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Formulating and evaluating long-term fiscal rules based on the Medium-Term Budgetary Objective

Abstract:
The paper considers fiscal rules for Finland that are explicitly based on the Medium-Term Budgetary Objective (MTO) and aim at keeping public finances sustainable in the long run. We use a general equilibrium overlapping-generations model to study fiscal rules where consumption taxes are conditioned on observed and forecasted variables related to the MTO. The uncertainties considered include future demographics, productivity, and asset yields. We find that a rule based directly on the 'implicit liabilities and debt' part of the MTO keeps public debt at roughly acceptable levels. The rule, however, would work better, especially in timing the measures, if structural deficits would exclude social security funds. We also find that the MTO contains forecast elements that could be left out without essentially weakening the rule. Finally, additional forecast-based information is likely to improve the rule.

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1 Introduction

The purpose of this paper is to study fiscal policy rules that aim at long-term fiscal sustainability under uncertainty. The study is a part of the FIRSTRUN project that investigates the need for fiscal policy coordination in the EU, assesses the coherence of the recent reforms in the economic governance framework, and identifies reforms to fill possible gaps in the current EU governance framework.

We use an open economy general equilibrium model FOG (short of Finnish Overlapping-Generations model). We extend the model so that it can be used to study how a government could design a fiscal policy rule that keeps it within the new EU debt and deficit limits, with given probabilities in an environment where several key factors are uncertain. The model accounts for many important features of the Finnish economy (for instance, a detailed description of the Finnish pension system after the 2017 reform), and it has been used in many published studies of population ageing and fiscal sustainability. The model looks at the long term; all cyclical aspects are absent.

The uncertainties in this paper include future demographics, labour productivity and asset yields. These uncertainties are kept explicit in all phases of the study, to avoid an unrealistically narrow perception of the size of potential problems and to provide probabilistic assessment of the effects of the reform.

Our approach is motivated by the fact that uncertainty in long-term projections is larger than that grasped by typical high-low variants, and stochastic projections can indicate the probability of different outcomes (see Alho, Cruijsen and Keilman, 2008). The overlapping-generations structure of the economic model facilitates the description of population aging and its effects to public finances, via e.g. health and long-term care services, pensions and other public transfers, in a logical manner. In dynamic general equilibrium models, consistency prevails in market equilibria and intertemporal budget constraints.

Alho (2014) has created a method for regular demographic forecast revisions that are embedded in stochastic population projections. Lassila, Valkonen and Alho (2011, 2014) introduced the use of the method in fiscal policy analysis. The method allows the separation of the expected and the realized effects of population ageing on public finances, in each demographic outcome and under different policy rules. This method is especially suitable for studying fiscal policy rules, such as those implemented in EU countries. The EU rules include forecast variables such as the sustainability gap, and with the revised forecasts embedded in projected future demographics we can make a forecast of the gap in each period and simulate the effects of the rules.

Applied to the ageing population in Finland (Lassila, Valkonen and Alho, 2014), demographic uncertainty produces considerable sustainability risk. The authors considered alternative rules based on the model's forecasts of gross public debt/GDP to reduce the likelihood of getting highly indebted. They demonstrated that although demographic forecasts are uncertain, they contain enough information to be useful in forward-looking policy rules.

Our contribution is, firstly, to expand the set-up with asset yield risks, which are important to the Finnish public sector due to its large financial assets, and to include productivity growth risks which are important to all public sectors, secondly, to formulate a fiscal policy rule based directly on the 'implicit liabilities and debt' part of the MTO, and to study its behaviour, and thirdly, to consider whether the rule could be improved by adding or removing something or changing the definitions.

Technically, we are interested in the effects of policies that are based on point forecasts. Auerbach and Hassett (2001, p. 74) condense the policy question that population ageing poses as 'how and when to deal with long-term fiscal imbalances that are at once very significant and very uncertain'. We concentrate on 'when', especially in the form of rules. 'How' in this study is by raising consumption taxes (henceforth VAT) when deemed appropriate; rules and practices concerning public services and transfers are not changed despite changing demographics.

Section 2 describes the methods. In Section 3 the base policy is defined and its outcomes are described. Section 4 presents the MTO, specifies the rules and analyses the outcomes. Section 5 concludes.

2 Methods

2.1 The FOG model

We use a numerical overlapping-generations general equilibrium model of the type originated by Auerbach and Kotlikoff (1987). The model is called FOG (Finnish Overlapping Generations model). It is modified to describe a small open economy and calibrated to the Finnish economy. The model is usually run under the assumption of perfect foresight: households and firms know all the future prices, wages, taxes and values of other variables they need in their decision-making. In this study, however, we follow the assumption in Lassila, Valkonen and Alho (2011, 2014) that households believe in population forecasts with certainty. The forecasts are erroneous, and when a new forecast appears the households and firms re-optimize. They do not learn, however, that forecast errors occur, but continue to believe in the new forecast with certainty. In this study, the forecast approach is expanded to include also asset yields and productivity.

The FOG model consists of five sectors: households, enterprises, a government, pension funds and a foreign sector. Households make economic decisions according to the life-cycle hypothesis. They maximise the utility from consumption and leisure in different periods and the bequest that they give. The lifetime budget constraint says that discounted lifetime incomes and discounted received bequest and transfers equal discounted consumption expenditure and the given bequest. Households enter the model at age 20 and exit at age 100 at the latest. The unit period is 5 years.

Firms choose the optimal amount of investment and labour to maximise the price of their shares. The market value of the firm is determined as a discounted sum of future dividends. The problem can be presented as maximising at the beginning of the period the dividends distributed during the period plus the value of the firm at the end of the period, subject to the amount of initial capital stock, the cash-flow equation of the firm, the CES production function, the accumulation condition of the capital stock, the determination of the firm's debt and the investment adjustment costs. The three markets, for labour, goods and capital, are all competitive and prices balance supply and demand period-by-period. There is no money or inflation in the model.

The driving forces of the model economy are the transitions in the demographic and educational structure of the population and the trend growth of labour productivity. The population is ageing due to longer lifetimes, low fertility rates and the transition of baby boomers from working age to retirement. The educational level improves somewhat in the future since the current middle-aged generations have on average lower levels of education than the young ones. The improvement raises the productivity of labour. Each household generation is divided into three educational groups with different lifetime productivity profiles determined by empirical observations of recent wage profiles. The educational shares are supposed to develop in the future in line with the official projections.

The labour input is determined partly by exogenous assumptions and partly due to endogenous adjustments in the model. Hours of work are decided by households. The average retirement age follows the period life expectancy at 30 as described earlier, and in the model this is achieved by changing in each age group the share of those retired. Exogenous factors are the trend growth of labor productivity (1.75 % per annum in private goods production), educational gains and the unemployment rate. The model is calibrated so that the trend labour productivity growth and the following higher wages do not affect the otherwise endogenous labour/leisure choice of the households.

The growing number of people in old age and near death increases the demand for health and old age care (see Appendix 2 for details). We assume that these demography-driven additional services are produced in the private sector, but production costs are paid totally by the public sector. These services are produced using labour and intermediate goods as inputs, and there is no productivity growth. The shares of employees in private and public sectors are kept constant.

The real wage adjusts to equalize the value of marginal product of labour and labour costs in the production of private goods and services. The rest of the workers, who provide tax-funded services produced in private and public sectors, earn the same wage. Our model thereby includes the Baumol effects. The price of the health and long-term services evolves so that the increase in labour costs constitutes roughly two thirds of the price change, and the GDP price change constitutes one third.

Public expenditures have a strong connection to the age of individuals in Finland. The provision of public services is allocated mainly either to the early part of the life cycle (day care and education) or to the last years (health care and old age care). Similarly, income transfers are distributed mainly either to young families or to retired individuals. This is why the changes in the demographic structure are so important for the public expenditures. We assume that all income transfers (except the earning-related pensions) are fully indexed to wages because any other assumption would have dramatic consequences for income distribution in the very long-term analysis. Other than age-related expenditure is assumed to grow at the same rate as the GDP.

Revenues of the public sector originate from two types of sources in the model. The majority of the receipts are accumulated by income taxes, consumption taxes and social security contributions. Another noteworthy revenue source is the yield of the public sector wealth. The yield of the wealth is particularly important for the pension funds, but the Finnish central government has also a substantial amount of financial assets.

We assume that the modelled main subsectors of the general government, such as the municipal sector, the public and the private sector pension fund and the national social security institute, have their own budgets, which are balanced either by social security contributions or earned income taxes. The only exception is the state budget, which is balanced by borrowing until 2145, and after that by using a lump sum transfer. Earned income tax brackets are adjusted with the growth of the economy. The pension funds follow their current prefunding plans, and pension contributions are endogenous. Households are modelled to react to the income and substitution effects of taxation, social security contributions and pension accrual rules. The model is described in more detail in the appendices.

The FOG model is basically non-stochastic, and the shocks we use as inputs operate only through very few channels. Asset yield shocks only affect the return on the pension funds, the interest payments of public debt, and the return on the state's financial assets. Households and firms operate under a fixed interest rate.

Productivity growth varies between simulated paths. In each path the growth rate is constant and the model agents know what it is.

