additionally, we conduct a series of other diagnostic tests: the modified Wald test for heteroscedasticity by Baum (2001); cross-sectional dependence tests by Frees (1995) and Pesaran (2004); and serial correlation test or the test for autocorrelation by Wooldridge (2010).[21] These tests first show that the idiosyncratic errors are heteroscedastic, meaning that the variation of the

[18] These tests show that both serial correlation and random effects are present.

[19] The test for time fixed effects reveals that no time fixed effects are needed in our specification of the model.

[20] As referred in Castles (1994), cultural heritage and the tradition of Catholicism can play an important role in public expenditure on education. The countries that have Catholicism as their predominant religion might have to spend less on education of children as the Catholic Church undertakes a large part of the children's education.

[21] The latter is in addition to the previous Baltagi-Li test, as we saw above.

errors across countries is not constant. Second, there is contemporaneous correlation, namely the errors between countries are correlated, and third there is a first-order autocorrelation in errors within countries. As mentioned in Cameron and Trivedi (2010), ignoring cross-sectional dependence and correlation of errors over time can lead to systematic bias and thus to erroneous results.

Therefore, we have to use estimation methods that allow us to conduct consistent estimations in the presence of AR(1) autocorrelation within panels and cross-sectional correlation and heteroscedasticity across panels. For that purpose, we use an estimator (SCC) introduced by Hoechle (2007), that produces Driscoll and Kraay (1998) standard errors for the estimated coefficients using fixed effects. In our specification of this estimator, the error structure is assumed to be heteroscedastic, autocorrelated up to one lag and correlated between the countries. As mentioned in Hoechle (2007), Driscoll-Kraay standard errors are robust to very general forms of cross-sectional and temporal dependence when the time dimension is large enough. Additionally, their particular technique to estimate standard errors does not impose any restrictions on the number of countries, which can be even bigger than the number of periods. Finally, the implementation of Driscoll and Kraay's covariance estimator works for both balanced and unbalanced panels Cameron and Trivedi (2010). All the above properties make this estimator suitable for our panel data.

$$Y_{i,t} = b + \beta Z'_{i,t} + \alpha_i + \epsilon_{i,t}$$

where $i = 1 - 31$, $t = 1996 - 2015$, and $Y_{i,t}$ is education expenditure as a % of GDP (or expenditure per student) of country i at time t. All the explanatory variables are included in $Z'_{i,t}$. The demographic variables: old dependency ratio (ODR) or future old dependency ratio (PR.ODR), the young population of official age for education (PopEduc) and fertility rate. Macroeconomic control variables: GDP per capita (GDPpc) and real GDP growth rate (RGDPgr). Fiscal control variables: tax revenues (TaxRev) and total social expenditure (TotSocExp).[22] Control for the quality of education: mean years of schooling (MYS). Institutional control variables (indices): globalization (GI), voice and accountability (VAI) and economic freedom index (E.F.I). Dummy variable

[22] Later, in the regressions, we "break" the total social expenditure into two variables, total retirement spending (TPS) and the rest of social expenditure (SocExp).

for the political ideology of the government: Left. Finally, b is the constant term , β is a coefficient vector, α_i represents the unobserved country-specific characteristics and $\epsilon_{i,t}$ is the idiosyncratic error term.

At this juncture, we should emphasize that, by using an aggregate data model of this kind, we are likely to be facing the usual problems of endogeneity. One potential problem might be the presence of reverse causality between education spending and the old-age dependency ratio. In this case, higher education spending could negatively influence the fertility rate and, in the long run, may essentially lead to a higher old-age dependency ratio. However, the impact of education on the fertility rate is far from straightforward. On the one hand, more educated women tend to have fewer children (Becker et al., 1990; Galor and Weil, 1996) yet, on the other, as discussed in Esping-Andersen and Billari (2015), recent studies conducted in some OECD countries point to a reversal of this negative relationship between education and fertility. In addition, it could be argued that the more educated tend to live longer, increasing the old-age dependency ratio. However, it is plausible to assume that both of these effects (decreased fertility and prolonged life expectancy) take place in the long run – after one generation – rather than in the short period examined in this study. A further source of potential reverse causality could be endogenous migration. For example, generous spending on education could plausibly increase migration of the sort that would increase the future old-age dependency ratio. Again, this is more of a long-run effect and such a demographic change would take time to occur. Hence, the potential endogeneity problems of our analysis seem to be limited.

The general response to potential problems of endogeneity of this nature would be to reduce any causality claims that we might make, based on the nature of the data and the difficulty in using instrumental variable techniques to tackle the endogeneity problems properly. Ultimately, however, the main goal of the empirical analysis of aggregate data models is to identify connections of interest and to test theoretical predictions and hypotheses.

2.3 Current Population Ageing and Education Spending: Intergenerational Conflict

We begin our analysis with a replication of past studies. More specifically, we examine the direct impact of population ageing on public education expenditure. As discussed above, the increasing percentage of elderly in the population can be expected to have a negative effect on educational spending (intergenerational conflict). In order to test whether there is a conflict in relation to fiscal resources between the generation of people aged over 65 and the generation of young people, we employ the old-age dependency ratio (ODR).

As can be seen in the Table 2.2, the effect of the ODR on total education spending (size), without controlling for total social expenditure and for the institutional indices, is positive and statistically non-significant (reg. 1). However, when we take into account total social expenditure, the effect of the ODR on education spending becomes negative, as expected by the intergenerational conflict hypothesis (reg. 2 and 3). The reason for running the model sequentially and starting without including total social expenditure is the plausible strong relationship between education spending and total social expenditure. It is reasonable to expect people to vote for social packages as a whole (pensions and education). For instance, if voters are willing to support an extended welfare state, they might also be willing to support higher education spending. However, if we do not take into account social expenditure then, as our results show, the ODR can absorb these effects. A closer look shows that a 1% increase in the ODR generates a 0.041% reduction in total education expenditure (reg. 3). However, as is shown in regression 5 and 6, the old dependency ratio has positive but not significant effect on education spending per student (generosity of the education system).

Regarding the performance of the control variables, it seems that the level of economic development (GDPpc) has a positive and significant impact only on per-student spending (reg. 4, 5 and 6). Moreover, as it is obvious, education spending is not affected significantly by the business cycle (real GDP growth). In addition, the level of fiscal resources (tax revenue) has the expected positive sign for total spending on education but they only weakly affect the level of education spending per student. Next, the size of the welfare state represented by total social expenditure has an important positive

Table 2.2: *Current Old Dependency Ratio and Education Spending*

	Total Education Spending (% of GDP)			*Education Spending per Student*		
	(1)	(2)	(3)	(4)	(5)	(6)
ODR	0.0044	-0.0448**	-0.0411*	0.0597†	0.0198	0.0366
	(0.017)	(0.014)	(0.015)	(0.029)	(0.033)	(0.034)
TotSocExp		0.1325***	0.1361***		0.1425*	0.1420*
		(0.022)	(0.023)		(0.054)	(0.057)
PopEduc	0.0324**	0.0009	-0.0018			
	(0.011)	(0.012)	(0.015)			
GDPpc	0.0040	0.0042	0.0035	0.2379***	0.2343***	0.2353***
	(0.008)	(0.007)	(0.006)	(0.009)	(0.007)	(0.008)
RGDPgr	-0.0336***	-0.0020	-0.0042	-0.0514***	-0.0147	-0.0168
	(0.005)	(0.009)	(0.009)	(0.012)	(0.027)	(0.029)
TaxRev	0.0450	0.0239	0.0229	0.0326	0.0086	0.0072
	(0.035)	(0.023)	(0.023)	(0.040)	(0.030)	(0.029)
MYS	0.0645	0.0441	0.0302	0.1774	0.1810	0.1670
	(0.050)	(0.032)	(0.043)	(0.123)	(0.120)	(0.127)
Left	0.0591	0.0639	0.0425	0.1705*	0.1746*	0.1635*
	(0.054)	(0.053)	(0.047)	(0.071)	(0.065)	(0.063)
Fertility				0.6388	0.8439*	0.8663*
				(0.417)	(0.393)	(0.353)
GI			-0.0022			-0.0172
			(0.003)			(0.012)
VAI			0.8677***			0.4191†
			(0.114)			(0.218)
EFI			0.0076			0.0042
			(0.008)			(0.011)
Obs.	608	597	597	606	595	595
R^2-within	0.0955	0.2316	0.2625	0.9042	0.9124	0.9134

NOTE: *Fixed effects regressions with Driscoll-Kraay standard errors reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. Education spending per student and GDPpc are measured in U. S. $1,000 and population of the official age for education (PopEduc) is measured in millions of people. ODR: Old dependency ratio. TotSocExp: Total social expenditure including pensions (% of GDP). TaxRev: Tax revenue (% of GDP). RGDPgr: Real GDP growth. MYS: Mean years of schooling. Left: Dummy variable for the political ideology of the government. Institutional variables: Globalization index (GI), Voice and Accountability Index (VAI) and Economic Free- dom Index (EFI). Constant term is included but not reported.*

impact on both measures of education spending.[23] The variable used as an approximation of education quality, the mean years of schooling (MYS), has no significant influence on education. Left-wing governments have important positive influence only on education spending per student. Finally, the fertility rate, which reflects the interest of young parents in education spending, has a strongly positive influence on per-student spending. A higher fertility rate means more children per couple and that makes young parents more willing to "push" for a higher level of educational expenditure. We could call that the "political power of parents" hypothesis.

In regard to the institutional variables in Table 2.2, globalization index (GI), Voice and Accountability Index (VAI) and Economic Freedom Index (EFI) have the expected signs. The first one has a negative sign, reflecting the "race to the bottom" hypothesis that claims that more globalised countries engage more actively in competition with other countries and, hence, aim to lower the level of public spending in order to be able to lower taxes and become more competitive. The second index has a positive effect on both measures of education spending, showing that a higher level of democracy promotes the expansion of the public education system. The Index of Economic Freedom shows that the process of economic liberalization has encouraged higher spending on public education.

In this section, we test the intergenerational conflict hypothesis using data for OECD countries. In line with previous studies Krieger and Ruhose (2013), we find only partial support for the intergenerational conflict, since the ODR has a significant and negative effect only on total education spending rather than on education spending per student. This result suggests that the relationship between population ageing and education spending might be more complicated than was first thought and that we should examine it more closely. This is precisely what we do in the next section.

2.4 Intergenerational Conflict: Revisited

Most previous studies of the intergenerational conflict focus on the direct effect of the elderly population on education spending and fail to take into account the presence of many plausible indirect effects. As discussed in the

[23] The social expenditure used for these regressions also includes retirement spending.

introduction, an increase in the ODR can have two opposite effects on education expenditure. On the one hand, we find the well-known negative effect due to the increased numbers of the elderly putting greater pressure on fiscal resources (direct effect). On the other hand, there might be a positive effect derived from the link between pensions and education. The working-age generation, in the face of population ageing, realizes that the increasing number of elderly will make the PAYG pension system less profitable in terms of pensions per retiree and financially unsustainable. Hence, the middle-aged generation decides to back investment in the education of young people in order to boost their productivity and, consequently, the level of their contributions to social security and the revenues from taxing their future income (indirect effect).[24]

One way to investigate further the relationship between current population ageing and education spending – allowing for indirect effects – is to take into account the level of pensions spending. One can claim that it is plausible to assume that the impact of population ageing on education expenditure depends on the scarcity of fiscal resources.[25] For instance, the effect of the old dependency ratio on education spending might depend on the level of total retirement expenditure. Thus, we need to disentangle the effect of retirement spending from the effect of total social expenditure on educational outlays. In order to do so, we "break" total social expenditure into two parts, social expenditure (survivors and incapacity-related benefits, health, family, active labour market programmes, unemployment, housing and other social policy areas) and total pensions spending (TPS). In this way, we are able to interact TPS with the old dependency ratio in order to investigate further the effect of population ageing on education expenditure.

In addition, we obtain the individual effect of retirement spending on education expenditure in order to test whether there is a direct link between these two public policies.[26]

[24]However, note here that the latter effect is likely to be limited as the current ODR is more of a concern to the elderly than it is to the middle-aged generation (see Figure 2.2).

[25]It is shown in Tables 2.6 and 2.7 in the Appendix 2.8.1, that the effect of population ageing on pensions expenditure depends on the scarcity of fiscal resources and after a certain point reduces the amount spent per retiree.

[26]As suggested by Kemnitz (2000), in contrast with the negative predictions for the social security system due to higher life expectancy and lower fertility, the demographic transition has beneficial effects on both education and pensions. According to his theoretical model, in a steady state equilibrium there is higher investment in per capita human capital and a higher

As we can see from the regression 1 (3) of the Table 2.3, total pensions spending has a positive but non-significant (strongly significant) effect on total education spending (education spending per student), and the new variable for social expenditure is strongly significant and positive. Moreover, we do not observe any significant evidence in favour of the intergenerational conflict. The negative effect from Table 2.2 is absorbed by TPS, probably due to the presence of the indirect effect of current old dependency ratio on education spending. Moreover, in the regression 2 (4), where the interaction term between the old dependency ratio and retirement spending is taken into account, we can observe that the individual effect of both variables (ODR and TPS) becomes significantly positive and, additionally, the interaction term is negative on a high level of statistical significance. In technical terms, this means that the effect of the old dependency ratio on total education outlays depends on the level of total retirement expenditure.[27] More specifically, the effect of the old dependency ratio on education is positive until a certain level of total retirement spending (TPS=8%). When the level of retirement expenditure exceeds 8% of GDP, then the effect of the old dependency ratio on total education outlays becomes negative.[28]

As it is mentioned above, an increase in the old dependency ratio can have two opposite effects on education spending. There is the negative effect of the intergenerational conflict due to the increasing number of elderly and the positive effect derived from the link between pensions and education. Therefore, when retirement spending is low, the former effect is dominated by the latter

contribution rate to the social security

[27] Isolating the effect of the ODR and TPS on total education spending, we obtain the expression below:

$$TES = 0.1011 * ODR + 0.3628 * TPS - 0.0142 * ODR * TPS$$

In order to obtain the effect of the old dependency ratio on total education spending, we take the derivative of TES with respect to the ODR:

$$\partial TES / \partial ODR = 0.1011 - 0.0142 * TPS$$

In the same way, we can obtain the derivatives with respect to TPS.

[28] Similarly, after a certain point (ODR=26%), the effect of increasing spending on retirement has a negative effect on total education spending. The theoretical intuition behind this result can be derived from the intergenerational conflict hypothesis. Thus, when the old cohort is politically stronger (higher ODR), an increase in total retirement spending is financed out of the same public resources that are used for education expenditure, bringing about a negative impact on education expenditure.

and hence the net effect on education expenditure is positive. This effect is a result of the choice by the working-age generation to invest public resources in education in order to ensure their future pensions. However, when the total expenditure on retirement is quite high, the former effect dominates the latter, and hence the net effect on education is negative. This outcome reflects the fact that, when there are limited fiscal resources, an increase in the political power of the elderly is translated into a decrease in education expenditure. This can be attributed to the old generation attempting to appropriate more public resources in its own favour.

Furthermore, as is evident from Table 2.3 (reg. 4), the same interaction effect is present in the case of education spending per student. The effect of old dependency ratio depends on the level of the total retirement spending. However, the effect of the old dependency ratio becomes negative only after the level of total retirement spending is above 13% of GDP.[29] Therefore, the negative impact of the interaction terms takes place only at a very high level of the old dependency ratio and retirement spending, respectively. This evidence is in favour of the intergenerational conflict hypothesis that claims that there is competition for fiscal resources between young and old cohorts. However, we show that this effect of intergenerational conflict depends on the level of pensions.

Last but not least, in regressions 5 and 6 we present the effect of retirement spending per retiree on education and the interaction of retirement spending with the old dependency ratio, respectively. It is obvious that there is no interaction between the old dependency ratio and average spending per retiree (reg. 6). Hence, the impact of retirement spending per retiree and the impact of the old dependency ratio on education do not depend on each other. As we can see from Table 2.3, it seems that the higher the average spending on retirees, the higher the education expenditure per student. The intuition behind this result is that an increase in education spending per student as a result of an increase in average pensions is financially backed by the working-age generation because, for them, this is a way to secure their future pensions. Moreover, this could be an indication that pensions and education are also directly and positively linked. More specifically, an average increase of U. S. $1,000 in pensions results in an increase of U. S. $59 in education spending

[29]Likewise, in this case the effect of total retirement spending on education becomes negative at the point where the level of the ODR is 37%.

Table 2.3: *Population Ageing Interacted with Pension Spending*

Total Education Spending (% of GDP)			*Education Spending per Student*			
	(1)	(2)	(3)	(4)	(5)	(6)
ODR	-0.0192	0.1011***	0.0309	0.0961*	0.0474*	-0.0214
	(0.016)	(0.017)	(0.027)	(0.045)	(0.022)	(0.033)
TPS	0.0077	0.3628***	0.0861**	0.2872***		
	(0.040)	(0.064)	(0.028)	(0.069)		
TPS*ODR		-0.0142***		-0.0078*		
		(0.002)		(0.003)		
PSPR					0.0591***	-0.0460
					(0.014)	(0.030)
PSPR*ODR						0.0041**
						(0.001)
SocExp	0.2137***	0.1995***	0.2367***	0.2280***	0.2419***	0.2556***
	(0.013)	(0.011)	(0.039)	(0.042)	(0.038)	(0.038)
PopEduc	0.0025	-0.0076				
	(0.014)	(0.021)				
GDPpc	0.0000	-0.0043	0.2343***	0.2299***	0.2114***	0.2204***
	(0.005)	(0.006)	(0.007)	(0.006)	(0.011)	(0.011)
RGDPgr	0.0036	0.0008	0.0083	0.0081	0.0096	0.0091
	(0.006)	(0.005)	(0.011)	(0.011)	(0.010)	(0.010)
TaxRev	0.0213	0.0223	-0.0076	-0.0040	-0.0026	-0.0075
	(0.015)	(0.013)	(0.019)	(0.018)	(0.019)	(0.019)
MYS	0.0341	0.0752	0.0718	0.1033	0.0603	0.0052
	(0.052)	(0.062)	(0.120)	(0.131)	(0.126)	(0.133)
Left	0.0678	0.0863	0.1549*	0.1661*	0.1436†	0.1153
	(0.047)	(0.053)	(0.071)	(0.076)	(0.070)	(0.068)
Fertility			0.8428*	1.0891**	0.7406*	0.4763
			(0.303)	(0.353)	(0.288)	(0.302)
Instit.Variab.	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	550	550	548	548	548	548
R^2-within	0.3392	0.3782	0.9210	0.9217	0.9221	0.9228

NOTE: *Fixed effects regressions with Driscoll-Kraay standard errors reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. Education spending per student, pensions spending per retiree (PSPR) and GDPpc are measured in U.S. $1,000 and population of the official age for education (PopEduc) is measured in millions of people. ODR: Old dependency ratio. TPS: Total pension spending (% of GDP). SocExp: social expenditures excluding pension spending (% of GDP). TaxRev: Tax revenue (% of GDP). RGDPgr: Real GDP growth. MYS: Mean years of schooling. Left: Dummy variable for the political ideology of the government. Institutional variables: Globalization index (GI), Voice and Accountability Index (VAI) and Economic Freedom Index (EFI). Constant term is included but not reported.*

per student. For the same reason a one percentage point increase in the old dependency ratio enhances education spending with U. S. $47 per student.

Following our focus on the current ODR, we find that there is competition for resources, at least above a certain level of total retirement spending. This outcome probably reflects the fact that population ageing has a different impact on working-age and elderly voters. Moreover, it is plausible to claim that current population ageing is more closely related to intergenerational conflict (direct effect) than it is to the positive link between pensions and education (indirect effect). The latter is quite intuitively associated with the future rather than with current population ageing. The working-age voters worry more about the future than they do about current population ageing for the simple reason that they receive their pensions in the future. Hence, it is interesting to consider also the effect of the future ODR on education spending as the positive indirect effect can be expected to be reinforced. This is what we do in the next section where we employ instead of the current the projected old dependency ratio.

2.5 Projected Population Ageing and Education Spending

In this section, we move away from the focus taken by the existing empirical literature and indeed that adopted in the previous sections herein. Instead of employing the current ODR, we employ the projected ODR (PRODR) to examine the effect of future population ageing on education. The latter corresponds to the period (2018–2035)[30], allowing us to capture the retirement of the generation of "baby boomers" and, hence, the massive increase in the elderly population (see, Figure 2.1).

Future population ageing in contrast to current population ageing is expected to reinforce the indirect (positive) effect and mitigate the direct (negative) impact. Following the same mechanism as in the previous section, the former captures the reaction of the middle aged to investments in current public education – as a response to the decreasing future financeability of the pension system – and the latter reflects the fiscal pressure driven by the increasing number of elderly. However, in this case, future population

[30]From 2015 to 2017 we use the real ODR rather than the projected one.

Figure 2.2: *Generational Effect on Education Spending*

	Middle aged (indirect effect)	Elderly (direct effect)	Overall
ODR	moderate positive	strong negative	**moderate negative**
PRODR	strong positive	weak negative	**strong positive**

NOTE: *This figure depicts the type and magnitude of the effect that each generation has on education spending according to the theoretical predictions of the literature presented above.*

ageing has a stronger indirect effect because the working-age voters are more concerned with the future than they are about current population ageing, for the simple reason that they care more about the generosity of future pensions than they do about that of current pensions. Moreover, the direct effect is expected to be limited because there is no fiscal struggle between generations as the increasing number of future retirees does not concern the current elderly. Overall, the effect of future ageing is predicted to be positive (see, Figure 2.2).

As is evident from Table 2.4, the PRODR has the expected positive impact on both total level of education spending and spending per student. In both cases, we control either for the size (TPS) or the generosity (PSPR) of the pension system (reg. 1 & 3 and 2 & 4, respectively). In this way, we control for the fiscal pressure attributable to the increased number of retirees. Hence, in a way, we also account for the number of current retirees – reflected in the TPS and PSPR – which is expected to have a negative influence on education spending. However, as can be seen, the size and generosity of pensions have overall positive and significant impacts on education generosity (reg. 3 and 4). This can be attributed to the positively reinforced indirect effect – operating via the link between pensions and the education system – over the direct effect on education. A closer look reveals that a one percentage point rise in the proportion of old people in the future, *ceteris paribus*, generates an increase of about 0.0207% (reg. 1 and 2) in total education spending and around a U. S. $47-60 rise in expenditure per student (reg. 3 and 4). These results are in contrast with the negative impact that the current ODR has on education spending in Tables 2.2 and 2.3. It might be argued that these differences are attributable to the limited negative impact of intergenerational conflict. Future population ageing is not a concern for the current old generation and, hence, they do not "fight" for public resources now. In contrast, the incentives for the middle aged to invest in education so as to preserve future pensions

Table 2.4: *Future Ageing and Education Spending*

Total Education Spending			*Education Spending per Student*	
	(1)	(2)	(3)	(4)
PRODR	0.0207*	0.0206*	0.0473**	0.0605***
	(0.008)	(0.008)	(0.014)	(0.015)
TPS	-0.0125		0.1029***	
	(0.037)		(0.018)	
PSPR		0.0035		0.0717***
		(0.014)		(0.014)
SocExp	0.2012***	0.1993***	0.2136***	0.2159***
	(0.014)	(0.012)	(0.039)	(0.035)
PopEduc	0.0103	0.0115		
	(0.010)	(0.008)		
GDPpc	-0.0074	-0.0086	0.2192***	0.1873***
	(0.006)	(0.010)	(0.008)	(0.013)
RGDPgr	0.0025	0.0037	0.0096	0.0113
	(0.006)	(0.007)	(0.009)	(0.008)
TaxRev	0.0195	0.0200	-0.0038	0.0047
	(0.016)	(0.017)	(0.021)	(0.022)
MYS	-0.0173	-0.0226	0.0362	0.0296
	(0.051)	(0.049)	(0.129)	(0.136)
Left	0.0672	0.0631	0.1472†	0.1323†
	(0.048)	(0.048)	(0.071)	(0.072)
Fertility			0.9701**	0.8832*
			(0.324)	(0.318)
Instit.Variab.	Yes	Yes	Yes	Yes
Obs.	550	550	548	548
R^2-within	0.3418	0.3416	0.9221	0.9235

NOTE: *Fixed effects regressions with Driscoll-Kraay standard errors reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. Education spending per student, pension spending per retiree (PSPR) and GDPpc are measured in U. S. $1,000 and population of the official age for education (PopEduc) is measured in millions of people. PRODR: Projected old dependency ratio. TPS: Total pension spending (% of GDP). SocExp: social expenditures excluding pension spending (% of GDP). TaxRev: Tax revenue (% of GDP). RGDPgr: Real GDP growth. MYS: Mean years of schooling. Left: Dummy variable for the political ideology of the government. Institutional variables: Globalization index (GI), Voice and Accountability Index (VAI) and Economic Freedom Index (EFI). Constant term is included but not reported.*

are reinforced. As a result, the net effect of the projected future ageing is positive.

Another interesting aspect that is observed in Table 2.4 is the significantly positive effect of the fertility rate on the education expenditure (reg. 3 and 4). More specifically, one percentage point increase in the fertility rate brings about roughly a U. S. $885-970 increase in the generosity of the education system (reg. 3 and 4). This outcome can be associated with the parental willingness to support public education. In general, most of the control variables in these specifications of the model behave as expected by the literature. The political ideology seems to have only a weak role in the determination of education expenses. More specifically, left-wing and social-democratic governments tend to spend more per student than their ideological opponents. As in the previous section, the level of the welfare state (excluding pensions) and economic development have a positive and very significant impact on per-student spending. Finally, institutional indices have significant effects in the expected direction.

The above findings are consistent with the main theoretical predictions of Kemnitz (2000) and Gradstein and Kaganovich (2004). More specifically, in order to interpret the results, it can be argued that the working-age generation, foreseeing the severe consequences of the ageing process for their retirement benefits, decide to exploit the current set-up of the PAYG pension system. Thus, they react to an increasing PRODR by investing in the education of young people "today" in order to boost their labour productivity and, consequently, the revenues from income tax "tomorrow". Hence, in this way, the fiscal resources generated from the investment of the working-age cohort in education now can be used to pay for their pensions in the future. Therefore, future population ageing – operating through the link mechanism between pensions and education – positively affects current education expenditure.

2.6 Projected Population Ageing and the Levels of Education

In this section we go one step further by investigating which educational levels are the driving forces behind the impact of future population ageing on total education expenditure. Moreover, we examine to what extent they are

Table 2.5: *Future Ageing and Spending by Level of Education*

	PPES	PES	SES	TERES
	(1)	(2)	(3)	(4)
PRODR	0.0111**	-0.0084	0.0041	0.0151***
	(0.004)	(0.006)	(0.008)	(0.003)
TPS	0.0050	0.0140	0.0151	-0.0073
	(0.004)	(0.009)	(0.015)	(0.011)
SocExp	0.0050	0.0710***	0.0626***	0.0383***
	(0.007)	(0.010)	(0.014)	(0.004)
ppoap	0.0599			
	(0.057)			
poap		0.0007		
		(0.051)		
soap			0.1019***	
			(0.016)	
toap				-0.0072
				(0.012)
GDPpc	-0.0030	-0.0024	-0.0127**	-0.0038
	(0.004)	(0.002)	(0.004)	(0.002)
RGDPgr	-0.0042	-0.0021	-0.0001	0.0012
	(0.003)	(0.004)	(0.003)	(0.002)
TaxRev	-0.0083	-0.0097	0.0096†	-0.0003
	(0.006)	(0.006)	(0.005)	(0.002)
MYS	0.0268	-0.0116	0.0105	0.0176
	(0.025)	(0.014)	(0.017)	(0.012)
Left	0.0211*	-0.0343*	-0.0216	0.0018
	(0.007)	(0.012)	(0.029)	(0.008)
Instit.Variab.	Yes	Yes	Yes	Yes
Obs.	421	418	425	445
R^2-within	0.2087	0.3571	0.2464	0.3420

NOTE: *Fixed effects regressions with Driscoll-Kraay standard errors reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. PPES (ppoap), PES (poap), SES (soap) and TERES (toap) represent pre-primary, primary, secondary and tertiary, education spending (children population measured in millions of people), respectively. GDPpc is measured in U. S. $1,000. PRODR: Projected old dependency ratio. TPS: Total pension spending (% of GDP). SocExp: social expenditures excluding pension spending (% of GDP). TaxRev: Tax revenue (% of GDP). MYS: Mean years of schooling. Left: Dummy variable for the political ideology of the government. Institutional variables: Globalization index (GI), Voice and Accountability Index (VAI) and Economic Freedom Index (EFI). Constant term is included but not reported.*

affected by demographic transition that acts through the link mechanism between pensions and education. We investigate the effect of population ageing on public education per level (pre-primary, primary, secondary and tertiary). In order to estimate the effect of the projected population ageing, we employ the same model as in Table 2.4. In this specification of the model, among other variables we control for the total size of the pensions, social expenditure (excluding pensions) and the proportion of pupils/students per level of education. The dependent variables are spending by education level measured as a percentage of GDP.

