LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Inspection générale de la Sécurité sociale

Cahiers méthodologiques

Août 2012 [1] *Numéro 1*

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On the Sustainability of Public Finances under an EU Framework: Ageing as a Threat for Luxembourg

Abstract

In the light of a persisting phenomenon of ageing, sustainability of public finances is an increasingly prevailing issue for a broad set of developed countries. Considering the projected increase in age-related expenditures over the medium- to the long-run, Luxembourg as a Member State of the European Union (EU), belonging to an economically integrated area and a unified monetary zone, should endeavour to cope with this anticipated burden in a proactive way. To our knowledge, there has not yet been a synthetic work which makes a thorough treatment of sustainability accounting for Luxembourg. To this end, we propose through this paper to clarify the following issues: (i) We judge necessary to incorporate first a comprehensive analysis of the methodology, used by the European Commission (EC), to projecting long-term economic growth. (ii) Equipped with this crucial starting knowledge, we investigate the magnitude of the ageing cost, through estimation of numerous expenditure components pertaining to ageing. A special focus will be dedicated to analysing public pensions' expenditure, as it represents a dominant age-related spending item for Luxembourg. (iii) We move on to define the concept of sustainability, to derive some sustainability indicators and to reveal the EC common methodology adopted for the computation of such indicators. (iv) The same approach will be applied now for the rather "puzzling" Medium-Term Objectives (MTO's), which are of crucial interest in monitoring sustainable public finances, in the context of the preventive arm of the Stability and Growth Pact (SGP). Indeed, these

Contents

1. **Acknowledgement:** This working paper was prepared by Issam TIAR, of the General Inspection of Social Security (IGSS) under the direct supervision and contribution of Tom Dominique from the Statistics, Actuarial Studies and Social Planning Department, within the framework of a research internship. Specific comments from collaborators of the Ministry of Finance were incorporated. We are vividly thankful for their contribution.
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objectives should bring the several Member States to a political involvement, in order to fulfill some quantified fiscal targets, via a budgetary consolidation. (v) After this overall analysis, we finally apply the theoretical apparatus to quantify the prior sustainability indicators and MTO's for Luxembourg. There will be an appraisal of the derived figures, on the basis of two scenarios, a first baseline scenario and an alternative altered constant policy scenario, resulting from the EC Ageing-Working Group (AWG) long-term age related expenditures projections.

Keywords: Public finances, Ageing, Sustainability, Indicators, SGP, MTO's.

Contents

1 Introduction

1.1 Background

Current age-related expenditure projections for the EU stipulate that in the absence of "courageous" structural reforms for the consolidation of government accounts, expenditure on debt interest and public pensions, as well as on healthcare and long-term care, is expected to increase significantly over the coming decades. The conjunction of the fiscal costs of the crisis and the expected demographic developments renders the fiscal sustainability a considerable challenge for European countries. There are mainly two factors that bring about larger uncertainty, with the context of the crisis and the prospective recovery:

(i) The difficulty of the accurate assessment of the initial structural fiscal position. This is related to the way tax revenue has been impacted by the crisis, and whether support measures adopted by governments are temporary or permanent.

(ii) The crisis impact may embody a structural feature in European economies, insofar as it may determine how these economies will evolve over the next decades.

Without consolidation, figures from the EC's age-related expenditure projection exercise in 2009 [4] based on a scenario of growth returning to the long-term path of before crisis reveal that the gross debt-to-GDP ratio for the EU could reach 100 % in 2015, and could even keep going up. A consolidation effort of 0.5% of GDP per year until the Member States' MTO's [5] are satisfied will only maintain the debt ratio at around 100% of GDP, if growth comes back to the pre-crisis tendency. Thus, fiscal policies must steadily be oriented towards sustainability. Exit strategies have to be implemented in a coordinated manner as soon as recovery holds, while accounting for countries specificities. Recent projections [6] confirm those trends, with even a slight lower long-term average potential GDP growth rates in the long term.

1.2 The population ageing

Demographic projections Future demographic projections have a crucial role in the framework of age-related expenditure projections. This phenomenon is characterized by an increase in life expectancy and/or a decrease in fertility rates.

Over the next 50 years, it is expected [7] that the phenomenon of ageing population will be enhanced by a life expectancy, which is increasing, on average, by 7 years for women and 8.5 years for men. Meanwhile, fertility rates are anticipated to rise up from their current level of 1.5 children on average, to 1.6. Accordingly, they remain far below the stable population level of 2.1, and then entailing a falling population tendency.

A supplementary factor that is included in population projections is migration. Europe has become a destination for migrants, even though there are significant differences in tendencies across countries. Usually migration flows are difficult to predict, since they do not depend entirely on the socio-economic situation in the EU, but also in third countries. By 2060, net migration into the EU is forecast [8] to stabilize at 0.2% of the EU population.

The overall size of the EU population is expected to remain broadly the same in 2060 as today, considering the slight increase in fertility and relatively dynamic immigration flows. Nevertheless, the age distribution of the populations is set to differ significantly.

In general, the old age dependency ratio defined as the population aged 65 or over as a share of the population aged 15 to 64, is expected [9] to increase from 25% in 2007 to 54% in 2060. Present demographic projections confirm those trends of the ageing population [10].

4. See [EC2] p.5
5. To be defined in section 5
6. See [EC8] p.38
7. See [EC2] p.22
8. See [EC2] Table p.23
9. See [EC2] p.26
10. See [EC8] p.27

Labour force projections The projected trajectory of the working age population and total employment in the EU [11] shows that the working age population is set to increase until 2013 and then starts to decrease. Generally, employment rates are expected to increase from 65.5% in 2007 to nearly 70% in 2060. 2012 EU long term projections [12] report even higher employment rates in 2060 (74%). Within this overall tendency, the employment rate of older workers is expected to rise significantly as a consequence of reforms aiming to prolong working life in many Member States.

Economic growth and public finances An ageing population puts pressure on the economic growth, as fewer people are taking part to the working activity. A reduction of the working age population impacts the sustainability of public finances, via changes in future economic growth and fiscal revenues. Whereas in a pre-crisis projection exercise for the EU area, potential growth is set to decrease from 2.4% per annum over 2007-2020 to 1.3% over 2041-2060, 2012 long-term projections suggest, due to the impact of the crisis, lower growth rates in the medium-term (1.5% up to 2020), whereas similar results [13] are expected on the long run. An ageing population also puts pressure on public spending as more and more people are being retired and increasing age-related expenditure impacts directly future budgetary balances. Whereas in the 2009 EU projections strictly-age-related public spending is projected to increase by 4.8 p.p., present 2012 projections show increases of 4.1 p.p. for the EU Member states up to 2060 [14].

1.3 Paper's outline

The main objective of the paper is to study the sustainability of Luxembourg public finances under the European framework. Accordingly, the approach chosen intends to answer the question: *to which extent, an ageing population could embody a threat on the sustainability of Luxembourg's public finances, assessed from an EU standpoint?* In this respect, the paper means giving a comprehensive insight on a common EU methodology, taking into account the specificities of Luxembourg as a small open economy facing the threat of an ageing population. The paper first highlights the main methodology used by the EC for the projection of future economic growth. In a second step age-related expenditure projections are presented. In a next stage the sustainability concerns upon the common EU methodology, along with a useful clarification of the rather "puzzling" MTO's, are exposed. An additional part then confronts the above-mentioned theoretical apparatus to Luxembourg's specificities based on national data. To this end, the impact of two different scenarios is assessed and an appropriate interpretation of the several results is presented as a final step.

2 The Projection of Economic Growth

2.1 The projection of potential output

Determinant factors of long-term economic growth as modelled under the common EU framework are the increase in the number of people in production and the increase in their productivity. Thus, a shrink in employment will therefore act to lower economic growth unless productivity increases.

A production function approach for the long-term projection exercise of the EC [15] is used to projecting long-term economic growth. Potential GDP is then expressed as a combination of factor inputs (capital and labour), and Total Factor Productivity (TFP). The crucial macroeconomic simplifications of this section are:

(i) The real GDP growth rate represents the sum of the labour input growth rate and the labour productivity per hour growth rate.

(ii) The labour input growth rate represents mainly the sum of the employment growth rate and the growth rate expressing the changes in hours worked per employee.

(iii) The labour productivity per hour growth rate represents the sum of the TFP growth rate and the capital deepening, which stands for the capital stock per worker growth rate.

11. See [EC2] Graph II.1.5 p.27
12. See [EC8] p. 32
13. See [EC8], p. 37
14. See [EC8], p. 48
15. See [EC4] p.124

The production function is specified by the standard Cobb-Douglas production function, with constant returns to scale so that Potential GDP can be exposed formally as total output formed by a combination of the classical production factors (labour and capital inputs), multiplied with TFP, which incorporates technological level.

It will be of interest to depict the link between economic growth and demographic growth. In this respect demographic projections play a determinant role for the projection analysis of economic growth over the long-term since the hypotheses used for the population projections yield a deep impact on projections for the labour input [16].

In addition, TFP growth and the growth in capital per hour worked, (so called capital deepening or capital intensity growth) are the crucial driving forces of the projected labour productivity growth over the medium-term. In the long term, considering the neo-classical growth model of Solow, the economy will achieve a steady state, in which the capital intensity expressed in efficiency units [17], remains constant over time. In consequence, the capital stock per hour worked increases at the same pace as the labour augmenting technical progress. Accordingly, labour productivity growth represents the ratio of the TFP growth to the labour share [18]. We should highlight as well that in an equilibrium state; the contribution of capital deepening to labour productivity growth is a simple function of TFP [19]. This latter becomes the only visible driving force of labour productivity.

2.2 The underlying assumptions on the production function

For the short- and medium-term available country specific forecasts are applied for capital and labour input (EC spring forecast and OGWG medium term extension) [20].

There are mainly two principles, which are taken into account to elaborate long-term projections:

First, there should be a consistency between the medium term projections based on country-specific trends and the common EU long-term projections.

Second, there is a prevailing constraint to guarantee comparability across the EU, through the use of a common methodology for all Member States. In this respect there should be convergence in growth rates over the long-run projection, and it was decided to opt for rather a convergence of the TFP projections toward the same growth rate in the long-run. Meanwhile, there should be a consideration of the catching-up potential for Member States with a relatively low income levels by permitting a specific period of "fast" convergence.

The main assumptions on labour input The employment projections are based on the EUROPOP [21] population projections by Eurostat with the close involvement of National Institutes of Statistic. In a separate step participation rates are projected using the cohort simulation model (CSM) [22]. This approach mainly assumes that given the fact that younger female cohorts have their own specific level of participation, which is usually higher than the corresponding level of older generations, the age specific participation rates of the younger cohorts are being maintained as they get older. If necessary, modelled age specific participation rates are adapted to legislated pension reforms. Finally, labour force is derived by applying CSM participation rates to population projections. Specifically for the case of Luxembourg, it is assumed that cross-border labour force growth equals domestic employment growth.

The crucial assumption on TFP developments In a steady state analysis over the long run, the growth in labour productivity (output per hour worked) fairly corresponds to the TFP growth divided by the labour share which is fixed to 0.65 [23]. Thus, a conservative hypothesis for TFP would be that

16. See [EC4] p.372
17. It represents the share of capital by efficient worker $\frac{K}{L \cdot E}$.
18. See equation (10) as well as a discussion about labour share parametrized by ß in the annex.
19. See equation (11) in the annex.
20. In the short run, all these variables can be impacted by the business cycle. It is more convenient to project the potential output, which stands for the output adjusted for cyclical movements in the economy. This involves an estimation of the trend components for the individual production factors, apart from the capital stock that can only adjust in the long-term. Thus, evaluating potential output could be done through the removal of the cyclical component from both TFP and labour. Trend TFP is obtained via a de-trending technique. Potential labour input is the total labour evaluated when the unemployment rate equals the structural unemployment rate (NAWRU). It equals LF · (1 - NAWRU) · hours , in which LF denotes the total labour force and Hours stands for the average hours worked per worker. The potential output denoted Yp can be expressed in logarithmic terms. See *proposition 2* in the annex.
21. See [EC4] p.37
22. See [EC4] p.72
23. See [EC4] p.126

country-specific TFP growth rates would tend to a longer historical average TFP growth rate recorded in the EU of 1%. As a consequence of this hypothesis, the labour productivity growth rate is expected to be 1.5% in the long-run.

The speed of convergence to this long-term TFP growth rate depends on the relative income position in the different Member States. Particularly, the lower the GDP per capita, the higher the catching up potential [24]. Member States with per capita GDP higher than the EU average tend to the long-run growth rate by 2025. In parallel, for countries with below average per capita GDP, convergence is delayed in respect to the gap of country-specific GDP and EU average.

The assumptions on TFP growth are not considering specific effects of ageing population, since TFP is assumed to be exogenous. Indeed, increasing participation that is likely to benefit to less skilled workers, can depress TFP. On the other hand, the anticipated rise in educational achievement can be set to enforce TFP growth, provided the age profile of productivity. Nevertheless, available studies recommend that older workers are not systematically less productive than younger ones, the crucial factor being the level of education. Some also suggest that older workers could be less flexible and less keen to approve technological changes. Provided the intensity of the debate, the endogenous dimension of this variable has not been integrated in productivity projection.

