

**Projektbericht**  
**Research Report**

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# Population aging, pensions and cross-country spillovers in currency unions\*

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## Abstract

Population aging challenges the financing of social security systems in developed economies, as the fraction of the population in working age declines. The resulting pressure on capital-labor ratios translates into a pressure on factor prices and production. While European countries all face this challenge, the speed at which their population ages differs, and thus the pressure on capital-labor ratios. If capital markets are integrated, differences in population aging may lead to cross-country spillovers, as investors freely seek the best returns on capital. Using a multi-country overlapping-generations model covering 14 European Union countries, I quantify spillovers and find that capital market integration leads to redistribution across countries over the long run. For instance, GDP per capita would on average be 2.9 %-points lower in Germany in each of the next 50 years if capital markets were perfectly integrated and increases in labor income taxes maintained public debt constant, compared to a closed economy case; by contrast, GDP per capita would on average be 2.1 %-points higher in France, whose population ages slower than in Germany. I also show that pension reforms can change the cross-country redistribution patterns, some countries losing from capital market integration without the reform but winning with it. The research has policy and methodological implications.

**Keywords:** population aging, pensions, cross-country spillovers, policy coordination, overlapping-generations modelling

**JEL-Classification:** C68, E60, F41, J11

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# 1 Introduction

Differences in population aging speed lead to differences in capital-labor ratios and returns to capital, *ceteris paribus*. Integration of capital markets can thus lead to slow changes in the distribution of capital across countries over time. Using a multi-country overlapping-generations model calibrated for 14 European countries, the main goal of this paper is to quantify cross-country spillovers due to population aging and capital market integration. The influence of social security reforms is also investigated.

The old-age dependency ratio is projected to increase from 35% to 60% over the next five decades in Germany, but only from 30% to 47% in France. Everything else equal, population aging should thus increase the capital-labor ratio and depress returns to capital more in Germany than in France. With integrated capital markets, capital should gradually flow from Germany to France, a basic theoretical prediction (Adema et al., 2009). There is empirical support for some of these theoretical predictions, countries with lower dependency ratios having a smaller net foreign asset position (Higgins, 1998; Lane and Milesi-Ferretti, 2002). Assuming integrated capital markets, quantitative simulation studies in general equilibrium find international spillovers across world regions which differ in demographic and institutional characteristics (e.g. Boersch-Supan et al., 2006). Whether differences in population aging are sufficient to generate spillovers between countries with similar institutional setups is however unknown.

The paper also uses general equilibrium quantitative simulations to answer this question. Compared to the existing literature, there are two main differences. First, I consider differences between countries, not only between regions of the world. Existing general equilibrium analyses with endogenous labor supply consider several world regions, all having different economic institutions (including Fehr et al., 2005; Boersch-Supan et al., 2006; Attanasio et al., 2007; Krueger and Ludwig, 2007; and Vogel et al., 2017)<sup>1</sup>. Using a multi-country model calibrated for Europe allows to detect spillovers even if institutional setups are similar. The analysis also provides a practical contribution to the policy debate, policy coordination discussions usually taking place between countries and seldom between regions. Second, I pay particular attention to the role of capital in production, given the focus on capital market integration. Consistent with empirical evidence (Duffy et al., 2004), I assume capital-skill complementarity, the fact that capital is more complementary to high-skilled than low-skilled labor<sup>2</sup>. In related research ignoring population aging (Davoine and Molnar, 2017), we found that capital-skill complementarity indeed increases the magnitude of output spillovers, as variations in capital in the integrated capital market impact the domestic contribution of the most productive type of labor<sup>3</sup>.

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<sup>1</sup>Some of these models also have one country among several regions. There exist also some general equilibrium quantitative evaluations with multi-country models and endogenous labor supply, as opposed to multi-regions models, but they do not assess the impact of capital market integration (Catalano and Pezzolla, 2016). Other models with exogenous labor supply exist, but only consider variations of the the numerator of the capital-labor supply ratio.

<sup>2</sup>Capital-skill complementarity also helps to account for wage inequality variations over time (Krusell et al., 2000). The approach here has similarities with Jin (2012): allowing usage of capital in production to differ across countries, she provides a theory which can help to rationalize the direction of international capital flows.

<sup>3</sup>A third difference with the existing literature is the focus on redistribution between countries (or

Concretely, the first goal of the paper is to quantify cross-country spillovers due to population aging and capital market integration within the European Union, taking into account major demographic and economic variations in the rest of the world. The second goal is to assess the influence of social security reforms on the spillovers, while the third goal is to assess the influence of differences in reforms across countries. Policy implications are then derived from these assessments.

To achieve these goals, I use a multi-country overlapping-generations model developed in related research (Davoine and Molnar, 2017). The basis is an Auerbach and Kotlikoff (1987) model with endogenous labor supply decisions, three exogenous skill classes, capital-skill complementarity and detailed social security features. As in Buiter (1981) and Boersch-Supan et al. (2006), labor is assumed to be immobile but capital mobile in perfectly integrated capital markets, which leads to international spillovers. The model is calibrated for a representative sample of 14 European Union countries and two stylized Rest-of-the-world regions, one representing developed countries and the other developing countries.

Simulations show that differences in population aging and capital market integration lead to visible cross-country spillovers, even when institutional settings are comparable. For instance, GDP per capita is projected to be an average of 2.9 %-points lower in each of the next fifty years in Germany when capital markets are integrated and labor taxes increased to keep public debt constant, compared to a closed economy case with separated capital markets. On the other hand, GDP per capita would on average be 2.1 %-points higher in France under integrated capital markets. The reason are aging differences: as the population is projected to age faster in Germany, labor supply will be reduced faster, the capital-labor ratio increased more and thus the returns to capital depressed further; investors will gradually shift their asset holdings away from Germany and towards France, which sustains production there.

I also find that cross-country redistribution patterns depend on social security reforms. For instance, GDP per capita is projected to be 1.9 %-points lower in Denmark with capital market integration when public debts are kept constant by increases in labor income taxes, but 0.8 %-points higher when public debts are kept constant by an increase of the retirement age and a (smaller) increase in labor income taxes (in all countries). In other words, Denmark would be a long-term loser of capital market integration if the unique reform was on the labor tax code, but a winner if retirement age was also increased. The main reason is the current size of the Danish welfare state, which requires a high level of taxation. In the first case, the disincentive effect of higher taxes is strong and dominates other effects. In the second case, the tax increase is milder and the disincentive effect too, so that the slow population aging effect dominates.

As a related result relying on the same mechanisms, I find that capital market integration changes the ranking of pension reform options in some countries. For instance,

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regions) in overall macroeconomic terms. Fehr et al. (2005), Attanasio et al. (2007) and Krueger and Ludwig (2007) also provide information on redistribution, but this information is either not part of the discussion (first two studies) or the discussion is restricted to the impacts on capital markets (last study). By contrast, I consider the overall macroeconomic impact, summarized by the usual GDP per capita indicator.

simulations show that labor tax increases are preferable to a 20% cut in pension benefits in Belgium with no integration, but the opposite with full capital market integration: instead of cutting pensions, implementing tax increases leads to an average 0.7 %-points gain in GDP per capita in each of the next 50 years without integration, but a yearly 0.4% loss with integration.

The paper also provides a methodological result, concluding that the closed economy assumption is preferable to the small open economy assumption in single-country models for assessing the long run impact of population aging. Additional results shed some light on the benefits of cross-country coordination. For instance, simulations show self-inflicted penalties for countries who would attempt free riding, letting other countries increase retirement age and hoping to benefit from spillovers.

The paper continues as follows. The next section presents the model. Section 3 describes the experiments and provides their results. Section 4 derives coordination and policy implications while section 5 concludes.

## 2 Model

To quantify the cross-country spillovers of population aging and associated social security reforms, I use a multi-country overlapping-generations model, presented in Davoine and Molnar (2017). The only difference is the calibration of aging-related processes, including demographics and anticipated social security reforms. Below I summarize the model and then present the aging-related calibration in details. Details on the model can be found in Davoine and Molnar (2017).

### 2.1 Model overview

The basis is a large-scale single-country overlapping-generations model which is used regularly for policy evaluation<sup>4</sup>. The model is then extended to a multi-country version following the procedure developed by Buiter (1981) and later applied in a number of general equilibrium analysis, such as Boersch-Supan et al. (2006).

The single-country model is an overlapping-generations model in the Auerbach and Kotlikoff (1987) tradition. As unemployment varies across countries, the single-country model starts from Jaag et al. (2010), an overlapping-generations model with imperfect labor markets. Because the skill distribution also differs across countries, this basis is extended to include three skill classes with exogenous education decisions<sup>5</sup>.

Concretely, households in the model take consumption and labor related decisions to maximize lifetime utility. Once their education is completed, households decide to participate in the labor market or not; if they participate, they choose search efforts to find a job; if they have a job, they decide how many hours to work. Retirement is exogenously defined. Representative firms maximize discounted future profits through investment and hiring decisions. In a static search-and-matching framework, workers

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<sup>4</sup>See for instance Berger et al. (2016), which quantifies the long run public finance contribution of immigration in four European countries.

<sup>5</sup>There is also a version of the model with endogenous education decisions, which follows Heckman et al. (1998).



and firms bargain over the wage. Governments collect social security contributions as well as labor income taxes, capital income taxes, firm income taxes and consumption taxes. Government revenue is used to finance its own expenditures, welfare benefits, unemployment insurance, age-dependent health- and long-term care, as well as public pay-as-you-go pensions with a flat part and an earnings-related part. All policy parameters are exogenously defined, with one exception: one parameter is chosen and varies endogenously to meet a public debt target. Consistent with empirical evidence, production exhibits capital-skill complementarity. Production output is a single composite good.

For the multi-country extension of the model, the main assumption is that labor is immobile but capital is perfectly mobile. This assumption can be relaxed by allowing mobility of labor with exogenously defined international flows, as will be done in the quantitative analysis. One also assumes that all countries produce the same composite good and that they either belong to the same currency union, or that exchange rates are constant.

Our implementation covers 14 countries from the European Union<sup>6</sup>. Although this subset defines a large economic compound, it is still insufficient to be isolated from the world capital markets. A pair of stylized Rest-of-the-world countries (or regions) is included in the model to capture the influence from the world capital market. One such region represents developed countries (the North Rest-of-the-world) and the other developing countries (the South Rest-of-the-world), which not only differ in economics and policy terms, but also in population structure and the speed at which they age<sup>7</sup>.

Under these assumptions, there is a unique world interest rate in equilibrium: investors ship investments abroad if the home interest rate is initially too low, which depresses the capital-labor ratio at home and increases it abroad and gradually closes any interest rate differential until it disappears. Note that in models with a single composite good, trade flows and investment flows are identical.

## 2.2 Aging-related calibration

Calibration of the model is presented in Davoine and Molnar (2017), with exception of aging-related processes, which I describe here.

I choose fertility and mortality rates for the 14 European countries in the model to match the demographic projections from Eurostat (Eurostat, 2015), which are used in the Ageing Working Group (2015). Fertility and mortality rates for the two Rest-of-the-world countries are chosen to match the projections from the United Nations (2015).

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<sup>6</sup>Austria, Belgium, Czech Republic\*, Denmark, Finland, France, Germany, Italy, The Netherlands, Poland\*, Slovakia, Spain, Sweden\* and the UK\*. In this list, stars identify the four countries whose currency is neither the Euro nor pegged to the Euro, and thus do not meet our assumption of fixed exchange rates. We keep these countries in the list to have broader diversity. In reality, exchange rate variations absorb some of the country-specific shocks, reducing the size of cross-country spillovers for these four countries, *ceteris paribus*. Our quantitative analysis illustrates for these countries what would be some consequences of joining the Eurozone.

<sup>7</sup>Concretely, we calibrate the North Rest-of-the-world country by averaging values for Canada, Japan and the US, while the South Rest-of-the-world country is calibrated with average values for Brazil, China and India. With these choices the model overall captures close to 60% of the actual real world GDP and 40% of the total trade of the EU.