As the Table 2.5 shows, spending on non-mandatory, pre-primary and tertiary education is positively affected by the increasing percentage of the elderly. In contrast, the impact on the mandatory, primary and secondary educational level is negative and positive but insignificant, respectively. One can argue that an increase in the projected old dependency ratio raises the future welfare state fiscal requirements (pensions and other social expenditure) as the number of beneficiaries increases. Hence, enhancing the productivity of the current and future generations as an attempt to generate additional fiscal resources (tax revenues) can be considered as the main reaction of the working-age population to handle the forthcoming financial sustainability issues of the welfare state. Thus, in order to boost current and future productivity, voters decide to support investments in the non-mandatory levels of education and those more related to productivity, pre-primary and tertiary education. In our opinion, the investment in non-mandatory education takes place only because there is a space for political intervention. In other words, increasing the quality of the non-compulsory educational levels may have a larger positive effect on the participation rate of these educational levels than on participation in mandatory education.

More specifically, investment in pre-primary public education can positively affect the productivity of young parents (especially young mothers) by supporting them with such a time-consuming process as child-raising. Therefore, improving the quality of pre-primary education could eventually lead to an increase in productivity. However, in the case of primary and secondary education, the mandatory character of participation prevents such an investment from being beneficial for the productivity of current workers. Regarding the productivity of future workers, there is a positive impact from the projected population ageing on higher education spending. Consequently, one

can expect that this could bring about an increase in participation in tertiary education and eventually lead to a future working generation with enhanced skills and productivity. In other words, as mentioned above, working-age voters, on considering their future public benefits, choose to support investments in higher education in order to boost the productivity of the young generation and "reap" the benefits from increased income tax in the future.

2.7 Conclusions

The share of the elderly in the population of many developed countries is rising as the demographic transition runs its course. The implications of this trend for major public policies, including pensions and education, have been a chief concern for economists, as has its impact on the allocation of public funds among the different generations. Children and the elderly, located at opposite ends of the spectrum of dependency, are, as such, the chief beneficiaries of social spending. For this reason, a conflict of interests is likely to arise between the generations.

Here, we have reviewed the intergenerational conflict hypothesis, according to which increased numbers of the elderly seem set to result in more pensions and less expenditure on education (direct effect). As shown, this intergenerational conflict effect is present, but it is dependent on the overall level of pension spending. Thus, when this spending level is low and more public resources are available, an increase in the old dependency ratio has a positive (indirect) effect on education spending due to the positive link between pensions and education. However, when total retirement spending is high, an increase in the old dependency ratio has a negative impact on education spending, reflecting the struggle between generations for limited amounts of public resources. Hence, an increase in current levels of population ageing, which translates into an increase in the political power of the elderly (who obviously support more generous pension policies) seems to have a negative impact on both total spending on education and on spending per student.

The main focus of this paper has been on a future demographic change that seems set to strengthen the mechanism that links public pension and education policies. More specifically, we have tested the theoretical hypothesis – emerging from the studies of Kemnitz (2000) and Gradstein and Kaganovich (2004) – that population ageing results in a higher forward (education) re-

allocation of public funds. Our results show that, indeed, the projected (future) old dependency ratio has a positive impact on education expenditure and operates via the link between education and pensions (indirect effect). The specific design of the PAYG pension system creates the incentives to invest in education. The intuition underpinning the link is that the working-age generation, aware of the rise in life expectancy and the increasing number of retirees, invests more in public education "today" in order to derive some benefits in the form of higher contributions (income tax) for pensions "tomorrow". Therefore, even in the absence of altruism, middle-aged voters are in favour of a public education program as a way to improve their pensions, thanks to the increase in the productivity of future workers. This could have a number of policy implications in the context of the imminent demographic crisis faced by PAYG-financed pension systems. Educational expenditure can be seen as a complement or as an alternative pre-funding device to the long-discussed transition to a capitalization system.

Moreover, by disaggregating education expenditure by level of education, we have sought to determine whether future population ageing has a different impact according to each educational level. The results point solely to a positive effect on non-mandatory (pre-primary and tertiary) education spending. Our interpretation of this outcome is that investment in non-compulsory education only occurs because there is room for political intervention to increase participation in education and, consequently, the productivity of both current and future working-age generations.

The key lesson to be drawn from this study is that population ageing affects the working-age and the elderly generations in a different way. While current population ageing increases the number of retirees opposed to spending on education, the current and, especially, the future projection of population ageing stimulates (via the positive link between education and pensions) the working-age generation to support an expansionary education policy.

Further theoretical and empirical studies are clearly necessary. On the theoretical side, the reasons accounting for private transfers and their interaction with public transfers (as introduced by welfare state programs) need further investigation. On the empirical side, and related to these theoretical lines of investigation, the strong positive effect of fertility on education spending per student (which we report herein) could be analysed as an indication of the political power of parents driven by altruism or other types of motivation.

2.8 Appendix

2.8.1 The Effect of Population Ageing on Public Pensions

As we investigate the impact of the current and future population ageing on education expenditure it is also very interesting to examine how pensions – that are quite relative in our analysis to education – are affected by the demographic change. The main reason is to observe the dynamic in the relationship between our two main independent variables.

According to the literature on the political economy of social security, the ageing process affects the social security system through two opposing channels.[31] On the one hand, there is the "fiscal leakage" hypothesis, which suggests that the increased proportion of elderly people decreases the expected profitability of pay-as-you-go pension systems for current working-age voters, thereby inducing them to favour lower current pensions. Therefore, the working-age generation repudiates the social security system (Breyer and Stolte, 2001; Razin et al., 2002; Razin and Sadka, 2007). On the other hand, population ageing makes the median voter older and hence more inclined to support higher expenses on pensions, the well-known in the literature "political power of elderly" hypothesis (Browning, 1975; Boadway and Wildasin, 1989; Breyer and Craig, 1997; Mulligan and Sala-i Martin, 1999; Tabellini, 2000; Disney, 2007; Shelton, 2008; Tepe and Vanhuysee, 2009; Hollanders and Koster, 2012). Nevertheless, Castles (2004) argues that the higher total spending on pensions is attributed to the design and some specific characteristics of the social security system rather than to population ageing. However, Castles admits that the cuts in pensions are negatively correlated with an increased political clout of the elderly. Alternatively, Lindert (1996) argues that the effect of the old dependency ratio on both the size and the generosity of the system is non-linear. When the old dependency ratio is low, the relationship with pension spending is positive but, as the ratio increases over the years, after a certain point the sign of the relationship becomes negative. As we show below we find similar results while replicating previous analysis of the impact of population change on pension's expenditure.

Our investigation is focused on the determinants of the size (as a percentage of GDP) and generosity (expenditures per pensioner) of the public pen-

[31] Breyer (1994) and Galasso and Profeta (2002) provide good reviews of this literature.

sion system and how they are affected by demographic transition. We conduct a panel data analysis for 23 OECD countries over the period 1980–2010.[32] We use intervals of five years for the period instead of 1 year in order to capture the political cycle in which pension reforms and changes in demographic structure usually take place. Using fixed effects, we deal with the large source of omitted variable bias by controlling the cross-country unobserved heterogeneity. Our baseline model is constructed as a synthesis of the previous studies (Tepe and Vanhuysee, 2009; Hollanders and Koster, 2012).

$$Y_{i,t} = c + \gamma X'_{i,t} + \alpha_i + \mu_t + \epsilon_{i,t}$$

where $i = 1 - 23$, $t = 1 - 6$. The dependent variable $Y_{i,t}$ is the total pension spending (TPS) as % of GDP or pension spending per retiree (PSPR).[33] All the explanatory variables are included in $X'_{i,t}$. First, our main focus is on the demographic variables: current old dependency ratio (ODR) or projected old dependency ratio (PRODR) or the ratio of the population above 55 years old over the working-age population (ODR55). We chose these demographic variables in order to test the "political power of elderly" and the "fiscal leakage" hypotheses. Second, we include as control variables four macroeconomic indicators: GDP per capita (GDPpc), real GDP growth (RGDPgr), interest rate (Intrate) and trade openness (Openc). Third, we add two variables related to the labour market: unemployment (Unemp) and union density (Un.Den.). Fourth, we include political variables: type of government (G.T.) and government party (G.P.).[34] In addition, in order to fit a two-way FE model, we include time fixed effects, μ_t. In this way, we control for time effects in order to capture any unexpected variation or special events that may affect the dependent variable. Finally, c is the constant term, γ is the coefficient vector, α_i represents the unobserved country-specific characteristics and $\epsilon_{i,t}$ is the idiosyncratic error term.

From Table 2.6 we can see that the total pension expenditure is affected

[32] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland,U. K. , U. S. .

[33] Definitions and sources of the variables can be found in Table 2.9 in the Appendix 2.8.2.

[34] The former is a variable that takes values that represent five different types of government starting from the strongest type (=1, single party majority) to the weakest type (=5, multi-party minority). The latter represents the ideological spectrum of the government cabinet (also known as Schmidt-Index) and goes from the hegemony of right-wing and centre parties (=1) to the hegemony of social-democratic and other left-wing parties (=5).

Table 2.6: *The Effect of Ageing on Pension Spending*

	TPS	PSPR	TPS	PSPR	TPS	PSPR
	(1)	(2)	(3)	(4)	(5)	(6)
ODR	0.209***	-0.168*				
	(0.031)	(0.076)				
ODR55			0.122**	-0.0983		
			(0.033)	(0.057)		
PRODR					-0.0365	-0.201**
					(0.048)	(0.060)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Ctry & Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	152	152	152	152	152	152
Adj. R^2-within	0.692	0.920	0.665	0.919	0.615	0.924

NOTE: *Fixed effects regressions with robust standard errors reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. Pension spending per retiree (PSPR) and GDPpc are measured in U. S. $1,000. TPS: Total pensions spending (% of GDP). (PR)ODR55: (Projected) Old dependency ratio (the ratio of the population above 55 years old over the working-age population). Constant term is included but not reported.*

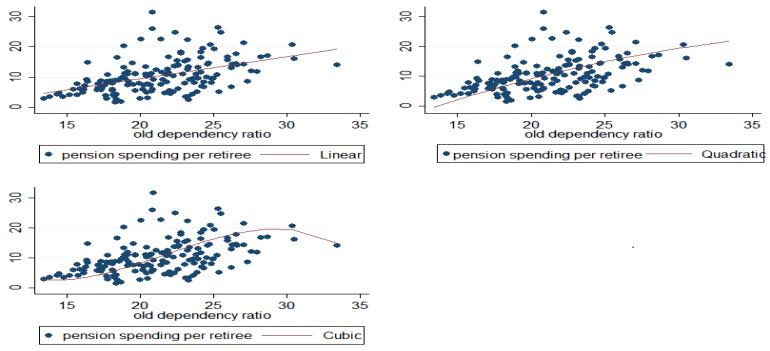
positively by all the demographic variables except of projected old dependency ratio. This result can be attributed to the size effect; the higher number of old people means more total expenditure. However, the effect of the same demographic variables on the pension spending per retiree is negative and significant only for the current and projected in the future old dependency ratio. These outcomes are in favour of the "fiscal leakage" hypothesis. The high current and projected in the future old dependency ratio make the pay-as-you-go system less profitable for the currently working voters who push for less generous pensions. It is interesting to notice here that, when we include part of the working-age voters in our demographic variable (ODR55), the negative effect is moderated (reg. 4). This can be attributed to the fact that the working-age voters close to retirement age will not claim less generous pensions, even though the profitability of the system is lower because they are about to retire.

Extending the scope of the aforementioned empirical literature we examine the presence of non-linear effects in our model. As far as we are concerned, the only study from the empirical literature on political economy of the social security that considers the non-linear effect of ageing on social-spending patterns is the one undertaken by Lindert (1996).

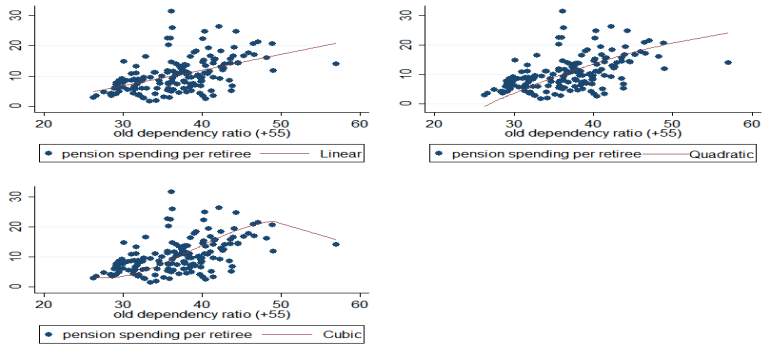
First, in order to check for non-linear effects, we test which specification fits our data better with the help of simple scatter-plots of Figure 2.3. We

Figure 2.3: *Relationship Between Pensions and Old Dependency Ratio*

(a) PSPR and ODR



(b) PSPR and ODR55



NOTE: *As we can see from the scatter plots of pension spending per retiree (PSPR) with old dependency ratio (ODR) (scatter plot, a) and old dependency ratio for the population over 55 years old (ODR55) (scatter plot, b), the best fit is the cubic model.*

check for non-linear effects concluding that the cubic regression model fits the data better than the quadratic or the linear one.

As it is obvious from the Table 2.7, the effect of the population ratios (ODR and ODR55) on retirement spending per retiree is non-linear (reg. 2 and 4, respectively). More specifically, the effect of the ODR on retirement spending per retiree can be analysed through its cubic regression model. A change in the ODR from 13 to 14% has a negative impact (-1.201) on pension expenditure, *ceteris paribus*.[35] The negative impact of the ODR on generosity of the system can be observed until the level where the ODR=23%; however, the magnitude of the effect decreases gradually from 13 to 23. This direction of the effect is clearly in favour of the "fiscal leakage" hypothesis; the gen-

[35]The range of the variable old dependency ratio in our data is from 13 to 33% and for ODR55 is from 26 to 57%, respectively.

Table 2.7: *Non-Linear Specification of the Demographic Variables*

	TPS	PSPR	TPS	PSPR
	(1)	(2)	(3)	(4)
ODR	-1.422	-5.743**		
	(0.914)	(1.980)		
$(ODR)^2$	0.0691	0.229*		
	(0.042)	(0.088)		
(ODR)3	-0.000935	-0.00300*		
	(0.001)	(0.001)		
ODR55			-0.432	-6.764*
			(1.162)	(2.477)
$(ODR55)^2$			0.00892	0.156*
			(0.029)	(0.061)
$(ODR55)^3$			-0.0000326	-0.00118*
			(0.000)	(0.000)
Controls	Yes	Yes	Yes	Yes
Ctry & Time FE	Yes	Yes	Yes	Yes
Obs	152	152	152	152
Adj. R^2-within	0.697	0.928	0.677	0.933

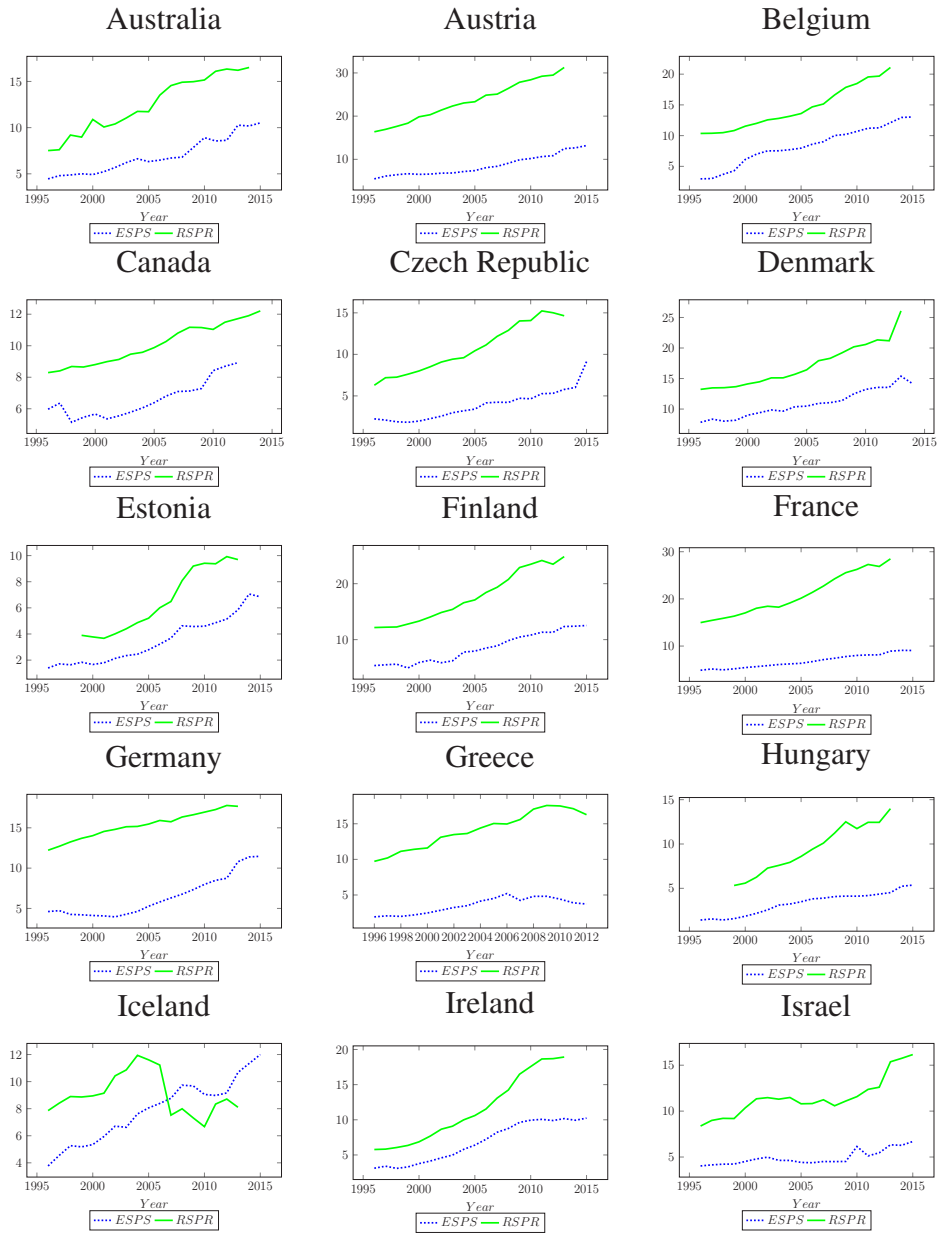
NOTE: *Fixed effects regressions with robust standard errors reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. Pension spending per retiree (PSPR) and GDPpc are measured in U. S. $1,000. TPS: Total pensions spending (% of GDP). ODR55: Old dependency ratio (the ratio of the population above 55 years old over the working-age population). Constant term is included but not reported.*

erosity of the PAYG pension system decreases with a larger share of elderly people in society. As we can observe after this point (ODR=23%), a change in the old dependency ratio from 23 to 24 has a positive effect on pension and this effect holds until the point where the ODR=28%. The demographic transition in this range (23 to 28) has a positive effect on pension generosity and that is in favour of the "elderly power" hypothesis. However, beyond the point where the old dependency ratio is 28, we observe again the negative impact of a change in the ODR on pension generosity, and the magnitude of the effect increases as the old dependency ratio increases, even beyond our data range. The intuition behind these results can be as follows. The initial increase in the number of retirees puts pressure on the pension system and therefore has a negative effect on it. However, as the old dependency ratio grows, it reaches a certain point (ODR=23%) where the elderly acquire considerable political power in order to influence the government to favour more generous pensions. It seems that they manage to cancel out the negative effect on the PAYG pension system from the increasing number of old people. Nevertheless, after a certain point (ODR=28%), the number of retirees is too big to be counterbalanced by the political power of the elderly. Similar interpretation applies to the other demographic proxy variable (ODR55).

Hence, our empirical findings provide an indication that population ageing has a non-linear effect on pension expenditure per retiree and therefore both effects are present. Thus, the outcome and the strength of both effects depend on the proportion of old people. Hence, when the old dependency ratio (or ODR55) is at a very high level, the "elderly power" effect is dominated by the "fiscal leakage" effect.

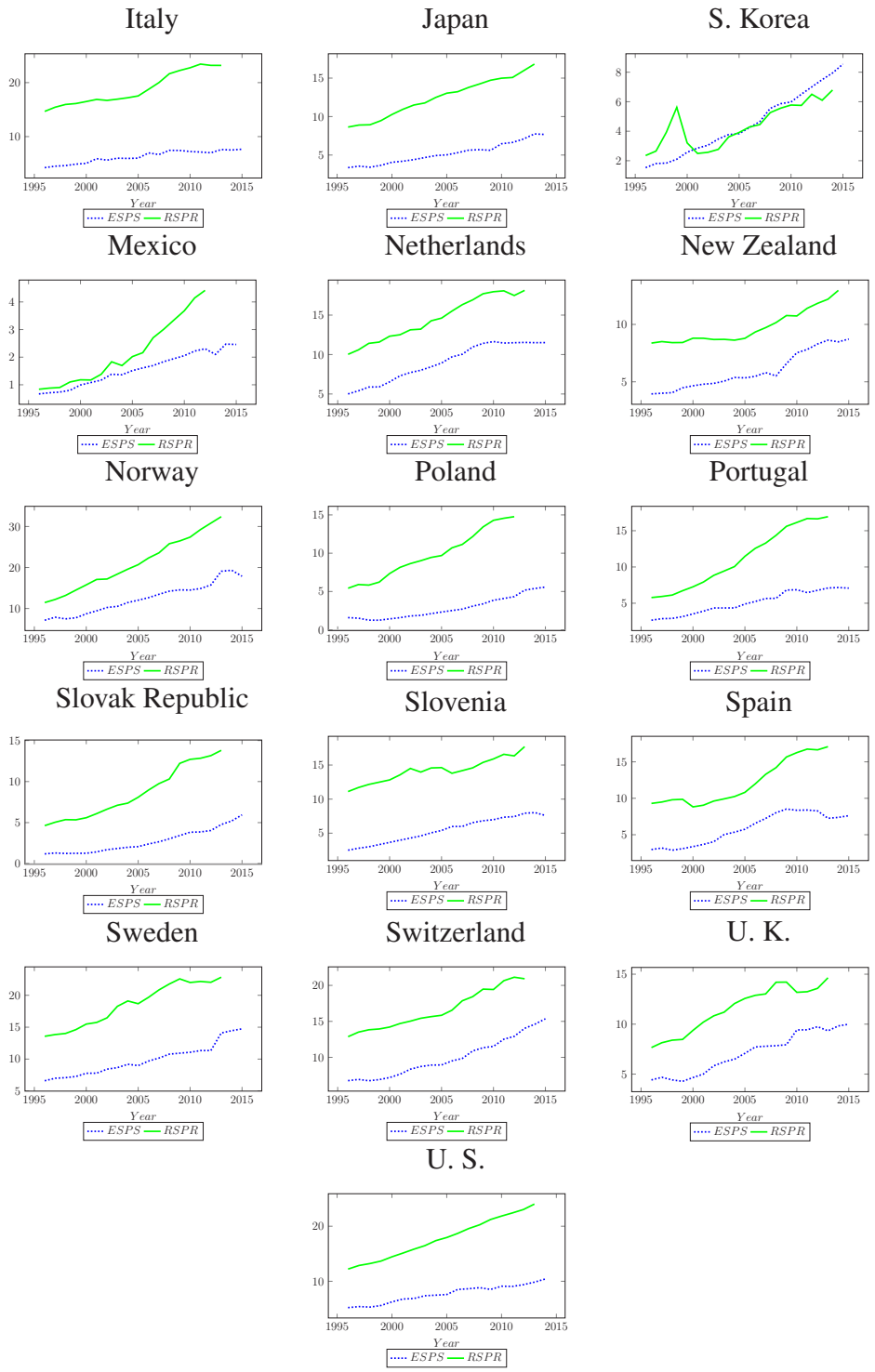
2.8.2 Graphs, Tables, Data Sources

Figure 2.4: *Trends for Education and Pensions per Student and Retiree*



NOTE: *In this graph we can observe the across time parallel trend for education and pension spending. Education spending per student and pension spending per retiree are measured in U. S. $1,000.*

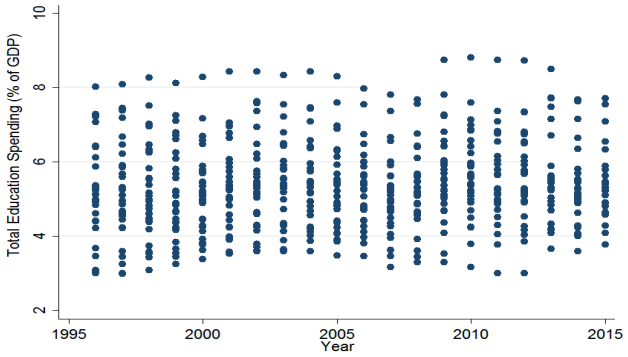
(Continued): Trends for Education and Pensions per Student and Retiree



NOTE: *In this graph we can observe the across time parallel trend for education and pension spending. Education spending per student and pension spending per retiree are measured in U. S. $1,000.*

Figure 2.5: *Total Education and Pensions Spending Over Time*

(a) Total Education Spending Over Time



(b) Total Pension Spending Over Time

NOTE: *In those graphs we can see the difference between the variation of the total education and pension spending. Unlike the pensions that are clustered over periods of 4 to 5 years (period needed for a pension reform), education seems to vary on an almost annual basis.*

Table 2.8: *Panel Data Descriptive Statistics*

Variable		Mean	Std. Dev.	Min	Max	Observations
TES	overall	5.3710	1.1699	2.9887	8.8069	N = 609
	between		1.1026	3.3789	8.2799	n = 31
	within		0.4619	2.7280	6.9282	T = 19.65
ESPS	overall	6.3954	3.2454	0.6691	19.3315	N = 606
	between		2.5710	1.0988	13.2837	n = 31
	within		2.0224	1.3138	10.3288	T = 19.55
TPS	overall	6.8624	2.8467	0.5	13.72	N = 554
	between		2.7724	0.9411	12.0233	n = 31
	within		0.7772	4.1624	10.3689	T-bar = 17.87
PSPR	overall	13.2055	5.7301	0.8376	32.3935	N = 554
	between		4.8821	2.1447	23.4547	n = 31
	within		3.1507	3.6482	24.5951	T-bar = 17.87