The capital formation In the medium term, the "investment rule" is applied: capital stocks are derived from the ratio of investment to GDP ratio, considering depreciation. This scenario may function very well for EU-15 Member States as well in the medium- and the long-run. However, it would imply excessively optimistic investment performances in a set of new Member States, given that it leads to extrapolating forward very high investment rates that are related to structural transition process. As consequence, it is supposed in the long-term projections that the capital stocks adapt to the steady state path following the "capital rule": the growth rate of the capital stock equals the sum of growth rate of labour and labour augmenting technical progress.

A transition between the investment rule and the capital rule is used to smooth the profile of investment (linear interpolation).

3 Estimating the Cost of Ageing

Age-related public expenditure comprises pension benefits, health-care, long-term care, education and unemployment benefits systems. A common methodology is used to carry out long-term projections for these government budget's components using common models developed by the EC in cooperation with the AWG, except for pension expenditure projections for which Member States using national models.

3.1 The public pension's expenditure

Pension expenditure projections cover private and public sector pension's schemes. Only public expenditures is considered. Demographic assumptions should be in line with Eurostat EUROPOP projections. Labour participation must be aligned to assumptions used in the general macroeconomic scenario. Pensions expenditures cover pensions and equivalent cash benefits granted for a long period for old-age, early retirement, disability, survivors and other specific purposes which should be considered as equivalents or substitutes as pensions due to reduced capacity to work or due to labour market reasons.

Luxembourg's perspective Specifically for Luxembourg, a data-processing tool (SOBULUX, Social budget simulating software for Luxembourg) is run by the General Inspectorate of Social Security (IGSS) in order to perform the financial projections of the pension schemes. In order to take account of the particularities of the Luxembourg labour market, the instrument is designed to include dimensions such as country of origin or employment status (beyond the general breakdown by age, sex and benefit type). The model thus makes a difference between total labour force and 'national' labour force. The tool is used for long-term planning, the assessment of pension reform options and in political debates. SOBULUX includes a demographic component, it projects the number of contributors and

24. See [EC4], Table 3.1 p.127

pensioners and a financial component to evaluate receipts and expenditures of the systems. All model components are calibrated in order to fully comply with common agreed assumptions.

3.2 The healthcare expenditure

A macro-simulation model is used to project health expenditure. The exception is when the effect of technology and other non-demographic determinants of expenditure is estimated using econometric analysis. The population is divided into groups with certain characteristics (e.g. age, gender, per capita expenditure, health status...). Changes in the size and features of these groups lead to expenditure changes overtime. Eurostat EUROPOP is taken as a baseline for the population projections. Age-specific expenditure profiles are then applied to compute total health-care expenditure. Two main scenarios are computed: the pure demographic scenario which assumes that age specific health status does not change over the projection period. This scenario may be pessimistic as it implicitly assumes that all gains in life expectancy would be spent in bad health. A second constant health scenario assumes on the other hand that the number of years spent in bad health during a life time remains constant over the whole projection period, so that all future gains in life expectancy are spent in good health. This later scenario is a rather optimistic scenario in terms of public expenditure. A more realistic scenario is a mix of both for which health care expenditures are driven by the assumption that half of the future gains in life expectancy are spent in good health.

3.3 The long-term expenditure

The methodology applied for long-term care expenditure is similar to the one applied for health-care. In addition, the methodology allows projecting the future need for long-term services in terms of numbers of people who are assumed to need long-term care services. This is done by using dependency rates, by estimating the fraction of the elderly population which is dependent. First, a projection is made of the dependent population, on the basis of the baseline population projection and disability rates. Second, the dependent elderly population is split, by age and gender, following the type of care received (informal, formal at home, formal in institutions). Third, average expenditure (i.e. age-gender profiles) are calculated for both types of formal care, and then multiplied by the projected number of recipients to obtain the projected public expenditure.

3.4 The education expenditure

The methodology is "quasi-demographic", in the sense that not only demographic data but also participation rate projections are used. Projections are run separately for four International Standard Classification of Education (ISCED) groupings. It is assumed that enrolment in primary and lower secondary education levels is compulsory (ISCED 1 and 2), while enrolment in upper secondary and tertiary education levels depends on labour market outcomes, as changes in participation rates affect enrolment rates in the opposite direction. For the compulsory levels considered (ISCED 1 and 2), enrolment rates per single age are assumed to remain constant at the level observed in a base year. Enrolment rates for ISCED groupings 3-4 and 5-6 take into account labour market participation. In order to obtain the projected number of students, demographic projections are multiplied by the corresponding enrolment rates. Applying a unit cost by educational level, total expenditure can be computed.

3.5 The unemployment benefits

The model applied assumes that unemployment benefit systems is unchanged throughout the projection period and the number of individuals receiving benefits is derived from the commonly agreed labour market assumptions, and unemployment rates are applied to active population in order to compute unemployed individuals. Unemployment expenditure is calculated for the sum of all unemployment benefits.

4 On Sustainability under an EU Framework

4.1 A common definition of sustainability

There has been no common specification on what represents a sustainable position for the public finances.

We may argue though that *sustainability* of public finances would represent the capacity of a government to finance its current debt and expected expenditure. A sustainable position would then involve a debt level, which does not give rise to interest payments so significant that they cannot be paid. One can retain a necessary condition by stipulating that the debt (relative to GDP) is left bounded at any time in the future, in order not to follow an explosive path. This implies that the discounted value of future structural primary balances relative to GDP, should compensate the current proportion of debt, as a share of GDP.

In other terms, the *sustainability* of public finances *concept* refers to the ability of the government to finance the costs of its debt via future revenues. *Sustainability* is thus a concept that differs from *Solvency*. The latter concerns the short- or the immediate-run ability of a country to service its expenditure.

In general, the concept of *sustainability* can be approached from the standpoint of *efficiency* and *intergenerational equity* [25]. *Sustainability* is associated to *efficiency*, since it anticipates the expected increase of tax rates due to the ageing burden. It allows then to avoid this measure in the future, as an increased tax rate may enhance distortionary effects of taxes on the labour market. In addition, that potential significant future tax rate tend to discourage savings, and then investment.

Pertaining to *intergenerational equity*, this *equity* will involve current generations to account for the future ones, so that they will not bear an excessive cost of ageing inherited from the past. A *sustainable* policy is such that it can be maintained up to an infinite horizon so that future generations will take profit from "[...] *the same social security arrangements, the same spending programmes, and the same tax rates as current generations*." [26]. In other terms, the government as a neutral social planner should treat all the generations equally, by allocating to each cohort an equal net benefit [27].

4.2 The IBC as a theoretical reference

The concern of *sustainability* is specified in our context through an Inter-temporal Budgetary Constraint (IBC). This translates the ability of the government to fulfil the costs of its debt via future revenues. It is satisfied if the projected outflows of the government (current public debt and the discounted value of all future expenditure, considering the projected increase in age-related expenditures) are compensated by the discounted value of all future government revenue. In other terms, the government must justify sufficiently large primary surpluses in the future to cover the cost of servicing its current liabilities [28].

$$d_{t_0} - \sum_{t=t_0+1}^{\infty} \frac{pb_t}{(1+g)^{t-t_0}} = 0 \qquad (1)$$

where:

(i) t is the year index;

(ii) t_0 demotes the last year before the long-term projection;

(iii) $T_t > 0$ is the total annual public income at time t;

(iv) $G_t > 0$ is the public annual expenditure net of interest, at time t;

(v) PB_t is the annual structural primary balance (receipts minus spending without considering debt interest payments) at time t. $PB_t \equiv T_t - G_t$;

(vi) D_t represents the gross debt level at time t;

25. See [VEW] p.13.
26. See [VEW] p.13.
27. Defined as the amount of government spending every generation benefits over its lifetime, minus its tax contribution.
28. See *proposition* 5 for a proof of IBC.

(vii) r stands for the nominal interest rate, $r > 0$;

(ix) γ stands for the nominal GDP growth, and g for the differential between nominal interest rate r and the nominal GDP growth rate γ. Thus, $g \equiv r - \gamma$;

(x) $d_t \equiv \frac{D_t}{GDP_t}$, and $pb_t \equiv \frac{PB_t}{GDP_t} \equiv$ represent respectively the per GDP ratios of debt, and primary balance.

This budget constraint is usually considered over an infinite time horizon. There are no binding conditions pertaining to the value of debt that will be achieved ultimately [29]. On one hand, the infinite horizon assumption can be a good tool to give a thorough picture of the sustainability of the public finances. On the other hand, it can be insufficient from a policy standpoint, given the lack of concrete immediacy and the related issues of time consistency. This issue will be clarified later on in the assessment of the sustainability indicators.

In contrast, a finite version of the budget constraint can be taken into account, by fixing a target date and a target debt level. With short time-scale, the requirements imposed on the government are stronger, since the leeway to adjusting the fiscal position in the near future gets harder. Conversely, the longer the time-scale, the more abstract the exercise gets as a tool to policy makers.

If the target debt level is high, it is likely that sustainability will be compromised in the period after the target date. Picking a low level of debt may implicitly generate a further burden on current tax payers with respect to those in the more distant future. In the EU context [30], the target date is 2060, and the target level of debt is 60% of the GDP, which is the threshold in terms of general government gross debt, stipulated in the Maastricht treaty. Since expected costs of ageing represent a component of the IBC, the bigger these costs, the more difficult it is for the budget constraint to be satisfied, holding the *Ceteris Paribus* [31] condition.

4.3 Preliminary assumptions

Before the definition and the analysis of prospective indicators related to *sustainability*, the current subsection exposes a number of underlying assumptions. The derivation of the EU sustainability indicators [32] is performed, as previously mentioned, on the basis of a *partial equilibrium* analysis. This entails the following:

Firstly, the growth path is intrinsically related to the demographic profile, in order to assess future labour input by establishing assumptions about the total population, employment rate, the share of the working age population and the average hours worked [33].

Secondly, invoking the use of a production function approach, the first assumption is combined with hypotheses on TFP and capital deepening to reach a forecast of potential GDP. This is related to demographic developments (i.e. working age population) but plays an exogenous role relatively to public finance and therefore to the fiscal policy evolution. Accordingly, the growth projection does not account for the effect that unsustainable fiscal policies or the rise in tax burden to cover sustainability gaps may have on a plausible contraction of economic activity.

Similarly, it is assumed that the real interest rate is fixed in an exogenous way at 3% for all Member States, unconditional on the government debt developments in the EU and the Euro Area. This proves formally to be a small open economy assumption, in terms of economic modelling.

A further assumption is the continuation of current revenue and expenditure policies over a finite or infinite time-scale, considering the projections on the population size and the structure. For both indicators, non-age related and non-interest spending is supposed to remain constant as a share of GDP in the applicable time period. This is commonly referred to as *unchanged policy assumption*. This does not mean that the scenario is plausible, but it aims within the framework of comparative statics exercise to single out the unsustainable fiscal policies and to grasp the size of the required recovery action.

29. See the specification of a transversality condition in *proposition 6* in the annex.
30. See [EC2] p.149.
31. All other parameters being equal.
32. See [EC2] p.148.
33. See section 2.

However, two components of government revenue stand for an exception to the *unchanged policy assumption*. Projections for revenues from pension taxation and property income are considered separately. For the former case, revenues from pension taxation represent themselves a consequence of ageing. The modelling is performed through elasticities of personal income tax revenues with respect to the tax base.

In addition, property income was assumed to stay constant as a share of GDP [34]. Moreover, no accumulation of financial assets (or other components of the stock-flows adjustment (SFA)) is integrated in the long-term. This made the evolution of nominal debt only driven by the actual government deficit/surplus. These two latter assumptions are mutually incompatible. Indeed, a non-changing ratio-to GDP of property income would have required a progressive accumulation of financial assets. This generates gross debt developments. Thus, the assumption of constancy of property income as a ratio to GDP is dropped [35]. Alternatively, the assumption of no accumulation of financial assets is kept in the same report. It means that the nominal value of government-owned financial assets is left unchanged and so there is a decline in the share of those assets in GDP. Property income from those assets will also decrease as a share of GDP. This assumption stands for interest-bearing assets (bonds) and also shares and other equity.

Finally, the increase in age-related expenditure due to demographic change is incorporated to a constant level of other public spending as a share of GDP. Beyond 2060, it is assumed that the government revenue and primary expenditure, stay constant as a share of GDP, whereas interest payments evolve according to debt developments. Since ageing is a persisting phenomenon even after 2060, this assumption results in underestimating the long-term cost. The magnitude of such projection error being although reduced by the discounting process of future expenditure flows.

4.4 The sustainability indicators

The S2 indicator

The S2 indicator defines the durable adjustment to the current structural primary balance required to satisfy the infinite horizon IBC, considering the payment of an additional expenditure arising from an ageing population [36].

$$S_2 = \underbrace{g \cdot d_{t_0} - pb_{t_0} - g \sum_{t=t_0+1}^{\infty} \frac{\Delta pi_t}{(1+g)^{t-t_0}}}_{:\equiv D} \underbrace{- g \sum_{t=t_0+1}^{\infty} \frac{\Delta pb(ageing)_t}{(1+g)^{t-t_0}}}_{:\equiv E}. \qquad (2)$$

where:

(i) Δpb_t expresses the change in structural primary balance compared to the base year. This change is relative to GDP and follows this relationship: $pb_t = pb_0 + \Delta pb_t$;

(ii) PI_t is the annual property income at time t.