The stochastic analysis will be done around a dynamic baseline. The initial situation reflects the Finnish economy around 2015, to a limited degree a calibrated equilibrium model can produce. The future baseline consists of the current official population projection and base forecasts of other variables.

2.2 Uncertainty specifications

We deal with demographic uncertainty by using stochastic population projections, which are used as inputs in the economic model. Statistical methods of expressing demographic uncertainty have been developed by many researchers (see e.g. Alho & Spencer, 2005, Lee & Tuljapurkar, 1998). These methods quantify uncertainty probabilistically, based on analyses of past demographic data and the views of experts. Fertility, mortality and migration are considered as stochastic processes. The parameters of these processes are fitted to match the errors of past forecasts (see Alho, Cruijsen and Keilman, 2008). After the processes for fertility, mortality and migration have been modeled, sample paths for future population by age-groups are simulated. The projections, made by Juha Alho, are presented around Statistics Finland's 2015 projection. For earlier examples, see Firstrun Deliverable 5.1 (Lassila, 2016).

The stochastic models for equity and bond returns are from Ronkainen (2012). For equities, the S&P 500 yearly total return, in log-differences, is modeled by an uncorrelated and Normally-distributed process to which exogenous Gamma-distributed negative shocks arrive at Geometrically distributed times. This regime-switching jump model takes into account the empirical observations of infrequent exceptionally large losses. For bonds, Ronkainen (2012) models the 5-year US government bond yearly total return as an ARMA(1,1) process after suitably log-transforming the returns. This model is able to generate long term interest rate cycles and allows rapid year-to-year corrections in the returns. In simulations we use Model 5 for equities (see p. 31 in Ronkainen, 2012) and for bonds the model that Ronkainen reports on p. 52. For a fuller description see Firstrun Deliverable 5.1 (Lassila, 2016).

Ronkainen modeled nominal equity and bond returns. To get real returns, we deduct inflation, which we model as a simple AR(1) model from Finnish yearly data in 1995 – 2016. The period corresponds to Finland's membership in the EU and includes the euro years.

In our simulations, productivity grows at a constant rate in each path, but the rate varies between paths. The variation specification utilizes Christensen et al. (2016), especially results concerning high-income countries in Table 3. They report as their preferred estimates for high-income countries for 2010 – 2100 an average growth rate of 1,47 % and a standard deviation of 0,88 %.

We use 1,5 % as the mean growth, and limit the variation between 0,75 % and 2,25 %. If normally distributed, this would include 60 % of outcomes.

2.3 The forecast set-up

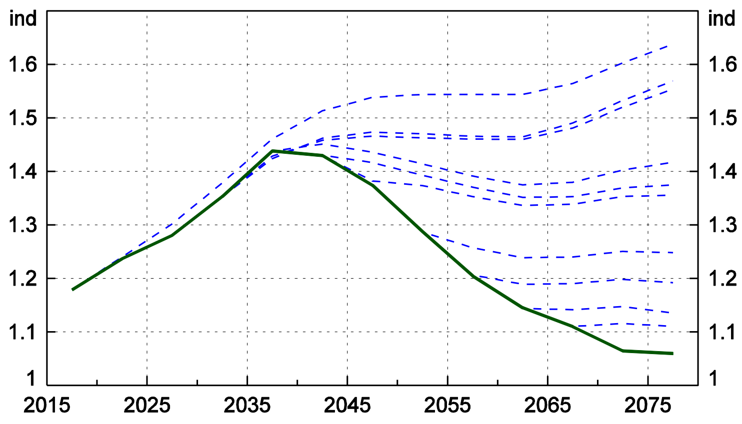
When using stochastic population projections, we add a demographic forecast to each time-point in each simulated population path. Thus the view concerning future demographics is periodically updated when we move along any simulated population path. Given the uncertainty of population forecasting, it might seem that trying to forecast what future population forecasts are like would be nearly hopeless. As argued in Alho (2014), however, such forecasts are, for both theoretical and practical reasons, more regular than actual developments. As a practical reason, the development of the recent past often has a heavy influence on projections of the remote future. This is usually true for all so-called vital rates, namely fertility, mortality and migration.

Stochastic population projections are produced by a computer program PEP (Program for Error Propagation). Another computer program FPATH extends the application of results from PEP to the FOG model, where agents are allowed to revise their lifetime economic plans as they realize that the population has not evolved according to the expected path. For this purpose FPATH calculates a numerical approximation to the conditional expectation of future population at future years for a (typically random) subset of paths. The details of computation are spelled out in Alho (2014). Briefly, the whole computation is based on stochastic simulation in which samples are taken from the predictive distribution of future population as disaggregated by age and sex. A set, 200 in this study of such samples play the role of target paths, for which the economic OLG calculations are made. A much larger set of supplementary paths is used in the calculation of updated forecasts. This is done by selecting of subset of supplementary paths after the first time period that are the closest to a given target path at that time. A weighted average of the future values of these supplementary paths forms the estimated conditional expectation (= updated forecast) at that time. The next period the weights are revised to reflect the distances of the chosen supplementary paths from the target path, at that time. The weighted averages are recalculated for the remaining future years of interest, etc. In statistical terms, this is equivalent to repeated nearest neighbour kernel regressions. We can think of the conditional expectation as being a forecast of what would be a forecast in a future year.

In this study, FPATH has been further developed in mortality forecasts, to yield smoother predictions in e.g. earliest eligibility age for old-age pension and the longevity adjustment for pension benefits.

As an example of an economic variable based on one demographic path, Figure 1 shows one projection for health and long-term care demand for 5-year periods between 2020 – 2074 and the forecasts (dash lines) associated with this particular projection, first from 2020-24. The forecast is revised in period 2025-29, and again in 2030-34, and so on.

Figure 1: Health and long-term care index and related forecasts, in one simulated path (1995-99 = 1)



For equity and bond yields, the forecast is always the expected value.

2.4 Running the model with revised forecasts

In our analysis, households and firms sequentially optimize their behaviour according to revised demographic forecasts. With any simulated population path, the full solution of the economic model is obtained by a series of runs. In each run, the agents believe that they have perfect foresight of future demographics, even though the forecast has previously turned out to be erroneous. The model is first solved starting from period 1, with the model agents having a perfect foresight type expectation that future demographics will follow the official population projection made by Statistics Finland. From the values obtained from this first solution, the values of variables in the fiscal rule are calculated. There are now two possibilities: either the fiscal rule requires the VAT rate to be changed, or not. If not, period 1 values for all model variables have been obtained from this first solution, and the model economy moves on to period 2. But if the VAT rate is increased, by an amount specified by the rule, the model is solved again, starting from period 1, with the model agents expecting that the new VAT rate will be effective in all future periods. Period 1 values for all model variables have now been obtained from this new model solution, and the model economy moves on to period 2.

In period 2 in any simulated population path the agents realize two things about demographics: first, the population size and age structure in period 2 is different from what was forecasted in period 1, and second, the forecast for the population from period 3 onward has been revised. They have also noticed unexpected changes in pension funds and public assets and debts, due to shocks in returns. The model is then solved again, starting from period 2, with the model agents having a perfect foresight type expectation that future demographics will follow the revised population projection and assets will yield expected values. From the values obtained from this model solution the values of variables in the fiscal rule are calculated. If the rule does not warrant a VAT rise, period 2 values for all model variables have been obtained and the model economy moves on to period 3. If the rule requires that VAT is increased, the model is solved, starting again from period 2. Period 2 values for all model variables have now been obtained from this new model solution, and the model economy moves on to period 3. In period 3 the model agents again realize that they need to re-optimize, and so on.

We consider 11 periods – 55 years – after the initial period 1, so the results cover the five-year periods from beginning of 2020 to end of 2074.

3 Base policy's projected outcomes

3.1 Defining the base policy

In the base policy, welfare transfers and services are provided according to current Finnish rules and practices, except that health and long-term care will follow new practices that are currently being legislated. Aggregate health and long-term care costs depend on the population age structure and proximity to death. They have been financed by municipalities, with the state providing partial help in the form of block grants. In the new plan the state will finance these services fully. Municipalities finance basic education, and thus municipal taxes depend on demographic developments. Mandatory pension contributions adapt to pension expenditure, which vary from one demographic path to another.

State tax rates are held constant in the base policy, except that in some cases the VAT rate is lowered. This happens when the gross debt is projected to decline to a level where it exactly matches the state's financial assets, so the net debt would be zero. We assume that, with such a positive future outlook, the decision-makers see room for reducing taxes, and use the VAT which is the only policy instrument used in this study. Thus the base policy is not symmetric: if the gross debt is projected to rise, even very rapidly, there is no reaction in the base policy. As a result, variation in expenditure and tax bases causes variation in public debt and sometimes also in the VAT rate.

