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THE FINNISH CORPORATE AND CAPITAL INCOME TAX REFORM:
A General Equilibrium Approach

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ABSTRACT: This study simulates the macroeconomic and welfare effects of the recent Finnish corporate and capital income tax reform with a numerical overlapping generations model (FOG). It shows that the impact of the reform on the capital stock and production depends on the reactions of firms. If the financial strategy is changed to prefer dividend distribution and share issues, as the planners of the reform assumed, the cost of capital falls and the capital stock increases. If the firms stick to the earlier policy and earnings are still mainly retained, the capital stock does not markedly change, but the value of the firms and the wealth of current shareholders rises. Taking into account the future generations nevertheless shows that the overall welfare implications are in both cases negative. The reason is that the increase in interest income taxation reduces saving, expands the net foreign debt of the economy and weakens the terms of trade in the long run.

Key words: Corporate income tax reform, financial strategy of firms, numerical overlapping generations model

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TIIVISTELMÄ: Tässä tutkimuksessa simuloidaan Suomessa 1990-luvun vaihteessa toteutetun pääomatulojen verotuksen uudistamisen kansantaloudellisia ja hyvinvointivaikutuksia numeerisella sukupolvimallilla (FOG). Tutkimus osoittaa että uudistuksen vaikutukset yritysten pääomakantaan ja tuotantoon ovat ehdolliset yritysten rahoituspolitiikalle. Jos politiikkaa muutetaan suosimaan osingonjakoa ja osakeanteja, kuten tarkoitus oli, pääomakustannukset alenevat ja pääomakantaa voidaan kasvattaa. Jos toisaalta yritykset pysyvät aiemmassa politiikassaan ja rahoittavat investoinnit pidätetyillä voitoilla, pääomakanta ei juuri muutu, mutta yritysten arvo ja nykyisten osakkeenomistajien varallisuus maksimoituvat. Jos kuitenkin otetaan huomioon myös tulevien sukupolvien hyvinvointi, uudistuksen vaikutukset ovat rahoituspolitiikasta riippumatta negatiiviset. Tämä johtuu siitä, että korkotulojen verotuksen kiristäminen vähentää säästämistä, lisää ulkomaista velkaa ja heikentää vaihtosuhdetta pitkällä aikavälillä.

Asiasanat: Pääomatulojen verouudistus, yritysten rahoituspolitiikka, numeerinen sukupolvimalli

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Overview and motivation

The aim of this study is to analyse the macroeconomic and intergenerational effects of the recent Finnish corporate and capital income tax reform. It is motivated by three reasons. First and foremost, capital income taxation is from the point of view of alternative theories of corporate finance a potentially very effective but at the same time very controversial method to affect saving and investment. Second, the environment in which the taxation is pursued is rapidly changing and therefore the reactions of private sector agents to a tax reform might vary. Third, there are actual tax reforms which are partially a reaction to the changes in the environment, but which also reflect the new, more modest attitude towards the possibilities of the public sector to enhance growth and welfare. The study takes as an example the Finnish case.

Our starting point concerning the alternative theories of corporate finance was to find out the justifications for the tax reform given by the government. One of main arguments used was to abolish the double taxation of dividends, applied first at the corporate level and then to personal income. Since the two dominating theories about the taxation of dividends[1] give radically different outcomes of the effects of taxation and thereby policy recommendations, we find that it is essential to study the tax reform assuming either that firms continue to follow their earlier financial strategy or that they shift to another regime, as the government implied.

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[1] The theories called "new view" and "old view" are discussed in Section 2.2.

The method used should be able to describe the optimal reactions of the private sector to the tax reform in varying circumstances. We study the responses of firms and households to the changes in effective corporate and capital income tax rates using a numerical overlapping generations model calibrated to the Finnish economy (FOG). The model has a sound theoretical basis laid on the optimisation decisions of firms and households. The dynamic structure allows a consistent analysis of the intertemporal investment and financing decisions of firms and the labour supply and saving decisions of households. This allows us to avoid the Lucas-critique thereby giving a considerable comparative advantage over macro-econometric models, see Bovenberg (1989b). On the other hand, the numerical approach allows us to consider the life-cycle of households in a much more realistic way compared to the use of an analytical two-period overlapping generations model (Broer and Lassila 1997).

In addition to describing the new equilibrium of the economy under the changed tax rules, the model offers many results in the form of adjustment paths of the macroeconomic variables such as market prices, production, capital stock, employment and foreign debt and of micro-economic variables such as generational life-cycle paths of incomes, consumption and labour supply. Moreover, the shifts in welfare can be calculated for the ultimate evaluation of the desirability of the tax reform.

One of the main elements in general equilibrium model analysis is the sensitivity analysis of the simulation results to various assumptions about the key behavioural parameters of the individual agents. We add to this three other aspects. The lag between the announcement and implementation of tax reforms is often long. Financial markets react, however, immediately when new information comes. Hence, we have carried out a sensitivity analysis of the impacts of an early announcement. Another interesting issue is the sensitivity of the welfare outcomes to alternative assumptions about the initial portfolio composition of households, since the tax reform affected differently the market price of capital and the after-tax yield on assets. Third, a more fundamental issue is the connection between the open economy and the international markets of goods and financial capital, which affect profoundly price and interest rate formation. We are not satisfied with the often used simple assumption that the economy behaves as a price-taker. Hence, we carry out a comprehensive sensitivity analysis concerning the impact of imperfect substitutability in the markets of domestic and foreign goods and capital.

The renewal of the Finnish capital income taxation was part of a larger reform, which markedly changed the taxation of both income and consumption during the years 1987-1993. Following the footprints of other reforms in OECD countries, it lowered the high marginal tax rates and widened the tax base in income taxation. Also, the shift from a sales tax to a value added tax broadened the tax base. This measure lowered, however, the cost of capital since purchases of new investment goods were allowed to be deducted from the tax base.

The motivations for the corporate and capital income tax reform were both external and internal. Domestically, the most compelling reasons were the need to improve the efficiency of the allocation of capital and to promote neutrality in taxation of industrial branches, types of capital, sources of financing and investing sectors (Myhrman et al. 1995). Also, opportunities for tax arbitrage had emerged as a result of the deregulation of credit markets (Ministry of Finance 1991). International pressures were generated by the deepening economic integration to other parts of Western Europe and the wave of tax reforms carried out there, which intensified tax competition.

The tax reform followed the guidelines of other Nordic reforms by separating taxation of earned income and capital income and by applying a low equal flat tax rate to the latter tax base, see Sörensen (1994a) for justifications of the dual tax system adopted. An additional element of the Finnish reform was the introduction of full imputation of paid corporate taxes in taxation of dividends. The main goal was to reduce the double taxation of dividends of personal investors, but it also attempted to guarantee single taxation of distributed profit, because the old system included both a limited dividend deduction in corporate taxation and large number of tax-exempt shareholders. In spite of the allowances in taxation of distributed profits, the earlier system could be described as favouring retained earnings together with debt as cost-of-capital minimising marginal sources of finance. Share issues were rare indeed.

Another connected objective of the reform was to reduce the observed locking-in of profits in firms. The introduction of the imputation system and the increase in the effective capital gains tax rate were supposed to encourage firms to shift towards favouring distribution of profits

and financing investments with share issues. The higher dividend distributions were assumed to be reinvested in capital markets and thereby considered to improve allocational efficiency.

There exists some disagreement about the actual amount of distortions in the earlier system. Even though the statutory marginal tax rates were high, the large amount of exemptions and allowances reduced the effective rates markedly. This study applies the view that the tax system affected substantially the financing structure of firms and thereby household portfolios, but since the firms were able to adjust, not so much the cost of capital and investments. This view is supported by the theoretical studies summarised in Andersson et al. (1998) and the empirical evidence provided by Dufwenberg et al. (1994).

One of the benefits of using a dynamic general equilibrium model is that it takes into account how the initial tax system distorts the behaviour of the private sector. We can also simulate a reform of several tax rates while ensuring that the interaction of these tax shifts will be considered. The chosen approach is to first study the impacts of shifts in individual tax rates one-by-one. The justification for this is that we can thereby illuminate the results more profoundly and find out the main driving forces of the outcomes of the overall reform.

*The earlier tax reform literature and the new ingredients included in our mode*l

The links between our study and the earlier tax reform literature are divided in the following to two subgroups. The earlier Finnish research was typically based on the partial equilibrium analysis of corporate income taxation and aimed to produce cost of capital calculations. Another described tradition, unknown in the Finnish literature, applies dynamic computable general equilibrium models in studies of corporate taxation. Our study links the two traditions.

The origins of the Finnish capital income tax reform discussion can be traced back to the 1970's. The contributions of e.g. Puumanen (1976, 1977) and Koskenkylä and Pekonen (1978) included mostly a verbal evaluation of the distortive effects of the tax system on investments and indebtedness of the economy. Ylä-Liedenpohja (1980) presented a formal analysis of the combination of corporate and personal capital income taxation. The international wave of tax reforms and the increasing doubts about the ability of the complicated

capital income tax system to optimally allocate resources revived the discussion in the mid-1980's. One important milestone was the report of the one-man Committee concerning the reform of corporate income taxation (Ministry of Finance 1987). The method used was mostly calculations of the effective tax rates and cost of capital in the spirit of King and Fullerton (1984), see e.g. Airaksinen and Hagfors (1987), Koskenkylä (1987) and Ylä-Liedenpohja (1984, 1987a, 1987b). Also, the first experiments of using a numerical general equilibrium model in tax reform analysis were published at that time (Ylä-Liedenpohja 1988).

The tax reforms of 1989-1991 intensified modelling efforts in Finland. The King-Fullerton-type of analysis continued (Iivonen 1990, Kanniainen 1991a, Voipio 1991, Ministry of Finance 1991), but also CGE models were used. The problem with the model analyses from the point of view of capital income taxation was that they were still carried out using static CGE models (see Heinonen and Ylä-Liedenpohja 1992 and Törmä and Rutherford 1992), which could not deal with forward-looking saving and investment decisions properly. There are two additional features, which aggravate the comparison of the earlier Finnish CGE results to the ones generated by our model. These simulations considered, namely, overall tax reforms, which also included other elements than the capital income tax system. Another problem is that these calculations do not take into account the major shifts in the tax system in 1993. The rules which prevailed before the tax reform was completed provided markedly different incentives to save and invest than the final tax system.

The last, and perhaps most profound, stage of the tax reform in 1993 inspired again King-Fullerton analyses, which generally agree with us about the effects of the tax reform on the cost of capital, see e.g. Hakola (1993), Koskenkylä (1992), Myhrman et al. (1995) and Tähtinen (1992). Kanniainen and Hernesniemi (1994) also examined the changes in the market value of firms, just as we do in our study, but were not able to analyse the implied reactions of the shareholders due to the partial equilibrium nature of their model. In addition, Piekkola (1995) evaluated the impacts of the 1993 reform on foreign investment in Finland.

The use of dynamic computable general equilibrium models in tax analyses has increased rapidly since their introduction in the 1980's (see e.g. the survey by Pereira and Shoven 1988), but the development of the models has given new insights. At least three major advancements

in the models should be mentioned. The first is the inclusion of adjustment costs of investments, which spur a *Tobin's q*-type of investment behaviour. Another is to model the household sector using overlapping generations instead of one infinitely living household[2]. We have tackled the often raised question of the validity of the pure life-cycle theory by modifying the optimisation problem of households to take into account a hump-shaped working efficiency time profile, a pension system and "joy of giving" bequests.

The third improvement is to bring into the dynamic models the interaction between domestic and foreign economies, nevertheless originally often assuming that the domestic economy is small and behaves as a price taker in the international markets of goods and capital (see e.g. Söderlind 1990). In our model, foreign agents are allowed to participate in the markets of the domestic good and bond markets, but do not necessarily determine the prices: in goods trade the Armington assumption[3] can be used and the domestic interest rate can be linked to supply and demand of financial capital[4]. Foreigners are not allowed to own domestic firms, which ensures that the required rate of return for firms' capital is determined from the point of view of a domestic investor, who is affected by domestic taxation[5].

The earlier CGE studies have not devoted much attention to the justification of the modelled financial policy, even though the policy affects the results profoundly. In most cases some stylised version of either the "old view", the "new view" or the hierarchical financing scheme have been adopted.

The simplest new view CGE models finance all investments with retained earnings and distribute the rest of the income to the shareholders (see Frederiksen 1994 and Söderlind 1990). This leads to volatile dividend behaviour and dividends can turn out to be negative. A more developed version finances investments with retained earnings and debt using a fixed debt-to-capital ratio (see Jensen et al. 1993 or Knudsen et al. 1998). Goulder and Summers (1989)

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2 The first applications were made by Summers (1981a) and (1981b). Auerbach and Kotlikoff (1987) used both features in their path-breaking dynamic CGE model analysis.

3 See Armington (1969).

4 Goulder and Eichengreen (1989) and Perraudin and Pujol (1991) are among the few that have also endogenised the interest rate in an open economy CGE model.

5 This model feature is based on the actual ownership structure at the time of the tax reform. See e.g. Gordon (1986) or Apel and Södersten (1999) for the implications of capital income taxation in the case of foreign ownership of the domestic capital stock.

used also a fixed debt ratio formulation, but in their model the other source of marginal finance is share issues. Dividends were determined as a fixed ratio of the book profit. This old view formulation has been used later by Keuschnigg (1991) and Offerdahl (1991).

There are also some studies that carry out sensitivity analysis concerning the financial structure of firms. Fullerton and Henderson (1986) and Fullerton and Mackie (1989) compare the results of U.S. tax reforms using different assumptions about the financing structure. The used model has a detailed description of the production sector, but is only "artificially" dynamic in the sense that aggregate investments are determined by households' two-period savings decisions, which are based on myopic expectations. The main interest is in the allocation of capital across industries, sectors and assets. The results show a larger welfare gain in the old view case, in which firms increase financing with share issues. Fullerton and Rogers (1993) used an enlarged version of the model to study tax incidence. The results show e.g. that abolishing the corporate income tax generates a smaller welfare gain in the "new view" case, in which there is no double taxation of dividends, since the distortions created by taxation increase progressively.

Hutton and Kenc (1998) compare the effects of reducing various capital income taxes under the new view, the old view and the endogenous determination of the debt-equity ratio[6]. Their CGE model, which is calibrated for the UK, has a simple production structure, but is genuinely dynamic. Households have an infinite planning horizon. The authors find that in order to promote investments, elimination of the interest income tax is most preferable, if the government does not know the actual financial strategy of the firms. As will be shown in our study, this outcome is sensitive to the assumption of a closed economy, which guarantees that the generated higher household saving lowers enough the domestic interest rate.

The study of Broer and Westerhout (1993) utilises an open economy version of the Auerbach-Kotlikoff overlapping generations model calibrated to the Dutch economy. In their model, the agency costs of increased use of debt financing and a tax structure which favours retained earnings lead to a hierarchy-of-financing scheme. First, the retained earnings are used together with the debt. When retained earnings are exhausted, debt is the sole financing

[6] In this approach the marginal investments are financed with bond issues. The optimal amount of debt is determined to balance the benefits of lower taxation and the agency costs of debt.

method. When the cost of debt rises high enough, share issues are also used. The endogenous financing structure affects markedly the results of reducing the corporate income tax rate, just as does the assumption of a minimum dividend pay out (imitating the old view) applied in the sensitivity analysis.

Our core economic model is most similar to the one of Broer and Westerhout (ibid.). From the point of view of corporate taxation, the main difference is that in our study the firms' debt-to-capital ratio is fixed. We focus on choosing the optimal amounts of external and internal equity finance and dividend distribution policy. The choice of the financial strategy is not genuinely endogenous in our model, but can easily be justified either by minimising the cost of capital or maximising the value of the firms. The additional restrictions that we must pose on the financial strategies (restrictions on the amount of distributed dividends and prohibition of share repurchases) are in line with the tax system and book accounting rules which prevailed before the tax reform.

Our aim is not to downplay the importance of the debt-equity choice. The Finnish tax reform did not change the cost of capital financed with bonds (if general equilibrium repercussions are ruled out), but reduced markedly the possibilities to use tax debt for investment finance. Since these possibilities were not fully used before the reform, taking into account the shifts in tax debt would complicate the analysis markedly, see e.g. Virolainen (1998). Also, the amount of non-tax costs and benefits of debt are ambiguous, see Kanniainen and Södersten (1994). As noted above, there are some studies that also incorporate the endogenous determination of debt in general equilibrium tax analysis, but these models are tax regime specific. For example, the model of Broer and Westerhout is sensitive to the assumption that dividends are taxed more than capital gains. As Hasselman (1991) notes, the outcomes in these types of hierarchy-of-finance models depend also on the growth rate of the economy. See also Hansen (1994) for empirical support of the target debt-to-capital ratio compared to the pecking-order theory in the Finnish case.

Just as all the above mentioned other numerical general equilibrium models, our model has also further simplifications. One of those is that we do not analyse intragenerational income distribution or intersectoral distortions in production. In fact, most studies which focus on

income distribution use static production blocks and the ones which analyse intersectoral issues assume infinitely living households. The approach used in our model of having a single type of household generation and a representative firm is therefore a compromise aimed to put an equal weight on the impacts of taxation on saving and investment decisions.

The structure of the study is as follows. The next section depicts the model used, emphasising corporate finance modelling. The third section describes in more detail the Finnish tax reform. The fourth section illuminates the effects of changes in individual tax rates both in the case of an early announcement and a surprise implementation of the tax reform. In the following section the tax rates are shifted simultaneously. This part also includes the sensitivity analysis regarding the openness of the economy. The sixth section analyses the interaction of the tax reform and alternative financial strategies of the firms. Conclusions are provided in the seventh section.

2. MODEL DESCRIPTION

2.1 Overview of the FOG model

The model is an Auerbach-Kotlikoff-type perfect foresight numerical overlapping generations model. There are five sectors: households, enterprises, a government, a pension fund and a foreign sector. The labour, goods and capital markets are competitive and prices balance the demand and supply period-by-period. There is no money or inflation in the model. The unit period is five years.

The household sector consists of 12 overlapping generations. Households enter the model at the age of 20, without wealth, participate in the labour market until they are 60 years old, and live as pensioners the next 20 years. They make utility maximising lifetime plans for consumption, labour supply and bequests when they enter the model. After a simulated shock every household cohort revises its plans for the remaining lifetime. The dying generation leaves bequests to their 50-55 year old descendants. The utility from giving bequests is not linked to the utility of the inheriting generation.

The enterprise sector consists of small, listed, forward looking companies which maximise the value of their shares. The representative firm decides investment and the use of labour. Investments cause adjustment costs, which allows the investment decisions to be based on a tax-adjusted Tobin's q-theory.

The public sector collects taxes and uses them to hire workers and to pay transfers to households and the interest costs of the public debt. The incomes and expenditures are balanced period-by-period with lump-sum taxes and transfers. The pension institution finances pen-

sions with contributions and capital income from the pension fund. The pension system is balanced period-by-period by the employers' contribution rate.

The households' working efficiency first increases and then decreases with age, which induces a hump-shaped life cycle earnings profile. The efficiency wage is formed in labour markets where the aggregate labour supply meets the exogenous public sector demand and the enterprises' labour demand which is determined from the marginal productivity of labour rule. There are two "basic" goods in the model, one imported and one domestically produced. The goods are imperfect substitutes and are combined with a CES structure to form cost minimising composite intermediate, investment and consumption goods. The domestic good is also exported. Export demand depends on the terms of trade with a constant price elasticity. The price of the imported good is fixed and used as a numeraire in the price system.

In the market of one-period-bonds the issuers of debt are firms and the government and the investing sectors are households, a pension fund and foreigners. The domestic interest rate is either fixed to the foreign rate or the imbalance (period-by-period or accumulated) of national savings and investments is allowed to generate a difference between the domestic and foreign interest rate. In the market of domestic firms' shares domestic households are the sole owners.

2.2 Sectors, markets and calibration

2.2.1 Households: life-cycle theory, saving and capital income taxation

Models of consumption behaviour

Models of household behaviour can be classified according to the planning horizon or according to the degree of altruism of the households. These approaches lead to similar model type when households behave as if they lived infinitely or as if they were extremely altruistic. This model tradition implies the well-known Barro neutrality of fiscal policy. From the point of view of welfare, the results of these models are based on substitution effects which generate pure efficiency changes.

The planning horizon is shortest in the Keynesian type models, which assume that periodic incomes determine consumption, i.e. the propensities to consume and save the incomes are fixed in time. There is also at least implicit presumption that households are constrained in labour and capital markets, which restrict their possibilities to choose optimal labour supply and consumption timing. In this framework fiscal policy is most powerful due to the strong income effects.

The third way is to model households as finite lifetime utility maximisers, who do not consider the welfare of their descendants. Therefore the Ricardian equivalence fails. There are several versions of the model.

In the simplest version overlapping household generations live two periods. The households typically work during the first period and save for the second period consumption. Taxes and transfers generate both income and substitution effects, which distort labour supply and saving decisions. The income changes are due to shifts in net tax burdens and prices. Even though this model type allows to study also intergenerational resource transfers, it cannot describe the dynamic adjustment paths properly and may generate strange results. The problems with the short and medium term dynamics are understandable, when one notes that in such a model one period would cover about 40 years. An example of the outcomes due to the model type is the result of Uhlig and Yanagawa (1996), who claimed that a shift from labour income taxation to capital income taxation may generate higher savings and growth. This conclusion is sensitive to the assumption of the two-period lifetime.

A second overlapping generations (OLG) model group, which also allows aggregation of the households for theoretical analysis, is based on the contributions of Yaari (1965) Blanchard (1985) and Weil (1989). In this model group the distribution of the residual lifetimes of the households is the same for all survivors. It encompasses the infinitely living household model as a limit case. It can also be adjusted to imitate the two period case by shortening the planning horizon and setting the lifetime labour supply to be steeply declining. The deficiencies of

this model type, at least in the theoretical versions, are exogenous labour supply and age-independent saving[1].

The OLG models of the third group are often identified to be successors of the numerical model of Auerbach and Kotlikoff (1987)[2]. The original A-K model includes 55 overlapping generations, which allows to study the reactions of households year-by-year from age 20 to age 75. In these models the optimisation problem of the perfect foresight households is to maximise their lifetime welfare consisting of consumption of goods and leisure. The maximisation task takes shape by choosing the optimal consumption and labour supply paths taking into account the lifetime budget constraint.

From the point of view of intergenerational incidence of capital income taxation it is important that in this model tradition households have often a hump-shaped lifetime working efficiency profile, so that smoothing of lifetime consumption requires little saving when young, substantial saving when middle-aged and dissaving when old. It does not, however, necessarily imply that the aggregate wealth of households is larger. The generated age-specific variation in initial wealth causes diverse reactions to changes in taxation.

The advances of the Auerbach-Kotlikoff approach compared to the above mentioned more theoretically oriented overlapping generations models are largely recognised. On the other hand, the empirical studies of the validity of the behavioural assumptions of life-cycle model are inconclusive and the predictions of at least the pure version are often rejected. The problem seems to be that current incomes explain too much of the variation in consumption and the reduction in wealth at old age is much less pronounced as forecast. The explanations given include e.g. that households are myopic or that there is income uncertainty and markets are incomplete, preventing households to shelter from the uncertainty.[3]

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1 Frederiksen (1994) has endogenous labour supply in his numerical model. In Jensen et al. (1993) labour supply decisions are made endogenously by a labour union, but are exogenous to individual households. Jensen and Nielsen (1993) introduce age-dependent saving.

2 The authors designate the life-cycle models of Modigliani and Brunberg (1954) and Ando and Modigliani (1963) as the theoretical ancestors of their household sector description.

3 See e.g. Deaton (1986) and Pemberton (1997). Some studies claim that the excess sensitivity of consumption to incomes in household data can at least partly be eliminated by modifying the life-cycle model, see e.g. Blundell et al. (1994), Attanasio et al. (1995) and Hubbard et al. (1995).

We have modified the pure life cycle model to take into account a joy-of-giving bequest motive. The bequest motive encourages the elderly households to keep wealth until they die. It means also that a substantial part of aggregate wealth accumulation can be explained by intergenerational transfers (see Kotlikoff and Summers 1981 or Gale and Scholtz 1994 for evidence). Another empirically important feature that affects markedly the life-cycle wealth trends is the pension system. In our case the financing of pensions is based on a pay-as-you-go method, which means that the pensions for current retired are financed by the working age generations. On impact, the working-age households have both less net income and reduced motive for saving for old age[4].

The optimisation problem of households in the FOG model

The model economy includes one household type, but at each point of time there live 12 overlapping generations of those households, born at different periods.

Households maximise the discounted sum of periodic utilities u_t and utility from the bequest n they give. The optimal life-cycle plan is the solution to the following problem.

$$\max_{c,l,n} \qquad U = \sum_{t=1}^{T} \frac{1}{1-\frac{1}{\gamma}} \frac{u_t^{1-\frac{1}{\gamma}}}{(1+\delta)^{t-1}} + \frac{1}{1-\frac{1}{\gamma}} \mu \frac{[n(1-\tau_t^n)]^{1-\frac{1}{\gamma}}}{(1+\delta)^{T-1}} \quad . \tag{2.1}$$

Of the constant preference parameters γ and δ are the elasticity of intertemporal substitution and the pure rate of time preference, and μ is a bequest preference parameter. Bequests are taxed with a rate τ^n. The maximisation is subject to the budget constraint (2.2):

$$\begin{aligned} &\sum_{t=1}^{T_w}(1-l_t)e_t w_t(1-\tau_t^w)R_t + \sum_{t=T_w+1}^{T} z_t(1-\tau_t^w)R_t + R_7 n_7(1-\tau_t^n) + \sum_{t=1}^{T} s_t R_t \\ &= \sum_{t=1}^{T} c_t p_t^C(1+\tau_t^C)R_t + R_T n_T \ . \end{aligned} \tag{2.2}$$

and the determination of pensions z_t[5]. The first term in the sum describes the discounted after-tax lifetime labour incomes, which depend on the wage rate w_t and on the age-specific

[4] In the case of a fully funded defined contribution pension system the model would be identical to that without a pension system if the pension funds were invested and taxed in the same way as household wealth.

[5] The determination of pensions is described in more detail in Appendix 1.

working efficiency e_t, which makes the life-cycle wage-income profile hump-shaped. The labour incomes are subject to a wage tax τ_t^w. Households retire at the age of $T_w + 1$, which is assumed to be 60 years. They receive pensions z_t after retirement until they die at age T, which is 80 years. They get also an after-tax bequest of $n_7(1-\tau_t^n)$ at age of 50-55 (period 7). The last income item is the discounted sum of net transfers from government s_t. The discounted sum of expected capital incomes is zero because households enter the model at age 20 without any initial wealth and the discount rate is the same as the expected yield of saving. Households use the lifetime incomes to buy the composite consumption goods of various periods with after-tax consumer price $p_t^C(1+\tau_t^C)$ and to leave a bequest when they die. The determination of the price p_t^C and composition of the consumption good have been described in detail in Section 2.2.4.

The discount factor R_t depends on the domestic interest rate r^d and on the interest income tax rate τ^r.

$$R_t = 1 \qquad t = 1 \tag{2.3}$$

$$R_t = \Pi_{s=1}^{t-1} \frac{1}{1+r_s^d(1-\tau_{s+1}^r)} \qquad t = 2..T$$

The denominator in the equation (2.3) depicts the after-tax rate of return on saving.