(iii) pi_t denotes property income relative to GDP, $pi_t = \frac{PI_t}{GDP_t}$;

(iv) Δpi_t exposes the change in property income compared to the base year relative to GDP;

(v) The change in structural primary balance equals a sum of a change in structural primary balance due to a change in age related expenditure and a change in property income $\Delta pb_t = \Delta pb(ageing)_t + \Delta pi_t$.

The S2 represents a change in the structural primary balance for every future year that guarantees that (1) is satisfied. Accounting for the decomposition of the change in structural primary balance performed in notation (v) [37].

The first term (D) denotes a condition regarding the initial budgetary position and a discounted value of future income flows from property income. In the case in which the structural primary balance relative to GDP is left unchanged in the future, the IBC stipulates that the structural primary balance should be equal to the technical interest paid on the current level of debt, and adjusted by the discounted value

34. See [EC3].
35. See [EC2].
36. See *proposition 7* for a proof of S2 in the annex.
37. See [EC2] p.p.148-154 for an exhaustive derivation of the sustainability indicators, as well as their formal proofs.

of future property income flows. Thus, the level of debt would be stable as a share of GDP. (D) would then represent the distance between current structural budgetary primary balance pb_{t_0} and the debt-stabilizing structural primary balance $g \cdot d_{t_0}$ [38].

(E) is a overall measure of the time-varying future changes in the adjusted primary balance as a share of GDP, which are mainly due to change in age-related expenditure.

The S1 indicator

The S1 indicator defines the durable adjustment to the current structural primary balance required to meet a target government gross debt of 60% of GDP in 2060, considering the payment of an additional expenditure arising from an ageing population [39].

$$S_1 = \underbrace{g \cdot d_{t_0} - pb_{t_0} - \frac{\sum_{i=t_0+1}^{T} \frac{\Delta pi_i}{(1+g)^{i-t_0}}}{\sum_{i=t_0+1}^{T} \frac{1}{(1+g)^{i-t_0}}}}_{:\equiv A} + \underbrace{\frac{g(d_{t_0} - d_T)}{(1+g)^{T-t_0} - 1}}_{:\equiv B} \underbrace{- \frac{\sum_{i=t_0+1}^{T} \frac{\Delta pb(ageing)_i}{(1+g)^{i-t_0}}}{\sum_{i=t_0+1}^{T} \frac{1}{(1+g)^{i-t_0}}}}_{:\equiv C} \tag{3}$$

Similarly to S2, and for ease of notation, the expression of S1 is broken down to three different terms (A); (B) and (C).

The term (A) ensures that debt as a share of GDP will be bounded by its initial level at a certain point in time. Accordingly, further effort evaluated by the term (B) is necessary to allow the debt to reach 60% of GDP in 2060. This term tends to be significant if the targeted level of debt is small, the time horizon given to reach this debt target is short or the starting debt level is considerable. Regarding countries which display lower initial level of debt, the term (B) is negative and reduces the sustainability gap. The last term (C) is a condition pertaining to future developments of the structural primary balance due to age-related expenditure. To a certain extent, it is different from (E) in the S2 indicator since S1 by definition only considers changes in the structural primary balance up to 2060.

The RPB indicator

The Required Primary Balance (RPB) is another indicator used to illustrate the sustainability framework. It shows the starting budgetary position that, if met, guarantees the sustainability of the public finances under *unchanged policy assumption*. It can then be used for a comparison between actual or planned budgetary strategy and the structural primary balance necessary to fulfil the IBC. In other terms, the RPB would allow us to realize what a sustainable budgetary position looks like for any Member State.

$$RPB_{t_0} = pb_{t_0} + S_2 = g \cdot d_{t_0} - g \sum_{t=t_0+1}^{\infty} \frac{\Delta pb_t}{(1+g)^{t-t_0}} \tag{4}$$

So rather than exposing public finance imbalances as a gap towards a sustainable situation, the target in terms of primary balance can be exposed as a result of a budgetary consolidation in the medium-run that would guarantee sustainability. The RPB can be computed for both indicators.

The RPB is a more stable indicator than the sustainability indicators S1 and S2. In fact, it is only dependent on the present level of debt, the interest rate/growth rate differential and the projected budgetary change over the long-term. Usually these data do not change frequently, unless one considers the implementation of a pension reform or that future demography, potential growth or interest rate can fluctuate. In contrast, sustainability indicators S1 and S2 are sensitive as well to changes in the current structural primary balance, which prove to be more usual.

The RPB is different from the S2 indicator to the extent that it displays a level of a budgetary position, instead of a gap. It is a dynamic indicator. If a country has reached its RPB (if this country has S2 gap of zero, and which is expected to remain zero), the actual and required primary balance will progressively worsen provided the increase in age-related expenditure, albeit a situation of solvency.

38. See the steady state condition in the annex.
39. See *proposition 8* for a formal proof in the annex.

Should the actual (or planned for the medium run) budgetary balance equal or greater than the RPB, the public finances are considered as sustainable, and the opposite statement holds.

4.5 A comparison between S1, S2 and RPB

The sustainability indicators reflect under the current policy, the projected evolution of main tax revenues (direct, indirect, social contribution) and expenditures (pensions, health care, long-term care etc...) over a very long horizon. They give an idea about the gap that must be filled to ensure that public obligations can be financed in the future.

As previously mentioned, the time-scale has been set in purpose. Firstly, it is in correspondence with the requirement of the Treaty. Secondly, it has been selected to be long enough to allow for the effect of ageing to be assessed in an effective way.

One of the difference between S1 and S2 lies in the length of the time horizon considered when evaluating the sustainability of public finances. A positive value of these indicators illustrates the permanent adjustment to the fiscal policy that is necessary to ensure sustainability. The greater the value of the indicator, the greater the adjustment that is required to re-establish the sustainability of public budgets. In contrast, a negative value reveals the sustainability of the fiscal policy, and that the IBC is met. The table summarizes the main differences between the indicators.

Comparative criteria	S_1	S_2
Time Horizon	T = 2060	∞
Components	$A + B + C$	$D + E$
Debt ratio target	d_T = 60%	No target (IBC)
Dimension	p.p. of GDP	p.p. of GDP

4.6 An in-depth look at the S1 and S2 indicators

The sustainability indicators S1 and S2 can be broken down into their components:

(i) The required adjustment given the Initial Budgetary Position (IBP) [40].

(ii) The required adjustment given the Long-Term Change (LTC) [41].

(ii) The adjustment necessary to reach the debt target of 60% of GDP in 2060, or what is called Debt Requirements (DR) [42].

The decomposition of these indicators into three components turns useful since it permits an in-depth analysis of the main driving forces. Thus, an identical overall sustainability gap can be the consequence of either the current fiscal position IBP, the expected increase in ageing-related expenditure LTC or the level of debt DR. The comparison of the LTC components in S1 and S2 indicates as well the urgency in handling the demographic-related sustainability issues.

The IBP

The IBC component represents namely the gap between the initial structural primary balance and the debt-stabilizing primary surplus.

The expected growth and interest rates determine the size of this component. The IBP should not display the same magnitude in the S1 and the S2 indicators, given that interest rates and expected growth fluctuates over time. But, in practice IBP are quite similar for the S1 and the S2 indicators. The concept of debt stabilizing primary balance [43] should be perceived in the long-run perspective and not year by year.

In order to assess the accurate contribution of the budget balance at the starting year, it is crucial to account for the underlying fiscal position instead of the actual value of the government deficit or surplus assessed by statisticians. This entails the adjustment of starting balance to account for the effect of the business cycle and temporary measures, such as one-off revenues or expenditures, to obtain the structural balance [44].

40. It is denoted by the term A for S1 in equation (3), and the term D for S2 in equation (2).
41. It is denoted by the term C for S1 in equation (3), and the term E for S2 in equation (2).
42. It is denoted by the term (B) for S1 in equation (3) in the annex.
43. See equation (6) in the annex.

An accurate estimation of the structural balance involves an evaluation of the position of the economic activity with respect to its potential, the so-called output gap. An appraisal of the effect of the economic cycles on government revenues and spending should be done as well. Cyclical adjustment are always associated with a certain level of imprecision, and the accurate judgement of the position of the economy in respect to the output gap is difficult. Under prospective structural changes, the current potential output as well as its trajectory in the future includes a significant feature of uncertainty. Tax elasticities tend to fluctuate over the economic cycle, and they are implicitly impacted by asset price changes which are difficult to predict.

The forecast trajectory of growth over the medium- and long-run is a decisive factor in assessing the impact of the initial budgetary position and debt on *sustainability*, and the required adjustment given the initial budgetary position. Nevertheless this trajectory remains particularly uncertain.

The LTC

The LTC stands for the required adjustment given the long-term change in primary balance (LTC). It represents an additional adjustment to finance the increase in public expenditure due to ageing up to 2060 for the S1 indicator, and over an infinite horizon for the S2 indicator. The size of this LTC component depends essentially on the demographic stance for countries and their social protection settlements. It denotes either the change required to pay for the additional expenditures or the magnitude of a structural reform to social protection packages such as public pensions and healthcare.

The amplitude of this component may vary between both indicators S1 and S2. If the part of the expected population ageing occurs in the short- instead of the medium-run, the impact on the S1 indicator will be greater, relatively to S2. Conversely, should the costs of an ageing population be endured closer to 2060 than now, the relative impact of ageing would be larger on the S2 indicator [45]. The impact of the economic crisis on LTC is obvious. Indeed the crisis triggers a durable decrease in prospective growth, and implicitly on several government expenditures that related to growth. In addition, the net costs of servicing for pension schemes that manage large assets (such as the funded schemes) are impacted by shocks in asset prices and asset returns.

In addition, costs of pension systems turn out to be the main determinant of the high expected costs that Member States are facing. Thus, countries with the largest expected increase in pension-related expenditure are those who have so far initiated at best "shy" reforms as a response to population ageing to their pension systems.

The DR

For S1, the effect of starting level of debt relative to the 60% of GDP target in 2060 represents a further adjustment in the S1 indicator. It translates the size of interest payments on government debt that should be covered to achieve a target of 60%. If a country has a starting government gross debt above 60% of GDP, the required adjustment to reach the target debt by 2060 term will increase the size of the indicator, since the effort of debt reduction by 2060 has to be accounted for. If a country has current debt below 60%, DR is negative and reduces the S1 indicator.

The present economic and financial crisis enhances uncertainty in DR. Indeed, one notices historically large deficit ratios in several European countries, reaching in some cases up to i0% of GDP. Thus, the likely increase in debt in the future would generate very different estimates of the contribution of the debt component in the S1 indicator.

44. This methodology is described in subsection 2.5.
45. See *proposition 9* in the annex.

4.7 A POLICY PERSPECTIVE

Adjusting the sustainability gaps

Indicators S1, S2, and RPB do not provide any way to show how the adjustment should take place. The required adjustments might be initiated through:

(i) An increase in government receipts, usually through higher direct or indirect taxes.

(ii) A reduction in government spending.

(iii) Structural reforms.

The choice of measure, or a set of measures, has an impact on the economy or fiscal sustainability. A sharp increase in the tax burden to cover the sustainability gap may generate deterioration in the economy's growth prospects, with consequences for sustainability. Not making the required adjustment would have the short to medium-term effect of raising the debt, before significant sustainability issues arise and affect countries abilities to levy debt as the perceived long-term risks increase.

From a policy standpoint, an optimal response involves a deep understanding of the components of the sustainability indicators. It will be easier politically to correct a sustainability gap arising essentially from an initial imbalanced budgetary position or one that is insufficient to stabilize debt, through tax increases or spending cuts, than one generated primarily by costs of ageing. In fact, for the latter, the deterioration on government budgets may only become obvious in the future. In consequence, anticipatory recovery action may be harder to establish.

The cost of delay indicator

Considering the size and the reasons underlying the gaps, Member States should use some combination of structural reforms of their social protection system that may lead to a reduction in the cost of ageing, an increase in tax or a reduction in spending.

In addition to the choice of the optimal manner to address the expected gap in their public finances, the *timing* of policy action is also crucial, especially when the fiscal policy is playing a significant role in helping the economy to overcome the crisis. Implicitly, another interpretation of the sustainability gap could be seen as the magnitude of the correction that must happen *immediately* and be kept for the future. Should corrections be undertaken later, then countries displaying sustainability gap would need to perform a greater adjustment.

The absolute additional costs relating to the required adjustment of the delay is linked to the magnitude of the sustainability gap and the government gross debt. However, its relative size depends also on the expected economic growth.

The measure of the cost of delay fosters the issue of *intergenerational fairness*, treated previously when the concepts of *sustainability* and *efficiency* have been invoked. The further costs of ageing will be borne at least partly by future taxpayers for countries with a sustainability gap. By adjusting the gap later, future taxpayers will undergo more of the burden than current ones [46].