A number of European countries have scheduled pension reforms, in order to deal with the future financing challenges created by an aging population. Typically, the statutory retirement age is scheduled to be increased and pension benefits reduced<sup>8</sup>. In order to quantify cross-country spillovers due to population aging alone and isolate them from policy reforms influences, pension parameters will be kept unchanged in some scenarios. By contrast, scheduled pension reforms, as consolidated by the Ageing Working Group (2015), will be used in other scenarios involving policy reforms.

Public health- and long-term care are also expected to change over time. There is a large debate over cost drivers and how they will change in the future. Unlike pension expenditures however, there are cost drivers which are neither demographic nor economic, such as technological progress. In its reference scenario, the Ageing Working Group (2015) assumes that age-dependent per capita costs will be declining. Because social security policy has little (direct) influence on technological improvements, I therefore follow these projections and apply a gradual age-dependent per capita reduction of health- and long-term care costs<sup>9</sup>.

### 3 Quantitative results

This section presents the experiments performed to quantify cross-country spillovers with aging populations and associated reforms required to ensure the financing of welfare states. Parts of the experiments are also relevant for a discussion of policy coordination. The approach is presented first and results for each experiment next. At the end of the section, a methodological note is provided. Policy coordination is discussed in section 4.

For ease of reading, results and discussion will be focused on four countries illustrating the range of possible outcomes, namely Belgium, Denmark, France and Germany. Results for the other countries in the sample, provided in appendices, are similar and so are their explanations. I report and discuss evolutions between 2015 and 2065, to allow for comparisons with the benchmark results of the Ageing Working Group (2015)<sup>10,11</sup>.

#### 3.1 Approach

I use the multi-country overlapping-generations model presented in section 2 to perform simulations. Under population aging, I consider several scenarios which ensure the financial sustainability of the welfare state over the long run and compare two cases. In the first case, capital markets are perfectly integrated. In the second case, capital markets are not integrated. Instead of assuming small open economies, I assume in the second case that trade with foreign countries remains constant in per capita terms, which

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<sup>8</sup>Social security contributions rates are seldom scheduled to change, if at all (Ageing Working Group, 2015).

<sup>9</sup>Because the project focuses on demographic and economic components and not on health technology components, which may differ across countries, I apply the same reduction to all countries, taking the projections for Germany from the Ageing Working Group (2015).

<sup>10</sup>For technical reasons, simulations are made over 200 rather than 50 years, to allow for a stationary steady state at the end of the period. Results over the first 50 years are not influenced.

<sup>11</sup>Two simulation rounds have been performed. Tiny differences are possible between numbers for identical scenarios presented in different sections. The analysis and magnitudes are unaffected.

corresponds to isolated closed economies<sup>12,13</sup>. The reason for avoiding the small open economy assumption will become clear in section 3.4. The comparison of outcomes in the two cases will allow to identify benefits (or losses) from capital market integration under an aging population.

I consider three types of simulations. In the first, I simulate outcomes when all countries perform the same reform (possibly with different magnitudes). In particular, simulations of this kind help to quantify cross-country spillovers. In the second kind, I consider reforms which may differ by country. Simulations will provide information on cross-country policy coordination. In the last kind of simulations, I perform simulations to make a methodological point. Details of the scenarios will be presented below. The only constant element in all scenarios is the use of labor income taxes to keep public debt constant: if a particular reform was insufficient to avoid an increase in debt, taxes are increased on top of it<sup>14</sup>.

## 3.2 Results with identical reforms across countries

### 3.2.1 Population aging and tax scenario

Population aging creates a financing challenge for welfare states, as the proportion of households in working age is reduced: without any reforms, social security revenue declines while expenditures for public pay-as-you-go pensions, healthcare and long-term care increase, threatening the financial sustainability of welfare systems (Ageing Working Group, 2015). In the first scenario presented here, we assume that no social security reforms take place, so that labor income taxes need to be increased to finance the social security system. Specifically, taxes are adjusted so that public debt remains constant.

Figure 1 and table 1 provide the results for the two cases, in a multi-country environment where capital markets are integrated and in a single-country closed environment where capital markets are separated for each country<sup>15</sup>.

The key finding is as follows:

**Finding 1.** *Capital market integration with an aging population and variations in labor income taxes to keep public debt constant lead to international spillovers and redistribution across countries over the long run: some countries benefit from capital market integration (up to 2.1 %-points higher GDP per capita on average in each of the next 50 years, compared to a closed economy) while others lose (up to 4.8 %-points lower GDP per capita).*

For instance, table 1 shows that the GDP per capita should drop 4.9% in yearly

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<sup>12</sup>In the second case, a standard single-country model can be used. The same model is used for simulations in the two cases however, either in its multi-country version (with integrated capital markets) or in its single-country version (without capital market integration).

<sup>13</sup>I choose to keep constant trade per capita rather than no trade at all, as in strictly closed economies, because I want economies to be the same at the start in the two cases, to be able to compare outcomes.

<sup>14</sup>If a reform would bring so much gains that debt would decrease, then taxes are lowered to keep public debt constant.

<sup>15</sup>In all figures and tables, GDP per capita figures represent deviations from the long run growth trend.

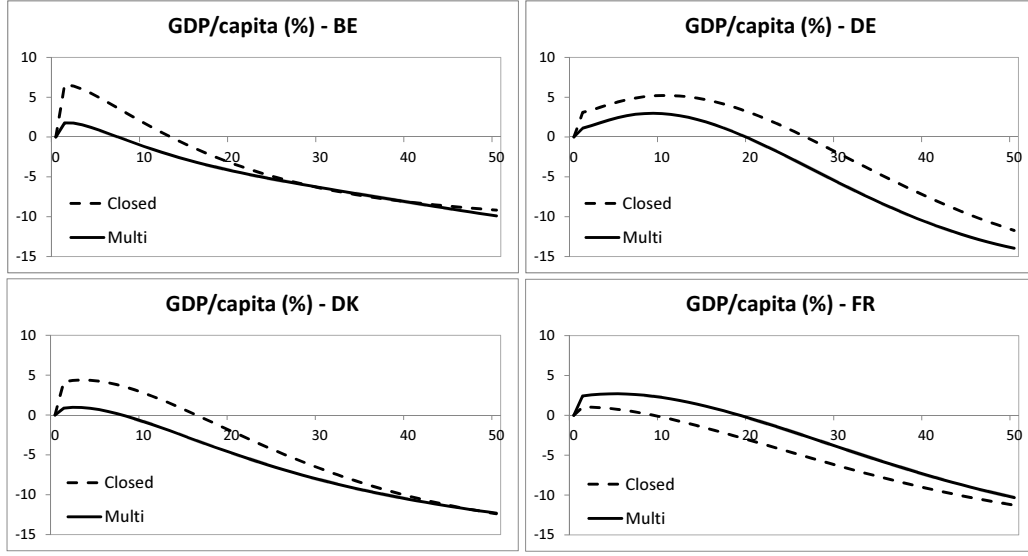


Figure 1: Aging and labor tax reforms, GDP per capita variations, 2015-2065

	Belgium			Denmark			France			Germany		
	2015	2065		2015	2065		2015	2065		2015	2065	
		CE	MC		CE	MC		CE	MC		CE	MC
Dependency ratio	0.29	0.41	0.41	0.29	0.42	0.42	0.30	0.47	0.47	0.35	0.60	0.60
Retirement age	59.6	59.6	59.6	62.7	62.7	62.7	60.2	60.2	60.2	60.6	60.6	60.6
Pension benefits*	0.0	-1.1	-3.6	0.0	0.6	-1.8	0.0	-1.5	0.1	0.0	11.8	8.0
Labor tax	0.15	0.29	0.30	0.29	0.52	0.51	0.10	0.28	0.28	0.09	0.29	0.30
Labor/capita*	0	-10	-10	0	-14	-14	0	-13	-12	0	-16	-18
Interest rate*	-53	-40	-36	-22	-39	-36	0	-26	-36	-10	-59	-36
Capital/capita**	0.0	2.6	-2.0	0.0	4.8	-1.2	0.0	-2.0	2.1	0.0	10.4	2.0
GDP/capita**	0.0	-3.6	-4.9	0.0	-4.1	-6.1	0.0	-4.9	-2.8	0.0	-1.2	-4.1
GDP/capita gap***			-1.3			-1.9			2.1			-2.9

**Legend:** \* = variation in 2065, compared to 2015 (in %); \*\* = average variation over years 2015 to 2065, compared to 2015 (in %); \*\*\* = average percentage points variation over years 2015 to 2065, compared to 2015; *Pension benefits* = average pension expenditure per retiree; *Labor tax* = average labor income tax for employed workers; *Labor/capita* = effective worked hours per capita; *GDP/capita gap* = difference between CE and MC cases; *CE* = single-country with closed economy; *MC* = multi-country with perfect capital market integration.

Table 1: Aging and labor tax reforms, 2015-2065

average between 2015 and 2065 in France when capital markets are not integrated (corresponding to a closed economy case) but only 2.8% when capital markets are integrated (in a multi-country setting). In yearly average thus, the GDP per capita is 2.1 %-points higher with capital market integration. By contrast, all other countries reported in the table lose from capital market integration, average GDP per capita being 1.3 %-points lower in Belgium, 1.9 %-points lower in Denmark and 2.9 %-points lower in Germany. In our sample, the biggest gain is in France and the largest loss in the Netherlands (at 4.8 %-points, see appendix A).

The main explanation is differentials in demographic dynamics. The old-age dependency ratio in Germany is projected to increase from 0.35 to 0.60 over the next 50 years for instance, but only from 0.30 to 0.47 in France over the same time span. The rapid decline in labor supply in Germany increases the capital-labor ratio fast, and thus depresses returns on capital investment faster than in France (and other countries). In an integrated capital market, investors thus modify their portfolio over time, shifting investments from Germany to France (until the unique international interest rate is equalized). The capital stock thus drops in Germany and increases in France, relative to a closed economy case. GDP per capita variations follow. Figure 5 in appendix B illustrates the explanation chain with the transition path of key variables.

This explanation applies to France, Germany and most of the countries in our sample. There are however a few exceptions, namely Belgium, Denmark and Italy. The first two are aging slowly so should benefit from capital market integration, yet lose. The opposite applies to Italy. Another factor also plays a role in all three cases, namely taxation and its associated Laffer curve effect. I take the example of Denmark to illustrate.

Denmark ages slowly, its dependency ratio being projected to increase from 0.29 to 0.42 over the next five decades. One would expect Denmark to benefit from capital market integration, as France. However, its initial level of taxation is so high that the necessary increase in taxes to finance increasing social security expenditures has a strong negative impact on labor supply incentives (Laffer curve effect). To finance its large welfare state indeed, Denmark needs to set labor income taxes and social security contributions at a cumulated effective rate of 40% for employed workers (while the second highest rate is 30% in our sample and the average is 25%). The effect is strong enough to dominate the benefits from a slowly aging population, relative to other countries. Taking all margins into account (demographics, working hours,...), the net labor supply drops more in Denmark than the average in other countries. As for Germany then, the capital-labor ratio increases faster, returns to investment decline more and thus capital moves overtime from Denmark to other countries, which are aging slowly and have a milder exposure to Laffer curve effects.

The following remark will play a role in the discussion of policy coordination. In this scenario and for our sample, there are winners and there are losers, but the weighted average GDP per capita gains and losses is close to zero: five countries benefit from capital market integration (for an average GDP per capita gain of 1.2 %-points) and nine countries lose from it (for an average loss of 1.8 %-points; see appendix A). Capital market integration is, in this sense, a zero sum game.