The periodic utility u_t depends on the amount of available consumption good c_t and leisure l_t as follows:

$$u_t = (c_t^{1-\frac{1}{\rho}} + \alpha l_t^{1-\frac{1}{\rho}})^{\frac{1}{1-\frac{1}{\rho}}} \quad , \tag{2.4}$$

where α is the leisure preference parameter and ρ is the substitution elasticity between consumption and labour.

Total consumption, labour supply, pensions received and taxes paid are aggregated from individual household decisions. The size of each age cohort is the same, i.e. there is no demo-

graphic variation allowed. The actual equations of the numerical model are the first-order conditions of the optimisation problem.

Household saving and capital income taxation

In this study the household behaviour is based on a modified life-cycle model, which says that the saving decision is affected by the amount and timing of incomes, the yield on saving, the rate of time preference, the intertemporal elasticity of consumption and bequest preference.

The expected yield on saving is composed of the after-tax interest rate[6] and of the future changes in consumer prices[7]. The subjective time preference characterises the willingness of the household to consume now instead of postponing the consumption to the future.

The changes in the rate of return and thereby also changes in the capital income tax rates create both income and substitution effects. The substitution effect encourages to postpone consumption if the future price is lower (the net return higher). The income effect implies that for reaching a given savings target a higher return requires less saving. The intertemporal elasticity of consumption describes the relationship between the income and substitution effects, i.e. the willingness to postpone consumption when the rate of return changes. Most empirical studies show that the substitution effect dominates and therefore a higher capital income tax rate reduces saving.

The timing of lifetime incomes, saving and the rate of return are connected also in another way. The later the incomes are received, the more sensitive is the current consumption to the variation in the yield of saving. When the yield rises (due e.g. lower tax rates), the purchasing power of the future incomes is of less value from the point of view of lifetime consumption.

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[6] The portfolio choice between bonds and shares of the firms does not matter, because the arbitrage condition of financial markets guarantee that the expected after-tax yield of the assets is the same and the households are risk-neutral.

[7] Since the numeraire in the model is the price of the imported good, the interest rate is expressed in units of that good. See Bovenberg (1989a) for the open economy implications of the consumption interest rate, which takes into account shifts in the terms of trade. In our model households have perfect foresight about the future path of the interest rate and consumer prices immediately after the announcement of a policy measure. The practice of using myopic expectations would possibly strengthen the reaction of savings, but do not affect the steady state (Fullerton and Mackie 1989).

The households reduce therefore current consumption and save more[8]. Head (1997) sees even that capital income taxation both distorts the intertemporal consumption choice and discriminates between individuals who have different intertemporal consumption preferences or lifetime earnings profiles.

The motives for household saving in the model are smoothing of the consumption path and planned bequests. Precautionary saving and saving due to unknown length of life are instead not considered because of the perfect foresight of the households. Accounting for those would mean that savings rate would be higher and the sensitivity of the savings to the variations in the rate of return would be lower. Households would also leave unintentional bequests. The importance of uncertainty from the point of view of savings behaviour is more pronounced in case of undeveloped public safety net or private insurance and financial markets.

A life-cycle model gives a fresh standpoint to the capital income tax incidence discussion. Households incur typically debt when they are young and save during their years of high productivity in order to pay the debts and to finance part of the consumption when retired. The variation in composition of incomes and expenditures during the lifetime and in the amount and composition of accumulated wealth means that the outcomes of a tax reform will be complicated, at least when the tax system is modelled in more detail. These outcomes can be, however, traced back to the initial optimisation conditions of households (and firms).

The household sector is the heart of this model in a sense that they own the firms and provide the means for the public sector. It is therefore useful to review the links between their saving and the saving of other sectors.

One important issue is how households perceive the public sector intertemporal budget constraint. In our case the households have perfect foresight about the future policy of the government (excluding the studied shifts in tax rates). The model allows to make various assumptions about the budget balancing rule. In the simulations we balance the incomes and expenditures period-by-period with a lump-sum transfer. This does not rule out, however, in-

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[8] See Summers (1981b) and Boadway and Wildasin (1994).

tergenerational transfers of tax burden, because future capital income taxes may capitalise into the current market value of the capital stock.

There exists also a link between saving decisions of households and firms. The households, who own the firms, "see through the corporate veil" in a sense that they fully take into account the profit retention decisions of the firms as increasing household wealth. The valuation of these retentions depend, however, on the details of the tax system and the financing strategy of the firms, which are discussed more closely in the following section.

2.2.2 Firms and corporate taxation

Integration of capital income taxation and the "views"

This section describes the interaction of capital income taxation of households and firms. The capital income generated by the firms are usually taxed both with corporate income taxes and as interest incomes, dividends or capital gains of households. Mintz (1995) lists the reasons for taxing the incomes in firm level as follows. A corporate income tax can serve as a benefit tax, as a withholding tax or as a rent tax. Mintz (1992) adds to the list also the function of the tax as a means of altering the investment patterns of production by using e.g. tax incentives.

The role of a corporate income tax as a benefit tax is justified due to the possibility for the firm to use infrastructure and due to limited liability. The withholding role of the tax can be aimed either to domestic or to foreign owners of the firm. A backstop for the domestic personal capital income tax is needed because taxation could be avoided or delayed by retaining the earnings in the firm. On the other hand, government can use the corporate income tax as a source tax for foreign investors, which are otherwise seldom taxed by the host country.

Head (1997) links the withholding role of corporate income tax to the comprehensive income tax tradition. This tradition emphasises that taxing the distributed profits both as corporate and as household incomes creates significant distortions to real and financial decisions. Therefore the ideal tax system would integrate corporate and personal income taxation.

The role of corporate tax as a rent tax is based implicitly on the idea that the normal profit is a deductible cost in taxation (i.e. at least main part of costs of capital for depreciation and financing can be deducted in present value terms). The economic rents due such factors as entrepreneurship, land or natural resources can be fully taxed without creating economic distortions (Mintz 1995). The "new view" literature carries this point further claiming that the taxation of dividends is neutral from the point of view of investments, but the capitalisation of the dividend tax to the equity share prices serves as an once-off wealth tax (Head 1997). So integration creates just a windfall gain to current shareholders.

This disagreement of the outcomes of dividend taxation and the policy recommendations implied is important, but unresolved issue. Since any capital income tax reform study must respond to the issue, it is useful to discuss the main arguments. We describe below the main features of the old view, the new view and the neutrality hypotheses. The descriptions follow closely the approaches of Sinn (1990) and Zodrow (1991). Head (1997) and Sørensen (1994b) provide for more recent surveys.

The neutrality hypothesis justifies the choice of the mode of finance purely on the basis of the after-tax cost of capital. While in most countries firms' interest expenditures are deductible in corporate taxation, the use of debt is less taxed than the use of equity. All investments should therefore be financed with debt. If deductibility is complete and the tax base for corporate taxation is actual profits, the cost of capital for debt-financed investment is not affected by corporate and personal taxation.

Advocates of the other two views agree on the neutrality of debt but claim that the use of debt is limited because of the increasing risk of bankruptcy and therefore the capital stock must be financed at least partly with equity.

The main assumption in the "old view" (traditional view) is that shareholders benefit from dividends more than from capital gains. This is justified either by cash preference, by signalling of profitability or by the preference of reducing the managerial discretion over the use of profits. These gains must be evaluated against the generally observed higher effective tax burden of dividend incomes compared to the taxation of capital gains. The preference for divi-

dends is generally expressed as a target dividend/profit ratio. Distributing the dividends leaves less earnings to be retained and therefore the marginal investments of firms are financed by new share issues.

According to the old view, the double taxation of profits causes major distortions in investment decisions. This can be seen in the following equation, which is derived by assuming that one dollar is invested either in newly issued shares or in bonds. The bond yields an after-tax interest rate and the share gives the distributed profit taxed both at the corporate and at the personal level:

$$P = r^d \times \frac{1-\tau^r}{(1-\tau^D)(1-\tau^{Fd})} \quad . \qquad (2.5)$$

where P is required dividends per invested dollar, r^d is the domestic interest rate, τ^r is the personal tax rate for interest income, τ^{Fd} is the corporate tax rate on distributed profits and τ^D is the personal tax rate for dividends.

If the personal tax rates are assumed to be equal, the corporate tax rate determines the difference between the cost of capital and the interest rate. Arguing that the difference is large, the proponents of the traditional view have asked for integration of the corporate and personal income taxation. There is also a later version of the old view, described e.g. in Poterba and Summers (1983) and Goulder and Summers (1989), in which the arbitrage condition between the after-tax yield of debt and equity takes into account the possibility of capital gains. It also produces a formula identical to (2.5) in the case of maximum distribution of dividends.

The opposing "new view" (tax capitalisation view, trapped equity view) supporters claim that, empirically, the amount of share issues is small and retained earnings dominate equity finance. This dominance is a result of minimising the cost of equity capital[9]. The lower cost of capital is due to the low tax rate for capital gains and the neutrality of dividend tax when investments are financed with retained earnings.

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[9] They do not accept the old view justifications for the dividend preference. See Sørensen (1994b) for some of the critiques against these preference arguments. There is also a well-known competing explanation for preference of internal finance, which is based on asymmetric information, see e.g. Myers and Majluf (1984).

The neutrality argument is based on the idea that dividend taxes are avoided when earnings are retained[10]. The present value of these tax savings is at the margin as large as the future dividend tax payments which are generated by investing the retained earnings and distributing the yield as dividends. Now the corresponding equation for the required dividend per invested dollar is (see e.g. Sinn 1990 for the derivation):

$$P = r^d \times \frac{1-\tau^r}{(1-\tau^g)(1-\tau^{Fr})} \quad , \tag{2.6}$$

where τ^{Fr} is the corporate tax rate for retained earnings and τ^g the personal tax rate for capital gains. The amount of dividends is a residual from the firms' cash flow equation remaining after the investments have been financed by retaining earnings. Shareholders value the after-tax dividends and capital gains equally. Now the policy recommendations are significantly different. If the tax rate for dividends is lowered, it has no effect on the costs of the marginal investment and on the profit distribution, but gives a windfall capital gain to the owners of the shares.

The weakness of the new view is that it assumes the earnings of the firms to be eventually distributed to shareholders in the form of taxable dividends. But if firms repurchase their shares, the distributed profit is taxed at capital gains tax rates, not at dividend tax rates. The neutrality also requires that the firms do not plan to finance any investments with share issues in the future.

Comparing equations (2.5) and (2.6) shows that the cost of capital under both views is equal only when the personal capital income tax rates are equal as well as the corporate tax rate on distributed and retained earnings. Generally they differ and therefore the validity of the views is important.

Unfortunately, empirical tests have not given unanimous support to either of them[11]. The cost of capital calculations above are derived from a partial equilibrium model. The modifications for our dynamic open economy general equilibrium model are presented below.

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[10] Bond, Chennels and Devereux (1996) note that the dividend tax is neutral also when the marginal shareholders are tax-exempt.

[11] The old view has gained somewhat more empirical support, see Zodrow (1991) for a survey.

The nucleus theory of corporate capital (Sinn 1990) combines the elements of the two views. It claims that the double taxation argument is valid for young firms during their growth phase. Therefore they should start with a small initial capital, avoid share issues and distribution of heavily taxed dividends. When the growth-phase is passed, the mature firm can finance the investments internally and distribute the rest of the profits, as the new view suggests. This is a way to escape the distortions created by heavy taxation of dividends. The theory runs, however, to problems in countries which apply imputation system or dividend deduction system and taxes capital gains with higher tax rate than dividends.

Firms and capital income taxation in the FOG model

This section presents the decision problem of the firms and the way in which capital income taxation affects the decisions in the model.

The real process of the firms in the model can be described as follows. A representative small firm produces the domestic good using capital inherited from the previous period, intermediate good and labour. Infinite horizon decisions of investment and employment are made to maximise the firm's market value. The firm takes prices, demand for production and supply of factors at given prices, production technology and taxation as given. Intermediate and capital goods are costs minimising CES (constant elasticity of substitution) composites of domestic and imported goods.

Gross production is a combination of value added and the composite intermediate good in fixed proportions. The production function is a standard CES function of capital and labour. In the process of installing new capital some of the production is lost as investment adjustment costs. Maximising the firms value subject to the adjustment costs leads to q-theory investment function[12].

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[12] See Tobin (1969) for the idea and Hayashi (1982) and Dixon et al. (1992) for the conditions ensuring that the investments are also a function of observable average q. Chirinko (1993) and Hubbard (1998) provide an extensive review of the features and econometric evidence of the Tobin's q model and alternative models of investment determination. The majority of the empirical tests show, that the relation between q and investments is weak (see e.g. Blundell et al. 1992 and for the Finnish case, Kajanoja 1995). Some recent studies (e.g. Cummins et al. 1994) claim, however, that the studies have typically underestimated the relation. Ali-Yrkkö (1998) finds that investments in Finland are affected by the amount of production and profits, indebtedness of the firms and the user cost of capital.

In a tax-free world with perfect foresight and well functioning capital markets, the financial decisions of the firm have no effect on the cost of capital and the value of firms. Taxation changes the picture profoundly: it can lead to situations where the tax arbitrage can increase the value of firms indefinitely. If capital gains are taxed at a lower rate than dividends, shareholders benefit if firms repurchase their shares and finance this by reducing dividends. If the dividend tax rate is lower, firms should issue shares and distribute the returns as dividends. Also, debt can be used in a similar way. These results imply that to keep the model tractable, some restrictions must be set on the choices of the sources and uses of finance[13].

We assume that the firms' debt stock B_t^F at the end of period t is restricted to a fixed ratio b to the replacement value of the firm's capital stock[14]. This imitates the practise of using the capital stock as collateral for loans, or a target debt-to-capital ratio:

$$B_t^F = bp_t^K K_t \ . \tag{2.7}$$

The other source of marginal finance is retained earnings or share issues. The dividends can exceed actual profits if the capital stock falls.

Determination of the firm's value is based on an arbitrage condition, which says that the expected after-tax yield on investment in firms' shares must be equal to the after-tax interest rate:

$$r_t^d(1-\tau_{t+1}^r)V_t = (1-\tau_{t+1}^D)D_{t+1} + (1-\tau_{t+1}^g)(V_{t+1}^E - V_t) \ . \tag{2.8}$$

where the left-hand side describes the returns when amount V_t is invested in bonds at the end of period t. Interest income is paid and taxed at the rate τ_{t+1}^r in the beginning of period $t+1$. Investment in firm's shares gives dividend income D_{t+1} and expected capital gains $(V_{t+1}^E - V_t)$, which are taxed respectively at tax rates τ_{t+1}^D and τ_{t+1}^g during the same period.

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[13] There are also restrictions in the real world, which mainly limit the amount of distributed dividends. Especially the practice of uniform reporting, which claims that the profit reported to shareholders must be equal to the one reported to tax authorities, has been relevant in the Finnish case. The implications of the practice is studied by Kanniainen and Södersten (1995). Repurchases of shares were not allowed in Finland before the tax reform.

[14] Another possibility would have been to use the market value of capital. This could have led, however, e.g. to situations where the amount of debt increases and the capital stock decreases. When the capital stock is valued at replacement cost, these anomalous situations are less likely.

Solving the equation (2.8) forward and ruling out bubbles gives the value of the firm as a discounted sum of tax-adjusted values of future dividends:

$$V_t = \sum_{s=t+1}^{\infty} \left(\frac{1-\tau_s^D}{1-\tau_s^g} D_s\right) \prod_{v=t+1}^{s} \left(1 + r_{v-1}^d \frac{1-\tau_v^r}{1-\tau_v^g}\right)^{-1} \quad . \tag{2.9}$$

The next step is to define the dividend policy. Let us start with the definition of the firm's after-tax earnings E_t^A:

$$E_t^A = (1-\tau_t^F)\left[p_t^F (F_t - G_t) - (1+\tau_t^l) w_t L_t^F - r_{t-1}^d B_{t-1}^F\right] + \tau_t^F d\, p_{t-1}^K K_{t-1} \quad . \tag{2.10}$$

The first term within the square brackets is the value added of the firm composed as a difference between the net production of the firm $p_t^F F_t$ and the investment adjustment costs $p_t^F G_t$, which are deductible in corporate taxation. Earnings are reduced by labour costs $(1+\tau_t^l) w_t L_t^F$ (wages and a payroll tax) and the interest costs of the firm's debt $r_{t-1}^d B_{t-1}^F$. The last term after the brackets is the depreciation allowance, which corresponds to the real depreciation. All other allowances are included by using an effective average corporate tax rate.

Gross production Y_t is a combination of value added and the composite intermediate good in fixed proportions:

$$Y_t = \frac{F_t - G_t}{1-\zeta} \; . \tag{2.11}$$

Value added is determined as the difference between net production F_t and the investment adjustment costs G_t. The corresponding price of the value added p_t^F is:

$$p_t^F = \frac{p_t^d - \zeta p_t^v}{1-\zeta} \, , \tag{2.12}$$

where p_t^d is the price of the domestic good, p_t^v is the price of the composite intermediate good and ζ is the input-output coefficient.

The production function (2.13) is a standard CES function of capital K_{t-1} and labour L_t^F:

$$F_t = A\left[\varepsilon K_{t-1}^{1/(1-\beta)} + (1-\varepsilon)(L_t^F)^{1/(1-\beta)}\right]^{\frac{\beta}{\beta-1}} \quad . \tag{2.13}$$

The investment adjustment cost function (2.14) is quadratic. The costs depend positively on the investments and negatively on the amount of capital:

$$G_t = \frac{\xi}{2}\frac{I_t^2}{K_{t-1}} \quad . \tag{2.14}$$

According to the new view the dividends are a residual from the firm's cash flow identity:

$$D_t = E_t^A + (B_t^F - B_{t-1}^F) - p_t^K I_t \quad , \tag{2.15}$$

where the sources of finance are after-tax earnings and an increase in the firm's debt. The proceeds are used to finance investment costs and the rest is distributed as dividends.

The end-of-period capital stock is the sum of investment during the period and the depreciated capital stock from the previous period:

$$K_t = K_{t-1}(1-d) + I_t \quad . \tag{2.16}$$

Firms choose the optimal amount of investment and use of labour to maximise the price of their shares. The problem can be presented as maximising in the beginning of period t the tax-adjusted dividends plus the value of the firm at the end of the period:

$$\text{Max}_{\text{L,I,K}} \quad \frac{1-\tau_t^D}{1-\tau_t^g} D_t + V_t \quad , \tag{2.17}$$

subject to the amount of the initial capital stock and conditions (2.7), (2.10) and (2.12) - (2.16).

The first order conditions for the maximum of the firm's value are as follows. In the optimum the firm employs labour until the value of the marginal product of labour is the same as the marginal costs (wage and social security contribution):

$$p_t^F F_{L,t} = (1+\tau_t^l) w_t \quad . \tag{2.18}$$

The second first order condition (equation 2.19) implies that investments should be carried out until the benefit from an additional unit of capital λ_t, equals the marginal cost of investment, adjusted for the effects of firms' financial policy. The strategy of financing the investments with retained earnings is reflected in the tax factor before the brackets. The marginal cost includes the price of a unit of the composite capital good p_t^K plus the tax-deductible change in the installation costs due to increase in investments.

$$\lambda_t = \frac{1-\tau_t^D}{1-\tau_t^g}[p_t^K + (1-\tau_t^F)p_t^F G_{I,t}] \quad . \tag{2.19}$$

Dividing both sides of (2.19) by the price of the capital and writing explicitly the change in the installation costs gives Tobin's marginal q:

$$q_t = \frac{\lambda_t}{p_t^K} = \frac{1-\tau_t^D}{1-\tau_t^g} + \frac{1-\tau_t^D}{1-\tau_t^g}\frac{p_t^F}{p_t^K}(1-\tau_t^F)\xi\frac{I_t}{K_{t-1}} \quad . \tag{2.20}$$

Assuming away the role of adjustments costs (the second term on the right-hand side in equation 2.20) gives an expression which is familiar to the new view analyses: the market valuation of the marginal unit of capital in the firm is the same as the ratio of the two tax terms. It has two interesting interpretations.

The first is that it is an arbitrage condition for the two possible uses of earnings: the amount p_t^K can either be distributed as dividends yielding after tax $(1-\tau^D)p_t^K$ or retained and invested, which gives an after-tax capital gain of $(1-\tau^g)\lambda_t$. The shadow value of the capital unit λ_t adjusts to preserve the equality when either of the tax rates changes[15]. In other words, the taxes are capitalised in the market value of capital. In our case there are also investment adjustment costs, which generate an additional difference between the price of the investment good and the tax-adjusted value of the capital unit in firm's use. The investment adjustment costs are deductible in the corporate taxation and priced with the price of value added. Another important issue is that since these investment adjustment costs are financed with

[15] Sorjonen (1988) suggests that the ratio of the two tax factors gives the relative market valuation of dividends and capital gains only if the effective corporate tax rates of distributions and retentions are equal. This holds in our case both before and after the tax reform, see for the justifications in Chapter 3.

retained earnings, dividend and capital gains tax rates affect also via this route to the shadow value of the new marginal capital unit and thereby also to the market value of old capital.

The second interpretation follows from the usual assumption that dividends are more heavily taxed than capital gains. It means that the firm's value is maximised when Tobin's marginal q is smaller than one i.e. the marginal unit of capital in the firm is valued in the markets less than the repurchase price. The critics of the new view note that in this case firms should never build new capital but acquire it via taking over other companies[16].

The link between the average and the marginal Tobin's q is:

$$\frac{V_t}{p_t^K K_t} = \frac{\lambda_t}{p_t^K} - \frac{1-\tau_t^D}{1-\tau_t^g} b \quad . \tag{2.21}$$

Equation (2.21) says that the average Tobin's q, which is formed by dividing the market value of the firm by the replacement value of the capital stock, is lower than the marginal one because of the partial debt financing (parameter b gives the debt-to-capital ratio in the model). This link has been derived using the homogeneity of production and capital installation technologies, see Appendix 1.

The q-theory investment equation (2.22) used in the model is a transformation of the equation (2.20):

$$I_t = \left(\frac{\lambda_t}{p_t^K} - \frac{1-\tau_t^D}{1-\tau_t^g} \right) K_{t-1} \left[\frac{1-\tau_t^D}{1-\tau_t^g} (1-\tau_t^F) \xi p_t^F \right]^{-1} . \tag{2.22}$$

The third first order condition (equation 2.23) describes the path of the shadow value of capital λ_t:

$$\begin{aligned} \lambda_t = \Bigg\{ & \frac{1-\tau_{t+1}^D}{1-\tau_{t+1}^g} \Big[(1-\tau_{t+1}^F)(p_{t+1}^F (F_{K,t} - G_{K,t}) - r_t^d b p_t^K) - b p_t^K + \tau_{t+1}^F d p_t^K \Big] \\ & + \frac{1-\tau_t^D}{1-\tau_t^g} b p_t^K (1 + r_t^d \frac{1-\tau_{t+1}^r}{1-\tau_{t+1}^g}) + \lambda_{t+1}(1-d) \Bigg\} \left(1 + r_t^d \frac{1-\tau_{t+1}^r}{1-\tau_{t+1}^g} \right)^{-1} . \end{aligned} \tag{2.23}$$

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[16] The life-cycle theory of firms, presented in King (1989) combines the trapped equity view to births of new firms and to expansion of existing firms either by acqusitions or by investments.

During periods of rapid growth of investments the shadow value of capital must be higher to cover the increased investment adjustment costs. When the investment boom fades, so does also the valuation of capital. The expected future loss raises the required initial marginal productivity of capital further[17]. This is most easily seen in the equation (2.23b) which is a simplified version of (2.23) assuming that there is just one good (with price 1), no taxes and no debt in the model:

$$F_{K,t} - G_{K,t} = (1 + r_t^d)\lambda_t - (1 - d)\lambda_{t+1} \quad . \tag{2.23b}$$

The left-hand side of (2.23b) describes the value of the marginal product of capital taking into account that an additional unit of capital reduces future investment adjustment costs by amount $-G_{K,t}$.

The effects of taxation on the optimal amount of capital stock can be studied by analysing the required pre-tax rate of return in a steady state, generated as a combination of equations (2.19) and (2.23).

$$\begin{aligned} p^F(F_K - G_K) = p^K\left[d + br^d + (1-b)r^d \frac{1-\tau^r}{(1-\tau^g)(1-\tau^F)} \right] \\ + r^d \frac{1-\tau^r}{(1-\tau^g)(1-\tau^F)}(1-\tau^F)p^F G_I + dp^F G_I \end{aligned} \tag{2.24}$$

The right-hand side of (2.24) is a sum of the depreciation and finance costs and investment adjustment costs of a marginal capital unit. Inside of the brackets is the depreciation rate d, followed by the interest cost of debt financed share of capital br^d and the cost of the share $(1-b)$ of the capital stock unit financed by retained earnings (see the similarity of the last term to the equation 2.6). The first term in the second row represents the after-tax costs of installation of a one capital unit, when they are financed by retained earnings. The last term describes investment adjustments costs associated to replacement investments.

The cost of retained earnings increases when the capital gains tax rate or the corporate tax rate is raised and decreases when the tax rate on interest income is raised. The dividend tax does

[17] see Auerbach and Kotlikoff (1987) p. 38.

not have any effect on the costs. The neutrality of dividend tax is due to the fact that even though it reduces after-tax revenues of capital, as can be seen in (2.23), it also diminish the costs of new capital unit, since the tax payments are saved, when earnings are retained. This can be observed by looking at the equation (2.19)[18].

It is important to note that the above mentioned implications of the role of taxation holds both to the financing of a new capital unit and the costs of installing the unit. The only exception is the corporate income tax, which is neutral from the point of view of installation costs, since they can be deducted from the tax base. The relative importance of the interaction between taxation and financing of the investment adjustment costs is emphasised by the fact that these costs are totally financed with retained earnings[19], but a major part of the purchasing price a new capital unit is financed by tax-neutral debt (in our calibration value of b is 0.6).

The terms of trade affect the required rate of return through the price of value added p^F and the price of the capital unit p^K, which is a composite of the domestic and the imported good. A rise in the relative price of the domestic good raises incomes from a unit of capital more than costs because part of the capital unit is imported.

It is useful to summarise the neutrality results in order to ease the comparison with other studies (see e.g. Turnovsky 1990). Dividend tax does not affect marginal investments when they are financed with retained earnings. If the acquisition cost of a new capital unit is financed totally with debt ($b = 1$), the corporate tax is neutral with respect to the optimal capital stock, but due to retained earnings finance of the investment adjustment costs, the personal capital gains tax and interest income tax are not, if the tax rates are not equal.

The fourth first order condition is a transversality condition ensuring that the discounted shadow value of capital goes to zero as time approaches infinity.

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[18] The tax multiplier in these equations is not from the same period, which has been interpreted that only a constant dividend tax is neutral. The neutrality applies, however, also in cases where the tax rate is changed unexpectedly permanently. This is because the neutrality is due to the expectation that the tax rate will be the same in future as it is in the current period. Correspondingly, expected future dividend tax rate change is not neutral.

[19] This assumption can be justified e.g. by the practise of financing the investment adjustment costs from the cash-flow of the firm and not from external sources, even though the costs are fully taken into account in the profitability calculations

2.2.3. Capital income taxation and the public sector

Balancing the budget

Any shift in tax rates has direct income effects on the public sector revenues. In addition, the tax change induces typically reactions of households and firms, and thereby affects market prices. The second round general equilibrium outcomes are often important for the actual incidence of taxation, but dampen usually the direct income effects. In any case, the policymaker must determine the rule how to balance the government budget.

