Making Decision Planning work for Pensions in a Small Open Economy

Marion Laboure*

May 3, 2017

Abstract

The pension system brings challenges in many developed countries. While the system was set up at the time of economic growth, policymakers are facing both economic slowdown and aging population. Moreover, there is an incentive mis-match between short to medium term popularity and re-election versus taking necessary decisions to affect long-term sustainability of the system.

In a small open economy, the situation is further accentuated by high volatility driven by migrations and cross-borders workers. This paper aims to address the policymakers' challenges in these type of economies by providing both a highly innovative modeling taking into account not only population aging but also the cohort of cross borders workers and their entitlement to the partial pension in the future. It also provides an approach to analyze issues at stake and remove decision biases faced by politicians through policy options and their impact under various economic scenarios.

We illustrate this approach through the case of Luxembourg and its pension challenge at horizon 2060 under three highly plausible scenarios: the "Successful economic reorientation", the "Progressive convergence to normal", and the "Perfect storm".

Keywords: Aging; Population; Small Open Economies; Pensions; Decision Planning; Government Strategy; Optimism bias; Planning fallacy; Reference class problem.

1 Introduction

The sustainability of the pension system is being challenged in most developed countries. While the system was set up at the time of economic growth, policymakers are facing both economic slowdown and aging of the population. In order to correct for further long-term imbalances, policymakers can only take unpopular measures such as delaying retirement age, increasing contribution on current working population or decreasing pensions.

The problem is further accentuated in a small open economy where the future is much harder to predict. Some economies benefited from a strong migration of young workers which helped to balance the pension, but they may not be replicated to the same magnitude in the future. Similarly, the size of the workforce and the age pyramid are moving targets as the comparative attractiveness of the local economy and wages can create strong inflows of workers in both the directions from the larger neighboring countries.

*XXX

As a result, it is rather difficult for the policy makers to first forecast the future and the magnitude of the challenges and then to decide which policy is currently the best for implementation. The issues may look far away and less tangible, especially for social welfare and aging issues such as pensions with a twenty-thirty years' horizon and a large time gap between decisions making, policy implementations and observed outcomes.

There is an incentive mis-match between short to medium term popularity and re-election and taking necessary decisions to affect the long-term sustainability of the system. Besides, there are multiple theoretical political reasons explaining why it is difficult to influence policies and put in place reforms such as the fear or public opinion, the "free rider theory"[1] ((Alesina and Drazen, 1991), (Velasco, 2000)), the lobbyist activity (Tornell, 1998), the "pork barrel"[2] problem or the "optimism bias"[3].

The "Planning Fallacy" theory first developed by Kahneman and Tversky (1979) underlines the phenomenon in which the predictions about how much time would be needed to complete a future task, displays an optimism bias and underestimates the time needed. This phenomenon occurs regardless of the individual's knowledge that similar previous tasks have taken longer to complete than generally planned ((Buehler et al., 1994), (Koole and van't Spijker, 2000)).The bias only affects predictions about one's own tasks; when outside observers predict task completion times, they show a pessimistic bias, overestimating the time needed ((Buehler et al., 1995), (Buehler et al., 2002)). Lovallo and Kahneman (2003) proposed an expanded definition as the tendency to underestimate the time, costs, and risks of the future actions and at the same time overestimate the benefits of the same actions. According to this definition, the planning fallacy results in not only time over-runs, but also cost over-runs and benefit shortfalls.

The theories behind "reference class forecasting" were developed by Kahneman and Tversky[4][5]. They found that human judgment is generally optimistic due to overconfidence and insufficient consideration of distributional information about outcomes. Therefore, people tend to underestimate the costs, completion times, and risks of planned actions, whereas they tend to overestimate the benefits of those same actions. Such error is caused by actors taking an "inside view", where the focus is on the constituents of the specific planned action instead of the actual outcomes of similar ventures that have already been completed.

Kahneman and Tversky concluded that regardless of the distributional information, risk is perhaps the major source of errors in forecasting. Based on this, they recommended that forecasters "should, therefore, make every effort to frame the forecasting problem so as to facilitate utilizing all the distributional information that is available" (Kahneman and Tversky, 1982). Using distributional information from the previous ventures, similar to the one being forecasted, is called taking an "outside view". Reference class forecasting is a method for taking an outside view on the planned actions.

In our paper[6], we use the "reference class forecasting" approach to study the evolution of

[1] Emphasizing that while reforms are necessary for the collectivity, each group tries to avoid sharing the burden.
[2] Consisting in endless debates rather than action where everybody wants to prove they are right.
[3] Rejecting that when consensus expects situation to improve naturally, reforms may appear less necessary.
[4] See Kahneman and Tversky (1982) and Kahneman and Tversky (1979).
[5] Kahneman earned the Nobel Prize in 2012 "for having integrated insights from psychological research into economic science, especially concerning human judgment and decision-making under uncertainty".
[6] Very few policy articles refer to game theory in leading journals. Table 4 presents the articles found: Windle

a small open economy's pension's equilibrium between 2015 and 2060, in order to reduce the policy making biases. This involves the following three steps. First, we start by identifying a reference scenario of past, similar, continuous economically successful visible trend: the 'Successful economic reorientation'. Then, we establish a probability distribution for our reference scenario and create two alternative scenarios: the 'Progressive convergence to normal', and the 'Perfect storm'. We then assess a set of policy actions and assess their impacts in each of these scenarios. It leads to discussions on risk assessment under uncertain outcomes, where policymakers can have a rationale debate about "insuring" for the future economic volatility.

This paper also addresses a modeling issue specific to small open economies: how to forecast and assess future contribution and liabilities when a large proportion of the workforce is made of either cross-border workers or recent emigrants. These migrants or cross-border workers work for a short period of time, yet are entitled to receive pensions and other social benefits at least partially. It is further challenging as the churn of cross-borders is very important. For example, assuming 100 cross-border workers in year N and the same number in year $N+1$, a large proportion of the 100 workers in the two years will be different persons.

To address this challenge of forecasting future liabilities, we use a highly innovative modeling taking into account not only population aging but also yearly cohort of cross-border workers and their entitlement to partial pension in the future. It not only allows us to assess the state liabilities but also the evolution of age pyramid with a significant portion of new migrants.

The purpose of this paper is to provide a unique modeling of pensions in a small open economy, using a process that leverages game theory, to make decisions under high volatility and uncertainties.

The remainder of this paper is organized as follows. Section 2 describes the model. Section 3 takes the model and scenario-based approach to the applied case of Luxembourg pension reform.

2 The model

2.1 The demographics

Total population P at year t is defined as the sum of the total population being aged from 0 to 95 years at year t.

$$P_t = \sum_{a=0}^{95} P_{a,t}, \tag{1}$$

2.1.1 Resident and non residents

We assume a country with an open labour market economy. Population in this country is made up of residents and cross-borders. We call "residents" or "home population" citizens who officially live in the country. We call "cross-borders" citizens who live in the bordering countries and may supply the labor force in the home country. We denote residents and cross-borders by the superscripts r as resident and c as cross-border respectively hereafter.

and Neigher (1978), Peters et al. (1986), Langbein (1994), Niklasson (1998), Scriven (1996), Feller (2002) and Sharkey and Sharples (2008).

2.1.2 Forecasting resident population

To determine the number of resident pensioners, we must know the structure of the total population in the home country which is calculated from the survival probability rate, the fertility rate and the number of net migrations.

The resident population aged of a years at year t is forecast by

$$P^r_{a,t} = P^r_{a,t}\beta^r_{a,t}\phi^r_{a,t} + B^r_{a,t} + X^r_{a,t} \tag{2}$$

where β is the survival probability rate, ϕ a coefficient reflecting the longer life expectancy, B the number of births, and X the number of net migrations[7]. The number of net migrations is split proportionally across the ages of 25-40 (15 years).

2.1.3 Structure of population

In order to determine the number of retired resident people, we must determine the structure of the population. We assume people to be aged less than 15 years to not work and people aged more than 65 years to be retired.

We determine the number of people who contribute to finance the pension system with the participation rate. We take the participation rate as it refers to the number of people who are either employed or are actively looking for work and both workers and people benefiting from unemployment allowances contribute to finance the pension system.

2.1.4 Forecasting cross-border population

Cross-borders may come from several countries. For simplicity reason, we will consider that cross-borders come from a large closed economy.

Similarly, the cross-border population aged of a years at year t is forecast by

$$P^c_{a,t} = P^c_{a,t}\beta^c_{a,t}\phi^c_{a,t} + B^c_{a,t} \tag{3}$$

where β is the survival probability rate, ϕ a coefficient reflecting the longer life expectancy and B the number of births.