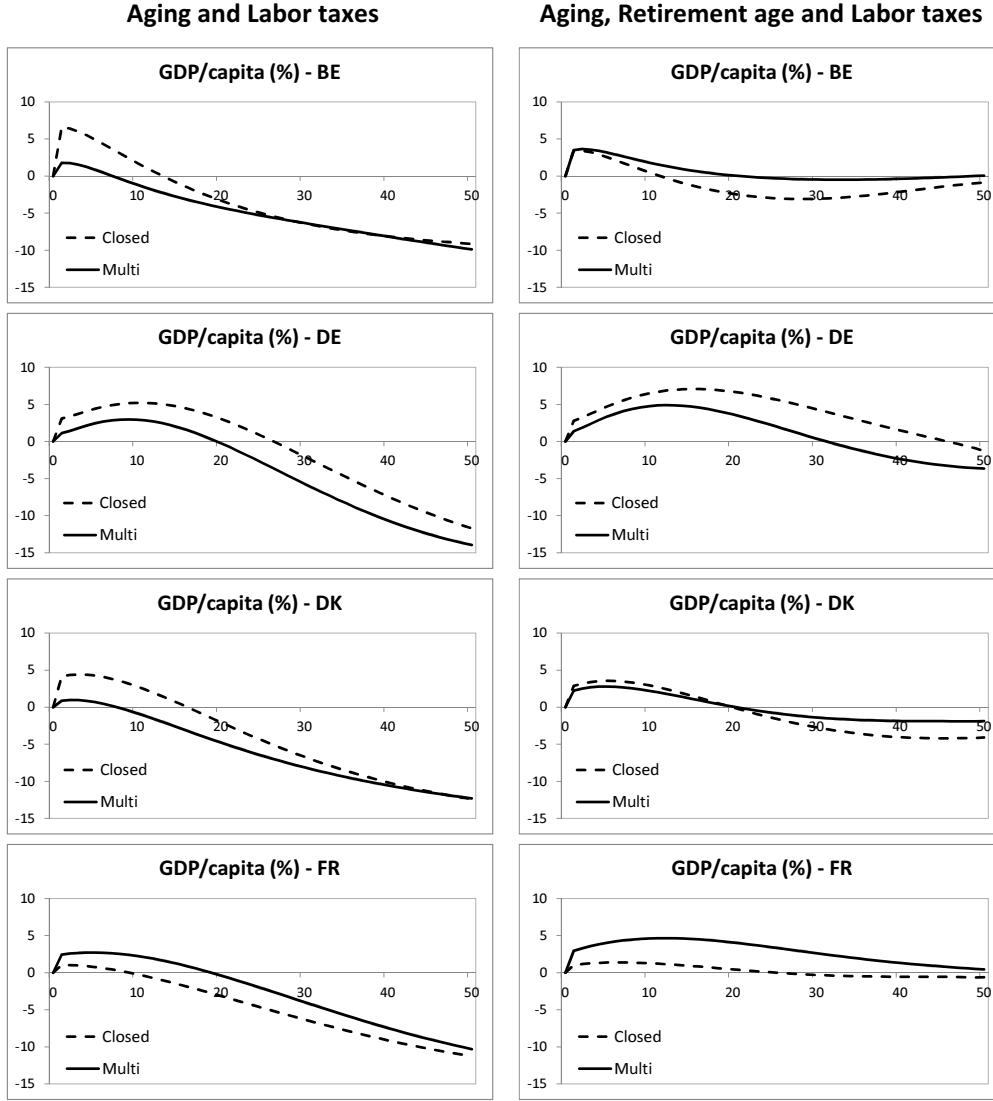


Figure 2: Aging and labor tax reforms without and with retirement age increase, GDP per capita variations, 2015-2065

### 3.2.2 Retirement age, tax and aging scenario

Increasing the statutory retirement age is one way to ensure the financial sustainability of the social security system with an aging population, as revenue from social security contributions increase and pension expenditures decline. I investigate the impact of the same retirement age reform in all countries (except the two Rest-of-the-world countries, which use labor income taxes to finance increasing social security expenditures). Specifically, the retirement age is gradually (linearly) increased by a total of 2.5 years over the next 50 years, the 2.5 years mark corresponding to the average scheduled retirement age in the countries from our sample (as per the Ageing Working Group, 2015). This increase may or may not be sufficient to finance all of the increase in social security expenditures. If it is not, labor income taxes are increased so that public debt remains constant.

	Belgium			Denmark			France			Germany		
	2015	2065		2015	2065		2015	2065		2015	2065	
		CE	MC		CE	MC		CE	MC		CE	MC
Dependency ratio	0.29	0.41	0.41	0.29	0.42	0.42	0.30	0.47	0.47	0.35	0.60	0.60
Retirement age	59.6	62.1	62.1	62.7	65.0	65.0	60.2	62.7	62.7	60.6	63.1	63.1
Pension benefits*	0.0	-0.2	-0.5	0.0	2.5	1.2	0.0	5.3	7.4	0.0	21.4	17.5
Labor tax	0.18	0.22	0.21	0.30	0.44	0.42	0.10	0.18	0.18	0.09	0.22	0.22
Labor/capita*	0	-2	-1	0	-5	-4	0	-3	-3	0	-8	-9
Interest rate*	-27	-45	-41	-14	-29	-41	0	-37	-41	-9	-84	-41
Capital/capita**	0.0	2.1	2.9	0.0	5.7	4.2	0.0	2.7	7.6	0.0	16.3	7.2
GDP/capita**	0.0	-1.2	0.5	0.0	-0.9	-0.2	0.0	0.2	2.9	0.0	4.0	1.1
GDP/capita gap***			1.8			0.8			2.7			-2.9

**Legend:** see table 1

Table 2: Aging, retirement age and labor tax reforms, 2015-2065

Figure 2 and table 2 provide the results. The figure reproduces the results from the scenario where aging is financed with labor income taxes only (from section 3.2.1), which is used as benchmark. Again results are provided for two cases, in a multi-country environment where capital markets are integrated and in a single-country closed economy where capital markets are separated by country.

There are two key findings. The first one is similar to finding 1 in section 3.2.1. It does not provide new insights but is included for the sake of completeness:

**Finding 2.** *Capital market integration with an aging population, a gradual increase of the retirement age of 2.5 years in all European countries and variations in labor income taxes to keep public debt constant lead to international spillovers and redistribution across countries over the long run: some countries benefit from capital market integration (up to 3.1 %-points higher GDP per capita on average for each of the next 50 years, compared to a closed economy) while others lose (up to 3.8 %-points lower GDP per capita).*

As shown in table 2 for instance, the GDP per capita should increase 0.2% on average between 2015 and 2065 in France when capital markets are not integrated (corresponding to a closed economy case) and 2.9% when capital markets are integrated (in a multi-country setting). The GDP per capita is thus on average 2.7 %-points higher with capital market integration. By contrast, average GDP per capita is 2.9 %-points lower in Germany with integrated capital markets. Results for our entire sample show that the biggest gain is 3.1 %-points in Italy and the biggest loss 3.8 %-points in the Netherlands (see appendix A).

The explanation for this finding is similar to the explanation for finding 1, based on demographics differentials: labor supply per capita drops faster in countries whose population ages fast, increasing more the capital-labor ratio and thus depressing more returns to investment, triggering a capital flight when markets are integrated, and thus a loss in production capacity in those countries.

The next finding, best visible in figure 2, shows that redistribution patterns created

by capital market integration depend on the exact reforms which ensure the financial sustainability of social security systems:

**Finding 3.** *Losses from capital market integration with an aging population are overturned (into gains) for some (but not all) countries when all European countries increase gradually the retirement age by 2.5 years, rather than relying solely on variations in labor income taxes to keep public debt constant: while the average GDP per capita in Austria, Belgium and Denmark is respectively 0.05, 1.3 and 1.9 %-points lower with capital market integration and a constant retirement age than with separated markets, it is respectively 1.3, 1.8 and 0.8 %-points higher with capital market integration and increased retirement age than with separated markets (yearly averages over the next 50 years).*

The explanation for this finding is similar for all three countries, with a twist for Austria. I take the example of Denmark, continuing on the explanation for finding 1 in section 3.2.1: Denmark is aging slowly but has a high tax burden, so that the labor supply disincentive effects (Laffer curve) of increased labor taxes dominate the gains from a slowly aging population, relative to other countries. When the retirement age is increased, taxes do not need to be increased so much, so the Laffer curve effects are dampened and dominated by the gains from the slow aging process: relative to the average European country, labor supply per capita does not drop as much, the capital-labor ratio does not increase as much so the returns to investment increase over time in Denmark; capital flows over time to Denmark, boosting production.

The twist for Austria is the following hypothesis<sup>16</sup>. The aging process in Austria is not particularly slow (but neither fast). Compared to other countries however, Austria makes a relatively strong use of capital in production, which helps to keep returns to investment high there and thus attracts foreign investments.

I conclude this section with a remark. The increase in the retirement age reduces the GDP loss per capita due to aging (and sometimes even transform the loss into gains), as production factors are larger. The outcome, which holds with and without capital market integration, is well known in the public finance literature (see for instance Jaag, Keuschnigg, and Keuschnigg, 2010).

### 3.2.3 Pension benefits, tax and aging scenario

The three standard parametric reforms of the pension systems are changes in the retirement age, changes in pension benefits and changes in social security contribution rates. Increases in the retirement age to maintain the financing of the social security system with an aging population have been investigated in section 3.2.2. Here I investigate cuts in pension benefits<sup>17</sup>. Specifically, I assume that the benefit ratio is gradually decreased over the next 50 years in all European countries of the sample, so that it is 19% lower in

<sup>16</sup>To be confirmed with a quantitative decomposition analysis, left for future research.

<sup>17</sup>I do not investigate increases in social security contribution rates on their own, because outcomes are in general similar to increases in labor income tax rates, investigated in section 3.2.1.



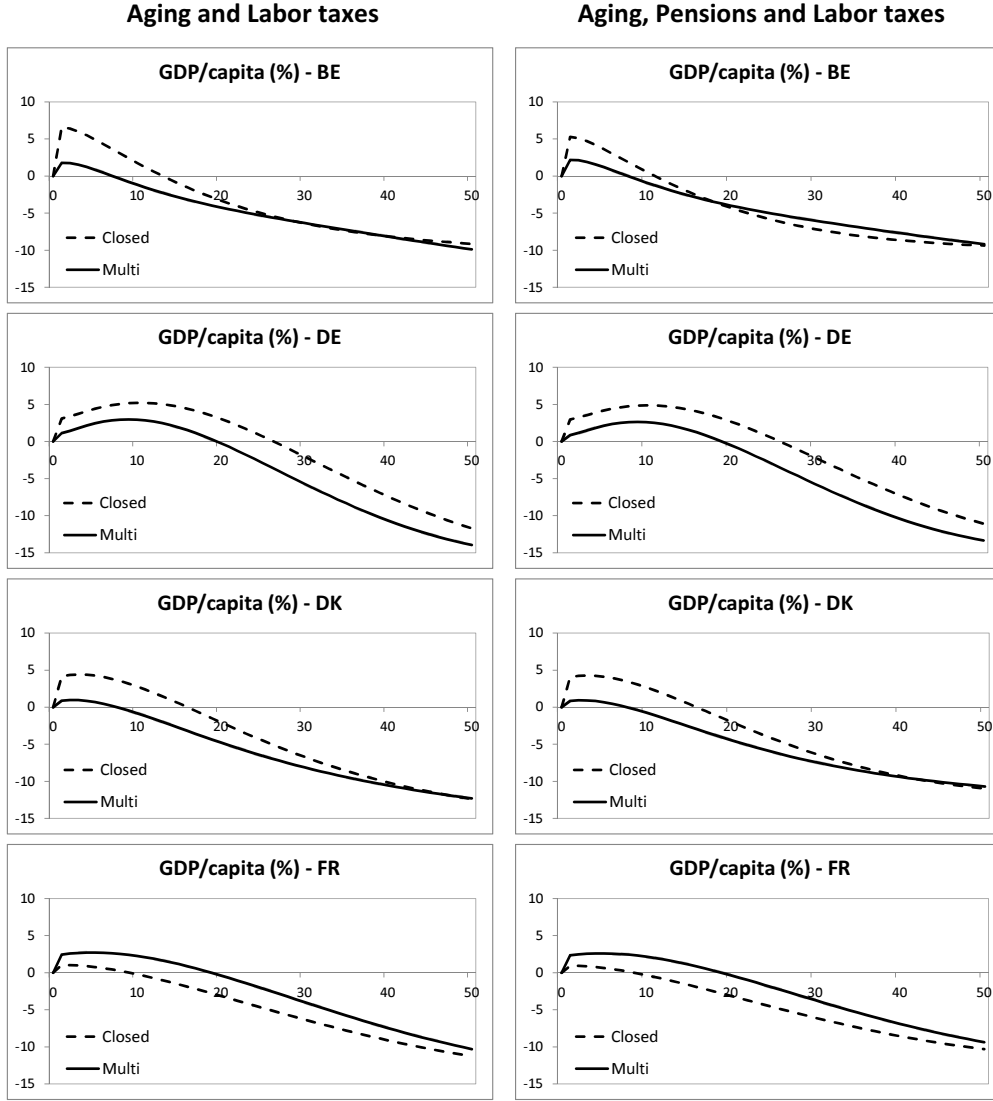


Figure 3: Aging and labor tax reforms without and with pension cuts, GDP per capita variations, 2015-2065

50 years<sup>18</sup>. The figure corresponds to the projected decrease in all countries of the sample, as per the Ageing Working Group (2015). The cuts reduce the pension expenditures but may or may not be sufficient to balance social security expenditures with revenues, as aging unfolds. If they are not, labor income taxes are increased so that public debt remains constant.