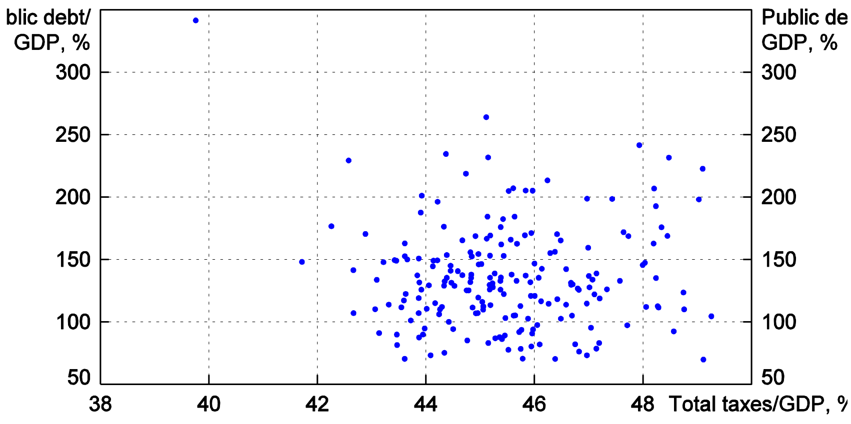
In the base policy, the decision-makers' attitude towards public indebtedness can be characterized as reckless: they don't mind if the debt goes up but act if there appears to be room for tax reduction. We have chosen to define the base policy this way for two reasons. Firstly, recklessness produces indebtedness problems and thus provides the EU's policy rules opportunities to show their possible merits. Secondly, not allowing the VAT rate to decline would in many cases result in negative debt levels. They would command unwarranted space and attention in graphs and tables, and distract attention unnecessarily, since negative indebtedness is not what we observe in Europe. It turned out that we declined VAT too little to avoid negative indebtedness, and decided to use only selected outcome paths in the analysis.

Technically, we started with 350 simulated paths. Some were too slow or otherwise difficult to solve, so we ended up with 250 paths that were solved under the base policy and all policy rules. For this report we have left out 50 paths that had the lowest public debt to GDP – ratio in 2070-74. The debt was low, often negative, and thus not very interesting for the purpose of this study while commanding. Thus there is heavy selection in our simulated sample, and the outcomes do not describe the distribution of the risky outcomes properly. They do, however, serve the purpose of comparing different policy rules in circumstances where high public indebtedness is a major threat.

3.2 Base policy outcomes

In Figure 2, we describe the outcomes of this base policy on gross public debt and on a total tax measure, which includes the pension contribution rate, municipal taxes and all state taxes. Both debt and taxes are related to GDP. Uncertainty in public indebtedness is clearly huge, and most of the outcomes would be highly problematic, so fiscal rules would certainly be needed.

Figure 2: Public debt / GDP and total taxes/GDP in 2070-74 under Base policy, %



Despite the selection bias, it is still useful to describe how the different risks and uncertainties affect the outcomes.

Fertility: The main fact concerning fertility effects is that it takes decades before newborns improve public revenues, whereas expenditures are affected immediately. Childhood and youth cause outlays such as child allowances, schooling and education, and children also use health care services. Public revenues start increasing only after future cohorts have entered the labour force. Part of public outlays accumulates into the state's debt, and in our time frame this effect dominates the added tax revenues that will come later.

Perhaps surprisingly, high fertility in the future may bring more income tax revenue to the state in periods where none of those born are yet working. The reason is that children need care and teaching, which require more workers in these services. That leaves fewer workers for the firm sector, which drives real wages up. The total wage bill is higher, and so is the income tax revenue. The same wage effect explains why pension contribution rates may be marginally lower with high number of children.

Mortality: Mortality variation concerns mostly the number old people, those over 60 and especially those over 80 years. These people are often retired from working life, although more and more of them continue to work past earliest eligibility age as longevity increases. They pay earned income taxes especially to the municipalities. The state gets less income tax revenues from them but collects a lot of consumption taxes. The old also use more health care services per capita than younger people, and especially those over 80 are heavy users of long-term care services. Along with age, also proximity to death influences the need for services, as shown by several studies. This approach limits the increase in the needed public services when mortality rates decline. It is useful to acknowledge that life expectancy does not uniquely define what happens in different age groups in the population, and using expectancy calculated for one period leaves out variations in other periods.

There are two main channels through which mortality changes directly affect public finances in our economic model. First, we assume that working lives on average become longer when people live longer. Longer working lives mean larger income tax bases and larger income tax revenue. Higher wage bills facilitate bigger consumption expenditure and thus increases in consumption tax revenues.

The second main channel is publicly-financed health and long-term care. In the economic model, the expenditure on health care depends both on the number of people in each age group and the number of people who will die within the next five years. This is explained in more detail in the Appendix. Since mortality variation is the main factor behind the variation in the sizes of old age groups, it causes substantial variation in health expenditure also. Because our modelling includes also the proximity of death as a cost factor, there may also be interesting dynamics that depend on when exactly do the big cohorts, the baby boom generations after WW2, die. When the baby boom generation is gone and the population age structure is more balanced, living longer then increases the need for health care services, aggregated over all age groups.

In the new system health and long-term care expenditure is financed by grants from the state to the counties. The grant is based on the age structure and morbidity of the population in the municipality. Since state tax rates are held constant, variation in expenditure, caused by variation in mortalities, shows in variation in the state debt.

Migration: In the simulations, we have made a strong assumption concerning migration: the migrants are exactly as natives in all economic issues. As discussed in Lassila and Valkonen (2014c), this assumption is probably more accurate in the long run than in the short run, but alternative short-run modelling would be more complex and require data and knowledge that are not currently available. With the assumption, the economic consequences of migration are straightforward. The more there are migrants, the more there are taxpayers and the larger are tax bases. The state’s revenues are large, and the municipalities and the pension system manage with low rates. The migrants of course use also health and LTC services and receive pensions and other income transfers, but as most of public expenditure is generated during retirement years and most tax revenues during working lives, the public sector benefits from the expansion of population. This effect is similar to gains of expanding a pay-as-you-go pension scheme by adding young participants in the system. The exact gain depends on the lag between paid contributions and received pensions and the difference between the interest rate and growth rate of the economy. With immigration, educational costs are also saved. Thus, within the timeframe we consider, their effects on public finances are generally positive.

Slow productivity growth raises total tax rate, mostly through higher pension contributions. Perhaps surprisingly, it has not much effect on indebtedness. Rapid growth has opposite effects.

Good equity yields lower pension contributions and bring capital incomes to the state, resulting in lower total tax rate and lower indebtedness.

Bond yields describe also the interest rate on public debt, so high rates increase public debt when there is net debt. If the state has positive net wealth, this means higher income. The pension system always benefits from high interest rates.

4 Fiscal rules based on Medium-Term Objective

4.1 General rules for setting the MTO

For an EU country, the MTO is defined in structural terms (cyclically-adjusted government budget position, net of one-off and other temporary measures). The MTO should be set so as to (i) provide a safety margin with respect to the 3% of GDP deficit limit, (ii) ensure sustainability or rapid progress towards sustainability (iii) in compliance with i and ii, allow room for budgetary manoeuvre, in particular taking into account the needs for public investment.

There are three bounds on the MTO that are then combined to yield country-specific greatest lower bound for the MTO. The result is the lowest MTO that fulfils all the criteria defined. The first criterion concerns the safety margin with respect to the 3% of GDP deficit limit. The second is related to sustainability. The third criterion requires compliance with the -1% lower bound. Further, euro area countries (like Finland) have committed themselves to MTOs of at least -0.5% of GDP, unless their debt ratio is significantly below 60% of GDP and long-term sustainability risks in public finances are low. In those cases, the lower limit is set at -1% of GDP.

We concentrate on the second criterion, defined as 'a minimum value for the MTO that ensures sustainability or rapid progress to sustainability taking into account implicit liabilities and debt (MTO^{ILD}) is computed' (EC 2017, p. 29). The MTO^{ILD} formula can be written as

$$MTO^{ILD} = -(60g)/(1+g) + 0.33s2 + 0.024Debt - 1.24$$

The first component, the product of 60% with the forecast average nominal growth g for 2010-2060, represents the budgetary balance that would stabilize the debt ratio at 60% of GDP.

The second component includes the sustainability gap $s2$. The component represents the budgetary adjustment that would cover a third of the present value of the projected increase in age-related expenditure.

The third component, where *Debt* is the per cent ratio of gross public debt to GDP, represents a supplementary debt-reduction effort if the general government gross debt is above 60% of GDP. The linear function 0.024*Debt* –1.24 ensures a supplementary effort of 0.2% of GDP when debt reaches 60%, while e.g. requiring a supplementary effort of 1.4% of GDP when the debt ratio attains 110%.

Both *g* and *s*2 are in practice calculated by the Ageing Working Group (AWG) every three years. The resulting value of the MTO^{ILD} (up to one decimal) is then rounded to the most favorable ¼ of a percentage point. We ignore the rounding. In our analysis both *g* and *s*2 are calculated from the model output (see Appendix 3).

4.2 Fiscal policy rules based on the MTO^{ILD}

In practice, if the public sector's structural deficit fails to meet the MTO criterion, it triggers a soft process including discussions, negotiations and interpretations. Countries do not want to enter these processes and prefer estimates and accounting practices that help in avoiding them (see e.g. Frej Ohlsson, 2007). We ignore this reality and adopt a positive approach, and ask: Can the MTO^{ILD} be used as a tool to determine when to react to expected long-term fiscal imbalances?

Public sector's structural deficit (SD) concerns general government. Social security funds are part of it, and in Finland they have substantial amount of assets and are usually in surplus. This helps in meeting the MTO conditions. But should it help? If the aim is to keep the gross debt below 60 of GDP, it would be logical to count in only the state and municipalities, who actually have debt. One could also ask the sense of looking at gross debt, especially in Finland where the state's financial asset holdings amount to about one third of GDP.