2.2 The labor market

2.2.1 Key categories

There are three different type of agents.

First, people who neither contribute nor benefit from pension allowances such as individuals below 15 as they are either enrolled at school or nursery.

Second, people in the labor force who contribute to finance the pension system (people aged from 15 to 55 who work or are unemployed).

Third, people who benefit from pension allowance, for example all individuals aged 65 or above are inactive, so that 65 is the legal and compulsory retirement age.

We assume the population to be aged from 55 to 65 can either contribute to the pension system or to benefit from a pension allowance. As our objective is not to explain participation rates of individuals of working age across time or over the life cycle, we take the participated rate as exogenous.

[7]By definition, the number of net migration is the number of people moving into a country less the number of people moving out of the same country.

$$P_{a,t} = S_{a,t} + L_{a,t} + N_{a,t} \tag{4}$$

where $0 \leq a \leq 95$, P is the population, S is the number of people enrolled at school (or nursery), L is the number of people in labor force, and N is the number of retired people.

$$L_{a,t} = U_{a,t} + E_{a,t} \tag{5}$$

where U is the number of unemployed people, and E is the number of employed people.

2.2.2 Resident population

The resident population is defined by

$$P^r_{a,t} = S^r_{a,t} + L^r_{a,t} + N^r_{a,t} \tag{6}$$

where $0 \leq a \leq 95$, P^r is the resident population, S^r is the number of people enrolled at school (or nursery), L^r is the number of people in labor force, and N^r is the number of retired people.

$$L^r_{a,t} = U^r_{a,t} + E^r_{a,t} \tag{7}$$

where U^r is the number of unemployed people, and E^r is the number of employed people.

2.2.3 Crossborder population

The cross-border population is made of employed, unemployed and retired people only. There is no people in education, unlike in the resident population. The cross-border workers are defined by

$$P^c_{a,t} = E^c_{a,t} + U^c_{a,t} + N^c_{a,t} \tag{8}$$

where $0 \leq a \leq 95$, P^c is the total number of cross-borders being employed, unemployed and retired, E^c is the number of employed people in the home country from another country, U^c is the number of unemployed people, and N^c is the number of retired people having worked in the home country and benefiting from pension allowance.

2.3 The pension payments

2.3.1 Forecasting pensions quantum

The total number of pensions granted by the home country government is the sum of the pensions of residents and the pensions of cross-borders.

$$N^{tot} = N^r + N^c \tag{9}$$

where N^{tot} is the total number of pensions granted, N^r is the number of pensions granted for residents and N^c is the number of cross borders pensions.

Primary spending is the sum of the number of retired resident by the average resident pension and the number of retired cross-borders[8] by the average cross-borders pensions.

[8] In Luxembourg, the average pension for residents is higher than the cross borders one as most of cross borders only do a partial career in Luxembourg and therefore do not benefit from a full pension allowance but only a partial one.

As a result, primary spending is defined as

$$S_t = (N_t^r W_t^r) + (N_t^c W_t^c) \tag{10}$$

where S stands for primary spending, N the number of pensions granted and W the average pension allocation. The subscript r and c refer to the resident and the cross-border populations.

2.3.2 Forecasting resident pension

Pension Laws distinguish between, on the one hand, the adjustment of pensions to the cost of living, based on the evolution of the price index for domestic consumption (IPCN) and, on the other hand, the adjustment of pensions to living standard, based on the increase in real wages (not indexed) due to productivity gains. To sum up, pension allowance is calculated as follow

$$W_t = W_{t-1}\tau_t(SR_t)R_t \tag{11}$$

where W is the pension allowance, τ is the inflation growth rate, SR is the real wage growth rate and R is the impact of the 2013 pension reform.

In order to forecast pension allowance, we depart from the previous year average pension allowance published. The forecast of the average pension is made from the average pension of previous year, the expected real wage growth, the anticipated rate of inflation and a corrective factor taking the most recent reform into account. We assume the real wage growth to rise in line with the nominal GDP and inflation growth rates.

2.3.3 Forecasting cross border pension

Most cross-border workers only work for a few years in Luxembourg and hence are entitled to a partial pension when they retire. We model the yearly cohort of cross-border workers and the partial entitlement of each cohort when it retires after a few years, taking into account the high volatility of workers and is the most suited model of the underlying future liability for the Luxembourg pension system.

For each year worked, the average pension as percentage of one year revenues is approximated by $\frac{Averagepension}{Averagerevenue}$*Average career length.

2.4 The pension financing

2.4.1 Number of workforce population

The total number of the workforce in the home country is the sum of the resident workforce and the cross borders.

$$L^{tot} = L^r + L^c \tag{12}$$

where L^{tot} is the total labor force in the home country, L^r is the number of residents workforce and L^c is the number of cross borders workers. Both workers and unemployed people contribute to the pension system.

2.4.2 Contribution per worker

Primary revenue is made up of pension contribution and exclude net assets. It is defined as

$$R_t = \delta_t(W_t^r L_t^r + W_t^c L_t^c) \tag{13}$$

where R stands for primary revenue and δ the pension contribution rate[9]

3 Illustration

3.1 Economic Context

Luxembourg is a wealthy country in Europe with a robust economy, which benefited from strong economic growth in the past twenty years. In 2015, Luxembourg was ranked as having the second[10] highest per capita GDP (after Qatar) in the world at $\$98,987$ (International Monetary Fund, 2016). Luxembourg developed as a banking and an administrative center and currently is a key financial center in Europe and globally with 46% of its GDP generating from the financial services. Luxembourg also hosts the headquarters of several European institutions such as the European Investment Bank, the European Investment Fund, and the European Stability Mechanism, to name a few.

This economic success was due to its capacity to rebalance the economy. In the 1970s, Luxembourg redirected its economy from industrial focus and metallurgy towards administrative and financial services. This highly successful reconversion resulted in economic growth and has attracted new workers in Luxembourg. According to the World Bank, the population has nearly doubled in 35 years from 364,150 in 1980 to 569,676 in 2015. The role played by the financial sector in the Luxembourg economy kept growing since the 1980s to become the main driver. From 1986 to 2007, the average annual growth rate of GDP was 5.7%, more than twice the average growth recorded in the neighboring countries. Financial activity resulted in migration and cross-border workers coming especially from France, Belgium, and Germany. Currently, the employment market is really competitive compared to the neighboring countries (the unemployment rate stood at 7.1% in 2014). Public finance situation is in a strong shape with a net surplus (of 1.2% of GDP in 2015) and a low public debt (21.4% of GDP in 2015).

The economic growth is expected to slow down and as such the increase in an influx of younger workers. The global financial crisis of 2008, affected the Luxembourg economy and, primarily its financial sector as banks in Luxembourg were exposed to the performance of their parent banks abroad (International Monetary Fund, 2011). At the beginning of the 21st century, Luxembourg was forced, with the end of the secret banking area, to redirect (again) its economy from financial services towards aeronautical and spatial research and wealth management. Given the size of its small open economy, a strategic reorientation was possible and could significantly impact the economy.

With a slowdown in the economic growth and an aging population, the implicit debt of Luxembourg may explode in the coming decades. This could affect the future capacity to pay generous pensions. Government has already started reforms. According to the Working Group of Aging set up by the European Commission (Directorate-General for Economic and Financial Affairs, 2015a), pension spending in Luxembourg is expected to record the strongest growth in

[9]Contribution rate, currently at 24%, is equally split between employees, employers and Government. If expenditure becomes higher than revenue, the contribution rate could be raised by 2pp for all contributors (so the contribution rate could increase to 30%).

[10]However, especially in the case of Luxembourg, GDP per capita is biased on the upside as it includes the significant contribution of cross borders to value added. For Luxembourg, GNI per capita would be a more appropriate indicator than GDP per capita (though Luxembourg's GNI per capita is also one of the highest in the world). However, we focus on GDP per capita to compare our results to those of other institutions (as for instance the Aging Working Group).

the European Union from 9.4% of GDP in 2013 to 13.4% of GDP in 2060. This will pose some risk regarding the sustainability of the current system.

Moreover, the current balance in the healthcare and pension system is largely the result of a manifest imbalance under which the non-residents account for 40% of the contributions' revenue but only 20% of expenditure (Le Gouvernment du Grand-Duché de Luxembourg, Ministére de la Sécurité sociale, 2015). It means that with unchanged policies, the active population will have to double every 30 to 40 years to keep the system viable.