Results are provided in figure 3 and table 3 for the two cases, multi-country with capital market integration and single closed economy without integration. As before, the figure reproduces the results from the benchmark scenario where aging is financed with labor income taxes only.

<sup>18</sup>Following the Ageing Working Group (2015), the benefit ratio is the average pension as a share of the average wage. In the simulation, I change the pension replacement rate in the same proportion as the benefit ratio is projected to change, ignoring general equilibrium effects (that is, assuming constant average wages). To illustrate, a country where the benefit ratio is 0.500 today would reduce it to 0.405 in 50 years (a 19% drop).

	Belgium			Denmark			France			Germany		
	2015	2065		2015	2065		2015	2065		2015	2065	
		CE	MC		CE	MC		CE	MC		CE	MC
Dependency ratio	0.29	0.41	0.41	0.29	0.42	0.42	0.30	0.47	0.47	0.35	0.60	0.60
Retirement age	59.6	59.6	59.6	62.7	62.7	62.7	60.2	60.2	60.2	60.6	60.6	60.6
Pension benefits*	0.0	-20.1	-21.3	0.0	-17.7	-19.6	0.0	-19.5	-18.1	0.0	-8.6	-11.7
Labor tax	0.16	0.27	0.26	0.29	0.48	0.47	0.10	0.22	0.22	0.09	0.25	0.26
Labor/capita*	0	-9	-9	0	-12	-12	0	-12	-11	0	-16	-17
Interest rate*	-43	-32	-36	-21	-36	-36	0	-25	-36	-11	-58	-36
Capital/capita**	0.0	0.6	-1.7	0.0	4.9	-0.6	0.0	-1.9	2.3	0.0	10.2	2.1
GDP/capita**	0.0	-4.5	-4.5	0.0	-3.8	-5.5	0.0	-4.6	-2.5	0.0	-1.2	-4.1
GDP/capita gap***			0.0			-1.7			2.1			-2.9

**Legend:** see table 1

Table 3: Aging, pension benefits and labor tax reforms, 2015-2065

With one exception, outcomes are very similar to the scenario where the welfare state is kept financially sustainable by increases in labor income taxes only, presented in section 3.2.1. The same finding can be applied here. In the interest of space, I do not repeat it.

The exception is as follows:

**Finding 4.** *Pension cuts in all European countries do not change the redistribution pattern created by capital market integration under an aging population where variations in labor income taxes keep public debts constant (as outlined in finding 1), with a minor exception: while Belgium loses from integration without pension cuts (yearly GDP/capita on average 1.0 %-points lower over the next 50 years), the impact of integration is neutral with pension cuts in all European countries (yearly GDP/capita on average neither lower nor higher).*

The finding, which is based on simulation results from tables 1 and 3, is explained as follows. For all countries but Belgium, pension cuts decrease aggregate pension expenditures and do not require as large an increase in labor income taxes, and thus do not depress labor supply incentive as much. But this benefit takes place with and without capital market integration. Demographic differentials thus continue to play a driving role (see section 3.2.1).

In Belgium, the smaller increase in labor income taxes is sufficient to change the balance of the two factors which dominate variations in effective labor supply. As seen for Denmark in section 3.2.1, when pension benefits are maintained, the high initial tax burden and large increase in labor taxes lead to strong Laffer curve effects with a large negative impact on labor supply, increasing the capital-labor ratio more than in other countries and thus lowering returns to investments, in spite of a slower aging of the population. When pension benefits are cut, labor income taxes do not need to be raised as much, which reduces the Laffer curve effect. In this case, the balance of the Laffer curve effect and slow population aging is tilted, so that the capital-labor ratio and thus

returns to investment in Belgium change in the same proportion as the average of other countries. Capital market integration then has a neutral impact.

### 3.3 Results with different reforms across countries

In this section, reforms differ across countries. The differences come from implementation or not of a reform, the timing, the magnitude or the type of the reforms.

#### 3.3.1 Deviations by one country

Simulations in section 3.2 showed that cross-country spillovers take place because countries age at a different speed, because tax burdens differ and because capital markets are integrated. In particular, investors change their portfolio composition over time to seek the highest returns, generally where the capital-labor ratio is increasing least. Countries, in this sense, compete for capital. There may be thus incentives for strategic behavior. In order to attract capital, countries may try to be the only country to perform a reform, or the only one to avoid a reform.

In this section, I investigate the impact of such strategic behavior, when one country deviates by implementing (or not implementing) one type of social security reform. Increases in the retirement age depress the capital-labor ratio and thus increase returns to investment. It may be strategic to be the only country to perform a retirement age increase. I thus take variations in retirement age as the reform which one country is alone to implement (or avoid implementing). Since Germany has the biggest economic size and is one of the countries which suffers most from capital market integration, I select it as the country seeking strategic advantage. As always, labor income taxes are changed in all countries so that public debts remain constant.

Results are provided in table 4, showing average macroeconomic impacts, measured by yearly average GDP per capita variations over the next five decades, in Belgium, Denmark, France and Germany, for four different scenarios. Two scenarios have been previously presented and are used as benchmarks: either no country increases retirement age (from section 3.2.1) or all countries gradually increase retirement age by 2.5 years (from section 3.2.2). The other two scenarios are new: either Germany is the only country to gradually increase retirement age by 2.5 years (*first mover* scenario), or it is the only country which does not do it (*avoider* scenario).

What the simulations show can be summarized in the following way:

**Finding 5.** *Deviations in retirement age reforms by one country lead to redistribution between that country and other countries to a small absolute extent, without any overall efficiency gain: Germany, as a first mover country (i.e. alone to increase retirement age) would gain an average 0.2 %-points GDP/capita in each of the next 50 years while other countries would lose on average 0.01 %-points; Germany would lose 0.2 %-points if it was an avoiding country (i.e. the only one to avoid a retirement age increase) and other countries gain on average 0.01 %-points; in each case, gains are offset by losses over the entire set of countries.*

GDP/capita, 2015-2065	Belgium	Denmark	France	Germany
Retirement age increase in ...				
... no country	-4.87	-6.07	-2.77	-4.09
... only in Germany	-4.88	-6.10	-2.78	1.24
... all except Germany	0.56	-0.14	2.90	-4.27
... all countries	0.55	-0.16	2.88	1.06
Gaps for scenario...				
... Germany first mover	-0.01	-0.02	-0.02	0.18
... Germany avoider	0.01	0.02	0.02	-0.18
<b>Legend:</b> the table shows average GDP/capita variations over years 2015 to 2065, compared to 2015 (% or percentage points); see text for additional details.				

Table 4: Aging, retirement age and labor tax reforms, Germany deviation, 2015-2065

I start the explanation with impacts on the deviating country (Germany). When it is the only country to make the retirement age reform (first mover scenario), the average GDP/capita increases by 1.24 % over the next 50 years. When all other countries also implement this reform, the average GDP/capita gain in Germany is 1.06%. Being a first mover thus delivers a 0.2 %-points gain. Conversely, when the deviating country is the only one to avoid the reform (avoider scenario), GDP/capita drops on average by 4.27%; when all other countries also avoid the reform, GDP/capita drops by 4.09% in Germany. Therefore, being an avoider leads to a 0.2 %-points loss.

The intuition is symmetric when it is a first mover or an avoiding country. I provide it for the first mover case. Population aging reduces labor supply in all countries. When Germany is the only one which increases retirement age, the relative decline in labor supply is smaller there. In relative terms thus, the capital-labor ratio declines less in Germany, which increases the returns to investment there: capital flows gradually towards Germany, an additional support to production.

Note that the magnitude of the gain (first mover) or loss (avoider) is small compared to the loss due to capital market integration with an aging population: 0.2 %-points instead of about 3.0 %-points (see sections 3.2.1 or 3.2.2). The main reason is that aging differentials lead to larger variations in labor supply, compared to variations generated by the retirement age reform.

The explanation for the impacts on the other countries (all except Germany) are reversed and similar. I thus briefly provide them. When the deviating country is alone to increase retirement (first mover case), GDP/capita drops on average by 4.88% in Belgium; when no country increases retirement, GDP/capita drops by 4.87% in Belgium. Thus, the first mover case leads to a 0.01 %-points loss in Belgium. The loss is similar in Denmark, France and all other countries (unreported). The reason for the losses is just the opposite of the reason for the gains in the deviating country: there, the returns to investment are increasing in relative terms, explaining why capital flows slowly towards the deviating country.

GDP/capita, 2015-2065	Belgium	Denmark	France	Germany
Retirement age increase in ...				
... no country	-4.87	-6.07	-2.77	-4.09
... in seven reformer countries	0.67	0.02	-2.84	1.19
... all countries	0.55	-0.16	2.88	1.06
Gaps for country...				
... among seven reformers	0.12	0.18	-	0.13
... not among seven reformers	-	-	-0.07	-

**Legend:** the table shows average GDP/capita variations over years 2015 to 2065, compared to 2015 (% or percentage points); the following countries increase the retirement age in the *seven reformers* case: Belgium, Denmark, Germany, Finland, the Netherlands, Poland and Spain; see text for additional details.

Table 5: Aging, retirement age and labor tax reforms, seven countries, 2015-2065

### 3.3.2 Deviations by several countries

As in the previous section, I consider the case where only some countries increase the retirement age. The rationale is similar: as countries compete for capital, strategic behavior where capital-labor ratios and thus returns to investment are improved may be rewarded. I investigate the quantitative benefits of such strategic behavior, if any. Specifically, I consider a case where half of the 14 European countries gradually increase the retirement age by 2.5 years, while the other half does not. As usual, public debts are kept constant in all countries through variations of the labor income tax rate.

Table 5 provides outcomes of the experiment. In addition to the scenario considered here, outcomes for two other scenarios are presented for comparison purposes, namely when all countries gradually increase the retirement age and when no country does it. Outcomes for these two benchmark scenarios, which come respectively from sections 3.2.2 and 3.2.1, are repeated for convenience.

In the table, the largest impacts are for France and Germany. France is not among the seven reformer countries and suffers from the deviation. Indeed, when no country increases the retirement age, GDP per capita drops on average by 2.77% in each of the next fifty years. When the seven reformers increase the retirement age, GDP per capita drops on average by 2.84%. France thus loses a yearly average of 0.07%-points of GDP per capita when other seven countries gradually increase the retirement age.

Germany on the other hand is among the group of seven reformers. Its GDP per capita increases on average 1.19% over the next five decades, when the seven reformers increase retirement age. By comparison, GDP per capita increased 1.06% when all countries increased the retirement age. The benefit from being among the seven reformer countries thus amounts to a yearly average of 0.13 %-points, in GDP per capita terms.