Tax reform studies use often the assumption that the incomes and expenditures are balanced period-by-period with lump sum taxes and transfers. The method is also used in this study. It simplifies markedly the analyses since it allows concentration to effects of a single tax change at a time.

In reality policymakers have to either to balance the budget yearly with changes taxes or they may use temporary surpluses and deficits. Also the amount of expenditures can be adjusted. The idea to use debt finance is often linked to the policy objective of tax smoothing. We do not take this step, but note that it could be carried out using a numerical overlapping generations model[20].

Even though we analyse the impacts of changing tax rates of the existing tax system, some general ideas about the theoretical optimality of capital income taxation are useful to present. Bernheim (1999) provides an up-to-date review of the issue. The main message is that if certain conditions are met, the capital income tax should be zero in the long term in an overlapping generations economy. These conditions are that the government should have enough instruments to aim for intergenerational redistribution and that household preferences must be

[20] Broer and Westerhout (1993) used the value added tax rate to balance the budget in tax simulations. This practice generates, however, large variations in consumer prices and thereby to the intertemporal allocation of consumption. Therefore, they presented also a version in which the VAT rate has been smoothed. We have also used the VAT rate as the balancing variable in the tax reform simulations in Valkonen (1997). The large initial variation in the tax rate was mitigated by allowing the public debt to adjust in the first period.

weakly separable into leisure and consumption and homothetic in consumption. If the first condition is not met, capital income taxes can be used to adjust the capital intensity to correspond to the golden rule. Another interesting note is that the nested CES-structure in household preferences, used in the Auerbach-Kotlikoff-type model (like ours), does not meet the criteria of separability. Therefore we cannot draw firm conclusions about the optimality of taxing saving even in a closed economy version of our model.

Although the normative outcome remains unclear even in simple theoretical models, we see that savings are taxed in practise almost everywhere, and often progressively. This suggests that redistribution has been considered to be important. Another more practical issue is that a large difference between capital income tax rates and earned income tax rates tends to promote income shifting towards the lower tax base. This can be a problem already at the prevailing capital income tax rates of the Nordic countries, which are close to 30 per cent, but certainly more so, if there were no capital income taxation. .

Another important issue, which is often associated to the dynamic approach of government behaviour, is the credibility of tax policy. It is well known that from the point of view of efficiency it is always optimal to tax current capital stock once if private sector agents believe that the measure will never be repeated. We assume in our analysis that the simulated tax changes are permanent and that the agents have perfect foresight after the announcement of the policy measure.

Taxes and expenditures of the government in the model

The government collects taxes from domestic households and firms and uses the receipts to pay transfers to households, to pay labour costs of public sector workers and to service the public debt.

Funds are raised from households by taxing wages and pensions with rate τ_t^w, interest incomes with rate τ_t^r, capital gains on accrual with rate τ_t^g, dividends with rate τ_t^D and bequests with rate τ_t^n. Consumption is taxed with a value added tax at rate τ_t^c. The profits of the firms are taxed with a corporate income tax rate τ_t^F.

The expenditures of the government are the transfers S_t to households, the wages and social security contributions of the public sector employees $L^G(1+\tau^l)w_t$ and the interest payments of the fixed amount of government debt Br^d_{t-1}. The constant government labour force L^G produces free public good. The utility gained by consuming the good is constant and therefore do not affect the optimisation problem of the households. Both the wage rate and the social security contribution rate is the same in private and public sector.

Equation (2.25) gives the budget constraint of the government, which is balanced by the lump-sum transfers to households, as noted above.

$$\begin{aligned}&\left[(L_t^G + L_t^F)w_t + Z_t\right]\tau_t^w + r_{t-1}^d B_{t-1}^h \tau^r + (V_t - V_{t-1})\tau_t^g + D_t\tau_t^D + N_t\tau_t^n + C_t p_t^C \tau_t^C \\ &+ \tau_t^F\left[p_t^F(F_t - G_t) - (1+\tau_t^l)w_t L_t^F - r_{t-1}^d B_{t-1}^F - d\, p_{t-1}^K K_{t-1}\right] = S_t + L^G(1+\tau^l)w_t + B^G r_{t-1}^d\end{aligned} \tag{2.25}$$

Taxation of cross-boarder capital incomes

The effects of taxation of capital incomes in an open economy may differ markedly from the ones in a closed economy. It is well known that in a simple closed economy model it does not matter whether savings or investments are taxed: the created distortion is equal. In an open economy the issue is more complicated.

With free capital movements and world-wide residence principle followed in capital income taxation, the required rate of return of investments is the rate determined in international markets. The yield on saving is the same rate reduced by the domestic tax on savings, which might differ from one country to another. If, on the other hand, source principle is followed world-wide, the required rate of return on investments depends on the country-specific source tax rate, but in market equilibrium the yield on saving is the same after-tax rate everywhere.

Actual tax systems follow mainly the residence principle, but there are a lot of exceptions. The issue is even more complicated when there are restrictions on capital mobility or some other differences in the ability of investors to participate international capital markets.

In 1987, before the capital income tax reform started in Finland, the control of capital movements was still tight. Portfolio investments abroad were generally not allowed. It was also the first year when manufacturing firms were allowed to borrow freely from abroad. Foreign ownership of Finnish firms was limited due to regulation[21].

Our model follows these practises by restricting the ownership of domestic firms to domestic households. Therefore government can influence the required rate of return on investments by taxing the capital incomes of households. The rest of the household wealth is invested in bonds issued by government and domestic firms. The only capital movements allowed are foreign investments in domestic bonds. Since the tax system follows the residence principle, the generated interest incomes are not taxed at source. It means that a shift of bond ownership from domestic households to foreign investors reduces the tax receipts of the government.

The final step of the liberalisation of capital movements was carried out in 1993. Since then the foreign portfolio investments in Finnish stocks have increased rapidly. The interaction of taxation and foreign ownership depends on the nationality of the dominating investor. If domestic households own the majority of the shares of the firms, their taxes still contribute to the required rate of return on the investments. But if the foreign investors dominate[22], the capital income taxes levied on domestic households affect only the after-tax yield on saving and possibly the portfolio composition of the households. We have concentrated on the tax reform and omitted these interesting aspects in our study[23].

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[21] National accounts show that 15 per cent of dividends were distributed to foreign agents in 1987 (Myhrman et al. 1995).

[22] Sorjonen (1999) finds indirect evidence of the dominance of the foreign investors in 1993-1997.

[23] Bovenberg (1993) and Bovenberg and Goulder (1993) study investment-promoting tax policies using general equilibrium models which include limited cross-boarder ownership of capital. The results show that from the point of view of the welfare of the domestic households, investment tax credits should be used instead of corporate tax cuts. One of the justifications is that the latter transfers resources abroad due to tax capitalisation. See also Boadway and Bruce (1992) and Apel and Södersten (1999) for implications of corporate and capital income taxation in economies with divergent amount and combinations of international investments. In case of the new Finnish tax system the avoir fiscal system applies only to the dividends distributed by domestic firms to domestic households creating a disincentive to invest in foreign equities. This practise supports investments in multinational enterprises listed in Finland as means of diversifying portfolios internationally. Andersson et al. (1998) provides an extensive discussion about the international dimension of the Nordic corporate tax systems.

2.2.4 Markets

Labour markets

The model includes four markets, which balance every period. In the labour markets the firms demand labour according to the marginal productivity of labour rule. Households' aggregate labour supply is divided between public and private employment. The wage rate is determined by equating supply and demand.

$$L_t = L_t^G + L_t^F \quad . \tag{2.26}$$

Markets of the domestic good

In the domestic good market firms are the sole supplier. The product is used by other firms as a part of the composite intermediate and investment goods, by households as a part of the composite consumption good and by foreign agents. The demand of domestic agents and the prices of the composite goods are determined by a cost minimising procedure. The following describes as an example the procedure in the case of the consumption good, see e.g. Keuschnigg and Kohler (1994).

Minimising the unit cost (price) of a composite good p_t^C:

$$p_t^C = \min_{c_t^d, c_t^m} \left\{ p_t^d c_t^d + p_t^m c_t^m \right\} \ , \tag{2.27}$$

subject to a CES-form substitutability restriction (2.28):

$$\left[\upsilon^C (c_t^d)^{(1-\frac{1}{\sigma^C})} + (1-\upsilon^C)(c_t^m)^{(1-\frac{1}{\sigma^C})} \right]^{\frac{\sigma^C}{(\sigma^C-1)}} = 1 \quad , \tag{2.28}$$

gives the following optimal unit cost :

$$p_t^C = \left[(\upsilon^C)^{\sigma^C} (p_t^d)^{1-\sigma^C} + (1-\upsilon^C)^{\sigma^C} (p_t^m)^{1-\sigma^C} \right]^{1/(1-\sigma^C)} \quad . \tag{2.29}$$

Demand for the domestic good per unit of the composite consumption good is calculated by differentiating the unit cost function with respect to the price of the domestic good. The unit demand c_t^d is expressed as:

$$c_t^d = \left[\frac{\upsilon^C p_t^C}{p_t^d} \right]^{\sigma^C} . \tag{2.30}$$

The aggregate demand of the domestic good for consumption is $C_t c_t^d$.

The aggregate demand of the domestic good as part of the composite intermediate good ($\zeta Y_t v_t^d$) and composite investment good ($I_t i_t^d$) are determined in a similar way. The export demand determination requires, however, a closer explanation.

The model imitates a small open economy, where the export share of the total demand is large. The amount exported depends on the price elasticity of foreign demand:

$$X_t = x_t \left(\frac{p_t^d}{p_t^m} \right)^{\sigma^X} . \tag{2.31}$$

A large negative value for the elasticity σ^X implies that a small country has to adjust to the price level of international markets.

The equilibrium condition which determines the price of the domestic good is thus:

$$Y_t = \zeta Y_t v_t^d + C_t c_t^d + I_t i_t^d + X_t \quad . \tag{2.32}$$

Markets of the imported good

The domestic demand of the fixed-price imported good is also determined by minimising costs of the composite goods. The perfectly elastic supply m_t adjusts to demand in these markets:

$$m_t = \zeta Y_t v_t^m + C_t c_t^m + I_t i_t^m \quad . \tag{2.33}$$

The price of the imported good p_t^m serves as a numeraire in the model.

*Capital market*s

In capital markets savings and investment are balanced. The arbitrage condition of domestic households ensures that they are *ex ante* indifferent between investing their savings in bonds and in firms' shares. Foreign agents are restricted to participate bond markets only. Total savings are a sum of domestic savings and foreign portfolio investments. In the small open economy version the perfectly elastic supply of foreign capital guarantees the resources needed for investments. The case of imperfect capital movements is discussed more closely in Chapter 5.3. The parallel stock equilibrium can be written as:

$$W_t + H_t = V_t + B_t^F + B^G + A_t^f \quad . \tag{2.34}$$

where W_t is the household wealth, H_t is the (fixed) value of the pension fund assets, V_t is the market value of the firm, B_t^F is the stock of firms' debt, B^G is the (fixed) public debt and A_t^f is the net foreign assets of the country.

2.2.5 Calibration and solution

Calibration

The builder of a numerical general equilibrium model has to make choices in three levels. The most general of these is the structure of the model, determining e.g. which sectors, markets and institutions are included, how markets are balanced and how budget constraints are determined. The second level is the choice of functional forms of the model equations, e.g. household preferences and production technology of the firms. The third level is to choose the parameter values used in equations. This level approach is not unambiguous: one can sometimes shift from one structure or functional form to another just by choosing appropriate parameter values.

It is often assumed that the importance of those choices reduces when one comes from the general level to details. Some studies show, however, that the lower level decision can dominate the results[24]. On the lowest level the main problem is that the econometric estimates of the key parameter values vary largely depending on the data and methods used. Dynamic models have the additional difficulty that short and long term values for the parameters may be different. The users of numerical models address usually to this critique by carrying out limited sensitivity analysis [25]. In our case the sensitivity analysis covers important features in all the above mentioned levels. We study also the impacts of early announcement of the policy measures.

Another challenge for dynamic models is their treatment of history. We use the norm that the economy is in a steady state equilibrium at the calibrated period. The history of the economy is reflected in some stock variables, such as household wealth, capital stock, public debt and net foreign assets.

The previous section described the structure and the functional forms used in our model. This section concentrates on the calibration of the model to the empirical facts of the Finnish economy and especially on the choices of the parameter values. We justify here only the values of the most important parameters, the rest are listed in the Appendix 3. Sensitivity analysis of the parameters is reported in the Appendix 2.

As discussed earlier, the most important parameters from the point of view of household saving decisions are intertemporal elasticity of consumption and the pure rate of time preference. Unfortunately, there is a large variation in the estimated values of both the parameters. Furthermore, since one can generate the initial amount of consumption with unlimited

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[24] See Fox and Fullerton (1991). However, McKitrick (1995 and 1998) suggests that functional forms are more important than the parameter values.

[25] The problem with sensitivity analysis is that a change in one parameter value leads to a different original steady state of the economy. The problem has been tackled usually by ignoring the shift and reporting the results of sensitivity analysis in form of differences. The other possibility would be to change also other parameter values in order to restore the original steady state. The difficulty with this procedure is that there is a large amount of possible parameter combinations which should be tested before one gets a reliable view of the effects of single parameter. For other methods of checking robustness of the results see e.g. Harrison et al. (1993).

amount of combinations of those two parameters, the modeller has a lot of freedom to manipulate the intertemporal consumption decisions in the model[26].

The views of the generally agreed size for the intertemporal elasticity of substitution have converged towards lower values, even close to zero, due especially to the influential study of Hall (1988). On the other hand, the cross-sectional studies (see e.g. Blundell et al. 1994) generate markedly higher values than the time series studies represented by the one of Hall. Our choice for the parameter value is 0.5, which is a compromise between the results of the two groups and somewhat lower than the 0.9 used for Finland by Kenc and Perraudin (1996).

In an overlapping generations model in which the earnings profile is hump-shaped and pension incomes are limited, lower elasticity of substitution generates less steep savings profile and less aggregate household wealth. It means that the modellers are compelled to broaden the gap between pure rate of time preference and the interest rate in the economy in order to generate the observed amount of wealth. This problem is aggravated if there is a pay-as-you-go pension system or productivity growth and well functioning financial markets, which allow the households to borrow against future labour incomes.

In a financially closed economy, interest rate reacts to the imbalance of saving and investments alleviating the problem somewhat. Even if the model describes a small open economy, the modeller can assume a high international interest rate to encourage saving. But in most cases this choice leads to further problems due to implied too low investment rate. Therefore a very low or even negative parameter value for the pure rate of time preference has sometimes been used in the calibration process (see Auerbach et al. 1989).

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[26] This is has been noted by Frederiksen (1994).

We solve this saving problem by using fairly low parameter value (0.0185) for the time preference. Also the assumption of no growth helps to reach a reasonable value for household wealth/GDP (2.8) without raising the real interest rate to higher level than 3 per cent or without using the option of credit constraints[27].

In addition to the intertemporal consumption decisions, the households are allowed also to choose intratemporally the shares of domestic and imported goods in the composite consumption basket. The substitution elasticity used between those goods is 0.99. The value of the share parameter in the corresponding CES-function is adjusted to generate roughly the amount of imports observed in trade statistics.

Also the labour supply plan of households have both inter- and intratemporal dimension[28]. The intratemporal choice is between consuming leisure and goods. We have chosen a value of 0.75 for the elasticity of substitution. This value is again somewhat lower than the one used by Kenc and Perraudin (1996), but more in line with some other Finnish and international studies. The intertemporal allocation of labour supply is determined mainly by the age-specific efficiency in work, the rules of the pension system and the intertemporal elasticity of substitution of labour (which is in the model the same as the intertemporal elasticity of consumption). The efficiency profile in the model follows the earnings profiles described in the study by the Prime Minister's Office (1994). The modelled pension system encourages labour supply at the end of working career, but does not allow any work after the employee reaches the retirement age.

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[27] Another related issue is the existence of dynamically efficient steady state equilibria in the model. The point is that in an OLG model a market process can lead to overaccumulation of capital. In this regime many policy rules are reversed, e.g. usual dynamic budget constraint of government is no more valid. Larch (1993) studied the parameter values which might generate such a regime in a closed economy version of the Auerbach-Kotlikoff model. The results show that rather improbable parameter values are required. In our model the relevance of the question depends on the model version. With a small open economy assumption the model user sets exogenously both the interest rate and the growth rate of the economy thereby determining unambiguously the existence of efficiency. On the other hand, the more the domestic conditions affect the interest rate, the more there is room for interest rate to shift. We do not see, however, that this is a problem since with reasonable assumptions about the sensitivity of capital movements to interest rate differential there is no risk of ending up to inefficient equilibria unless the growth rate and the initial interest rate are set very close to each other. The existence of the efficiency in the new steady state can, of course, also be checked from the simulation results.

[28] Therefore the reaction of labour supply to a shift in the wage rate cannot be described by a single "elasticity" figure (see the discussion in Frederiksen 1994 or Altig et al. 1999).

In the CES production function of firms the central parameters are the share parameter and the elasticity of substitution between capital and labour. The value of the share parameter has been adjusted to 0.35 in order to yield the observed value-added shares of labour and capital incomes. With respect to the elasticity of substitution between the production factors, cross-sectional data generates again higher values than time series data. The Finnish studies (e.g. Törmä 1989 and Tarkka et al. 1990) yield somewhat higher values for the elasticity than the median value of 0.58 found by Rowthorn (1996), who surveys 33 studies. We chose the value of 0.8.

The model has just one type of capital, which is assumed to depreciate yearly by 9 per cent. The value of the investment adjustment cost parameter is set to be 2, which corresponds to the lower end of the available estimates (see e.g. Lichtenberg 1988 and Whited 1994). The ratio of the costs to value of GDP is somewhat more than 6 per cent in the initial equilibrium.

The price elasticity of exports for the five-year model period is -4. This is based on the value of -3.8 estimated by Tarkka and Willman (1990). The scale parameter describing export demand has been adjusted to generate the required exports/GPD ratio. The elasticity of substitution between the domestic and the imported good has been chosen to be 0.99 also when firms consider the composition of investment and intermediate goods. It can be contrasted to the elasticity of aggregate imports (0.78) estimated by Tarkka and Willman (ibid.).

We present below in the Table 2.1 some indicators of the calibrated initial equilibrium.

Table 2.1 The initial equilibrium (ratios of values, per cent)

Flows		**Stocks**	
Private consumption/GDP	58	Capital stock/GDP	234
Investments/GDP	23	Household wealth/GDP	280
Exports/GDP	25	Net foreign assets/GDP	-13
Taxes/GDP	43	Public debt/GDP	6

One should note that in spite of the model building and calibration efforts, the description of the economy is simplified, as usual in dynamic numerical general equilibrium models. This

must be considered when the quantitative results of the simulations are interpreted (also Keuschnigg and Kohler 1994 and Fehr 1998 warn of too strict of an interpretation).

Solving the model

The FOG model is solved by two steps. The first step is to find out the initial steady state (or a steady growth path, if there is growth in the economy). This is solved by using a separate steady-state version of the model. The results are next transferred to the main dynamic model to describe the time path of the economy before the policy measure.

The second step is to implement the tax reform and to solve the main model by iterating the two segments of the model. First households' life-time labour supply and consumption are solved keeping prices, wages and interest rates fixed. The aggregated numbers are transferred to the other segment, which consists of firms, public sector, foreign agents and the market equilibria. Solving the dynamic problem of this segment with Fair-Taylor algorhitm (Fair and Taylor 1983) gives new prices, wages, interest rates and the balancing variables for public sector. The solution path for the dynamic problem that fulfils the perfect foresight expectations is looked for with a following procedure. First the model user gives a guess for initial values of the variables describing future expectations. Thereafter the period-by-period equilibria are calculated. The solution gives new values for the expectation variables, which are used to modify the initial guesses. This process continues until the values of the expectation variables do not change[29]. The iteration between the segments is continued until the equilibrium has been found[30].

One additional issue is that one cannot be sure about the uniqueness of the solution. Laitner (1990) have re-examined the results of the Auerbach-Kotlikoff model. The method based on marginal analysis allowed him to study also determinacy and stability of the model. Laitner could not find problems. The conclusion is supported by findings of Lappeteläinen (1995). This is comforting outcome, even though it cannot be generalised directly to other similar models. We have not either found any indications of multiple equilibria.

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29 See Lassila, Palm and Valkonen (1997a) for more details.

30 The segmental solution procedure is adopted from Broer and Westerhout (1993).

3. THE FINNISH TAX SYSTEM BEFORE AND AFTER THE CAPITAL INCOME TAX REFORM

3.1 The earlier tax system

Our aim is not to describe the very details of the earlier tax system here, but to give a general idea of the way the system affected decisions of households and firms and to "guesstimate" the relevant tax rates before the reform. The way to proceed is chosen due to the extreme complexity of the earlier system and the lack of statistical tax data to evaluate the tax rates with satisfactory precision. The somewhat vague starting-point description implies that the results should be interpreted as being more pedagogical than quantitatively accurate[1].

The statutory corporate income tax rate was very high before the reform (on average 50 per cent in 1987), but generous allowances like inventory and investment reserves and accelerated fiscal depreciation considerably reduced the corporate taxes collected. The double taxation of distributed profit was alleviated at the firm level also by allowing a 40 - 100 per cent dividend deduction in state taxation[2].

In the simulation model the depreciation allowances of the firms are assumed to correspond to the true economic depreciation and all other tax allowances have been included by using average effective corporate tax rates. So we do not consider separately e.g. the effects of tax

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[1] One should also remember, when comparing the model results and the actual behaviour of the private sector after the reform, that other profound structural reforms were also implemented at the same time of the tax reform.

[2] Another remarkable point is that the investments were supported by the strict regulation of financial markets, which was geared to keep the real interest rate low. The necessary saving for corporate investments was carried out by the firms themselves, by the pension funds and by the central government, which kept its budget mostly in surplus.

debt on the cost of capital. Myhrman et al. (1995) use average tax rates of 25 per cent to describe the tax burdens of both distributed and retained earnings before the tax reform. The 25 per cent tax rate for retained earnings is the average of the years 1981-1990 from the non-financial sector. The yearly variation and variation between firms was large[3]. The corporate income tax rate on dividends distributed on new equity, also 25 per cent (when the source of distribution was the fiscal period income), was low because of the dividend deduction system. We use the same 25 per cent corporate income tax rate in our simulations as the one prevailing before the reform.

At the household level the main principle was to tax capital income at the marginal rates of personal income taxation. The top marginal rate exceeded 70 per cent. The statutory marginal tax rates were, however, seldom applied to capital income due to the substantial use of non-taxed assets. The tax-exempt ceilings in personal capital income taxation[4] lowered average tax rates and abolished totally the tax burden from minor capital incomes.

The market for interest-bearing assets were dominated by banks. They collected funds for their lending by tax-free deposits yielding a regulated low interest rate. Households were encouraged to invest in the bank accounts by the fact that it was a precondition for receiving low interest rate housing loans. The small public debt was financed mainly by tax-free bonds. Hence, the possibilities to invest in taxable deposits and bonds were strongly limited[5]. The average effective interest income tax rate was, in fact, negative due to the possibility to deduct a given amount of interest expenses in personal income taxation. Taking also into

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[3] The theoretical analyses of Kanniainen and Södersten (1995) suggest that the corporate tax rate has no effect on the cost of capital when firms have unused tax allowances. The reason for the observed low utilisation ratio of allowances in the Nordic countries is the close connection between taxable and reported book profits. The degree of tax exhaustion has been negatively correlated with the performance of the firms, see Virolainen (1998). Also Ylä-Liedenpohja (1987) claims that for those firms the corporate tax from the point of view of investments was a lump-sum tax paid in order to be able to distribute dividends.

[4] The tax-exempt ceiling for interest incomes was FIM 3800 per person, for dividends FIM 5200 per person and for rental income FIM 7200 per person, while the aggregate tax-free tax-exempt ceiling was also FIM 7200 per person, see Airaksinen and Hagfors (1987). Because the tax statistics do not provide enough information to find out the utilisation of the tax-free quotas of various types of capital incomes, the evaluation of exact marginal tax rates is impossible.

[5] The amount of taxable interest incomes was only FIM 585 mill. (see Statistics of income and property, 1989) before taking into account the tax-exempted quota, while the assets were about FIM 180 bill. (according to Rantala 1998) and the 5-year bond market rate was nearly 11 per cent.

account the tax-exempt ceiling for interest income, the marginal and average tax rate applied in the model to interest income before the reform is chosen to be zero.

Capital gains from financial assets were also exempt from taxation if the holding period exceeded five years. Large capital gains were partly taxable also after that, but the tax could be avoided by realisation of the gains during several years[6]. We therefore assume that the tax rate in the model was zero before the reform.

The marginal average dividend tax rate, 13 per cent for the year 1987, was calculated as follows[7]: Statistics of income and property (1989) gives the number of persons, amount of taxable capital incomes and aggregate deductions used in 22 income brackets. It has been assumed that in each bracket the capital income deduction was first used to reduce the taxable interest and secondly to decrease the taxable dividend income. If the deduction had been used first for the interest income and next for rental income and the rest were used to reduce the taxable dividends, the marginal tax rate for dividends would have been 31 per cent. This represents the maximum of the average marginal tax rate.

The above mentioned tax system and the undeveloped and strongly regulated financial markets generated strong implications for investment and the financial strategy of firms and the saving and portfolio allocation decisions of households. The regulated low interest rate maintained a high investment rate. The tax allowances and the endogenous adjustment of financial strategies eliminated largely the effects of the high statutory tax rates on the cost of capital, but created other distortions. In addition, the extensive possibilities for earnings adjustments strengthened cyclical fluctuations by lowering the taxes paid by companies in boom years (Myhrman et al. 1995). Business fixed investments were financed almost entirely by retained earnings and loans from banks and insurance companies. Therefore the indebtedness of firms was heavy and the distributed dividends were small.

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[6] 20 per cent of the yearly sales profit above FIM 1 mill. was added to taxable income. The profit was assumed to be not more than half of the selling price (Airaksinen and Hagfors 1987).

[7] These calculations were provided by Pasi Sorjonen. See also Ylä-Liedenpohja (1987). Koskenkylä (1987) claimed that more than 90 per cent of dividend recipients paid no tax on their dividend income. The Ministry of Finance (1987) evaluated that this share was 60 per cent. Anyhow, the high share supports the use of low marginal dividend tax rate in the model.

Household wealth was invested mostly in owner-occupied housing and bank deposits. The share ownership of firms was institutionalised. The household saving rate and sensitivity of saving to changes in nominal interest rate was low (or ambiguous, see Koskela and Viren 1994).

As mentioned above, the ideal of neutrality and the aim to improve the international competitiveness of the tax system were the main driving forces in the tax reform. From the point of view of this study, especially the statement that double taxation of dividends should be abolished is important (in fact the Committee also stressed that single taxation should be guaranteed, see Ministry of Finance 1987). It refers clearly to the old view argument (see Chapter 2.2.2) in the justification of the tax reform. The observations of Sorjonen (1988) support the view. He proposed that the applied dividend deduction system lowered the corporate tax rate for distributed earnings below the tax rate of retained earnings, which more than compensates for the deprivation due to the personal level tax discrimination of dividends. The evidence provided by Kanniainen (1991b) shows that before the tax reform the pay-out ratio of firms was stable, which is also in line with the old view argument.