Luxembourg government made a pension reform in 2013, but limited the scope and did not substantially address the threat posed to the long-term sustainability of public finances. For instance, the reform only partially addressed the large gap between the statutory and the effective retirement age. Against a background of an effective-retirement age that stood at 58.9 in 2012 compared with the statutory retirement age fixed at 65, the reform still maintained the possibility of an early retirement at 57 or 60.

We will study the potential economic scenarios on the Luxembourg pension system as an illustrative case study of public finance challenges faced by the small open economies. Between 2015 and 2060, we consider the evolution of four factors: (i) macroeconomic, (ii) demography of residents, (iii) cross-border inflows, and (iv)pension policies[11] (retirement age, pension levels, and pension financing).

This paper incorporates three different scenarios.

Scenario 1: 'Successful economic reorientation', Luxembourg manages to succeed its strategic business reorientation from financial services towards aeronautical and spatial research and wealth management. This reorientation results in a sustained economic growth and a continued increase of net migrations from now till 2060.

Scenario 2: 'Progressive convergence to normal', Luxembourg's financial activities slow down due to the end of secret banking and firms relocate their businesses to other countries. Investments into new economic activities are not sufficient to maintain a strong economic outperformance.

Scenario 3: 'Perfect storm', Luxembourg's competitive advantage as a headquarter of banks and e-commerce companies is vanishing and no strong relay of growth is found. Not only does the economy converges to its neighboring countries but also suffers from a correction. This scenario strongly impacts the prospects of net migration and cross-border workers.

3.2 Calibration and data sources

Our aim is to use the model to (i) forecast expenditure and revenue of the pension system in Luxembourg; and (ii) prescribe policy recommendations regarding the sustainability of the long-run pension system.

In this paper, we use time series from 2001 to 2016 depending on availability from the Luxembourg National Statistical Office[12] (STATEC) and the European Commission database[13] (AMECO). Actual numbers for the total population by age and year and survival probability rates are from the STATEC; effective exit age is published by the IGSS; average pension allowance is available in the 2015 IGSS General Report.

[11] All the measures voted end 2012 are effective over the considered horizon. The reform basically implies a progressively less generous pension system.

[12] Les Portail des Statistiques (2010), Les Portail des Statistiques (2014b), Les Portail des Statistiques (2014c) and Les Portail des Statistiques (2014a).

[13] Directorate-General for Economic and Financial Affairs (2015b), Directorate-General for Economic and Financial Affairs (2015a) and Directorate-General for Economic and Financial Affairs (2012).

For the forecast, we take the following approach. First, we model the development of the economy such as economic growth, inflation, average gross income and real wage growth. Second, we set the demographics of the "stable" population: life expectancy, mortality and fertility rate per woman. Third, we model the broader exchanges (impacted by economic development): net migrations and cross-border workers. Finally, we model the policy in place: average effective departure age, pension contribution as a percentage of gross income and average level of pensions.

The model is highly innovative in the way it models cross-border workers' contributions and impacts. Most cross-border workers only work for a few years in Luxembourg and hence are entitled to a partial pension when they retire. In this paper, we model the yearly cohort of cross-border workers and the partial entitlement of each cohort when it retires after a few years. This model takes into account the high volatility of workers and is the most suited model of the underlying future liability for the Luxembourg pension system.

3.3 Baseline assumptions on the future

Luxembourg's pay-as-you-go pension system is generous and currently generating surpluses. Its effective retirement age is low (Figure 7) while its replacement rate (average pension benefit as a share of average wage at retirement) is amongst the highest in Europe. This system is at equilibrium because the population has nearly doubled in the past forty years, with new population inflows coming as contributors and not beneficiaries.

However, pension expenditures are expected to increase significantly over time as the recent migrants are retiring. The population growth may also slow down. The core value of this model is to assess the potential future scenarios for the economy and its impact on pension sustainability. The most impacting variables (that are also correlated) are (i) demography (residents); (ii) cross-border workers (nonresident working in Luxembourg); and (iii) economic activity. We briefly describe these different assumptions below.

First, demography is hard to predict and differs a lot across institutes. Population ranges from 700,000 inhabitants according to the AWG2012 to 1,100,000 inhabitants according to the AWG2015 in 2060. Most institutes forecast a total population of around 700,000 inhabitants by 2060 and use a linear forecast extension to come to a continued growth. This, of course, makes the underlying assumptions of a continued economic outperformance and as such capacity to attract new workers.

Migrations, cross-border workers and economic growth are closely correlated as shown in Figure 1. Economic growth drives activity and migration and the other way round holds true too. Potential GDP depends on two components, namely, demography and activity. While it is relatively acknowledged that with the aging of population, the working share of the working population will decrease; the total population is expected to rise till 2060 due to an expected increase in economic growth. Projecting these subcomponents is possible and necessitates taking a view on the activity and the success of the country to make the strategic business reorientation. The AWG2015 forecasts potential GDP growth from 1.4% y/y in 2013 to 3% in 2035 and then to slow to 1.9% in 2060. In contrast, the OECD ((OECD, 2015))forecasts a real GDP growth of 1.4% in 2060.

We do a bottom-up forecast with three main components determining demography (i) organic growth of the current population (driven by fertility rate and life expectancy), (ii) net migrations and (iii) cross-border inflows. While the first is relatively predictable, the second and the third are less so and are highly volatile and correlated with economic activity.

We take the following approach for each of the components:

(i) Organic growth of the current population: life expectancy and fertility rate are relatively stable across statistical agencies. They are in line with forecasts of other countries and fluctuates relatively little over the years. For instance, the STATEC forecast Les Portail des Statistiques (2014b), in the Bulletin No. 5 published in 2010, life expectancy at birth to be 84.5 (vs. 84.9 in the AWG2015) for men and 88.5 (vs. 89.5 in the AWG2015) years for women and a fertility rate of 1.72 (vs. 1.68 in the AWG2015) in 2060. We make similar assumptions as made by most of the state agencies.

(ii) Net migrations: Net migrations strongly differ across statistical agencies and are responsible for the sharp revision of population from the AWG2012 to the AWG2015. The AWG2015 forecasts 10,800 net arrivals per year on an average from 2015 to 2040. The Luxembourg National Statistics Office (STATEC) forecasts that the net migrations are expected to be around 3,370 people per year on an average between 2020 and 2060. We take three scenarios with net migration growing at 8,500 per year in case of continued economic outperformance, 3,500 per year in case of convergence to normal and 300 in case of the perfect storm.

(iii) Cross-border inflows: in the case of Luxembourg, the evolution of cross-border worker inflows is a key, with direct effects on the labor supply in the model. Non-residents account for 45% of the contributions' revenue but only 20% of pension's expenditure. According to the National Statistic Agency in Luxembourg Les Portail des Statistiques (2014b), the median scenario foresees a rise in cross-border workers, reaching an employment share of 52% by 2060. We take three scenarios with cross-border inflows increasing to 327,824 in 2060 in the most optimistic economic scenario, only increasing to 160,000 in the median scenario and decreasing to 130,000 in the perfect storm scenario.

3.4 Three alternative scenarios

The three scenarios are summarized in Table 2. The key differentiator between them is the level of economic success and the impact it has on migration and cross-border workers.

Scenario 1 'Successful economic reorientation'

Luxembourg manages to succeed its strategic business reorientation from financial services towards innovation, research and wealth management. This reorientation will result in sustained economic growth and continued increase of net migrations till 2060.

This scenario forecasts a resident population of 1,000,000 inhabitants including 8,500 net migrations per year on an average between 2015 and 2060 and 250,000 cross-border workers, and a potential GDP growth (2.0% on average over the period 2015-2060). The assumptions of this scenario are summarized in Table 3.

Scenario 2 'Progressive convergence to normal'

Financial activities slow down due to the end of secret banking and firms relocate their businesses to other countries. Investments into new economic activities are not sufficient to maintain strong economic outperformance. Luxembourg's competitive advantage erodes due to an expensive labor market which is no longer competitive, leading to an increase in unemployment and a low working force. This scenario is an extension of the actual visible trend with a slower economic growth than before the previous crisis level and a slow net migration.

This scenario forecasts a resident population of 690,000 inhabitants including 3,500 net migrations per year on an average between 2015 and 2060, 170,000 cross-border workers on an average

and a potential GDP growth (1.0% on average over the period 2015-2060). The assumptions of this scenario are summarized in Table 4.