The outcome for Belgium and Denmark, other reform countries, is similar to the outcome for Germany (respectively 0.12 and 0.18 %-points yearly average gains). Collecting and adding outcomes from the other 10 countries in the sample (unreported), one can summarize the experiment in the following way:

GDP/capita, 2015-2075	Belgium	Denmark	France	Germany
Retirement age increase in ...				
... with lags in some countries	0.28	-0.61	0.53	0.01
... all countries at same time	0.29	-0.60	2.22	0.01
Gaps ...				
... when using lags	-0.01	-0.01	-1.69	0.00
<b>Legend:</b> the table shows average GDP/capita variations over years 2015 to 2075, compared to 2015 (% or percentage points); the following countries delay the increase of the retirement age by 10 years: Austria, the Czech Republic, France, Italy, Slovakia, Sweden and the United Kingdom ; see text for additional details.				

Table 6: Aging, retirement age and labor tax reforms, reform lags, 2015-2075

**Finding 6.** *There are small benefits for countries among the sample half increasing the retirement age (up to a yearly average GDP/capita gain of 0.2 %-points over the next 50 years, compared to the case where all countries do it) and small losses for countries outside the sample (up to a yearly average GDP/capita loss of 0.1 %-points over the next 50 years, compared to the case where no countries does it).*

The same mechanism as for finding 3 operates and explains finding 6, namely a relative decrease of the capital-labor supply ratio among the seven reformer countries raising the retirement age, which increases returns to investment there and thus attracts foreign capital (see section 3.2.2 for details).

### 3.3.3 Differences in timing

When all countries gradually increase the retirement age, capital-labor ratios drop everywhere, pushing up returns to investment everywhere and thus producing a drag on the integrated capital markets. If some countries delayed the gradual increase in the retirement age, one could hope that the pressure on the capital markets would be lower, easing investments, the demand on the capital markets being lower at any given point in time (but over a longer period of time). In this section, I investigate whether such a coordination approach delivers any efficiency gains.

Results are presented in table 6, which includes two scenarios. First, there is a scenario where the implementation of the reform is delayed by 10 years in half of the country sample. Second and for comparison purposes, the scenario where there is no lag in implementation is repeated for convenience from section 3.2.2. Contrary to other experiments however, the reporting period is 10 years longer (from 2015 to 2075), because the gradual increase in the retirement age finishes 10 years later in countries with implementation lags.

The results are, to some extent, striking. In countries where there is no lag in implementation, there is no difference in outcomes: in Belgium, Denmark and Germany, the yearly average GDP/capita impact over the next 60 years is the same, whether some countries lag the reform implementation or not. In countries where there is a lag in the implementation, the outcomes are worse: in France for instance, GDP/capita increases

on average by 0.53% in each of the next 60 years when the reform is lagged, but increases by 2.22% without implementation lag, a 1.7%-points average differential. Outcomes are similar in the rest of the sample. Simulation results can thus be summarized by:

**Finding 7.** *Delaying the implementation of increases in the retirement age in half of the countries leads to counterproductive outcomes, as impacts are worse for countries which delay the implementation (GDP/capita is between 1.2 and 1.7 %-points lower averaged over the next 60 years, compared to no delays) and unchanged for countries which do not delay the implementation (same GDP/capita impacts whether other countries delay the implementation or not).*

The fact that capital stock adjustment is a slow process explains the outcomes. When some countries delay the increase in the retirement age by 10 years, there are capital outflows towards other countries during these 10 years (see explanation for finding 6, in the previous section), but this is not sufficient to generate permanent and significant re-balancing of international investment portfolios. Capital stock variations over time are thus comparable when some countries delay implementation of the reform and when they do not. This is sufficient to explain why there are no differences for non-lagged countries. In the lagged countries, delaying the increase in retirement age simply leads to a lower increase of the labor supply, and thus a relative loss in production.

### 3.3.4 Differences in magnitudes

Other than differences in country scope and timing, one can consider differences in reform magnitudes across countries. In this section, I compare the implementation of pension cuts that countries currently plan (as per the Ageing Working Group, 2015) with implementation of the same average pension cut (as in section 3.2.3). Over the sample of countries considered in this paper, own reform plans range from a 2% cut of the pension benefit ratio over the next 50 years (Belgium) to a 39% cut (Poland), the average being a 19% cut.

Table 7 provides the results, providing outcomes for reforms of own magnitude, of the same average magnitude, when capital markets are integrated and when they are not. Unlike in other result tables, outcomes are provided for Poland but not for Denmark, to better illustrate the variety of impacts.

As the table shows, outcomes differ when countries implement a reform of different magnitude, which is not a surprise. This result holds whether capital markets are integrated or not. The only exception is Germany, due to the fact that the scheduled pension cuts in Germany (-17%) are very close to the average over the entire sample (-19%). More interesting is the comparison of outcomes when capital markets are integrated and when they are not, which can be summarized in the following fashion:

GDP/capita, 2015-2065	Belgium	France	Germany	Poland
Integrated markets, pension cuts of ...				
... own magnitude	-4.85	-2.44	-4.11	-8.28
... average magnitude	-4.50	-2.53	-4.12	-8.64
Gaps own vs average	-0.36	0.08	0.01	0.36
Separate markets, pension cuts of ...				
... own magnitude	-3.71	-4.57	-1.23	-6.87
... average magnitude	-4.45	-4.64	-1.24	-7.13
Gaps own vs average	0.74	0.07	0.01	0.26
<b>Legend:</b> the table shows average GDP/capita variations over years 2015 to 2065, compared to 2015 (% or percentage points); the average magnitude is -19%; the own magnitude in Belgium is -2%, in France -24%, in Germany -17%, in Poland -39%; see text for additional details.				

Table 7: Aging, pension benefits and labor tax reforms, different magnitudes, 2015-2065

**Finding 8.** *In a few countries (Belgium, the Czech Republic, Poland and Sweden), capital market integration changes the gap between pension cuts of own magnitude and pension cuts of the same average magnitude (to an extent comprised between 0.1 and 1.0 %-points of the yearly average GDP/capita variations over the next 50 years); in one case (Belgium), capital market integration even changes which of the two reform scenario is preferable (own cut by a yearly 0.7 %-points margin in separated markets, average cut by a yearly 0.4 %-points margin in integrated markets).*

Outcomes are most striking for Belgium. When capital markets are integrated, its own pension cut of 2% would lead to a yearly average GDP/capita loss of 4.85% over the next 50 years; if all countries implement the average cut of 19%, the yearly loss is 4.50%. According to production criteria, Belgium would thus support a policy coordination measure where all countries implement the same average cut of 19%, which would lead to a yearly average GDP/capita gain of 0.4 %-points in the country. If capital markets were isolated, its own pension cut would lead to a yearly average loss of 3.71%, while the average cut would lead to a yearly average loss of 4.45%. Belgium would not support the same policy coordination if capital markets are not integrated, to avoid a 0.7 %-points yearly average loss of GDP/capita. The overall GDP/capita differential created by capital market integration is a yearly average larger than 1.0 %-points over the next 50 years, a significant number.

The explanation for such an outcome has two steps. Notice beforehand that the own pension cut of -2% is very small, so that this scenario is close to no pension cut at all, variations in labor income taxes alone ensuring the financial sustainability of social security over the long run. To simplify the exposition, I thus compare a tax hike scenario with the average pension cut scenario. First, tax hikes can be preferable to a 19% pension cuts in a closed economy setting, where capital markets are separated. Each of the two options have advantages and disadvantages. Tax hikes directly reduce labor supply incentives. Pension benefit cuts reduce the value of accumulated pension rights



in pay-as-you-go pension systems with earnings-related components, so indirectly reduce labor supply incentives. Which of the negative and positive effects dominate depends on the specifics of the tax and pension systems. One remarkable feature in Belgium is that the tax and social security contribution burden is distributed relatively evenly over the life-cycle, retirees being exposed to an average cumulative rate which is 90% of the average cumulative rate of working households. By comparison, the (unweighted) average is 56% in the other countries of the simulation sample. Unlike in other countries, financing with labor income taxes is preferable to financing with pension cuts.

The second step involves capital market integration. Another effect weighs on the balance between tax hikes and pension cuts. The same mechanism operates as in section 3.2.3. Pension cuts move the country away from strong Laffer curve effects, reducing the negative impact of aging on labor supply, pushing down the capital-labor ratio and thus increasing returns to investments. With integrated capital markets, pension cuts lead to capital inflows, sustaining domestic production. Simulations show that this effect is sufficiently strong to change the balance between tax hikes and pension cuts in favor of pension cuts.

The mechanism is the same in the other countries, but smaller in magnitude. In the Czech Republic, Poland and Sweden, there are quantitative but no qualitative changes. Note in particular that own pension cuts in Poland are larger than the average cut, so the signs are reversed: unlike Belgium, own cuts are preferable to average cuts when capital markets are integrated.

### 3.3.5 Differences in reform types

In a national context, it is well-known that different types of pension reforms (increase in retirement age, pension benefit cuts or increases in social security contributions) have different outcomes, some positive and others negative. Simulations above showed that, in an international context, there are cross-country spillovers when capital markets are integrated. They also showed that spillovers depend on the type of pension reforms. One could thus consider cases where different types of reforms are implemented in different countries, in the hope of generating positive spillovers.

I thus consider a mixed reforms case where a gradual increase of 2.5 years of the retirement age takes place in some countries, gradual 19% cuts of pension benefits take place in other countries and the rest gradually increases the social security contribution rates by 39%. As always, labor income taxes are adjusted (if needed) to keep public debts constant. In other words, the reform from section 3.2.2 is applied to the first group of countries, the reform from section 3.2.3 is applied to the second group of countries while a reform similar to the one from section 3.2.1 is applied to the last group of countries<sup>19</sup>.

Key results are presented in table 8. For comparison purposes and convenience, results from previous sections are also reported. Unlike other tables, outcomes for Poland

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<sup>19</sup>For better comparisons, the simulations should be adjusted so that the last group of countries applies exactly the same reform as in section 3.2.1, using labor income taxes only (and no change of social security contributions). Alternatively, a new scenario where all countries gradually increase 39% the social security contribution rates should be performed. This is left for future research. Outcomes are however expected to be very close to the scenario presented here, labor taxes and social security contributions influencing labor supply in a similar fashion.

GDP/capita, 2015-2065	Belgium	France	Germany	Poland
Reform scenarios ...				
... mixed reforms	0.68	-2.46	1.20	-9.23
... pension cuts everywhere	-4.50	-2.53	-4.12	-8.64
... retirement age increase everywhere	0.55	2.88	1.06	-3.66
... SSC / labor tax increase everywhere	-4.87	-2.77	-4.09	-8.97
Gaps between mixed reforms and...				
... pension cuts everywhere	-	0.07	-	-
... retirement age increase everywhere	0.13	-	0.14	-
... SSC / labor tax increase everywhere	-	-	-	-0.26
<b>Legend:</b> the table shows average GDP/capita variations over years 2015 to 2065, compared to 2015 (% or percentage points); in the <i>mixed reforms</i> case, retirement age increases take place in Belgium, the Czech Republic, Finland, Germany and Spain, pension cuts take place in Austria, France, the Netherlands, Slovakia and Sweden, while social security contributions are raised in the rest of European countries; see text for additional details.				

Table 8: Aging and different reforms across countries, 2015-2065

are presented in the table rather than those for Denmark, the former being more illustrative than the latter. Results can be summarized in the following way:

**Finding 9.** *Implementing different types of pension reforms across countries does not lead overall to better outcomes, compared to the implementation of identical reforms in all countries, since gains and losses are small and gains for those countries implementing rewarding reforms (retirement age increases, up to yearly 0.15 %-points higher GDP/capita averaged over the next 50 years) are offset by losses for those countries implementing other reforms (social security increases, up to yearly 0.26 %-points lower GDP/capita averaged over the next 50 years).*

I discuss impacts in Germany and Poland, the largest in the table. Impacts in other countries are similar. Consider Germany first, which implements an increase in retirement age. Consistent with outcomes in previous sections, this reform extracts benefits from other countries not implementing this reform: yearly GDP per capita increases by 1.20% on average over the next 50 years, compared to a 1.06% increase when all countries increase the retirement age, a 0.14 %-points differential. In Poland, the mixed reform case where social security contributions are increased in the country leads to an average yearly drop of 9.23%, compared to a 8.97% loss when all countries balance their social security budget with a similar instrument (namely labor income taxes), a negative 0.26 %-points differential.