Our interpretation is, as stated above, that the new view describes more reliably the financial strategy of the firms before the tax reform. This is supported by the tax rate calculations of Myhrman et al. (1995) and in the case of high income earners also the ones by Ylä-Liedenpohja (1990). Further evidence in favour of the new view is the observed negligible role of share issues in investment finance and the low dividend distribution rate, see Kanniainen (1991b) and Virolainen (1998)[8].

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[8] Kanniainen (1991a) analyses the Finnish case using the implications of the Miller equilibrium (Miller 1977). The basic idea is that the bonds of firms are first sold to investors with low marginal tax rates. When they have invested all their available money, the bonds are sold to investors in the next tax bracket. The process continues until in the ensuing segmented Miller equilibrium the marginal cost of debt and equity is the same for the firms and so is the yield to the marginal investor. If demand for finance increases, the interest rate must rise in order to persuade investors in higher tax brackets to enter markets. The theory runs into problems if interest rate is determined abroad and with flat tax rates. In general, the econometric evidence of the relation between taxation, the financial structure of firms and investments in Finland have been mixed, see e.g. Kanniainen and Airaksinen (1989), Virolainen (1990, 1998), Dufvenberg et al. (1994) and Brunila (1994).

3.2 The new tax system

The main reforms of the tax system were carried out during the years 1987 - 1993, i.e. there was no "big bang" but instead a gradual implementation. The elements of the reform are: the broadening of tax bases and the lowering of tax rates from 1987 onwards, the adoption of an avoir fiscal system in corporate income taxation (1990), the introduction of source taxation of interest income (1991), the separation of taxation of earned income and capital income[9] and a major corporate income tax reform (1993). The tax rate is now 28 per cent[10] (in the case of no inflation) regardless of whether the tax base is rental income, interest income, dividend income, capital gains[11] or corporate income. The withholding tax on interest incomes does not apply to foreign investors.

In the avoir fiscal system the corporate tax paid on distributed earnings can be deducted in the dividend taxation of domestic households. Because the corporate tax rate and the personal dividend tax rate are equal and there is full imputation, the effective dividend tax rate for a private individual is zero[12]. In corporate taxation the effective rate is now close to the statutory rate because most allowances have been abolished and possibilities to use accelerated tax

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9 Separation of the two incomes are not complete. Interest expenditures from housing loans are deductible in capital income taxation, but if there is not enough taxable capital income, expenses can also be deducted (with an upper limit) in labour income taxation. Another exemption is that capital income and even wealth are considered when some means-tested transfers and payments for public services (like day-care) are determined.

10 The tax rate was raised from the original 25 per cent to 28 per cent in 1996.

11 After the reform the presumed acquisition costs used in taxation was 50 per cent of the selling value, if the asset was purchased before 1989. The reason for this relatively high assumed purchasing price was to alleviate the effects of the hike in taxation during the transition period. It lowers the effective capital gains tax rate below the statutory rate on gains exceeding 100 per cent. Our analysis shows that the tax reform does not generate such a revaluation. The impact of the appreciation of assets accruing before the reform and not realised cannot be measured and are omitted from the analysis.

12 The imputation system is applied both to listed and to unlisted incorporated companies. For the unlisted companies the 28 per cent dividend tax rate is applied up to the amount of distribution (dividend before the corporate tax) corresponding to a 13.5 per cent yield on the net wealth of the firm. Higher dividends are taxed at marginal tax rates of personal taxation (but receives the imputation), which has motivated some shareholders to retain earnings markedly above the quota (Kari 1999a provides a thorough analysis of the investment and financial decisions of the unlisted companies in the new tax system). We concentrate on the effects of the reform on listed companies. Another limitation is that we do not include in the model the system of compensatory taxation and tax surpluses, which allows for a tax-free smoothing of the dividend distribution over the business cycle and guarantees that the distributed profits are taxed once.

depreciation rates have been reduced. Therefore the tax neutrality between industries has also increased. The corporate tax rate is the same for both distributed and for retained earnings.

The shift from a sales tax to a value added tax was implemented in 1994. After that purhases of new investment goods were allowed to be totally deducted from the VAT base. We were not able to incorporate this feature in our model.

The following table describes the tax rates used in the analysis before and after the tax reform.

Table 3.1 Effective tax rates before and after the reform

	before	after
Corporate tax	25	28
Interest income tax	0	28
Dividend tax	13	0(28)
Capital gains tax	0	28

The tax reform is thereby modelled as a large and equal rise in the interest income and capital gains tax rates, a considerable reduction in the dividend tax rate and a minor hike in the corporate tax rate. From the point of view of the different theories of corporate finance, the most interesting feature of the reform is the shift to the full imputation system in which capital gains are taxed more than dividends. But from the point of view of household saving, the hike in interest income taxation is the most important.

Two additional notes of the application of the reform to the model should be made. It has been assumed that the tax system is proportional in the model. This causes no problems in the case of the new capital income tax system, but in the old system the average rates were most likely lower than the marginal rates. We use the marginal rates of personal capital income taxation also as average rates. On the other hand, the average corporate tax rate is used as a marginal rate. Therefore the tax proceeds in the model deviate from the amounts observed empirically in the case of personal taxation and there is some ambiguity concerning the

incentive effects of corporate taxation in the model. We cannot measure the importance of these features since there is not enough data, but it is most likely not too high.

The second qualification is more fundamental. We have assumed that the whole capital stock of the economy and its finance are subject to the tax rules described above. When we know that a large part of the capital stock is outside of the business sector (mostly in housing) and, in addition, part of the rest is used by unincorporated firms which follow somewhat different tax rules, the simulations overstate the macroeconomic and welfare effects of the reform. Also, the fact that firm ownership is mainly indirect (other companies receive most of the dividends) blurs the impacts of taxation. Other institutional investors, such as pension funds, invested mostly in corporate loans at the time of the tax reform.

The scale critique applies also to the modelling of interest income, which is also tax-free in the new system if the money is kept in regulated low interest rate deposit accounts. On the other hand, this exception is to be abolished in the year 2000. In addition, tax-favoured private pension saving, which was small before the tax reform, has increased, but does not play any significant role in aggregate household wealth (Kari 1999b). These qualifications must be kept in mind when interpreting the results.

4. THE CHANGES IN THE TAX RATES ONE BY ONE

4.1 The overall setting of the simulations

A typical tax reform includes a large amount of policy actions, which possibly strengthen or dampen each others' effects, but in any case complicate the interpretation of the results. Therefore, even though we have strongly simplified the features of the Finnish corporate and capital income tax reform in the simulations, it is useful to consider first the outcomes of the changes in tax rates one by one and to study the aggregate effects later. In addition, even if the results of individual measures cannot quite be aggregated to produce the outcome of the overall reform, they can be still used to evaluate the contributions of the single measures[1].

Before going into the details of the simulation results, we present some of the most important options used in the base case simulations. The first option considers the way in which the openness of the economy is modelled. The basic assumption is that the price of the imported good is fixed but the price of the domestically produced good is determined by price elastic supply and demand. The domestic interest rate is fixed to an exogenously given foreign interest rate due to the risk-free, free-of-charge cross-border movements of interest bearing assets. The sensitivity of the results to these assumptions can be checked from Appendix 2.

Another point is that the policy measures in the base case are unanticipated when introduced, but we compare these results to those of an expected policy measure. It is well known than there are planning, decision making and implementation lags in tax reforms. The possibility

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[1] In addition to the impact of missing interaction of various taxes there is also tax planning, arbitrage and avoidance connected to the changes in individual tax rates. These reactions might be different in the case of aggregate reform. Tax avoidance behaviour has been studied e.g. by Feldstein (1995) and Gordon and Nielsen (1996).

of reacting to the reform beforehand can markedly change the short-term results in a model in which the decision makers have perfect foresight and forward-looking behaviour. The long-term outcomes are, however, identical[2].

The budget of the general government is balanced by lump sum transfers, which are distributed equally to household generations. We know that this type of policy is not applied in practice, but the aim is to concentrate on the effects of a tax rate change one at a time. This assumption is important when there are large variations in time in some tax bases such as in capital gains. The tax structure and the tax rates correspond to those prevailing before the tax reform, i.e. the initial tax distortions due to the capital income tax system are small.

The actual outcomes of the tax reform in terms of tax revenues are not easy to evaluate, since after the reform there has been rapid growth in capital incomes due to the recovery of the economy from the deep recession. Also the income share of capital in production has increased strongly. On the other hand, the interest rate is much lower. All in all, it is very likely that the outcome is an increase in tax revenues, at least in the short and medium term.

Finally, these simulations assume that firms follow the new view in their financial strategy. As explained in the previous section, this means that the marginal investments are financed with retained earnings and debt, and dividends are determined as a residual from the cash flow of the firm. Also the investment adjustment costs are financed with retained earnings. The choice of the financial strategy is important when dividend or capital gains tax rates are changed. As noted earlier (Section 3.1), the official justifications for the Finnish tax reform were based more on the old view, but they are not convincingly supported by the details of the previous tax system and the actual behaviour of the firms.

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[2] The tax rate changes are known to be permanent. Elder (1999) studies uncertainty about the duration of a tax cut in an Auerbach-Kotlikoff model. The author shows that short-term reactions of the economy depend largely on the expected duration but long-term outcomes on the actual duration of the tax cut.

4.2 A higher corporate tax rate

An unexpected increase in the tax rate

The role and effects of corporate level taxation of profits depend largely on the details of the tax system. In this study the tax rules are very simple, because the main interest is on the effects of tax rates changes on the cost of capital financed with equity. Therefore, we leave out the effects of accelerated tax depreciation or inflation and determine the depreciation allowance in the model to correspond to the actual economic depreciation of the capital stock[3]. Since there are no pure profits or foreign ownership in the model either, the justifications mentioned in Section 2.2.2 for corporate level income taxation are not valid.

As explained in more detail in the previous section, the tax reform raised the effective corporate income tax rate somewhat. We first study the effects of an unexpected hike in the tax rate from 25 percent to 28 per cent. The effects are presented in Table 4.1 and Figure 1. The measure is implemented unexpectedly at the end of period 0. This allows for a comparison with the effects of the same tax hike, when it is announced at the end of period 0 and implemented at the end of period 1 (after five years).

A hike in the corporate tax rate reduces the amount of both distributed and retained earnings from the point of view of the shareholder and therefore lowers the value of the firm's shares. Raising the tax rate also increases the required return on the proportion of capital financed by retained earnings (a partial equilibrium calculation shows that it rises by an amount of $(1-b)\times r^d \times 0.06$, which means that the increase in tax distortion is limited, see section 6.1). While the proportions of debt and equity are fixed[4], the overall return must rise, which calls for a permanently lower capital stock. The initial reaction of investment is subdued by the investment adjustment costs.

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[3] We are well aware of the possible "tax paradox" (a higher corporate income tax rate lowers the cost of debt finance due to accelerated tax depreciation), but have to ignore it. The reduction of tax allowances in the new system have limited the importance of tax debt, see the evidence in Virolainen (1998). It should be noted, however, that reducing the possibilities of accelerated depreciation have moved the corporate tax systems further away from the theoretically preferable cash flow taxation (Haufler 1998).

[4] The hike in the corporate tax rate creates an incentive to shift to debt finance, but it has been assumed that the debt-to-capital ratio is already at the maximum value set by the lenders.

Table 4.1 Corporate income tax hike

	5 years	10 years	20 years	50 years	150 years
Private production	0.0	-0.1	-0.3	-0.4	-0.4
Imports	-0.3	-0.3	-0.2	-0.1	0.0
Exports	0.7	0.3	-0.2	-0.7	-0.9
Private consumption	-0.2	-0.1	-0.1	0.0	0.1
Investment	-0.4	-0.5	-0.6	-0.7	-0.7
Consumer price	-0.1	-0.1	0.0	0.1	0.2
Wages	-0.2	-0.2	-0.2	-0.1	-0.1
Employment	0.0	0.0	-0.1	-0.1	-0.1
Current account surplus/GDP	0.2	0.1	0.1	0.0	0.0
Terms of trade (producer price)	-0.2	-0.1	0.0	0.2	0.2
Household wealth	-1.6	-1.1	-0.7	-0.2	0.0

In Table 4.1, the current account surplus/GDP variable describes the relative deviation from the original equilibrium in percentage points, while the other variables describe per cent deviations. An improvement in the terms of trade is presented as a positive number. Household wealth is measured in the first column in the beginning of the period to illuminate the initial tax capitalisation effect. The above notes apply to all tables in this study.

Since the actual value of the financial wealth of households is now lower, but the amount of optimal wealth has not been changed, current households increase saving. Aggregate household wealth increases gradually also because in each period there will be a new household generation, which has a fairly similar lifetime savings profile as the current ones had before the tax reform. A larger part of the additional wealth is invested in bonds due to the diminished market value of domestic firms.

The initial fall in consumption and investment and the slow downward adjustment of domestic production lead to an excess supply in the market for the domestic good, which low-

ers its price, see Figure 1E on the next page[5]. The adjustment to excess supply occurs both via increased exports and the more extensive domestic use of the home good. The resulting current account surplus reduces the foreign net debt of the economy.

The path of the goods price dampen the saving and investment effects of the tax hike. The fall in the price of the composite consumption good and the knowledge that the price will be higher later reduce households' incentives to save in the first few periods (see Bovenberg 1989a for a detailed analysis of the consumption interest rate). The corresponding price paths of the composite investment good and the domestic production tend to increase investment. This is because investment goods are purchased at a lower current price and final goods are sold later, when the price is higher.

Improved terms of trade also support the profitability of domestic production by raising the price of output while the price of the imported part of the investment good and the intermediate good remains unchanged.

While the domestic capital stock and production adjusts gradually to the lower optimal level and consumption revives, the price of the domestic good rises. The smaller capital stock reduces the marginal productivity of labour and the wage falls.

The welfare measure in Figure 1H reflects largely the capitalisation of the higher corporate tax on share prices and the limited lifetime of households. The currently living generations suffer a welfare loss due to the fall in stock market prices. The oldest lose most because shares compose a large part of their wealth and they have the shortest time to adjust.

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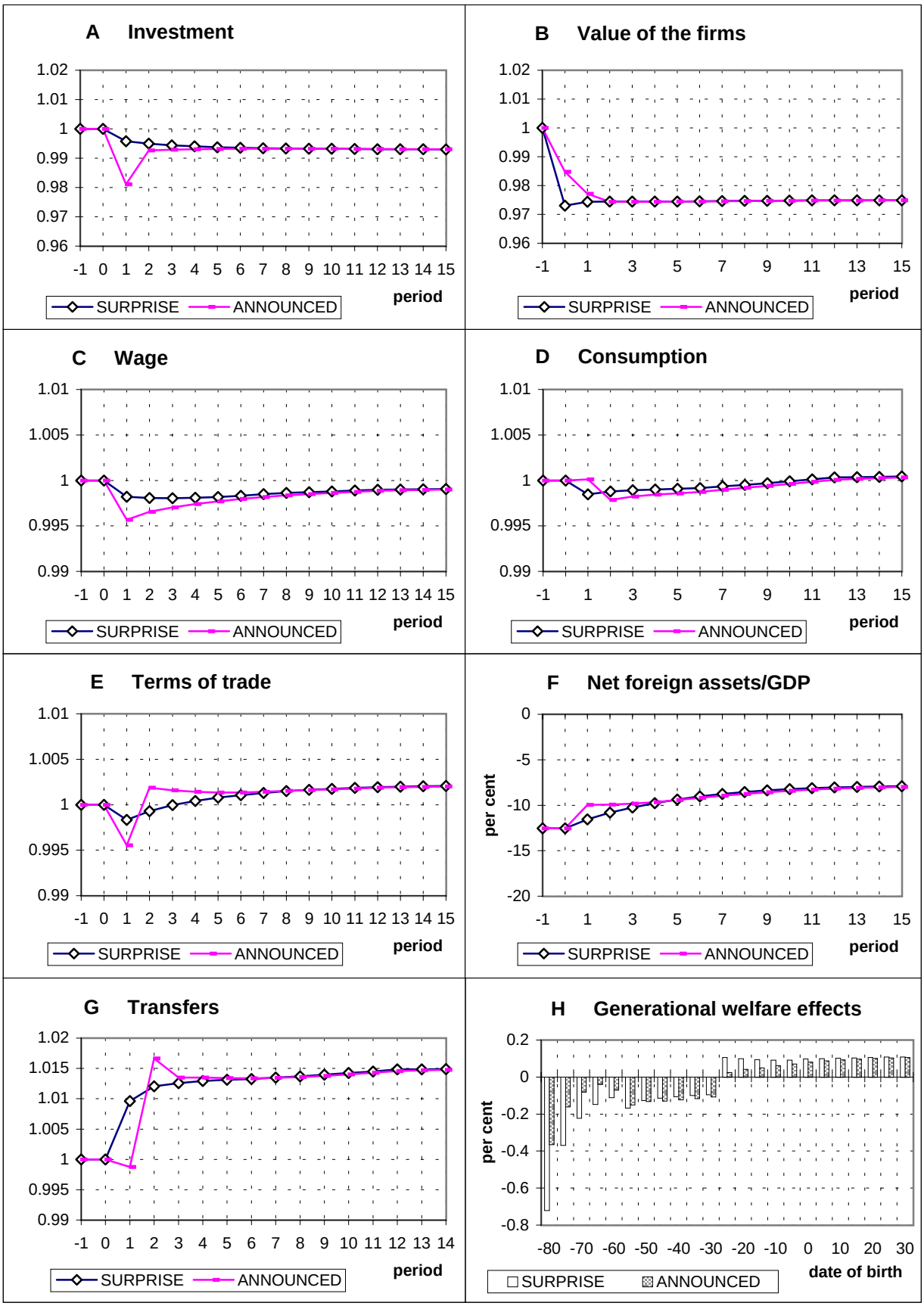
[5] The simulation figures should be interpreted as follows. Figures A - E and G describe percentage deviations from the initial steady state. The number -1 depicts the initial steady state. The unexpected tax change and the announcement of a future tax change is implemented at the time point 0, which is just before the first period starts. Stock market prices and thereby household wealth are the only variables that react immediately. One period is five years, so the time span of Figures A - G is 75 years. The utility measure in Figure H shows relative compensated variations by generations. They are measured as logarithmic differences between the new discounted lifetime consumption expenditures and the consumption necessary to achieve the baseline utility at the new prices. Therefore, positive numbers express a welfare gain.

Figure 1 The effects of raising the corporate income tax from 25 per cent to 28 per cent



Furthermore, the only means of adjusting for retired households is to smooth their consumption paths by saving or dissaving. This implies that the amount of the welfare loss for these generations is especially sensitive to the intertemporal substitution elasticity of consumption. Future generations gain from the reform because they can consume both leisure and the consumption good more than before the tax hike. They can afford to consume more due to higher government transfers, which are financed by the larger corporate tax revenues.

It is important to note that even though firms will pay more taxes in the future, the lower price of the shares compensates for this and the after-tax rate of return to future investors from share ownership does not change. This is how the tax reform transfers resources via tax capitalisation to future generations.

We are well aware that there are difficult problems associated with the aggregation of overall welfare impacts of the reform (for the discussion on weighting the welfare of various generations see e.g. Calvo and Obstfeld 1988). One simple way to proceed is to calculate a discounted sum of income transfers, which would compensate the welfare shifts of the domestic households. We use the domestic interest rate as the discount rate to depict the cost for the government of distributing the transfers in different points of time. The discounted sum is related to the value of GDP before the reform. This method has been used also by Broer and Westerhout (1993).

The numbers calculated this way confirm the outcome seen in Figure 1H. The discounted sum of the losses of current generations is 0.4 per cent of GDP and the gain of future ones is 0.3 percent of GDP, which means that the measure reduces the aggregate welfare of the domestic households.

In addition to the intergenerational resource transfer described above, there is also an international transfer of welfare generated by the permanent improvement in the terms of trade. Broer and Westerhout (ibid.) measure the compensating income variation using a discounted sum of shifts in consumer surplus. They measure the total transfer abroad as:

$$T = \sum_{t=1}^{\infty} \left[\frac{1}{1-\sigma^X} \left(p_{t+1}^d X_{t+1} - p_t^d X_t \right) \right] \prod_{s=0}^{t} (1 + r_s^d)^{-1}, \quad (4.1)$$

where σ^X is the price elasticity of export demand and the term inside the brackets is the increase in the value of exports in two successive periods. We approximate the infinite sum by summing up the transfers of 45 periods (225 years). This approximation does not affect our interpretations in any of the simulations, since the discounted value of the period 45 income transfer is extremely small.

In the case of the corporate tax rate hike, the transfer related to the value of GDP is 0.01 per cent. The overall outcome is that since the reform generates a small efficiency loss due to the increased distortion of the investment decision, the gain of future domestic household generations is based on the losses of other households, domestic and foreign, and cannot be used as a justification for the tax hike.

An expected increase in the tax rate

Since tax reforms are often discussed largely before their implementation, the private sector already reacts to the expected reform. The policymaker can use these reactions to modify the intergenerational and international welfare shifts generated by the reform. In any case, it is important to be aware of the possible announcement effects. Therefore, we simulate the same hike in the corporate income tax rate announcing it one period before the actual change is implemented. Timing the measure differently does not change the long-term results of the reform when the general government budget is balanced period-by-period and there is no growth.

The first period decision problem of the firms now changes profoundly. In the case of an expected corporate income tax hike, it is optimal to try to shift profits from future periods to the current period. The only way to adjust is to reduce investment immediately and distribute more profits as dividends[1].

[1] If the firm finances marginal investments with share issues, the increased profits will be distributed less via dividends, but more via share repurchases. Otherwise the results are similar.

The simulation results show that the incentive is so strong that investment undershoots the steady state optimum level[2], see Figure 1A on page 54. It is likely that if firms were allowed to freely vary their debt position, they would finance the extra dividends with debt and react less with investment.

While the amount of production and consumption do not markedly change in the first period, the lower investment demand increases pressures to export more. The market for the domestic good balances therefore at a considerably lower price, which is also reflected in the labour market as a fall in the marginal product of labour and a lower wage rate. These effects are similar as in the unexpected case, but stronger (see Figures 1C and 1E on page 54).

The initial fall in the value of the firm is now smaller, because the profitability of the firm's production has not yet changed. The stock market value continues to descend and has adjusted almost to the new steady state level at the end of the first period. From the point of view of the welfare effects of the tax reform, only the initial reduction is important because the higher dividends in the first few periods compensate for the fall in the share prices and investment in the firm's shares continues to yield the required rate of return determined by the arbitrage condition.

Figure 1H shows that, since there are just a few future generations which do not gain as much in the anticipated case, announcing the reform lowers the initial negative effects. The discounted sum of the compensating transfers for the current generations is, indeed, smaller, i.e. 0.3 per cent of GDP. Correspondingly, the future gain declines to 0.2 per cent of GDP. Again, since we know that the tax hike increased the distortion in the firm's investment decision and therefore reduced efficiency, we can deduce that the long-term gains from the reform are caused by the intergenerational and international[3] welfare transfer to future domestic household generations.

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[2] Goulder and Summers (1989) note that the anticipated reduction in the corporate income tax rate leads to initial overshooting of the investment rate. They explain this by the expected reduction in the present value of tax savings from depreciation deductions of new investments (investment finance with tax debt will be cut). Our results show that this reaction is likely to appear independently of the possibility of accelerated tax depreciation.

[3] Sensitivity analysis with small open economy assumptions shows much smaller welfare gains to the future domestic households, see Appendix 2.

4.3. Introduction of an interest income tax

An unexpected increase in the interest income tax rate

The measure studied next is an unexpected hike in the interest income tax rate from 0 to 28 per cent. This measure is symmetric in the sense that it also generates a possibility to deduct interest expenditures in household income taxation.

It turns out that the effects of the measure depend largely on the openness of the economy and the ownership of the domestic firms. In our small open economy, in which the domestic households own the firms, a hike in the interest income tax has similar impacts on saving and on the required rate of return of equity investments as a fall in the domestic interest rate[4].

The higher tax rate has an initial impact via four channels. The first is via a lump-sum income change: the higher tax rate reduces the after-tax interest flows and increases the tax receipts of the government in the first period. It does not cause any distortions since the interest flows are based on the debt stocks inherited from the previous period.

The second route is to cut the yield on saving. The impacts of the lower yield on saving were discussed more closely in Section 2.21. If the substitution effect and the human wealth effect together are, as assumed, larger than the income effect of the tax hike, the measure diminishes household saving.

The third channel is to reduce the required rate of return on the firm's capital. The link between the after-tax return on saving and investment is determined by the arbitrage condition between after-tax bond and share investment returns. In equilibrium the after-tax bond yield corresponds to the expected after-tax yield of the shares, and this relation starts to hold

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[4] One might also claim that if the after-tax interest rate is fixed and the before-tax interest rate adjusts, a hike in the tax rate raises the required rate of return on investments. The Finnish tax reform might have created initially also this type of adjustment, since low interest rate tax-free deposits were the dominating assets in household wealth before the tax reform. On the other hand, in 1987 the marginal cost of funds for bank lending was already the interest rate determined in the rapidly developing money markets.

immediately after the initial adjustment of share values to a policy measure. When the after-tax yield of bonds falls, so does the required return on shares, which promotes investment.

The smaller discount factor also raises the present value of the future dividends flow. Since domestic households own the firms, this revaluation enhances their wealth, see Table 4.2. The initial stock market value of the firm overshoots the long-term value. This is because of the increase in debt (based on the temporarily higher purchasing price of the capital stock) supports profit distribution in the first period.

Table 4.2 Interest income tax hike

	5 years	10 years	20 years	50 years	150 years
Private production	-0.9	0.4	2.3	4.3	4.8
Imports	4.5	3.6	2.2	-0.3	-1.3
Exports	-11.1	-6.4	0.3	9.6	12.9
Private consumption	2.5	1.7	0.5	-2.1	-3.4
Investment	4.5	5.6	7.0	8.4	8.9
Consumer price	2.2	1.2	-0.1	-1.7	-2.2
Wages	4.2	3.9	3.0	1.4	0.8
Employment	-1.3	-0.9	-0.2	0.7	0.9
Current account surplus/GDP	-3.2	-2.6	-1.7	-0.5	0.0
Terms of trade (producer price)	3.0	1.7	-0.1	-2.3	-3.0
Household wealth	5.8	-3.6	-10.3	-20.6	-23.8

Because the optimal amount of saving is now lower and wealth has jumped, households temporarily increase their consumption of goods and leisure. The simultaneous heightening of both consumption and investment demand and the sluggish response of domestic production creates excess demand in the market for the domestic good and raises its price. The price reaction postpones somewhat consumption to following periods, because prices are known to fall after the initial jump. Also investors consider this price path as dampening the optimal investment rate, because current period investment goods are expensive compared to the future price of the produced goods.

After the adjustment period the terms of trade weaken permanently because the optimal level of production is now considerably higher with the larger capital stock and the temporary consumption boom has faded. The higher capital-labour ratio enhances the productivity of labour and raises, therefore, wages and pensions. The overall income of the households is, however, lower due to the diminished capital income and transfers. There is less capital income because households have reduced markedly their wealth and the after-tax yield of saving is lower.

Public transfers are larger during the first periods of adjustment due to the still high interest income tax and wage tax revenues. But when the capital stock and household wealth have adjusted to the lower optimal level, the sum of revenues from corporate and personal capital income taxes falls below the initial amount and so do consumption tax receipts. The final outcome is that the hike in the interest income tax reduces long-term tax revenues and raises public sector labour costs, thereby reducing the government transfers distributed to households, see Figure 2G.