4.8 OTHER SUSTAINABILITY FACTORS

Government debt projections

The long-term evolution of debt An alternative way of considering sustainability is to account for the trajectory of debt [47], considering that the cost of servicing debt and paying for age-related spending are accounted for.

Such projections are though not robust forecasts and do not aim to be realistic scenarios of what may occur in the future. For practical reasons, the financial markets are not very keen to keep financing government debt that accumulated to a drastic amount representing several times the annual GDP of a country. In addition, it is less likely that governments would not modify their policies in the presence of a huge debt. The objective of these debt projections is rather to reveal the long-term tendencies and the magnitude of the required recovering action to avoid an exponentially increasing debt.

46. See *proposition 11* and *proposition 12* in the annex.
47. The results of this analysis are exposed in [EC2] Graph III.1.2, and more detailed in Table III.1.4.

The additional risk of debt The current level of government debt impacts directly the sustainability indicators S1 and S2 through the term that is linked to IBP. It also impact S1 through the DR that includes further efforts to the debt stabilization of 60% of GDP for 2060.

Aside from the direct effect of the level of debt in sustainability, the size of the debt can trigger further consequences on both the real and political size of the economy. A significant level of debt can diminish a country's capacity to handle even a temporary shock to its interest rate and growth rate. A shock to the cost of financing the debt tends to be significantly more impacting than for countries with a lower stock of debt. A higher level of debt can also entail some threshold effects, to the extent that when a country reaches a specific level, interest rates will be pushed further. Therefore, the level of debt can include a further risk factor over the previously explained sustainability gaps.

The increase in interest rates occurs in order to keep attracting buyers of government debt, and may trigger the effect of crowding out private investment. The size of debt at which it arises varies across countries and is related to characteristics such as size, economic development, structure of financial market, debt maturity, external imbalances and the monetary regime.

By elaborating credible plans to stop and reverse the raise in their debt levels, government can try to reduce the perceived sovereign risk. Once debt attains a high level, such measures may become necessary to inhibit the snowball effect of government debt and guarantee the continued sustainability of a country's economy.

Primary balance

The primary balance is an important determinant of the change in the debt ratio.

A higher level of debt requires a higher level of interest payments and thus involves a durably positive primary surplus mainly to service the debt, and higher surpluses to diminish its level. This can be politically and socially hard to maintain and when associated to an ageing population, let the necessary adjustments even more difficult. The significance of this factor will depend on the strength of institutions and the political debate within a country. Experience revealed that some countries turned to be less able or keen to initiate this, whereas others are able to find the political agreement to reduce high levels of debt.

Government assets

Assets should be considered when evaluating the sustainability position of countries. Indeed, a possession of assets may allow paying off debt, since they are generating property income. Assets have notably an impact on sustainability, should the real value and the book value of assets vary or the returns on assets are different from the interest rate on debt.

The role of contingent liabilities

A large range of expenditure may be encountered by the government that is not integrated in its projected revenues or expenditures. Contingent liabilities are those that the government only needs to suppose when a specific situation happens [48]. These may be implicit such as managing natural disasters, or explicit such as loan guarantees.

Implicit liabilities are not backed up by law, but require expenditures for which there is an anticipation that it will go on or materialize. *Implicit* and *contingent liabilities* are not mutually exclusive categories but different dimensions of categorization. The scale of contingent commitments of the public sector can only be evaluated by determining explicit parameters that fix what will be considered. Indeed, beyond the *explicit contingent liabilities*, which are backed up by legal provision, like guarantees to borrowing of public and private enterprises, there are also *implicit contingent liabilities* whose scale is open. Aside from the scale, the data may not be available.

An augmented interest in contingent liabilities due to the government support initiatives in the crisis, should allow an improved statistical understanding and measures of these liabilities in time. An evaluation of the value of those liabilities and commitments would involve an understanding of the probability of situations that yield liabilities occurring, and the magnitude of these liabilities under numerous outcomes.

48. The occurrence of a specific "state of the world".

Within the economic and financial crisis, many Member States have contracted *explicit contingent liabilities* to permit the functioning of the financial sector and other industries. Thus, the public finances of the Member States may bear further spending that is not currently accounted for [49]. How these *liabilities* affect the public sector risk varies according to their nature.

Aside from this, governments have supported their financial sectors via capital injections, the relief of impaired assets, and underwriting liquidity and bank support schemes. The capital injections are shown in the public sector's balance sheet and then provide the governments with assets that will be sold, but which value is marked by uncertainty. The asset relief, liquidity and bank support schemes are a balanced set of interventions, some of which transfer risk to the public sector without a spending that appears in debt, hence also augmenting the explicit contingent liabilities of the government.

Nevertheless, beyond these schemes, governments provide depositors with guarantees that will only generate cost to the government if they occur [50]. There is a discrepancy among Member States with respect to these explicit limits, and it might prove that Member State with lower limits find themselves obliged under political pressure to reimburse the full amount of deposits, should a bank goes bankrupted.

Tax ratios

This represents the range, in which Member States should address the sustainability problems. Theoretically, a sustainability gap can be filled by levying tax revenues or cutting spending. Decreasing spending means either decreasing spending on non-age related expenditure or reforming the social security scheme so that the costs of ageing can be restricted. For Member States with very high size of tax or low levels of spending, the alternatives could be more restrained as it is economically costly for them to levy tax further.

In the absence of reforms to tackle the costs of ageing, or cuts in other expenditure categories, the sustainability gap will have to be closed by adjusting tax revenues. The feasibility and easiness of such an initiative is related in part to the prior situation in the different Member States. Countries with high levels of tax revenues, might find it difficult to levy taxes further.

This is both because it can be politically hard to convince voting taxpayers to increase taxes, and economically there might be an issue on the dead-weight loss due to high taxes on the economy, since higher taxes will represent a disincentive to work and diminish competitiveness. Alternatively, amongst some countries with usually significant levels of tax, there could be other factors that would alleviate the pressure against tax raising initiatives.

4.9 An assessment of the Methodology

First, one should notice that the approach for the derivation of the several sustainability indicators (S_1; S_2; *RPB*) offers a general framework on a EU level for Member States, to grasp an intuition at a specific moment about the sustainability of public finances. The comparability of the different results for such indicators could be performed to a certain extent among Member States, since the same modelling benchmark has been used for the computation. This approach to account for the sustainability of public finances is consequential to [BLC], in which he aimed first to account for a sustainable measure of the tax rate which has to be levied. As previously indicated, this common EU methodology extends the thoughts of [BLC] to consider rather required measures of gaps to reach a sustainable primary balance upon horizon up to 2060, and over the long-run.

Yet, the usefulness of a common framework does not exclude the necessity to highlight country-specific discrepancies amongst Member States and the choice of the horizon for such sustainable indicators proves strategic from a policy standpoint. Any related interpretation should involve remarkably what horizon has been selected for the projections.

In addition, purely from a technical consideration, one should recall that IBC has been selected as a starting theoretical framework for the derivation of such sustainability indicators. It can be referred to as the specification of a necessary but not a sufficient condition of sustainability, and we insisted on the issue that there is not a common and an agreed definition amongst practitioners and economists on what a sustainable position for public finances looks like. The choice of the IBC has been then set

49. Figures are taken from [EC2] and listed in the first six data columns of Table V.3.1 p.79. Columns three and four reveal the approved and effective guarantees provided to the financial sector. For some countries, these are markedly significant.
50. The final column of the same table, shows the limit value of the deposits that Member States guarantee.

strictly for the purpose of such derivation, and any interpretation of the different values for the sustainability indicators has to incorporate the numerous criticisms, to which the IBC might be a subject. The deterministic part of the IBC represents a major shortcoming for any modelling and subsequent derivation [51]. Including a part of uncertainty related to the distribution of future primary balances and debt ratios may represent an improvement.

Rather than considering deterministic values for the future primary balances, conditional expectations [52] (with respect to the initial instant of the projection) could be used to account for future primary balances [53]. This "improved" modelling displays obviously an added value with respect to the general EU framework, but should be replaced in a practitioner's context and assessed carefully on its feasibility from a public policy view.

5 On MTO's

5.1 A clear-cut definition

The Medium-Term Objective is a *quantitative target* for the *structural primary balance* over the *medium-term* (e.g. 3 years). This objective would bring Member States to anticipate the future burden of *liabilities* (or debt) by generating resources, following a structural budgetary effort. The EU legislation consider mainly two kinds of liabilities:

(i) *Explicit liabilities*, which represent current stock of public debt.

(ii) *Implicit liabilities* that stand for commitments related to strong expectations in terms of *increases in age-related spending*, or simply *contingent liabilities*. These *liabilities* represent unfunded commitments that are not backed by law or contractual obligations, but related to strong expectations in terms of pension spending, or *liabilities* occurring in relation with a prospective support to the financial sector in crisis.

Performing the structural budgetary effort (or fiscal consolidation) imposed by the MTO's has to be *smooth*, in order to allow for a "*politically feasible*" implementation. One should further underline that policies leading to the achievement of MTO have to satisfy a smooth adjustment path, without displaying politically unrealistic fiscal tightening at the end of the planning horizon.

The European Council aimed through MTO's to a threefold objective pursued by : First, providing a safety margin. Second, enabling quick progress towards public-finance sustainability. And last, permitting an adequate budgetary margin of manoeuvre to enhance public investment.

The MTO seeks to enable progress towards sustainability of public finances, which has been defined broadly to account for *explicit liabilities* associated to the current stock of debt and *implicit liabilities* related to the expected worsening of fiscal balances due to the cost of ageing:

Regarding *explicit liabilities*, a Member State which debt-to-GDP ratio is above the Treaty reference value of 60% of GDP should undertake a more requiring MTO, in addition to the Member State which prospective growth rates of potential GDP are relatively low. These MTO's will lead them to reach a sounder fiscal position generating a debt growth below the nominal GDP growth, hence a decreasing debt-to-GDP ratio.

Pertaining to *implicit liabilities*, the MTO seeks to partially front-load the cost of ageing. This front-loading involves the improvement of the budget balances and the present increase of public savings by reducing the speed of debt accumulation in order to generate further financial resources available in the future, and to cope with the ageing concern, in threatening public finances.

Furthermore, the MTO allows for an opportunity for a Member State that decides to promote public investment as to cover aggregate demand or to launch economic growth. To this end, a low-debt

51. See [BOH].
52. See [BOH].
53. The *ad-hoc* specification of IBC by [BOH] is of the form: $d_{t_0} - \sum_{t=t_0+1}^{\infty} \frac{E_{t_0}(pb_t)}{(1+g)^{t-t_0}} = 0$.

country is endowed with a less requiring MTO so that its fiscal budget can bear further investment spending without missing the targeted MTO.

In addition, it should be noted that Member States have to indicate MTO's for budget balances in structural terms, which means adjusting for cyclical dimensions and deducting one-off and temporary measures. In overall, MTO's should consider the government debt, the potential output growth, and a safety margin pertaining to the Treaty threshold of 3% of GDP in terms of nominal budget deficit.

5.2 The institutional framework

Initially, the Stability and Growth Pact (SGP) did not expose a well-detailed methodology for the computation of MTO's. Thus, broad room for subjective analysis was then left to each Member State while fixing budgetary targets. This triggered a prospective flaw to the general credibility of the EU fiscal framework. In 2009, the EC and Member States elaborated a joint work aiming to generate an agreed methodology that gives an accurate vision of MTO determination criteria. Notably, this agreement gives foundations for the computation of country specific minimum budgetary targets that Member States can declare as MTO's. Moreover, countries have the flexibility to declare MTO's that are more demanding than these minimum thresholds. This methodology includes not only public debt, potential growth, and budgetary safety margins but also the *implicit government liabilities* corresponding to rising expenditure due to ageing.

It is important to recall that the SGP includes two major features: a corrective arm and a preventive one. The corrective dimension is based upon the Treaty criteria: the public finance deficit and the public debt should not go beyond the thresholds of 3% and 60% of GDP, respectively. The preventive dimension requires from the Member States the implementation of a Medium-term budgetary strategy to ensure *rapid progress* balanced public finances.

The legal framework of the new MTO methodology is found in the conclusions of the 2005 Spring Council of the EU, which established the main economic principles of the SGP reform and guaranteed the required political involvement to make the endorsement of the European fiscal framework fully credible. Due to the previous failures to reach MTO's from the large majority of Member States, the European Council aimed to enhance the SGP preventive arm by permitting MTO's to be country-specific and to consider discrepancies across Member States, given economic fundamentals and risks to public-finance sustainability, particularly those related to demographic changes.

MTO's are not explicitly mentioned in the treaties, but are defined in the following documents:

(i) The EC Regulation N0. 1466/97 [54] pertaining to the reinforcement of the budgetary positions monitoring as well as the harmonization of economic policies.

(ii) The Code of Conduct [55], which after a thorough debate on the issue arisen by MTO's, and notably the conceptual and methodological issues, exposes an agreement on the implementation of MTO determination criteria in the Spring 2009, and was set official in November 2009. 15 Member States have then computed their MTO's via the new methodology in the 2009 updates of SCP. In addition, the updated code of conduct [56] provides an ultimate explanation on the SGP and the content of stability programs.