The same mechanism operates as in previous sections (see for instance section 3.3.2) and explains the finding: those countries increasing the retirement age are able to reduce the increase in the capital-labor ratio due to population aging, which leads to higher returns to investment and thus attracts capital from countries not increasing the retirement age.

### 3.4 Methodological results

To assess the macroeconomic impact of population aging and associated policy reforms, models need to have an overlapping-generations structure and to quantify factor prices. Indeed, what leads to aging is variations in mortality rates. Further, the main economic impact of population aging is an exogenous variation of labor supply, which affects capital-labor ratios and thus wages and interest rates. General equilibrium models deal endogenously with wage variations. Most models are also capable of dealing with interest rate variations, but only under some assumptions. I discuss these assumptions in this section and show that the commonly used *small open economy* assumption may not be satisfactory, as it exaggerates in the majority of the countries the negative economic impact of population aging, sometimes overpredicting yearly GDP per capita declines by more than 10 %-points for each of the next 50 years. At the end of the section, I also include a small remark on alternative assumptions in single-country models.

Most general equilibrium models are calibrated for one region or one country, and virtually all large-scale models used for policy evaluation with an aging population apply to single countries<sup>20</sup>. Single-country models put a price on labor assuming that labor is immobile or that migration flows are exogenous. In reality, labor is mobile but much less than capital, which allows to defend the assumption. There is however no unique approach to putting a price on capital in single-country models. One can either assume that capital is immobile and obtain closed economy equilibria. Or one can invoke the small open economy assumption, arguing that countries are open to trade and capital flows but are usually too small to influence the worldwide price of capital, in which case the interest rate is exogenously set (and usually constant).

To evaluate these two single economy assumptions, I compare the outcomes they generate over the long run with those coming from the multi-country model used above, which serves as benchmark. Below I report and discuss outcomes for only one scenario, with population aging and variations in labor income taxes. Results are nearly identical for the other scenarios with variations in retirement age or in pension benefits.

Figure 4 and table 9 provide the results. Outcomes for the closed economy case (labeled *Closed*) and the multi-country case with integrated capital markets (labeled *Multi*) are identical to section 3.2.1 and repeated to simplify comparisons. The new case makes the small open economy assumption (label *SOE*).

The figure illustrates and numbers in the table confirm the fact that outcomes with single-country models differ from the multi-country benchmark, especially when the small open economy assumption is used. For instance, the single-country model with the small open economy assumption predicts a drop of GDP per capita averaging 14.2% for each of the next 50 years in Denmark, compared to a drop of 4.1% in the closed economy case and 6.1% in the multi-country case with integrated capital markets: the small open economy assumption is thus 10.1 %-points more pessimistic in the first instance and 8.2 %-points in the second one. Over the entire sample, the largest gaps are for Spain, at

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<sup>20</sup>QUEST, from the European Commission, is a large scale multi-country model used for policy evaluation but does not have an overlapping-generations structure (see Ratto et al., 2009). I am not aware of a large scale multi-country overlapping-generations model used for policy evaluation.

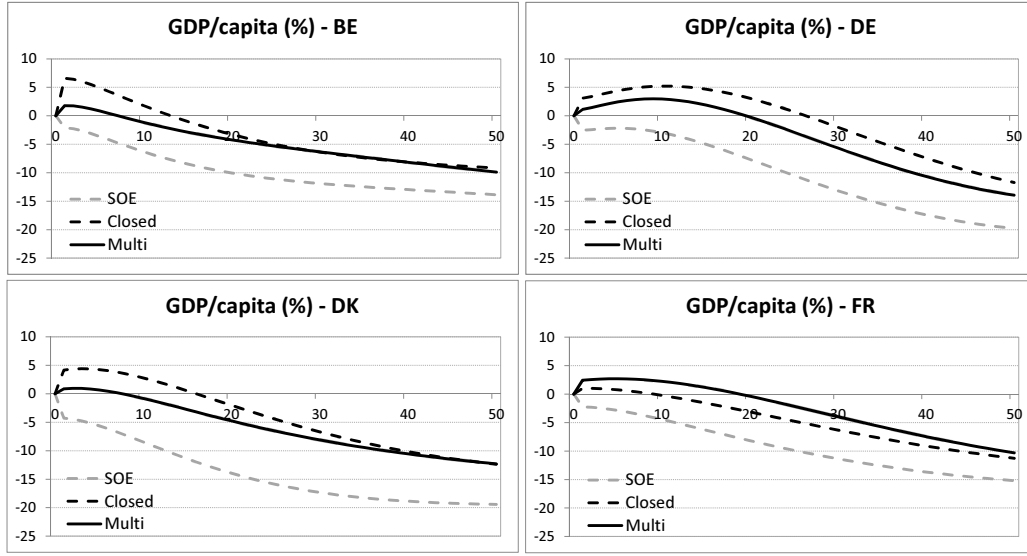


Figure 4: Aging and labor tax reforms in three cases, GDP per capita variations, 2015-2065

	Belgium			Denmark			France			Germany		
	SOE	CE	MC	SOE	CE	MC	SOE	CE	MC	SOE	CE	MC
Labor tax	0.33	0.29	0.30	0.57	0.52	0.51	0.30	0.28	0.28	0.34	0.29	0.30
Assets/capita**	6	10	24	12	33	40	13	33	40	22	48	50
Labor/capita**	-13	-10	-10	-19	-14	-14	-15	-13	-12	-22	-16	-18
Interest rate*	0	-40	-36	0	-39	-36	0	-26	-36	0	-59	-36
Capital/capita**	-9.1	2.6	-2.0	-12.2	4.8	-1.2	-8.1	-2.0	2.1	-9.1	10.4	2.0
GDP/capita**	-9.9	-3.6	-4.9	-14.2	-4.1	-6.1	-9.4	-4.9	-2.8	-10.6	-1.2	-4.1
GDP/capita gap***		6.3	5.1		10.1	8.2		4.5	6.6		9.4	6.5

**Legend:** *SOE* = single-country with small open economy assumption; *CE* = single-country with closed economy; *MC* = multi-country with perfect capital market integration; \* = variation in 2065, compared to 2015 (in %); \*\* = average variation over years 2015 to 2065, compared to 2015 (in %); \*\*\* = average percentage points variation over years 2015 to 2065, compared to 2015; *GDP/capita gap* = difference with *SOE* case. See also table 1

Table 9: Aging and labor tax reforms in three cases, 2015-2065

respectively 12.0 and 11.0 %-points (see appendix A).

The outcomes can be summarized as follows:

**Finding 10.** *Long run projections of the impact of population aging where labor income taxes are used to keep public debts constant are more pessimistic under the small open economy assumption than either the closed economy assumption or perfect capital market integration assumption, sometimes by a significant margin: in 9 countries out of 14, the predicted GDP per capita for each of the next 50 years drops at least 6 %-points more with the small open economy assumption than either of the two other assumptions; in one case, the gap is larger than 11 %-points.*

The reason for such an outcome is directly tied to the assumptions on the interest rate. Life expectancy increases with population aging. With a constant retirement age, households increase saving to maintain consumption after retirement, an intertemporal smoothing mechanism (as evidenced by the assets per capita variation). When the interest rate is flexible (closed economy and multi-country cases), the increasing supply of capital drops its price, which stimulates investment, builds the capital stock and thus reduces the GDP per capita drop<sup>21</sup>. When the interest rate is constant (small open economy case), there is no such investment stimulation mechanism.

The finding has the following methodological implication for the small open economy assumption. In reality, capital markets are neither completely separated (as in the closed economy case) nor perfectly integrated (as in the multi-country case). The creation of the Euro has however increased capital market integration, ahead of goods market integration and far ahead of labor markets integration (Lane, 2006). Further, capital markets have become more integrated for several decades not only in the Eurozone, but outside as well (Longin and Solnik, 1995). Over the long run thus, the multi-country model simulations with perfect capital market integration provide a useful benchmark, arguably close to the future reality. Population aging being a slow and long-run phenomenon, the bias from projections with the small open economy assumption is too large to be ignored. By contrast, the gap is smaller with the closed economy assumption. When projections can only be made with a single-country model, the closed economy assumption should thus be used and the small open economy assumption avoided. Besides, the small open economy assumption may only be valid if one further assumes that the population in the rest of the world is not aging, which is not the case. One should just keep in mind that the closed economy assumption may come with a small to moderate optimistic bias in fast aging countries.

I finish the section with another methodological implication, this time on the closed economy assumption in single-country models, using results in section 3.3.4. As summarized in finding 8, small 2% pension cuts are preferable in Belgium when capital markets are separated, but larger 19% cuts when capital markets are integrated. When capital markets are integrated, the yearly average loss amounts to 1 %-points of GDP/capita

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<sup>21</sup>There is a related additional reinforcing mechanism: the increase of the capital stock pushes the capital-labor ratio up, thus increasing the wages and stimulating labor supply, which further contributes to sustaining production.

over the next 50 years, when the small rather than the large pension cuts are implemented.

From a methodological standpoint, if markets were perfectly integrated, using a single-country model with the closed economy assumption would lead to wrong policy recommendations, with an average yearly cost of 1%-points of GDP/capita over five decades. The same mistaken recommendation would be reached with the small open economy assumption. As noted above, markets are not yet fully integrated, but have become more integrated in recent decades. If the trend continues, the use of single-country models for policy analysis will become problematic, whether one uses the small open economy assumption or the closed economy assumption. In that case, multi-country models with appropriately integrated capital markets will become necessary. Whether such models are already necessary depends on the extent to which capital markets are currently integrated, an open empirical and modelling question left for future research.

## 4 Coordination and policy implications

Implications for policy reforms and coordination are derived from the results in the previous section. I start with an overview and then proceed to details, for each category of implication. A few implications are very similar, differing sometimes only in the formulation. These different formulations are presented here, as the best formulation can depend on the concrete policy case.

Before presenting the implications, it is useful to remember that there were restrictions to the international mobility of capital only a few decades ago and that they have been gradually removed, increasing the integration of capital markets. The creation of the Euro in particular has led to a marked integration of these markets, ahead of the integration of the product markets and far ahead of the integration of the labor markets (Lane, 2006). However, capital markets are not yet fully integrated (Morelli, 2010; Gropp and Kashyap, 2010). Whether full integration takes place is also a matter of policy. There are for instance calls for measures supporting greater integration (e.g. Veron and Wolff, 2016).