Also the external balance of the economy reacts strongly to the tax induced changes in saving and investment, when the interest rate is fixed to the foreign rate. The initial consumption and investment boom is financed by a larger external debt. Hence, the increased interest expenditures of the firms run abroad and do not even generate more interest income tax revenues for the domestic government, since the residence principle is followed in taxation.

The welfare results of the currently living households depend mostly on the initial portfolio composition. The more bonds there are, the larger is the welfare loss. We assume that all generations (except the youngest) have same amount of firms' shares. Therefore, the age-dependent amount of wealth is reflected in the bond position. Young households have net debt and the amount of bond investments is highest among those who are near the retirement age. Figure 2H shows that the oldest generations gain marginally due to the higher stock market prices. The same applies also to the few youngest generations, who benefit additionally from the increase in the deductibility of the interest expenditures[5] . Large losses are met by middle-aged households who have most of the interest income.

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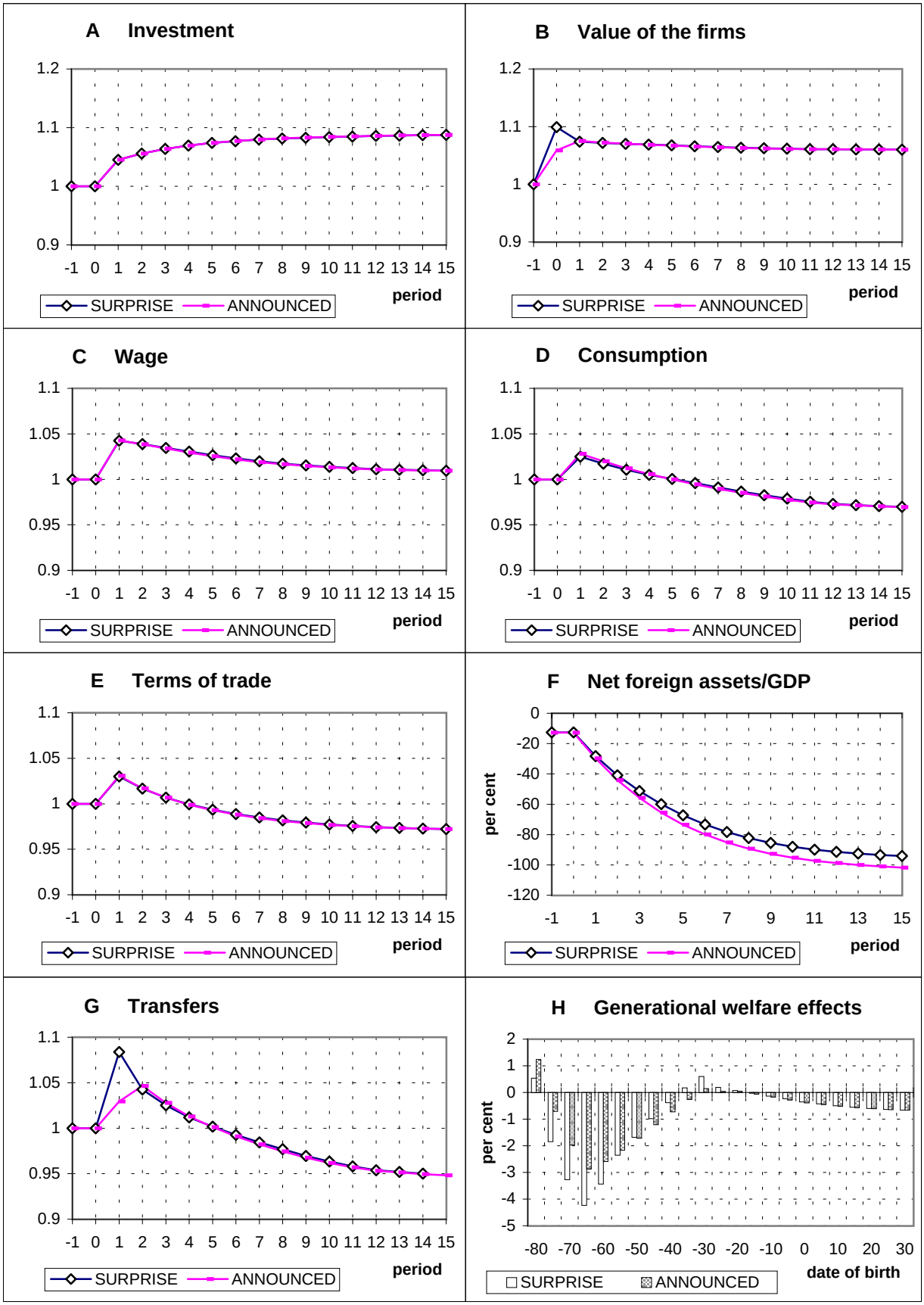
[5] This result is due to the way the tax system was modelled. Actually, deductibility of interest expenditures of housing loans was reduced.

Figure 2 The effects of introducing a 28 per cent interest income tax



The discounted aggregate shows a loss of 3.5 per cent of GDP for the currently living generations and 0.8 per cent of GDP for the future ones. Since the yield on saving is lower, they have to work more in order to have enough income after retirement, but the consumption of goods still lags the earlier norm.

It is useful to recall that after the tax hike has been implemented, households have no incentives to change the portfolio composition, because the expected yield is again the same for bonds and shares. Actually, their portfolio composition still changes, since they save less even though the value of the firms is higher.

Our life-time welfare measure shows also a steady-state utility effect which comes through the timing of the periodic utility changes. The utility losses are concentrated in the last periods of the life cycle because old-age consumption is lower than before the tax reform due to the less favourable conditions of saving. The utility gains based on higher real wages originate during the working periods. When a new household considers the utility effects of the reform, it gives more weight to the nearby gains because of the time preference. Therefore, the long-term average periodic utility losses are even larger than those shown on Figure 2H.

Another point is that future households of foreign countries gain from the tax hike since the terms of trade of the domestic economy are weaker in the new steady state. The discounted aggregate welfare gain of 0.07 per cent of GDP is small, since the short- and long-term variation is of a different sign.

The efficiency results can be considered by comparing the yield on saving and the required rate of return on investments to the interest rate. The comparison reveals that the interest income tax hike creates a strong distortion in the saving decision, but eliminates at the same time the distortion, created by the existing corporate income tax, on the investment decision. Therefore, the ultimate efficiency outcome is ambiguous, even though Figure 2H and the discounted sum of compensating transfers, -4.3 per cent of GDP, show that it is very likely to be negative.

Sensitivity analysis shows that a lower intertemporal substitution elasticity of consumption mitigates the welfare losses, see Appendix 2. The reason for this is that with a lower elasticity households are less willing to save for old age and they react less to the changes in incentives to save.

Another sensitivity analysis, using a model version in which the domestic interest rate is linked to the external debt of the economy, gives a very important result. It shows that the reduction of saving raises the interest rate so much that the capital stock falls in the long term below the initial level. This result is similar to the one obtained using a closed economy model, see e.g. Hutton and Kenc (1998). The welfare outcomes do not, however, change much, since households have more capital income due to the higher interest rate, but less labour income, since the capital stock is smaller, see Appendix 2[1].

An expected increase in the tax rate

In the next simulation the same tax hike is announced one period before its implementation. The main outcome is that an early announcement does not change the simulation results much. The first period income effect of the tax change is now missing, but since the tax revenues are distributed back to the households as transfers, this causes just some intergenerational variation due to the age-dependent amount of interest income. The second and third group of effects mentioned above, which were due to the revised investment and savings plans, are identical. The fourth mechanism, which was the revaluation of the future dividend flow, differs somewhat, because the required rate of return in the first period has not changed. That's why the original jump in stock market prices is not as large as in the case of a surprise tax hike, see Figure 2B.

The differences in welfare effects are due to the above mentioned disparities in interest flows and stock market reactions. The gain of the oldest generation households is larger, because they benefit from the jump in share values and can maintain the after-tax interest income in the first period. The same outcome applies to all those generations who have a positive

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[1] If, in a small open economy, foreign investors had been the dominant owners of the companies, the residence-based interest income tax would have had no effect on the required rate of return on capital.

amount of bonds at the time of the tax rate hike. The youngest generations lose due to the same reason: they cannot deduct their interest expenditures in the first period of taxation.

4.4 A lower dividend tax rate

An unexpected reduction in the dividend tax rate

In the next simulation the personal dividend tax rate was reduced from 13 per cent to zero. The impacts depend largely on how the financial strategy of the firms is modelled. In what follows, we study the tax change in the new view case. It predicts that a change in the dividend tax rate is neutral from the point of view of investment decisions, but creates a windfall gain to current shareholders at the expense of future taxpayers. There is also an additional factor, which expands the revaluation effect in our model. That is the financing of the investment adjustment costs with retained earnings. Since these costs are high at the margin, the impact is substantial.

The partial equilibrium results described above characterise the main impacts of the measure also in our model, but the general equilibrium repercussions give more insight into the aggregate effects and lead to a slight deviation from the perfect investment neutrality result.

The reduction in the tax rate does not change the long-term optimal level of household saving, and households react to the once-for-all jump in their wealth again by temporarily consuming more goods and leisure. The reduction in labour supply curtails production and lowers the marginal product of capital, thereby also initially reducing investments. The dominating trend in the market for the domestic good is, however, the consumption boom, which induces excess demand and raises the price. After the initial shock, the imbalance in the market diminishes and the price falls gradually. This path of prices tends to postpone consumption and slacken investment. The higher price of output and the unwillingness to work raise wages during the first periods.

Table 4.3 Dividend tax rate reduction

	5 years	10 years	20 years	50 years	150 years
Private production	-0.1	-0.2	-0.1	0.3	0.5
Imports	1.1	0.8	0.4	-0.5	-1.1
Exports	-2.1	-1.6	-0.8	1.7	3.0
Private consumption	1.3	0.9	0.4	-0.6	-1.2
Investment	-0.3	-0.2	-0.1	0.2	0.4
Consumer price	0.4	0.3	0.1	-0.3	-0.6
Wages	0.7	0.5	0.1	-0.6	-0.9
Employment	-0.2	-0.1	0.0	0.4	0.5
Current account surplus/GDP	-0.7	-0.6	-0.5	-0.2	0.0
Terms of trade (producer price)	0.5	0.4	0.2	-0.4	-0.7
Household wealth	9.1	6.6	4.6	0.5	-1.0

The intergenerational shift of resources via tax capitalisation can be explained in more detail as follows. The future domestic household generations receive the same rate of return on saving as the current ones did before the tax reduction. They have to suffer, however, from diminished public transfers due to the losses in dividend tax revenues.

When the older generations have adjusted to the higher level of wealth, consumption falls. The new generations entering the labour force try to increase their lifetime income by supplying more labour. Together with the falling price of production, this lowers the marginal productivity of labour and wages fall permanently. The capital stock increases somewhat in the long run, since the positive effect of augmented labour supply more than offsets the negative profitability effect of the lower price of output.

Figure 3H below confirms that the dominating welfare impact is due to the intergenerational tax capitalisation effect[2]. Since there are no shifts in efficiency, the loss borne by future domestic households (2.4 per cent of GDP) is based on the gain of current domestic household generations (2.7 per cent of GDP) and future foreign households, which benefit from the weaker terms of trade of the domestic economy.

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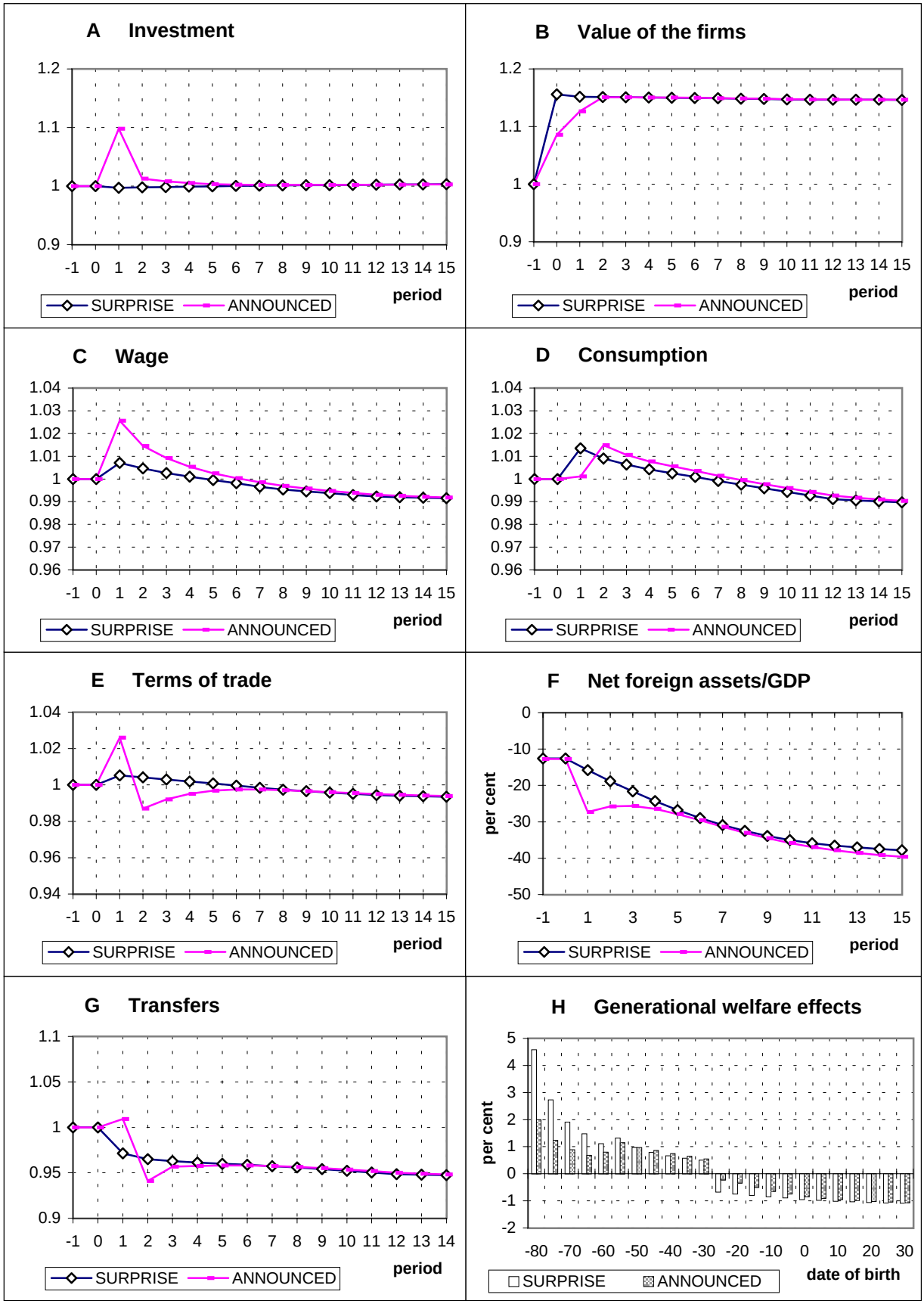
[2] Nielsen and Sørensen (1991) note that if households live infinitely (or are altruistic enough) and the population is stationary in a small open economy with domestically owned firms, there will be no intergenerational and international welfare transfers.

Figure 3 The effects of abolishing the 13 per cent dividend tax rate



The latter effect is, however, small. The welfare measure shows a larger welfare improvement the older is the household, the only exception being the generation which receives high bequests (50-55 years old).

Sensitivity analysis with a model in which the interest rate reacts to the amount of foreign net debt shows that the temporary consumption boom generates a permanently higher interest rate and a lower capital stock and real wage. On the other hand, there will be a higher return on saving and less deterioration in the terms of trade, which mitigates the negative welfare results, see Appendix 2.

An announced reduction in the dividend tax rate

Announcing the reduction in the dividend tax rate one period in advance essentially generates stronger short-term impacts. Firms try to postpone the distribution of dividends until the tax rate is lower (the incentives are comparable to those created by a beforehand informed change in the corporate income tax rate). Since the debt-to-capital ratio is fixed[1] and share repurchases are not allowed, the only way to increase future distribution is to cut current dividends and to invest more[2].

The hike in investment demand leads to one-period shortage of the domestic good, because the higher capital stock does not increase the supply of the good until the next period. This excess demand temporarily raises the price of the good. The higher output price allows firms to pay higher wages. The purchasing power of the wage-earner is, however, improved only in relation to the imported good. The tax-based jump in share prices, too, is not as high as in the case of an unexpected tax rate reduction (the real value of first-period dividends for the shareholder is now even lower). The price paths encourage households to enhance consumption from the second period onwards, see Figure 3D.

A comparison of the welfare results shows that the less intense tax capitalisation limits the welfare gain of the old, and the price variation reduces the loss of a few new-born generations

[1] See Howitt and Sinn (1989) for a case in which the possibility to freely borrow and lend implies neutrality for an anticipated change in a dividend tax.

[2] See Summers (1981a) for a similar result in the old view case, in which the dividend tax affects also the cost of capital.

in the case of an early announcement. The gain of current generations is 2.1 per cent of GDP while future ones lose by 1.9 per cent of GDP. When evaluating the results, one must remember again that they are conditional on the relevance of the restrictions set with respect to the financial strategy of the firms.

4.5 Introduction of a capital gains tax

An unexpected hike in the capital gains tax rate

The next studied measure is a surprise introduction of a 28-percent unit capital gains tax. We assume again that firms follow the new view and finance marginal investments with retained earnings and debt. Since financing future investments with retained earnings raises the market value of the firm and generates capital gains, taxation of these gains heightens the required rate of return on new investments and reduces the optimal amount of capital stock[3]. The old capital has, however, been generated at the time of the zero tax rate and the valuation of these capital units rises since their financing is not subject to the new tax[4]. The same phenomenon applies also permanently: after the tax has been paid once, the additional capital unit is "old" and its finance does not generate any taxable capital gains. This advantage in relation to the tax-burdened new capital keeps the market value of the old capital stock high.

One should also note, just as in the case of dividend taxation, that since the investment adjustment costs are financed with retained earnings, the valuation effect of the tax factor is larger than in a model without these costs. A higher capital gains tax rate also raises the costs of financing the installation of the new capital unit. The relative importance of this factor is large,

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[3] Again, the measure here generates an incentive to increase the debt-to-capital ratio if it is possible.

[4] The opposite effects of capital gains taxation to the valuation of the current capital stock and the optimal amount of future capital in the case of profit financing has been noted e.g. by Sinn (1987) pp. 315 - 318. It is familiar also from the literature of dynamic incidence of investment tax subsidies, see e.g. Goulder and Summers (1989). The outcome is sensitive to the assumption of taxing the capital gains on accrual. If the capital gains associated with financing the current capital stock by retained earnings were not realised before the reform, the higher tax rate would not raise the value of this part of the old capital before the tax has been paid.

since the new capital unit is financed only partly, but the adjustment costs totally, with retained earnings. [5]

The revaluation of the capital stock induces a peak in household wealth and consumption. Yet the weaker investment demand dominates in the market for the domestic good and an initial excess supply of the good cuts its price. This price reaction reverses during the second period when the smaller capital stock starts to limit production.

Table 4.4 Capital gains tax hike

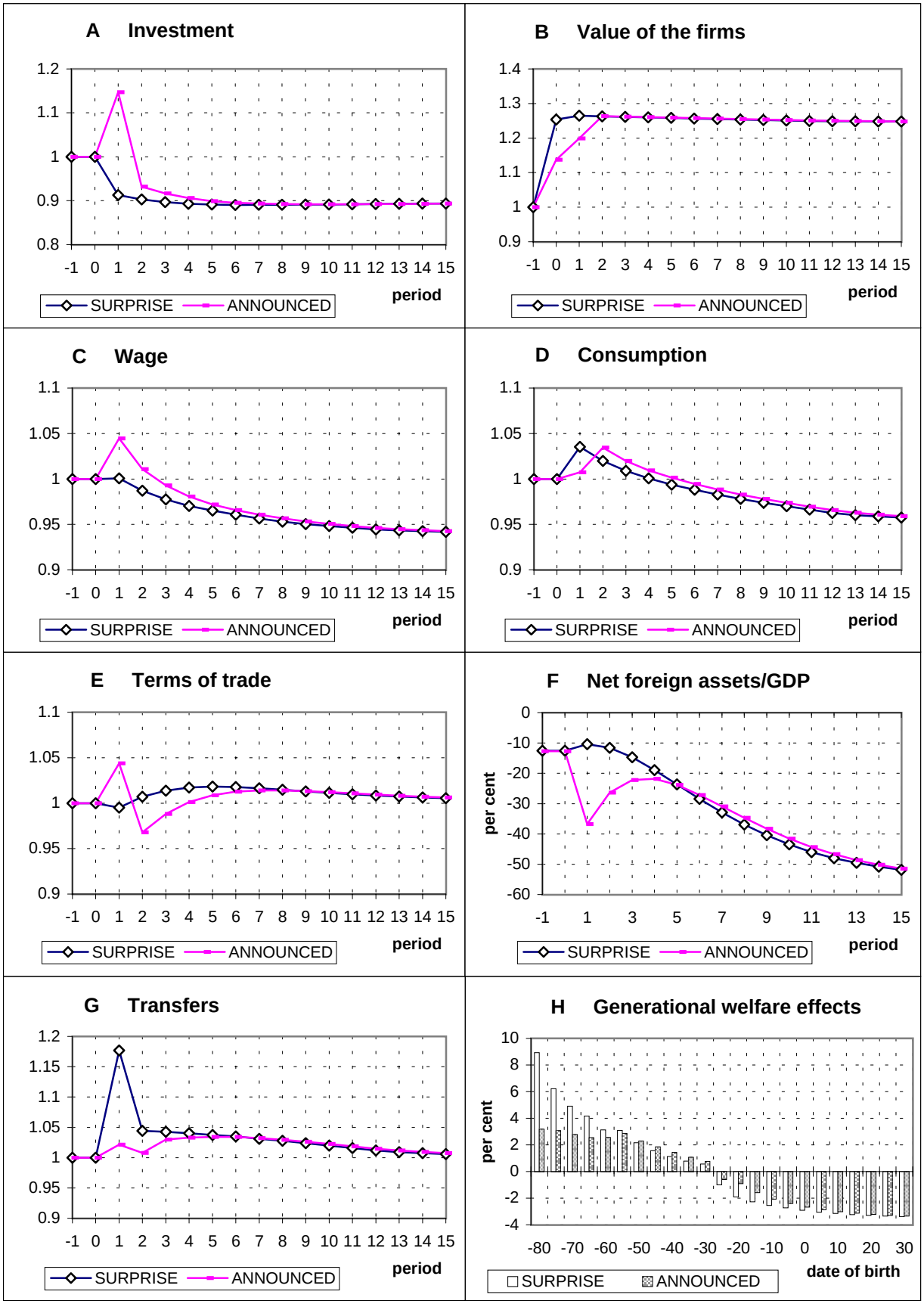
	5 years	10 years	20 years	50 years	150 years
Private production	-0.6	-2.8	-5.0	-5.6	-5.3
Imports	-0.2	-1.0	-2.0	-4.5	-6.0
Exports	-11.1	-2.7	-6.6	-4.4	-1.0
Private consumption	3.5	2.0	0.1	-3.0	-4.8
Investment	-8.7	-9.7	-10.7	-10.9	-10.5
Consumer price	-0.4	0.5	1.3	0.9	0.2
Wages	0.1	-1.3	-3.0	-5.2	-6.1
Employment	-0.8	-1.0	-1.0	-0.4	-0.1
Current account surplus/GDP	0.4	-0.2	-0.8	-0.6	0.0
Terms of trade (producer price)	-0.5	0.7	1.7	1.1	0.3
Household wealth	14.8	12.5	8.8	-0.8	-5.2

The climbing producer price supports wages, but cannot eliminate the impact of the lower capital-labour ratio on the marginal product of labour, and wages fall permanently. The reduction in labour income compels households to save less for their old age. In other words, the negative income effect reduces in the long term optimal household saving and wealth, although the rate of return on saving has not changed in this open economy.

The opposite initial reactions of consumption and investment curb the external imbalance, but since the savings rate revives more slowly than the investment rate, the economy has to borrow somewhat from abroad to finance the current account deficit. The small discrepancy

[5] If the equity financing is carried out with share issues, the implications change. We study these more closely in Section 6.2.

Figure 4 The effects of introducing a 28 per cent capital gains tax



between domestic demand and supply in the market for the domestic good also implies that a sensitivity analysis with exogenously determined export prices does not change the results markedly.

The new tax does not generate any income in the new no-growth steady state, but increases somewhat the tax receipts from dividend taxation, due to the higher pay-out ratio. From the point of view of the government budget balance, the deterioration of wage income and consumption tax bases are nevertheless compensated primarily by the lower public sector labour costs.

The welfare effect of this tax policy depends again on the intergenerational distribution of ownership of share wealth at the time of the reform. Since it is distributed evenly, the revaluation improves by the same amount the welfare of all current generations (except the youngest) and worsens the welfare of future generations.

The utility measure in Figure 4H above shows nevertheless a larger gain to the elderly people, since the jump further raises their relative lifetime wealth. Another main factor which shapes the intergenerational incidence is the gradually strengthening negative wage effect, which cuts the wage and pension incomes in proportion to the length of the remaining lifetime of the households. The huge utility loss of future generations, 6.7 per cent of GDP, is largely determined by the capitalisation of the tax in the stock market prices. The corresponding gain of currently living households is 5.9 per cent of GDP. This time there is, nevertheless, also a significant efficiency loss created by the capital gains tax on the marginal investment decision. The international shift in welfare is small.

An announced introduction of a capital gains tax

If the introduction of a capital gains tax is revealed one period in advance, firms maximise their value by trying to avoid tax payments. Since it is known that investment finance by retaining earnings is more costly in the next period, firms cut their current period dividends and increase their investment. Hence, the initial surprise jump in the firm's value is lower because the first period dividends are smaller. The market price of the firm continues to rise during

the first period due to the higher capital stock and jumps in the beginning of the second period due to the tax valuation effect. The latter anticipated changes in share prices do not affect household wealth, which is then determined solely by new saving and inheritances.

The first period excess demand and price jump in the market for the domestic good are due to the higher level of investment, which does not augment production until the second period. The second period tax hike reduces investment at the same time that production increases. Therefore, the markets balance at a lower price. The path of the consumer price guides households to postpone the consumption of their capital gains to the second period. The long-term results with a lower capital stock and consumption are again exactly the same as in the case of an unexpected tax rate change. The deviations in intergenerational welfare implications rest on the smaller stock market reaction, which limits most strongly the relative welfare gain of the oldest generations. The overall improvement in the welfare of the current households is now 4.9 per cent and the loss of future households is 5.8 per cent of GDP.

The overall assessment of the short-term impacts says that they are largely similar to those in the cases of an announced dividend tax cut or an announced corporate income tax reduction. All these measures create an incentive to shift the profit distribution to the following periods when it is valued more. This shifting is carried out by temporarily increasing investment, since corresponding operations using bond markets are not allowed. Although the restricted financial adjustment of the corporate sector causes some undue macroeconomic variation, the welfare outcomes are again in the pre-announced case more "acceptable" due to the smaller intergenerational welfare shift. Acceptability is here conditional on the optimality of the initial position of the households.

There is one further point which should be kept in mind when discussing the effects of an announced increase in capital gains taxation. In the model world, capital gains are taxed on accrual, not when they are realised. Since in the real world the gains are not taxed until realisation, an announcement of a tax hike would generate a large amount of postponed realisations[1].