NOTE: *ESPS and PSPR are measured in U. S. $1,000.*

Table 2.9: *Data: Definitions and Sources*

Variable	Definition and Source
TES	Total Education Spending as % of GDP. Source: UNESCO, UIS.Stat, http://data.uis.unesco.org/Index.aspx?DataSetCode=EDULIT_DS
ESPS	Education Spending per Student. Source: Our own calculation using Total Education Spending % of GDP, GDP PPP (U. S. $ current) and the population of the official age for education.
TPS	Total Pension Spending as percentage of GDP. Source: OECD, Social Expenditure-Aggregate data, http://stats.oecd.org/Index.aspx?DataSetCode=SOCX_AGG
PSPR	Pensions Spending per Retiree. Source: Our own calculations using Total Pension Spending as % of GDP, GDP PPP (U. S. $ current) and the number of people over 65 years old.
ODR55	Population over 55 years old as a proportion of the working age population. Source: OECD, Demography and Population, http://stats.oecd.org/#
ODR	Old Dependency Ratio. Population over 65 years old as proportion of the working age population (15-64). Source: OECD, Demography and Population, http://stats.oecd.org/#
PRODR	Projected Old Dependency Ratio. Source: OECD, Historical population data and projections, http://stats.oecd.org/.
GDPpc	GDP per capita PPP (US current $) Source: OECD, https://stats.oecd.org/index.aspx?queryid=60702#
GDP Growth	Growth of real GDP, percentage change from previous year. Source: World Bank, http://databank.worldbank.org/data/
Interest rate	Long-term interest rate on government bonds. Source: Comparative Political Data Set, (Armingeon et al., 2018).
Openc	Openness of the economy, measured as total trade (sum of imports and exports) as a percentage of GDP, in current prices. Source: Comparative Political Data Set, (Armingeon et al., 2018).
Unemp	Unemployment rate as a percentage of civilian labour force. Source: Comparative Political Data Set, (Armingeon et al., 2018).
Union Density	Ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners. Source: OECD, http://stats.oecd.org/Index.aspx?DataSetCode=UN_DEN

Continuation: *Data Definitions and Sources*

Variable	Definition and Sources
G.T.	Type of Government. Source: Comparative Political Data Set, (Armingeon et al., 2018).
G.P.	Cabinet composition (Schmidt-Index). Ideology of the government parties. Source: Comparative Political Data Set, (Armingeon et al., 2018).
Tax Revenue	Tax revenue as % of GDP. Source: OECD, http://stats.oecd.org/viewhtml.aspx?datasetcode=REV&lang=en#
TotSocExp	Total Social Expenditure. Source: OECD Social Expenditure-Aggregate data, http://stats.oecd.org/Index.aspx?DataSetCode=SOCX_AGG
MYS	Mean years of schooling. Source: United Nations: Human Development Reports, http://hdr.undp.org/en/dataviz-competition
Left	Dummy variable for Left ideology of the government. Source: Comparative Political Data Set, (Armingeon et al., 2018).
GI	Globalization Index. Source: KOF, ETH Zurich, http://globalization.kof.ethz.ch/
VAI	Voice and Accountability Index. Source: Worldwide Governance Indicators (WGI) project, http://info.worldbank.org/governance/wgi/index.aspx#home
EFI	Economic Freedom Index. Source: Heritage Foundation Research Institute/Wall Street Journal, http://www.heritage.org/index/
PopEduc	Population of the official age for education in total population. Source: UNESCO, UIS.Stat Education, http://data.uis.unesco.org/Index.aspx?DataSetCode=EDULIT_DS
Fertility	Fertility rate. Source: OECD, Demography, https://data.oecd.org/pop/fertility-rates.htm
PPES	Education spending by level of education as percentage of GDP, pre-primary (PPES), primary (PES), secondary (SES) and tertiary (TERES). Source: UNESCO, UIS.Stat, http://data.uis.unesco.org/?queryid=181
ppoap	Population of the official age for education in total population by level of education, pre-primary (ppoap), primary (poap), secondary (soap) and tertiary (toap). Source: UNESCO, UIS.Stat, http://data.uis.unesco.org/?queryid=181

3 Political Viability of Public Pensions and Education. An Empirical Application.§

3.1 Introduction

Why should we care about future generations? Why should the generations care about each other? The answer to both questions lies in the fact that generations are interconnected by nature. Biologically speaking there are two periods in our life cycle when we find ourselves in a state of dependence. Infants and young children are unproductive and become fully productive only as they mature physically and intellectually (United Nations, 2013). Likewise, with ageing the ability to produce is affected dramatically. It is these biological forces that produce the inverted U-shaped pattern that characterizes labour productivity and which generate the economic life cycle illustrated in Figure 3.1.

As Figure 3.1 demonstrates the life-cycle pattern of consumption and income leads to a mismatch between needs and means. On the one hand, age groups like the young and elderly consume more than they produce while, on the other, working-age cohorts consume less than they produce. As such, there is a need for a mechanism to reallocate economic resources between age groups, that is, market or private and/or public intergenerational transfers (henceforth, IGTs).[1] In this chapter, we opt to focus solely on public IGTs.

The literature on public IGTs is large but fragmented. It dates back to initial studies that sought to determine the golden rule of capital accumulation in

§The paper in this chapter is coauthored with Concepció Patxot (Michailidis and Patxot, 2018)

[1]Figure 3.4 in the Appendix 3.6 shows the IGTs and the life cycle deficit for all the countries in our sample. It highlights the different patterns of public and private transfers in countries with different economic structures and different levels of economic development.

the standard overlapping generations (OLG) framework (Diamond, 1965). In this setting, abstracting from altruism and the consideration of young dependence, the failure of the competitive economy to meet the golden rule creates a key role for public IGTs financed via capitalization (pay-as-you-go) when there is under (over) accumulation.

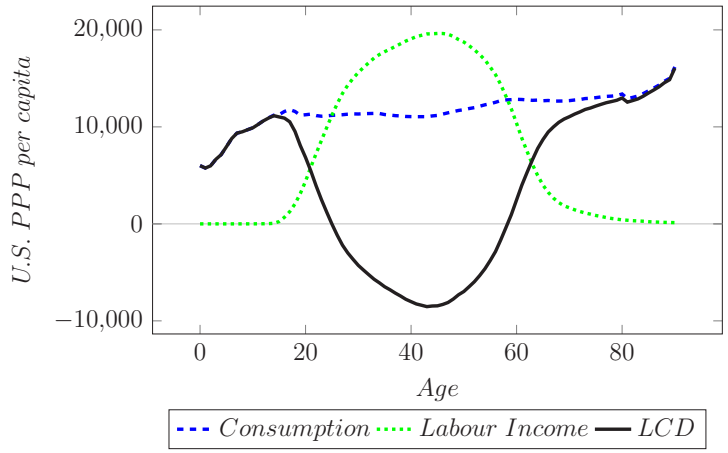
After various decades, probably as a result of the demographic transition, this literature struck out again but in a number of different directions. Some authors highlight the fact that besides the elderly, children are also dependent.[2] Thus, in accounting for the dependence of both age groups, the need for government intervention might derive from the fact that the markets and intra-family reallocations are failing to achieve certain important social goals by providing non-optimal investments in human capital for the young and pensions for the old (Becker and Murphy, 1988).[3] But, if the government only finances public pensions and public education, this may not be sufficient to achieve economic efficiency (Boldrin and Montes, 2005). One way of solving this problem is to create a link between public education and pensions, providing generations with appropriate incentives to reallocate public funds. A social contract of this type – where public pensions are properly linked to earlier investments in education – allows a complete market allocation to be obtained (Boldrin and Montes, 2009).

Thus, the connection between the transfer to children and the transfer to the elderly (already present in the family) has emerged also in the public sphere. Various scholars have argued in favour of the link between forward and backward public IGTs as they seek to answer the question as to why selfish generations might choose to transfer resources to future generations. Pogue and Sgontz (1977) argue that the design of the pay-as-you-go (PAYG) pension system creates the appropriate incentives to invest in public education, because it enhances the income of the future working generation. In a similar vein, Konrad (1995) claims that, even in the absence of altruism, the working-class generations are only willing to pay for public education if they

[2] Peters (1995) and Boldrin and Montes (2005) investigate a similar policy when parents take decisions regarding their children's human capital, while Bental (1989) and Abio et al. (2004) consider fertility to be endogenous.

[3] Bommier et al. (2010) assess the argument of Becker and Murphy (1988) by looking to the public transfers paid and received by generations in a period more than a century. They argue that most of the generations except those born before 1879 are better off with the introduction of public transfers.

Figure 3.1: *Economic Life Cycle*



NOTE: *Average patterns of consumption, labour income and life-cycle deficit for 18 NTA countries. The young and elderly obviously consume more than they produce, a fact that is highlighted by the line taken by the life-cycle deficit (consumption minus labour income). The opposite scenario is presented by the working-age cohorts. All the values are calculated converting currencies to U. S. $ (per capita) based on purchasing power parity (PPP) ratios in a particular year for each country.*

can "reap" gains by taxing the results of higher productivity in the future. Another incentive for the working-age generation to transfer economic resources towards the young one could be the higher returns on savings (Boldrin, 1992; Boldrin and Rustichini, 2000). More specifically, the decision to invest in education reflects positively on physical capital productivity because of its complementarity with human capital productivity. This in turn enhances the future return on savings and therefore offers higher future income to the current working age generation.

Kemnitz (2000) considers the link between pensions and education in an OLG setting using the public choice framework, where policy is forged by the relative political power of generations. The level of IGTs is decided by the majority of voters in a context of representative democracy, where governments seek to maximize political support. The main result stemming from this study is that the structure of the PAYG pension system stimulates investments in education that provide future benefits for the current working generation. According to this study, the structure of the PAYG pension system provides incentives to the working-age generation to support educational transfers towards the young even in the absence of altruism. Moreover, the author shows that population ageing achieves a better backward (pensions) and forward (education) redistribution of public funds.

From the perspective afforded by the political economy, a critical aspect of an IGT system is its political sustainability and the actuarial fairness between contributions paid and benefits received.[4] In this regard, Rangel (2003) employing a game theoretical framework of intergenerational exchange, examines the possibility of sustaining a system of public forward and backward intergenerational transfers (hereafter, FITs and BITs, respectively). He uses the concept of a sub-game perfect equilibrium in order to investigate, in the context of selfish generations, the ability of non-market intergenerational arrangements to invest optimally in forward and backward transfers. According to Rangel, for this to happen three conditions must be satisfied: First, the agents should have at least two exchange problems that require simultaneous cooperation; second, the intergenerational program must generate a positive continuation surplus in order to be supported by the middle-aged generation; and, third, the generations must play a game of simple trigger strategies that creates the link between BITs and FITs. The fear of punishment provides incentives to the middle-aged generation to choose the right amount to invest in BITs and FITs.

We conduct an empirical exercise that exploits the novel data approach of the National Transfer Accounts (henceforth, NTA) and the political economy framework of Rangel (2003) application. To the best of our knowledge, no empirical work has yet to assess in this way whether a joint system of public pensions and education or a system of total public IGTs – directed towards the elderly and young – can be politically sustained. This is what we attempt here, and is what can be considered as the value added to the existing literature. Our main findings suggest that in terms of the political viability countries with a strong ageing process and already developed system of public intergenerational transfers (i.e. an extended welfare state) are more likely to support a system of public pensions and education. Moreover, a system of total public transfers towards the elderly and young would receive significantly more political support than a joint system of pensions and education. This latter outcome is probably driven by the fact that total public transfers appeal more to a broader group of voters than is the case of a system of pen-

[4]Regarding the actuarial fairness, Bommier et al. (2010) calculate present values of generations before the introduction of public intergenerational transfers and for a long period after. They try to assess whether the generations have been benefited from the public transfers or not. The results suggest that most generations born after 1930 have been better off from the introduction of social security and public education.

sions and education. In addition, we find that population ageing has a positive effect on the political viability of both systems of IGTs.

The remainder of the chapter proceeds as follows. Section 3.2 presents the data and section 3.3 the methodology. In section 3.4 we provide the results of our empirical exercise on pensions and education as well as on total public IGTs. The last section 3.5 contains concluding remarks and some insights on what we learn from this exercise, the potential policy implications and future lines of research.

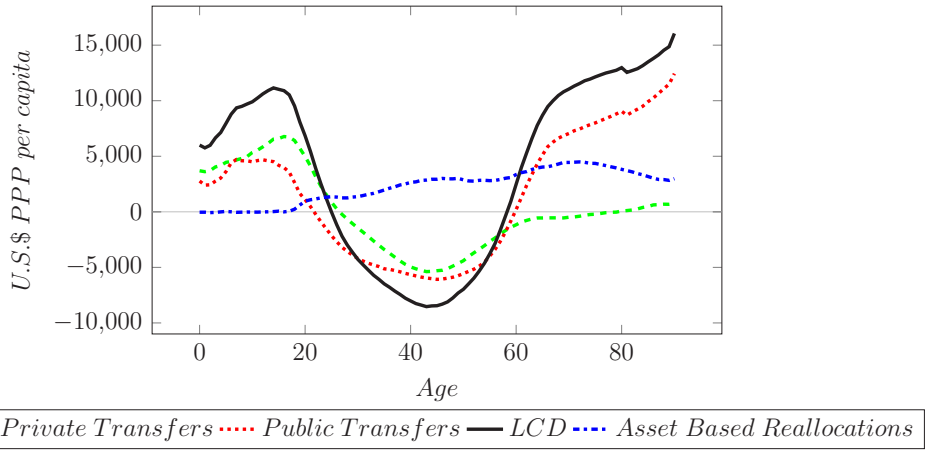
3.2 National Transfer Accounts Data

Conventional economic accounts do not lend themselves to analyses of the way people behave at different stages of the economic life cycle. More specifically, such methods usually report annual flows of public benefits and taxes as a share of GDP. Although this is useful information, it does not capture the age direction of public transfers and, therefore, fails to provide crucial information about who pays and who receives. Furthermore, private transfers occurring outside the market are ignored. By way of alternative, here, we exploit the specific structure of the National Transfer Accounts (NTA) data, which provide us with a complete, systematic and coherent accounting of economic flows from one age group to another.[5].

Starting from the national accounting identity, this method employs public administrative data and micro data surveys to measure, first, the age reallocations made by the public sector, and, second, the private transfers within the family. Figure 3.2 plots the age profile of the life-cycle deficit (LCD) for 18 countries and how this is financed via private (TF) and public transfers (TG). The part of LCD not covered by transfers is funded resorting to the asset market (asset income and dissaving). These NTA age profiles are consistently upgraded in the National Accounts. The transfer profiles (TG and TF) are net. In the case of public transfers, the NTA method assigns an aggregate amount of taxes to each category of public expenditure and we use the age profile of explicit earmarked taxes, that is, social contributions, in the

[5]The NTA data is taken from Ronald Lee and Andrew Mason (2011) and `http://www.ntaccounts.org/web/nta/show/Country%20Summaries`. All the concepts, methods and estimation procedures to measure the economic flows over the life-cycle are presented in United Nations (2013).

Figure 3.2: *Life Cycle Deficit and Intergenerational Transfers*



NOTE: *Average life-cycle deficit (LCD), and public (TG) and private transfers (TF) for 18 countries. The higher the LCD, the greater is the need for IGTs. LCD, TG and TF values are calculated by converting currencies to U. S. $ (per capita) based on purchasing power parity (PPP) ratios in a particular year for each country. See detailed country graphs in Figure 3.4 in the Appendix 3.6.*

case of pensions, or general taxes in all other cases. The balance is set to zero and the eventual surplus/deficit is recorded as public savings/dissaving.

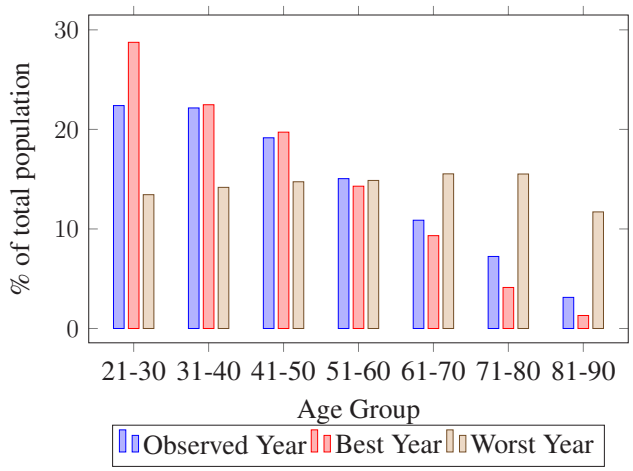
We employ the NTA estimates that provide us with measures of total public transfer inflows (benefits) and outflows (taxes and public asset-based flows) by single years of age.[6] We use cross-sectional data for a specific year in each of 18 countries.[7] Likewise, when available, we use the same type of public transfer data disaggregated between pensions and education.[8] These data provide us with the net transfers (net of taxes and/or contributions) received by individuals at each stage of the life cycle, thus enabling us to gauge their willingness to vote. In this way, we are able to assess the political sustainability of the IGT system, i.e. of pensions and education. Moreover, we use data for the current demographic structure of each country as well as for that projected in the future to compute the size of the voting cohorts. Figure 3.3 illustrates the demographic transition showing the current population age

[6]Public transfers comprise public education, health, pensions, and other in-kind and in-cash transfers. Each of these categories includes the inflows and outflows that people receive and pay during each year of their life.

[7]Austria (2000), Brazil (1996), Costa Rica (2004), Finland (2004), Germany (2003), Hungary (2005), India (2004), Indonesia (2005), Japan (2004), Mexico (2004), Philippines (1999), Slovenia (2004), S. Korea (2000), Spain (2000), Sweden (2003), Taiwan (1998), Thailand (2004), U. S. (2003).

[8]These data are not available for two countries in our NTA sample, Indonesia and Philippines.

Figure 3.3: *Demographic Structure of Population Per Cohort*



NOTE: *This bar plot illustrates the changing demographic structure in NTA countries on average. Observation year is the year that each country in the sample is observed. The "best" and "worst" years are identified using the old-age dependency ratio. Hence the "best" ("worst") year is the year with the lowest (highest) old-age dependency ratio. As can be seen, population ageing has a substantial impact on the demographic structure of the voting cohorts. Details on the demographic structure of each country are provided in Figure 3.5, in the Appendix 3.6.*

structure compared to the "best" and "worst" years defined in terms of old-age dependency. The old-age dependency ratio is the percentage of people over 65 in the working age population (15-64). Hence the "best" ("worst") year is the year with the lowest (highest) old-age dependency ratio. Similarly, as we discuss below, an essential element in our empirical exercise is the interest rate. We use data on the real interest rate, drawn from the World Bank database.[9]

3.3 Methodology

The empirical exercise that we conduct in this section is based on the political economy application proposed by Rangel (2003). In his stylized model, individuals of different generations interact to decide on the size of IGTs. Intergenerational altruism does not exist, so every decision is driven by selfish preferences. Rangel argues that it is possible to have a sustained IGT system with positive BITs and FITs even with "egoistic" generations. As discussed in the introduction, for this to happen, three conditions must be satisfied: first, the agents should have at least two exchange problems that require simultane-

[9]The real interest rate is defined as the lending interest rate adjusted for inflation measured by the GDP deflator, `http://data.worldbank.org/indicator/FR.INR.RINR`.

ous cooperation; second, the intergenerational program must generate a positive continuation value for working cohorts for them to back it; and third, the generation should be engaged in a game of simple trigger strategies, where the fear of punishment creates a link between FITs and BITs, i.e. an incentive for the middle aged to invest sufficiently in transfers to the old and young to avoid the punishment for not cooperating.

By way of application, Rangel generates a political economy model where agents live for nine periods ($a = 1, ..., 9$) and where each period represents ten years. The individuals are dependent children during the first two periods, working age adults in the following five and retirees in the last two. Only workers receive an income; the rest receive transfers only. Agents can borrow and save at the interest rate, $r > 0$. In addition, every period, society decides the amount it wishes to devote to the system of BITs (i.e. public pensions, health care, other in-cash or other in-kind transfers). The system is financed solely by workers, who have to pay a lump-sum payroll tax T.[10] Finally, there is another lump-sum tax E that is used to finance the FITs (i.e. education, child health care, other in-cash or other in-kind transfers), which is imposed on both workers and retirees.

In the following section, we explain in detail how the continuation value of the system of IGTs is calculated to assess the political viability of such a system.

3.3.1 Continuation Value

The continuation surplus is the value generated from the transition from a state of autarky to one in which IGTs take place. The continuation value of the BITs is measured as the present value of all benefits received minus taxes paid.

In the case of the linked system of pensions and education (Section 3.4.1), all the benefits received by the voting cohorts are those received during the retirement period ($a \geq 8$); and, all the taxes paid are those paid during the working age period ($a = 3...7$). The continuation value is computed as shown by equations 3.1 and 3.2 following the stylized model of Rangel (2003).

[10] This is the baseline version; in the case of the total public transfers below, we also take into account the non-payroll taxes that the elderly pay and the benefits that the working-age agents receive in order to compute their continuation value.

In the case of total public transfers (Section 3.4.2), we consider taxes (benefits) paid (received) by the voting age groups ($a \geq 3$) in order to calculate the continuation value of total public IGTs. In this case, we take into account the present values of all the benefits received less the taxes paid during both working age and retirement as shown in equation 3.3.[11]

$$CV_a = \sum_{i=8}^{9} \frac{PB_i}{(1+r)^{i-a}} - \sum_{i=a}^{7} \frac{PT_i}{(1+r)^{i-a}} \tag{3.1}$$

where CV_a is the continuation value for working age population ($a \geq 3$), PT are the payroll taxes paid by workers $a \geq 3$ and PB are pension benefits received when retired $a = 8, 9$, and

$$CV_a = \sum_{i=a}^{9} \frac{PB_i}{(1+r)^{i-a}} \tag{3.2}$$

where CV_a is the continuation value for the retirees $a = 8, 9$.

$$CV_a = \sum_{i=a}^{9} \frac{TPB_i - TT_i}{(1+r)^{i-a}} \tag{3.3}$$

where TPB are total public benefits and TT are total taxes paid by cohorts ($a \geq 3$) for public IGTs.

3.3.2 Voting

The continuation value measures the value of keeping the current system (i.e. public pensions or total public transfers towards the adults) and, hence, the willingness to vote in favour of it. Furthermore, according to Rangel's model, only if the continuation value is positive for the majority of voters it is possible to invest in education. In each period, voters choose between $(0; T)$ for the BITs and between $(0; E)$ for the FITs. All agents in cohorts above the second cast a vote. This means that if we have a representative voter for each cohort (decade), there is a total of seven votes.[12]

First, what is needed for a viable BITs (i.e. PAYG pension) system is to

[11] This equation is authors' elaboration on the basis of present value analysis.

[12] In more realistic case, as shown below, we weight the votes by the size of each cohort using the demographic structure as a proxy for the electorate size of each cohort.

hold a majority, that is, to obtain at least four votes in favour of such a system. Bearing in mind that retirees always vote in favour of the current system – because they receive positive net transfers – the decision to retain the current system depends entirely on the middle-aged cohorts. More specifically, cohorts $a = 3,4,5,6,7$ are the final decision makers. That is, to sustain the system in a representative voting scenario, at least two out of these five votes are needed to ensure a simple majority. This means that as long as the continuation values of at least two out of five middle-aged cohorts are positive, the majority votes for BITs. Note that the middle-aged cohorts vote for BITs not because they care about current retirees, but because they believe, quite rightly, that otherwise they will not receive any benefits when retired.

However, to sustain a system of bilateral intergenerational transfers (BITs and FITs) besides choosing the amount deemed sufficient to invest in BITs, it is also needed to invest optimally in FITs.[13] Thus, if inequality 3.4 holds for, at least, four of the age cohorts $a = 3,4,5,6,7,8$, the majority is willing to vote for education, because the system that links BITs and FITs generates a continuation value that is bigger than the FITs (i.e. education) tax that they have to pay.[14]

$$CV_a \geq EP_a \tag{3.4}$$

where P_a is the relative size of each age cohort. Therefore, in short, there could be a sustained path of BITs and FITs – and hence a system of IGTs would be politically viable – if three conditions are satisfied: First, if and only if the continuation value of choosing BITs (3.1, 3.2 or 3.3) is positive for the majority of voters; second, if and only if the continuation value of BITs is greater than the amount invested in FITs (inequality 3.4); and, third, age cohorts play voting strategies that link BITs to FITs.

The next section shows the results, which we expect to be driven by the age shape of the public transfers profile plus the demographic structure of each country. In addition, the usual discount effect should also be noted, that is, where taxes paid and benefits received at earlier stages in the life cycle are

[13] This is a direct consequence of generations adopting simple trigger strategies. In fear of being punished and receiving no benefits, current working cohorts are forced to transfer and invest optimal (sufficient) amounts in BITs and FITs, respectively.

[14] Note that cohort 9 always votes against FITs because they are not alive during the next period. The amount invested in FITs is paid proportionally in accordance with the size of each cohort.

discounted to a lesser extent.

3.4 Results

3.4.1 Public Transfers for Pensions and Education

In this section we conduct our exercise for a linked IGT system of pensions and education.[15] These transfers have been linked in the previous literature and are the main public policies devoted to the two dependent sides of the economic life cycle (i.e. children and the elderly).[16]

First, we compute the continuation values for the pension systems in our sample of countries. Second, by deducting tax E to finance education, we obtain the continuation value for the system of linked pensions and education. Finally, we assess whether such a system is viable during a particular year for each sample country, and also when using alternative demographic scenarios.

Thus, first, using equations 3.1, 3.2 and the real interest rate – for each country in a particular year – we calculate the continuation value of each voting cohort. As can be seen from Table 3.1, the continuation values for age groups $a = 3, 4$ (CV_3, CV_4) are negative for the vast majority of the selected countries.[17] The results confirm the theoretical predictions made by Rangel (2003) and the interpretation is quite straightforward. Under dynamic efficiency, young workers aged 21 to 40 (age groups 3 and 4) are unwilling to support the system of IGTs, because given the present values the taxes they pay are higher than the benefits they receive. At the same time, it is clear that retirees ($a = 3, 4$) fully support this system (CV_8, $CV_9 \gg 0$), because they enjoy retirement benefits without having to pay any more taxes. With two groups against and two in favour of the system, the final outcome of the voting procedure depends on age groups $a = 5, 6, 7$. As is derived from the results, the CVs of groups six and seven are positive for all countries except

[15] Data for Indonesia and the Philippines are not available for this exercise.

[16] The size of public pensions and education in OECD countries in 2013 was on average 8.2% and 4.8% of GDP, respectively. Data on public pensions and education are taken from `https://data.oecd.org/socialexp/pension-spending.htm` and `https://data.oecd.org/eduresource/public-spending-on-education.htm`, respectively.

[17] This result is in line with Bohn (1999), who calculates the continuation value of PAYG social security in the U. S.Ḣe shows that it is negative for the young voters, but strictly positive for voters above the median voter age.