### 4.1 Overview

Simulation results have six main implications:

- capital market integration leads to cross-country spillovers and creates losers and winners over the long run, generating new country coalition patterns
- capital market integration strengthens the need for social security reforms due to population aging in some countries, and reduces it in other countries
- capital market integration changes the ranking of pension reform options for some countries
- capital market integration makes increases of the retirement age a more interesting reform option in all countries

- There are rewards for early implementers of retirement age increases (and penalties for late implementers), due to capital market integration and cross-country spillovers
- If countries hold coordination discussions on pensions, they should also discuss capital market integration at the same time

Other implications can be derived. Repeating the six main implications for the sake of completeness, coordination and policy implications can be classified into four categories. The complete overview and classification is the following:

#### **Implications for pension reforms:**

- capital market integration changes the ranking of pension reform options for some countries
- capital market integration makes increases of the retirement age a more interesting reform option in all countries
- For some countries with a high tax burden, capital market integration makes labor tax or social security contributions increases less interesting options

#### **Implications for implementation:**

- capital market integration strengthens the need for social security reforms due to population aging in some countries, and reduces it in other countries
- There are rewards for early implementers of retirement age increases (and penalties for late implementers), due to capital market integration and cross-country spillovers
- Losers from capital market integration should be first movers (on retirement age increases)
- capital market integration makes uncoordinated increases in retirement age a virtuous cycle

#### **Implications for policy coordination:**

- capital market integration leads to cross-country spillovers and creates losers and winners over the long run, generating new country coalition patterns
- If countries hold coordination discussions on pensions, they should also discuss capital market integration
- Countries in coordination discussion should watch out on first movers, not on late implementers (of retirement age increases)

### Other implications and remarks:

- Spreading out the implementation of retirement age increases over time in the hope of reducing the stress on integrated capital markets only delivers losses
- There are no additional benefits due to capital market integration from implementing different types of pension reforms across countries (no free lunch)
- So far, no efficiency gains from coordination have been identified (in production per capita terms), but welfare gains have not (yet) been considered and efficiency gains with other coordination experiments have not been ruled out

It may be useful to remind that the simulation experiments, which lie behind the implications, have all been performed in a modelling setting where the only international spillovers take place through an integrated capital market. Capital is simply assumed to be free to move from country to country without restriction. Labor migration on the other hand is exogenously defined and there is no monetary policy, thus no monetary policy interaction effects. One can thus replace the words *capital market integration* by the words *cross-country spillovers* in each of the implications presented above (and remove duplicates where needed). Which formulation to keep depends on the intended use of the results.

The remainder of this section provides a discussion for each of these thirteen implications, category by category.

## 4.2 Implications for pension reforms

Every pension reform option comes with advantages and disadvantages. Pension cuts for instance help to keep taxes low and thus labor supply and production high, but increase the risk of old-age poverty. Increases in the retirement age have the most favorable impact on production without detrimental distributional consequences but may not conform with workers preferences. Tax and social security contributions increases may be more in line with these preferences but have a negative impact on labor supply incentives and thus production. These general statements hold whatever the organisation of capital markets. The difference with capital market integration is that the way to rank the different pension reforms options needs to be changed, when one uses impacts on production as evaluation criteria. Governments may thus have to change their reform evaluations as capital markets become more and more integrated. The implications discussed below provide guidance on evaluation revisions.

**Implication:** capital market integration changes the ranking of pension reform options for some countries.

The simulation results behind this implication are summarized in section 3.3.4. For instance, simulations show that labor tax increases are preferable to a 20% cut in pension benefits in Belgium with no (low) integration<sup>22</sup>, but the opposite with full (strong)

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<sup>22</sup>More specifically, labor taxes increase alone are preferable to a combination of 20% cuts in pension benefits and (milder) increase in labor taxes. See section 3 for details.



capital market integration: instead of cutting pensions, implementing tax increases lead to an average yearly 0.7 %-points gain in GDP per capita over the next 50 years without integration, but a yearly 0.4% loss with integration. The key reason is that pension cuts have one more benefit under capital market integration: the smaller Laffer curve effect leads to smaller drops in labor supply and returns to investment, whose benefits can only be reaped when foreign investors make use of the integrated capital markets to invest more in Belgium.

**Implication:** capital market integration makes increases of the retirement age a more interesting reform option in all countries.

This implication is derived from various simulation results contained in section 3, in particular findings 5 and 6. Cross-country spillovers indeed generate rewards for countries increasing retirement age while it generates penalties for countries which do not. Further discussion is provided below (section 4.3).

**Implication:** For some countries with a high tax burden, capital market integration makes labor tax or social security contributions increases less interesting options.

Various simulation results from section 3 stand behind this implication. Recall first that increases in retirement age, cuts in pension benefits, increases in social security contributions or labor income taxes are the main reform options. According to finding 5 and 6, there are additional benefits from increasing the retirement age when capital markets are integrated. According to finding 4, some countries with a high tax burden can avoid the negative impacts of capital market integration with pension cuts. Labor tax and social security increases are thus less interesting in that context. Differences between these reform options are of particular importance for countries with an initially high tax burden, given the importance of Laffer curve effects in this case (see section 3.2.1 for details).

### 4.3 Implications for implementation

Once a reform option is chosen, it needs to be implemented. Some options come with a larger political cost than others, for several reasons. For instance, the use of the general budget, indirectly relying on labor income or capital income taxes, is less visible and thus less likely to generate opposition from parts of the population than some reforms of social security, such as retirement age increases. In this section I investigate to which extent cross-country spillovers can help implementation processes.

The second policy implication is directly derived from simulation results and then generates two further implications.

**Implication:** capital market integration strengthens the need for social security reforms due to population aging in some countries, and reduces it in other countries.

Simulations results summarized in section 3.2.1 lead to this policy implication. The three standard pension reforms to ensure the long-term financing of the public pay-as-you-go pension systems are increases in retirement age, cuts in pension benefits and

increases in social security contributions. These reforms are generally more visible to the voter than the use of the general government budget to finance social security deficits, either through debt or tax increases. On many counts however, the passive approach of relying on the general budget delivers worse economic outcomes than active social security reforms. Section 3.2.1 presents one such passive case, where labor income tax variations ensure the financing of increasing social security expenditures when populations are aging. The key result is that outcomes are even worse in some countries when capital markets are integrated, because they age faster, are submitted to a worse drop in labor supply, larger increase in the capital-labor ratio, bigger drop in returns to investment, and thus capital outflows. For instance, GDP per capita in the Netherlands is projected to be an average 4.8 %-points lower in each of the next fifty years with full capital market integration (compared to no integration at all). In that country, integration makes the need for social security reforms bigger. On the other hand, capital market integration helps some countries. GDP per capita is projected to be an average 2.1 %-points higher in France with capital market integration, which thus reduces the need for social security reforms.

**Implication:** There are rewards for early implementers of retirement age increases (and penalties for late implementers), due to capital market integration and cross-country spillovers.

The simulation results which lead to this implication are summarized in sections 3.3.1 and 3.3.2. The yearly rewards and penalties remain moderate, simulations finding an average yearly gain or loss in GDP per capita of around 0.2 %-points over the next 50 years. Accumulated over years or decades, these differences can however become notable. Increases in retirement age before (resp. after) other countries mitigate (resp. worsen) the drop in labor supply per capita due to aging, compared to other countries. This leads to a smaller (resp. larger) relative increase in the capital-labor ratio and larger (resp. smaller) relative increase in returns to investment, attracting (resp. pushing away) capital from the integrated market.

**Implication:** Losers from capital market integration should be first movers (on retirement age increases).

As noted in section 3.2.1, capital market integration leads to redistribution from fast-aging to slow-aging countries, *ceteris paribus*. The previous policy implication, rewards for early implementers of retirement age increases, is thus of particular relevance for fast-aging countries, which can use early implementation as a way to reduce the negative redistributive impacts.

**Implication:** capital market integration makes uncoordinated increases in retirement age a virtuous cycle.

This implication is a consequence from the second policy implication in this subsection. Assume production is the main evaluation criteria. Increases in the retirement age is the preferable pension reform option. In several countries, implementation of such reform are difficult, as it can face opposition from a fraction of the population, often a

sufficient threat for politicians with a high priority on re-election. If only a few countries are successful in implementing such a reform, other countries will pay a penalty, which makes status quo in these countries increasingly costly, an incentive for them to implement retirement age increases sooner rather than later. This virtuous cycle is automatic and does not rely on coordination between countries.

#### 4.4 Implications for policy coordination

First, capital market integration depends to some extent on policy arrangements, including differences across countries. Investor protection for instance differs across countries. Further integration of the markets thus depends on international coordination of policy reforms. Second, our simulations show that there are cross-country spillovers due to differences in the speed of population aging and to country-specific tax and pension policy. If countries want to tackle jointly the cross-country redistributive effects of aging differentials and social security policy, international coordination is needed. Below I provide implications for such policy coordination efforts, and note that discussions on the two topics, capital market integration and social security reforms, are related.

**Implication:** capital market integration leads to cross-country spillovers and creates losers and winners over the long run, generating new country coalition patterns.

Section 3.2.1 leads to this implication. Redistribution generated by capital market integration over the long run is sizable: for instance, when labor income taxes are used to cover the social security costs of population aging, capital market integration leads to yearly average gains in GDP per capita exceeding 2 %-points in some countries over the next 50 years, and yearly losses larger than 4 %-points in other countries. From our sample of 14 countries, five benefit from integration (Finland, France, Italy, Sweden and the UK), one essentially is not impacted (Austria) and eight lose (Belgium, the Czech Republic, Denmark, Germany, the Netherlands, Poland, the Slovak Republic and Spain). In most cases, the first group of countries ages slower and is thus exposed to a slower increase of the capital-labor ratio, leading to higher relative returns to investments and attracting capital from other countries.

Recall that capital markets are not yet fully implemented and that further integration is, to some extent, a matter of policy coordination, such as harmonization of investor protection. The dividing line between countries which benefit or lose from capital market integration over the long run is not the same as the lines which separate countries on other topics of economic policy. There are different views on social security conditions attached to labor market integration, for instance. Typically, less developed countries are not interested in setting the higher social security standards that more developed countries expect. There are however both less and more developed countries which stand to lose from further capital market integration. Capital market integration thus creates different coalition patterns.

**Implication:** If countries hold coordination discussions on pensions, they should also discuss capital market integration at the same time.

This implication follows from simulation results summarized in section 3.3.4. Currently, European Union countries have scheduled different adjustments of their pension benefit schemes (see Ageing Working Group, 2015). Belgium, for instance, plans a small decrease of 2% of its pension benefit replacement rate, while the average over the 14 countries of the simulation sample is a decrease of 19%. Assume EU countries hold discussions to harmonize the adjustment of pension reforms and consider an option where all countries implement this average 19% cut. Then Belgium would lose a yearly average 0.7 %-points of GDP per capita over the following 50 years if capital markets were not integrated, but gain an average 0.4 %-points if these markets were fully integrated. The yearly average differential is 1 %-point over the next 50 years, a significant number. Whether capital markets are fully integrated or not would change the position of a country like Belgium. Coordination discussions on pension reforms should thus be held at the same time as discussions on the policy measures furthering the integration of capital markets. In the case of pension benefit reforms, the stronger the measures to further integrate capital markets, the larger the support from Belgium to strong cuts of pension benefits<sup>23</sup>.

**Implication:** Countries in coordination discussion should watch out on first movers, not on late implementers (of retirement age increases).

Simulation results leading to this implication are presented in sections 3.3.1 and 3.3.2. This implication is the coordination version of the second implication in section 4.3, rewards for early implementers and penalties for late implementers. Countries which want to neutralize redistribution due to differences in implementation timing should thus pay attention and speed up coordination discussion when there are early implementers, but not if some partners delay implementation. As noted in section 4.3, the yearly production rewards or losses are moderate, but can accumulate to notable values over the years. Thus, the need for discussions does not immediately follow early implementation. However, the longer the delay in discussions, the longer the accumulation of rewards by early implementers.

## 4.5 Other implications and remarks

This section provides other policy implications from the simulation results which are no less important but negative, rather than positive. In other words, it discusses reform ideas which do not work. The section also provides a remark on potential gains from coordination.

**Implication:** Spreading out the implementation of retirement age increases over time in the hope of reducing the stress on integrated capital markets only delivers losses.

Simulation results summarized in section 3.3.3 stand behind this policy implication. A higher retirement age increases the labor supply, depress the capital-labor ratio and thus increase returns to investment. If all countries raise the retirement age at the

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<sup>23</sup>It is beyond the scope of this project to make a comprehensive evaluation of pension reforms coordination options. Analyses of the impact for all countries of the European Union, for each reform type, is left for future research.

same time, the drag on capital markets is large. One could thus hope that spreading out retirement age reforms over time would deliver some efficiency gains, by reducing the stress on capital markets. Simulations shows that the opposite happens, mostly because significant capital stock variations require a lot of time, so that implementation lags bring little gains from temporarily re-balancing international investment portfolios; instead, factor supply gains in countries delaying retirement age reforms are simply lost (see section 3.3.3 for details). The idea of spreading out retirement age reforms over time should simply be dropped.