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[1] According to Klein (1999) capital gain lock-in lowers the pre-tax returns of securities.

4.6 Sensitivity of the welfare results to the portfolio composition of the households

Households are in this perfect foresight model indifferent towards investing in firms' shares or in the one-period bonds. The arbitrage condition guarantees that the after-tax yield is equal *ex ante*. The yields can vary, however, *ex post* since any unexpected change in the future dividend flow or in its taxation is reflected in the share prices immediately after the news reaches the stock market. But an unexpected increase in the interest income tax rate does not cause a capitalisation of future tax payments in the value of the current bonds.

In the baseline simulations it has been assumed that households have an equal amount of shares in their portfolios. The amount of bond wealth is proportional to the age-specific amount of wealth, see Figure 5A. This portfolio distribution is not based on empirical data, but is aimed to distribute equally the initial change in share price valuation among the currently living generations (except the youngest one, which enters the economy without wealth). Since this portfolio choice is likely to affect the intergenerational welfare results, it is useful to check the outcomes with an alternative assumption. The sensitivity analysis was carried out supposing that the ratio of shares to aggregate wealth is the same for every household generation. As the aggregate market value of the capital stock is about 60 per cent of the household wealth in the used calibration, each generation has somewhat more shares than bonds in their portfolios. The alternative distribution is presented in Figure 5B. The implication of this assumption is that some young generations have a little negative share wealth[2].

A general look at Figures 6A - 6D show that the welfare effects are indeed sensitive to the choice of portfolio composition. For the middle-aged generations the welfare loss due to the higher corporate income tax hike is multiple in the case of wealth-weighted share ownership. This implies that a large part of the loss is associated with the lower share prices. The young generations even gain from the reform.

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[2] The obvious alternative is to restrict the share ownership to those generations which have positive net wealth and divide the shares according to a fixed ratio of shares to bonds. The outcome would be almost identical in our case. The main problem here is that there are not enough data on the age-distribution of capital incomes and wealth. Another major question is how we should treat owner-occupied housing.

Figure 5 Household portfolios

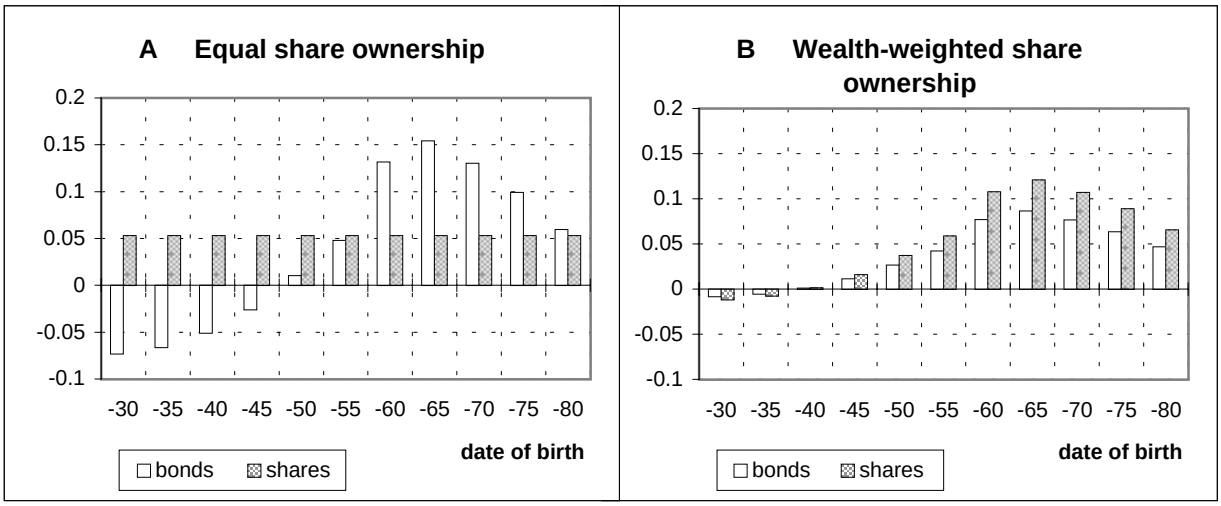
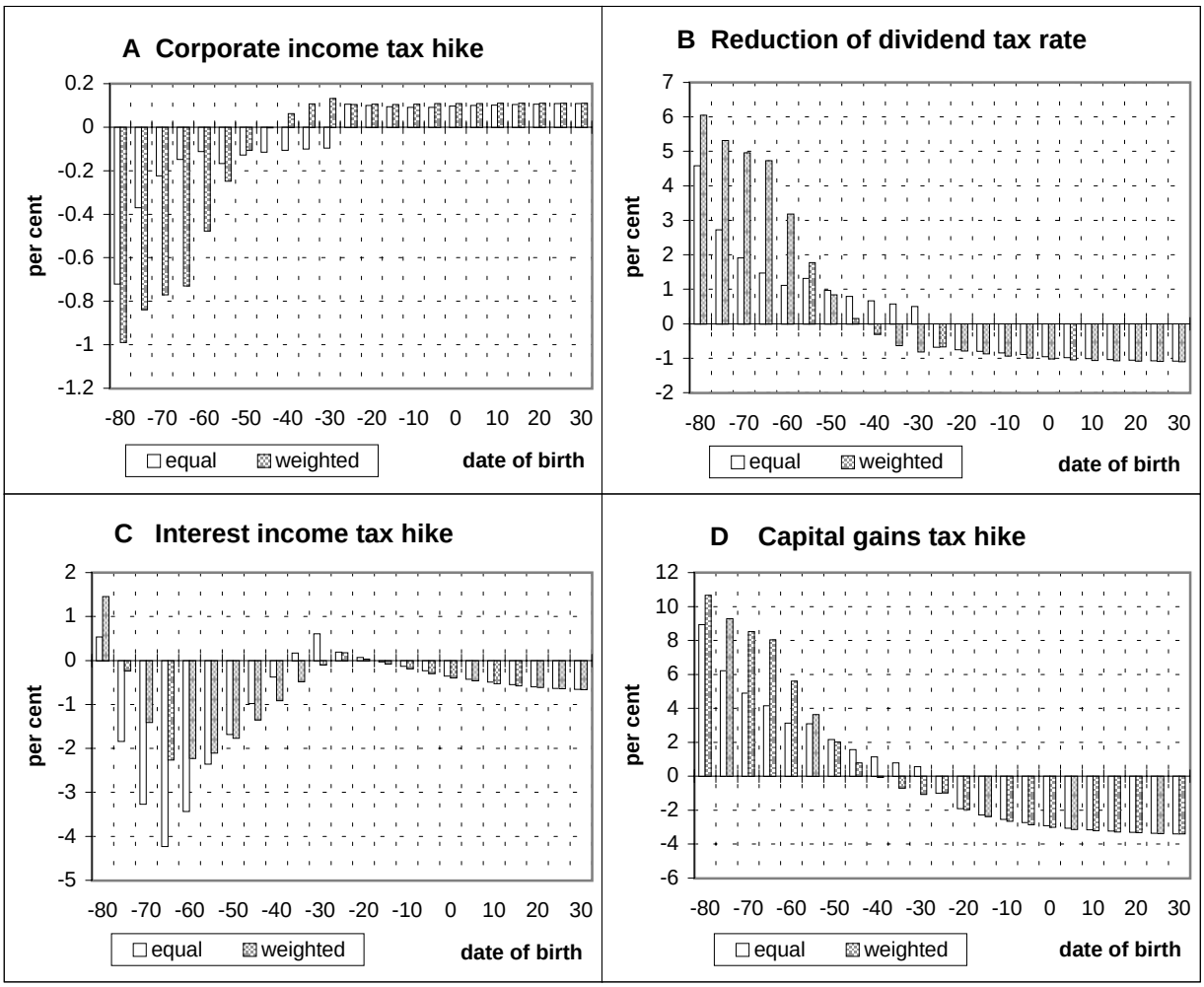


Figure 6 The welfare effects of the unexpected tax rate changes with equal and wealth-weighted intergenerational share ownership



The same interpretations are valid also in the cases of a lower dividend tax rate and a higher capital gains tax rate. The welfare gains based on the revaluation of the capital stock dominate the intergenerational utility changes. The only exception is the interest income tax hike, which produces a more pronounced welfare deprivation in the case of equal share ownership. Now the welfare shifts are mostly due to the varying amount of bonds in the household portfolios. The more bonds there are, the bigger is the loss caused by the lower after-tax interest rate. It is important to note, however, that the deviations in the initial portfolio composition no longer have any effects in the new steady state of the economy. Therefore the welfare outcomes of the households born far in the future do not change either.

5. THE AGGREGATE EFFECTS OF THE TAX REFORM

This section presents the aggregate outcomes of the tax rate shifts listed in Table 3.1 in Section 3.2. We first anticipate the partial equilibrium results and demonstrate next the consequences of the behavioural reactions by using a computable general equilibrium model. The third part includes a sensitivity analysis regarding the openness of the economy. The idea is to simulate the tax reform with alternative assumptions of price formation in export markets and in the bond market.

5.1 Incentives to save and invest and the value of the capital stock

The results of Section 4.3 pointed out that a hike in the interest income tax rate creates a strong incentive to consume part of the existing wealth and to permanently reduce saving. The impacts of all the elements of the tax reform on the investment decisions and the market value of the firms must be considered, however, simultaneously. It is useful to recall that the steady-state required rate of return on investments financed with retained earnings was presented in equation (2.24) as follows:

$$p^F(F_K - G_K) = p^K\left[d + br^d + (1-b)r^d \frac{1-\tau^r}{(1-\tau^g)(1-\tau^F)} \right] + r^d \frac{1-\tau^r}{(1-\tau^g)(1-\tau^F)}(1-\tau^F)p^F G_I + dp^F G_I \quad . \tag{5.1}$$

In tax reform simulations both the initial value and the hike in the interest income tax rate τ^r and in the capital gains tax rate τ^g are equally large in (5.1). This implies that their aggregate impact is negated. Only the minor increase in the corporate tax rate on retained earnings τ^F

raises the yield requirement of capital. In addition, the higher corporate income tax rate does not apply to the investment adjustment costs, since they are deductible in corporate taxation.

The tax-based revaluation of the firm is more complicated to describe. One way is to look at the value of the firm as a tax adjusted discounted sum of future dividends as in equation (2.9), which is numbered here as (5.2).

$$V_t = \sum_{s=t+1}^{\infty} \left(\frac{1-\tau_s^D}{1-\tau_s^g} D_s\right) \prod_{v=t+1}^{s} \left(1 + r_{v-1}^d \frac{1-\tau_v^r}{1-\tau_v^g}\right)^{-1} \tag{5.2}$$

The tax multiplier reveals that both the reduction in the dividend tax rate and the hike in the capital gains tax rate raise the valuation of dividends. The higher capital gains tax rates negates the positive impact of the hike in the interest income tax in the discounting factor at the end of the equation.

Another way of express the firm's value is to combine the equations of marginal (2.20) and average (2.21) Tobin's q as follows:

$$V_t = \frac{1-\tau_t^D}{1-\tau_t^g} \{K_t \, [p_t^K + (1-\tau_t^F) p_t^F G_{I,t}] - B_t^F\}. \tag{5.3}$$

This static formulation pays attention to the valuation of the capital stock. It consists of four elements. The first is the acquisition price of a new capital unit. The second element is the investment adjustment costs, which raise the value of the capital stock in the use of the firm above the acquisition cost. The third is the impact of taxes on the market value of the firm. The final calculation of the firm's value takes also into account that part of the new capital unit is financed with debt.

The higher corporate tax rate reduces the value of the extant capital because it increases the corporate income tax deduction associated with the adjustment costs of new investments. Another factor is the finance of the acquisition cost and investment adjustment cost with retained earnings, which is reflected in the first tax term on the right hand side of (5.3). The shift from

dividend to capital gains taxation strongly enhances the value of this term and hence dominates the overall valuation effects of the tax reform.

In all, the partial analysis above shows that the higher interest income tax reduces the motivation of households to save, but the revaluation of the existing capital stock generates a jump in the actual wealth of households. This discrepancy stimulates markedly consumption. The only tax factor which directly affects investment incentives is the slight hike in the corporate tax rate.

5.2 The general equilibrium results

Next we study the macroeconomic and welfare effects of the tax reform using the FOG model. The results of the base case simulation are presented in the following verbally and with a summary table 5.1 and Figure 7. The overall impression is that the large positive short-term impacts reverse gradually and the adjustment period is very long. The slow adjustment is typical in overlapping generations models and easier to understand when one remembers that a policy measure changes the life-cycle plan of households who live 80 years.

The short-term outcomes are mostly driven by the household consumption reaction. Especially middle-aged households, which are at the top of their life-cycle wealth hump and still of working age, consume a higher quantity of both goods and leisure, which reduces the initial aggregate supply of labour markedly. This is also reflected in production and investment, since the diminished labour supply raises wages and lowers the marginal productivity of capital.

Although investment demand declines, the initial large jump in consumption and fall in production generate an excess demand for both the domestic and the imported good. The market for the domestic good is balanced by a deep fall in the amount exported and a higher price. On the other hand, the supply of the imported good is infinite at a fixed price. The induced substantial deficit in goods trade is financed by corresponding imports of financial capital, and foreign net debt begins to accumulate. The discrepancy between domestic saving and

investment is not allowed to affect the interest rate paid from foreign borrowing in the benchmark model.

When households have adjusted to the imbalance between current and optimal wealth and new household generations gradually replace the old ones, the consumption boom weakens and labour supply revives. The large fall in after-tax capital incomes forces households to increase their labour supply above the initial level even though the expansion of labour supply and weaker terms of trade spur a decline in wages. The supply reaction is so strong that it raises the steady state optimal capital stock and production marginally above their original amounts although the corporate tax rate is higher and the producer price has declined. The net effect of the paths of increasing labour supply and declining output price combined with the impact of the investment adjustment costs produce a slowly rising path of investment, see Figure 7A.

Table 5.1 The effects of the overall reform

	5 years	10 years	20 years	50 years	150 years
Private production	-1.6	-2.2	-2.1	0.0	1.2
Imports	6.2	4.0	1.0	-4.9	-7.7
Exports	-12.8	-11.0	-6.3	8.6	16.9
Private consumption	7.8	5.0	1.3	-5.4	-8.9
Investment	-3.4	-3.3	-2.7	-0.9	0.2
Consumer price	2.6	2.2	1.2	-1.5	-2.9
Wages	5.6	3.6	0.7	-3.9	-5.4
Employment	-2.2	-2.0	-1.1	1.0	1.6
Current account surplus/GDP	-4.0	-3.8	-3.4	-1.4	0.0
Terms of trade (producer price)	3.5	3.0	1.6	-2.1	-3.8
Household wealth	34.7	18.3	5.2	-19.1	-27.8

In the long term, the major fall in consumption and the revival of production turns the excess demand into an excess supply in the market for the domestic good and the price of the good falls. Households see the future fall in consumer prices, and postpone their consumption during the adjustment period.

Tax revenues jump in the first period due to the introduced capital gains taxation[1] and the increase in the receipts of the value added tax. Therefore the amount of transfers rises temporarily, as Figure 7G shows. In the new steady state the transfers distributed are markedly reduced by lower receipts of all other taxes than the corporate income tax. Even the receipts of the new interest income tax are negative, because the higher value of the firms crowds out bonds in the diminished household portfolios and the interest payments of the huge foreign debt are not taxed in source.

The permanently higher value of the domestically owned capital stock and the lower optimal life-cycle saving induces a substantial increase of firms' shares at the expense of bonds in the household portfolios. Actually, the bond markets are dominated in the new equilibrium by foreign investors, who invest both in public debt and the firms' debt. A major share of the domestic capital stock is therefore financed with foreign borrowing.

The hike in the interest income tax rate produces a large revaluation gain to all current shareholders, but it reduces at the same time the net yield of bonds, limiting markedly the welfare gain of the middle-aged generations who own most of them. The relative profit is biggest for the retired generations, but also the other currently living generations (except the youngest) benefit. The 50 - 55 year-old generation gains also from the larger bequest. The main losses are directed to the still unborn generations, which are burdened both with a lower real wage and lower after-tax rate of return on savings[2].

The aggregate discounted sums indicate a gain of 7.1 per cent of GDP to the currently living households and to those not yet born a loss of 11.3 per cent of GDP. Summing up yields a reduction in welfare corresponding to 4.2 per cent of GDP.

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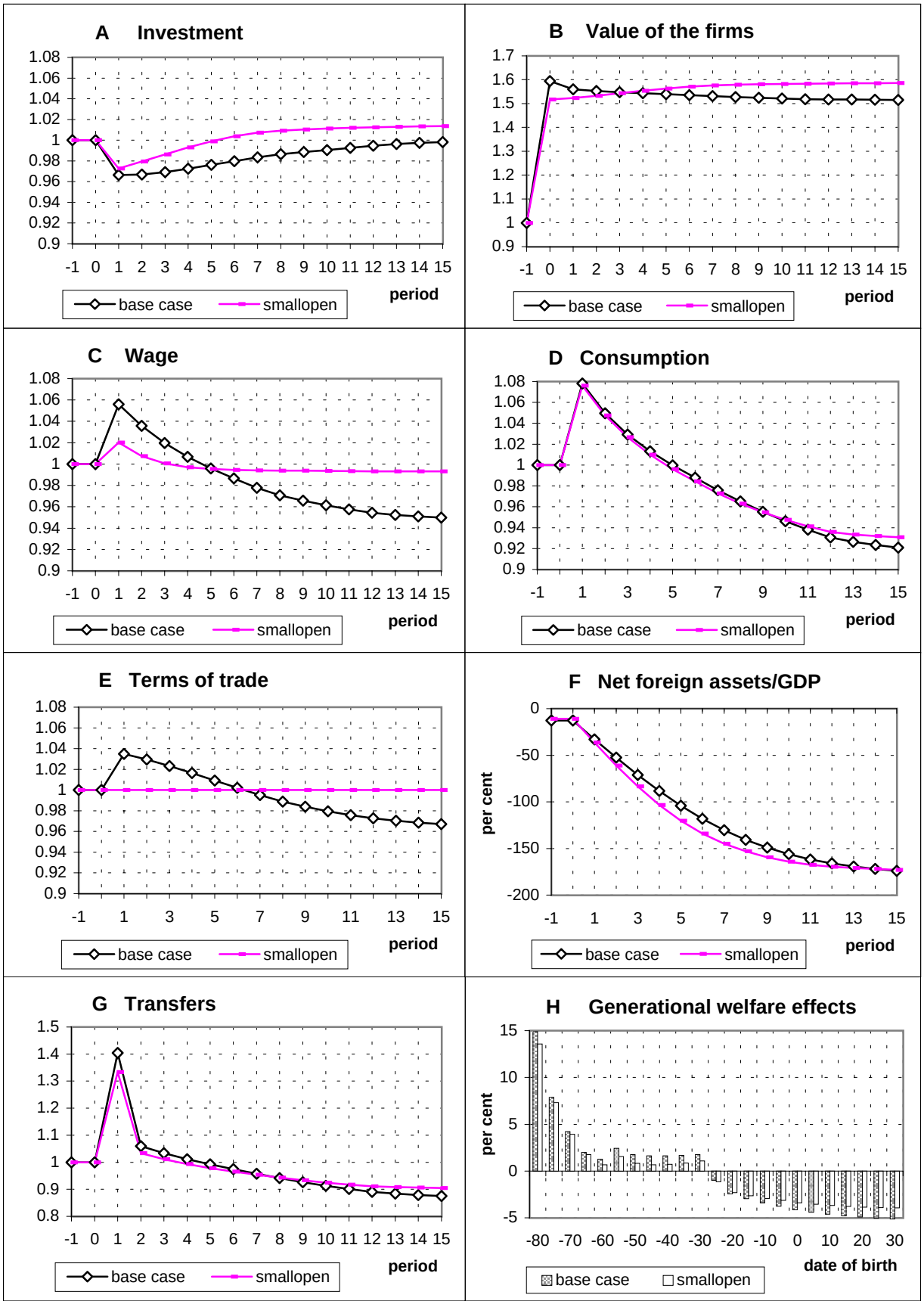
[1] Even though the assumption of taxing capital gains on accrual (i.e. during the first five-year unit period in the model) can be criticised, there are no empirically tested alternatives. We have moderated the effects of the assumption on intergenerational welfare by assuming that the existing generations (except the youngest one) own equal amount of shares and that the budget is balanced period-by-period with lump sum transfers of equal size.

[2] The negative welfare effect would have been larger if there were no pension system, which reduces the need to save privately for the old age.

Figure 7 The total tax reform in the base case and in the small open economy model



The overall evaluation of the tax reform is therefore that the measure is hard to justify from the point of view of domestic households. There are also large international welfare transfers via shifts in the terms of trade, but they reverse in time so that their discounted sum is small.

The reform generates a minor efficiency loss linked with investment incentives, but the main efficiency problem is the strong distortion caused by the interest income tax on saving decisions. In a closed economy the shifts in saving and investment incentives would interact strongly. Therefore it is important to check the sensitivity of the results to modifications in the openness of the goods and capital markets. This sensitivity analysis is performed in the following section.

5.3 Open economy sensitivity analysis

The studies of tax reforms with open economy models have revealed that the international shifts in welfare can reverse the domestic welfare outcomes generated by closed economy models. For example, Perraudin and Pujol (1990) note that substituting a lump-sum tax for a wage tax can reduce domestic welfare if export demand is inelastic. Also, in the study of Broer and Westerhout (1993) changes in tax rates induce unexpected welfare results.

In this chapter we study the outcomes of alternative assumptions of modelling the openness of the economy. The first alternative is the case of a small open economy, in which both the export price and the interest rate are given from abroad[1]. The second set of simulations analyse the consequences of an alternative determination of the domestic interest rate.

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[1] It is necessary to specify exactly how this study defines a small open economy. In the simulation model it means that goods prices are fixed and determined in international markets, just as the interest rate on domestic bonds is. But we assume that the labour market is restricted to balance the domestic demand and supply of labour, which allows the wage to deviate from the international wage level. Another essential assumption is that equity markets are totally domestic, but are linked to the international bond market yield via the arbitrage condition of the domestic household investors. It implies that the required rate of return on capital is affected both by the foreign interest rate and the corporate and capital income taxation of domestic households. This is important to remember when we compare the outcomes of our model to the often cited statement that a residence-based capital income taxation does not affect the domestic investment in a small open economy, see e.g. Bovenberg (1994) pp. 123 - 124.

When evaluating the decision problem of the private sector it is useful to remember that the implicit monopoly power of the country in the international capital and goods markets cannot be utilised by single decision makers in the model, because they are too small to have any effect on aggregate quantities and prices.

5.3.1 Small open economy: exogenous terms of trade

Vennemo (1990) suggests that modellers who use the Armington assumption[2] in their models (as we do) should perform a sensitivity analysis with respect to the value of the elasticity of export demand. This is because the terms of trade changes can alter the welfare results profoundly[3]. This important note applies, of course, also to the elasticity between the imported and domestic good, because a high elasticity leads to the absorption of disturbances without large terms of trade changes.

Recall that in our model the exported amount X_t depends on the price elasticity of foreign demand as follows:

$$X_t = x\left(\frac{p_t^d}{p_t^m}\right)^{\sigma^X}, \tag{5.4}$$

where x is a scaling constant, $\frac{p_t^d}{p_t^m}$ describes the terms of trade, and σ^X is the price elasticity of export demand. Empirical estimates typically produce fairly low absolute values for the elasticity, which means that exported goods are at least in the short term imperfect substitutes for foreign ones. The assumption of imperfect substitution gives rich adjustment-period dynamics in the model, because households and firms also consider the future changes in relative prices of the domestic and foreign good when they perform their intertemporal optimisation.

The openness of economies with respect to goods trade is in industrial countries comprehensive. Furthermore, the price elasticity is likely to increase when the studied time

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2 See Armington (1969).

3 Melo and Robinson (1989) argue that the terms of trade and welfare effects are too large and so the assumption should not be used at all.

horizon is extended [4]. Our sensitivity analysis described in the following takes an extreme position and assumes that the elasticity is infinite, i.e. the economy behaves as a price taker in the international markets. This assumption also fixes the domestic price level and thereby the terms of trade of the economy. In addition, it changes the initial equilibrium somewhat, suggesting that the outcomes are not exactly comparable to the baseline case results. Our detailed analysis indicates, however, that this feature does not affect the interpretations of the results generated by the small open economy version of the model.

The results are presented in Table 5.2 and Figure 7 (with legend *base case* for the base case and *smallopen* for the fixed price case). Compared to the results of the previous chapter, the difference is that there are no price reactions in the market for the domestic good, which could dampen the adjustment of supplied and demanded quantities. Therefore, quantities converge faster to their new equilibrium. One should remember that the sector-specific intertemporal budget constraints guarantee that the economy will end up with a current account balance also with fixed goods prices and interest rate (if there were a fixed rate of productivity growth, the current account/GDP would stabilise eventually).

The initial excess supply of the domestic good is in the small open economy case absorbed in the world markets without any price reactions. Since there is no positive effects from producer prices, the initial jump in household wealth and the hike in real wages are less pronounced. But the future decline in labour income is not as deep either, and so there is not much difference in the consumption path during the first 50 years.

Also, the initial reaction of the capital stock is somewhat surprising. Even though there is no major difference in labour supply and the price of the produced good, and thereby the marginal product of capital is lower in the small open economy case, the capital stock falls less. The explanation for this is the adjustment costs of capital. Since firms know that future profitability rises along with the higher labour supply and there will be no negative effect

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[4] We focus in this study on the impacts of the tax reform. The small open economy assumptions are, however supported in the Finnish case by the later adopted single currency, which eliminated most exchange rate risks and enhanced the possibilities to compare prices between the EMU countries. Together with the future (market driven or harmonised) convergence of rates of indirect taxation and development of information technology, they intensify the competition in the goods markets substantially. Therefore, it is likely that the price elasticity of Finnish exports will rise in the future.

from lower future output price, it is now optimal to moderate the reduction in the initial capital stock. This is an excellent example of how the paths of consumption and investment are determined as a result of intertemporal planning.

Table 5.2 The overall reform in a small open economy

	5 years	10 years	20 years	50 years	150 years
Private production	-1.8	-2.2	-1.4	1.2	1.7
Imports	3.5	1.9	0.1	-2.6	-3.6
Exports	-16.3	-14.0	-6.5	12.3	17.4
Private consumption	7.6	4.8	1.0	-5.2	-7.3
Investment	-2.7	-2.1	-0.7	1.1	1.4
Consumer price	0.0	0.0	0.0	0.0	0.0
Wages	2.0	0.8	-0.3	-0.6	-0.7
Employment	-2.5	-2.1	-1.0	1.1	1.5
Current account surplus/GDP	-5.1	-4.9	-4.0	-1.0	0.0
Terms of trade (producer price)	0.0	0.0	0.0	0.0	0.0
Household wealth	30.0	12.5	-0.8	-20.7	-24.5

The welfare comparison of Figure 7H shows that the initial welfare gain (4.1 per cent of GDP) as well as the loss of the future household generations (8.4 per cent of GDP) are dampened in the small open economy due to the stable price of the domestic good. Furthermore, international welfare transfers are ruled out.