Scenario 3 'Perfect storm'

Luxembourg's competitive advantage as a headquarter of banks and e-commerce companies is vanishing and no strong relay of growth is found. Not only does the economy converge to its neighboring countries but it also suffers from a correction. This scenario also strongly impacts the prospects of net migration and cross-border workers as banking activity ceased and few much-specialized jobs are created in the aerospace industry.

This scenario forecasts a resident population of 450,000 inhabitants, lower than the previous two scenarios. This includes 300 net migrations per year on an average between 2015, 145,000 cross-border workers per year on an average and a lower potential GDP growth (0% on average over the period 2015-2060). The assumptions of this scenario are summarized in Table 5.

3.5 Results

Overall, the three scenarios result in a significant imbalance of the pension system over time, the worst being scenario 3 'Perfect storm'.

The first scenario 'Successful economic reorientation', presented in Table 6, is by far the best economic outcome in terms of public finance, with a pension deficit limited to 3.8% in 2060. This outcome is in line with current equilibrium and results from a robust economic growth and a record high number of cross-border workers.

The second scenario 'Progressive convergence to normal', presented in Table 7, is more negative and the pension deficit is expected to reach 5.6% in 2060. This scenario reflects an extension of the actually visible trend and forecasts a slowdown in the activity with a more modest economic growth, lower inflation, and net migrations.

The third scenario 'Perfect storm', presented in Table 8, is by far the worst scenario and pension deficit is expected to reach 10.3% in 2060. This scenario mirrors a worsening of the economic situation with job destructions and economic growth drop impacting net migrations and cross-borders.

3.6 Potential policy actions and impact

Continued reform of the pension system is advisable. The very strong population growth projection, through long-term net migration, should be treated with caution. Additional pension reforms should be considered, as reforms of 2013 are not sufficient for system equilibrium in particular if the economic outperformance is not sustained. We present several set of reforms for the three scenarios in Table 9.

Potential reform levers include an increase in contribution, re-indexation of pension benefits and postponing of the retirement age. Each of these policy actions have a different level of impact and implementation time.

The increase in contribution is the fastest policy to implement, and probably the most likely given that citizen protestation against this measure is assumed to be low contrary to a drop in the level of pension or an extension of the retirement age, as it can be implemented almost immediately. However, there is a natural cap to how much it can be increased to maintain the competitiveness of the local workplace (gross to net income ratio).

Indexation of pensions' benefit will take time if policymakers want to avoid making a straight haircut (in this case it will re-adjust over time by freezing pension indexation vs. inflation). In extreme cases of the deficit, it can be implemented quickly and significantly re-adjust deficit.

Postponing of the retirement age has a large impact, as it theoretically increases the number of contributors while decreasing the number of pensioners. However, implementing the policy does not immediately solve the issue of senior employment rate, as it takes time to implement on a cohort-by-cohort basis.

We have modeled a set of policy readjustment from mild to important, from the easiest to implement for policy makers to the most difficult one, and tested it against each scenario.

We have analyzed the impact of each reform-set on current scenarios.

To sum up, without any policy reform, pension budget in 2060 is expected to reach:
Scenario 1 Successful Economic Reorientation: -3.8% of GDP and -11,780 mn
Scenario 2 Progressive Convergence to Normal: -5.6% of GDP and -7,268 mn
Scenario 3 Perfect Storm: -10.3% of GDP and -6,574 mn

First, the mildest and easiest reform for policymakers to implement would probably to slightly and gradually increase the contribution rate[14]. This measure could also pass with little protestation from citizens. Taking into consideration a gradual rise of 4p.p. in the contribution rate to 2060, pension budget in 2060 is expected to decrease in all the three scenarios to:
Scenario 1 Successful Economic Reorientation: -2.4% of GDP and -7,289 mn
Scenario 2 Progressive Convergence to Normal: -4.5% of GDP and -5,909 mn
Scenario 3 Perfect Storm: -9.3% of GDP and -5,885 mn

Second, other measures will be acted once the contribution rate has been raised. The second most likely measure will probably be to raise the effective exit age. With an aging population, it would be rational to align the effective exit age on lifespan, or at least postpone the exit age. Adding these two policy reforms, pension budget is expected to reach
Scenario 1 Successful Economic Reorientation: +0.3% of GDP and +1,077 mn
Scenario 2 Progressive Convergence to Normal: -2.6% of GDP and -3,416 mn
Scenario 3 Perfect Storm: -7.1% of GDP and -4,520 mn

Third, the next policy reform likely to be implemented would be another increase in the contribution rate, but at a higher level, than the one implemented previously. Instead of +4p.p., it would be +8p.p. to 2060. Taking the two measures into consideration (increase of the effective exit age by 4 years associated with an increase in the contribution rate by 8p.p.) would yield a pension budget of:
Scenario 1 Successful Economic Reorientation: +1.9% of GDP and +5,784 mn
Scenario 2 Progressive Convergence to Normal: -1.5% of GDP and -1,966 mn
Scenario 3 Perfect Storm: -6% of GDP and -3,800 mn

Fourth, the next policy reform likely to be implemented would be another increase in the effective exit age, but at a higher level than the one previously implemented. Instead of 4 years, the effective exit age will rise by 8 years to 2060. Taking the two measures into consideration

[14]This reform has been enacted by the government. Contribution rate, currently at 24%, is equally split between employees, employers and Government. If expenditure becomes higher than revenue, the contribution rate could be raised by 2p.p. for all contributors (so the contribution rate could increase to 30%

(increase of the effective exit age by 8 years associated with an increase in the contribution rate by 8p.p.) would yield a pension budget of:

Scenario 1 Successful Economic Reorientation: +4.6% of GDP and +14,308 mn

Scenario 2 Progressive Convergence to Normal: +0.4% of GDP and +563 mn

Scenario 3 Perfect Storm: -3.6% of GDP and -2,292 mn

Fifth, the last and least popular pension measure is likely to be a drop in pension benefits. As this measure is rather unpopular, the likely way to implement it would be to freeze pension benefits from inflation and to stop automatically adjusting pension benefit levels taking into consideration inflation rate. Given that the inflation rate is the highest in the first scenario and the lowest in the third scenario, we can expect this measure to have a wider impact in the first scenario than in the last one. Taking into account the three measures (inflation freeze of pension benefits, increase of the effective exit age by 8 years associated with an increase in the contribution rate by 8p.p.) would yield a pension budget of:

Scenario 1 Successful Economic Reorientation: +9.1% of GDP and +28,119 mn

Scenario 2 Progressive Convergence to Normal: +4.3% of GDP and +5,660 mn

Scenario 3 Perfect Storm: -0.1% of GDP and -90 mn

Obviously, policy makers are reticent to make unpopular reforms, given their interest to be (re)elected. Of course, at this stage, it is hard to predict which scenario is the most likely and...

4 Conclusion

In our paper, we use the "reference class forecasting" approach to study the evolution of a small open economy's pension's equilibrium between 2015 and 2060 in order to reduce policy making biases and gut feeling. We assess a set of policy actions and their impact in three different scenarios: the 'Successful economic reorientation', the 'Progressive convergence to normal', and the 'Perfect storm'. It leads to risk assessment discussion under uncertain outcomes, where policymakers can have a rationale debate about "insuring" for the future economic volatility.

This paper addresses a modeling issue specific to small open economies - how to forecast and assess future contribution and liabilities when a large proportion of the workforce is made of either cross-border workers or recent emigrants.

To overcome these challenges, we built a highly innovative model in the way it models cross-border workers' contribution and impact. Most cross-border workers only work a few years in Luxembourg and hence are entitled to a partial pension when they retire. It is further challenging as the churn of cross-border workers is very important and strongly varies over the years. We model yearly cohort of cross-border workers and the partial entitlement of each cohort when it retires after a few years. It allows us to not only assess the state liabilities but also the evolution of age pyramid with a significant portion of new migrants. This takes into account the high volatility of workers and is the most suited model of the underlying future liability for a small open economy's pension system.

As a result, we built a model allowing policymakers to navigate in a strongly volatile and an open small economy. Also, we paved the way for healthy debate between policymakers and also on how to present the challenges to the population with a collective "call for action" with several economic and policy reform scenarios.

Though, in this paper, we focus on pensions in a Small Open Economy, our approach is highly

relevant and can be easily tailored to model other areas that are highly impacted by employment migration and demographic balance such as unemployment benefits or social welfare. The model can also be used to reflect any country's pension reforms, assess the need for reforms, and provide an update with several economic scenarios depending on the cyclicality.