We specify four rules. The motivation for Rule 1 is that it describes the basic comparison of structural deficits to the criteria given by MTO^{ILD}. Rule 2, on the other hand, removes the social security institutions effect from the structural deficit, and leaves only the deficits of the sectors that actually have gross debt, namely the municipalities and the state. Rule 3 tries to find out whether it is worthwhile to include the two forecast-based elements in the MTO^{ILD} or would a much simpler criterion suffice. Rule 4 provides a completely different criterion, leaving out the structural deficit and all the elements in MTO^{ILD} and relying completely on the forecast future.

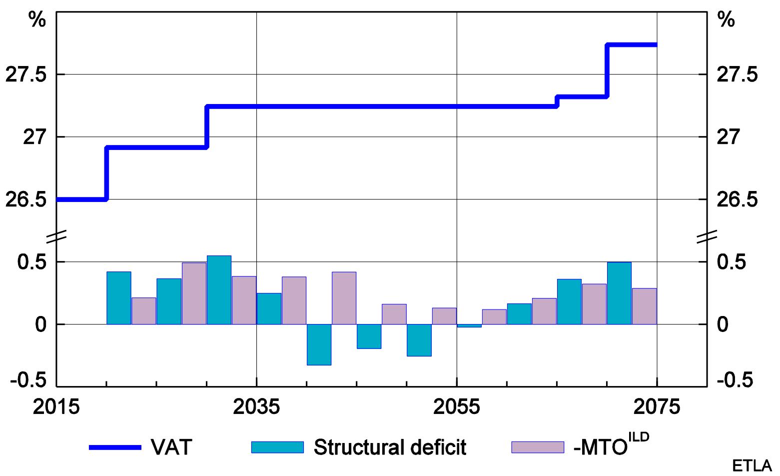
Rule 1: If structural deficit of the general government (SD) is bigger than MTO^{ILD} allows, then the VAT rate is increased. The increase is relative to the amount that SD is too big. However, if the forecast public debt/GDP ratio is below 60 % during the next 50 years without the VAT rate increase, then VAT is not increased.

Rule 1:	if	$SD(t) + MTO^{ILD}(t) = a > 0$
	and	$\min[E(Debt(t)), \ldots E(Debt(t+50))] > 60$
	then	$\Delta VAT = 2a$

Notice that MTO^{ILD} gives a lower limit to surplus, and thus $-MTO^{ILD}$ gives an upper limit to deficit, so $SD(t) + MTO^{ILD}(t)$ is positive when the deficit is too big.

Figure 3 gives an example of how rule 1 works in one path. VAT rate is increased when structural deficit is higher than $-MTO^{ILD}$ but not otherwise. The second line in rule 1 (also in rules 2 and 3) states that the increase would not take place if it is forecast that the debt/GDP ratio would fall below 60 % in the next 50 years without the raising the VAT, even though the deficit is too big. This amendment, meant to prevent unnecessary VAT increases, has no effect in the example in Figure 3..

Figure 3. Structural deficit, MTO^{ILD} and VAT rate in one simulated path



Rule 2: If structural deficit of the central and local government (Narrow SD) is bigger than MTO^{ILD} allows, then the VAT rate is increased. The increase is relative to the amount that SD is too big. However, if the forecast public debt/GDP ratio is below 60 % during the next 50 years without the VAT rate increase, then VAT is not increased.

Rule 2:	if	Narrow SD(t) + MTO^{ILD}(t) = a > 0
	and	min[E(Debt(t+1)), … E(Debt(t+50))] > 60
	then	ΔVAT = 2a

Rule 3: If structural deficit of the general government (SD) is bigger than allowed by simplified MTO^{ILD}, which is calculated without the forecast terms, then the VAT rate is increased. The increase is relative to the amount that SD is too big. However, if the forecast public debt/GDP ratio is below 60 % during the next 50 years without the VAT rate increase, then VAT is not increased.

Rule 3:	if	SD(t) + Simplified MTO^{ILD}(t) = a > 0
	and	min[E(Debt(t+1)), … E(Debt(t+50))] > 60
	then	ΔVAT = 2a

Rule 4: In each period, the VAT rate is set to a level where the forecast public debt/GDP ratio is the same after 20 years than it is in the beginning of the period.

Rule 4: Set VAT so that E(Debt(t+20) = Debt(t)

4.3 Predictive distributions of debt/GDP ratios and VAT rates

Tables 1 to 5 present the predictive distributions of gross public debt, as percent of GDP, in the base case and under the four fiscal rules.

The base policy usually leads to high public indebtedness. The outcomes are not meant to represent fiscal policy that in history has been normal in Finland; the aim was to produce a baseline where good fiscal rules would really be needed. Still the outcomes in Table 1 are worrying because they show possible magnitudes of problems resulting from population ageing, if no measures are taken.

Table 1. Gross public debt/GDP, %, under base policy

End of period	d1	Q1	Md	Q3	d9
2020 – 24	52.94	61.23	68.85	75.22	82.27
2025 – 29	51.75	60.57	72.60	83.76	91.04
2030 – 34	50.48	65.00	80.18	89.85	101.40
2035 – 39	58.95	72.10	87.04	99.31	112.02
2040 – 44	59.10	76.38	92.30	110.13	122.52
2045 – 49	67.56	81.72	99.98	116.48	135.31
2050 – 54	70.67	86.83	106.24	126.09	147.41
2055 – 59	70.41	92.46	109.58	130.90	154.56
2060 – 64	74.02	97.68	116.41	136.17	161.41
2065 – 69	82.77	103.46	123.39	147.17	174.42
2070 – 74	87.44	109.11	131.31	154.52	193.01

d1 and d9 are the first and ninth deciles, Q1 and Q3 the first and third quartiles, and Md the median.

The second observation from Table 1 is the magnitude of uncertainty. Predictive intervals grow rapidly in time. The 80 % interval (the difference between d9 and d1) is 30 percentage points (henceforth p.p.) wide at the end of 2024, grows to 50 p.p. in the next 10 years, and is over 100 p.p. in 2074. This happens because in these simulations nothing is done to change the courses. Table2 will show whether fiscal rules will change the outcomes.

Table 2. Gross public debt/GDP, %, under different fiscal rules

	d1	Q1	Md	Q3	d9
End of period	Rule 1 (SD v MTO^{ILD})				
2020 – 24	52.20	59.30	67.55	73.11	80.04
2025 – 29	47.15	57.06	69.10	80.51	86.39
2030 – 34	46.14	57.95	72.70	83.59	92.93
2035 – 39	47.71	59.47	75.72	88.22	98.83
2040 – 44	40.83	58.07	75.16	92.15	104.84
2045 – 49	36.94	57.24	75.74	91.59	107.10
2050 – 54	34.85	51.70	73.36	90.96	106.39
2055 – 59	28.91	48.23	72.52	91.42	103.62
2060 – 64	16.50	45.99	66.76	89.36	103.82
2065 – 69	10.07	44.17	67.14	86.84	102.04
2070 – 74	-2.95	42.91	67.32	86.96	101.36
	Rule 2 (Narrow SD v MTO^{ILD})				
2020 – 24	52.94	59.30	66.84	71.41	76.28
2025 – 29	47.85	56.14	66.50	76.28	81.35
2030 – 34	46.32	57.47	67.53	76.95	84.27
2035 – 39	44.36	56.58	68.39	78.62	87.66
2040 – 44	36.89	55.92	66.53	79.59	87.91
2045 – 49	33.07	53.43	65.59	78.19	88.27
2050 – 54	27.69	47.79	62.67	76.00	85.70
2055 – 59	20.12	40.83	59.29	73.09	82.34
2060 – 64	12.32	37.65	56.20	69.81	81.33
2065 – 69	1.11	34.13	55.61	67.13	77.82
2070 – 74	-5.88	26.91	53.21	67.26	82.46
	Rule 3 (SD v simplified MTO^{ILD})				
2020 – 24	52.51	59.30	68.20	73.45	81.38
2025 – 29	48.38	57.39	70.26	81.21	86.76
2030 – 34	46.51	59.31	73.71	84.20	93.25
2035 – 39	48.36	62.28	77.60	89.24	99.49
2040 – 44	45.85	59.75	77.24	94.47	104.52
2045 – 49	41.09	61.91	76.98	92.88	109.56
2050 – 54	39.06	58.20	76.52	93.39	109.18
2055 – 59	34.57	54.21	74.44	95.17	107.35
2060 – 64	23.77	50.54	72.26	93.68	109.55
2065 – 69	17.37	48.64	70.11	91.68	106.91
2070 – 74	8.56	45.88	70.74	90.58	108.77
	Rule 4 (VAT based on debt target)				
2020 – 24	53.28	59.10	64.58	69.77	74.79
2025 – 29	49.58	55.64	64.43	71.83	76.73
2030 – 34	45.53	54.77	65.01	71.85	80.12
2035 – 39	47.06	56.13	65.62	75.97	83.38
2040 – 44	44.95	55.24	67.50	76.46	87.96
2045 – 49	44.25	56.54	66.37	78.74	89.11
2050 – 54	43.31	54.74	67.01	79.98	91.32
2055 – 59	39.34	54.35	67.40	80.53	92.86
2060 – 64	41.72	53.51	66.04	79.00	92.49
2065 – 69	41.00	52.56	66.36	80.42	90.89
2070 – 74	38.28	51.38	66.21	79.99	93.09

d1 and d9 are the first and ninth deciles, Q1 and Q3 are the first and third quartiles, and Md is the median.