Table 3.1: *Continuation Values for Public Pensions*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	CV_3	CV_4	CV_5	CV_6	CV_7	CV_8	CV_9
Austria	-45.049	22.627	115.223	219.421	312.111	374.165	206.664
Brazil	-20.797	-20.480	-10.319	12.260	40.298	80.584	44.210
Costa Rica	-13.956	-6.155	5.360	19.203	33.398	44.577	20.414
Finland	-73.976	-20.978	57.938	144.292	216.533	242.355	121.095
Germany	-43.184	-7.935	60.574	147.478	232.267	288.043	143.717
Hungary	-56.584	-27.156	22.544	76.746	116.893	124.785	64.183
India	-2.909	-1.755	-137	1.698	3.852	6.098	3.238
Japan	-47.645	-20.595	19.732	72.614	129.101	164.056	65.588
Mexico	-20.890	-14.223	-4.591	6.011	13.144	17.234	7.940
Slovenia	-67.928	-30.221	31.077	90.867	133.616	158.028	77.067
S. Korea	-30.272	-24.535	-15.987	-6.373	2.824	9.815	1.888
Spain	-59.423	-26.995	28.131	92.044	142.951	167.603	81.416
Sweden	-90.612	-17.526	87.126	205.319	328.886	411.976	202.918
Taiwan	-37.026	-31.258	-21.991	-11.503	-2.850	2.139	1.127
Thailand	-15.950	-13.912	-10.998	-7.115	-3.125	113	57
U. S.	-63.071	-37.726	15.610	81.181	148.336	195.378	101.788

NOTE: *CV_a is the continuation value and the subscript indicates the cohort. For example, CV_3 and CV_9 are the continuation values for cohort 3 (21-30 year-old) and cohort 9 (81-90 year old), respectively. The negative/positive values denote the willingness/reluctance of a particular cohort to support pensions, respectively. Continuation values are calculated converting currencies to U. S. $ (per capita) based on purchasing power parity (PPP) ratios in a particular year for each country.*

S. Korea, Taiwan and Thailand. Therefore, as Table 3.2 shows, the rest of the countries (i.e. 13 out of 16 countries – see column 1) obtain a majority with at least four votes in favour of the pensions. To obtain this result, we weight all cohorts equally (adopting a representative agent view) and ignoring the demographic structure of the population. In contrast, when we weight the age groups – using the real demographic structure to compute number of votes – the voting outcomes are considerably different. Only half the countries – most of which are developed – vote in favour of pensions (column 2).

As equations 3.1 and 3.2 make apparent, the value of the interest rate plays a key role in the calculation of the continuation value for workers and for retirees, respectively. So next, we examine how the outcomes would be modified if all countries were to "play under the same rules". Thus, we seek to determine the changes generated when assuming the same interest rate for each country in the sample. In this way, we control for the fact that the interest rate might be affecting our results. As is evident from column 3 in Table 3.2 the results do not vary significantly from that of the baseline scenario (column 2) for most of the countries in the sample except of Brazil.[18]

[18]This outcome is due to the high real interest rate in Brazil for the particular year and hence higher discount for the future retirement benefits.

Table 3.2: *Voting Scenarios for Pension and Education Transfers*

	Voting on Pensions					Voting on Pensions & Education				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	VR	VDS	VSIR	BY	WY	VR	VDS	VSIR	BY	WY
Austria	85,71	83,12	83,12	79,24	86,76	57,14	56,16	78,69	77,53	75,23
Brazil	57,14	25,83	100	21,59	58,49	42,86	24,26	98,42	20,99	45,66
Costa Rica	71,43	46,14	46,14	40,58	73,78	57,14	44,22	44,22	38,81	60,48
Finland	71,43	65,85	65,85	51,48	69,87	57,14	61,49	61,49	50,24	58,08
Germany	71,43	64,33	85,28	60,92	74,93	57,14	59,94	80,90	59,46	64,15
Hungary	71,43	61,74	61,74	54,30	70,71	57,14	58,02	58,02	52,94	60,63
India	57,14	24,26	24,26	21,85	55,37	42,86	23,40	23,40	21,13	46,62
Japan	71,43	65,47	65,47	46,22	75,38	57,14	60,46	60,46	45,38	61,40
Mexico	57,14	24,80	24,80	23,26	57,95	42,86	23,18	23,18	22,40	45,55
Slovenia	71,43	61,75	61,75	54,41	73,04	57,14	58,60	58,60	52,76	61,93
S. Korea	42,86	15,01	15,01	10,06	46,27	28,57	13,77	13,77	9,21	16,31
Spain	71,43	57,97	57,97	49,91	73,92	57,14	53,65	53,65	48,25	61,79
Sweden	71,43	64,74	64,74	56,99	70,01	57,14	58,55	58,55	54,82	58,30
Taiwan	28,57	6,53	6,53	-	-	14,29	5,20	5,20	-	-
Thailand	28,57	6,54	6,54	3,56	26,24	0	0	0	0	0
U. S.	71,43	59,95	59,95	52,07	68,71	42,86	34,17	34,17	31,96	42,71

NOTE: *VR: percentage of votes of a cohort-representative agent. VDS: vote percentage taking into account the demographic structure of the voting cohorts. VSIR: vote percentage when part of the imposed real demographic structure, CVs are gauged with same interest rate for all countries (4,2%). BY: Best year, the year of the lowest old-age dependency ratio. WY: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year): Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Japan (1950, 2051), Mexico (1955, 2095), Slovenia (1950, 2055), S. Korea (1950, 2064), Spain (1950, 2050), Sweden (1950, 2095), Taiwan (not available), Thailand (1950, 2075), U. S. (1950, 2100). The old dependency ratio in assessed in the period between 1950 and 2100.*

Table 3.3: *Political Sustainability of Pensions and Education*

	(1)	(2)	(3)	(4)	(5)
Country	VR	VDS	VSIR	BY	WY
Austria	Sustained	Sustained	Sustained	Sustained	Sustained
Brazil	Not	Not	Sustained	Not	Not
Costa Rica	Sustained	Not	Not	Not	Sustained
Finland	Sustained	Sustained	Sustained	Sustained	Sustained
Germany	Sustained	Sustained	Sustained	Sustained	Sustained
Hungary	Sustained	Sustained	Sustained	Sustained	Sustained
India	Not	Not	Not	Not	Not
Japan	Sustained	Sustained	Sustained	Not	Sustained
Mexico	Not	Not	Not	Not	Not
Slovenia	Sustained	Sustained	Sustained	Sustained	Sustained
S. Korea	Not	Not	Not	Not	Not
Spain	Sustained	Sustained	Sustained	Not	Sustained
Sweden	Sustained	Sustained	Sustained	Sustained	Sustained
Taiwan	Not	Not	Not	-	-
Thailand	Not	Not	Not	Not	Not
U. S.	Not	Not	Not	Not	Not

NOTE: *VR: percentage of votes of a cohort-representative agent. VDS: vote percentage taking into account the demographic structure of the voting cohorts. VSIR: vote percentage when part of the imposed real demographic structure, CVs are gauged with same interest rate for all countries (4.2%). BY: Best year, the year of the lowest old-age dependency ratio. WY: Worst year, the year with the highest old-age dependency ratio. Sustained: when a linked system of pensions and education transfers would be voted for by the majority. Non-sustained: when not supported by the majority.*

In a second exercise, we consider two different demographic scenarios (see columns 4 and 5 in Table 3.2). Essentially, we test what would happen to the voting process if instead of using the demographic structure of each country in the year selected for observation, we employ the demographic structure of the "best" and "worst" years as defined above. As can be seen, we obtain better results in terms of votes during the "worst" year than we do during either the "best" year or the observed year for each country.[19] This can be understood in terms of political economy, whereby population ageing makes the median voter older, thus increasing his/her continuation value and making the system politically more popular. This result is in line with the hypothesis of the "political power of the elderly", according to which population ageing makes the median voter older and, hence, more inclined to support greater expenditure on pensions.[20]

The next step is to test whether a positive investment in education is maintained (Table 3.2, columns 6 to 10) and whether a system of intergenerational transfer – where generations link the education to pensions – is politically tenable (Table 3.3). To conduct this test, we check whether inequality 3.4 holds for age cohorts $a = 5, 6, 7, 8$. If inequality 3.4 holds for these age groups, this means that the majority of voters are willing to support investments in education, because the system – that links education and pensions – generates a continuation value that is higher than the education tax they have to pay. As illustrated in Table 3.2, inequality 3.4 holds for the simple majority of voters, in only a few countries. More specifically, only half the countries can support forward IGTs such as education (column 7).

However, a system of IGTs like the one linking education to pensions can only receive political backing, if the majority support both pensions and education transfers. As such, the results of voting on pensions have to be matched by the voting outcomes on education. As is apparent from Table 3.3, a system of pensions and education would receive the support of the majority of voters in very few countries. Indeed, if the decision was put to the vote, Aus-

[19] In Table 3.7 in the Appendix 3.6 we reproduce the voting scenarios using the ageing demographic structure as projected in the future. Evidently the voting outcomes are better than in the observed year (see Table 3.2).

[20] See the political economy literature on social security (pensions):(Browning, 1975; Boadway and Wildasin, 1989; Breyer and Craig, 1997; Mulligan and Sala-i Martin, 1999; Tabellini, 2000; Disney, 2007; Shelton, 2008; Tepe and Vanhuysee, 2009; Michailidis et al., 2019).

Table 3.4: *Continuation Values for Total Public Transfers*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Country	CV_3	CV_4	CV_5	CV_6	CV_7	CV_8	CV_9
Austria	116.759	200.851	324.282	462.498	512.525	394.904	224.439
Brazil	-11.290	-6.318	18.047	58.877	78.975	73.906	43.133
Costa Rica	24.491	35.445	55.533	79.842	89.322	74.576	40.300
Finland	72.115	137.836	267.056	406.803	479.540	371.168	224.679
Germany	66.614	101.477	209.753	348.485	456.041	382.131	234.291
Hungary	28.951	59.340	140.305	237.132	283.061	204.029	104.942
India	-1.778	-600	519	1.148	1.635	1.612	1.325
Indonesia	-6.542	-5.040	-2.918	-701	701	847	425
Japan	30.560	63.883	131.474	226.446	317.498	267.527	155.417
Mexico	17.802	24.759	42.105	60.191	62.456	48.344	22.921
Philippines	-9.944	-8.906	-6.676	-3.935	-856	128	-244
Slovenia	71.433	114.753	212.301	302.837	315.782	235.287	126.627
S. Korea	-6.245	2.851	23.459	44.863	53.484	37.116	15.704
Spain	-47.451	-20.166	49.278	137.278	195.204	165.904	90.720
Sweden	153.341	226.425	355.452	522.530	687.532	611.277	387.882
Taiwan	-9.096	-3.078	30.420	68.044	84.687	70.803	36.927
Thailand	-19.106	-18.730	-14.879	-8.226	-2.224	393	1.140
U. S.	34.878	49.256	141.447	262.920	381.279	345.935	219.527

NOTE: *CV_a is the continuation value and the subscript indicates the cohort. For example, CV_3 and CV_9 are the continuation values for cohort 3 (21-30 year-old) and cohort 9 (81-90 year old), respectively. The negative/positive values denote the willingness/reluctance of a particular cohort to support pensions, respectively. Continuation values are calculated converting currencies to U. S. $ (per capita) based on purchasing power parity (PPP) ratios in a particular year for each country.*

tria, Finland, Germany, Hungary, Japan, Slovenia, Spain and Sweden would vote in favour of a system of pensions and education in most of the voting scenarios in our exercise.

3.4.2 Total Public Transfers

In the previous section, we assessed the political sustainability of the common system of pensions and education. In this section, we conduct the same exercise considering instead the total public IGTs for the elderly (BITs) and children (FITs), respectively. Total public transfers consist of public education, public health, public pensions, public transfers, and other in-kind and in-cash transfers. Each of the categories includes the inflows (benefits) and outflows (taxes) received and paid by individuals during each year of their life.

In this case we employ equation 3.3 to compute the continuation value of the voting age cohorts.[21] As shown in Table 3.4 when the whole NTA profile is taken into account to compute the continuation value, the results

[21]Note that when using equations 3.1 and 3.2, we omit taxes paid in dependent ages and benefit received in working ages. This is a minor problem when dealing with retirement

Table 3.5: *Voting Scenarios, BITs and FITs*

	Voting on BITs					Voting on BITs & FITs				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Country	VR	VDS	VSIR	BY	WY	VR	VDS	VSIR	BY	WY
Austria	100	100	100	100	100	85,71	95,57	95,57	98,29	88,46
Brazil	71,43	44,06	100	39,52	72,93	57,14	42,49	98,42	38,91	60,10
Costa Rica	100	100	100	100	100	85,71	98,09	98,09	98,22	86,70
Finland	100	100	100	100	100	85,71	95,64	95,64	98,77	88,21
Germany	100	100	100	100	100	85,71	95,62	95,62	98,54	89,22
Hungary	100	100	58,02	52,94	60,63	85,71	96,28	58,02	52,94	60,63
India	71,43	43,52	43,52	40,72	71,09	57,14	42,66	42,66	40	62,34
Indonesia	42,86	12,86	12,86	10,98	40,06	28,57	12,06	12,06	10,22	14,49
Japan	100	100	100	100	100	85,71	94,99	78,22	68,52	86,02
Mexico	100	100	100	100	100	85,71	98,38	67,37	99,14	87,60
Philippines	14,29	2,87	2,87	2,79	13,03	14,29	2,87	2,87	2,79	0
Slovenia	100	100	100	100	100	85,71	96,85	96,85	98,35	88,88
S. Korea	85,71	74,90	74,90	67,95	87,61	57,14	47,64	47,64	41,64	60,10
Spain	71,43	57,97	57,97	49,91	73,92	57,14	53,65	53,65	48,25	61,79
Sweden	100	100	100	100	100	85,71	93,81	93,81	97,82	88,30
Taiwan	71,43	47,94	47,94	-	-	57,14	46,61	46,61	-	-
Thailand	28,57	6,54	6,54	3,56	26,24	0	0	0	0	0
U. S.	100	100	100	100	100	71,43	76,36	55,68	73,37	89,41

NOTE: *VR: percentage of votes of a cohort-representative agent. VDS: vote percentage taking into account the demographic structure of the voting cohorts. VSIR: vote percentage when part of the imposed real demographic structure, CVs are gauged with same interest rate for all countries (4,2%). BY: Best year, the year of the lowest old-age dependency ratio. WY: Worst year, the year with the highest old-age dependency ratio. Country (best year, worst year: Austria (1950, 2060), Brazil (1950, 2085), Costa Rica (1980, 2085), Finland (1950, 2100), Germany (1950, 2040), Hungary (1950, 2059), India (1950, 2100), Indonesia (1965, 2095), Japan (1950, 2051), Mexico (1955, 2095), Philippines (1995, 2100), Slovenia (1950, 2055), S. Korea (1950, 2064), Spain (1950, 2050), Sweden (1950, 2095), Taiwan (not available), Thailand (1950, 2075), U. S. (1950, 2100). The old dependency ratio is assessed in the period between 1950 and 2100. .*

are strikingly different from the corresponding outcomes in Table 3.1. In contrast with the previous section, more than half the countries have positive continuation values even for the youngest voting cohorts (CV_3 and CV_4). This indicates that the net present value (benefits received minus taxes paid) of the welfare system is positive for voting cohorts. Therefore, they have strong incentives to support such a system of IGTs.

Nevertheless, there are some countries, including India, Indonesia, the Philippines, S. Korea, Taiwan, and Thailand, where the voting cohorts present negative current values of the system of welfare transfers.[22] These differences between countries can be explained by the differences in the structure of their NTA profiles. In other words, countries have different patterns for the reallocation of resources and, therefore, different patterns of IGTs. As is

pensions and education, but it is of greater importance when referring to all welfare state transfers.

[22]Just as before in the case of Brazil, the negative continuation values are mainly driven by the unusually high real interest rate.

Table 3.6: *Political Sustainability of Total Public Transfers*

	(1)	(2)	(3)	(4)	(5)
Country	VR	VDS	VSIR	BY	WY
Austria	Sustained	Sustained	Sustained	Sustained	Sustained
Brazil	Sustained	Not	Sustained	Not	Sustained
Costa Rica	Sustained	Sustained	Sustained	Sustained	Sustained
Finland	Sustained	Sustained	Sustained	Sustained	Sustained
Germany	Sustained	Sustained	Sustained	Sustained	Sustained
Hungary	Sustained	Sustained	Sustained	Sustained	Sustained
India	Sustained	Not	Not	Not	Sustained
Indonesia	Not	Not	Not	Not	Not
Japan	Sustained	Sustained	Sustained	Sustained	Sustained
Mexico	Sustained	Sustained	Sustained	Sustained	Sustained
Philippines	Not	Not	Not	Not	Not
Slovenia	Sustained	Sustained	Sustained	Sustained	Sustained
S. Korea	Sustained	Not	Not	Not	Sustained
Spain	Sustained	Sustained	Sustained	Not	Sustained
Sweden	Sustained	Sustained	Sustained	Sustained	Sustained
Taiwan	Sustained	Not	Not	-	-
Thailand	Not	Not	Not	Not	Not
U. S.	Sustained	Sustained	Sustained	Sustained	Sustained

NOTE: *VR: percentage of votes of a cohort-representative agent. VDS: vote percentage taking into account the demographic structure of the voting cohorts. VSIR: vote percentage when part of the imposed real demographic structure, CVs are gauged with same interest rate for all countries (4.2%). BY: Best year, the year of the lowest old-age dependency ratio. WY: Worst year, the year with the highest old-age dependency ratio. Sustained: when a linked system of pensions and education transfers would be voted for by the majority. Non-sustained: when not supported by the majority. .*

evident from Figure 3.4 in the Appendix 3.6, the aforementioned countries with negative continuation values present similar patterns of IGTs. For most Asian countries in our sample, the overall size of public transfers is small and remains quite concentrated among young dependents. As such, the age groups reallocate their resources primarily via family transfers as opposed to via publicly funded systems of BITs and FITs. This might constitute the main reason why the continuation values of total public transfers are negative for most of the voting cohorts in these countries. In contrast, in European countries, public transfers are greater and seem to have crowded out private transfers. Similarly, they are quite clustered around the old, which explains the greater support given by voters, despite the discounting effects.

The voting outcomes for the total welfare transfers are shown in Tables 3.5 and 3.6. Evidently, most of the countries in our sample would have voted in favour of a system of total public IGTs. More specifically, as shown in Table 3.6, when we consider a representative voter, 15 out of 18 countries would have backed total public transfers (column 1). The number of countries falls to 11 when we take into account the observed population structure

and we weight the votes by the size of each cohort (column 2). Controlling for the interest rate does not change the outcomes very much, with the exception of Brazil, where allowing for the same interest rate changes the outcome in favour of public transfers (column 3). Finally, as in the previous section 3.4.1, when considering the demographic transition the outcomes vary considerably, between the "best" year (column 4), the observed year (column 2) and the "worst" year (column 5). Clearly, population ageing increases the political support for total public transfers directed towards the young (FITs) and old (BITs).[23]

At this juncture, we should stress that differences in outcomes between the previous and the current sections are due primarily to the differences in the data used. In this section, we take into account all the public transfers that are made in each country. This means, the continuation value of each cohort is measured including the present value of all benefits received and all taxes paid. In contrast, the continuation value of pensions and education takes into account only those pension benefits received when retired and those social contributions paid when working. Hence, many of the benefits that young and middle-aged workers ($a = 3, 4, 5, 6, 7$) receive are included in the calculation of the continuation value in this section but not in the previous one. These benefits might include, for example, health care or other in-kind or in-cash transfers that these voting cohorts receive from the welfare state. Thus, in present values middle-aged workers benefit more from a system of total public transfers than they do from a linked system of pensions and education. Thus, by including a broader spectrum of transfers it is plausible to assume that more votes can be attracted from young and middle-aged workers ($a = 3, 4, 5, 6, 7$).

3.5 Conclusions

The empirical exercise conducted in this chapter follows the political economy application made by Rangel (2003) using National Transfer Accounts data. The main goal has been to evaluate the political sustainability of an intergenerational system organized through the linkages between backward

[23] In Table 3.8 in the Appendix 3.6 we reproduce the voting scenarios using the ageing demographic structure as projected into the future. Evidently, the outcomes of the voting scenarios are better during the "worst year" than during the observed year (Table 3.5).

and forward public transfers. We have assess the political viability of this system by computing the continuation value for these backward and forward transfers. We employ two types of data: first, we use pensions and education as backward and forward transfers, respectively; and, second, we use the total public transfers directed towards the old and the young. Then, we assess the political sustainability of the system by computing the continuation value – i.e. if the majority of voters receive more than they pay in present values in the observed years – of the system of intergenerational transfers. In those instances that the continuation values for the majority of voters is positive, we assume that they would support such a system if the decision was put to the vote in the particular year for each country.

Our findings suggest that only in about half of the countries studied – primarily developed countries – the majority would vote for a system of intergenerational transfers, including only pensions and education. In contrast, when we conduct the same exercise using the total public intergenerational transfers, our results concerning the voting decisions turns to be significantly better. The difference between the respective outcomes could be attributed to differences in the data. More specifically, the differences can be associated with the inclusion of a broader spectrum of public transfers (i.e. health care, other in-kind and other in-cash transfers) other than pensions and education. In this way, the young and the middle-aged take into account not only the present values of retirement benefits but also the present values of the benefits that they receive from the aforementioned public transfers. Hence, in the case of total public transfers, it is more plausible to attract votes from the young and middle-aged.

Also, we identify a cluster of countries for which continuation values are negative for most of the voting cohorts and, as such, the voting outcomes indicate a non-sustained system for both pensions and education and for total backward and forward public transfers. We associate these results with the stage of development of intergenerational transfers and, especially, with the fact that public transfers continue to be dominated by private transfers. Hence, there are still few political incentives for voting in favour of public transfers.

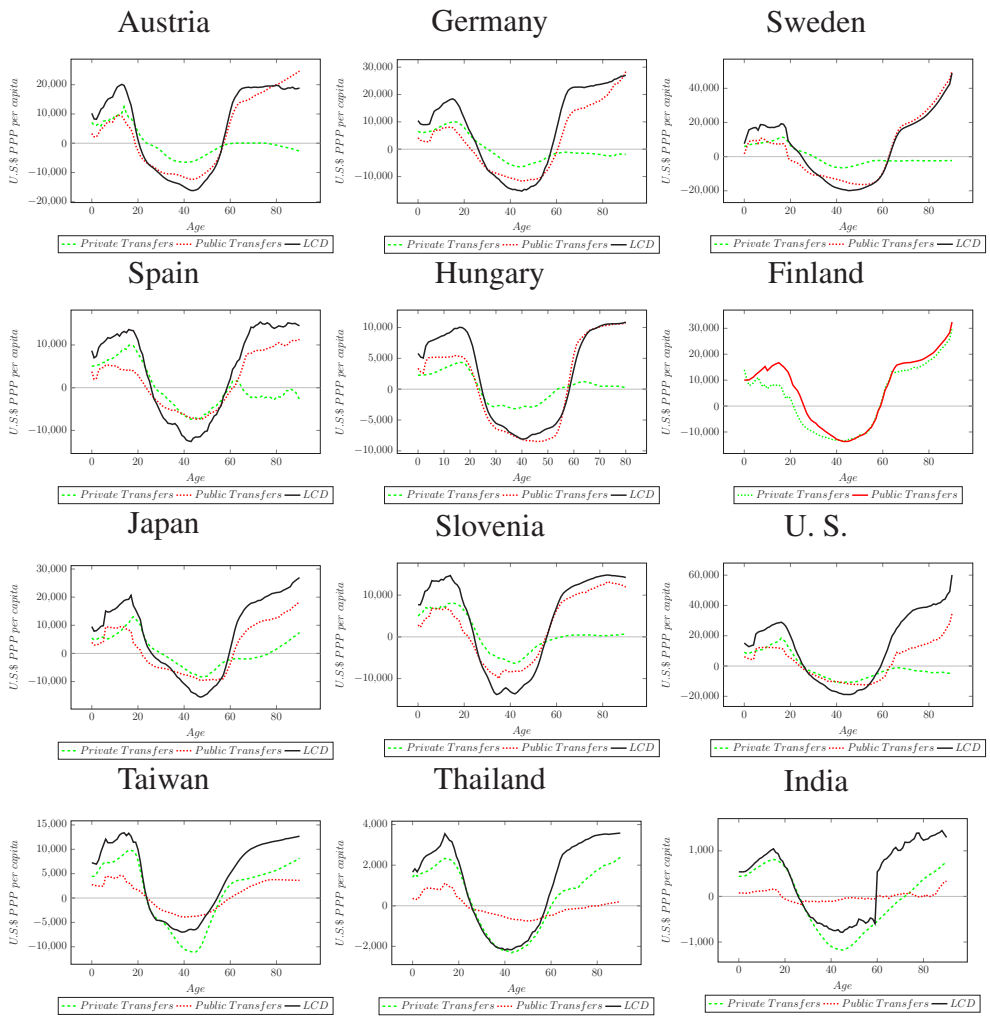
In addition, when we conduct our exercise employing the "best" and the "worst" demographic scenarios in terms of the old-age dependency ratio, we find that population ageing has a positive effect on the political viability of

both systems of intergenerational transfers considered here. In other words, in terms of political economy, ageing makes the median voter older and increases his/her continuation value, thus, boosting the political sustainability of the system. This result is in line with the hypothesis of the "political power of the elderly", according to which population ageing makes the median voter older and, hence, more inclined to support higher expenditure on public transfers towards the elderly. However, this raises the question as to how increasing political viability might interact with decreasing financial feasibility.

Thus, although ageing pressure on the financial health of the PAYG pensions system points to a conflict between financial and political sustainability, our results indicate some positive signs. More specifically, population ageing can be translated into a higher continuation value for the median voter that can be invested in education making the joint system of pensions and education politically more viable (Rangel, 2003). Thus, pensions can foster education. This, in turn, improves the future financial prospects of the PAYG system. Higher investment in education can boost the productivity of future workers and consequently the level of their contributions to social security and revenues from taxing their income. The immediate policy conclusion is that pensions could be pre-funded by increasing education expenditure. Moreover, we can suggest that it might be a useful reform to require legislation to vote on pensions and education as a unique social policy package. This reasoning could also be applied to a broader spectrum of intergenerational transfers directed toward children or the elderly, which also tend to be financed implicitly on a PAYG basis.