The 2013 Luxembourg Pension reform

The pension allowance is made of three components. First, the fixed additional charges ("majorations fixes") which are the fixed additional charges, depending on the insurance increase. Second, the accrued charges ("majorations proportionnelles") which depend on the earning contributions. Third, the increased of accrued installments charges ("majorations proportionnelles échelonnées"). Fourth, an end-year-allowance which is allocated to those entitled to a pension by December 1st.

A pension reform came into force in 2013, which is reflected in this model. The fixed additional charges (depending on the insurance period) increase from 23.5% to 28% of the social minimum wage over the next 40 years. The accrued charges decrease from 1.85% in 2013 to 1.60% in 2052, representing a decrease in pension around 10%. The weighting of these two effects gradually reduced pension allowance by 7.7% from 2013 to 2052.

The increase of accrued installments charges also changed. To benefit from an increase of accrued installments charges, before the reform there were two thresholds, both in terms of age (55 years) and of career length (38 years). Both criteria had to be respected. The Pension Law sets a new single minimum threshold for the sum of both of age (60 years) and of career length (40 years). According to the reform only one of both criteria needs to be respected to grant rights to accrued installments charges.

The end-of-year allowance would be withdrawn if expenditure is higher than revenue. Cutting the allocation of year-end, which represents 2% of all paid pensions, occur when pension expenditures exceed revenues.

The ages of retirement and early retirement remain unchanged and the contribution rate of 24% (8% employees, 8% employers and 8% Government) to the pension system is similar. If expenditure is higher than revenue, the contribution rate could be raised by 2pp for all contributors so that the contribution could reach 30%.

The adjustment to real wage developments will be no longer automatic as it used to be the case before the reform. Indeed, pensions are now adjusted to actual salaries every two years (odd years) on the basis of a series of reference compiled by the IGSS after elimination of the most extreme income. However, if spending becomes higher than revenue, there is therefore a compensation mechanism that would be triggered, limiting to half of wage increases of what was granted before the reform.

Overview of articles that refer to game theory in leading evaluation journals

Table 1: Overview of articles that refer to game theory in leading evaluation journals

Articles (by publication year)	Extent of use of game theory	How game theory is used or mentioned
Windle and Neigher (1978)	Suggest use	Study ethical problems in evaluations and suggest game theory as one of the systematic approaches to develop a better understanding of those.
Peters et al. (1986)	Illustrate an argument	Point out limits of technocratic notion of rationality as 'epitomized in game theory'.
Langbein (1994)	Use	Game theory is used to study enforcement and compliance in regulatory programs
Niklasson (1996)	Use and reflect	Game theory is used to support interpretation of evaluation data on university reform policies
Scriven (1996)	Illustrate an argument	Discusses gap between theory and practice in evaluation as a young discipline: 'the payoffs from theory to practice, when we fill the gaps, are sometimes very large. Psychology, probability theory, game theory and computer science are other examples of this phenomenon from our era.'
Feller (2002)	Illustrate an argument	Illustrate difficulties of performance measurement for science agencies; Impact of game theory was not predicted or visible in early years
Sharkey and Sharples (2008)	Indirect use, foundational	Look into role of negotiation skills in community evaluations. Game theory is mentioned as one of the traditions involved in negotiation literature.

Figure 1: Net migrations & Cross borders - workers

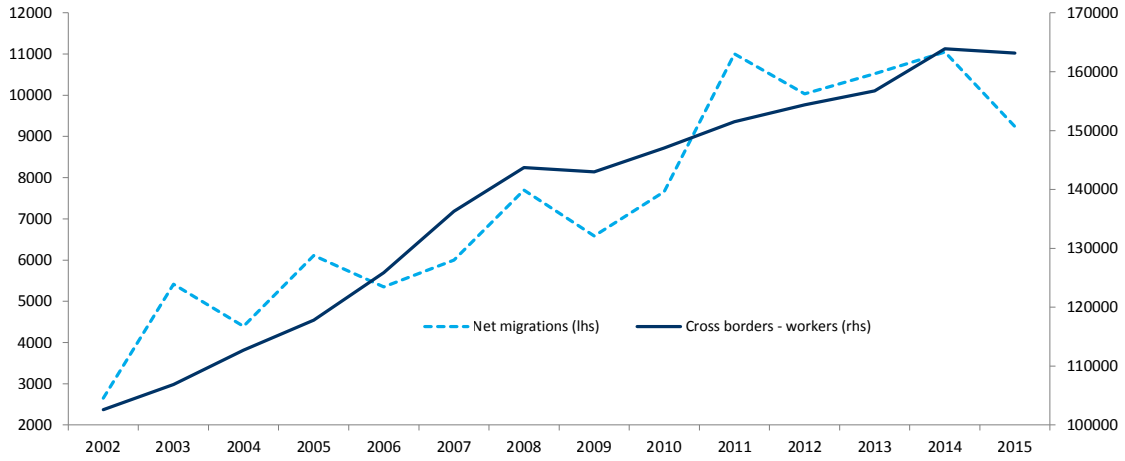
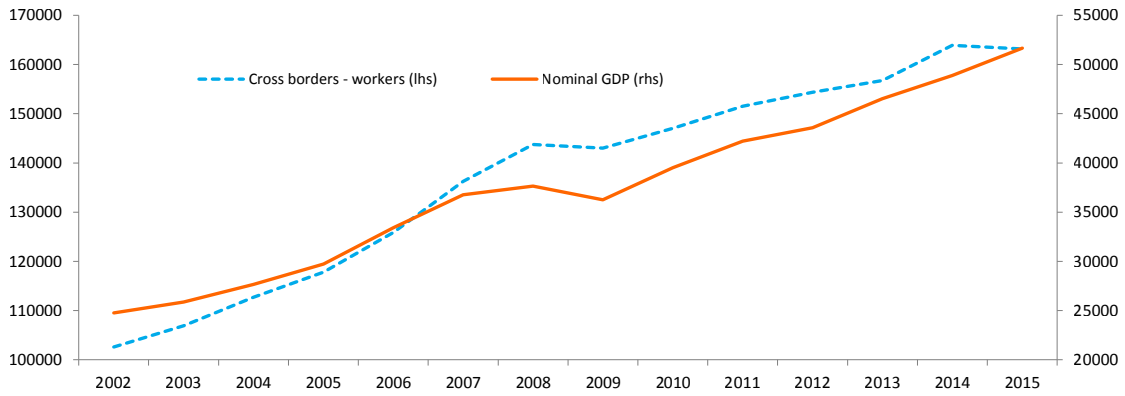
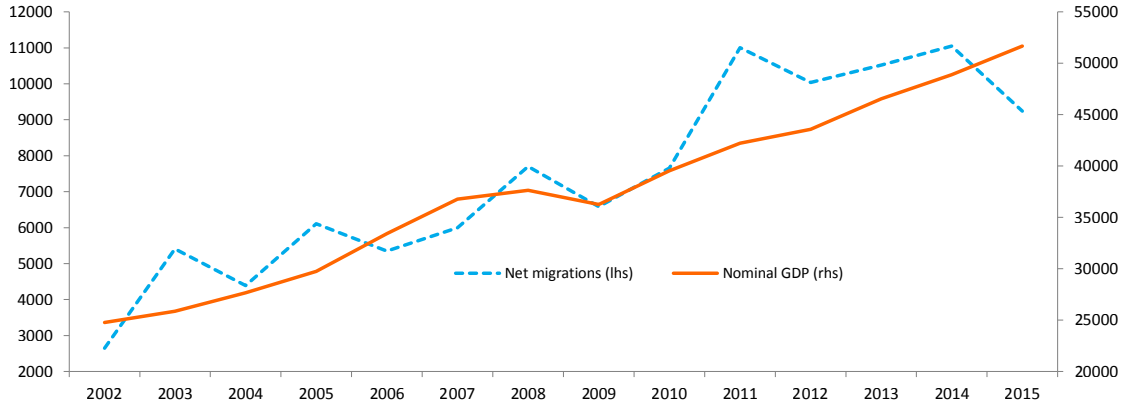


Figure 2: Cross borders - workers & GDP



Primary deficit, spending and revenue

Figure 3: Net migrations & GDP



Statutory and Average retirement age

The statutory retirement age is 65 and the early retirement age is 57. The effective exit age in 2014 was 60.2 for men and 60.9 for women as shown in Figure 7, the lowest in the European Union. We expect the effective retirement age to remain unchanged for men and women until 2060 (in line with the AWG2015), despite the Pension reform and the incentives to work longer in order to keep the same salary than before the reform. The incentives to work longer are rather low as there are neither penalties nor bonuses to work longer (AWG2015).