If the fiscal rule is built directly around the MTO^{ILD}, the future indebtedness outlook looks much brighter. In Table 2 the median outcome will be the same in 2074 as it is in 2024. Uncertainty is not reduced by very much if one looks the 80 % interval because there are a lot of very low debt outcomes. It is better to look at outcomes with higher indebtedness, such as the difference between d9 and the median. Under rule 1 the width is 34 p.p. in 2074, whereas it was 62 p.p. in the base.

If the fiscal rule excludes social insurance institutions from the deficit (rule 2), the debt outcomes become still distinctly better (Table 3). The median turns to a declining trend in 2050s, and is 14 p.p. lower in 2074 than with rule 1. Uncertainty in high debt area is also reduced: the distance between d9 and the median is 29 p.p. in 2074, down 5 p.p. from rule 1.

Rule 3 simplifies the MTO^{ILD} criterion by leaving out the terms that are forecasts (g) or include forecasts ($s2$). Table 4 shows that public indebtedness will be higher than under rule1 that includes forecasts. The median in 2074 is 3 p.p. higher than in Table 2, and the difference is 7 p.p. at the ninth decile d9. One should note, however, that although the indebtedness seems to be systematically higher throughout the distribution under rule 3 than under rule1, the differences are not large.

Rule 4 is an entirely different fiscal rule, based solely on a 20-year forecast. Table 5 demonstrates that the chance for very high indebtedness is lower than with rules 1 and 3, but higher than with rule 2. There are no really low debt outcomes, as the VAT rate is reduced rapidly if there appears to be room for it. Uncertainty is somewhat lower than under other rules.

Table 3 present the predictive distributions of VAT rate under the four fiscal rules. VAT is calibrated to 26.5 % at the start, representing the current level of all consumption taxes in Finland. The tax rate increases under every rule, the median by about 6 – 7 p.p. The distributions appear to be rather similar to each other. Rule 2 stands out slightly by having the highest median, lowest ninth decile and narrowest 80 % predictive interval in 2070s.

Table 3. VAT rate, %, under different fiscal rules

	d1	Q1	Md	Q3	d9
Period	Rule 1 (SD v MTO^{ILD})				
2020 – 24	26.50	26.50	26.50	27.93	32.20
2025 – 29	26.50	26.50	26.50	30.11	32.77
2030 – 34	26.50	26.50	28.07	31.37	33.61
2035 – 39	26.50	26.68	29.38	32.05	34.87
2040 – 44	26.50	28.53	30.98	33.61	36.05
2045 – 49	26.67	29.82	31.58	34.35	36.42
2050 – 54	28.02	30.07	31.82	34.78	36.92
2055 – 59	28.22	30.08	32.21	34.92	36.82
2060 – 64	28.29	30.22	32.33	34.93	37.80
2065 – 69	28.68	30.41	32.36	35.40	38.53
2070 – 74	28.76	30.75	32.38	35.30	39.11
	Rule 2 (Narrow SD v MTO^{ILD})				
2020 – 24	26.50	26.50	27.13	30.72	33.76
2025 – 29	26.50	26.86	29.35	32.14	33.81
2030 – 34	26.50	28.33	30.60	32.43	34.70
2035 – 39	27.66	29.97	31.64	33.24	35.45
2040 – 44	28.76	30.50	32.54	34.60	37.22
2045 – 49	29.26	31.15	32.92	34.94	37.63
2050 – 54	29.40	31.35	33.25	35.15	38.35
2055 – 59	29.69	31.27	33.36	35.43	38.13
2060 – 64	29.69	31.35	33.44	35.96	38.41
2065 – 69	29.53	31.36	33.56	36.05	38.22
2070 – 74	29.97	31.60	33.58	36.12	38.53
	Rule 3 (SD v simplified MTO^{ILD})				
2020 – 24	26.50	26.50	26.50	26.75	31.00
2025 – 29	26.50	26.50	26.50	29.04	32.05
2030 – 34	26.50	26.50	27.26	30.79	32.91
2035 – 39	26.50	26.50	28.90	31.66	34.93
2040 – 44	26.50	27.38	30.51	33.11	36.29
2045 – 49	26.50	28.87	31.11	34.12	36.51
2050 – 54	26.79	29.30	31.25	34.59	36.53
2055 – 59	27.41	29.67	31.76	34.66	37.19
2060 – 64	27.65	30.03	32.06	35.01	38.80
2065 – 69	28.35	30.22	32.36	35.12	38.95
2070 – 74	28.86	30.62	32.68	35.73	39.30
	Rule 4 (VAT based on debt target)				
2020 – 24	26.26	28.10	30.16	31.93	33.64
2025 – 29	26.40	28.75	30.60	32.50	34.46
2030 – 34	27.15	28.95	31.32	32.97	34.64
2035 – 39	27.36	28.99	30.96	33.73	36.10
2040 – 44	25.92	28.19	31.08	33.32	35.45
2045 – 49	25.81	28.31	30.44	32.93	36.04
2050 – 54	25.64	27.69	30.21	33.09	35.18
2055 – 59	25.82	27.85	30.42	33.37	35.13
2060 – 64	25.48	28.74	30.92	33.80	36.24
2065 – 69	25.98	28.79	31.74	34.46	37.98
2070 – 74	26.18	29.43	32.92	36.05	39.08

d1 and d9 are the first and ninth deciles, Q1 and Q3 are the first and third quartiles, and Md is the median.

4.4 Comparing the fiscal rules

The predictive distributions above showed that the fiscal rule 2, which leaves out the social security institutions from the deficit, leads to lower level levels of debt than the rule 1 which covers the whole general government. Both rules strongly restrict public debt formation, as Figure 4 demonstrates. The rules also lead to different VAT outcomes (Figure 5). Rule 2 usually leads to higher VAT rate, but the highest rates, however, come under rule 1.

Figure 4. Frequency distribution of public debt, as % of GDP, in 2074

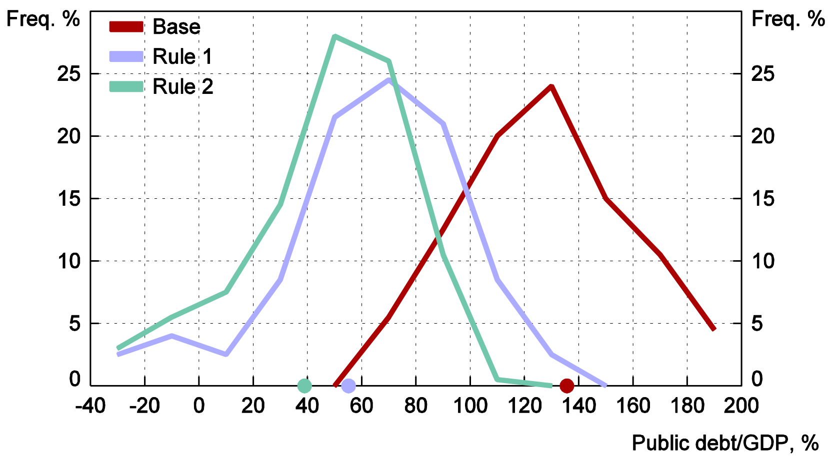
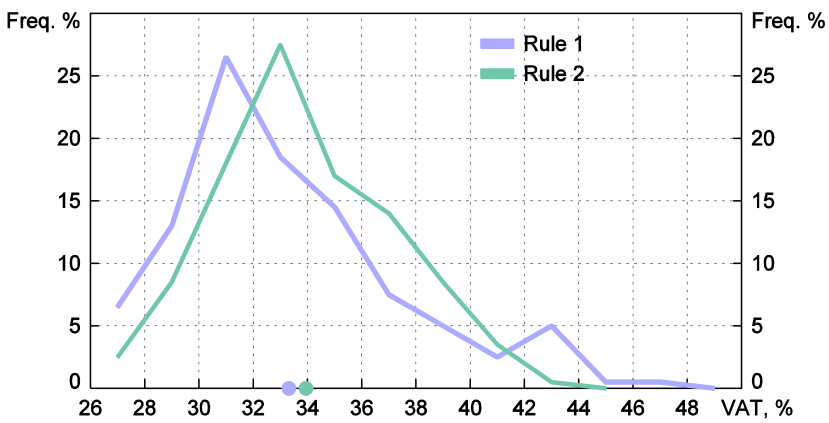


Figure 4 excludes seven observations below -40 % from both rules.

Figure 5. Frequency distribution of VAT rate in 2074



Comparing rules 1 and 2 thus requires weighing the gain from lower public indebtedness against the loss from higher tax rate, although keeping in mind that the risk of really high tax rate is reduced. The median gain in indebtedness is 14 p.p. in 2070s and the mean gain is about the same (the means are denoted by dots in the x-axis in the figures). The tax difference is about 1 p.p.