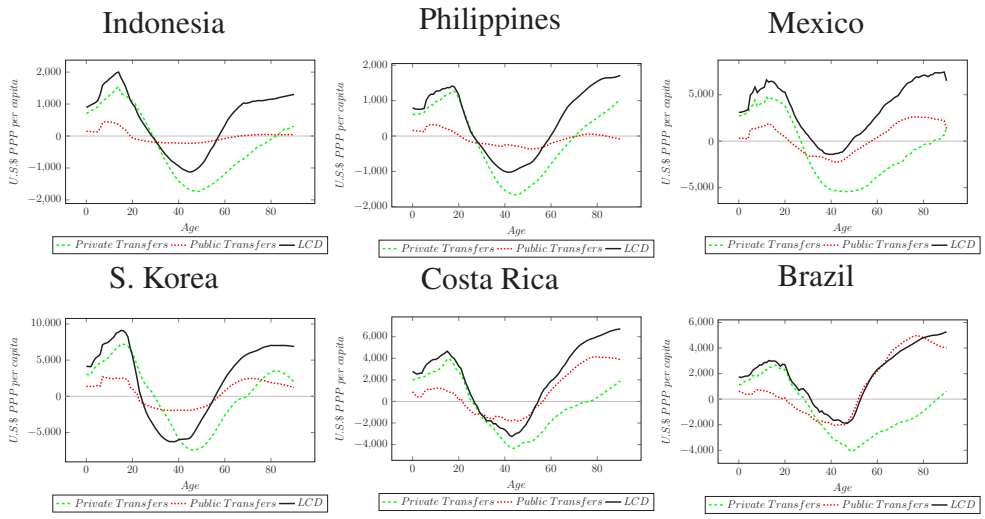
3.6 Appendix: Tables and Figures

Figure 3.4: *Intergenerational Transfers and Life Cycle Deficit per Country*



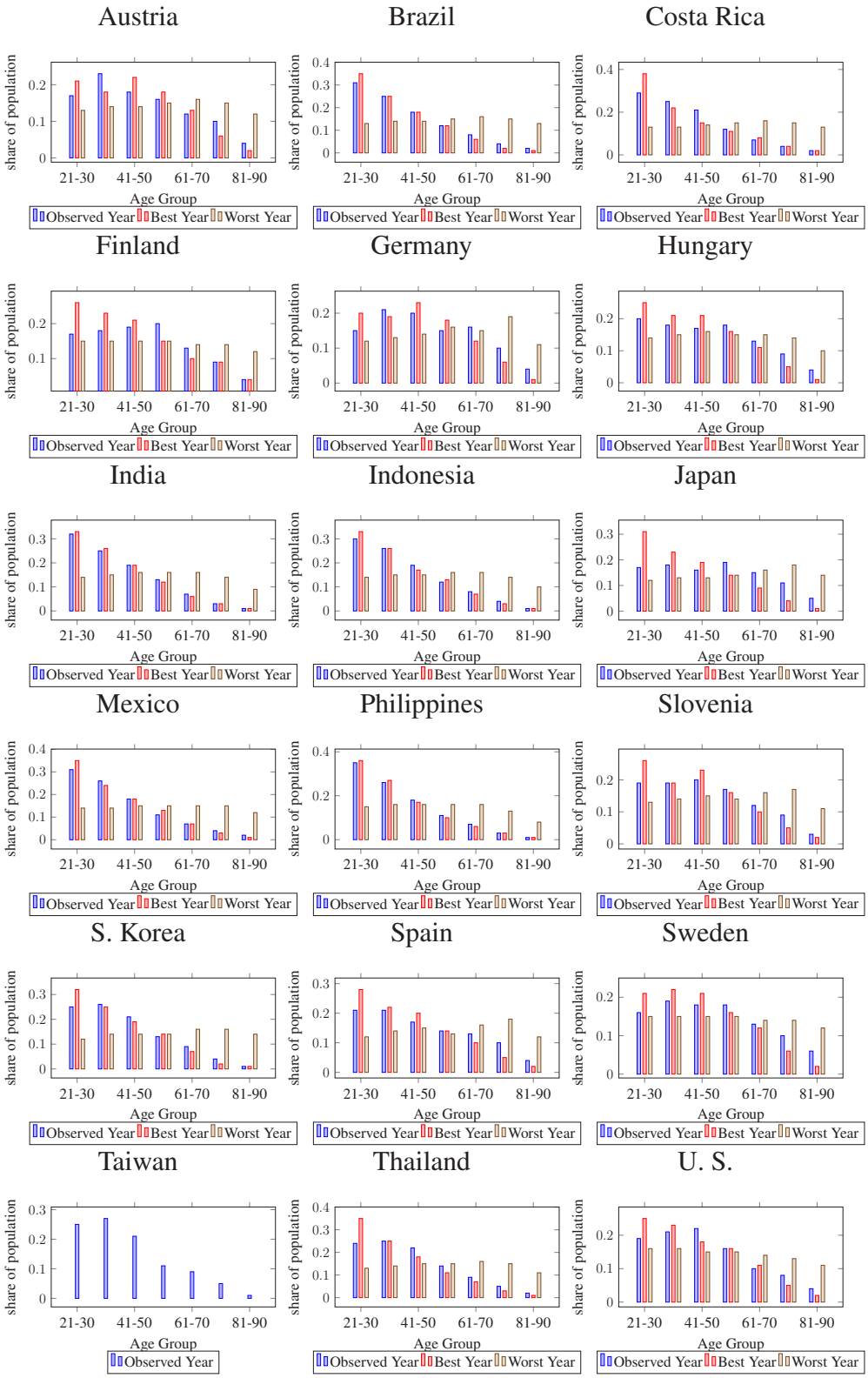
NOTE: *LCD: Life cycle deficit. TG: Public transfers. TF: Private transfers. LCD, TG and TF values are calculated converting currencies to U. S. $ (per capita) based on purchasing power parity (PPP) ratios in a particular year for each country.*

(Continued): Intergenerational Transfers and Life Cycle Deficit per Country



NOTE: *LCD: Life cycle deficit. TG: Public transfers. TF: Private transfers. LCD, TG and TF values are calculated converting currencies to U. S. $ (per capita) based on purchasing power parity (PPP) ratios in a particular year for each country.*

Figure 3.5: *Demographic Transition per Country*



NOTE: *Observation year is the year that each country is observed in the sample. The "best" and "worst" year are identified using the old dependency ratio (not available for Taiwan). Hence the "best" ("worst") year is the year with the lowest (highest) old dependency ratio. As we can see population ageing has a substantial impact on the demographic structure of the voting cohorts.*

Table 3.7: *Voting on Pensions and Education in the "Worst" Year*

	Voting on Pensions			*Voting on Pensions & Education*			*Pensions & Education*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Country	WY_VR	WY_VDS	WY_VSIR	WY_VR	WY_VDS	WY_VSIR	WY_VR	WY_VDS	WY_VSIR
Austria	85,71	86,76	86,76	71,43	75,23	75,23	Sustained	Sustained	Sustained
Brazil	57,14	58,49	100	42,86	45,66	87,17	Not	Not	Sustained
Costa Rica	71,43	73,78	73,78	57,14	60,48	60,48	Sustained	Sustained	Sustained
Finland	71,43	69,87	69,87	57,14	58,08	58,08	Sustained	Sustained	Sustained
Germany	71,43	74,93	87,55	57,14	64,15	76,78	Sustained	Sustained	Sustained
Hungary	71,43	70,71	70,71	57,14	60,63	60,63	Sustained	Sustained	Sustained
India	57,14	55,37	55,37	42,86	46,62	46,62	Not	Not	Not
Japan	71,43	75,38	75,38	57,14	61,40	61,40	Sustained	Sustained	Sustained
Mexico	57,14	57,95	57,95	42,86	45,55	45,55	Not	Not	Not
Slovenia	71,43	73,04	73,04	57,14	61,93	61,93	Sustained	Sustained	Sustained
S. Korea	42,86	46,27	46,27	14,29	16,31	16,31	Not	Not	Not
Spain	71,43	73,92	73,92	57,14	61,79	61,79	Sustained	Sustained	Sustained
Sweden	71,43	70,01	70,01	57,14	58,30	58,30	Sustained	Sustained	Sustained
Thailand	28,57	26,24	26,24	0	0	0	Not	Not	Not
U. S.	71,43	68,71	68,71	42,86	42,71	42,71	Not	Not	Not

NOTE: *WY: Worst Year. Every voting scenario is calculated using the demographic structure of the "worst year". WY_VR: vote percentage when each cohort has a representative voter. WY_VDS: vote percentage when the demographic structure is taken into account. WY_VSIR: vote percentage when CVs are computed with same interest rate for all countries (4,2%). "Worst" year, the year with the highest old dependency ratio. Country ("worst" year): Austria (2060), Brazil (2085), Costa Rica (2085), Finland (2100), Germany (2040), Hungary (2059), India (2100), Japan (2051), Mexico (2095), Slovenia (2055), S. Korea (2064), Spain (2050), Sweden (2095), Taiwan (not available), Thailand (2075), U. S. (2100).*

Table 3.8: *Voting on Total BITs and FITs in the "Worst" Year*

	Voting on BITs			*Voting on BITs & FITs*			*BITs & FITs*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Country	WY_VR	WY_VDS	WY_VSIR	WY_VR	WY_VDS	WY_VSIR	WY_VR	WY_VDS	WY_VSIR
Austria	100	100	100	85,71	88,46	88,46	Sustained	Sustained	Sustained
Brazil	71,43	72,93	100	57,14	60,10	87,17	Sustained	Sustained	Sustained
Costa Rica	100	100	100	85,71	86,70	86,70	Sustained	Sustained	Sustained
Finland	100	100	100	85,71	88,21	88,21	Sustained	Sustained	Sustained
Germany	100	100	100	85,71	89,22	89,22	Sustained	Sustained	Sustained
Hungary	100	100	100	85,71	89,93	89,93	Sustained	Sustained	Sustained
India	71,43	71,09	71,09	57,14	62,34	62,34	Sustained	Sustained	Sustained
Indonesia	42,86	40,06	40,06	14,29	14,49	14,49	Not	Not	Not
Japan	100	100	100	85,71	86,02	86,02	Sustained	Sustained	Sustained
Mexico	100	100	100	85,71	87,60	87,60	Sustained	Sustained	Sustained
Philippines	14,29	13,03	13,03	0	0	0	Not	Not	Not
Slovenia	100	100	100	85,71	88,88	88,88	Sustained	Sustained	Sustained
S. Korea	85,71	87,61	87,61	57,14	60,10	73,68	Sustained	Sustained	Sustained
Spain	71,43	73,92	73,92	57,14	61,79	61,79	Sustained	Sustained	Sustained
Sweden	100	100	100	85,71	88,30	88,30	Sustained	Sustained	Sustained
Thailand	28,57	26,24	26,24	0	0	0	Not	Not	Not
U. S.	100	100	100	85,71	89,41	58,12	Sustained	Sustained	Sustained

NOTE: *WY: Worst Year. Every voting scenario is calculated using the demographic structure of the "worst year".WY_VR: vote when each cohort has a representative voter. WY_VDS: vote percentage when the demographic structure is taken into account. WY_VSIR: vote percentage when CVs are computed with same interest rate for all countries (4,2%). Country ("worst" year): Austria (2060), Brazil (2085), Costa Rica (2085), Finland (2100), Germany (2040), Hungary (2059), India (2100), Indonesia (2095), Japan (2051), Mexico (2095), Philippines (2100), Slovenia (2055), S. Korea (2064), Spain (2050), Sweden (2095), Taiwan (not available), Thailand (2075), U. S. (2100).*

4 Inequality and Education Spending in a Greying Society[§]

4.1 Introduction

Population ageing has become an issue of growing concern for OECD countries, especially as the generation of "baby boomers" reach retirement age, putting considerable pressure on pensions system and the welfare state. Parallel to this, during the last decades there was a strong increase in income inequality. These trends have drawn attention to the public finance of education and the sustainability of public pensions as they aggravate two of the main political conflicts over the welfare state. The increase in income inequality intensifies the intragenerational conflict between rich and poor over redistribution in the form of public education. Population ageing exacerbates the intergenerational conflict over the allocation of resources between elderly and young.

These conflicts are examined in the literature on the political economy of pensions and education. In this literature, most of the studies consider these conflicts in isolation. Studies on the intergenerational conflict use a one dimensional voting process where voters decide either on the allocation or the size of government spending on pensions and education (Soares, 2006; Kaganovich and Zilcha, 2012; Naito, 2012). Other studies consider two dimensional voting models where the allocation and the size are determined jointly (Rangel, 2003; Lancia and Russo, 2016; Ono and Uchida, 2016). In the literature on the intragenerational conflict parents are allowed to opt-out of public education by sending their children to private schools, which generates diverging interests between rich and poor (Stiglitz, 1974; Glomm and Ravikumar, 1992; Levy, 2005; De La Croix and Doepke, 2009).

[§]The paper in this chapter is coauthored with Niclas Poitiers.

This paper is most related to Naito (2012); Ono and Uchida (2016); Levy (2005) and De La Croix and Doepke (2009). In Naito (2012) these conflicts are boiled down to a political dispute between a coalition of retirees and poor middle-aged and a coalition of rich middle-aged. This study shows that in a repeated majority voting game there is a politico-economic equilibrium where a high initial level of income inequality reduces the size of public education and pensions. Ono and Uchida (2016) consider the intergenerational conflict over pensions and education spending in a probabilistic voting setting. An increase in longevity increases total public pension spending, but the effect of longevity on education is hump shaped. Levy (2005) introduces a model of endogenous political party formation, where there is income redistribution between rich and poor as well as redistribution between young and old in the form of public education. There are four voting groups as agents are differentiated according to their income and age. In this model, if the young are in a minority there is high level of public education provision but the opposite outcome occurs when the young constitute a majority in population. De La Croix and Doepke (2009) show that in an probabilistic voting setting with private and public education, an increase in income inequality that decreases public education participation increases public education quality, but private education can crowd out public education if the political process is dominated by the rich.

We contribute to this literature by augmenting the probabilistic voting model on public and private education developed in De La Croix and Doepke (2009) by the dimension of a pay-as-you-go pension system. This allows us to consider the two political conflicts together and investigate the effect of income inequality and population ageing on education and pension spending. Moreover, we depart from Naito (2012) and Ono and Uchida (2016) by allowing agents to opt-out of public education, and from Levy (2005) by considering pensions for the old. In our model the preferences of heterogeneous agents are aggregated through probabilistic voting. Our goal is to determine simultaneously the size of the government and the allocation of public spending. We find that the education spending per student and pensions per retiree are affected by income inequality and ageing in the same direction. An increase in income inequality increases both per student public education spending as well as public pensions per pensioner, whereas an increase in the share of the population that is retired decreases both public education spending and

pensions.

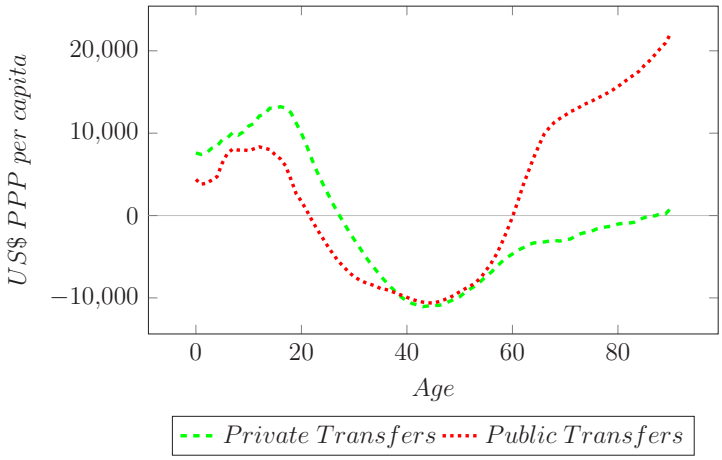
In our overlapping generations (OLG) model agents are heterogeneous with respect to their income. They live for three periods – young, adults (parents) and elderly – and each period they make sequentially two kind of choices, private and public. First, parents decide on the number of children and they choose whether to send them to a public or private school. Afterwards, the electorate (working age adults and pensioners) chooses the level of taxes and their allocation between pension and education spending according to a probabilistic voting model (Lindbeck and Weibull, 1987; Persson and Tabellini, 2000). In this setting, on the one hand, an increase in income inequality increases the level of per student public education spending and pensions. On the other hand, an increase in the retired population decreases both the level of public education and pensions. The former operates through the channel of a decreasing public education participation due to the substitution of public by private schooling freeing public resources for higher per student spending. At the same time, some of the resources that are not used for public schooling any more are used in order to finance more generous pensions. The latter works directly via the budget constraint. The increased proportion of elderly burdens the government's budget, inducing cuts in the expenditure on pensions and education per beneficiary.

We conduct a panel data analysis using OECD countries to examine if an increase in income inequality increases, and population ageing decreases public spending per student in primary and secondary education. More specifically, we employ two different specifications, a fixed effects approach and a dynamic panel analysis. We find evidence in favour of a negative effect of population ageing on education spending per student, but we obtain mixed results regarding the effect of income inequality.

Our theoretical approach is motivated by the shape of public and private intergenerational transfers depicted in Figure 4.1. The working age adults pay for the young through both public and private transfers, but for the retired population entirely through public transfers. Figure 4.2 presents further evidence for this: for almost all countries the vast majority of pensions spending is publicly provided. Therefore we choose this particular setting where there is public and private education for the young, but only a public pay-as-you go pensions system for the elderly.[1]

[1] In our model, the consumption of the retirees is covered by pensions rather than pri-

Figure 4.1: *The Life Cycle of Intergenerational Transfers*



NOTE: *This graph depicts the allocation of private and public intergenerational transfers among generations through life. Source: National Transfer Accounts (NTA) data are taken from Ronald Lee and Andrew Mason (2011).*

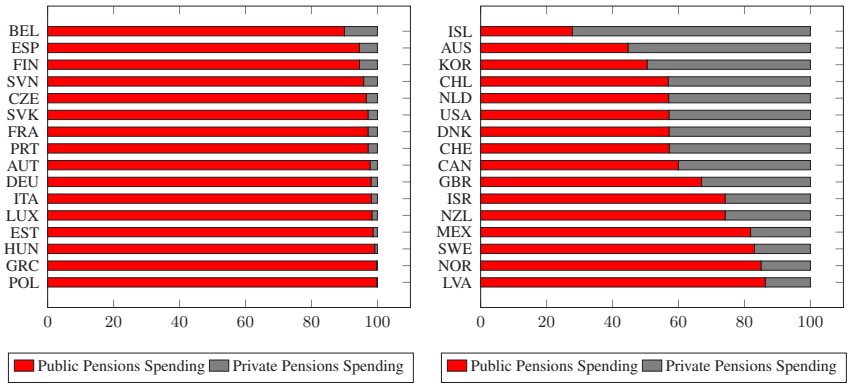
Moreover, as we can see from Figure 4.3 and Figure 4.4, the old dependency ratio (the ratio of retirees that have to be supported by working age adults, henceforth ODR) has increased substantially and it is expected to grow even stronger in the near future.[2] Parallel to the ageing of the population, there was a strong increase in income inequality, leading to an even stronger increase in resources available for education to high income households and a sharp decrease in the resources available to low income households. As can be seen in Figure 4.3, the Gini index as a measure of pre-tax and transfers income inequality has increased for all observed countries. As a result of these trends we expect the intensity of the two political conflicts – intergenerational and intragenerational – over the welfare state to be increasing.

The first political conflict belongs to the literature of the political economy of social security (i.e. public pensions). In this literature, the ageing process

vate savings, which constitute only a fraction of the elderly income in OECD countries (see OECD, 2017).

[2]The main forces behind population ageing are, declining fertility rates after the post-war "baby boom" and increased life expectancy. Among other things, the latter is a result of better quality services due to technological progress in the healthcare system, while the former results from the increasing opportunity cost for women of having children in developed economies. According to Galor and Weil (1996), this is brought about by the higher increase in female wages with respect to household income. Other potential channels include the increase in human capital investment per child and the quantity-quality trade-off à la Becker (1960) (Becker et al., 1990; Galor and Weil, 2000).

Figure 4.2: *Public and Private Pension Spending*



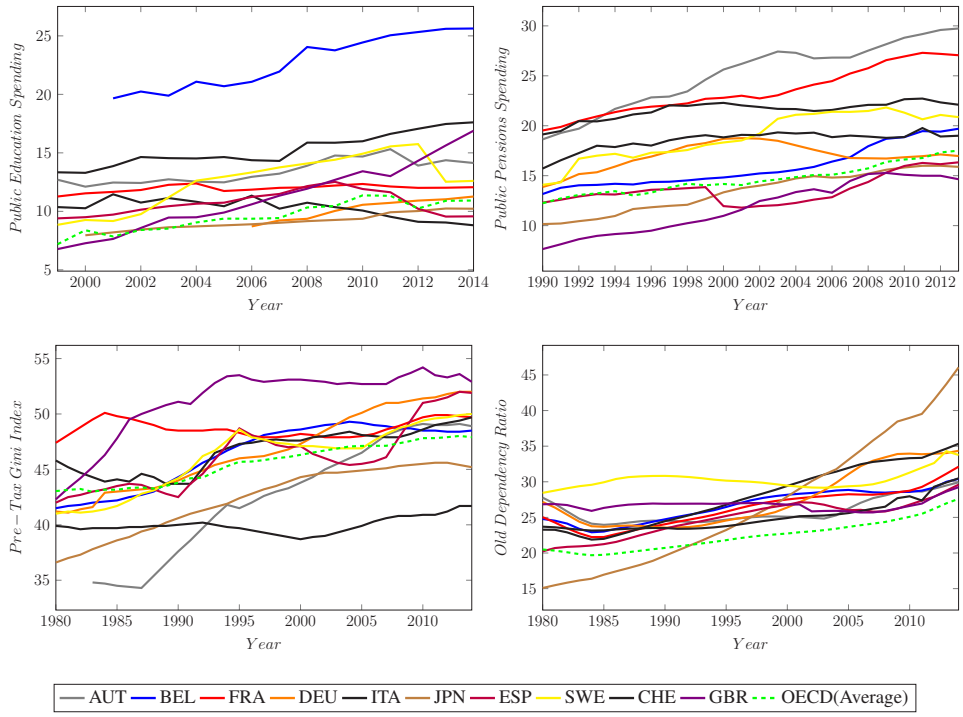
NOTE: *These graphs depict private and public pensions spending. Pension spending is defined as all cash expenditures (including lump-sum payments) on old-age and survivors pensions. Source: Pension spending, OECD.*

affects pensions through two opposing channels. On the one hand, there is the "fiscal leakage" hypothesis, which suggests that the increasing proportion of elderly decreases the expected profitability of pay-as-you-go pension systems for current working-age voters, thereby inducing them to favour lower current pensions. Therefore, the working-age generation repudiates the social security system (Breyer and Stolte, 2001; Razin et al., 2002; Razin and Sadka, 2007). On the other hand, according to the median voter theorem, governments implement the distribution of public funds that is preferred by the median voter (Downs, 1957) and as the median voter becomes older – due to population ageing – the political clout of the elderly seems set to grow. In turn, the increasing political power of the elderly transforms the allocation of public resources, shifting more resources towards the older cohorts (e.g. for pensions) and fewer to the younger cohorts (e.g. for education) (Browning, 1975). In the context of a limited fiscal budget, this reallocation of public funds might trigger a "struggle" for fiscal resources between the young and elderly, the so-called "intergenerational conflict" hypothesis (Poterba, 1997; Cattaneo and Wolter, 2009; Krieger and Ruhose, 2013).[3]

However, it has been pointed out by Casamatta and Batté (2016) that it is crucial to examine the nature of the linkage between publicly funded education and pensions before attempting to predict the effect of ageing on them. Becker and Murphy (1988) consider this connection as an exchange of

[3] In the literature this hypothesis is also known as the "political power of elderly" (Boadway and Wildasin, 1989; Breyer and Craig, 1997; Tabellini, 2000; Disney, 2007; Shelton, 2008; Tepe and Vanhuysee, 2009).

Figure 4.3: *Trends in Demographics, Income Inequality, Education and Pensions*



NOTE: *These plots show the increasing trends in education spending per student and pensions spending per pensioner measured in constant U. S. $1,000 (PPP 2011), pre-tax and transfers income inequality and old dependency ratio. Data Source: OECD, United Nations and the Standardized World Income Inequality Database. The time span of the graphs is dependent on data availability.*

transfers between young and old, where the former pay social security contributions and the latter invest in education. In the same vein Rangel (2003) and Boldrin and Montes (2005) consider a type of intergenerational contract in which generations link forward (e.g. education) to backward intergenerational transfers (e.g. pensions) in order to achieve an optimal and sustainable allocation of public economic resources. In particular, Rangel (2003) demonstrates the imperative role of backward intergenerational transfers in sustaining forward intergenerational transfers.[4]

Furthermore, the seminal paper of Pogue and Sgontz (1977) shows that the design of the PAYG pension system – pay contributions "now" and receive benefits "tomorrow" – and consecutively the connection of old age benefits to labour productivity of the future generations – the positive link between pensions and education – generates the appropriate incentives to invest in public

[4]The political economy application of this theory is empirically evaluated in Michailidis and Patxot (2018).

education. More specifically, the working age generations are willing to pay for public education only if they can "reap" gains of higher (human capital) productivity in the future in terms of higher taxable income (Konrad, 1995), social security contributions (Kemnitz, 2000) and/or higher returns on savings (Gradstein and Kaganovich, 2004). Moreover, Lancia and Russo (2016) argue that adults support education only if they can ensure that they will be able to extract a political rent in form of future pensions. Hence, the strategic role of human capital is more important when the political power of the elderly is larger and the forward looking adults support public education policy as they are democratically entitled to claim share of the produced human capital of future generations.[5]

The second political conflict that we are interested in is the intragenerational conflict between rich and poor. Since the 1970s, there was a strong increase in income inequality in the OECD countries (see Piketty, 2013). In the U. S. this has taken the form of a polarisation of incomes (Goos et al., 2009; Acemoglu and Autor, 2011)[6] and parallel to this there was an increase in the inequality of investments into children and the achievement gap between poor and rich students (Kornrich and Furstenberg, 2013; Reardon, 2011).[7] In a similar vein, Mayer (2002) finds that in the U. S. states with higher income inequality have higher differences in educational attainment between children from poor and rich backgrounds, but higher per pupil public education expenditures.[8]

There is a vast literature on income inequality, education and voting. Stiglitz (1974) discusses the effect of different educational institutional arrangements (public v. s. private education) on educational outcomes in a setting with majority voting. He shows that the equilibrium outcome is depending on whether education is mainly understood as a private good or a public good.

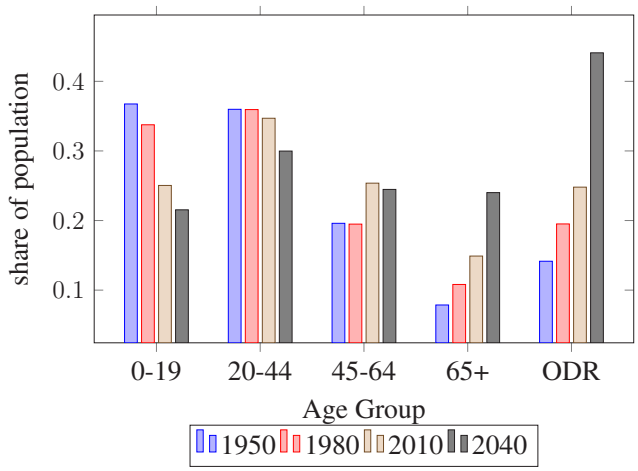
[5] See Michailidis et al. (2019) for the empirical confirmation of this theoretical prediction.

[6] There is no evidence of a polarisation of wages in Europe yet. There is an increase of upper tail inequality, but no decrease of lower tail inequality in the U. K. and Germany (Manning et al., 2007; Antonczyk et al., 2018).

[7] Reardon (2011) shows that parallel to the increase in income inequality in the U. S. there was an increase in the education achievement gap between children from the 90th and the 10th income percentile, though rising income inequality appears not to be the dominant factor.

[8] Bailey and Dynarski (2011) show that there was a strong increase in the college completion rate between 1979 and 1997, with a much stronger increase for children from high income families. This is driven by a strong increase in the college attendance rate of women from high income families.

Figure 4.4: *Changing Demographic Structure of Voting Cohorts*



NOTE: *The bar plot illustrates the changing demographic structure in OECD countries on average. We divide the total population in 4 major age cohorts: A) Children: Children under 20 years old, B) Young Adults: people from 20 to 44 years old, C) Old Adults: People from 45 to 64 years old, D) Elderly: people above 65 years old. Every age cohort is expressed as share of total population. E) ODR: the share of elderly (over 65 years old) over the working population (20-64 years old). The share of each cohort is depicted over 90 years (1950 to 2040) demonstrating the demographic transition.*

Bearse et al. (2005) study the effect of income inequality on public and private education in a majority voting model where public education can be both substituted and supplemented by private education expenditures. If supplementary private education spending and private schooling are prefect substitutes, there is no private school enrolment. In a mixed equilibrium, where they are not perfect substitutes, an increase in income inequality first increases per student public education spending, but then decreases it as students start to drop out of private education. Ichino et al. (2011) has a model of social mobility and public education spending. When the poor families are less politically active, there is less public education spending and less social mobility.

Another strand of the literature uses education to link income inequality to economic growth. In Galor and Zeira (1993) and Moav and Galor (2004), credit constraints hinder poor families from acquiring an optimal level of education, which leads to a negative effect of income inequality on economic growth. Other strands of the literature find a negative link between inequality, education and growth through assortive mating (Fernández and Rogerson, 2001) or technological progress (Galor and Tsiddon, 1997). The most related study to us, Glomm and Ravikumar (1992), shows in an endogenous growth model with majority voting that if income inequality is high a public edu-

cation regime leads to higher growth, whereas if income inequality is low a private education regime leads to higher growth.