**Implication:** There are no additional benefits due to capital market integration from implementing different types of pension reforms across countries (no free lunch).

Section 3.3.5 leads to this implication. The paper showed that cross-country spillovers lead to redistribution across countries and that they are influenced by the type of pension reforms. One could hope that the implementation of different types of reforms in different countries generate some gains. Finding 9 shows that no such thing happens. In other words, there is no free lunch from diversity in reform types across countries.

**Remark:** So far, no efficiency gains from coordination have been identified (in production per capita terms), but welfare gains have not (yet) been considered and efficiency gains with other coordination experiments have not been ruled out.

One question in the project was the quantification of (potential) gains from coordination of economic policy under aging populations. When the gains are measured in efficiency terms (production per capita), experiments carried out in section 3 have not identified any coordination gains. Some countries indeed gain over the long run from capital market integration, other countries lose, but it is a zero sum game: scaling by economic size, the weighted average yearly impact on GDP per capita is close to zero<sup>24</sup>. However, it could be a positive sum game (coordination gains) with other policy experiments. The research presented here has not ruled out such a possibility.

The point of view of governments, which tend to focus on GDP as main indicator for economic policy, has been taken in this project. The point of view of households, who balance consumption gained through labor with leisure, was out of the scope of the research. Welfare analyses could thus reveal that capital market integration, with or without the social security reforms considered in section 3, deliver coordination gains, measured in welfare terms. For instance, countries with a slow aging population, which benefit from cross-country redistribution via the integrated capital markets, could increase the retirement age less than other countries, losing some of the capital and production gains but winning with leisure. Welfare gains in all countries might thus be possible. This investigation is left for future research.

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<sup>24</sup>One can verify it for instance by a weighted average of values in each of the last columns of the tables in appendix A. The sum might slightly differ from 0 due to precision. See also the end of section 3.2.1.

## 5 Concluding remarks

This document summarizes the results of a research project on international spillovers due to capital market integration when population ages, using a multi-country overlapping-generations model calibrated for 14 European Union countries.

The first key finding is that differences in population aging speed generate redistribution across countries. When no social security reforms take place and labor income taxes are increased to ensure sustainable public finances, GDP per capita can be more than 4 %-points lower under perfect capital market integration in fast aging countries than under completely separated capital markets, as yearly average over the next five decades. In slow aging countries, GDP per capita can be more than 2 %-points higher. Labor supply indeed drops more in fast aging countries, pushing up the capital-labor ratio more, which depresses returns to investment more and generates capital flows towards slow aging countries, supporting production there.

The second key finding is that tax and pension policy influence redistribution patterns. Some countries lose from capital market integration when no social security reform is implemented, but gain from it when the same reform is implemented in all countries.

Finally, capital market integration influences the relative performance of different tax and social security reforms. In particular, it makes retirement age increases a more interesting option. In some countries, labor tax increases are preferable to pension cuts under separated capital markets, while it is the opposite with fully integrated capital markets.

The research also has methodological implications. In particular, it shows that the small open economy assumption, frequently used for quantitative analysis with single-country models, leads to pessimistic biases which can exceed 10 %-points, in yearly average GDP/capita terms over the next five decades.

An immediate policy implication is that capital market integration increases the need for social security reforms in some countries, but eases it in other countries. Capital markets are not yet completely integrated. Countries which want to tackle jointly the redistribution effects of population aging thus need to discuss social security reforms and deeper capital market integration at the same time.

The research can be continued in different directions. I mention some of the most interesting options. First, welfare analyses can be performed. In this paper, the point of view of governments was taken, which tend to focus on production and public finance outcomes. Although the analyses did not rule out potential efficiency gains from coordination, it did not find any. One could take the point of view of households, looking for potential welfare gains from coordination. Second, an endogenous migration component can be added. In this paper, international migration is taken as given, from demographic projections. In reality, capital-labor ratios and thus wages will be increasing more in fast aging countries. Migration towards fast aging countries should thus increase, reducing the magnitude of cross-country redistribution.

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## A Appendix: overview of results for all countries

This appendix provides an overview of the results for all countries for the main scenarios, focusing on the main macroeconomic indicator (average GDP/capita variations over the next 50 years). The legend of the tables follows those of tables 1 and 9.

	Dependency ratio		GDP/capita change (%)				
	2015	2065	Average 2015-2065				
			SOE	CE	MC	Gap MC-SOE	Gap MC-CE
Austria	0.28	0.50	-15.7	-8.1	-8.1	7.6	0.0
Belgium	0.29	0.41	-9.9	-3.6	-4.9	5.1	-1.3
Czech Republic	0.27	0.51	-13.3	-6.0	-7.6	5.7	-1.6
Denmark	0.29	0.42	-14.2	-4.1	-6.1	8.2	-1.9
Finland	0.31	0.45	-8.7	-3.4	-2.6	6.0	0.8
France	0.30	0.47	-9.4	-4.9	-2.8	6.6	2.1
Germany	0.35	0.60	-10.6	-1.2	-4.1	6.5	-2.9
Italy	0.34	0.54	-13.1	-5.9	-4.6	8.5	1.3
Netherlands	0.28	0.48	-15.0	-3.1	-7.9	7.1	-4.8
Poland	0.24	0.58	-12.9	-7.4	-9.0	4.0	-1.6
Slovakia	0.22	0.53	-15.2	-7.8	-8.8	6.3	-1.1
Spain	0.29	0.63	-16.3	-4.2	-5.2	11.0	-1.0
Sweden	0.31	0.42	-10.2	-4.5	-4.3	6.0	0.3
United Kingdom	0.28	0.44	-10.4	-7.1	-5.7	4.7	1.4

Table 10: Aging and labor tax reforms, all countries, 2015-2065

	Dependency ratio		GDP/capita change (%)		
	2015	2065	Average 2015-2065		
			CE	MC	Gap MC-CE
Austria	0.28	0.50	-3.9	-2.6	1.3
Belgium	0.29	0.41	-1.2	0.5	1.8
Czech Republic	0.27	0.51	-2.5	-3.1	-0.6
Denmark	0.29	0.42	-0.9	-0.2	0.8
Finland	0.31	0.45	1.0	1.7	0.7
France	0.30	0.47	0.2	2.9	2.7
Germany	0.35	0.60	4.0	1.1	-2.9
Italy	0.34	0.54	-1.6	1.5	3.1
Netherlands	0.28	0.48	1.1	-2.7	-3.8
Poland	0.24	0.58	-2.0	-3.7	-1.6
Slovakia	0.22	0.53	-3.6	-4.6	-1.0
Spain	0.29	0.63	1.5	0.6	-0.9
Sweden	0.31	0.42	0.2	1.5	1.3
United Kingdom	0.28	0.44	-3.1	-2.0	1.1

Table 11: Aging, retirement age and labor tax reforms, all countries, 2015-2065

	Dependency ratio		GDP/capita change (%)		
	2015	2065	Average 2015-2065		
			CE	MC	Gap MC-CE
Austria	0.28	0.50	-7.9	-7.8	0.1
Belgium	0.29	0.41	-4.5	-4.5	0.0
Czech Republic	0.27	0.51	-5.8	-6.8	-1.0
Denmark	0.29	0.42	-3.8	-5.5	-1.7
Finland	0.31	0.45	-3.4	-2.7	0.7
France	0.30	0.47	-4.6	-2.5	2.1
Germany	0.35	0.60	-1.2	-4.1	-2.9
Italy	0.34	0.54	-5.7	-4.4	1.3
Netherlands	0.28	0.48	-2.9	-7.7	-4.8
Poland	0.24	0.58	-7.1	-8.6	-1.5
Slovakia	0.22	0.53	-7.7	-8.8	-1.1
Spain	0.29	0.63	-4.2	-5.3	-1.0
Sweden	0.31	0.42	-4.8	-4.1	0.7
United Kingdom	0.28	0.44	-6.9	-5.6	1.3

Table 12: Aging, pension benefits and labor tax reforms, all countries, 2015-2065

## B Appendix: transition path aging and tax scenario

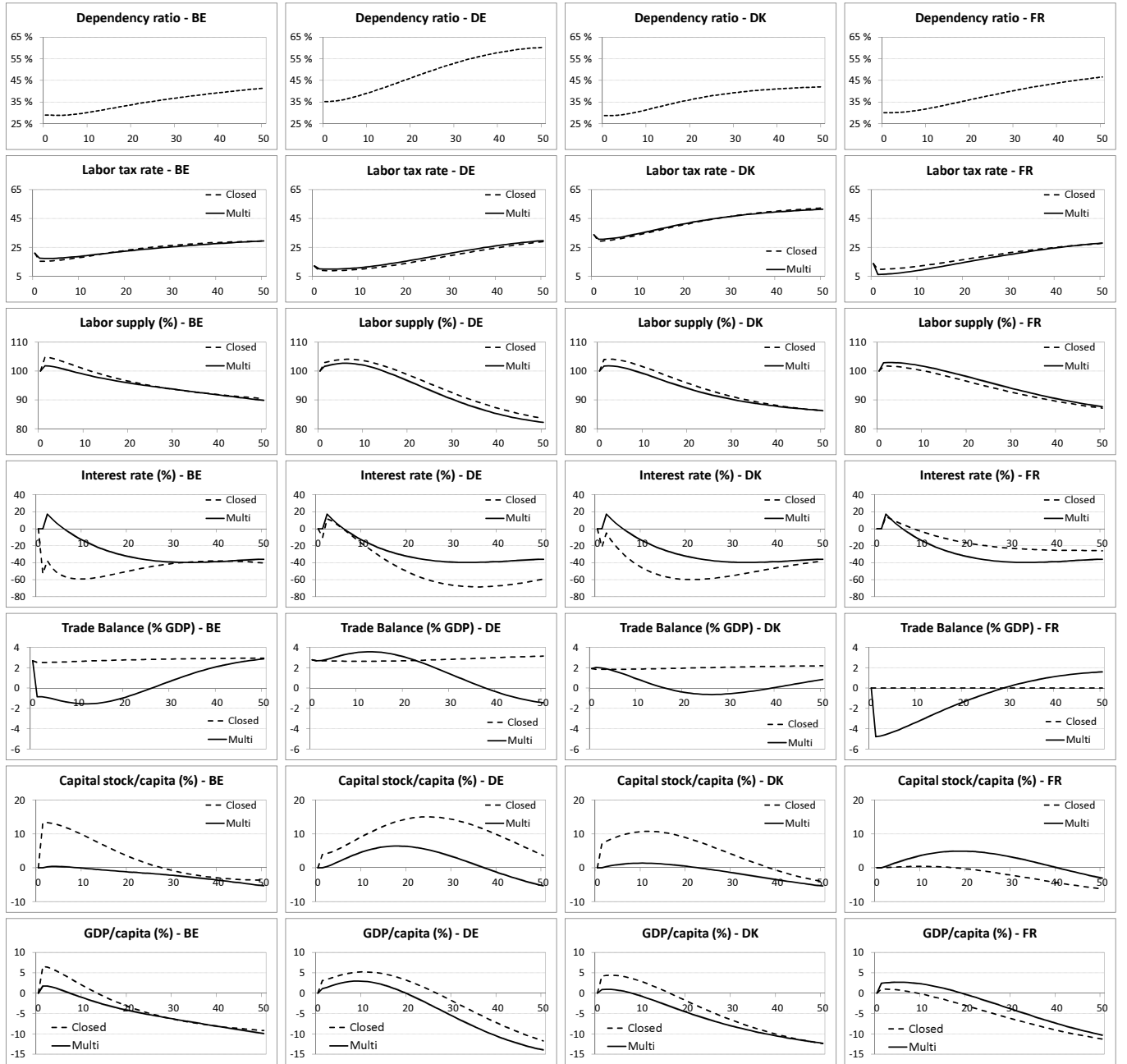


Figure 5: Aging and labor tax reforms, key economic variations, 2015-2065

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Title: Population aging, pensions and cross-country spillovers in currency unions

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