On a more general level, the rules should act as indicators of emerging problems, like fire alarms. With that interpretation, rule 2 certainly looks more lucrative. The important difference between the rules is when they trigger off the tax raise. Using the narrower definition of structural deficit leads to earlier tax reactions. Looking at, e.g., the medians in Table 3 we notice that with rule 1 the first reactions are visible in the 2030s, whereas with rule 2 the measures are visible 10 years earlier.

The second comparison concerns the role of forecast terms in the fiscal rules. Comparing rule 1 and rule 3 tells us whether the forecasts behind the sustainability gap s2 and the long-run growth rate are useful. In rule 3 the simplified criterion consists of three terms. The first is the productivity growth rate which is used instead of GDP growth rate. The forecast GDP growth, used in the MTO^{ILD} criterion, varies around the growth rate of productivity and is affected by, e.g., the population forecast. The second term is a constant, set at the average of *s*2 values observed in rule 1 analysis. Thus it is on average at a reasonable level, but the forecast-based variation is removed. The third term is the observed debt component in the MTO^{ILD}.

Visually, the increases in public indebtedness that result from excluding the forecast components seem rather small (Figure 6). On the policy instrument side, the VAT distributions in Figure 7 look roughly the same. Thus it appears that the forecast elements in MTO^{ILD} could be left out without doing much harm to the rule. There two obvious candidates for such a result to occur. It is possible that expected average growth and the sustainability gap are too difficult to forecast. It is also possible that the gap suffers from the same coverage issue as the structural deficit: it includes social insurance institutions.

The importance of taking a longer view of public finances in fiscal rules, instead of concentrating on short horizon events, is stressed in Auerbach (2013). He notes that this becomes a very complex task once one accounts for forecast uncertainty. In our model analysis, however, it is hard to see why s2 would be forecast very poorly. Every expenditure and revenue item's formation is assumed to be known exactly, so this is not the reason in the model calculations. The errors come from stochastic inputs: Population forecasts are erroneous, and the economic outcomes based on them are also erroneous. Future shocks in asset yields also have effects. These uncertainties prevail also in the real world, and in addition there are many unknown mechanisms that the AWG has to make assumptions about. Thus in our model context s2 must be forecast better than the s2 in the real world.

Sustainability gap s2 covers the general government. Thus developments in the pension sector affect it. Positive asset yield shocks, e.g., make room for lower contributions, which lowers s2 but does little to help the state's indebtedness. Demographic developments may also have vastly different effects to pension systems from those to the state and the municipalities.

Figure 6. Frequency distribution of public debt, as % of GDP, in 2074

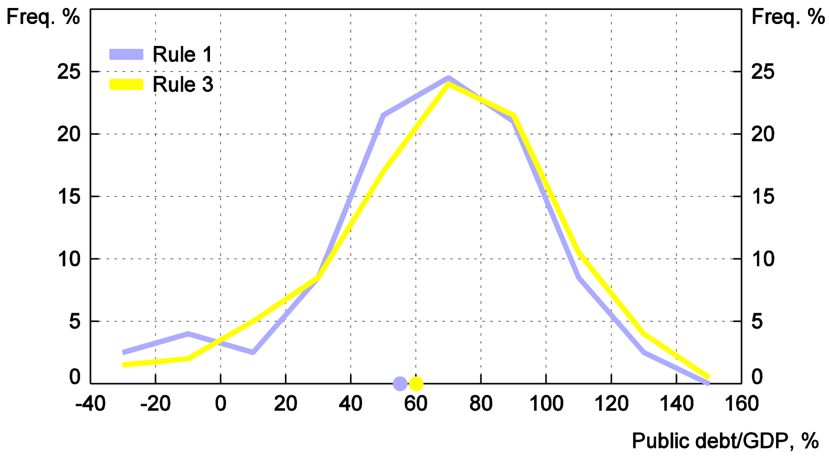
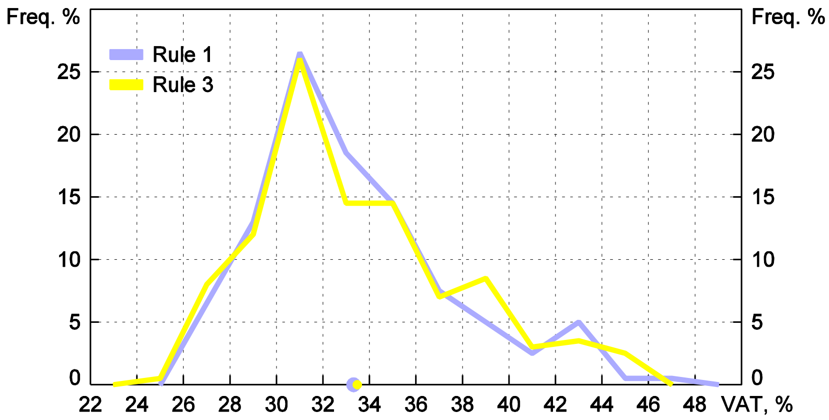


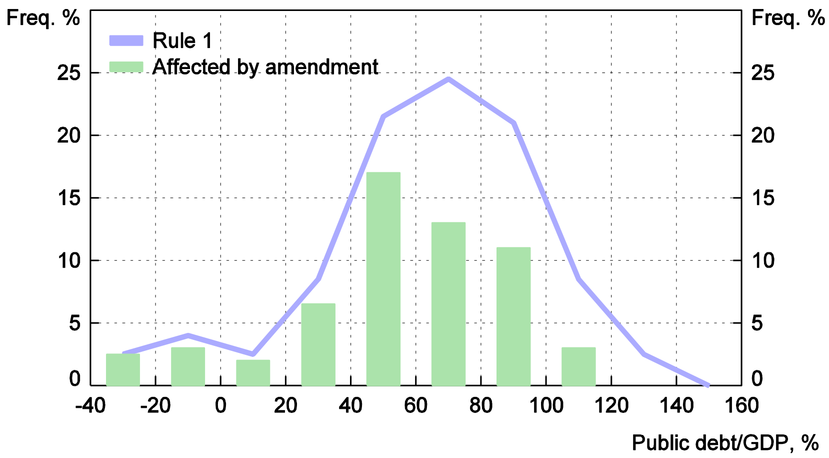
Figure 6 excludes 7 observations below -40 % from rule 1 and 11 from rule 3.

Figure 7. Frequency distribution of VAT rate in 2074



Rules 1, 2 and 3 included the condition that, even if the structural deficit is higher than $-\text{MTO}^{\text{ILD}}$, the VAT increase will not take place if it is forecast that the debt/GDP ratio would fall below 60 % in the next 50 years without the raising the VAT. This amendment, meant to prevent unnecessary VAT increases, affected over half of the paths under rule 1. The green bars in Figure 8 show how these paths appear in the 2070s frequency distribution. They cover a great deal of paths that end up with low debt but few paths with debt over 100 % of GDP. This indicates that the forecast-based amendment is very likely useful, although the limit for forecast debt ratio should be lower than the 60 % we have used in this study.

Figure 8. Frequency distribution of public debt, as % of GDP, in 2074



Figures 9 and 10 display the frequency distributions for rule 4, which ignores the deficits and MTO^{ILD} and changes VAT on the basis of the 20-year indebtedness forecast. The debt outcomes are more concentrated than under other rules, and there are few negative or low debts. The distribution of VAT rates, on the other hand, is flatter than those under other rules.

Figure 9. Frequency distribution of public debt, as % of GDP, in 2074

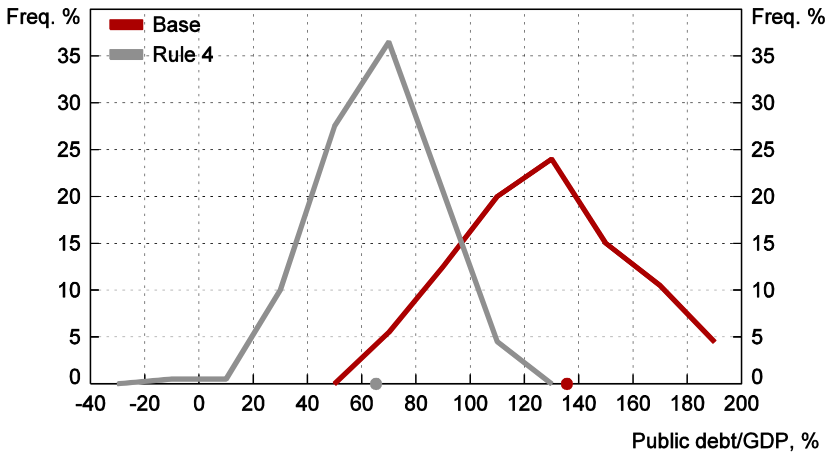
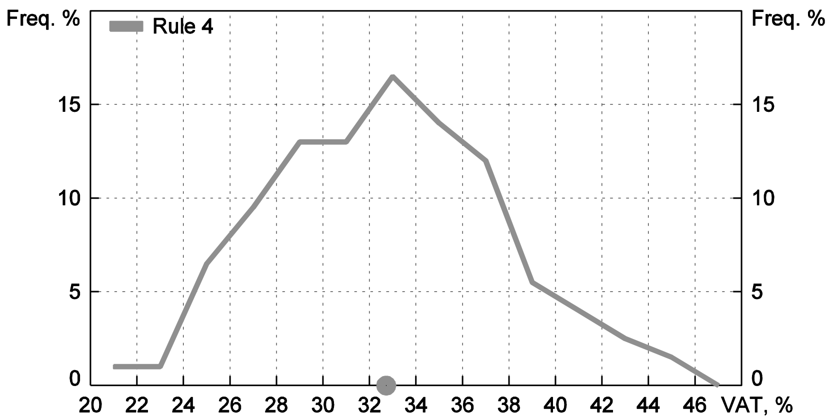


Figure 10. Frequency distribution of VAT rate in 2074



The predictive distributions of VAT describe what kind of tax levels follow from different rules. They do not tell, however, how much VAT changes within the paths. This variation is displayed in Table 4 for all paths and in Table 5 for the 100 paths that end up with highest debt in 2070s. The reason for Table 5 is that variation under rules 1 to 3 is very small if the deficits stay small, whereas under rul4 VAT changes in every period. Since we are more interested in the behaviour of rules in situations where high indebtedness is the threat, Table 5 is relevant. It shows that variation in tax rates under rule 4 is smaller than under other rules, when fiscal developments warrant higher taxes.