5.3.2 Endogenous domestic interest rate

Another important feature of the model is the determination of the domestic interest rate. We have compared the effects of the tax reform in three cases of interest rate determination.[5] In the base case international bond markets are perfect and the domestic interest rate follows the foreign rate. There is, however, a lot of evidence of segmentation of global capital markets.[6] Home preference is most evident in equity markets, but the permanent differences in real

[5] These interest rate determination rules have been used also in Lassila, Palm and Valkonen (1997b), which studies the effects of pension policies.

[6] See e.g. Feldstein (1994).

interest rates of various countries reveal also the imperfect substitutability of bonds. We have developed two alternative mechanisms to express the home preference of bonds[7], namely a flow equilibrium model and a portfolio balance model.

It is important to note that the future change in the real exchange rate (which is in our case the terms of trade) does not have any effect on the domestic interest rate, because the interest rate is denominated in foreign prices. The home preference is based on either risk or liquidity considerations, which are not explicitly modelled here[8]. We assume in the following that both the terms of trade and the domestic interest rate is determined in markets where domestic and foreign goods and bonds are not perfect substitutes.

In **the flow equilibrium model** the domestic interest rate r_t^d rises above the foreign interest rate r_t^f when the current account is running a deficit, and vice versa:

$$r_t^d = r_t^f - \frac{A_t^f - A_{t-1}^f}{\varpi Q_t} \tag{5.5}$$

where ϖ is a parameter which determines the sensitiveness of the interest rate differential to the ratio of current account surplus $A_t^f - A_{t-1}^f$ to gross domestic product Q_t. With a chosen value of 4 for the elasticity parameter, the reaction of the interest rate is modest.

In this no-growth version of the model, the sector-specific budget constraints gradually restore the current account balance after a shock. Therefore the domestic interest rate returns in the flow equilibrium model to the level of international rates in the long term. This also implies that the economy ends in the same equilibrium as in the fixed interest rate case[9]. The macroeconomic and welfare implications of the adjustment phase nevertheless deviate.

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[7] Our view should be separated from two-country studies, in which each country is large enough to affect the international interest rate, see e.g. Sibert (1990). In these models there may e.g. be interaction between capital and goods markets in the other country, which affects export demand.

[8] Goulder and Eichengreen (1989) derived the demand of assets from utility maximisation of personal investors, but did not justify the home preference in more detail in their perfect foresight model either. One of their results is that, if international capital mobility is allowed to be free, promoting saving or investment creates different outcomes.

[9] If there were growth in the economy, it would end on the same growth path. Comparing the results after 150 years in Tables 5.1 and 5.3 shows that there is some minor discrepancy. This unveils that the economy has not yet exactly reached the final equilibrium.

The simulation results are presented in Table 5.3 and compared in Figure 8 to the ones simulated with the base case model version.

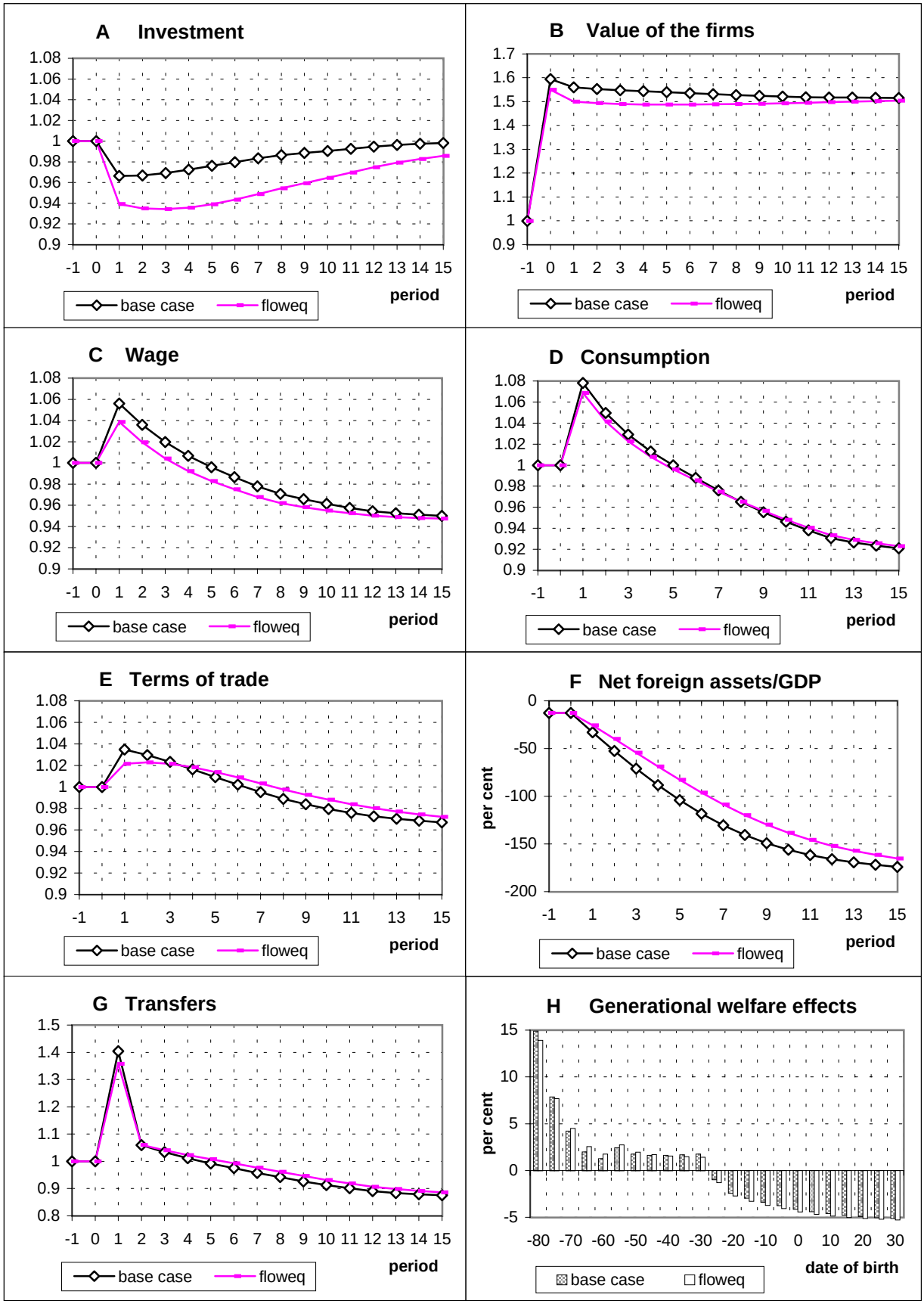
The interest rate reaction mitigates the short-term increase in consumption and aggravates the loss in investment. The less pronounced rise in consumption is due both to the direct stimulating effect on saving and the dampened jump in wealth, since the future dividend flow is now discounted with a higher rate. The limited discrepancy of saving and investment is reflected in the accumulation of foreign net debt, which is substantially slower during the first 50 years, see Figure 8F.

Table 5.3 The overall reform with an interest rate link to the current account balance

	5 years	10 years	20 years	50 years	150 years
Private production	-1.4	-2.8	-3.6	-1.7	1.2
Imports	4.1	2.2	-0.3	-5.0	-7.7
Exports	-8.1	-8.6	-7.0	4.9	16.7
Private consumption	6.9	4.2	0.8	-5.2	-8.9
Investment	-6.1	-6.5	-6.4	-3.6	0.1
Consumer price	1.6	1.7	1.4	-0.9	-2.9
Wages	3.9	1.9	-0.8	-4.5	-5.4
Employment	-1.9	-1.8	-1.2	0.7	1.6
Current account surplus/GDP	-2.6	-2.8	-2.8	-1.7	0.0
Terms of trade (producer price)	2.1	2.3	1.8	-1.2	-3.8
Household wealth	32.1	17.9	7.1	-15.8	-27.7
Interest rate	3.3	3.3	3.3	3.2	3.0

When the domestic interest rate is allowed to respond to the imbalance in the bond market, it mitigates some of the price reactions in the labour market and in the market for the domestic good. This can be seen in Figures 8C and 8E. It is, however, useful to keep in mind that reaching the same equilibrium requires that the adjustment must be correspondingly more pronounced at some later stage in the flow equilibrium model.

Figure 8 The tax reform in the base case and in the flow equilibrium model



This later adjustment stage can be described as follows. The saving incentive fades when the current account approaches zero and the interest rate shifts back to its initial level. During the process, the consumption which is foregone will be realised later as savings are taken in use. Respectively, the negative effect of a higher interest rate on investment abates gradually, and apart from falling more rapidly, the capital stock also revives faster in the flow equilibrium model than in the fixed interest rate case. Therefore, being temporary, the hike in the interest rate does not have any permanent effects on the economy.

The welfare effects presented in Figure 8H show little variation. The middle-aged and several of the youngest retired generations are better off, since in their portfolios the dominating asset is bonds, which now yield a higher interest rate. For all other currently living generations the less pronounced positive share revaluation and wage outcomes dominate. Also for many of the still unborn generations the outcome seems to be worse in the flow equilibrium case. Calculation of the discounted sum of welfare transfers gives, however, an interesting result. The higher discount rate reduces the sum of future losses marginally below the one generated by the benchmark model. Therefore also the aggregate domestic welfare shift is slightly less negative (3.8 per cent of GDP).

Another interesting issue is the welfare of foreign households. Most likely, the current elderly foreigners gain marginally, since their investment in foreign (from their point of view) bonds now yield more and the loss due to the terms of trade is smaller. The position of the current young and many future foreign household generations is, however, weaker because they do not gain from the variation in the terms of trade. The overall international welfare transfer is, therefore, limited.

The portfolio adjustment model is based on the idea that foreign investors require permanent changes in returns to permanently change the share of domestic bonds in their portfolios. Therefore the current amount of debt A_t^f related to the initial equilibrium level[1] A_0^f (scaled with the value of the gross domestic product Q_t) determines the sign and size of

[1] We have chosen for the relevant standard of comparison the net position in the initial equilibrium. Anther possible choice would have been zero debt. There is not much difference since the initial net debt/GPD ratio was low (12.7 per cent). Also, the high credit ratings of major Finnish borrowers support the choice, since they show that the international investors did not consider the initial debt as a problem.

the difference between domestic and foreign interest rates as follows:

$$r_t^d = r_t^f - \frac{A_t^f - A_0^f}{\varpi Q_t}, \tag{5.6}$$

where ϖ is the parameter which this time determines the sensitiveness of the interest rate differential to the debt factor. Now current account imbalances and thereby changes in the net debt position of the country produce permanent changes in the domestic interest rate. We consider that the portfolio adjustment model has stronger justifications in terms of the theory of finance and should therefore be preferred to the flow equilibrium model.

Compared to the effects of the tax reform in the flow equilibrium model, the initial reactions to the tax reform are alike. The tax reform discourages household saving due to the lower after-tax return, and the ensuing current account deficit raises the domestic interest rate. The perfect foresight firms now perceive, however, that the required rate of return is permanently higher. On impact, the firms reduce investment and the capital stock radically. Also the household consumption enhancement is more limited. The higher interest rate dampens the initial jump in share values and household wealth, but also moderates the negative effect of the interest income tax hike on the yield on saving, see Figures 9A, 9B and 9D.

The aggregate outcome in the market for the domestic good is that the short-term excess demand and the jump in the price are now less pronounced than both in the base case and in the flow equilibrium model. But the long-term price reaction differs, too. Even though domestic demand is even lower, while the consumption boom has faded and investment activity has adjusted to the higher return requirement, so is the supply of the domestic good. Therefore the output price declines approximately to the initial level.

One could expect that the labour income of households falls markedly because of the reduced capital stock. This is indeed the case, but at the same time steady-state consumption decreases marginally less than in the baseline case. Why is that? The explanation is the heavily increased capital incomes. Both the optimal amount of wealth and the return on financial investment are now considerably higher. The higher return on saving compensates also most of

the utility loss induced by lower wages, which explains the fairly similar utility effects in the adjacent Figure 9H.

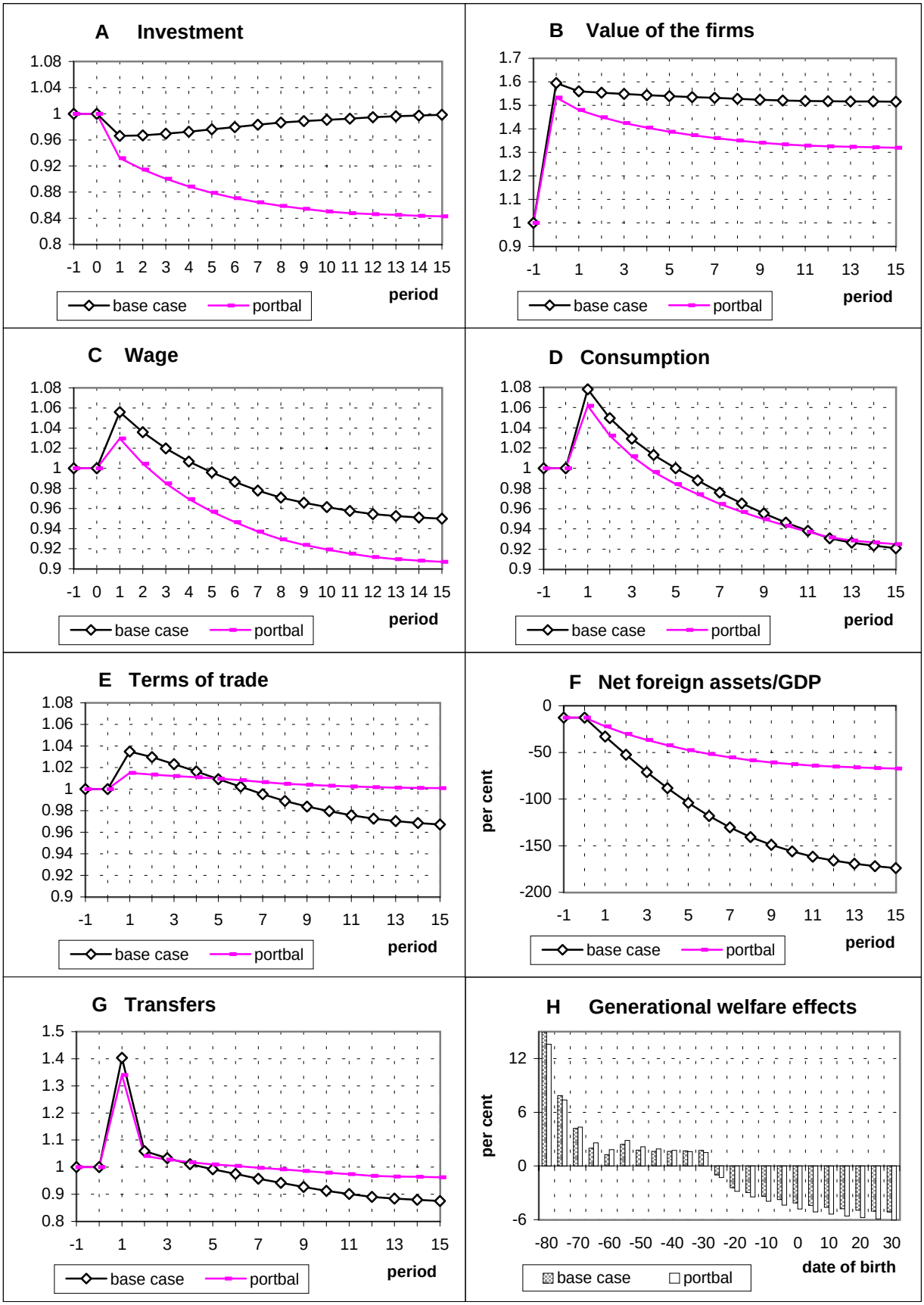
Table 5.4 The overall reform with an interest rate link to the foreign debt position

	5 years	10 years	20 years	50 years	150 years
Private production	-1.2	-2.7	-4.7	-7.0	-8.0
Imports	3.1	0.5	-2.8	-7.8	-9.9
Exports	-5.8	-5.2	-4.3	-1.3	0.1
Private consumption	6.2	3.2	-0.4	-5.7	-8.2
Investment	-6.8	-8.5	-11.1	-14.9	-16.1
Consumer price	1.1	1.0	0.8	0.2	0.0
Wages	3.0	0.5	-3.1	-8.1	-9.8
Employment	-1.6	-1.5	-1.1	0.0	0.2
Current account surplus/GDP	-1.9	-1.5	-1.1	-0.4	0.0
Terms of trade (producer price)	1.5	1.4	1.1	0.3	0.0
Household wealth	31.1	17.8	9.2	-4.3	-8.5
Interest rate	3.2	3.4	3.6	4.0	4.1

In fact, since the steady-state consumption of both goods and leisure are greater, it is not immediately clear why the utility figure shows a marginally larger permanent welfare loss. The explanation is the life-cycle timing of the welfare shifts. The labour income deprivation is discounted less than the gains in capital incomes, which accrue later in the lifetime. The higher discount rate mitigates also the importance of the losses of future generations (now 9 per cent of GDP) in the overall evaluation of the reform. The discounted sum of all the domestic welfare changes is, correspondingly, limited to -1.9 per cent of GDP.

The permanent utility shift abroad in the form of weaker terms of trade is now eliminated, but the interest cost per unit of foreign net debt is larger than in the base case. Therefore the amount of the international welfare shift is ambiguous and also sensitive to the price elasticity of foreign trade and the interest rate elasticity of capital flows.

Figure 9 The tax reform in the base case and in the portfolio balance model



The markedly smaller welfare loss of the domestic households suggests that in our case the interest rate elasticity of capital flows dampens the international shift of resources. One should, however, note, that foreign countries use the world market rate to discount the welfare outcomes from their point of view.

The open economy sensitivity analysis generates three main implications. The first insight is that if both the interest rate and the terms of trade are determined in markets where substitution is less than perfect, the need for the other price to adjust is mitigated when compared to the case in which domestic agents are price-takers in one of the markets. Price reactions also affect the adjustment paths of quantities and curb the external imbalance caused by fiscal policy measures, which is most clearly seen when one compares the simulation results in the small open economy and portfolio adjustment models.

The main welfare shifts take place in all cases between the various domestic household generations. The international welfare transfers due to the endogenous price reactions in goods and capital markets should, however, also be kept in mind. The scale of the international welfare effects depend on the relevant elasticities, but also on the openness of the economy (measured e.g. by foreign trade/GDP ratio) and the initial net foreign asset position. We know that there are no such intergenerational shifts if there are no changes in prices, i.e. in a small open economy where substitutability is perfect. The results of this study show, however, that it is not clear whether the intergenerational welfare shifts are larger if the substitutability is imperfect in just one of the markets (goods or capital) or if it is imperfect in both of them. This is because the reaction of one price dampens the need for the other to change.

The third implication concerns policy recommendations. Although private sector agents are too small to utilise implicit monopoly power in the trade of goods and capital, governments should take the endogeneity of the prices into account when carrying out tax reforms[1]. One

[1] The link between the optimal tax policy and the implicit monopoly power of the country in the international capital and goods markets has been noted also earlier. The trade literature has suggested that in the case of monopoly power it is beneficial to restrict or tax exports. Also a country which is a net demander of capital in imperfect markets (as in our case) should try to limit demand, if acting in isolation. The policy is not, however, necessarily optimal from the point of view of worldwide welfare, see e.g. Gordon and Varian (1989). The problem with comparing the results of these studies to ours is that either they are often based on static models or the households have an infinite planning horizon, which rules out intergenerational welfare shifts (among the exceptions are e.g. Engel and Kletzer 1990).

aspect, which blurs the planning, is that the optimal decision making should be able to value the utilities of different generations. In the case of international welfare shifts this is clearly seen in the variation of the terms of trade, which is often of different sign in the short and long term.

Also, the interest rate shifts have intergenerational implications. A higher interest rate transfers resources of an indebted country abroad. It might, however, benefit the future domestic generations due to higher savings and national wealth generated by current households. Therefore, the analysis of the adjustment period welfare effects is at least as important as the comparison of the steady states.

6. THE SHIFT IN THE FINANCIAL POLICY OF FIRMS

The previous sections analysed the effects of the tax reform assuming that the firms follow the "new view" guidelines in their financial strategy before and after the tax reform. As discussed earlier, the reform was, however, justified in terms of the "traditional view", claiming that double taxation of dividends increased the cost of capital. According to empirical observations, share issues were rare, indebtedness high and the profit distribution ratio was very low, which suggested that the firms preferred retained earnings and debt in investment financing before the tax reform. This was the way firms adjusted to the higher taxation of external equity finance and to the undeveloped state of the stock markets.

If we accept the new view behaviour describing the initial conditions, the remaining issue is, did firms actually shift their financial strategy after the reform. The introduction of the imputation system and the increase in the effective capital gains tax rate were supposed to encourage firms to shift towards favouring distribution of profits and financing investment with share issues.

We analyse the issue by first checking if the tax reform actually changed the cost of capital to favour share financing. Thereafter we describe how the traditional view behaviour can be implemented in the model. Finally, we simulate the FOG model assuming that the regime shift was carried out and compare the effects of the reform with and without the regime shift to find out if the welfare outcomes support the strategy shift..

6.1 Required rate of return as a justification for the regime shift

The earlier literature has justified the need for the tax reform and also the effects of the reform by calculating the cost of capital or required rate of return on investment before and after the reform. We follow this tradition and apply the tax rates presented on Table 3.1 to the equations introduced in Section 2.2.2, which describe the required rate of return on investment in the two financing regimes.

Equation (6.1) gives the required before-tax yield for investment financed by retained earnings before the reform.

$$P = r^d \frac{1-\tau^r}{(1-\tau^g)(1-\tau^{Fr})} = r^d \frac{1-0}{(1-0)\times(1-0.25)} \approx r^d \times 1.33 \ . \qquad (6.1)$$

While the tax rates on interest income τ^r and for capital gains τ^g are zero, the gap between the domestic interest rate r^d and the required rate of return is generated solely by the corporate tax τ^{Fr} on retained earnings (in our calibration the tax rates for retained and distributed earnings are equal).

After the tax reform the corresponding calculation yields:

$$P = r^d \frac{1-0.28}{(1-0.28)\times(1-0.28)} \approx r^d \times 1.39 \ . \qquad (6.2)$$

In this case the hikes in the interest income tax rate and in the capital gains tax rate cancel out, and the remaining increase in the corporate tax rate slightly raises the required rate of return[1].

The pre-tax required return on investments financed with share issues before the tax reform is presented in equation (6.3):

$$P = r^d \frac{1-\tau^r}{(1-\tau^D)(1-\tau^{Fd})} = r^d \frac{1-0}{(1-0.13)\times(1-0.25)} \approx r^d \times 1.53 \ . \qquad (6.3)$$

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[1] One should keep in mind that these conclusions are conditional on the assumptions of no inflation and taxation of capital gains on accrual.

The tax reform abolishes, however, the distortions because of the full imputation of the distributed profit and the equalisation of the interest income and corporate tax rates, as shown in equation (6.4):

$$P = r^d \frac{1-0.28}{(1-0)\times(1-0.28)} = r^d \quad , \tag{6.4}$$

In both cases the required rate of return for debt financed investment is the interest rate (when tax debt is excluded). If we consider the minimisation of the required rate of return as the criteria for selecting the means of marginal investment finance, it suggests that before the reform debt should have been preferred and after the reform both debt and share issues. The use of debt is, however, restricted because of collateral costs. Therefore some equity finance is also necessary and the above figures show that before the reform, the other marginal source of finance should have been retained earnings and after the reform it should be share issues. This is precisely the way corporate finance has been implemented in the simulation model described below.

The possibility of making the regime shift immediately leads to another conclusion: the required return for marginal investment is now lower and the optimal capital stock higher than before the reform, if the other factors of the economy do not change. The final judgement should not, however, be made before the general equilibrium effects of the reform are studied.

6.2 Behaviour of a firm following the traditional view

The optimisation problem of the corporate sector presented in Section 2.2.2 changes somewhat when the firms follow the traditional view. As in the previous case, we start the analysis from the arbitrage condition of a domestic household investor, who compares the after-tax return of bonds and firms' shares. The representative firm now uses both debt and share issues M_t to finance investment. As equation (6.5) shows, the share issues must be subtracted from the expected capital gain in order to find out the actual return:

$$r_t^d(1-\tau_{t+1}^r)V_t = (1-\tau_{t+1}^D)D_{t+1} + (1-\tau_{t+1}^g)(V_{t+1}^E - M_{t+1} - V_t). \tag{6.5}$$

Hence, the value of the firm expressed using the discounted flow of dividends also change as the share issues are taken into account. So we get:

$$V_t = \sum_{s=t+1}^{\infty} \left(\frac{1-\tau_s^D}{1-\tau_s^g} D_s - M_s\right) \prod_{v=t+1}^{s} \left(1 + r_{v-1}^d \frac{1-\tau_v^r}{1-\tau_v^g}\right)^{-1}. \tag{6.6}$$

According to the old view, the firm pays some minimum amount of dividends to the shareholders. In (6.7) it is modelled as a fixed ratio a to the after-tax earnings E_t^A net of depreciation costs:

$$D_t = a(E_t^A - dp_{t-1}^K K_{t-1}). \tag{6.7}$$

In the old view case, the value of share issues is solved from the firm's cash flow identity as follows:

$$M_t = p_t^K I_t + D_t - E_t^A - (B_t^F - B_{t-1}^F). \tag{6.8}$$

Equations (6.7) and (6.8) show that replacement investment and investment adjustment costs (subtracted from earnings) are always financed by retained earnings. If the firm retains more than necessary for that ($a < 1$), the additional amount reduces the need for share issues and raises the value of the firm's shares. Acquisition of new capital is, however, always financed by share issues. Also dividends are financed partly with share issues if $a > 1$. This is ruled out in most countries. Since negative dividends are not possible either, the value of the dividend preference parameter is between 0 and 1.

As the optimisation problem of the firm was presented already in more detail in Section 2.2.2, we continue by demonstrating the implications of the first order conditions. The condition describing the optimal use of labour has not changed. Therefore we start from the optimality condition of investment yielding:

$$\lambda_t = p_t^K + \left(1 - a + \frac{1-\tau_t^D}{1-\tau_t^g} a\right) p_t^F (1-\tau^F) G_{I,t}\,. \tag{6.9}$$

The condition (6.9) tells us that in the optimum the gains of one additional invested unit must be large enough to cover the costs, which are composed of the price of the unit of capital, p_t^K and the tax-adjusted increase in the installation costs[2].

Dividing both sides of (6.9) by the price of the capital and carrying out the derivation, we get Tobin's marginal q:

$$q = \frac{\lambda_t}{p_t^K} = 1 + (1 - a + \frac{1-\tau_t^D}{1-\tau_t^g} a)\ \frac{p_t^F}{p_t^K}\ (1 - \tau^F)\ \xi \frac{I_t}{K_{t-1}}. \qquad (6.10)$$

In this old view case the dividend preference parameter a complicates the corresponding marginal q equation (6.10) somewhat. If there were no investment adjustment costs in the steady state, the equilibrium value for Tobin's marginal q would be one. This describes one of the main old view assumptions: in equilibrium the non-tax gains of dividends and the losses due the higher taxation of dividends are equally large and investors are indifferent between retained earnings and share issues, which implies that the value of an additional capital unit is the same as the repurchasing price, see Zodrow (1991).