Table 2: The three assumptions on the future (in the three scenarios)

	Scenario 1 'Successful economic reorientation'	**Scenario 2 'Progressive convergence to normal'**	**Scenario 3 'Perfect storm'**
(i) Economic growth			
Average economic growth per year	2.0%	1.0%	0.0%
Average inflation growth per year	1.5%	1.0%	0.5%
⇒ All 3 scenarios: increase in economic growth depending on the country reconversion			
(ii) Demography			
Total population in 2060	1,000,000	690,000	450,000
Average net migration per year	8,500	3,500	300
⇒ Increase in population (except in the third scenario) depending on the country reconversion			
(iii) Crossborder workers			
Average cross-borders per year	250,000	170,000	145,000
⇒ Increase in cross-borders (except in the third scenario) depending on the country reconversion			

Note: the numbers in this table are an average over the period 2015-2060 unless specified.

Figure 4: Primary Deficit (% GDP)

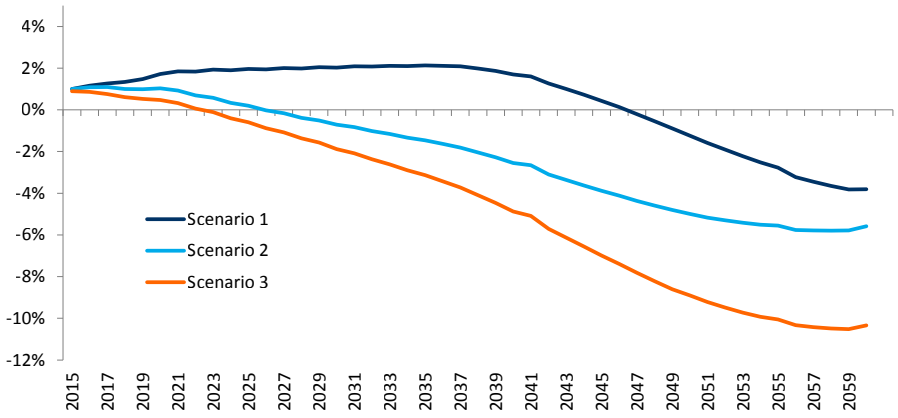


Figure 5: Primary Revenue (% GDP)

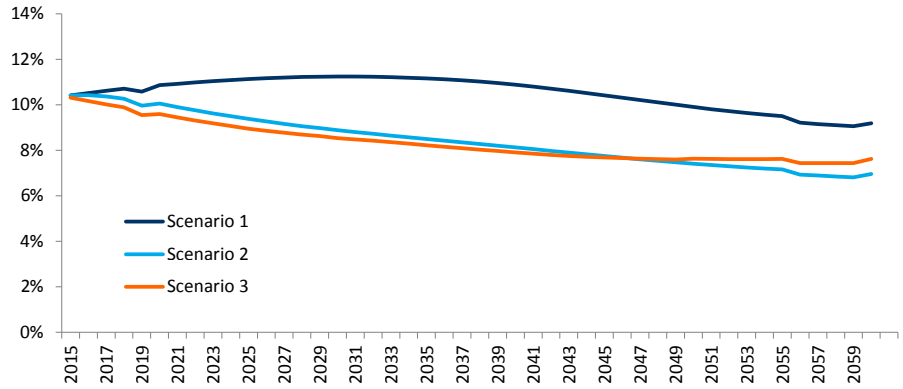


Figure 6: Primary Spending (% GDP)

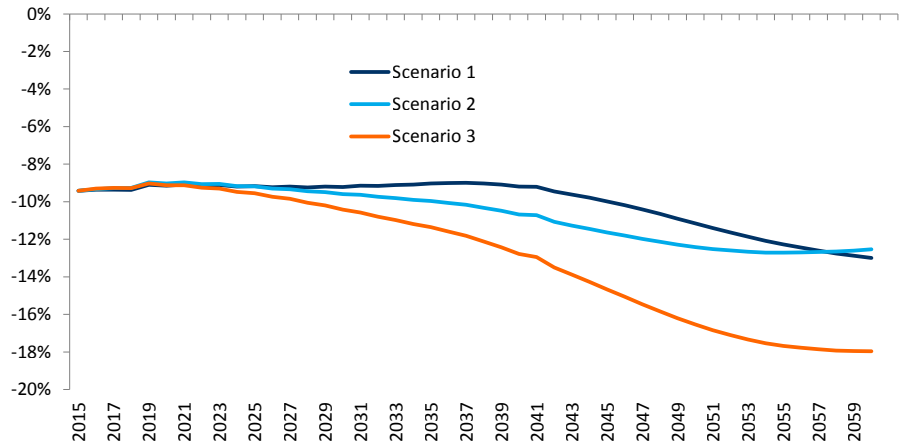


Table 3: Assumptions in Scenario 1 'Successful economic reorientation'

Scenario 1 'Successful economic reorientation'	**2015**	**2020**	**2030**	**2040**	**2050**	**2060**
Macroeconomic assumptions						
Nominal GDP (euro mn)	51,663	66,151	101,460	153,539	221,869	309,657
Nominal GDP (per capita)	91,771	105,372	132,307	171,478	224,366	296,425
Real GDP (euro mn)	45,196	52,949	70,265	91,984	114,905	138,565
Real GDP (per capita)	80,284	84,341	91,628	102,731	116,198	132,644
Demography (Residents) assumptions						
Total population	562,958	627,792	766,857	895,387	988,872	1,044,638
Net migrations	11,189	11,748	11,245	9,145	5,495	4,945
Number of potential workers (15-64 years)	383,009	438,844	533,810	611,153	645,101	624,204
Number of pension contributing workers	267,213	309,385	380,072	436,363	456,731	436,943
Population 64+	79,840	87,123	112,641	135,579	171,960	239,468
Share of population 64+ as % of total population	0.14	0.14	0.15	0.15	0.17	0.23
Pensions as % contribution	1.40	1.25	1.17	1.17	1.63	2.20
Dependency ratio	0.47	0.43	0.44	0.47	0.53	0.67
Demography (Crossborders) assumptions						
Total number of crossborders workers	167,554	185,767	222,192	258,617	295,042	327,824
Cross borders pensions as % contribution	0.09	0.12	0.15	0.24	0.33	0.41

Table 4: Assumptions in Scenario 2 'Progressive convergence to normal'

Scenario 2 'Progressive convergence to normal'	**2015**	**2020**	**2030**	**2040**	**2050**	**2060**
Macroeconomic assumptions						
Nominal GDP (euro mn)	51,663	64,117	81,275	96,671	112,191	130,202
Nominal GDP (per capita)	91,771	106,757	125,095	140,576	157,864	181,335
Real GDP (euro mn)	45,196	51,425	59,094	63,678	66,934	70,357
Real GDP (per capita)	80,284	85,625	90,954	92,598	94,183	97,988
Demography (Residents) assumptions						
Total population	562,958	600,590	649,706	687,679	710,679	718,021
Net migrations	9,579	3,700	3,400	3,100	2,800	2,600
Number of potential workers (15-64 years)	383,009	412,316	427,856	435,207	431,919	421,814
Number of pension contributing workers	267,213	290,683	304,633	310,738	305,799	295,270
Population 64+	79,840	87,123	112,641	135,579	157,526	174,497
Share of population 64+ as % of total population	0.14	0.15	0.17	0.20	0.22	0.24
Pensions as % contribution	1.40	1.35	1.55	1.73	2.09	2.17
Dependency ratio	0.47	0.46	0.52	0.58	0.65	0.70
Demography (Crossborders) assumptions						
Total number of crossborders workers	167,554	180,000	176,770	171,180	165,590	160,000
Cross borders pensions as % contribution	0.09	0.14	0.25	0.55	0.93	1.13

Table 5: Assumptions in Scenario 3 'Perfect storm'