Table 4. Predictive distributions of means and standard deviations of VAT rate, %

Policy rule	Rule 1 SD v MTO^{ILD}		Rule 2 Narrow SD v MTO^{ILD}		Rule 3 SD v simplified MTO^{ILD}		Rule 4 VAT based on debt target	
	E	σ	E	σ	E	σ	E	σ
d_1	28.13	0.60	29.06	0.19	27.71	0.75	28.42	2.32
Q_1	29.51	1.33	30.83	1.13	29.18	1.38	29.54	2.72
Md	31.01	2.40	32.15	2.15	30.63	2.39	30.89	3.21
Q_3	32.68	4.00	33.81	3.22	32.41	3.94	32.39	3.76
d_9	34.54	5.13	35.91	4.51	34.91	5.63	33.73	4.50

How to read Table 4: There are 200 simulated paths. Thus, for each policy rule, there are 200 expected values (E) for the period 2020 – 2074. Their distributions are described by deciles d1 and d9, quartiles Q1 and Q3, and the median Md. There are also 200 standard deviations (σ), each describing variation within one path during the period 2020 – 2074. Their distributions are described in a similar fashion. The distributions of E and σ are separate, not joint.

Table 5. Predictive distributions of means and standard deviations of VAT rate, %

Policy rule	Rule 1 SD v MTO^{ILD}		Rule 2 Narrow SD v MTO^{ILD}		Rule 3 SD v simplified MTO^{ILD}		Rule 4 VAT based on debt target	
	E	σ	E	σ	E	σ	E	σ
d_1	29.60	1.14	31.23	0.46	29.29	1.29	29.89	2.15
Q_1	30.83	1.66	32.01	1.34	30.28	1.83	30.72	2.65
Md	32.23	3.05	33.15	2.86	32.07	3.22	31.96	3.22
Q_3	33.44	4.85	34.72	4.06	33.60	4.81	33.32	3.81
d_9	35.51	6.11	36.48	4.83	35.46	6.52	34.82	4.54

How to read Table 5: As in Table 4 but numbers are based on only 100 simulated paths.

4.5 Intergenerational aspects of the fiscal rules

From the point of intergenerational fairness, good fiscal rules should lead to tax burdens that are for all generations roughly the same in relation to public services and transfers received. Increases in longevity should be taken into account when assessing this, since it affects both the tax side and especially the services received side. In the Finnish case, Lassila and Valkonen (2018) concluded that with a proper link between retirement ages and longevity, working lives may develop so that the sustainability gap becomes roughly independent from developments in longevity. The link decided in the 2017 pension reform between eligibility ages and longevity is close to what Lassila and Valkonen (2018) used, so intergenerational fairness can be interpreted to require that the fiscal rules should adjust taxes quickly to a level that suffices in the long run. This appears to be too difficult to do with the available forecasts. Table 3 reveals that under all the rules studied here, VAT rates have rising trends. Rules based on the MTO thus appear to be more or less unfair from a generational viewpoint, and the same goes for rule 4, which aims to keep the debt level constant.

5 Conclusions

We have simulated the effects of fiscal rules for Finland that are explicitly based on the Medium-Term Budgetary Objective (MTO) and aim at keeping public finances sustainable in the long run. We have used a general equilibrium overlapping-generations model to study fiscal rules where consumption taxes are conditioned on observed and forecasted variables related to the MTO. The key inputs are regular demographic forecast revisions that are embedded in stochastic population projections, based on a method created by Alho (2014). The other included uncertainties consider productivity and asset yields.

Auerbach and Hassett (2001, p. 74) condense the policy question that population ageing poses as 'how and when to deal with long-term fiscal imbalances that are at once very significant and very uncertain'. This study has demonstrated that the imbalances are truly significant and uncertain, and then concentrated on when to deal with them.

The key finding of the study is that, while a rule based directly on the 'implicit liabilities and debt' part of the MTO keeps public debt at roughly acceptable levels, the rule would work better if structural deficits would exclude social security funds. The improvement concerns especially the timing of the measures. Although this is a country-specific result, due to both the private sector and the public sector pension systems having substantial funds, similar situations exist in other countries. As Frej Ohlsson (2007, especially sections 6 and 7) describes, countries try their utmost to utilize such systems when reporting general government deficits.

We also find that the MTO contains forecast elements that could be left out without essentially weakening the rule. Two reasons for this must be considered. Firstly, the sustainability gap suffers from the same coverage issue as the structural deficit: it includes social insurance institutions.

Thus developments in the pension sector affect it. Secondly, it is possible that average future growth and the sustainability gap are too difficult to forecast.

The role of fiscal rules is to start and keep up discussions on fiscal situations, and direct it toward quantitative issues. The more weight is given to quantitative issues, the more useful it would be that the rules are quantitatively sensible and the elements of the rules are useful for the purpose of the rule. If the rules contain forecasts, their forecast record should be known and deemed acceptable.

Anderson (2012) notes that although sustainability gap is perhaps a good way to summarize expected long-term fiscal development because it facilitates communication, it can be criticized for aggregating too much information into one metric. Furthermore, this metric is very sensitive to the discount rate and the horizon. He writes that it might be better to consider the time profile of fiscal variables, which also makes it easier to assess when particular fiscal limits will probably be met.

Our results appear to support this view. Sustainability gap s2 is probably not an ideal form to operationalize the future outlook in a fiscal rule, because it does not seem to add useful information into the rule. It is also a variable whose forecasting properties are difficult to study, and will remain so in the future. This is true by definition, if we take literally the instruction that 'ageing cost corresponds to the discounted value of the increase in the cost of ageing, calculated up to an infinite horizon' (EC 2017, p. 29), an instruction under which time will never tell. But also concerning gap calculations for finite periods I find it unlikely that they will be evaluated as forecasts ever in the future. The components of the gap are more likely to be evaluated this way. It might be better to look at the debt forecast or public expenditure forecast; information concerning their long-term forecast properties may also be difficult to gather, but not as difficult as concerning the sustainability gap.

Whether or not s2 is used, additional forecast-based information is likely to improve the rule. We amended the MTO-based rules with a condition that no measure is taken if the debt/GDP ratio is forecast to fall below 60 % in the future without the measure. The amendment appears promising, although the limit, 60 %, was somewhat high, and it seems likely that a lower limit would be better. In principle, a good fiscal rule should avoid recommending that measures be taken unless truly needed, and under the huge uncertainties this is also difficult to obtain.

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Appendix 1: The Finnish earnings-related pension scheme

The earnings-related pension scheme aims to provide sufficient retirement income to cover consumption comparable to levels enjoyed during working years and to current workers' consumption. It covers risks related to old age, disability and death of family earners. In cases where the earnings-related pension is absent or insufficient, the national pension guarantees a minimum income. Both of these first-pillar schemes are mandatory. Voluntary pensions are still of minor importance in Finland but are becoming more common. Below we describe the private sector earnings-related scheme. Public sector pension schemes are becoming similar, except that funding is different and there are long transition periods from old benefit rules.

The pensions can be thought of as consisting of both disability pensions and old-age pensions. Every year's earnings directly affect the future pension. After the 2017 reform, the accrual rate is 1.5 % per year in all ages after 17. Both pension rights and benefits are index linked, with 80-20 weights on wages and consumer prices respectively during working years and 20-80 weights after retirement, irrespective of retirement age.

The pensions are adjusted for increasing life expectancy simply by taking the increasing longevity into account in the value of the annuity. The adjustment coefficient is a ratio of two present values of a unit pension, calculated at two different periods. The present value of a unit pension, which begins in period t and is calculated forward from age 62, is as follows.

(3) $$A(t,62) = \sum_{s=63}^{100} S(t-1,62,s)/(1.02)^{s-62}$$

The present value of a unit pension is a discounted sum of terms generated during various retirement years. The terms have two parts. The first term, S, expresses the survival probability from age 62 to age s, and the first subscript of the term demonstrates that the probability is evaluated using information available in period t, when the latest the observed mortalities are from period t-1. The survival probabilities are actually five-year moving averages. The second term is the discount factor where the discount rate is 2 % per year. In the model individuals die at the age of 100 at the latest.