The rest of the chapter is structured as follows: Section 4.2 introduces our model, Section 4.3 analyses the effect of income inequality and population ageing on the equilibrium levels of public education and pensions, Section 4.4 evaluates these effects using OECD data, and Section 4.5 concludes the paper.

4.2 The Model

Our model based on De La Croix and Doepke (2009) is populated by a continuum of agents that has a mass of one. They live for three periods: in the first period they are born and children, in the second they are adults and work, and in the third they receive a pension and live from that pension. Agents that are working adults in period t base their decisions on the following utility function:

$$\ln(c_t) + \gamma\left[\ln(n_t) + \eta\ln(h_t)\right] + \beta\mathbb{E}\left[U^o_{t+1}(p_{t+1})\right], \tag{4.1}$$

where $U^o_{t+1}(p_{t+1})$ is their utility when old:

$$U^o_{t+1}(p_{t+1}) = \ln(p_{t+1}). \tag{4.2}$$

Here, c_t is the consumption of the agent as adult, p_{t+1} is the pension which they consumes as retiree, n_t is the number of children they have, and h_t is the education of their children in terms of per child education spending. In this model we consider the pension spending per pensioner and education spending per student as the "quality" of pensions and education, respectively. The parents are altruistic towards their children with parameter γ and care about the quality of their children's education relative to the number of children with parameter η. β is the discount factor for the future consumption, and future consumption is equal to the expected pension p_{t+1} that the agent receives.

There are no savings in this economy, and the consumption after retirement is financed through a pay-as-you-go pension system. The agent's budget con-

straint is equal to

$$c_t + (1 - v_t) n_t e_t = (1 - v_t) y_t (1 - \phi n_t), \tag{4.3}$$

where y_t is the wage, v_t is the income tax rate. ϕ is the per child time that an agent has to dedicate to child rearing, and $1 - \phi$ is the time that an agent works. e_t is the private education spending per child, which is tax exempt, therefore $(1 - v_t) n_t e_t$ is the total private spending on education. We distinguish between agents that send their children to public education, denoted by a superscript s, and agents that send their children to private education, denoted by a superscript e. If parents are sending their children to private education they have to choose the per child spending on education e_t that they have to pay themselves and $h_t = e_t$. If they send their children to public education the level of education is decided and provided for by the government and $h_t = s_t$, where s_t is a political variable. The agents cannot supplement public education by private spending, and $e_t = 0$ for agents with children in public education. The budget constraint for parents sending their children to public education is thus:

$$c_t = (1 - v_t) y_t (1 - \phi n_t).$$

There is no capital in this economy, the potential economic output Y_t (when all agents are employed full time) is equal to a Cobb-Douglas production function using privately and publicly educated agents. The relationship between potential output Y_t and education is defined in the following way:

$$\ln Y_t = \ln A + (1 - \Psi_{t-1}) \ln \hat{e}_{t-1}^{\alpha} + \Psi_{t-1} \ln s_{t-1}^{(1-\alpha)}, \tag{4.4}$$

where $\hat{e}_{t-1}$ is the average spending per student in private education, s_{t-t} is the spending per student in public education, and $\alpha \in [0, 1]$ is the elasticity of substitution between the two. We introduce the share of public education Ψ into the Cobb-Douglas parameter in order to ensure the marginal return on an increase in the spending per student in both the public and the private education sector increases with the number of students attending public and private education respectively. This is needed to guarantee the tractability of the model. This also allows for the existence of a total private education

system and a total public education system. A is a parameter that captures the technology and non human capital related parts of the economy. Only adults work, therefore the output depends on the human capital accumulated in the previous period. Individuals differ in the relative share of the total income x that they receive. We normalise the distribution $G(x)$ of x to have mass one, therefore the income that an individual with x could get if they worked full time is equal to

$$y_t = xY_t.$$

We assume that the distribution of x is independent of the choices of last period. Private and public choices do affect the level of potential income in the future, the relative population size, but not the income distribution. Therefore the distributional parameters stay constant over time, and the political choice in t becomes a static problem independent of the future income distribution and future political choices.

The next period potential output is a function of this period's decisions. In order to solve this model, we assume that the expected value of next periods pensions is proportional to the output of the economy:

$$\mathbb{E}_t(p_{t+1}) \propto Y_{t+1}.$$

That means that if the next periods output increases, agents expect to have an increase in their pensions of the same magnitude as well. This assumption refers to the positive intergenerational link between the working age adults and children.[9] In particular, we assume that it is of the following form:

$$\mathbb{E}_t(p_{t+1}) = \Theta_{t+1}Y_{t+1},$$

where Θ_{t+1} is the expected share of potential output that is dedicated to pensions, a variable that captures the expected future policies. We assume, as standard in the political choice literature, that current policies and decisions do not affect expected future policies, i. e. that Θ_{t+1} is independent of choices made in t.

[9]The working age adults are willing to pay for the education of young because they expect to reap the gains of higher productivity during their retirement in the near future (Konrad, 1995; Kemnitz, 2000; Gradstein and Kaganovich, 2004).

4.2.1 The Private Choice

Agents optimise their utility over the number of children n_t, their consumption c_t, and the investment into their children's education h_t given their budget constraint (4.3). They take political variables as exogenously given. We distinguish between agents that choose public education for their children, and agents that choose private education for their children, denoted by superscript s and e respectively. If an agent chooses to send their children to public education, they will receive an education in the value of s_t, which will be paid and determined by the government (i. e. the political process). If they send their children to private education, they can choose the level of education spending e_t but have to pay for it themselves.

Incorporating (4.2), (4.3), and (4.4) into utility (4.1), we get the following indirect utilities in the cases of private and public education:

$$\begin{aligned} U_t^s(y_t, n_t | s_t, v_t, p_{t+1}) &= \ln(1-v_t) + \ln(y_t) + \ln(1-\phi n_t) + \gamma \ln(n_t) \\ &\quad + \gamma\eta \ln(s_t) + \beta \mathbb{E}\left[\ln(p_{t+1})\right], \qquad (4.5) \\ U_t^e(y_t, n_t, e_t | v_t, p_{t+1}) &= \ln(1-v_t) + \ln\left[y_t(1-\phi n_t) - n_t e_t\right] + \gamma \ln(n_t) \\ &\quad + \gamma\eta \ln(e_t) + \beta \mathbb{E}\left[\ln(p_{t+1})\right]. \qquad (4.6) \end{aligned}$$

There is a Beveridgean redistributive pay-as-you-go pension system and agents do not choose the level of pension, which is a political variable. They optimise their utility only over consumption, number of children, and in case they are choosing private education the education spending per child. The optimal choice of variables for parents choosing private education is equal to:

$$\begin{aligned} c_t^e &= (1-v_t)\frac{y_t}{1+\gamma}, \\ n^e &= \frac{\gamma(1-\eta)}{\phi(1+\gamma)}, \qquad (4.7) \\ e_t^e &= \frac{\eta\phi y_t}{1-\eta}, \qquad (4.8) \end{aligned}$$

where $n_t^e = n^e$ is static and independent of other variables. The optimal choice

for parents choosing public education is equal to:

$$\begin{aligned} c_t^s &= (1-v_t)\frac{y_t}{1+\gamma}, \\ n^s &= \frac{\gamma}{\phi(1+\gamma)}, \end{aligned} \tag{4.9}$$

where $n_t^s = n^s$ is static and independent of other variables as well.

Agents choose private education if the value of private education in terms of utility is larger or equal to the value of public education in terms of utility, i. e.:

$$U^e(y_t, c_t^e, n^e, e_t^e | v_t, p_{t+1}) \geq U^s(y_t, c_t^s, n^s | s_t, v_t, p_{t+1}). \tag{4.10}$$

These indirect utilities only depend on y_t, which is directly proportional to x. Agents differ only in the share of total output x that they receive. Thus there will be a $\tilde{x}_t$ for which the utilities in both education systems will be the same. Solving (4.10) for $\tilde{x}_t$ we get:

$$\tilde{x}_t = \frac{1-\eta}{\hat{\eta}\phi\eta}\mathbb{E}_t(s_t), \tag{4.11}$$

where $\hat{\eta} = (1-\eta)^{1/\eta}$. Here, $\mathbb{E}_t(s_t)$ is the expected value of public education. Agents do not know the realisation of the quality of public education when they decide on fertility and whether they send their children to public or private education. Therefore $\tilde{x}_t$, the x of the agent that is indifferent between sending their children to public or private education depends on the school quality that they expect when the agents make their private choice.

We assume a uniform distribution of x over the interval $[1-\sigma, 1+\sigma]$. Therefore the fraction of children participating in the public education system is equal to

$$\Psi_t = \begin{cases} 0 & \text{if} \quad \tilde{x}_t < 1-\sigma, \\ \frac{\tilde{x}_t-(1-\sigma)}{2\sigma} & \text{if} \quad 1-\sigma \leq \tilde{x}_t \leq 1+\sigma, \\ 1 & \text{if} \quad \tilde{x}_t > 1+\sigma. \end{cases} \tag{4.12}$$

In the first case, the x with which an agent would be indifferent between public and private education is lower than the one of the poorest agent in the economy and therefore the share of parents sending their children to public

education is equal to 0. In the last case, $\tilde{x}_t$ is larger than the one of the richest agent in the economy, and therefore everyone sends their children to public schools ($\Psi_t = 1$). In the case with $1-\sigma \leq \tilde{x}_t \leq 1+\sigma$ some parents send their children to public and some to private schools.

We define N_t as the population size of the adult at the time t. We define the population growth rate as ρ_t, such that the relation between population in t and $t-1$ is equal to

$$N_t = (1+\rho_{t-1})N_{t-1}.$$

We normalise the adult population at t to one, so in t the retired population size of generation $t-1$ is equal to $1/(1+\rho_{t-1})$. The population growth rate depends on the participation in public education Ψ_t in the following way:

$$1+\rho_t = \Psi_t n^s + (1-\Psi_t)n^e. \tag{4.13}$$

Since agents that choose public education do not have to pay the cost of education for their children, they choose to have a higher number of children ($n^s > n^e$), and thus an increase in the participation in public education Ψ_t leads to an increase in population growth ρ_t.

4.2.2 Public Choice

After making their private choices, i. e. deciding whether to participate in public or private education and how many children to have, the adult and the retired agents vote on the public choice variables s_t, p_t, and v_t. A policy $\{s_t, p_t, v_t\}$ has to fulfil the following government budget constraint:

$$\int_0^{\tilde{x}_t} s_t n^s g(x)dx + \frac{1}{1+\rho_{t-1}}p_t = v_t \left\{ \int_0^{\tilde{x}_t} x(1-\phi n^s)g(x)dx + \int_{\tilde{x}_t}^{\infty} [x(1-\phi n^e) - e_t^e(x)n^e]\, g(x)dx \right\}, \tag{4.14}$$

where $g(x)$ is the probability density function of $G(x)$. The left hand side of this equation represents the government expenditures, i. e. the expenditures for public education (first term on the left) and the expenditures for pension of the retired (second term on the left). The right hand side represents the

revenue from income taxes v_t on those with public education (first term on the right) and those with private education (second term on the right). Using (4.7), (4.8), and (4.9) we can show that the taxable income in period t is equal to

$$\begin{aligned}\int_0^{\tilde{x}_t} x\left(1-\phi n^s\right) g(x)dx + \int_{\tilde{x}_t}^{\infty} \left[x\left(1-\phi n^e\right) - e(x)n^e\right] g(x)dx \\ = \frac{Y_t}{1+\gamma}\int_0^{\infty} xg(x)dx = \frac{Y_t}{1+\gamma}.\end{aligned} \tag{4.15}$$

where $e(x) = e_t^e$ for agents with income $y_t = xY_t$. The tax revenue is independent of the participation rate Ψ_t and only depends on the economic output. Using this, we can rewrite the government budget constraint (4.14) as

$$v_t \frac{Y_t}{1+\gamma} = s_t \Psi_t n^s + p_t \frac{1}{1+\rho_{t-1}},$$

which leads to the following expression of the tax rate v_t as a function of per pensioneer pensions p_t and per student spending on public education s_t

$$v_t = \frac{1+\gamma}{Y_t}\left(s_t \Psi_t n^s + p_t \frac{1}{1+\rho_{t-1}}\right). \tag{4.16}$$

Thus we can replace v_t in the indirect utilities (4.5) and (4.6) with (4.16) and formulate the public decision as a decision on two variables p_t and s_t, where the tax rate v_t is a function of the two. The policy variables are chosen according to a probabilistic voting, where the adults and retirees vote on competing political platforms defined on $\{s_t, p_t\}$ (for a discussion of the probabilistic voting see Appendix 4.6.1). The winning political platform is the one that optimises the following objective function:

$$\begin{aligned}\Omega(s_t, p_t) = \int_0^{\tilde{x}_t} U_t^s\left[x, s_t, p_t, v_t(s_t, p_t)\right] g(x)dx \\ + \int_{\tilde{x}_t}^{\infty} U_t^e\left[x, s_t, p_t, v_t(s_t, p_t)\right] g(x)dx + \frac{1}{1+\rho_{t-1}} U_t^o(p_t).\end{aligned}$$

One can show that Ω is strictly concave in s_t and p_t. The maximisation of

Ω with respect to s_t leads to

$$0 = -\frac{\Psi_t n^s}{\frac{Y_t}{1+\gamma} - s_t \Psi_t n^s - p_t \frac{1}{1+\rho_{t-1}}} + \Psi_t \frac{\eta\gamma}{s_t} + \frac{\beta \Psi_t (1-\alpha)}{s_t}. \tag{4.17}$$

The first term on the right is the costs of an increase in s_t through taxes for the adult population, the second term is the benefit of an increase in s_t for the parents sending their children to public schools, and the third term is the benefit of an increase s_t for all adults through the higher expected future production that is paying for their pensions.

Maximising Ω with respect to p_t yields

$$0 = -\frac{\frac{1}{1+\rho_{t-1}}}{\frac{Y_t}{1+\gamma} - s_t \Psi_t n^s - p_t \frac{1}{1+\rho_{t-1}}} + \frac{1}{1+\rho_{t-1}} \frac{1}{p_t}. \tag{4.18}$$

Again, the first part of this equation represents the costs of an increase in p_t through taxes on adults income and the second part the benefit of an increase in p_t for the retirees.

We can now use (4.17) and (4.18) to solve for the political outcome of the voting process $\{s_t^*, p_t^*\}$:

$$s_t^* = \frac{(1+\rho_{t-1})\left[\eta\gamma + \beta(1-\alpha)\right]}{(1+\rho_{t-1})\Psi_t\left[\eta\gamma + \beta(1-\alpha) + 1\right] + 1} \frac{Y_t \gamma}{\phi}, \tag{4.19}$$

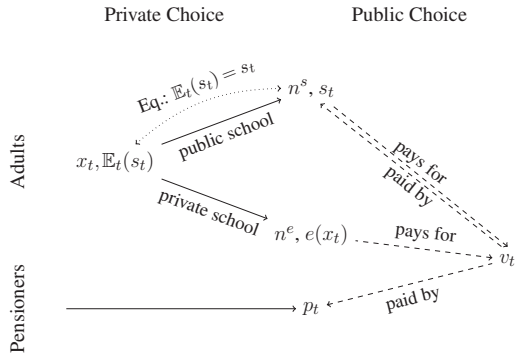
$$p_t^* = \frac{1}{(1+\rho_{t-1})\Psi_t\left[\eta\gamma + \beta(1-\alpha) + 1\right] + 1} \frac{Y_t(1+\rho_{t-1})}{1+\gamma}. \tag{4.20}$$

We can insert (4.19) and (4.20) into (4.16) to get the tax rate v_t^* that corresponds to this policy:

$$v_t^* = \frac{\Psi_t \gamma\eta + \frac{1}{1+\rho} + \Psi_t \beta(1-\alpha)}{1 + \Psi_t \gamma\eta + \frac{1}{1+\rho} + \Psi_t \beta(1-\alpha)}. \tag{4.21}$$

According to the probabilistic voting theory, it is optimal for competing political platforms to offer the policy $\{s_t^*, p_t^*, v_t^*\}$, which is maximising the probability of being elected. Therefore this is the equilibrium outcome of the political process. All these political variables are dependent on the participation rate in public education Ψ_t, which is an outcome of the expectations

Figure 4.5: *Sequence of Choices*



NOTE: *As we can see, first adults choose whether to send their children into public or private schools and how many children to have (n^s or n^e), as well as the level of private education $e(x_t)$ in case their children attend a private school. This private decision depends on their location in the income distribution x_t and the expected per student spending in public schools $\mathbb{E}(s_t)$. Afterwards the electoral body (adults and pensioners) vote simultaneously on the tax rate v_t, per pensioner pensions p_t and per student spending in public schools s_t. An equilibrium of this model is the point where the expectations are fulfilled, i. e. $\mathbb{E}(s_t) = s_t$.*

on the level of public schooling $\mathbb{E}_t(s_t)$. A representation of this sequence of the above choices is depicted in Figure 4.5. We are now going to define an equilibrium with perfect foresight of the agents with respect to s_t.

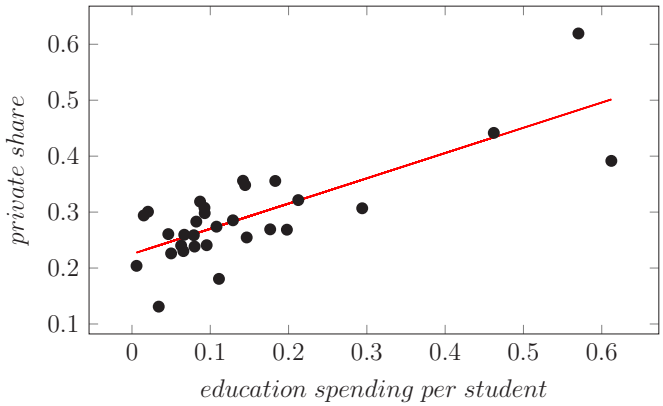
4.2.3 Equilibrium

In this model, agents are deciding first whether or not to send their children to public education based on their expectations on the level of public education ($\mathbb{E}(s_t)$). This decision then influences the outcome of the political process and thus the level of public education s_t itself. We are assuming perfect foresight of the agents with respect to this periods policies, and an equilibrium is thus defined as the expected value of s_t that yields itself as the outcome of aggregated private choices and the resulting public policies:

Definition 4.1. An equilibrium consist of an income threshold $\tilde{x}$ satisfying (4.11), a fertility rule $n = n^s$ for $x \leq \tilde{x}$ and $n = n^e$ for $x > \tilde{x}$, a private education decision $e = 0$ for $x \leq \tilde{x}$ and $e = e^e(x)$ for $x > \tilde{x}$, and aggregate variables $\{\Psi_t, s_t^*, p_t^*, v_t^*\}$ given by equations (4.12), (4.19), (4.20), and (4.21), such that the perfect foresight condition holds:

$$\mathbb{E}_t(s_t) = s_t. \tag{4.22}$$

Figure 4.6: *Public Education Spending and Private Participation*



NOTE: *This scatter plot depicts the relationship between the private share in primary & secondary education and public education spending per student in primary & secondary education as a share in GDP per capita, for OECD countries in our sample in 2014. This relationship is highly correlated and statistically significant 0.77*** (0.000).*

To show that an equilibrium exists and is unique, we are using Brouwer's fixed-point theorem. For this we need the following lemma:

Lemma 4.2. *The level of public education s_t^* and the level of public pensions p_t^* are decreasing in the participation in public education Ψ_t, whereas the tax rate v_t^* is increasing in participation in public education.*

Proof. The first derivative of s_t^* and p_t^* with respect to Ψ_t are equal to

$$\frac{\partial s_t^*}{\partial \Psi_t} = -\frac{(1+\rho_{t-1})^2 \left[\eta\gamma+\beta(1-\alpha)\right]\left[\eta\gamma+\beta(1-\alpha)+1\right]}{\left\{(1+\rho_{t-1})\Psi_t\left[\eta\gamma+\beta(1-\alpha)+1\right]+1\right\}^2}\frac{Y_t\gamma}{\phi}, \tag{4.23}$$

and

$$\frac{\partial p_t^*}{\partial \Psi_t} = -\frac{(1+\rho_{t-1})^2 \left[\eta\gamma+\beta(1-\alpha)+1\right]}{\left\{(1+\rho_{t-1})\Psi_t\left[\eta\gamma+\beta(1-\alpha)+1\right]+1\right\}}\frac{Y_t}{1+\gamma}, \tag{4.24}$$

which are both always negative. The first derivative of v_t^* with respect to Ψ_t is equal to

$$\frac{\partial v_t^*}{\partial \Psi_t} = \frac{\gamma\eta+\beta(1-\alpha)}{\left[1+\Psi_t\gamma\eta+\frac{1}{1+\rho}+\Psi_t\beta(1-\alpha)\right]^2}, \tag{4.25}$$

which is always positive. □

A decrease in the participation in public education Ψ_t means that there are now less parents that are voting in favour of public education, and also the weight of public educated children in the future production is decreasing. But at the same time the number of children in public education is decreasing, which is dominating the other effect here. Since with the decrease in the number of children a higher level of public education can be provided for a lower costs, there are more funds to increase the level of pensions and decrease the tax rate. This is in line with empirical evidence for OECD countries as shown in Figure 4.6, there is a positive correlation of 0.77*** (0.000) between participation in private education and per student spending in public education.[10]

Now, we are using Lemma 4.2 to show that an equilibrium exists and is unique.

An equilibrium exists and is unique.

Proof. The existence and uniqueness of an equilibrium as defined in Definition 4.1 follow from an application of the Brouwer's fixed-point theorem. Using (4.19), the actual quality s_t and the expected schooling quality $\mathbb{E}_t(s_t)$ lie in the interval

$$\mathbb{E}_t(s_t), s_t \in \left\{ \frac{(1+\rho_{t-1})\left[\eta\gamma+\beta(1-\alpha)\right]}{(1+\rho_{t-1})+1}\frac{Y_t\gamma}{\phi}, \right. \\ \left. \frac{(1+\rho_{t-1})\left[\eta\gamma+\beta(1-\alpha)\right]}{(1+\rho_{t-1})\left[\eta\gamma+\beta(1-\alpha)+1\right]+1}\frac{Y_t\gamma}{\phi} \right\}. \tag{4.26}$$

We define a mapping Δ from $\mathbb{E}_t(s_t)$ into s_t, which maps this interval into itself. A unique fixed point of this mapping implies the existence of a unique equilibrium with $\mathbb{E}_t(s_t) = s_t$. Using (4.11) and (4.12), we can show that the participation in public education $\Psi - t$ as a function of $\mathbb{E}_t(s_t)$ is equal to:

$$\Psi_t = \Psi[\mathbb{E}_t(s_t)] = \max\left\{\min\left[\frac{1-\eta}{2\sigma\hat{\eta}\phi\eta}\mathbb{E}_t(s_t) - \frac{1-\sigma}{2\sigma}, 1\right], 0\right\}. \tag{4.27}$$

This function is weakly increasing in $\mathbb{E}_t(s_t)$. The higher the expected quality of public education, the more parents are going to prefer sending their children to public education.

We can use (4.19) to define the mapping Δ, which gives us the actual per

[10] De La Croix and Doepke (2009) find this as well for the U. S. regions.

student public education expenditure s_t that results for the voting process with the participation rate $\Psi[\mathbb{E}_t(s_t)]$ from (4.27). This education quality $s_t = \Delta[\mathbb{E}_t(s_t)]$ is given by

$$\Delta[\mathbb{E}_t(s_t)] = \frac{(1+\rho_{t-1})\left[\eta\gamma+\beta(1-\alpha)\right]}{(1+\rho_{t-1})\Psi[\mathbb{E}_t(s_t)]\left[\eta\gamma+\beta(1-\alpha)+1\right]+1}\frac{Y_t\gamma}{\phi}. \tag{4.28}$$

An equilibrium is a fixed point of $\Delta[\mathbb{E}_t(s_t)]$, i. e. public education spending s_t that satisfies $s_t = \Delta(s_t)$. At this fixed point the schooling quality s_t that is expected by the agents is identical to the one that results from the voting process. Given (4.28) and Lemma 4.2, Δ is a continuous, weakly decreasing function mapping the closed interval given in (4.26) into itself. The mapping therefore crosses the 45 degree-line exactly once, and a unique equilibrium exists. □

This proof of the existence and uniqueness of the equilibrium works in the following way: according to Lemma 4.2 the equilibrium per student spending on public education is decreasing with the participation rate in public education. As $\Psi_t \in [0,1]$, the level of the per student spending on public education s_t^* is also bounded. Because the participation rate is an increasing function of the expected schooling quality, and the actual schooling quality is a decreasing function of the participation rate in public education, the actual schooling quality is a decreasing function of the expected schooling quality. As the actual schooling quality is decreasing in expected schooling quality, and both are bounded, according to Brouwer's fixed-point theorem there exists a unique fix point between the two. This is the equilibrium point where expected schooling quality and actual schooling quality coincide and the perfect foresight condition holds.

4.3 Comparative Statics

We can now use the equilibrium schooling and pensions to derive comparative statics in the model. In particular, we are interested in the effect of changes in income inequality on public education provision and pensions. There are three different education regimes: (i.) majority public with $\Psi_t \in [1,1/2)$; (ii.) equally separated with $\Psi_t = 1/2$; or (iii.) majority private with $\Psi_t \in (1/2,0]$. Unlike De La Croix and Doepke (2009) we cannot rule out

any of this regimes, but as can be seen in Figure 4.7 almost all countries have majority public education regimes, and therefore we concentrate our analysis on this case (for an analysis of the other regimes see Appendix 4.6.2). Initially we are looking at the effect of income inequality on the participation rate in public education. We get for the relationship between the inequality σ and Ψ_t the following: In a majority public education regime with $\Psi_t > 1/2$ participation in public education Ψ_t and the tax rate v_t^* are decreasing with income inequality σ and the quality of public education s_t^* and the pensions per pensioner p_t^* are increasing in σ.

Proof. The first derivative of Ψ_t with respect to σ is

$$\frac{\partial \Psi_t}{\partial \sigma} = \frac{\sigma - \left[\frac{1-\eta}{\hat{\eta}\phi\eta}\mathbb{E}_t(s_t) - (1-\sigma)\right]}{2\sigma^2} = \frac{1}{\sigma}\left(\frac{1}{2} - \Psi_t\right). \tag{4.29}$$

This is negative for $\Psi_t > 1/2$. Following Lemma 4.2 this means that p_t^* and s_t^* are increasing in σ and v_t^* is decreasing in σ for $\Psi_t > 1/2$. □

The mechanism of the effect of an increase in income inequality is the following: an increase in income inequality is increasing the income of the marginal agent that is indifferent between private and public education if this agent has an above average income. This means that this agent now prefers private education. This decrease in public education participation decreases the share of voters with children in public education, but it also decreases the number of children in public education. Therefore the total spending on public education decreases, but the number of children in public education decreases stronger. Overall this leads to an increase in per student public education spending. The decrease in total education spending leads to an increase in pensions and to a decrease in taxes.

Secondly, we look at the effect of an increase in the share of old people in the population $1/(1+\rho_{t-1})$ on pensions and per student public education spending. For this we look at the comparative statics of $1/(1+\rho_{t-1})$ on p_t^*, s_t^*, v_t^*, Ψ_t, and $(1+\rho_t)$: An increase in the share of retirees in the population $1/(1+\rho_{t-1})$ decreases the pensions per pensioner p_t^*, the level of public schooling s_t^*, and the participation in public education Ψ_t, and it increases the tax rate v_t^*. It also decreases future population growth $(1+\rho_t)$.