Moreover, the importance of fiscal consolidation for monetary stability in a currency union triggered differentiation by membership to the EA and ERM II. Then, Member States which adopted the Euro or, which are in the process of doing so, are asked to declare MTO's in a range between a structural deficit of 1 % of GDP for low debt/high potential growth countries, and a balanced structural budgetary position for high-debt/low potential growth countries.

New MTO's should endeavour to provide a balanced mix between the requirement of national ownership and the search for common framework. National ownership is guaranteed by agreeing of the SGP prescription that Member States should display country-specific MTO's in their SCP. The common framework is ensured through a fixed MTO "algorithm" [57], associated to a minimum specification of policy parameters, which are the debt-reduction effort and the incorporation of a share of *implicit liabilities*. This generates minimum values of MTO's for every Member State.

54. See [CON] point (14), p.3.
55. See [coC1] section 1, p.4.
56. See [coC2].
57. This expression is stated in [BIR] to denote the formula required for the computation of MTO's.

Pertaining to the assessment of the MTO's in the context of EU budgetary surveillance, MTO's are evaluated in the framework of the ensuing examination by the EC and the European Council yielding a Council opinion.

The new economic governance has led to numerous changes pertaining to MTO's. First, a modification of the 1467 rule on the preventive section of the SGP, which stipulates that MTO's should be revised at least every three years (instead of four). Second, Member States are asked to implement budgetary rules contributing to the respect of Member States' MTO's. Accordingly, an MTO not reaching the minimum value would be evaluated as not compliant with the objectives of the SGP. An MTO hitting the minimum value would be evaluated as reflecting the objectives of the pact. An MTO more requiring than the minimum value (assume by more than 0.5 p.p.), would be evaluated as more than adequately reflecting the objectives of the SGP.

Last, a puzzling question remains on how to act if the minimum MTO is considered to be "po-litically infeasible", notably for high debt countries or countries facing high cost of ageing.

5.3 The model

Analytically, the "algorithm" behind the MTO determination takes as inputs the fiscal and macroeconomic variables, and triggers as output the minimum budgetary target for a Member State. Provided the minimum target generated by this "algorithm" (hereafter MTO^{MT}), a Member State must engage itself to reach an MTO, denoted as a declared ($MTO^{D)}$, that is equal or more requiring than the minimum. Usually MTO^{D} is observed whereas MTO^{MT} is not. However, it must satisfy the following constraint $MTO^{MT} \leq MTO^{D}$.

$$MTO^{MT} = max(MTO^{ILD}, MTO^{MB}, MTO^{Euro/ERMII}) \quad (5)$$

The code of conduct [58] exposes the MTO^{MT} [59] "algorithm". It imposes that MTO^{MT} is the most requiring value amongst three options:

(i) the country-specific minimum benchmark (MTO^{MB}), which represents the fixed safety margin and which value has been exposed by the EC;

(ii) the country-specific commitment by Members of EA and ERM II to reach at least a structural deficit of 1% of GDP ($MTO^{EA/ERMII}$);

(iii) the country-specific MTO [60] that faces the issues of sustainability of public finances and budgetary manoeuvre allowed to low-debt countries MTO^{ILD}.

$$MTO^{ILD} = \bar{b}_{60} + \alpha \cdot \Delta AC + e_{60} \quad (6)$$

The code of conduct [61] illustrates the way MTO^{ILD} should be computed, by exposing three components:

(i) the budget balance that stabilizes the debt-to-GDP ratio at 60 % provided a country's long-term growth rate of nominal GDP,

(iii) a share of the adjustment required to offset the present value of the anticipated increase in age-related spending,

(ii) a further debt-reduction effort for countries whose debt goes beyond 60% of GDP.

58. See [CoC2].
59. Denoted simply as MTO in [CoC2].
60. [BIR] denotes it as MTOSM, with S denoting "sustainability" and M "Maneouvre".
61. See [CoC2].

First, the debt-stabilizing balance represents a standard result in debt dynamics, it is computed precisely from the long-term growth rate of potential GDP at current prices (nominal). This estimation is provided by the EC for all EU countries. Provided the hypotheses of economic growth, this represents an annual budgetary balance that allows stabilizing the public debt to the threshold of 60% of GDP, unconditional to the initial level of explicit public debt. One of the crucial criteria of the Treaty concerns debt requirements, and invoke Member States over the long-run to maintain the debt-to-GDP ratio, such that: $d_t = d_{t-1} = 0.6$, then:

$$\bar{b}_{60} \geq -0.6 \times \gamma \tag{7}$$

and :

$$p\ \bar{b}_{60} \geq 0.6 \times (r - \gamma) \tag{8}$$

Second, the adjustment required to front-load the country's cost of ageing as computed by the AWG. Either 33% of the overall increase in the cost of ageing over the long-term, or the annualized value of cost of the total age-related costs until 2040 will be accounted for. Cost pro-jections related to five categories of expenditures: pensions, healthcare, long-term dependence, unemployment benefits and education [62].

(i) First alternative $\Delta AC = E$

$$\alpha = 33\%$$
$$E = -g \sum_{t=t_0+1}^{\infty} \frac{\Delta pb(ageing)_t}{(1+g)^{t-t_0}}$$

(ii) Second alternative $\Delta AC = C_T$

$$\alpha = 100\%$$
$$C_T = \frac{\sum_{i=t_0+1}^{T} \frac{\Delta pb(ageing)_i}{(1+g)^{i-t_0}}}{\sum_{i=t_0+1}^{T} \frac{1}{(1+g)^{i-t_0}}}$$

On notices upon several projections that the two alternatives of computation would be identical for $T \cong 2040$.

Third, the supplementary debt-reduction effort is an additional feature of the MTO^{ILD}, aiming to trigger *rapid convergence* of debt-ratios in high debt countries towards the Treaty 60 % criterion. Therefore, it is specified that the effort should be proportional to the excess of the debt-to-GDP ratio over the 60% threshold.

$$e_{60} = 0.024 \cdot d - 1.24;\ e_{60} > 0$$

where d represents the last available actual debt data at the time of revision that is supposed to be shown after publishing the new projections of age-related spending. For instance, this component will take a value of 0.2 at 60% and 1.4 at 110% of debt as a % of GDP.

62. See section 3.

5.4 An assessment of the model

Three advantages of the revised methodology on MTO's compared to the former *ad-hoc* approach can be listed [63].

First, the new MTO methodology reinforces the concern of transparency, simplicity and political involvement of the procedures for establishing medium-term budgetary objectives. The revised MTO methodology is straightforward to permit understanding and to ease technical discussion among stakeholders in the EU fiscal framework, especially the EC and Member States involved in multilateral budgetary surveillance. Moreover, fiscal prudence is supposed to be reinforced since Member States are no longer entitled to provide minimum benchmarks, as they were previously.

Second, MTO's are now a crucial part of a well-detailed quantitative framework. Indeed, for every Member State, accurate values can be measured for the components of the MTO determination criteria. The analytical components of the overall framework: output gaps, budgetary sensitivities, the Treaty reference values, sustainability indicators etc. could refer to the broad scope of theoretical and applied work performed jointly by the EC and Member States. This guarantees compatibility of the MTO methodology with other existing formal procedures at EU level, such as the prosperous documentation on sustainability indicators (S1; S2 and RPB). [64]

Third, recent MTO's indicate explicitly the role of both government *explicit* and *implicit liabilities* in establishing minimum budgetary targets. Thus, MTO's can regulate the fiscal constraints imposed on Member State, to adapt to its own fiscal path in the past.

Consolidating *explicit liabilities* as driving forces of MTO's, requires an accurate distinction be-tween low-debt and high-debt countries and permits a differentiated treatment of both groups. Low-debt countries are endowed with a greater margin of manoeuvre in coping with government debt. They would afford for instance to finance further public investment. Indeed, they are not perceived as bringing immediate threats for the financial and macroeconomic stability of EMU. In contrast, high-debt countries are vividly encouraged to reach more requiring MTO's, which bring them to generate greater public savings, in order to smoothly diminish their debt-ratios and the prospective threat to the EMU.

As previously mentioned *implicit liabilities* were introduced in the MTO's. In order to consider the Member State sovereignty on the choice of policies financing the age-related spending, the new MTO methodology opted for a partial degree of front-loading. That being said, a minimum degree of front-loading is imposed to EU countries, in order to enhance the incentives leading to implementing pension reforms, or to maintain those already initiated. However, the code of conduct [65] stipulates that MTO's could be revised on a regular basis after performing crucial structural reforms that impact age-related spending.

On the other hand, there might be some shortcomings to this new methodology, which deserve to be exposed. Particularly, the supplementary debt-reduction effort does not speed up significantly the convergence of debt-to-GDP ratios towards the Treaty 60 % target value [66]. Moreover, the partial *front-loading* of age-related costs does not provide sufficient incentives to undertake profound reforms aiming at decreasing the future path of age-related spending.

Regarding the supplementary debt-reduction effort in the "algorithm" specification, a 10 p.p. increase in the debt-to-GDP ratio increases the MTO^{ILD} by 0.33 p.p. of GDP, and given that MTO^{ILD} is the maximum of the algorithm, it increases by the same amount MTO^{MT}. This increase stands for a substantial consolidation of the structural budget balance that should be performed over the medium-term. This effort is set to penalize high-debt countries through a tougher fiscal tightening in the next few years. However, one should keep in mind that the purpose of such debt-reduction effort is to guarantee *rapid progress* towards sustainability, and not to seek purely to penalize high debt countries for the strict purpose of fiscal discipline. Accordingly, the evaluation of such effort should be based on how quick is the convergence of debt-ratio towards the Treaty reference value, and not on how tough the fiscal tightening should be performed for high-debt countries. To this end, one notices that the effort has an insignificant impact on the *speed* at which the debt ratio of a high-debt country would

63. See [BIR].
64. See section 4.
65. See [CoC2].
66. See [BIR] for an alternative approach in the annex.

shrink over time if the MTO were achieved as planned. In other terms, the supplementary effort is ineffective as a tool of convergence.

Therefore for practical reasons, including the supplementary debt-reduction effort in the methodology of MTO determination criteria, plays a small role in guaranteeing *rapid progress* towards sustainability compared to the exclusion of such effort. In contrast, one should consider its effect of imposing larger fiscal tightening in the medium-term, which remains inconsistent with the objectives exposed by the code of conduct [67].

Pertaining to the front-loading of the age-related spending, the *explicit* and *implicit liabilities* impact symmetrically the IBC [68]. Indeed, within this solvency condition, the future increase in age-related spending is translated into a notional stock by estimating the net present value (NPV). This stock is completely comparable with the current stock of outstanding debt, since both require collecting taxes to cover either further primary spending or interests. Similarly, structural reforms that diminish future age-related expenditure trigger a reduction in the NPV of future expenditure that is comparable to a one-off reduction in the outstanding debt stock.

The symmetry clarified in the budget constraint is not present in the MTO determination, and MTO's do not provide balanced incentives between short-term budgetary tightening aiming at reducing the debt ratio, and the alternative of initiating structural reforms, both having although the same impact of solvency. MTO's opt clearly for a fiscal consolidation [69]. One may argue though that there are reasons why explicit and implicit liabilities may not be directly comparable, which may foster such a discrepancy between both policy alternatives.

6 The Impact of Alternative Scenarios for Luxembourg

The present section assesses the financial long-term aspects on *sustainability* in the case of Luxembourg in terms of the common EU framework, based on the different EU sustainability indicators and MTO's. Toward this goal, two scenarios will be confronted: a baseline scenario and an alternative one. The baseline scenario is based on the 2009 projection exercise on long term economic growth and age-related expenditure of the Ageing working group (AWG) of the Economic Policy Committee (EPC) of the EC [70]. The alternative scenario has the 2012 update of these projections as input.

6.1 The baseline scenario (AWG2009)

Scenario's description

Sustainability indicators Table 1 indicates the different values of the EU sustainability indicators for Luxembourg, decomposed into their different components. In terms of the S2 value, Luxembourg should improve its structural primary balance by 13.01 p.p. on a yearly basis, in order to ensure a convergence toward a sustainable path under the requirement of the IBC. Pertaining the S1 indicator, Luxembourg's structural primary balance should be consolidated by 6.70 p.p. on a yearly basis, in order to reach a target value of 60% for the debt-to-GDP ratio by 2060. In contrast to the gap analysis used for S_1 and S_2, the RPB value reveals that Luxembourg should display a structural primary balance of 13.85% every year, in order to retrieve a sustainable path over the long-run and then to fulfil the IBC. The figures obtained in Table 1 should be subject to a cautious analysis, since they translate strictly a normative reasoning, which is namely related to the fulfilment of the IBC over the long-term. It is obvious that an improvement of the structural primary balance of 13.01% (the S_2 value) is "politically infeasible", due to the severe feature of an unprecedented crisis on a European scale and the critical increase in age-related spending, if one considers projections for Luxembourg over the longer-term.