Scenario 3 'Perfect storm'	**2015**	**2020**	**2030**	**2040**	**2050**	**2060**
Macroeconomic assumptions						
Nominal GDP (euro mn)	51,663	61,398	70,541	73,048	68,917	63,598
Nominal GDP (per capita)	91,771	103,217	114,112	118,541	117,499	120,250
Real GDP (euro mn)	45,196	50,676	54,332	53,522	48,895	44,220
Real GDP (per capita)	80,284	85,193	87,892	86,854	83,362	83,610
Demography (Residents) assumptions						
Total population	562,958	594,844	618,172	616,228	586,539	528,885
Net migrations	9,239	2,000	500	-500	-1,500	-3,000
Number of potential workers (15-64 years)	383,009	406,713	399,001	373,154	330,130	280,550
Number of pension contributing workers	267,213	286,732	284,089	266,432	233,732	196,385
Population 64+	79,840	87,123	112,641	135,579	154,355	157,106
Share of population 64+ as % of total population	0.14	0.15	0.18	0.22	0.26	0.30
Pensions as % contribution	1.40	1.38	1.70	2.11	2.77	2.96
Dependency ratio	0.47	0.46	0.55	0.65	0.78	0.89
Demography (Crossborders) assumptions						
Total number of crossborders workers	163,158	159,390	150,000	142,464	137,000	130,000
Cross borders pensions as % contribution	0.10	0.16	0.32	0.74	1.24	1.49

Table 6: Results in Scenario 1 'Successful economic reorientation'

Scenario 1 'Successful economic reorientation'	**2015**	**2020**	**2030**	**2040**	**2050**	**2060**
RESIDENTS						
Contributors						
Number of pension contributing workers	267,213	309,385	380,072	436,363	456,731	436,943
Average gross income per contributor (eur)	53,206	61,293	78,575	100,729	129,131	165,541
Share of gross income to pension (%)	24%	24%	24%	24%	24%	24%
Average contribution per worker	12,769	14,710	18,858	24,175	30,991	39,730
Total pension revenue (eur mn)	3,336	4,575	7,400	10,739	13,241	15,995
Beneficiaries						
Population 64+	79,840	87,123	112,641	135,579	171,960	239,468
Average pension (eur)	42,819	47,192	56,198	68,879	86,321	110,200
Total pension spending (eur mn)	-4,657	-5,713	-8,679	-12,533	-21,614	-35,126
Deficit/surplus						
Primary deficit/surplus (eur mn)	7,993	10,287	16,079	23,272	34,854	51,121
Primary deficit/surplus (% of GDP)	-2.6%	-1.7%	-1.3%	-1.2%	-3.8%	-6.2%
Pensions paid as % of contribution	-1.4	-1.2	-1.2	-1.2	-1.6	-2.2
CROSSBORDERS						
Contributors						
Number of cross borders	167,554	185,767	222,192	258,617	295,042	327,824
Average gross income per contributor (eur)	50,847	55,866	61,711	68,168	75,299	83,177
Share of gross income to pension (%)	24%	24%	24%	24%	24%	24%
Average contribution per worker	12,203	13,408	14,811	16,360	18,072	19,963
Total pension revenue (eur mn)	2,045	2,612	4,004	5,975	8,738	12,447
Beneficiaries						
Total pension spending (eur mn)	-208	-337	-667	-1,575	-3,128	-5,096
Deficit/surplus						
Primary deficit/surplus (eur mn)	1,836	2,275	3,337	4,400	5,610	7,351
Primary deficit/surplus (% of GDP)	3.6%	3.4%	3.3%	2.9%	2.5%	2.4%
Pensions paid as % of contribution	0.102	0.129	0.167	0.264	0.358	0.409
TOTAL (RESIDENTS & CROSSBORDERS)						
Total number of pension contributors	434,767	495,152	602,264	694,980	751,773	764,767
Primary deficit/surplus (eur mn)	-515	1,137	2,058	2,605	-2,763	-11,780
Primary deficit/surplus (% of GDP)	1.0%	1.7%	2.0%	1.7%	-1.2%	-3.8%

Table 7: Results in Scenario 2 'Progressive convergence to normal'

Scenario 2 'Progressive convergence to normal'	**2015**	**2020**	**2030**	**2040**	**2050**	**2060**
RESIDENTS						
Contributors						
Number of pension contributing workers	267,213	290,683	304,633	310,738	305,799	295,270
Average gross income per contributor (eur)	53,206	58,458	64,574	71,330	78,793	87,036
Share of gross income to pension (%)	24%	24%	24%	24%	24%	24%
Average contribution per worker	12,769	14,030	15,498	17,119	18,910	20,889
Total pension revenue (eur mn)	3,336	4,031	4,603	5,061	5,326	5,863
Beneficiaries						
Population 64+	79,840	87,123	112,641	135,579	157,526	174,497
Average pension (eur)	42,819	45,010	46,185	48,776	52,671	57,940
Total pension spending (eur mn)	-4,657	-5,449	-7,133	-8,752	-11,106	-12,710
Deficit/surplus						
Primary deficit/surplus (eur mn)	7,993	9,480	11,736	13,813	16,431	18,573
Primary deficit/surplus (% of GDP)	-2.6%	-2.2%	-3.1%	-3.8%	-5.2%	-5.3%
Pensions paid as % of contribution	-1.4%	-1.4%	-1.5%	-1.7%	-2.1%	-2.2%
CROSS-BORDERS						
Contributors						
Number of cross borders	167,554	180,000	176,770	171,180	165,590	160,000
Average gross income per contributor (eur)	50,847	55,866	61,711	68,168	75,299	83,177
Share of gross income to pension (%)	24%	24%	24%	24%	24%	24%
Average contribution per worker	12,203	13,408	14,811	16,360	18,072	19,963
Total pension revenue (eur mn)	2,045	2,413	2,618	2,801	2,993	3,194
Beneficiaries						
Total pension spending (eur mn)	-208	-337	-667	-1,572	-2,817	-3,616
Deficit/surplus						
Primary deficit/surplus (eur mn)	1,836	2,077	1,951	1,228	175	-422
Primary deficit/surplus (% of GDP)	3.6%	3.2%	2.4%	1.3%	0.2%	-0.3%
Pensions paid as % of contribution	0.102	0.140	0.255	0.561	0.941	1.132
TOTAL (RESIDENTS & CROSS-BORDERS)						
Total number of pension contributors	434,767	470,683	481,404	481,918	471,389	455,270
Primary deficit/surplus (eur mn)	515	659	-578	-2,464	-5,605	-7,268
Primary deficit/surplus (% of GDP)	1.0%	1.0%	-0.7%	-2.5%	-5.0%	-5.6%

Table 8: Results in Scenario 3 'Perfect storm'

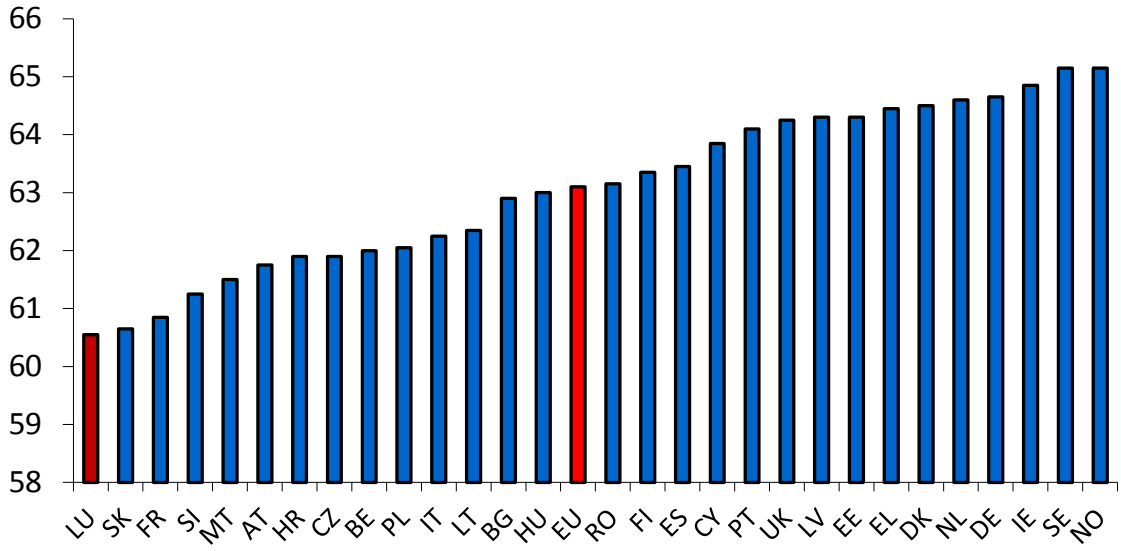
Scenario 3 'Perfect storm'	**2015**	**2020**	**2030**	**2040**	**2050**	**2060**
RESIDENTS						
Contributors						
Number of pension contributing workers	267,213	286,732	284,089	266,432	233,732	196,385
Average gross income per contributor (eur)	53,206	56,473	60,551	63,648	65,714	67,040
Share of gross income to pension (%)	24%	24%	24%	24%	24%	24%
Average contribution per worker	12,769	13,554	14,532	15,276	15,771	16,090
Total pension revenue (eur mn)	3,336	3,827	3,939	3,695	3,194	2,849
Beneficiaries						
Population 64+	79,840	87,123	112,641	135,579	154,355	157,106
Average pension (eur)	42,819	43,482	43,308	43,523	43,928	44,628
Total pension spending (eur mn)	-4,657	-5,264	-6,688	-7,786	-8,846	-8,445
Deficit/surplus						
Primary deficit/surplus (eur mn)	7,993	9,090	10,627	11,482	12,040	11,294
Primary deficit/surplus (% of GDP)	-2.6%	-2.3%	-3.9%	-5.6%	-8.2%	-8.8%
Pensions paid as % of contribution	-1.4%	-1.4%	-1.7%	-2.1%	-2.8%	-3.0%
CROSSBORDERS						
Contributors						
Number of cross borders	163,158	159,390	150,000	142,464	137,000	130,000
Average gross income per contributor (eur)	50,847	55,866	61,711	68,168	75,299	83,177
Share of gross income to pension (%)	24%	24%	24%	24%	24%	24%
Average contribution per worker	12,203	13,408	14,811	16,360	18,072	19,963
Total pension revenue (eur mn)	1,991	2,065	2,083	2,080	2,065	1,999
Beneficiaries						
Total pension spending (eur mn)	-208	-337	-667	-1,548	-2,550	-2,977
Deficit/surplus						
Primary deficit/surplus (eur mn)	1,783	1,728	1,416	532	-485	-978
Primary deficit/surplus (% of GDP)	3.5%	2.8%	2.0%	0.7%	-0.7%	-1.5%
Pensions paid as % of contribution	0.105	0.163	0.320	0.744	1.235	1.489
TOTAL (RESIDENTS & CROSSBORDERS)						
Total number of pension contributors	430,371	446,123	434,089	408,896	370,732	326,385
Primary deficit/surplus (eur mn)	461	291	-1,333	-3,560	-6,137	-6,574
Primary deficit/surplus (% of GDP)	0.9%	0.5%	-1.9%	-4.9%	-8.9%	-10.3%