The pension of a person born in period t – 62 is multiplied by the longevity adjustment coefficient E(t,62) after age 62. The coefficient is a ratio of two *A*-terms as follows.

(4) $$E(t,62) = A(2009,62)/A(t,62)$$

According to the 2017 pension reform, the pension scheme will react to longevity shocks also with retirement age. The earliest eligibility age for old-age pension is first raised gradually to 65, in 3-month cohort-wise steps. After that, for cohorts born 1965 and after, the eligibility age is linked to life expectancy. Longevity adjustment is still applied but it is mitigated, cutting monthly pensions to a lesser degree than the current longevity indicator does. The mitigated longevity indicator is also applied to the earned part of the disability pension. Eased longevity adjustment keeps the present value of pension unchanged, when the increase in the earliest eligibility age and in the length of the retirement period are both taken into account.

The earliest eligibility age for old-age pension is tied to adulthood life expectancy (adulthood begins at age 18) so that the retirement age divides the adulthood life expectancy in the same proportion each year. For cohorts born 1965 and after, the earliest old-age pension eligibility age V is such that

(*V* – 18)/(Life expectancy at *V*) = *C* where C is a constant determined by

C = (65 – 18)/(Life expectancy at 65 in 2025)

Life expectancies are calculated from mortalities from latest available 5 years. V is in full months, and can change at most by 2 months from previous V.

$E(t, V) = E(2026, 62)A(2026, 65)/A(t, V)$

Linking retirement age to life expectancy affects the length of working lives. Based on the study by Määttänen in Lassila, Määttänen and Valkonen (201), a one-year increase in life expectancy by itself increases working lives by two months. Raising the pensionable age, the unemployment pathway and the part-time pension by one year extends working lives by one month. These relations, from life expectancy to earliest eligibility age and from the eligibility age to working lives, and directly from life expectancy to working lives, are used in the stochastic simulations. Extending working lives are included in the OLG model exogenously in each simulation.

The Finnish earnings-related scheme has collected substantial funds to smoothen the contribution increases due to population ageing in the future. Funding is collective but based on individual pension rights. Individual pension benefits do not depend on the existence or yield of funds. Funds only affect contributions. When a person starts drawing old-age pension, his/her funds are used to pay that part of the pension benefit that was prefunded. The rest comes from the PAYG part, the so-called pooled component in the contribution rate. Both employers and employees pay contributions.

Appendix 2: Projecting health and long-term care expenditure

Whereas pension system is known exactly and is described in the FOG model in a detailed and accurate way, rather little is known and uncertainty is large concerning the links between population ageing and health and long-term care expenditures. This concerns the driving forces and causalities both currently and in the past. Uncertainties in future projections are magnified by the obvious possibility that whatever the current connections are, they may change in the future. The relevant issues include technological change, Baumol's disease, income effects and demographic effects (see, e.g. de la Maisonneuve et al., 2013 and Häkkinen et al., 2007).

FOG concentrates on issues that can be related to demographic changes. Some illnesses and injuries both hasten the death and increase the health and long-term care (LTC) costs in the last years of life. Thus when modeling the dependence of health and LTC expenditures on population and its age structure, it is reasonable to include mortality as an explanatory variable. This can be used in long-term projections also, as population forecasts include also mortality, implicitly or explicitly.

Our starting point is Häkkinen et al. (2006), who used individual-level health and care expenditures for a large sample (N= 285 317) of persons in ages 65+ in 1998. According to their calculations, 49 % of health expenditures and 75 % of care expenditures went to persons who died in 1998 – 2002. From these figures one can deduce that 51 % of health and 25 % of care expenditures were not directly death-related because they occurred to persons who were still alive five years later. Furthermore, part of the expenditure for those who died during these years obviously had no causal connection with death. A person who died because of lung cancer in 2002 may have been treated for a dislocated shoulder in 1998.

Using mortality data, we can estimate the share of expenditures of those who die within five years, assuming that proximity to death has no effect on these expenditures. To do this by age group, we have to use also data for 2006, and implicitly assume that the per capita supply and unit costs of health and care services were the same as in 1998. The weighted average of this share, estimated over 5-year age groups for persons aged 65 and above, was 28 % of health expenditures and 48 % of care expenditures. These are smaller shares than Häkkinen et al. (2006) report. The difference in the health expenditure share, 21 %, can be interpreted as a lower limit for the health cost that proximity to death causes. A corresponding lower limit for care is 27 %. Thus 21 – 49 % of health expenditures and 27 – 75 % of care expenditures have links to proximity to death.

Thus the Finnish data show that there are costs that depend on the proximity to death and costs that do not depend on it. Assuming that the latter, within each age group, are on average the same per capita for those who died and for those who did not, we can calculate the share of the former. This was 29 % in health expenditures and 51 % in care expenditures. We modeled it to be the same per capita, irrespective of the person's age. Thus the total expenditure depends both on the number of people in each age group and the number of people who will die within the next five years.

Appendix 3: Calculating the sustainability gap and expected growth

Sustainability gap: In the OLG model simulations, state tax rates are fixed. Tax revenues vary due to the extent of tax bases and the progressiveness of earnings. The financial assets of the state are kept at a constant ratio to GDP, and the net debt and the gross debt are flexible. Local government debt remains at a standard ratio to GDP. The pension funds of the private sector fluctuate in accordance with current funding regulations. The ratio of the state and municipal pension fund to the public wage sum has been fixed. The municipal tax rate is endogenous and balances the economy of municipalities together with state aid to municipalities. Earnings-related pension contributions are endogenous. As a whole, the tax rate and net indebtedness of the large public sector are determined endogenously.

The sustainability gap looks at the expected long-term disparity between public revenues and expenditure determined according to current tax rates and current procedures and consolidates that into a single figure. The gap is the difference between the current ratio of total tax revenues to GDP (the situation at the time of the calculation) and a hypothetical constant total tax ratio. The hypothetical tax rate is such that, if taxes were raised to the said level immediately and permanently, they would be sufficient to finance public expenditure for the next 50 or 100 years (in this study, 50) and return the public net debt in relation to the GDP to the initial level. This would occur when 1) surpluses collected during different years are invested in government bonds, and deficits are covered by selling bonds, 2) the discounted surpluses and deficits cancel each other out, 3) the financial assets of the state and the net assets of local governments remain in a standard ratio to the overall production and 4) pension funds develop in accordance with current funding rules. Note that in our simulations the state debt is endogenous, and thus the public net debt in relation to the GDP does not usually return to the initial level. That is taken into account in the sustainability gap calculation by the debt terms in equation 1.

The sustainability gap in equation 1 is calculated from the model simulation results. It is based on a hypothetical total tax rate. It does not take into account the effect that the immediate and permanent raising of taxes – necessary for reaching a standardized tax rate – would have on the labor supply, household savings and the decisions of companies. If one wanted to take these effects into account, the size of the sustainability gap would depend on which taxes would be raised to close the deficit gap. Since the model is a general equilibrium model, the gap estimates exclude any structural deficits that may exist in the start period.

The GDP in period *t* is denoted as *Y(t)* and the total tax rate with the term $\tau(t)$, public net debt (i.e. the debt of the central and local governments) at the end of the period is denoted as *V(t)* and the net tax rate at the starting point is denoted with the term $\tau(t(0))$. The interest rate *r* is assumed to be constant. The forward-looking sustainability gap *(s2)* calculated from period *t(0)* to *T* by period is then

$$(1)\quad s2(t(0),T) = \frac{\sum_{t=t(0)}^{t(0)+T}\left[\tau(t)-\tau(t(0))\right]Y(t)D(t) \;+\left[V(t(0)+T)-V(t(0)-1)\frac{Y(t(0)+T)}{Y(t(0))}\right]D(t(0)+T)}{\sum_{t=t(0)}^{t(0)+T} Y(t)D(t)}$$

where the discount term D(t) is

$$(2)\quad D(t) = (1+r)^{-(t-t(0))}$$

The first term of the numerator in the first formula describes the effect that changing pension contributions and municipal taxes have on the sustainability gap, and the second term describes the contribution of the change in net public debt.

Expected nominal growth: Since *g* in $\mathrm{MTO}^{\mathrm{ILD}}$ formula is nominal growth, expected inflation must be considered. FOG does not include inflation, so our results are best interpreted as zero-inflation outcomes. On the other hand, real deficits in relation to real GDP are roughly or perhaps exactly the same as nominal deficits in relation to nominal GDP. Expecting, e.g., 2 % annual inflation adds about 1.14 percentage points to $\mathrm{MTO}^{\mathrm{ILD}}$, giving more room to deficits. We have not included that. But there are compensating elements in our calculations. The balances of social insurance institutions include property incomes that, calculated according to national account's practices, exclude changes in asset valuations, and the same goes for the state's financial assets. We have assumed fixed yields for these assets in the deficit calculations, 3 % for private and public pension institutions and 4.4 % for the state's assets. The last term, the state's assets, are kept at 33 % of GDP, so they alone yield a permanent 1.25 percentage point surplus term to the structural balance in our calculations. Our results can thus be interpreted also as including a 2 % inflation expectation together a with lower property income yield assumption.