67. See [CoC1].
68. See [BIR].
69. See [BIR] for a numerical example.
70. See [EC7].

Table 1. - Sustainability indicators in the baseline scenario

Components	S_1	S_2	RPB
$D = \lim_{T\to\infty} A$	-0.12	0.09	-
B	-0.71	-	-
$E = \lim_{T\to\infty} C$	7.54	12.92	-
Total	**6.70 p.p.**	**13.01 p.p.**	**13.85 %**

MTO's Figures in Table 2 display the values for different alternative versions. Each MTO is broken-down into its three components. The first two columns show the values for MTO's according to the two alternatives based on the code of conduct [71]. Namely, if Luxembourg opts for a budgetary front-loading of the increase in its age-related spending up to a share of 33% (MTOinf33%), it should perform a fiscal consolidation of 1.46% over the medium-term, in order to comply with the preventive arm of the SGP. Furthermore, the last two columns of Table 2 show a sensitivity analysis on the two channels of computation of increase in age-related costs. If for instance the minimum share of the budgetary front-loading is increased from 33% to 66%, the new fiscal consolidation over the medium-run should be 5.73%. In contrast, if a horizon of 2060 is considered instead of 2040, a budgetary consolidation of 4.74% should be considered.

Table 2. - MTO's in the baseline scenario

Components	$MTOinf_{33\%}$	MTO_{2040}	$MTOinf_{66\%}$	MTO_{2060}
$\bar{b}_{60}$	-2.80%	-2.80%	-2.80%	-2.80%
$\alpha\Delta AC$	4.26%	3.90%	8.53%	7.54%
e_{60}	0	0	0	0
Total	**1.46%**	**1.10%**	**5.73%**	**4.74%**

Debt projections and adjustments Figure 1 shows the debt-to-GDP projections within this baseline scenario [72]. Figure 1 depicts clearly the explosive path of projected debt-to-GDP ratio over a horizon up to 2070 (dark red line). One notices explicitly the exponential feature of the debt-to-GDP trend. This dramatic projection will necessarily occur, if no budgetary consolidation will be undertaken to face the expected burden of the age-related expenditure in Luxembourg over the long-term.

Moreover, it indicates as well four other curves reflecting the evolution of the debt-to-GDP ratios under four different kind of adjustment [73]. The first two adjustment are based on the S1 and S2 indicators. The evolution of the dark blue curve complies with the reasoning underlying the S1 indicator, insofar as the final target of 60% in terms of debt-to-GDP ratio, is retrieved in 2060. Similarly, the adjustment through S2 displayed in the grey curve obeys to the requirement of the IBC, since debt-to-GDP ratio is stabilised at a value of -320% of GDP (which represents *a fortiori* a reserve of 320 % of GDP). These results confirm that there should be a careful interpretation of the S2 indicator, provided that in overall, it remains a very theoretical value. Thus, the main point to perceive in this analysis is that *in fine* debt-to-GDP ratio will remain unchanged from a certain horizon. The value of 320% of GDP does not provide us with any particular or crucial intuition on the final amount of debt ratio that should be reached.

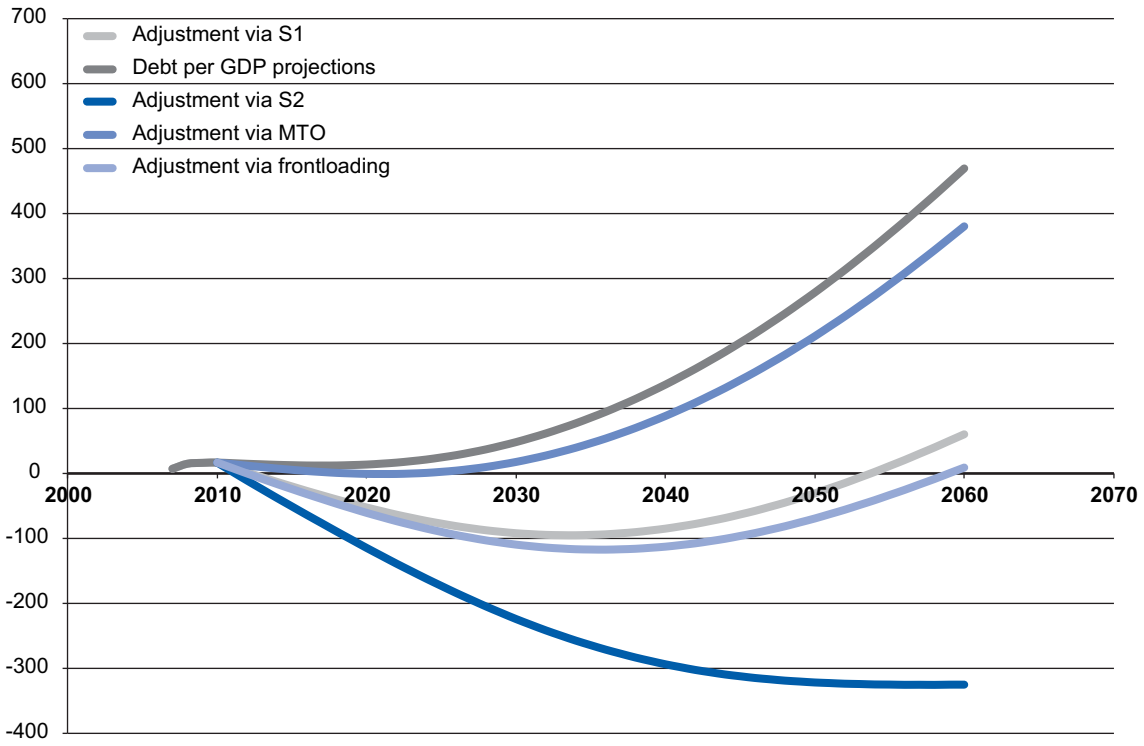
Apart from the adjustments via S1 and S2, a yearly consolidation via MTOinf33% and a total front-loading of the expected increase in age-related spending up to 2060 (respectively the purple and the light-blue curves) can be performed. For the first, the effect of the adjustment is rather significant in the medium-term, but gets insignificant in the long-run since it converges to the same path as the debt-to-GDP ratio without any adjustment. Pertaining to the front-loading, the adjustment is considerable up a horizon of 2060, in which nearly the same value of debt-to-GDP ratio as the initial one of 2010 is retrieved.

In overall, and on the light of all the previously mentioned facts, figures suggest that the main preoccupation in terms of public finance for Luxembourg is to perform a smooth effort through structural reforms of the age-related systems, particularly when pensions are responsible for 80% of the increase in overall age-related spending. Indeed the alternative measure consisting in a drastic

71. See [CoC1] and [CoC2].
72. See *proposition 13* in the annex for a complete view of the methodology adopted by the EC to project the debt-to-GDP ratios of the Member States, as well as some crucial hypothesis underlying these projections.
73. See *proposition 14* in the annex.

improvement of public finances, would not be a feasible solution, both politically and economically, especially in the context of deep economic uncertainty. It could be argued that a credible and politically stable strategy will be initiated through an efficient, fair and balanced allocation of efforts on both the budgetary pre-financing and structural reforms, in order to ensure a good quality of public finances sustainability.

Figure 1. - The baseline scenario



6.2 The altered constant policy scenario (AWG2012)

Scenario's description

Recurring AWG projection exercises downgraded economic growth of Luxembourg constantly: if in 2006 average growth rate over the period 2010-2050 was about 3.1%, this level reduced to 2.7% in the 2009 projection exercise and to 2.1% in the present projection. Whereas macroeco-nomic assumptions in the 2006 and 2009 AWG projection exercise were in line with the national reference growth scenario of 3%, present growth scenario is sensibly lower. Taking into account that the average economic growth of Luxembourg over the period 1980-2010 was 4.3%, the 2012 macroeconomic projection scenario has to be considered being the worst-case scenario for Luxembourg.

AWG projection results show that the pension expenditures exceed contribution income by 2020 and that the general pension scheme pension fund will run out of money by 2030. In this respect the 2012 AWG pension projections assume that the adjustment mechanism of the pensions relative to real wage growth will be modulated once the financial resources of the general pension scheme are insufficient. The 2009 AWG projections applied a full adjustment of pensions to wage evolution. In accordance with article 225 of the Code of social security, 2012 pension expenditure projections assume that the adjustment mechanism will only act partly to the evolution of the average level of wages once financial resources are insufficient. Taking account of the extreme pessimistic macroeconomic assumptions in the projection exercise, a full abolition of this mechanism could also be justified. In order not to produce optimistic projection results regarding future pension expenditure evolution it was decided to limit the pension adjustment mechanism to 50% of the wage evolution from 2019 onwards. Therefore new pension benefit, as well as pension stock expenditure evolution will be impacted.

Sustainability indicators The analysis of the sustainability gaps, under the light of the current scenario is conducted in the same fashion as it was previously done for the baseline scenario. The major change displayed by the results is that the three sustainability indicators (S1; S2 and RPB) are significantly lower than the above-mentioned results for 2009 projection scenario.

Table 3. - The sustainability indicators in the alternative scenario

Components	S_1	S_2	RPB
$D = \lim_{T\to\infty} A$	-0.05	0.14	-
B	-0.64	-	-
$E = \lim_{T\to\infty} C$	5.34	8.36	-
Total	**4.65 p.p.**	**8.51 p.p.**	**9.59%**

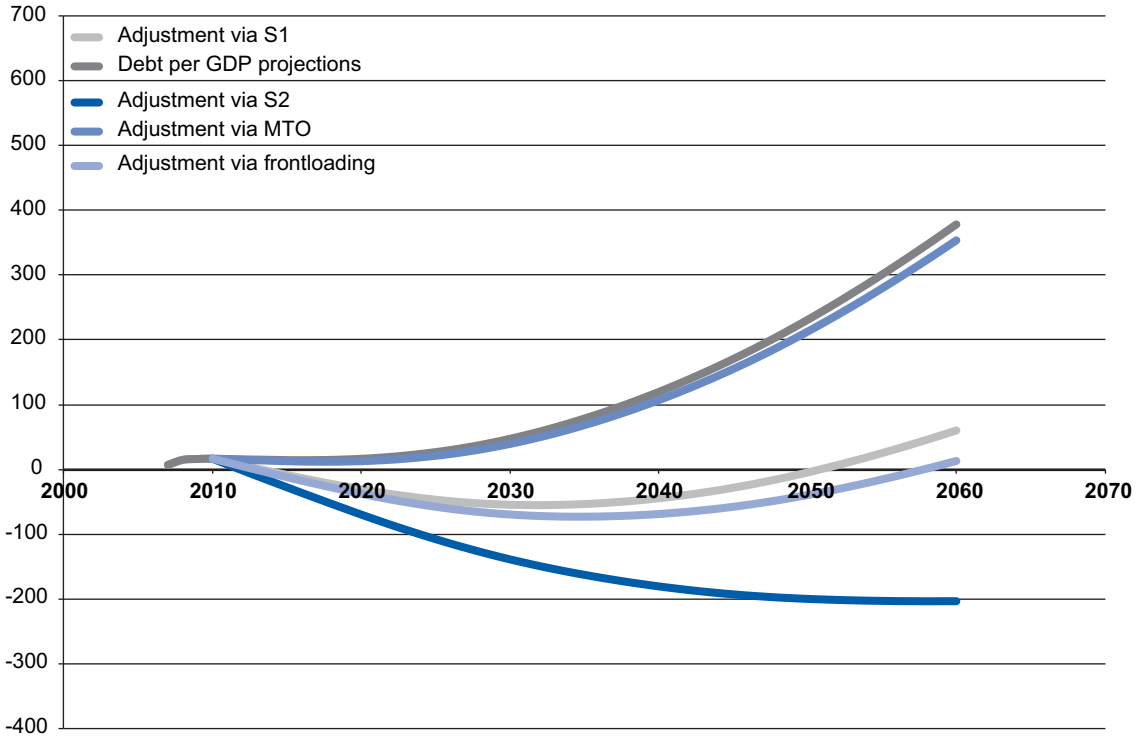
MTO's Within this altered constant policy scenario. Values for the four sorts of MTO's taken are remarkably decreased under the effect of the ad-hoc pensions adjustment. Most interestingly is the fact that the two values of MTO's which are compliant with EU suggestions for the MTO's computation ($MTOinf_{33\%}$ and MTO_{2040}) represent respectively a lower and an upper bound for the value of MTOD = 0.5% declared by the Luxembourg's Ministry of Finance.

Debt projections and adjustments Same dynamics as for the baseline scenario are observed in the present case. Two particular remarks should be done though for the adjustment of debt-to-GDP ratio via S2. Indeed, in contrast to the drastic value of debt-to-GDP ratio over the long-term under this adjustment of -320%, the same adjustment of the debt ratio stabilises over the long-term at another drastic threshold of -200%. This fact iterates the recommendation to adapt the interpretation of the S2 indicator to its theoretical context. Regarding the $MTOinf_{33\%}$, the adjustment in Figure 2 remains rather insignificant over the medium- and the long-run, if compared to the baseline scenario. This is strictly due to the very low value of these MTO's, which is equal to 0.36% of GDP.