Proof. Using the implicit function theorem, (4.11), (4.12), and (4.23), we can

derive the first derivative of s_t^* with respect to $1/(1+\rho_{t-1})$:

$$\frac{\partial s_t^*}{\partial \frac{1}{1+\rho_{t-1}}} = -\frac{1}{\frac{1-\eta}{2\sigma\hat{\eta}\phi\eta}[\eta\gamma+\beta(1-\alpha)+1]+\frac{\{(1+\rho_{t-1})\Psi_t[\eta\gamma+\beta(1-\alpha)+1]+1\}^2}{(1+\rho_{t-1})^2[\eta\gamma+\beta(1-\alpha)]}\frac{\phi}{Y_t\gamma}}, \tag{4.30}$$

which is always negative. Following (4.11) and (4.12) this leads to a decrease in the equilibrium value of Ψ_t and according to (4.13) this decreases $(1+\rho_t)$.

Using this, (4.11), (4.12), and (4.24), we can derive first derivative of p_t^* with respect to $1/(1+\rho_{t-1})$:

$$\frac{\partial p_t^*}{\partial \frac{1}{1+\rho_{t-1}}} = -\frac{\frac{1}{\eta\gamma+\beta(1-\alpha)}\frac{\phi}{\gamma(1+\gamma)}}{\frac{1-\eta}{2\sigma\hat{\eta}\phi\eta}[\eta\gamma+\beta(1-\alpha)+1]+\frac{\{(1+\rho_{t-1})\Psi_t[\eta\gamma+\beta(1-\alpha)+1]+1\}^2}{(1+\rho_{t-1})^2[\eta\gamma+\beta(1-\alpha)]}\frac{\phi}{Y_t\gamma}},$$

which is also always negative.

Following from (4.30), (4.11), (4.12), and (4.24) the first derivative of v_t^* with respect to $1/(1+\rho_{t-1})$ is

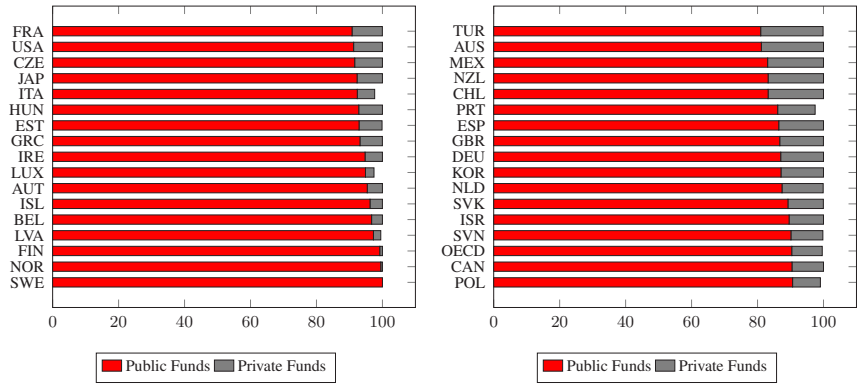
$$\frac{\partial v_t^*}{\partial \frac{1}{1+\rho_{t-1}}} = \frac{1}{\left[1+\Psi_t\gamma\eta+\frac{1}{1+\rho}+\Psi_t\beta(1-\alpha)\right]^2} \cdot \frac{\frac{1-\eta}{2\sigma\hat{\eta}\phi\eta}+\frac{\{(1+\rho_{t-1})\Psi_t[\eta\gamma+\beta(1-\alpha)+1]+1\}^2}{(1+\rho_{t-1})^2[\eta\gamma+\beta(1-\alpha)]}\frac{\phi}{Y_t\gamma}}{\frac{1-\eta}{2\sigma\hat{\eta}\phi\eta}[\eta\gamma+\beta(1-\alpha)+1]+\frac{\{(1+\rho_{t-1})\Psi_t[\eta\gamma+\beta(1-\alpha)+1]+1\}^2}{(1+\rho_{t-1})^2[\eta\gamma+\beta(1-\alpha)]}\frac{\phi}{Y_t\gamma}}.$$

This is always positive. □

The mechanism behind this is similar to the one in Proposition 4.3: an increase in the share of old people increases the share of voters voting for pensions, but also increases the number of pensioners. This increases the total spending on pensions, but decreases the pensions per pensioner. The increase in pensions is paid by an increase in taxes and a decrease in public education spending. The decrease in public education spending leads to a decrease in participation in public education, which leads to a decrease in population growth.

To conclude the theoretical predictions of the model, an increase in income inequality decreases taxes, but increases per student spending on pub-

Figure 4.7: *Distribution of Public and Private Funds*



NOTE: *Distribution of public and private funds for primary, secondary and post-secondary non-tertiary educational institutions. Final funds after transfers between public and private sectors, excluding international funds (2015). Source: Education at a Glance, OECD, 2018.*

lic education and per pensioner pensions. It decreases the size of the welfare state but increases the quality of the provided services. On the other hand, an increase in the population weight of the retirees does decrease both the per pensioner pensions and the public education spending per student. Both mechanism operate mainly through fiscal leakage in the budget constraint. An increase in income inequality increases the income of the agent indifferent between public and private education, and thus decreases the participation in public education. This reduces the share of voters caring for public education through altruism for their children, which reduces the total public education spending (which in turn decreases taxes and increases pensions). The number of children attending public education decreases faster than the total spending, which leads to an increase in per student spending on public education. The mechanism in the case of an increase in the number of retirees works in a similar fashion: The increase in the number of pensioners increases the political weight of the retirees, increasing total pension spending (which increases taxes and decreases per student public education spending). The number of pensioners increases faster than the total pension spending, thus the per pensioner pension is decreasing. In both cases we find a positive relationship between per student public education spending and pensions through the budget constraint.

4.4 Empirical Evidence

The theoretical model that we develop in this chapter makes prediction on how public education spending per student is affected by income inequality and population ageing. The main predictions of our model about the intergenerational and the intragenerational conflict are the following ones: (i.) Education spending per student and pensions spending per retiree are positively related and affected by changes in inequality and ageing towards the same direction. (ii.) When the majority of children attend public education, a rise in income inequality decreases the participation in public schooling (primary & secondary) and increases the per student spending on education. (iii.) An increase in the share of elderly decreases the per student education expenditures and the per pensioner pensions. We test these theoretical predictions using data on 34 OECD countries in order to assess the validity of our model. The main goal is to investigate how primary and secondary public education spending per student are affected by changes in population ageing and income inequality.

4.4.1 Data

We consider a cross-country analysis using panel data on OECD countries and yearly observations over the period 1998–2014.[11] [12] More specifically, we use aggregated data on public education spending, participation in public and private schooling, income inequality, population ageing and pensions, taken from OECD, UNESCO and World Bank datasets.[13]

As a dependent variable we set the public education spending per enrolled student in only primary public education (henceforth, ESPSPE), only secondary public education (henceforth, ESPSSE), as well as the total primary and secondary public education spending (henceforth, ESPSPSE). Education

[11] OECD countries in our sample: Australia, Austria, Belgium, Chile, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, S. Korea, Spain, Sweden, Switzerland, Turkey, the U. K. and the U. S.Ẇe exclude from our OECD sample Canada and the newest OECD member Lithuania, due to the missing data.

[12] As pointed out by De La Croix and Doepke (2009) it is a common sense to assume that governments adjust their budget for education on a yearly base.

[13] More detailed description of variables and data sources are provided in Table 4.7 in the Appendix 4.6.4.

expenditure is calculated by dividing the total general government expenditure on only primary, only secondary, and total expenditure on primary and secondary education – measured in $ PPP (constant 2011) – by the number of the enrolled students in only primary public education, only secondary public education, as well as the total enrolments in public primary and secondary education, respectively. We also use as dependent variable the total government education spending as % of GDP on primary (GEPE), secondary (GESE), and the sum of primary and secondary education (GEPSE). The main results hold for this specification. For the analysis on total education spending as % of GDP, see Table 4.5 in the Appendix 4.6.3.

As main explanatory variables we use the old dependency ratio (ODR) that measures the size of the elderly (population above 65 years old) relative to the size of the working age population (20–64 years old) in order to capture the effect of population ageing on education spending.[14] We use the Gini index (henceforth, Gini) as a measurement of the market income inequality before taxes and transfers to capture the impact of income inequality on education spending. Following De La Croix and Doepke (2009) the Gini coefficient is used in its lagged form in order to avoid possible reverse causality from education to income inequality. More specifically, we use levels of Gini index with a 24 year lag, i. e. the 1975 to 1991 time period of 17 years that correspond to our sample span (1998–2014).[15]

Furthermore, we control for the share of private enrolments – the indirect effect of income inequality on education spending in our model – in only primary, only secondary, and total primary and secondary schooling. Our model predicts that an increase in private schooling participation translates into less students attending public schools and hence higher per student public education spending. Moreover, since public education and pensions compete for the same fiscal resources (intergenerational conflict) we control for the level of pensions. More specifically, we control for pension "generosity" using the level of public pensions per retiree (henceforth, PubPen) as a proxy. Pensions per pensioner are calculated using the total public pensions in % of GDP di-

[14] As robustness check we also use a broader measure of old dependency ratio, that is population over 55 years old as a percentage of working age people from 20 to 54 years old. The quantitative results do not change, see Table 4.8 in the Appendix 4.6.4.

[15] We use a 24 year lag following the definition of the UN of "young people" for youth unemployment to ensure that the inequality is measured before the birth of anyone who is still in education.

Table 4.1: *Descriptive Statistics*

A. Dependent Variables: Public Education Spending Total and per Student, primary, secondary & both

	N	mean	sd	min	max
GEPE: Government Expenditure in Primary Education (as % of GDP)	475	1.4045	0.4343	0.5369	2.6773
GESE: Government Expenditure in Secondary Education (as % of GDP)	487	2.0414	0.4414	0.9650	3.0541
GEPSE: Government Expenditure in Primary & Secondary Education (as % of GDP)	472	3.4664	0.6456	2.2461	5.2068
ESPSPE: Education Spending per Student in Primary Education (in $1,000 PPP, constant 2011)	444	8.5155	4.1335	1.6243	27.3467
ESPSSE: Education Spending per Student in Secondary Education (in $1,000 PPP, constant 2011)	440	10.8157	5.5995	2.1625	30.1209
ESPSPSE: Education Spending per Student in Primary & Secondary Education ($1,000 PPP, constant 2011)	420	9.6731	4.6894	1.8134	25.6298

B. Main Explanatory Variables

	N	mean	sd	min	max
Gini: Gini index pre-tax and transfers (%)	595	47.1395	4.9288	30.8	60.3
ODR: Old Dependency Ratio (Over 65/20-64) (%)	595	24.2664	5.6864	9.9357	46.0558
ODR(20-54): Old Dependency Ratio (Over 55/20-54) (%)	595	30.4627	7.0934	12.0325	52.8460

C. Control Variables: Public & Private Enrolments

	N	mean	sd	min	max
ENPUBPE: Enrolments in Public Primary Education (in millions)	532	2.3827	4.4629	0.02857	22.5571
ENPUBSE: Enrolments in Public Secondary Education (in millions)	510	2.4966	4.2807	0.0268	22.5634
ENPUBPSE: Enrolments in Public Primary and Secondary Education (in millions)	503	4.9429	8.7864	0.0561	44.8700
SHPRPE: Share of Private Primary Education	515	0.0960	0.1315	0.0008	0.6151
SHPRSE: Share of Private Secondary Education	495	0.1424	0.1390	0.0032	0.6949
SHPRPSE: Share of Private Primary and Secondary Education	486	0.1198	0.1287	0.0055	0.6122

D. Other Control Variables

	N	mean	sd	min	max
PubPen: Public Pensions per retiree (in $1,000 PPP, constant 2011)	560	15.3260	7.1656	1.5390	44.1942
GDPpc: GDP per capita (in $1,000 PPP, constant 2011)	595	34.7077	14.4755	10.1492	97.8642

NOTE: *Definitions and sources of the data can be found in Table 4.7 in the Appendix 4.6.4*

vided by the number of the people that are expected to be retired (population above 65 years old). Finally, we control for the level of economic development using GDP per capita measured in $ PPP (constant 2011). Table 4.1 displays the descriptive statistics of all variables used in our empirical analysis.

4.4.2 Two-way Fixed Effects Model

The cross-country analysis over time (panel analysis) seems to be the most appropriate way to examine empirically the effects of income inequality and population ageing on public education expenditure for primary and secondary education levels. Since income inequality, population ageing, and education spending vary over time and across countries, the standard two–way fixed effects approach fits our purpose. More specifically, the fixed effects assumption is needed in order to avoid systematic biases connected to unobserved characteristics (like culture heritage or religion) that remain constant over years and might have a significant influence on public education spending (Castles, 1994). The Hausman test points to the use of fixed effects and is in line with our theoretical reasoning.[16] Additional diagnostic tests reveal a need to use time fixed effects and heteroscedastically robust standard errors.[17]

As baseline estimations we use the following two-way fixed effects specification:

$$\ln(Y_{i,t}) = b + \beta X'_{i,t} + \alpha_i + \gamma_t + \varepsilon_{i,t},$$

where $i = 1 - 34$, $t = 1998 - 2014$, and $Y_{i,t}$ is public education spending per student of country i at time t, b is the constant term, β is a coefficient vector, and α_i and γ_t represent country and time fixed effects, respectively. Finally, $\varepsilon_{i,t}$ is the idiosyncratic error term. The vector X includes all the regressors used in our estimations.

Table 4.2 shows estimations of the above specified model when we apply

[16] More specifically, we reject the the null hypothesis (H_0): *random effects provide consistent estimates* or that there is no correlation between the error term and the independent variables (Hausman, 1978).

[17] We use the time fixed effects test "testparm" available in STATA 14. We reject the null hypothesis (H_0): *no time fixed effects*. Also, we conduct the modified Wald test for groupwise heteroskedasticity in the residuals of fixed effects regression introduced by Baum (2001). Again, the null hypothesis (H_0): *presence of homoskedasticity*, is rejected.

the within regression estimator. In the first three regressions we use as dependent variable the log of education spending per student for total (primary and secondary), only primary and only secondary, respectively. Moreover, as main explanatory variable we employ the current (non-lagged) Gini index. In regressions 4 to 6 we use instead the lag of Gini. Regression 1 shows a weak negative effect of current income inequality on public education spending per student for primary and secondary education when they are considered together. Regression 2 reveals that this negative effect is mainly driven by public primary education spending, as the same effect is insignificant for the secondary education. However, as have mentioned above, the use of the current income inequality may generate problems of reverse causality – from education to income inequality – that we avoid by using a 24 lag of the Gini. When we address this problem – in regressions 4, 5 and 6 – the coefficients of income inequality become positive, although this effect is not significant for only primary education. This result is in line with our theoretical prediction that income inequality decreases the participation in public education increasing the spending per student in public schools.

Our estimations also show that while public pensions per pensioner have the expected positive effect, they are statistically insignificant for estimations with lagged inequality. Moreover, the share of private enrolments has a positive impact on primary and secondary education, but the effect is only significant for the latter. Additionally, the GDP per capita has the expected positive effect on education spending, reflecting the fact that richer countries have higher education spending. Except of the old dependency ratio, the rest of the variables in our estimations behave in the expected way.

As we can see from Table 4.2 the coefficient of the old dependency ratio is positive but is not significant (regressions 4 to 6). However, the effect of old dependency ratio might dependent on the level of pensions per pensioner which could lead to a misspecification of the model.[18] The intuition for this comes directly from the literature on intergenerational conflict where elderly try to appropriate more resources in their favour when there is a competition for fiscal resources. Hence, we estimate our model including the interaction between pensions and old dependency ratio.

Additionally, further diagnostic tests reveal the presence of cross-sectional

[18] As shown in Table 4.6 in the Appendix 4.6.4, the level of pensions and the old dependency ratio are positively correlated.

Table 4.2: *Ageing and Inequality Effect on Education Spending per Student*

	(1)	(2)	(3)	(4)	(5)	(6)
	ESPSPSE	ESPSPE	ESPSSE	ESPSPSE	ESPSPE	ESPSSE
Gini	-0.0149†	-0.0225*	-0.0131			
	(0.008)	(0.010)	(0.009)			
L.24.Gini				0.0186†	0.0216	0.0189*
				(0.011)	(0.017)	(0.007)
ODR	0.0073	0.0000	0.0147*	0.0092	0.0021	0.0145
	(0.008)	(0.010)	(0.007)	(0.010)	(0.014)	(0.009)
PubPen	0.0201*	0.0222**	0.0188*	0.0137	0.0136	0.0188
	(0.007)	(0.007)	(0.009)	(0.011)	(0.008)	(0.012)
GDPpc	0.0588***	0.0638***	0.0510***	0.0543***	0.0500***	0.0541***
	(0.007)	(0.011)	(0.008)	(0.009)	(0.013)	(0.007)
SHPRPSE	1.0795*			0.9953*		
	(0.413)			(0.395)		
SHPRPE		1.5482†			1.5024	
		(0.880)			(0.985)	
SHPRSE			1.1061**			1.0487**
			(0.340)			(0.292)
Ctry. & Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	371	396	391	294	315	304
Countries	32	33	34	31	32	33
R^2-within	0.8142	0.7829	0.7316	0.7674	0.7264	0.7378

NOTE: *Two-way fixed effects regressions with robust standard errors reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. The standard errors are clustered over the number of countries used in each regression. Dependent variables: education spending per student in primary (ESPSPE), secondary (ESPSSE), primary & secondary education (ESPSPSE) are in logs. Gini: current Gini index on pre tax and transfers income and L.24.Gini is a lag (24 years) of the Gini index, ODR: old dependency ratio. Public pensions spending per pensioner (PubPen) and GDPpc are measured in $1,000 PPP (constant 2011). Share of private education in total primary (SHPRPE), secondary (SHPRSE), primary & secondary (SHPRPSE) education, Constant is not reported but included in all the regressions above.*

dependence and autocorrelation in error terms.[19] As mentioned in Cameron and Trivedi (2010), ignoring cross-sectional dependence and correlation of errors over time can lead to systematic bias and thus to erroneous results. To cope with autocorrelation and cross-sectional dependence in the idiosycratic errors we use an estimation method that allows us to conduct consistent estimations in the presence of AR(1) autocorrelation within panels and contemporaneous correlation. For that purpose, we use the estimator (SCC) introduced by Hoechle (2007), that produces Driscoll and Kraay (1998) standard errors for the estimated coefficients using fixed effects. In our specification of this estimator, the error structure is assumed to be heteroscedastic, autocorrelated up to one lag and correlated between the countries. As mentioned in Hoechle (2007), Driscoll-Kraay standard errors are robust to very general forms of cross-sectional and temporal dependence when the time dimension is large enough. Additionally, their particular technique to estimate standard errors does not impose any restrictions on the number of countries, which can be even bigger than the number of periods. Moreover, as Cameron and Trivedi (2010) show, the implementation of Driscoll and Kraay's covariance estimator works for both balanced and unbalanced panels. All the above properties make this estimator suitable for our panel data analysis.

In Table 4.3 we make the following changes compared to Table 4.2: First, we introduce the interaction term between old dependency ratio and public pensions per pensioner in order to capture the plausible dependence of the former on the latter in its impact on education spending per student. More specifically, we estimate the first 3 regressions using time fixed effect just as in Table 4.2. Second, we use the estimation technique described above in order to avoid the biased estimates to estimate the same model in regressions 4, 5 and 6. There are not many significant differences between these two groups of regressions. The lagged income inequality has a strong positive effect on education spending for both regression groups, confirming our main theoretical prediction. More specifically, a rise of 1% in lagged income inequality has a positive effect of 2.35% on education spending per student when primary and secondary levels are considered together, 3.01% and 2.15% for primary and secondary levels respectively when they are considered sepa-

[19] More specifically, using Pesaran's cross-dependence test introduced by Pesaran (2004), we reject the null hypothesis (H_0): *residuals across entities are not correlated*. Also, using the serial correlation test or the test for autocorrelation by Wooldridge (2010), we reject the null hypothesis (H_0): *no serial correlation*.

Table 4.3: *Interaction Effect and Education Spending*

	(1)	(2)	(3)	(4)	(5)	(6)
	ESPSPSE	ESPSPE	ESPSSE	ESPSPSE	ESPSPE	ESPSSE
L.24.Gini	0.0235**	0.0301*	0.0215**	0.0235***	0.0301***	0.0215***
	(0.008)	(0.012)	(0.007)	(0.005)	(0.007)	(0.004)
PubPen	0.0648***	0.0867***	0.0549*	0.0648***	0.0867***	0.0549***
	(0.017)	(0.016)	(0.020)	(0.008)	(0.011)	(0.009)
ODR	0.0420***	0.0487***	0.0380**	0.0420***	0.0487***	0.0380**
	(0.009)	(0.012)	(0.011)	(0.007)	(0.005)	(0.012)
ODR*PubPen	-0.0024**	-0.0033***	-0.0017*	-0.0024***	-0.0033***	-0.0017**
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
GDPpc	0.0422***	0.0326***	0.0460***	0.0422***	0.0326***	0.0460***
	(0.006)	(0.007)	(0.007)	(0.006)	(0.007)	(0.004)
SHPRPSE	1.2158*			1.2158***		
	(0.448)			(0.289)		
SHPRPE		2.0764†			2.0764**	
		(1.020)			(0.579)	
SHPRSE			1.2190***			1.2190***
			(0.244)			(0.117)
Ctry. & Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	294	315	304	294	315	304
Countries	31	32	33	31	32	33
R^2-within	0.8079	0.7924	0.7562	0.8079	0.7924	0.7562

NOTE: *Two-way fixed effects regressions with robust standard errors (regression 1 to 3) and Driscoll-Kraay standard errors corrected for heteroscedasticity, autoregressive process of order 2 (regression 4 to 6) reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. The standard errors are clustered over the number of countries used in each regression. Dependent variables: education spending per student in primary (ESPSPE), secondary (ESPSSE), primary & secondary education (ESPSPSE) are in logs. L.24.Gini: is a lag (24 years) of the Gini index on pre tax and transfers income, ODR: old dependency ratio. Public pensions spending per pensioner (PubPen) and GDPpc are measured in $1,000 PPP (constant 2011). Share of private education in total primary (SHPRPE), secondary (SHPRSE), primary & secondary (SHPRPSE) education. Constant is not reported but included in the above regressions.*

rately. Furthermore, both public pensions and old dependency ratio have a positive individual effect on education spending, however their interaction indicates that the effect of ODR becomes negative beyond a certain level of public pensions per pensioner.[20] More specifically, the effect of ODR on primary and secondary education turns to be negative when the level of public pensions per retiree is beyond $14,000 (reg. 5), $22,000 (reg. 6), respectively and $17,000 when considered together (reg. 4). Finally, the share of private education in primary, secondary has a positive impact on education spending just as it is expected by the theory.

The results of Table 4.3 empirically support the theoretical predictions that we examine in this section. Next, we want to investigate the effects of the income inequality and ageing using a dynamic panel approach in order to consider possible path dependence in the determination of education spending.

4.4.3 Dynamic Panel Analysis

So far, it has been implicitly assumed in our model that the past values of the dependent variable do not play any role in the formulation of its current value. However, the current level of education spending might depend on its past levels. Hence, we include as an additional regressor only the first lag of education spending per student. This particular specification of the model implies that we assume that the education spending per student depends on its value in the previous period. Here, we can not apply the previous estimation techniques to the dynamic panel model because the lag of dependent variable is correlated with fixed effects in the error term (dynamic panel bias, see Roodman, 2009).

Moreover, we are not able to exclude the possibility of having endogeneity problems in our previous and current econometric model due to the reverse

[20] Isolating the interaction effect of the ODR and PubPen on total education spending, we obtain the expression below:

$$\text{EPSPPSE} = 0.0420 \cdot \text{ODR} + 0.0648 \cdot \text{TPS} - 0.0024 \cdot \text{ODR} \cdot \text{PubPen}$$

In order to obtain the effect of the old dependency ratio on total education spending, we take the first derivative of EPSPPSE with respect to the ODR:

$$\partial\text{EPSPPSE}/\partial\text{ODR} = 0.0419 - 0.0023 \cdot \text{PubPen}$$

causality from education spending to fertility and consequently to population ageing (ODR).[21] Also, we can not exclude the possibility of Tiebout effects in the international arena that can influence the fertility rate even at a cross-country level (for a discussion see Persson and Tabellini, 2000). In our case, an example of Tiebout sorting could be the immigration among OECD countries due to better education systems or welfare states. These threats to the internal validity of our model can bring potential biases to our estimations.

In order to address the aforementioned endogeneity concerns and incorporate the lag of the dependent variable as an additional regressor, we employ the "difference GMM" or Arellano-Bond estimation method introduced by Holtz-Eakin et al. (1988) and Arellano and Bond (1991).[22] [23] For this purpose we consider an autoregressive model of 1st order in education spending. We use the following specification:

$$\ln(Y_{i,t}) = \gamma \ln(Y_{i,t-1}) + \beta X'_{i,t} + u_i + \delta_t + \varepsilon_{i,t}, \tag{4.31}$$

where $Y_{i,t}$ is public education spending per student of country i at time t, and $Y_{i,t-1}$ is the first lag of public education spending per student. Just as before, the β is a coefficient vector, the u_i is the unobserved country-level effect and δ_t represents the time fixed effects, respectively. Finally, $\varepsilon_{i,t}$ is the idiosyncratic error term. The vector X includes all the regressors used in our estimations.

In Table 4.4 we present the estimations when applying difference GMM

[21] However, one can argue that this effect is taking place in the long-run. In other words, the age structure if affected is only affected in the long-run and it is fixed and predetermine in the short-run. Also, the impact of education on fertility is far from straightforward. In the past it was thought that more educated women tend to have fewer children (Becker et al., 1990; Galor and Weil, 1996) due to the increasing opportunity cost, however in the most recent study Esping-Andersen and Billari (2015) point to a reversion of this negative relationship.

[22] The Arellano and Bond estimator forms moment conditions using lagged-levels of the dependent variable and the predetermined variables with first-differences of the disturbances. This estimation technique transforms all regressors – by differencing them and removing the fixed effects – and uses Generalized Method of Movements (Hansen, 1982).

[23] When applying Arellano-Bond estimation to the model given by equation 4.31, we classify our regressors with respect to their level of exogeneity. We set as exogenous variables, the lag of income inequality and the private share of enrolments. As predetermined variables we set the public pensions per retiree and ODR. Finally, GDP per capita enters as endogenous variable.