Table 9: Pension deficit/surplus in 2060 in the three scenario with mildest, medium and extreme policy readjustments

Policy readjustment	SCENARIO		
	Scenario 1 'Successful economic reorientation'	**Scenario 2 'Progressive convergence to normal'**	**Scenario 3 'Perfect storm'**
Nothing	−3.8% (-11,780 mn)	−5.6% (-7,268 mn)	−10.3% (-6,574 mn)
+ Increase in contribution (+4pp)	−2.4% (-7,289 mn)	−4.5% (-5,909 mn)	−9.3% (-5,885 mn)
+ Increase in the effective exit age (+4 years)	0.3% (1,077 mn)	−2.6% (-3,416 mn)	−7.1% (-4,520 mn)
+ Increase in contribution (+8pp)	1.9% (5,784 mn)	−1.5% (-1,996 mn)	−6.0% (-3,800 mn)
+ Increase in the effective exit age (+8 years)	+4.6% (14,308 mn)	+0.4% (563 mn)	−3.6% (-2,292 mn)
+ Inflation freeze of pension allowance	+9.1% of GDP (Eur 28,119 mn)	+4.3% of GDP (Eur 5,660 mn)	−0.1% of GDP (Eur 90 mn)

Note: the numbers in this table relate to the pension deficit/surplus as % of GDP and in eur mn between brackets.

Figure 7: Average Effective Exit Age from Labour Market



Source: The 2015 Aging Report, European Commission and Fund staff calculations.

References

Alesina, A. and Drazen, A. (1991). Why Are Stabilizations Delayed? *American Economic Review*, 81(5):1170–88.

Buehler, R., Dale, G., and Ross, M. (1995). It's about time: Optimistic predictions in work and love. *European Review of Social Psychology*, 6(1):1–32.

Buehler, R., Griffin, D., and Ross, M. (1994). Exploring the "planning fallacy": Why people underestimate their task completion times. *Journal of Personality and Social Psychology*, 67(3):366–381.

Buehler, R., Griffin, D. W., and Ross, M. (2002). Inside the planning fallacy: The causes and consequences of optimistic time predictions. In Thomas Gilovich, D. G. . D. K., editor, *Heuristics and Biases: The psychology of intuitive judgment*, pages 250–270. Cambridge University Press, Cambridge, UK.

Directorate-General for Economic and Financial Affairs (2012). The 2012 ageing report: Economic and budgetary projections for the 27 eu member states (2010–2060).

Directorate-General for Economic and Financial Affairs (2015a). The 2015 ageing report: Economic and budgetary projections for the 28 eu member states (2013–2060). Technical report, European Commission.

Directorate-General for Economic and Financial Affairs (2015b). The 2015 ageing report: Underlying assumptions and projection methodologies. Technical report, European Commission. Joint Report prepared by the European Commission (DG ECFIN) and the Economic Policy Committee (AgeingWorking Group).

Feller, I. (2002). Performance measurement redux. *American Journal of Evaluation*, 23(4):435–453.

International Monetary Fund (2011). *Luxembourg: Financial System Stability Assessment – Update. IMF Country Report No. 11/148*. International Monetary Fund, Publication Services, Washington, D.C.

International Monetary Fund (2016). *World Economic Outlook: Too Slow for Too Long*. International Monetary Fund, Publication Services, Washington, D.C.

Kahneman, D. and Tversky, A. (1979). Intuitive prediction: biases and corrective procedures. *TIMS Studies in Management Science*, 12:313–327.

Kahneman, D. and Tversky, A. (1982). Intuitive prediction: Biases and corrective procedures. In Kahneman Daniel, Slovic Paul, T. A., editor, *Judgment Under Unvertainty: Heuristics and Biases*, pages 414–421. Cambridge University Press. Decision Research Technical Report PTR-1042-77-6.

Koole, S. and van't Spijker, M. (2000). Overcoming the planning fallacy through willpower: effects of implementation intentions on actual and predicted task-completion times. *European Journal of Social Psychology*, 30(6):873–888.

Langbein, L. I. (1994). Estimating the impact of regulatory program enforcement: Practical implications of positive political theory. *Evaluation Review*, 18(5):543–573.

Le Gouvernment du Grand-Duché de Luxembourg, Ministére de la Sécurité sociale (2015). Rapport général sur la sécurité sociale au grand-duché de luxembourg. Technical report, Ministré de la Sécurité Sociale.

Les Portail des Statistiques (2010). Projections socio-économiques 2010-2060. Technical report, Institut national de la statistique et des etudes économiques, Luxembourg. Bulletin du Statec no.5-2010.

Les Portail des Statistiques (2014a). Comptes Nationaux. Comptabilité Nationale du Luxembourg – SEC2010. Technical report, STATEC, Luxembourg.

Les Portail des Statistiques (2014b). La situation économique au Luxembourg - Evolution récente et perspectives. Note de conjoncture 2014-2. Technical report, Institut national de la statistique et des etudes économiques, Luxembourg.

Les Portail des Statistiques (2014c). Luxembourg in figures. Technical report, Institut national de la statistique et des etudes économiques, Luxembourg.

Lovallo, D. and Kahneman, D. (2003). Delusions of success: How optimism undermines executives' decisions. *Harvard Business Review*, 81(7):56–63.

Niklasson, L. (1998). A cultural revolution in the universities: The possible uses of rational choice models. *Evaluation*, 4(3):278–293.

OECD (2015). Labor force statistics. Technical report, OECD iLibrary, Organization for Economic Co-operation and Development, Paris.

Peters, M., Marshall, J., and Shaw, R. (1986). The development and trials of a decision-making model: An evaluation. *Evaluation Review*, 10(1):5–27.

Scriven, M. (1996). The theory behind practical evaluation. *Evaluation*, 2(4):393–404.

Sharkey, S. and Sharples, A. (2008). From the beginning: Negotiation in community evaluation. *Evaluation*, 14(3):363–380.

Tornell, A. (1998). Reform from Within. NBER Working Papers 6497, National Bureau of Economic Research, Inc.

Velasco, A. (2000). Debts and deficits with fragmented fiscal policymaking. *Journal of Public Economics*, 76(1):105–125.

Windle, C. and Neigher, W. (1978). Ethical problems in program evaluation: Advice for trapped evaluators. *Evaluation and Program Planning*, 1(2):97–108.