Table 4. - MTO's in the alternative scenario

Components	$MTOinf_{33\%}$	MTO_{2040}	$MTOinf_{66\%}$	MTO_{2060}
$\bar{b}_{60}$	-2.40%	-2.40%	-2.40%	-2.40%
$\alpha\Delta AC$	2.76%	3.12%	5.52%	5.34%
e_{60}	0	0	0	0
Total	**0.36%**	**0.72%**	**3.12%**	**2.94%**

Figure 2. - The altered-constant policy scenario



7 Conclusion

The present paper provided a comprehensive answer to the problematic of sustainability of public finance in the context of ageing populations, applied to the specific situation of Luxembourg. The analysis was performed based on the common EC methodology on projecting economic growth, assessing the overall cost of ageing, identifying the different sustainability indicators S1, S2 and RPB, and finally disclosing the "puzzling" MTO's. Specific results have been then derived for Luxembourg upon a baseline scenario and an altered constant policy one.

As a first step, the intuitive link between demographic projections and economic growth was clearly enhanced. Indeed some stylized facts were mentioned on a European level to foster the ageing phenomenon, through an increase in lifetime longevity and/or a decrease in fertility. It was shown that this ageing tendency may act as a trap to economic growth since fewer contributors are partaking to the labour activity. This means that the labour input growth (as a crucial determinant of the overall economic growth) is mitigated by the ageing effect, and so will be the potential output growth, which was specified by the Cobb-Douglas production function. The numerous assumptions underlying this production function have been stipulated pertaining to labour input, TFP developments and the capital formation.

Secondly, it was suggested that the same ageing trend impacts public spending through the increased retirement behaviour of individuals, and the entailed deterioration of future public budgetary accounts. It was of interest to expose the different components of the total age-related cost. Thus the particularities of public pensions, healthcare costs, long-term spending, education and unemployment benefits have been treated. Though, a meticulous attention was held for the public pension's item, since it denotes the salient and dominant part for the assessment of the overall cost of ageing. In this context, this expenditure was analysed under the light of Luxembourg's perspective. The ad-hoc tool at the disposal of the IGSS (SOBULUX) has been carefully described, as well as the specificities that it incorporates to account for the salient features of the Luxembourg's labour market.

Then, after a deep look at what characterized the sources of economic growth, and the main components of age-related spending upon the EC methodology, the definition of sustainability proved necessary to perceive the way ageing may trigger deteriorated public finances. To this end, a necessary condition of sustainability was retained. The IBC stood at this level of the analysis for a theoretical and a normative specification of sustainability over the long-term. Accordingly, any deviation from this equilibrium condition denotes a fortiori an unsustainable path. This element gave rise at a first step to the S2 as an infinite horizon indicator of sustainability. From a policy stand-point, it turned interesting to restrict the long-term horizon underlying the S2 to a finite one that corresponds better to the Treaty requirement. The S1 implemented these sustainability concerns over a concrete and finite horizon. Moreover, the RPB was displayed as well in the EC methodology as a normative "stock" version of the gap measures of sustainability (S1 and S2). It provided an intuition on how a sustainable position would look like in terms of structural primary balance for a Member State, which is facing the future threat of ageing or/and not favourable initial budgetary balances.

Furthermore, the issue of MTO's has been carefully exposed, after the description of sustainability indicators, upon four precise pillars. First, a clear-cut definition of these fiscal objectives has been provided as a conceptual starter of the analysis. A particular focus has been put to key concepts related to the MTO's such the explicit and the implicit liabilities or the concern of front-loading. It proved useful as well to disclose the institutional framework from which the MTO's enhance their legitimacy on a European fiscal context. The model for the computation of MTO's has been clearly exposed, and the components of computation extensively detailed. Last, the study of MTO's would not been complete without an evaluation of the proposed model. To this purpose, arguments from the scarce literature on MTO's have been listed and confronted to the hypotheses of the model.

Keeping in mind that the whole analysis of sustainability aimed to be directly applied for Luxembourg, the crucial concern was to confront the above-mentioned theoretical apparatus to Luxembourg's data. To this end, an altered constant policy scenario taking as input AWG data from 2012, was then confronted to a baseline scenario based upon AWG data from 2009. The technical particularities of the alternative scenario were highlighted. Then, the comparison between the two scenarios was conducted upon the different values for the sustainability indicators (S1, S2, RPB), and values for two legally mentioned MTO's values, and two MTO's values subject to a sensitivity analysis. Moreover, under the light of both scenarios debt projections exercises, as well as ad-hoc fiscal corrections, were proposed and the results indicate that the overall sustainability of Luxembourg's public finances will be jeopardized over the medium- to the longer-term if no structural reforms are considered.

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Annexe

The Projection of Economic Growth

Proposition 1 (Specification of the Cobb-Douglas production function [74]).

$$Y = TFP * L^{\beta} * K^{1-\beta} = \left[TFP^{\frac{1}{\beta}} * L\right]^{\beta} * K^{1-\beta} = (E * L)^{\beta} * K^{1-\beta}$$

where:

(i) Y is the total output or GDP;

(ii) L is the supply of labour (total hours worked);

(iii) K is the stock of capital;

(iv) E is the labour-augmenting technical progress, or the so-called Harrod-neutral technical progress. Thus, $E.L$ is interpreted as total labour in efficiency units,

(v) TFP and labour-augmenting technical progress are related such that: $TFP = (E)^{ß}$,

(vi) $ß$ represents the labour share, i.e. the share of labour costs in total added-value [75].

Potential labour productivity:

From proposition (1), we have:

$$Y = (E * L)^{\beta} * K^{1-\beta}$$

Then:

$$\left(\frac{Y}{L}\right) = E^{\beta} * \left(\frac{K}{L}\right)^{1-\beta}$$

By differentiating the prior expression, we obtain the following equation for labour productivity growth:

$$\left(\frac{\dot{Y}}{L}\right) = T\dot{F}P + (1-\beta)\left(\frac{\dot{K}}{L}\right) = \beta\dot{E} + (1-\beta)\left(\frac{\dot{K}}{L}\right) \quad (9)$$

Steady state labour productivity growth

$$\left(\frac{\dot{Y}}{L}\right) = \left(\frac{\dot{K}}{L}\right) = \dot{E} = \frac{T\dot{F}P}{\beta} \quad (10)$$

Steady state contribution of the capital deepening:

$$contrib\left(\frac{\dot{K}}{L}\right) = (1-\beta)\left(\frac{\dot{K}}{L}\right) = \frac{(1-\beta)}{\beta}T\dot{F}P \quad (11)$$

As a numerical example, the long-run TFP growth rate is assumed to be equal to 1% annum. This leads to a long-term contribution of capital deepening to labour productivity growth equal to 0.5% and then a labour productivity growth rate of 1.5%.

74. See [EC4], p.123

75. **Discussion about the ß's value:**
Albeit a persisting debate related to the recent and on-going decrease of the labour share, most economists suppose that it will stay fairly constant in a long-term standpoint. There was an agreement of the AWG to stipulate that real wages will increase according to labour productivity. Therefore, the wage share is left unchanged over the projection horizon. This assumption has strong basis in economic theory. If the real wage equals the marginal productivity of labour, it is implied that under the standard aspects of the production function, real wage growth equals the labour productivity growth, and real unit labour costs are left unchanged.

Proposition 2 (Potential Output Estimation).

$$log(Y_p) = log(trendTFP) + \beta Log(LF * (1 - Nawru) * Hours) + (1 - \beta) logK$$

Assumptions on the components of the production function in the medium-term (2013-15):

The potential growth estimates using the Output Gap Working Group (OGWG) methodology integrate a medium-term extension (for the years t+3 to t+5) for a base year of 2010, upon a certain number of assumptions, including transparent Auto-Regressive Moving Average (ARIMA) procedures:

1. The TFP trend is assessed from the Solow residual by using a bivariate Kalman filter method that refers to the link between the TFP cycle and capacity utilization;
2. The trend for the structural unemployment rate (NAWRU) is evaluated following this rule [76]

$$NAWRU_{t+1} = NAWRU_t + 0.5 * (NAWRU_t - NAWRU_{t-1})$$

3. The labour force follows Eurostat's latest demographic projection;
4. The average hours worked series is extended using an ARIMA process;
5. The investment to potential GDP series is used as an exogenous variable, whereas investment itself is made endogenous, via an AR process that permits a time trend and a constant. For a constant investment to GDP ratio, investment responds to potential output with an elasticity equal to one.

Pertaining to the NAWRU estimation, it proves to display a significant degree of persistence. Due to the recent financial crisis-induced increase of the NAWRU in numerous countries, this rule generates an additional increase of the NAWRU in the medium-run.

Estimating the Cost of Ageing

The potential budgetary impact of modifying some underlying assumptions on pension expen-diture, is assessed by the EC through sensitivity scenarios on the labour productivity growth rate and the structural unemployment rate, instead of the Member States using their national pension models [77].

Proposition 3 (Sensitivity analysis on pension expenditure). *The elasticity of public pension expenditure with respect to changes in GDP is calculated as follows:*

$$\varepsilon_t^{alt.scenario} = \frac{\frac{P_t^{alt.scenario} - P_t^{baseline}}{P_t^{baseline}}}{\frac{GDP_t^{alt.scenario} - GDP_t^{baseline}}{GDP_t^{baseline}}}$$

Where:

(i) P stands for pension expenditure (level);

(ii) GDP is the level of GDP;

(ii) $alt.scenario$ is the higher labour productivity scenario and/or the higher unemployment scenario, respectively.

The elasticity is time-varying in order to capture potential changes that pension reforms might have implied in the relationship between GDP growth and pension expenditure. The alternative scenarios for pension spending realized in [EC2] concern specific shocks (the 0.25 p.p. higher labour productivity growth rate and 1 p.p. lower structural unemployment rate). Concerning shocks of a different magnitude, the above-mentioned elasticity can be used as a proxy for the impact of such a shock on pension expenditure. Yet, it is obvious that the elasticity with respect to a shock of a different size will be different. This would happen particularly if there are non-linearities in the relationship. This straightforward set-up does not study such cases.

76. See [EC4], footnote 66, p.125.
77. See [EC2] p.50.

Proposition 4 (Public pension expenditure ratio). *This ratio can be broken down into the following components:*

$$\frac{PensionExp.}{GDP} = \frac{Population(65+)}{Population(15-64)} \times \frac{NumberofPensioners}{Population(65+)} \times \frac{Population(15-64)}{WorkingPeople(15-64)} \times \frac{\frac{AveragePension}{GDP}}{HoursWorked(15-71)}$$

On Sustainability under an EU framework

Debt Dynamics:

Proposition 5 (The IBC). *Proof.* Let us assume the debt relative to GDP stays bounded at any time in the future. This means that $\exists M$ such as $|d_t| = |d_{t_0}(1+g)^{t-t_0} - \sum_{i=t_0+1}^{t} pb_i(1+g)^{t-i}| < M$.

Then $|d_{t_0} - \sum_{i=t_0+1}^{t} pb_i(1+g)^{-i}| = |\frac{d_t}{(1+g)^{t-t_0}}| < \frac{M}{(1+g)^{t-t_0}}$

But $\lim_{t\to\infty} \frac{M}{(1+g)^{t-t_0}} = 0$, since g is strictly positive. This yields finally the following result:

$d_{t_0} - \sum_{i=t_0+1}^{\infty} pb_i(1+g)^{-(i-t_0)} = 0$

Provided an initial debt, an interest-growth differential hypothesis and a future path of the structural primary balance, the solvency condition may not be satisfied. Within this context, several sustainability indicators will intervene.

Proposition 6 (The *no-ponzi* game condition). *It is a transversality condition on the time profile of debt* [78]*. It does not claim that debt has to be necessarily repaid, but it imposes that the debt growth rate over the long-term γ has to be bounded by the interest rate r. One must guarantee that government does not tend asymptotically to a negative wealth. This condition is exposed in the continuous-time set-up* [79]*, which is equivalent in discrete-time to:*

$$\lim_{t\to\infty} d(t) \cdot \left(\prod_{s=0}^{t} \frac{1+\gamma}{1+r(s)} \right) \geq 0$$

In addition, one should specify that it will never aim to possess as well positive wealth asymp-totically. Thus, the no-Ponzi game can be alternatively exposed as:

$$\lim_{t\to\infty} d(t) \cdot \left(\prod_{s=0}^{t} \frac{1+\gamma}{1+r(s)} \right) = 0$$

In order to grasp the intuition behind this condition, let us consider these two situations that may arise:

- *(i) If $r(s) > \gamma$ the government will fulfil its IBC because the growth rate of debt is bounded by the interest rate, and the no-Ponzi game condition is fulfilled. This condition was necessary for the proof of proposition 5, when g was assumed to be strictly positive.*
- *(ii) If $r(s) < \gamma$ the government has the possibility to enter into a Ponzi-game scheme. Thus, keeping the primary surplus null and issuing new debt to finance existing debt, will render the ratio of debt-to-GDP declining over time. The inter-temporal path of debt will be explosive* [80]*.*

78. For a pedagogic purpose, let us relax the assumption of a constant *r*.
79. See [ACE] p.377.
80. Condition (ii) is then not considered for the EU sustainability framework, since IBC is not satisfied.