Table 4.4: *Dynamic Panel Estimation*

	(1)	(2)	(3)	(4)	(5)	(6)
	ESPSPSE	ESPSPSE	ESPSPE	ESPSPE	ESPSSE	ESPSSE
L.ESPSPSE	0.8013***	0.3808**				
	(0.087)	(0.128)				
L.ESPSPE			0.7990***	0.3252*		
			(0.086)	(0.162)		
L.ESPSSE					0.6082***	0.3959**
					(0.117)	(0.124)
L.24.Gini	0.0037	0.0108	0.0106*	0.0188*	-0.0018	0.0011
	(0.006)	(0.007)	(0.005)	(0.008)	(0.007)	(0.007)
PubPen	-0.0059	0.0748**	-0.0143	0.0846*	0.0182	0.0724*
	(0.010)	(0.028)	(0.011)	(0.038)	(0.013)	(0.033)
ODR	-0.0223	0.0389*	-0.0075	0.0573*	-0.0291	0.0264
	(0.018)	(0.018)	(0.012)	(0.023)	(0.024)	(0.029)
ODR*PubPen		-0.0028**		-0.0035**		-0.0023*
		(0.001)		(0.001)		(0.001)
GDPpc	0.0119	0.0137	0.0108	0.0055	0.0188†	0.0155*
	(0.009)	(0.009)	(0.009)	(0.016)	(0.011)	(0.007)
SHPRPSE	0.4600	0.7748				
	(0.525)	(0.685)				
SHPRPE			0.2931	0.7017		
			(0.494)	(0.881)		
SHPRSE					0.4364	0.8213
					(0.494)	(0.507)
Instruments	73	74	76	77	74	75
Sargan-Test	0.7181	0.6980	0.7626	0.8850	0.1591	0.1351
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	216	216	242	242	225	225
Countries	29	29	31	31	30	30
χ^2 test	1841.77***	2766.40***	19129.95***	2158.69***	1960.11***	9695.37***

NOTE: *One-step GMM estimation, Arellano-Bond robust VCE estimator. Robust standard errors reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. Time fixed effects included in all regressions. The null hypothesis (H_0) of the Arellano-Bond test for zero autocorrelation: no autocorrelation, is rejected only at order 1 but not at higher orders. The null hypothesis (H_0) of the Sargan test of overidentifying restrictions: overidentyfing restrictions are valid, is not rejected. In the specification of the model we use PubPen and ODR as predetermined variables and GDPpc as an endogenous variable. Dependent variables: education spending per student in primary (ESPSPE), secondary (ESPSSE), primary & secondary education (ESPSPSE) are in logs. L.24.Gini: is a lag (24 years) of the Gini index on pre tax and transfers income, ODR: old dependency ratio. Public pensions spending per pensioner (PubPen) and GDPpc are measured in $1,000 PPP (constant 2011). Share of private education in total primary (SHPRPE), secondary (SHPRSE), primary & secondary (SHPRPSE) education. Constant is not reported but included in the above regressions.*

to the above specified model. First, in regressions 1, 3 and 5 we estimate the dynamic model without the interaction term between ODR and PubPen. Second, when we include the interaction term – in regressions 2, 4 and 6 – the effect of the lag of education spending is statistically significant and positive. In this case, the coefficients are lower than without the interaction term. More specifically, a one percent increase in education spending of the previous year increases the current spending of total primary ans secondary public education by 0.80% (0.79% and 0.60% in primary and secondary, respectively). However, when we include the interaction term the effect is significantly lower, it is 0.38% for total primary and secondary, 0.32% for only primary and 0.39% for only secondary. One possible explanation for this could be that the interaction effect is absorbed by the lag of education when the interaction of ODR with PubPen is not considered.

Regarding our main explanatory variables, the coefficients have the expected sign, although not all of them are statistically significant. ODR has a negative but non-significant effect on all levels of education spending when we do not take into account its interaction effect with public pensions per pensioner (see regressions 1, 3, and 5). However, when the interaction term is considered the old dependency ratio has a negative impact on primary and secondary education spending per student only when public pensions spending per pensioner is beyond $14,000 (reg. 2).[24] The same effect is negative when public pensions spending per pensioner is beyond $17,000 when we consider only primary education, a level considerably higher compared to $14,000 in regression 4, Table 4.3. The effect of income inequality on education spending is statistically significant and positive (about 1.10-1.18%) for primary education spending per student (regression 3 and 4). However, the effect is not statistically significant when we consider primary and secondary education jointly (reg. 1 and 2). Finally, the effect on secondary education is positive but insignificant.

In our empirical analysis we use two different specifications to estimate the effect of income inequality and population ageing on education spending per student. We can conclude from our baseline specification that there is a positive effect of higher pre-tax and transfers income inequality on education spending per student. When we extend the specification to its dynamic form,

[24]The effect of the interaction is determined through the partial derivative just as in the previous section.

we find mixed results regarding the effect of income inequality on education spending per student. More specifically, the effect of income inequality on education spending is mainly driven by the primary education level. Furthermore, the results of both specifications indicate that population ageing has a negative effect on education spending when there is a competition for fiscal resources, namely, pensions spending per pensioner is above a certain level.

4.5 Conclusions

In the recent decades two major trends in income inequality and population ageing have generated significant concerns about the sustainability of the welfare state. The higher income inequality and the increasing elderly population have fuelled the intragenerational and intergenerational conflict, respectively, and in turn have affected the public financing of public education and pensions. The former is a conflict within generation and it is between "rich" and "poor" groups of population over taxation for public provision of pensions and education. The latter conflict is between generations, as young and old have different preferences how to allocate public resources. The aim of this chapter is to investigate the effect of these trends on public education and pensions spending per student and retiree, respectively.

To this end we developed a two-dimensional political economy model with public and private education and public pay-as-you-go pension scheme. Our model takes into account both political conflicts and uses the probabilistic voting model to examine the political outcome of the voting process on pensions and education given the preferences of each voting group. Our contribution is to examine those two trends simultaneously in order to understand the mechanisms through which they affect the public finance of education and pensions.

The model predicts that income inequality has a positive impact on education spending per student and the level of pensions per pensioner. This effect goes through the participation in public schooling. An increase in income inequality will increase the share of parents that choose to send their children to private schools, reducing the participation in public schools. Hence, increasing the spending per enrolled student and releasing fiscal resources that can be allocated towards a more generous level of pensions. When the state/government is the main provider of schooling an increase in income in-

equality would improve both the level of education and pensions and reduce the general tax level. The second theoretical prediction of our model states that a rise in the share of elderly population has a negative effect on education spending per student and worsens the level of pensions that every retiree is entitled to. This outcome is a result of a fiscal leakage that comes along with the rise in the population of elderly and puts more pressure on the welfare state.

Our empirical strategy concentrates on the effect of income inequality on education spending in a majority public education regime. We find some support of the theoretical claims using OECD data on pensions and education, inequality and ageing. More specifically, we show evidence of the negative effect of old dependency ratio on education when we take into account that the impact could depend on the level of pensions. However, we obtain mixed results regarding the effect of income inequality on education spending. More specifically, the impact on the primary education spending seems to be statistically significant and positive and the effect on the secondary education spending is positive but not significant when we consider the dynamic specification of the model.

An interesting direction for future research could follow an alternative approach by relaxing the assumption of a balanced government budget that we make in this model. The possibility to finance pensions and education by increasing the government's primary deficit could alter the incentives of the voting groups that we consider in this study. Moreover, it would be interesting to develop a model that considers a political process with a dynamic interaction between private savings and a PAYG pension system. Another possible trajectory concerns the weight of political power of different voting groups in policy-making.

4.6 Appendix

4.6.1 The Voting Mechanism

We extend the probabilistic voting model used in De La Croix and Doepke (2009) by introducing the dimension of pensions in the voting process. Hence, voters decide about the tax rate v_t the per student spending on public education s_t, and the per pensioner pension p_t according to a probabilistic voting mechanism based on Lindbeck and Weibull (1987) and Persson and Tabellini (2000). This voting works in the following way: There are two political platforms a and b competing for the votes of the agents. They are competing by offering a policy consisting of a tax rate v_t, a per pensioner pension p_t and a per student education spending s_t that are fulfilling the government budget constraint

$$\int_0^{\tilde{x}_t} s_t n^s g(x)dx + \frac{1}{1+\rho_{t-1}} p_t = v_t \left\{ \int_0^{\tilde{x}_t} x(1-\phi n^s) g(x)dx + \int_{\tilde{x}_t}^{\infty} \left[x(1-\phi n^e) - e_t^e(x) n^e \right] g(x)dx \right\}.$$

Voters are more likely to vote for the platform that yield them a higher utility. In contrast to the median voter theory, voters do not vote with probability one for the platform that maximises their utility but the probability of voting for platform a instead of platform b is an increasing and differentiable cumulative distribution function on the utility difference between policy a and policy b:

$$F\left\{ U_t\left[x, s_t^a, p_t^a, v_t(s_t^a, p_t^a)\right] - U_t\left[x, s_t^b, p_t^b, v_t(s_t^b, p_t^b)\right] \right\}.$$

This means that the voting decision is not discrete but rather a continuous function of the policy offered by both parties. The uncertainty of the voting is the result of the presence of ideological bias which is independent of the proposed policies. From this follows that the political platforms do not only appeal to the median voter, but consider the preferences of all voters instead. This allows us to aggregate the preferences of different demographical groups (rich, poor, young and old) in the policy function, which leads to the

following objective function:

$$\Omega(s_t, p_t) = \int_0^{\tilde{x}_t} U_t^s(x, s_t, p_t, v_t(s_t, p_t))g(x)dx + \int_{\tilde{x}_t}^{\infty} U_t^e(x, s_t, p_t, v_t(s_t, p_t))g(x)dx + \frac{1}{1+\rho_{t-1}} U_t^o(p_t).$$

Both parties maximise their expected vote share in a symmetrical way, leading to an equilibrium where both political platforms converge to the same policy $\{v_t^*, s_t^*, p_t^*\}$. The equilibrium policy is the policy that maximises the objective function above.

4.6.2 Education Regimes

In a majority private education regime with $\Psi_t < 1/2$, participation in public education Ψ_t and the tax rate v_t^* are increasing with income inequality σ and the quality of public education s_t^* and the pensions per pensioner p_t^* are decreasing with σ. In an equally separated education regime, participation in public education, tax rate, quality of public education, and pensions are not affected by changes in inequality. This follows from the proof of Proposition 4.3, where the first derivative of Ψ_t with respect to σ

$$\frac{\partial \Psi_t}{\partial \sigma} = \frac{\sigma - \left[\frac{1-\eta}{\hat{\eta}\phi\eta}\mathbb{E}_t(s_t) - (1-\sigma)\right]}{2\sigma^2} = \frac{1}{\sigma}\left(\frac{1}{2} - \Psi_t\right)$$

is positive for $\Psi_t < 1/2$, and equal to 0 for $\Psi_t = 1/2$. Following Lemma 4.2 this means that p_t^* and s_t^* are decreasing in σ and v_t^* is increasing in σ for $\Psi_t < 1/2$ and they are not affected by a change in σ is $\Psi_t = 1/2$.

The mechanism of the effect of an increase in income inequality is the following: an increase in income inequality is decreasing the income of the marginal agent that is indifferent between private and public education if this agent has a below average income. This means that this agent now prefers public education. This increase in public education increases the share of voters with children in public education, but it also increases the number of children in public education. Therefore the total spending on public education increases, but the spending per child decreases. Overall this leads to a decrease in public education quality. The increase in total education spending leads to a decrease in pensions and to an increase in taxes.

4.6.3 Analysis on the Total Education Spending

In Table 4.5 we consider the effect of income inequality and population ageing on total education spending as percentage of GDP. In this specification of the empirical model we use as control variables the level of public pensions, GDP per capita, the share of students in private education and number of students in public primary, secondary and total education. As we can observe, income inequality has a positive effect on primary and secondary education in both specifications of the model. Regarding the non-dynamic panel model in regressions 1,2 and 3, we observe that a percentage rise in past income inequality increases primary total education spending by 0.0325%, secondary by 0.0295%, and the aggregate spending on primary and secondary education by 0.0675%. Old dependency ratio and public pensions per pensioner have positive effect on most levels of education spending considered in the Table 4.5.

In regressions 4, 5 and 6 with dynamic panel specification, one percentage increase in income inequality in the past has an impact of about 0.0588% on total education spending (primary and secondary considered jointly), 0.0276% on primary and 0.0284% on secondary total spending. Moreover, our proxy for population ageing (ODR) has a negative but insignificant impact on education spending.

Table 4.5: *Total Spending in Primary and Secondary Education as % of GDP*

	(1)	(2)	(3)	(4)	(5)	(6)
	GEPSE	GEPE	GESE	GEPSE	GEPE	GESE
L.GEPSE				0.6107**		
				(0.191)		
L.GEPE					0.6813***	
					(0.125)	
L.GESE						0.3186*
						(0.139)
L.24.Gini	0.0675**	0.0325***	0.0295*	0.0588***	0.0276*	0.0284*
	(0.021)	(0.005)	(0.012)	(0.016)	(0.011)	(0.014)
ODR	0.0392*	-0.0151	0.0312**	-0.0018	-0.0464	0.0246
	(0.015)	(0.009)	(0.008)	(0.067)	(0.032)	(0.039)
PubPen	0.0681***	0.0294**	0.0351**	-0.0191	-0.0503*	0.0375
	(0.016)	(0.008)	(0.010)	(0.042)	(0.020)	(0.024)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Instruments				77	78	77
Sargan-Test				0.0978	0.0972	0.0564
Ctry. FE	Yes	Yes	Yes			
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	294	315	304	230	252	238
Countries	31	32	33	29	31	30
R^2	0.3493	0.3732	0.3213			
χ^2				403.79***	659.11***	453.21***

Note: ***Regressions 1,2 and 3:*** *Fixed effects with robust Driscoll-Kraay standard errors corrected for heteroscedasticity, autoregressive process of order 2.* ***Regressions 4, 5 and 6:*** *One-step GMM estimation, Arellano-Bond robust VCE estimator. Robust standard errors for both groups of regressions are reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. Time fixed effects included in all regressions. The null hypothesis (H_0) of the Arellano-Bond test for zero autocorrelation: no autocorrelation, is rejected only at order 1 but not at higher orders. The null hypothesis (H_0) of the Sargan test of overidentifying restrictions: overidentyfing restrictions are valid, is not rejected. In the specification of the model we use PubPen and ODR as predetermined variables and GDPpc as an endogenous variable. Dependent variable: total education spending in primary (GEPE), secondary (GESE), primary & secondary education (GEPSE). L.24.Gini: is a lag (24 years) of the Gini index on pre tax and transfers income, ODR: old dependency ratio. Public pensions spending per pensioner (PubPen) and GDPpc are measured in $1,000 PPP (constant 2011). As control variables (not reported) we use the GDPpc, the share of private education in total primary (SHPRPE), secondary (SHPRSE), primary & secondary(SHPRPSE) education, and the number of student in public primary (ENPUBPE), secondary (ENPUBSE) and total primary and secondary (ENPUBPSE) education. Constant is not reported but included in the above regressions.*

4.6.4 Appendix Tables

Table 4.6: *Partial Correlations Education, Pension and Old Dependency Ratio*

Variables	ESPSPSE	PubPen
PubPen	0.7334*** (0.0000)	
Obs.	389	
ODR	0.4525*** (0.0000)	0.4606*** (0.0000)
Obs.	420	803

NOTE: *Partial correlation coefficients of Education Spending per Student in Primary and Secondary Education (ESPSPSE) with Public Penions per Retiree (PubPen) and the Old Dependency Ratio (ODR). Standard errors are reported in parentheses, ***p<0.001, **p<0.01, *p<0.05.*

Table 4.7: *Data: Definitions and Sources*

Variable	Definition & Source
ESPSPE, ESPSSE, ESPSPSE	Education spending per enrolled student in primary, secondary, total primary and secondary educational level. It is calculated using the total public education spending and enrolments, Expenditure on Education, UNESCO, UIS.Stat.
ENPUBPE, ENPUBSE, ENPUBPSE	Enrolments (number of students) in primary, secondary, total primary and secondary educational level (as a % of total (private and public) primary & secondary), Enrollment by type of institution, UNESCO, UIS.Stat.
SHPRPE, SHPRSE, SHPRPSE	Share of enrolments in private primary & secondary education, World Bank Data: World Development Indicators.
GINI	Gini index of market income inequality before taxes and transfers, The Standardized World Income Inequality Database.
ODR (ODR(20-54))	Old dependency ratio, population over 65(55) years old as % of working age population 20-64(54) years old, World Population Prospects, United Nations.
PubPen	Public pensions spending per retiree, calculated using Total Public Pensions as % of GDP and population over 65 years old , Social Expenditure, OECD.
GDPpc	GDP per capita based on purchasing power parity (PPP), World Bank Data: World Development Indicators.

Table 4.8: *Alternative Old Dependency Ratio 20-54*

	(1)	(2)	(3)	(4)	(5)	(6)
	ESPSPSE	ESPSPE	ESPSSE	ESPSPSE	ESPSPE	ESPSSE
L.ESPSPSE				0.4382***		
				(0.126)		
L.ESPSPE					0.4101**	
					(0.158)	
L.ESPSSE						0.4169***
						(0.097)
L.24.GINI	0.0214***	0.0270***	0.0194***	0.0089	0.0163**	0.0009
	(0.005)	(0.006)	(0.004)	(0.006)	(0.006)	(0.006)
ODR(20-54)	0.0255***	0.0283***	0.0235*	0.0211*	0.0303*	0.0117
	(0.005)	(0.005)	(0.009)	(0.010)	(0.012)	(0.014)
PubPen	0.0585***	0.0741***	0.0539***	0.0538**	0.0550*	0.0541*
	(0.008)	(0.010)	(0.009)	(0.021)	(0.024)	(0.025)
ODR(20-54)*PubPen	-0.0016***	-0.0020***	-0.0013**	-0.0014**	-0.0017**	-0.0012†
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Instruments				74	77	75
Sargan-Test				0.5828	0.8022	0.0812
Ctry. FE	Yes	Yes	Yes			
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	294	315	304	216	242	225
Countries	31	32	33	29	31	30
R^2	0.8173	0.8011	0.7620			
χ^2				1678.31***	3297.80***	4231.70***

Note: ***Regressions 1,2 and 3:*** *Fixed effects with robust Driscoll-Kraay standard errors corrected for heteroscedasticity, autoregressive process of order 2.* ***Regressions 4, 5 and 6:*** *One-step GMM estimation, Arellano-Bond robust VCE estimator. Robust standard errors for both groups of regressions are reported in parentheses, ***p<0.001, **p<0.01, *p<0.05, †p<0.10. Time fixed effects included in all regressions. The null hypothesis (H_0) of the Arellano-Bond test for zero autocorrelation: no autocorrelation, is rejected only at order 1 but not at higher orders. The null hypothesis (H_0) of the Sargan test of overidentifying restrictions: overidentyfing restrictions are valid, is not rejected. In the specification of the model we use PubPen and ODR as predetermined variables and GDPpc as an endogenous variable. Dependent variable: education spending per student in primary (ESPSPE), secondary (ESPSSE), primary & secondary education (ESPSPSE) is in logs. L.24.Gini: is a lag (24 years) of the Gini index on pre tax and transfers income, ODR(20-54): old dependency ratio, people over 55 years old as a percentage of people 20 to 54 years old. Public pensions spending per pensioner (PubPen) and GDPpc are measured in $1,000 PPP (constant 2011). As controls variables (not reported) we use the GDPpc, the share of private education in total primary (SHPRPE), secondary (SHPRSE), primary & secondary (SHPRPSE) education. Constant is not reported but included in the above regressions.*

5 Conclusions

In the past few decades, theoretical and applied economists have focused their attention on the interplay between public finance and demographic transition. Low fertility and high life expectancy combined with the retirement of the generation of "baby boomers" generate adverse demographic projections for the foreseeable future. The implications of these trends in the age structure of the population for public policies, including pensions and education, have been a main concern for economists, as has their impact on the allocation of public funds among the different generations. Children and the elderly, located at opposite ends of the spectrum of dependency, are the main beneficiaries of social spending on education and pensions, respectively. Population ageing aggravates the dispute over the allocation of public resources between these policies leading to an intergenerational conflict. This Ph.D. thesis contributes to the understanding of the effects of population ageing on public finance of pensions and education in the context of political economy.

The second chapter of the thesis examines this intergenerational conflict, looking at the effect of population ageing on public education spending. On the one hand, ageing is expected to have a negative effect on education, as an increasing number of retirees results in intergenerational conflict and, hence, the condemnation of education spending (direct effect). On the other hand, population ageing, in combination with PAYG pension system, offers incentives for the working-age generation to invest in the public education of the young in order to "reap" the benefits (that is, higher income tax/contributions) of their greater future productivity (indirect effect).

Empirical evidence derived from the application of a fixed effects approach to panel data for OECD countries shows that both aforementioned mechanisms are in place. More specifically, we find that the intergenerational conflict (direct effect) is present, but it is dependent on the total level of pension spending. Thus, when total retirement spending is quite high, an increase in the share of retirees has a negative impact on education spending, reflect-

ing the struggle between generations for limited amounts of public resources. Hence, an increase in current levels of population ageing, which translates into an increase in the political power of the elderly seems to have a negative impact on both total and per student education spending.

The main focus in this chapter is on the future (projected) demographic change that seems set to strengthen the mechanism that links public pension and education policies (indirect effect). The specific design of the PAYG pension system creates incentive to invest in education. The intuition underpinning the link is that the working-age generation, foreseeing the rise in life expectancy and the increasing number of retirees, invests more in public education "today" in order to derive some benefits in the form of higher income and contributions for pensions "tomorrow". Hence, population ageing results in a higher allocation of public funds towards education. Empirical evidence suggests that the projected (future) old dependency ratio has a positive impact on education expenditure and operates via the link between pensions and education. Therefore, middle-aged voters are in favour of public education spending as a way to improve their pensions, thanks to the increase in the productivity of future workers.

Furthermore, looking at the education expenditure per level of public education, we investigate whether the effect of future population ageing on education spending varies with level of education. The results point solely to a positive effect on non-mandatory (pre-primary and tertiary) education spending. Our interpretation of this outcome is that investment in non-compulsory education occurs because there is room for political intervention to increase participation in education and, consequently, the productivity of both current and future working-age generations. Regarding the pre-primary education, better quality pre-primary schooling would liberate parents from a time-intensive task of raising children, and hence can generate a substantial boost in parental productivity that is directly linked to the current pensions. Second, an increase in the quality of early-education for children could have a significant effect on their future productivity and therefore on future taxable income. In the same vein, higher quality tertiary education would lead to higher future productivity, and thereby higher taxable income that is linked with the pensions of current middle-aged workers.

We also find mixed results regarding the effect of greater population ageing on pensions. We derive evidence that the effect on pensions actually depends

on their level. Initially, population ageing has a negative effect on pension spending per retiree because further population ageing puts additional pressure on the pension system. After a certain level of ageing, retirees obtain greater political power and hence direct more resources for their own benefit. Therefore, there is an initial positive effect on pension spending per retiree. However, when the population ageing is quite advanced, the increasing number of retirees causes a fiscal leakage, and hence a negative effect on retirees' benefits despite their growing political power.

The take away message of this chapter is that population ageing affects the working-age and the elderly generations in a different way. The current population ageing increases the number of retirees opposed to spending on education. However, the current and the future population ageing stimulate –via the positive link between education and pensions– the working-age generation to support an expansionary education policy. This could have a number of policy implications in the context of the imminent demographic crisis faced by PAYG-financed pension systems. Investment in public education can be seen as a complement or as an alternative pre-funding device to the long-discussed transition to a fully funded system.

The results above raise an important question as to how can such a system of public pensions and education be politically sustained. The empirical exercise conducted in the third chapter aims to evaluate the political sustainability of an intergenerational system organized through the linkages between backward (e.g. pensions) and forward (e.g. education) public transfers. More specifically, we examine the political sustainability of the system of public intergenerational transfers by asking what the outcome would be if the decision *per se* to reallocate economic resources between generations was put to the vote. We assess the political viability of such a system by exploiting the National Transfer Accounts data and the political economy application proposed in the theoretical literature. This data provides us with detailed, systematic and coherent accounting of economic flows (e.g. public transfers) from one age group to another. This allows us to measure the continuation value of a system of public transfers for each voting cohort. By applying the majority rule we derive the voting outcome and evaluate the political viability of a system of public intergenerational transfers for the 18 countries considered in this exercise.

Our results indicate that if the specific vote on pensions and education took

place, half of the countries in the sample, mostly developed ones, would support the joint system of pensions and education. The observed differences in terms of political viability can be explained mainly by the strength of the ageing process and the size of the welfare state. Countries with relatively younger population, where public transfers continue to be dominated by private transfers, intuitively have lower political incentives to support the joint system.

However, when we consider a broader spectrum of backward and forward intergenerational transfers (i.e. health care, other in-kind and other in-cash transfers) for the elderly and young, respectively, we observe that such a system would attract substantial political support and would be politically viable for almost all countries in the sample. This can be attributed to the fact that in this case the young and the middle-aged take into account not only the present values of retirement benefits but also the present values of the benefits that they receive from the aforementioned public transfers. Hence, they are more inclined to support such a system of intergenerational transfers.

Although ageing pressure on the financial health of the PAYG pensions system and on the education spending points to a conflict between financial and political sustainability, our results indicate some positive effects. Our findings indicate that population ageing has a positive effect on the political viability of the system of public intergenerational transfers considered in this exercise. Ageing makes the median voter older and this is translated into a higher continuation value that can be invested in public education. Thus, it enhances both the political and financial sustainability of the joint system of pensions and education. Therefore, pensions can foster education. This, in turn, improves the future financial prospects of the PAYG system. As we argue in the second chapter, higher investment in education can boost the productivity of future workers and consequently the level of their contributions to social security and revenues from taxing their income. The immediate policy conclusion is that pensions could be pre-funded by increasing education expenditure. Moreover, we can suggest that it might be useful to require legislation to vote on pensions and education as a unique social policy package. This reasoning could also be applied to a broader spectrum of intergenerational transfers directed toward children and the elderly, which also tend to be financed implicitly via welfare state on a PAYG basis.

Further research is needed in order to investigate the extent to which the

heterogeneity in the levels of private and public transfers across countries can be attributed to the cultural and/or institutional differences among countries. The future availability of longitudinal NTA estimates will broaden the possibilities of empirical analysis by completing the picture for the interplay between public and private intergenerational flows along the development process.

Apart from the demographic transition, income inequality is another important aspect that we should consider in the political economy analysis of welfare states. During the last decades there was a strong increase in income inequality. This trend has intensified the intragenerational conflict between rich and poor segments of population over the redistribution and the size of the welfare state.

In the fourth chapter of the thesis, we consider both intergenerational and intragenerational conflicts simultaneously and analyse the effect of inequality and ageing on the level of public education and pensions spending. For this, we develop an overlapping generations model with public and private education, a PAYG pension system, endogenous fertility, and probabilistic voting over the size and the allocation of public resources between pensions and education spending.

This model predicts that an increase in income inequality increases public education and pensions spending per enrolled student and retiree, respectively. An increase in the share of current retirees in the economy decreases the per student spending on public education and pensions. The intuition for the first theoretical result goes through the participation in public schooling. An increase in income inequality makes the marginal parent relatively richer, and thereby increases the share of parents that choose to send their children to private schools, reducing the participation in public schools. Hence, it increases the spending per enrolled student and releases fiscal resources that can be allocated towards a more generous level of pensions. When the state is the main provider of schooling, an increase in income inequality would improve both the level of education and pensions and reduce the general tax level. The second theoretical prediction of our model states that a rise in the share of the elderly population has a negative effect on education spending per student and decreases the level of pensions that every retiree is entitled to. This outcome is a result of a fiscal leakage that comes along with the rise in the population of elderly and puts more pressure on the welfare state.

The results from a panel data analysis on OECD countries are mostly in line with our theoretical predictions regarding public education spending. We show evidence of the negative effect of the old dependency ratio on public education spending for primary and secondary schooling when we take into account that the impact could depend on the level of pensions. However, we obtain mixed results regarding the effect of income inequality on primary and secondary education spending.

A future extension of this chapter would be to relax the assumption of a balanced government budget, introducing the possibility of government deficit and study the role of the size of the deficit in the decisions taken by the electorate regarding the public spending on education and pensions.

To sum up, this thesis reviews the existing literature on the effect of population ageing on pensions and on education, and explores empirically the intergenerational link between these programmes. This link between the adults and the young generation plays a crucial role in the analysis of both the effect of population ageing and the effect of income inequality on public finance of pensions and education. The main policy conclusion is that the debate on pension reform should be widen to consider the comprehensive action of public policy along the life cycle, i.e. the joint role of forward (from parents to children) and backward (from adults to elderly parents) intergenerational transfers. This will offer a more complete view of the incentives given to agents in decisions like savings, fertility and education.

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