The steady state condition [81] From (viii), we can single out a link between the annual total public imbalance B_t and the annual structural primary balance PB_t.

$$B_t = PB_t - rD_t$$

Dividing both hand-sides by GDPt:

$$\frac{B_t}{GDP_t} = \frac{PB_t}{GDP_t} - r\frac{D_t}{GDP_t}$$

This equation depicts the role of the structural primary balance and the interest over the total public unbalance. Let us single out the structural primary public balance, and use the relationship between B_t and PB_t :

$$\begin{aligned}\frac{B_t}{GDP_t} &= \frac{D_t}{GDP_t}\left(\frac{PB_t}{D} - r\right) \\ &= \frac{D_t}{GDP_t}\left(\frac{B_t + rD_t}{D} - r\right) \\ &= \frac{D_t}{GDP_t}\frac{B_t}{D}\end{aligned}$$

Finally:

$$\frac{B_t}{GDP_t} = -\frac{\Delta D_t}{D_t} \cdot \frac{D_t}{GDP_t}$$

However, the above-mentioned equilibrium condition amounts to impose that the GDP growth rate γ is equal to the debt growth rate, in order to have a stable debt-to-GDP ratio. This represents the main stake of this equilibrium approach. Therefore, this condition is declined as follows:

$$\frac{\Delta D_t}{D_t} = \frac{\Delta GDP_t}{GDP_t} = \gamma. \tag{12}$$

By plugging in the defined variables in point (x) of the preliminary notation, and accounting for the equilibrium condition (4), one gets:

$$b_t = -\gamma \times d_t$$

Condition (ii) is then not considered for the EU sustainability framework, since IBC is not satisfied.

In the long-run, we can even relax the equality constraint, and to assume that the sustainability of the debt/GDP ratio is given by the following equality:

$$b_t \geq -\gamma \times d_t \tag{13}$$

After performing some algebraic manipulations, and using the link between the annual structural primary balance per GDP and the annual total public imbalance per GDP, one gets a solution for the annual primary public balance per GDP:

$$pb_t \geq (r - \gamma) \times d_t \tag{14}$$

81. It is of interest to analyse debt dynamics within an equilibrium framework, assumed under this EU sustainability framework.

Proposition 7 (The S2 indicator). *Proof.* The S2 is defined such as:

$$d_{t_0} = \sum_{t=t_0+1}^{\infty} \frac{pb_t + S2}{(1+g)^{t-t_0}}$$

Considering that the discount rate is strictly positive, we obtain the following simplification:

$$\sum_{t=t_0+1}^{\infty} \frac{1}{(1+g)^{t-t_0}} = \frac{1}{g}$$

Then, substituting :

$$d_{t_0} = \frac{S_2}{g} + \sum_{t=t_0+1}^{\infty} \frac{pb_t}{(1+g)^{t-t_0}}$$
$$d_{t_0} = \frac{S_2}{g} + \frac{pb_{t_0}}{g} + \sum_{t=t_0+1}^{\infty} \frac{\Delta pb_t}{(1+g)^{t-t_0}}$$
$$S_2 = g \cdot d_{t_0} - pb_{t_0} - \sum_{t=t_0+1}^{\infty} \frac{\Delta pb_t}{(1+g)^{t-t_0}}$$

Proposition 8 (The S1 indicator). *Proof.* Debt dynamics can be exposed as follows:

$$d_t = d_{t_0}(1+g)^{t-t_0} - \sum_{i=t_0+1}^{t} pb_{t_0}(1+g)^{t-i} - \sum_{i=t_0+1}^{t} \Delta pb_i(1+g)^{t-i}$$

S_1 is such that $d_t = d_T$. Thus, by substitution:

$$S_1 = \frac{d_0(1+g)^{T-t_0} - d_T}{\sum_{i=t_0+1}^{T}(1+g)^{T-i}} - pb_{t_0} - \frac{\sum_{i=t_0+1}^{T} \Delta pb_i(1+g)^{T-i}}{\sum_{i=t_0+1}^{T}(1+g)^{T-t_0}}$$

Provided this simplifying result:

$$\sum_{i=t_0+1}^{T} (1+g)^{T-i} = \sum_{i=t_0}^{T-1}(1+g)^{i} = \frac{(1+g)^{T-t_0} - 1}{g}$$

This yields:

$$S_1 = \frac{g \cdot d_{t_0}(1+g)^{T-t_0} - g \cdot d_{t_0} + g \cdot d_{t_0} - g \cdot d_T}{(1+g)^{T-t_0} - 1} - pb_{t_0} - \frac{\sum_{i=t_0+1}^{T} \Delta pb_i(1+g)^{T-i}}{\sum_{i=t_0+1}^{T}(1+g)^{T-i}}$$
$$S_1 = g \cdot d_{t_0} - pb_{t_0} + \frac{g(d_{t_0} - d_T)}{(1+g)^{T-t_0} - 1} - \frac{\sum_{i=t_0+1}^{T} \Delta pb_i(1+g)^{T-i}}{\sum_{i=t_0+1}^{T}(1+g)^{T-i}}$$
$$S_1 = g \cdot d_{t_0} - pb_{t_0} + \frac{g(d_{t_0} - d_T)}{(1+g)^{T-t_0} - 1} - \frac{\sum_{i=t_0+1}^{T} \frac{\Delta pb_i}{(1+g)^{i-t_0}}}{\sum_{i=t_0+1}^{T} \frac{1}{(1+g)^{i-t_0}}}$$

Comparison of S1 and S2 The S1 indicator is seen to a certain extent as a finite version of the inter-temporal budget constraint. Indeed, if the debt requirement is fixed at a very distant instant in the future, the two indicators will be very similar. Thus considering the following asymptotic results:

$$A = gd_{t_0} - pb_{t_0} = D$$
$$\lim_{T\to\infty} B = 0$$
$$\lim_{T\to\infty} C = -g \cdot \sum_{t=t_0+1}^{\infty} \frac{\Delta pb_t}{(1+g)^{t-t_0}}$$

Proposition 9 (Equivalance between S1 and S2).

$$\lim_{T\to\infty} S_1(T, d_T) = S_2$$

and:

$$S2 > S1$$

Case where *S1* > *S2* Precisely there are two different reasons, which may result in a S1 greater than S2.

First, the debt requirement by definition will increase the value of S1 if the starting level of debt is beyond the threshold of 60%, and decrease it otherwise. This component does not appear in the computations of S2. Thus high-debt countries, i.e. countries, which display a debt ratio of 60% in 2005 or at the end of the programme period, may display a higher S1 than S2. For example, the debt requirement component will increase S1 by around 0.75 p.p. of GDP, for a country having a starting adjusted gross debt level of 100%, and considering a technical rate of 1.5%.

Second, a further difference is generated by the horizon over which future changes in the primary balance are considered. For Member States, the general budgetary impact of ageing is usually increasing over the next decades so that the maximum budgetary impact occurs around the end of the period. In this case, the change in the primary balance is higher in 2060 than it is on average over the horizon 2010-2060. The impact of changes in primary balances is then larger in S2 than in S1. To this end, the following is exposed:

Proposition 10 (Equivalence between the (E) and (C) terms).

$$E = \alpha \cdot C + (1-\alpha)(-\Delta pb(ageing)_{2060})$$

such that:

$$\alpha \equiv \frac{\sum_{i=t_0+1}^{T} \frac{1}{(1+g)^{i-t_0}}}{\sum_{i=t_0+1}^{\infty} \frac{1}{1+g)^{t-t_0}}}$$

Proof.

$$E = -g \sum_{i=t_0+1}^{\infty} \frac{\Delta pb_t}{(1+g)^{t-t_0}} = -\frac{\sum_{t=t_0+1}^{\infty} \frac{\Delta pb_t}{(1+g)^{t-t_0}}}{\sum_{t=t_0+1}^{\infty} \frac{1}{(1+g)^{t-t_0}}}$$

$$E = -\frac{\sum_{t=t_0+1}^{T} \frac{\Delta pb_t}{(1+g)^{t-t_0}} + \sum_{t=T+1}^{\infty} \frac{\Delta pb_t}{(1+g)^{t-t_0}}}{\sum_{t=t_0+1}^{\infty} \frac{1}{(1+g)^{t-t_0}}}$$

$$E = \frac{C \sum_{i=t_0+1}^{T} \frac{1}{(1+g)^{i-t_0}} - \Delta pb_T \sum_{t=T+1}^{\infty} \frac{1}{(1+g)^{t-t_0}}}{\sum_{t=t_0+1}^{\infty} \frac{1}{(1+g)^{t-t_0}}}$$

$$E = \alpha \cdot C + (1-\alpha)(-\Delta pb(ageing)_T)$$

Yet, a certain number of countries is implementing a large pension reform. Thus the increase in public expenditure displays its maximum in the middle of the period before being drastically reduced afterwards. These countries may then show *S1* > *S2*. In conclusion, S2 has to be in overall greater than S1, expect the case of countries whose initial level of debt is significantly higher than 60%, or where an increase in age-related spending is lower after 2060 than on average over the horizon up to 2060, or a combination of both prior cases.

The cost of a delay indicator The assumption of a constant interest rate-growth rate differential is kept. The cost of delays for both indicators is given by the following propositions:

Proposition 11 (the S1 indicator).

$$S_1' \equiv S_1 \left(\frac{\sum_{t=t_0+1}^{T} \frac{1}{(1+g)^{t-t_0}}}{\sum_{t=t_0+1+delay}^{T} \frac{1}{(1+g)^{t-t_0}}} - 1 \right)$$

Proposition 12 (the S2 indicator).

$$S_2' \equiv S_2 \left(\frac{\sum_{t=t_0+1}^{T} \frac{1}{(1+g)^{t-t_0}} + \frac{1}{(1+g)^{T-t_0} \cdot g_\infty}}{\sum_{t=t_0+1+delay}^{T} \frac{1}{(1+g)^{t-t_0}} + \frac{1}{(1+g)^{T-t_0} \cdot g_\infty}} - 1 \right)$$

such that:

$$g_\infty = \frac{1+r}{1+\gamma_T} - 1$$

On MTO's

MTO's "algorithm"

The supplementary debt-reduction effort *e*60

[BIR] postulates another approach of computation for this component. He considers the following: $k(d_i - 60)$, where i is the country's index and the parameter k is calibrated as the following. The declared MTO's in the 2009 updates of SCP are taken at first. Thus, high-debt EU countries that would face notably more this supplementary debt-reduction effort are keen to cope with as much fiscal space as possible in order to recover from the crisis. Thus, for such countries, it is probable that in the 2009 updates of SCP, their $MTOD's = MTO^{MT}s$. Following this reasoning, one obtains: $MTO^D = \max(MTO^{MB}, MTO^{EA}, -0.6 \cdot g + k(d - 60) + 0.33 \cdot E)$. Using this equation for a high-debt country j, an equation with a single unknown parameter k is obtained. This approach is applied for the case of Italy for which knowing the growth rate, the debt ratio and the increase in age-related spending, one obtains $k = 0.033$.

After the new computation of $MTO^{MT}*$ and $MTO^{SM}*$, the equality $MTO^{MT}* \leq MTO^D$ holds in most of the Member States. Afterwards, it can be shown that the preferred option for Member States is to declare an MTO^D that is not very far from MTO^{MT}. Indeed, announcing a very requiring MTO i.e. well above the MTO^{MT} may lack credibility for some Member States.

Proposition 13 (Debt projections). *The methodology adopted by the EC*

(i) if $t < 2060$, then

$$d_t^* = d_{t-1}^*(1 + g_t^*) + (\Delta AC_t^* - \Delta PI_t^*) - pb_{t_0}$$

(ii) if $t \geq 2060$, then

$$d_t{}^* = d_{t-1}^*(1 + g_{2060}^*) + (\Delta AC_{2060}^* - \Delta PI_{2060}^*) - pb_{t_0}$$

where: $\Delta AC^* >> \Delta PI^* \simeq 0$

Proposition 14 (Debt adjustment). *Adjustments (i) and (ii) are adopted by the EC*

(i) Through S1:

$$\hat{d}_t(S_1) = (1 + g_t{}^*)\hat{d}_{t-1} + (\Delta AC_t^* - \Delta PI_t^*) - pb_{t_0} - S_1$$

(ii) Through S2:

$$\hat{d}_t(S_2) = (1 + g_t{}^*)\hat{d}_{t-1} + (\Delta AC_t^* - \Delta PI_t^*) - pb_{t_0} - S_2$$

We propose to compare (i) and (ii) to the following adjustments:

(iii) Through $MTO_{inf33\%}$:

$$\hat{d}_t(MTO's) = \hat{d}_{t-1}(1 + g_t^*) + (\Delta AC_t^* - \Delta PI_t^*) - pb_{t_0} - MTO_{inf_{33\%}}$$

(iii) Through Front-Loading (FL):

$$\hat{d}_t(FL) = \hat{d}_{t-1}(1 + g_t^*) + (\Delta AC_t^* - \Delta PI_t^*) - pb_{t_0} - C_{2060}$$

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