Investment adjustment costs bring about new results. The market valuation of a marginal unit of capital is higher than one except in the very rare case of negative gross investment. Another point is that personal capital income taxation has interesting implications. If a maximum amount of dividends is distributed ($a = 1$), as in our case the investment adjustment costs do not affect the amount of share issues, but reduce with full amount the earnings available for distribution. In this case, the latter term on the right hand side of the marginal q equation (6.10) is similar to that of the corresponding new view equation and, independently of the adopted view, shifts in personal tax rates have identical effects via investment adjustment costs to the valuation of the marginal capital unit.

On the other hand, the smaller the value of a, the larger the role the investment adjustment costs have in reducing retained earnings and in increasing the need for share issues.

[2] Equations (6.7) and (6.8) represent a simplified version of the formulation used by Goulder and Summers (1989). From the point of view of the interpretation of equation (6.9), the main difference is that in their study the investment adjustment costs are always financed with share issues. In that case personal capital income taxation does not affect the shadow value of capital independently of the value of the dividend preference parameter.

When $a = 0$, adjustment costs increase the need for share issues by a full amount and the personal capital income taxation has no effect on the valuation of the capital unit. But this does not mean that the overall need for issues increases, when less dividends are distributed. This is because an increasing amount of retained earnings helps to finance the acquisition costs of a new capital unit. In fact, in a no-growth steady state share issues are negative, when $a < 1$, which means that the generated capital gain is distributed with share repurchases ($M_t < 0$). In a growing economy the need for share issues is zero if the amount of retained earnings covers both the costs of replacement investment and the share of the costs of additional capital units which is not financed with debt.

The old view average q is now[3]:

$$\frac{V_t}{p_t^K K_t} = \frac{\lambda_t}{p_t^K} - b \,. \tag{6.11}$$

If this is transformed to describe the value of the firms, it simplifies to (6.12):

$$V_t = K_t \lambda_t - B_t^F \,. \tag{6.12}$$

Transforming equation (6.10) somewhat gives the investment equation (6.13), which states that gross investment will be positive as long as Tobin's marginal q is greater than one:

$$I_t = \left(\frac{\lambda_t}{p_t^K} - 1 \right) K_{t-1} \left[(1 - a + \frac{1-\tau_t^D}{1-\tau_t^g} a)(1 - \tau_t^F)\, \xi\, p_t^F \right]^{-1} . \tag{6.13}$$

The optimality condition of capital is correspondingly transformed to equation (6.14) describing the path of the shadow value of capital:

$$\begin{aligned} \lambda_t = \Bigg\{ & \left(1 - a + \frac{1-\tau_{t+1}^D}{1-\tau_{t+1}^g} a \right) \left[(1 - \tau_{t+1}^F)\, (p_{t+1}^F (F_{K_t} - G_{K_t}) - p_t^K (r_t^d b + d)) \right] \\ & + p_t^K (d - b) + b p_t^K (1 + r_t^d \, \frac{1-\tau_{t+1}^r}{1-\tau_{t+1}^g}) + \lambda_{t+1} (1 - d) \Bigg\} \left(1 + r_t^d \frac{1-\tau_{t+1}^r}{1-\tau_{t+1}^g} \right)^{-1} . \end{aligned} \tag{6.14}$$

---

[3] The derivation is in principle similar to that in the new view case presented in Appendix 1.

It is again clarifying to combine the two first order conditions, stated in equations (6.9) and (6.14), and to study the outcome in a steady state. Equation (6.15) shows the equality between the before-corporate-tax value of the marginal product of capital and costs as follows:

$$p^F(F_K - G_K) = p^K\left[d + br^d + (1-b)r^d \frac{1-\tau^r}{a(1-\tau^D)(1-\tau^F)+(1-a)(1-\tau^g)(1-\tau^F)} \right] + \\ + r^d \frac{1-\tau^r}{(1-\tau^g)(1-\tau^F)}(1-\tau^F)\, p^F G_I + dp^F G_I. \tag{6.15}$$

The dividend distribution decision now influences the cost of the equity-financed portion of capital. Comparing equation (6.15) to the corresponding one in the new view case (equation 2.24), we see that if $a = 1$, the only difference is that the dividend tax rate has replaced the capital gains tax rate (if the corporate income tax rates of distributed and retained profits are identical) leading to the original old view version of the cost of equity financed capital, see equation 2.6.

If $a = 0$, no dividends are distributed and the dividend tax is neutral. In this case earnings are distributed via share repurchases and the required rate of return on capital is exactly the same as in the new view model (but the valuation of capital and the marginal source of investment finance are not). In what follows, we will set $a = 1$ implying that after the Finnish tax reform shareholders prefer dividends to capital gains, because they are taxed less (the dividend pay-out ratio actually increased strongly after the tax reform). We do not need, therefore, the justifications generally provided by the old view for the dividend preference, but we do have to rule out excess dividend distribution financed with share issues, i.e. we cannot allow a to be greater than one.

The second row in equation (6.15) is exactly similar as in the new view case (in equation 2.24), since the investment adjustment costs are always financed by retained earnings. Therefore the interpretations of the impact of the tax reform are also similar. On the other hand, if these costs were financed with share issues, the terms including derivatives of the investment adjustment cost function G would be multiplied by tax factors involving the effects of dividend taxation and the dividend pay-out parameter a. It would mean that after the tax reform the overall cost of capital would be lower and the capital stock higher.

Secondly, if the adjustment cost function is formulated so that there were additional costs only during a transition phase, as e.g. in Keuschnigg and Kohler (1994), the value of the derivatives of the investment adjustment cost function G will approach zero when the economy converges to the new steady state.

6.3 Simulation results

The regime-shift simulation studies the outcomes of a simultaneous implementation of the tax reform and the financial strategy transition from the new view type of behaviour to the old view behaviour. The tax reform includes a minor hike in the corporate income tax, a big drop in the dividend income tax and an even larger but equal increase in the interest income and capital gains tax rates. The shift in behaviour means that firms start to use share issues together with debt as sources of finance for marginal investment, continue to finance replacement investment due to depreciation and the investment adjustment costs by retaining earnings and distribute the rest of the earnings as dividends. The simulation results are characterised in the adjoining Figure 10 with the legend *regime shift* and in Table 6.1 below.

Some of the responses of firms and households to the tax reform can be seen even before running the general equilibrium simulation, just by looking at the equations described above. Equation (6.15) shows that the fall in the dividend tax rate to zero and the equal hike in the corporate and interest income tax rates means that the required rate of return on a new capital unit financed with share issues declines to the level of the domestic interest rate. Financing the investment adjustment costs still with retained earnings, however, prevents this part of the cost of capital descending.

Correspondingly, equation (6.9) illustrates that a higher corporate tax rate reduces the value of existing capital due to lower after-tax investment adjustment costs. This is, however, dominated by the tax-induced increase in the financing costs of installation, which are enhanced both due to the fall in the dividend tax rate and the rise in capital gains taxation (since $a = 1$), exactly as in the new view case[4].

[4] Both the simulations omit the effect of unrealised capital gains, which would lower the currently living shareholders' welfare.

Table 6.1 The results of the tax reform when firms shift their financial strategy

	5 years	10 years	20 years	50 years	150 years
Private production	-1.3	-1.0	0.0	2.2	3.1
Imports	5.9	4.1	1.7	-2.9	-5.0
Exports	-12.8	-9.4	-3.4	9.9	16.1
Private consumption	5.8	3.8	1.1	-4.0	-6.7
Investment	0.3	0.9	1.9	3.6	4.4
Consumer price	2.6	1.9	0.6	-1.7	-2.8
Wages	5.3	3.9	1.9	-1.6	-2.8
Employment	-1.8	-1.5	-0.6	1.0	1.4
Current account surplus/GDP	-4.0	-3.5	-2.8	-1.0	0.0
Terms of trade (producer price)	3.5	2.5	0.9	-2.3	-3.7
Household wealth	24.8	10.6	-0.3	-19.4	-26.1

It is important to note that also the mere shift in financial strategy raises the value of extant capital due to share issue financing of the acquisition of a new capital unit. Before the reform and the strategy shift the cost was lower owing to the impact of taxation (the value of the tax factor $(1-\tau^D)/(1-\tau^g)$ was smaller than 1, while after the regime shift taxation does not have any role, compare equations 2.19 and 6.9)[5]. Anyway, the tax-reform-based jump in the costs of financing a purchase of a new capital unit and thereby also in the value of the extant capital is smaller than without the regime shift.

The major hike in the interest income tax rate has similar effects on the savings motives of households as in the new view case. Hence, the current value of the household wealth is again too large, which stimulates consumption, the incentive being relatively more intense the older the household is.

The simulation results show that labour supply also declines in spite of the rise in the wage rate. This forces firms to adjust by limiting production. There are two factors which tend to reduce initial investment: the minor hike in the corporate tax rate and the diminished labour supply. But the shift in financing behaviour in favour of share issues means that the fall in the

[5] The same applies to installation costs, i.e. a mere regime shift would raise the value of old capital due to more expensive financing of the installation costs if they were financed by share issues in the replaced regime.

dividend tax lowers the acquisition cost of capital. An increase in the investment rate is supported also by the jump in the price of the domestic good, which increases firms' revenues more than costs.

The permanent increase in investment demand, the initial large jump in consumption and the fall in production generate excess demand for both the domestic and the foreign good, which leads to an increase in imports and to a deep fall in exports. The induced deficit in foreign trade prompts again a considerable rise in net foreign debt.

The labour supply and consumption reactions reverse gradually when the excessive wealth has been consumed and new young household generations enter the economy. So do the trends in the terms of trade. Households increase labour supply in the long term above the initial level, since they have to save for old age at a lower yield. The higher capital stock raises the productivity of labour, but the lower output price dominates and the wages fall permanently.

Tax revenues jump in the first period due to the capital gains taxation, which leads to a large increase in transfers. Later, although public sector labour costs are smaller, the decrease in tax revenues caused by the fall in the value of consumption, total wages and household wealth leads to a considerable reduction in the value of transfers which balances the government budget.

The changes in the generational incidence of the tax burden can be analysed using Figure 10H. The welfare outcomes for the currently living households depend largely on the amount of wealth and the portfolio composition at the time of the reform. All those households (except the youngest generation) gain from the revaluation of the capital stock. The young households benefit also since they have net debt and the deductibility of the interest expenditures increases. Some of the middle-aged generations, however, lose since the higher interest income tax rate cuts their after-tax interest incomes significantly[6]. Future generations must consume less leisure and goods since their labour and capital incomes and transfers are lower.

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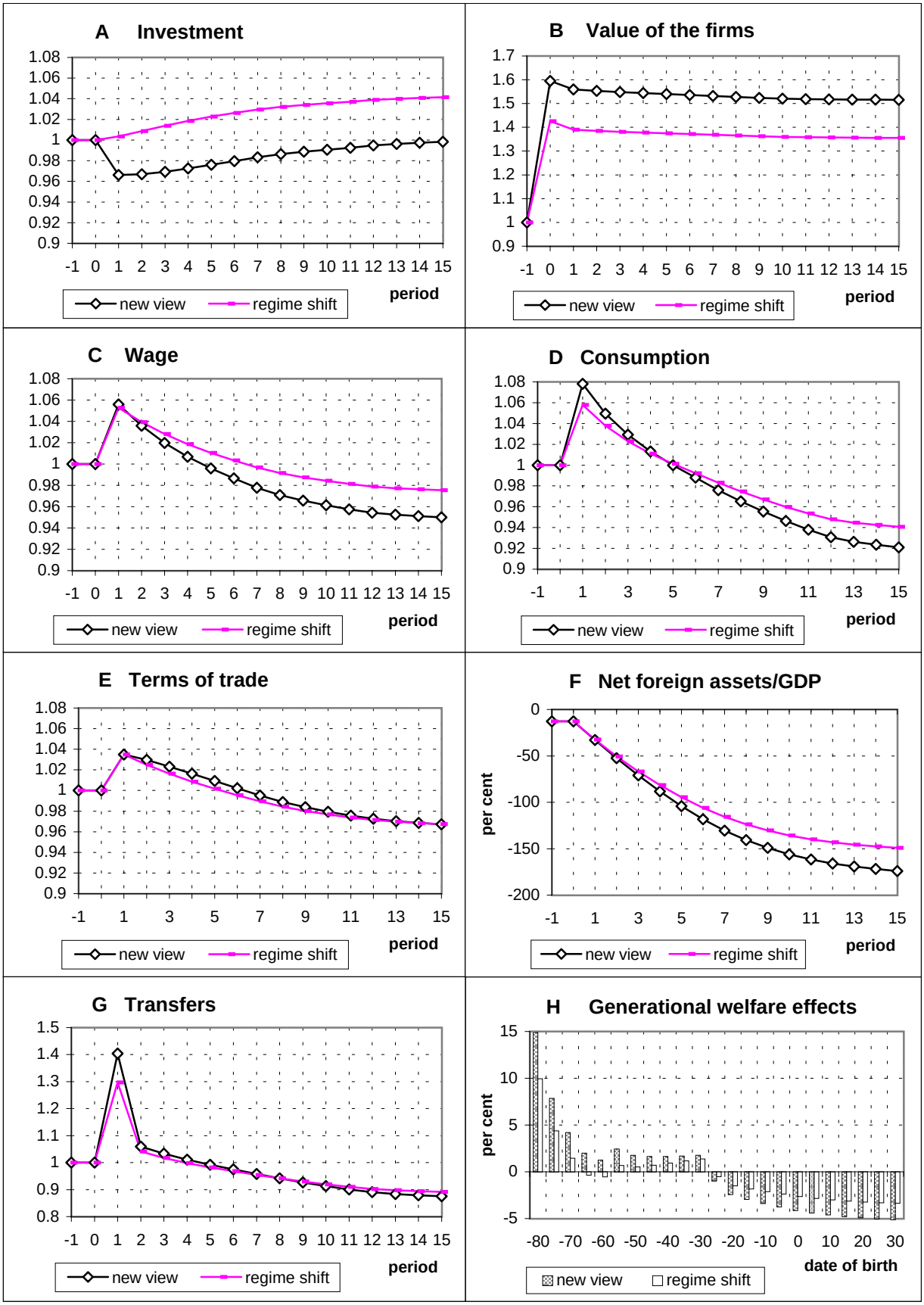
[6] If the amount of bonds had been generationally equal in the initial portfolios and firms' shares had varied in proportion to wealth, the gain of the oldest generations would have been somewhat larger and the young ones would have lost. At any rate, the permanent welfare loss of future households is not sensitive to the composition of the initial portfolios.

Figure 10 The tax reform in the new view and in the regime shift case



6.4 Is minimisation of the required rate of return an appropriate objective?

The regime shift was based on the minimisation of the cost of capital and it provides the desired results in terms of increasing the capital stock. One should, however, raise the question of whether this behaviour leads also to the maximisation of firms' value and households' utility. Policy optimality can be checked by comparing the outcomes of the tax reform in Figure 10, which presents the outcomes in the baseline case of no regime shift with the legend *new view*.

The results show that, even though the capital stock is lower, the value of firms is higher, when firms continue to follow the new view policy. The higher share value is based on the fact that the tax reform raises the acquisition costs of new capital financed with retained earnings. Therefore the old capital is valued more[1].

There are also two kinds of positive valuation factors in the regime shift case, but their aggregate influence is markedly smaller than in the unchanged regime. The first is due to the fact that the taxation no longer lowers the financing cost of acquiring a new capital unit. The second is that in our model the installation costs are financed with retained earnings generating a similar impact on the value of old capital as in the case of an unchanged financial strategy.

The utility comparison is also very interesting. The higher jump in the value of the firms improves the welfare of the currently living generations in the *new view* case. Future generations suffer more, however, because of the smaller capital stock. Is the regime shift in this case really carried out? It seems that the majority of existing shareholders would vote against the regime shift and future owners are not there to vote[2].

This conclusion is even more likely if also the investment adjustment costs were financed with share issues in the regime shift case. Another supporting case is the one in which inter-

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[1] This result is also noted e.g. by Sinn (1987 Ch. 10.6) and Turnovsky (1990) in closed economy models and by Nielsen and Sørensen (1991) in a small open economy. A similar contradiction between the value of new and old capital has been detected also in case of corporate income taxation, see e.g. Goulder and Thalmann (1990) and Bovenberg and Goulder (1993).

[2] See Lassila and Valkonen (1995) for an analysis of majority voting in computable OLG models.

nal financing is preferred for non-tax reasons, e.g. if external financing is more expensive because of transaction costs or because of asymmetric information between the insiders of the firm and the outside investors, see Myers and Majluf (1984).

From the point of view of efficiency one should note that if the firms carry out the regime shift, they reduce the distortion created by taxation in the investment decision of the firms. The major tax burden imposed on savings remains nonetheless. Actually, the general equilibrium repercussions from the reduced after-tax yield on savings support investment somewhat, since the increased labour supply reduces unit labour costs and raises the productivity of capital.

The overall conclusion of the simulations is that even though firms can reduce the tax burden on investment by shifting their financial strategy, thereby also diminishing the intergenerational resource transfer generated by the tax reform, the welfare loss created by reduced saving dominates the outcomes. The aggregate discounted sum of compensating transfers is in the regime shift case 4.0 per cent of GDP, while in the new view case 4.2 per cent of GDP. This shows that although the macroeconomic impacts of the tax reform are sensitive to the financial strategy of the firms, the negative aggregate welfare outcome is not.

We would obtain somewhat more favourable efficiency results by allowing the firms to also finance the investment adjustment costs by share issues. This would limit further the intergenerational transfer of resources. It is, however, very unlikely that the overall welfare outcome would change. Another point is that in this case the smaller jump in share prices would make the alternative of not making the regime shift even more attractive.

7. SUMMARY AND CONCLUSIONS

The starting point for the Finnish corporate and capital income tax reform was similar to that in many other Western countries. The previous tax system aimed to promote those investments which were seen as most important for a fast developing country with a shortage of capital and an aversion for foreign debt. The tax scheme was, however, also loaded with many other targets such as regional policy, income redistribution and the smoothing of business cycles. It was also strongly linked to other regulatory policy measures such as the control of capital movements and domestic credit rationing.

It is difficult to analyse and describe the complex incentive system associated with the previous corporate tax rules. Our strongly simplified interpretation is that the effective tax rates were much lower than the high statutory ones both due to allowances and the possibilities to avoid the burden by tax planning. Therefore, the initial distortions from the point of view of investment were not so intense, but they restricted substantially the portfolio choices of households and financial strategies of firms. The outcome was that firms financed their investment with debt and retained earnings, leaving little room for dividend distribution and new share issues.

The need for tax reform became evident when confidence in the superiority of the government and central bank to maximise welfare with strong regulation and an incentive system gradually faded. Also the development of financial markets made it impossible to continue the control. The radicalism of the reform was, however, surprising compared to earlier domestic tax reforms and also to international examples. The reform included the transformation to a dual income tax system and an implementation of markedly lower, flat, equal statutory tax rates and a wider tax base. The third innovation was the partial integration of

corporate and personal capital income taxation by adopting a full imputation of paid corporate taxes in dividend taxation.

Eliminating the tax concessions and roughly halving the statutory rates actually increased significantly taxation of capital gains and interest incomes. Also, the effective corporate tax rate rose somewhat. Only the effective dividend tax rate was reduced. Since the reform capital gains have been markedly more heavily taxed than dividends, which is not in line with the circumstances where the leading theories of corporate taxation have been created. The reform also created an incentive to reconsider the financial strategy of the firms. The earlier studies of the impacts of the Finnish tax reform have been primarily aimed nevertheless to find out the change in the cost of capital assuming that firms continue to hold on to their initial financial structure.

Our approach is more comprehensive. We have taken into account that firms actually can shift their financial strategy from the "new view" type to the "old view", as the planners of the reform supposed. The old view behaviour was formulated so that the investments which expand the capital stock are financed with share issues, but replacement investments and investment adjustment costs are still financed with retained earnings. It turns out that the shift in the strategy does lower the cost of capital but does not maximise the value of the firms.

The conflict between the two objectives cannot be analysed without considering the overall impacts of the behaviour of the firms on the welfare of the households, which are both owners of capital and labour. In addition, since the tax reform reduced the yield on household saving through the after-tax return on interest bearing assets, it is essential to also study their saving and labour supply decisions. Furthermore, we cannot ignore the fact that Finland participates in international markets for goods and capital. These prerequisites led us to develop a specific version of the numerical dynamic open economy general equilibrium model FOG (Finnish Overlapping Generations) and to simulate the model in order to find out the macroeconomic and intergenerational welfare effects of the tax reform.

The study discusses thoroughly the saving and investment decisions in this type of model when at the same time the essential behavioural equations, budget constraints and the market

conditions of the model are specified. The household generations are modelled to make optimal forward looking rest-of-lifetime consumption, labour supply and bequest decisions to maximise their utility. The objective of firms is to maximise their value. It turns out that the financial strategy is also important along with the production and factor demand decisions. We present the applications of the new and the old view strategies in an open economy general equilibrium framework and clarify the issue of financing the investment adjustment costs.

After describing the main elements of the tax reform, the study proceeds by presenting the effects of shifting the corporate income tax, interest income tax, dividend tax and the capital gains tax one by one assuming that the firms follow the new view. The macroeconomic results of the minor hike in the corporate tax rate are as expected since investment and the market value of the firms fall both in the short and the long term. The welfare results need, however, to be explained because the currently living generations lose, but the future ones gain. This gain is based mostly on the capitalisation of the higher tax in share prices, which allows future generations to benefit from the larger corporate tax revenues and still get the same net yield on investments in the firms' shares. Another route for a welfare improvement is the reduced supply of the domestic good, which improves the terms of trade. Without these international and intergenerational welfare shifts, the efficiency loss generated by the higher cost of capital would dominate.

The impacts of the rise in the interest income tax rate are strongly conditional on how the financial markets are structured and operate. If in a small open economy foreign investors were dominant owners of capital and the interest rate was determined abroad, a tax on saving would not affect the cost of capital. On the other hand, in a closed economy it would raise the interest rate and reduce investment.

In our base case model domestic household investors consider domestic bonds and firms' shares as substitutes and the domestic interest rate is fixed to the one prevailing in international markets. Therefore, an increase in interest taxation lowers the required rate of return on physical investments and the discounting factor of future dividends. Hence, the market value of the firms and household wealth rises. It also reduces the yield on existing bond wealth and discourages saving. The discrepancy between actual and optimal wealth generates a

consumption boom. In the long term the reduced saving and higher investment produces a higher foreign debt and a shift from capital incomes to labour incomes.

The welfare outcomes of an interest income tax hike are unfavourable to almost all generations. The losses among the currently living households is connected to the amount of wealth and especially to the share of bonds in their portfolios. The welfare loss of future domestic household generations is caused by the lower yield on saving and the inherited higher foreign net debt, which is reflected in weaker terms of trade. The efficiency implications are ambiguous *ex post*, since although the tax creates a distortion in the saving decision, it also neutralises the negative impact of the corporate income tax on the cost of capital. But since almost all generations lose and the gain of the few winners is small, we can be confident that there is a reduction in overall efficiency.

The third part of the tax reform is a reduction in the dividend tax rate. It has no direct impact on the cost of capital, but generates a windfall revaluation gain to the current shareholders, as the new view suggests. Households react to higher wealth by temporarily increasing consumption and reducing labour supply. The improved welfare is financed by future households, since the loss in dividend tax receipts reduces their income transfers. The general equilibrium feedback creates a slight deviation from the investment neutrality result: there is a minor increase in investment if interest rates are fixed, but a somewhat larger reduction in the portfolio balance model.

The introduction of a capital gains tax rate enhances the cost of new capital units, but leaves the cost of existing capital intact, which raises its market value. The result is a reduction in the capital stock but a revaluation in share prices. This startling response improves the welfare of current generations but causes a welfare loss to future ones.

We simulated the one-by-one tax reforms also assuming that the measure is announced one period before the implementation. The overall consequence is that the firms try to adjust the tax base beforehand. The adjustment possibility reduces the jump in the value of the firms and the subsequent intergenerational welfare transfer. The benefits of adjusting are limited by

the fact that the firms are restricted in the model to accommodate via profit distribution and investment decisions instead of also using bond markets.

Another sensitivity analysis concerning the before-tax-reform portfolio composition of the various household age cohorts shows that the intergenerational welfare results are indeed very sensitive to the assumption of equal distribution of ownership, which implies that the valuation of shares has a substantial role in the tax reform analysis. Both sensitivity analyses described above generate long-term results that are identical to those in the baseline case.

The next task was to simulate the impacts of the overall reform. All the personal capital income tax changes raise the market value of the firms, and therefore the amount of household wealth. The saving incentive is, nevertheless, weakened by the interest income tax. Therefore, the driving force of the short-term impacts of the tax reform is household dissaving. The income effect is so strong that the reduced motivation to supply labour is reflected also in production. The optimal amount of capital is not markedly affected in the long run since the interest income tax negates the impact of the capital gains tax on the cost of capital and investment does not depend on domestic saving in this open economy.

The overall tax reform improves the welfare of all the currently living households, except the youngest, which has no wealth at the time of the reform. The relative gain is largest for the oldest generations. The positive impacts of the capital gains and dividend tax rate changes outweigh the negative ones created by the higher corporate income and interest income taxes. All the future generations lose, which implies that the intergenerational welfare shift explains most of the variation in welfare. A calculation of the overall welfare results as a discounted sum of the transfers, which would compensate the welfare shifts, confirms that the losses are larger than the gains. The negative efficiency conclusion is supported by the observation that the reform does not affect markedly the cost of capital, but distorts strongly saving decision.

The open economy sensitivity analysis suggests that in the portfolio balance model the higher interest income compensates largely for the loss in labour income caused by the smaller capital stock. Therefore the welfare outcome is considerably less affected than the macroeconomic results. Another notable observation is that the need for the goods market and

labour market prices to adjust is much less pronounced if part of the adjustment takes place in the financial markets. On the other hand, fixing the terms of trade reduces substantially the intergenerational resource transfer from future domestic household generations. It also accelerates the adjustment speed, since it leaves out the dampening and postponing impacts of the price variation.

Imperfect substitutability of domestic and foreign goods and financial capital also raises the issue of whether countries should plan tax reforms in a such way that they can benefit from the international welfare transfers associated with the price changes, or should the policies be co-ordinated to maximise welfare internationally. Our study shows that this decision is complicated by the fact that the short- and long-run terms of trade outcomes can be of a different sign. The scale of the price effects emphasise the importance of also studying the transition period.

Even though one might guess that the substitution elasticity of saving and labour supply are very important at least for the short-term macroeconomic results, it turns out that in the used forward-looking model their impact is less essential than the assumption of interest rate formation in the economy. Also, the sensitivity analysis concerning the other central parameter values shows that the macroeconomic and welfare outcomes of the benchmark model are fairly robust.

Limiting the analysis to changes in marginal tax rates (which are also assumed to be the average rates), to the possible financial strategy shifts and to induced general equilibrium effects is not totally fair to the planners of the tax reform, because there were other elements in the reform which simplified the tax rules, reduced the other distortions of taxation and limited the incentives and possibilities to avoid taxes. Taking into account uncertainty could give further results, e.g. a rise in the capital gains tax rate mitigates the risks associated with variation of the value of the firms.

The simulations described above have all used the assumption that firms do not shift their financial strategy in order to minimise the cost of capital. The next step in our study was to determine the outcomes of the tax reform if firms actually followed the guidelines given by the

planners of the reform and started to distribute more dividends and to use share issues to finance investments.

As there is no uncertainty, liquidity constraints or asymmetric information in our model, the tax factors determine the financial strategy unambiguously. This means that if the object is to minimise the cost of capital, firms would distribute after the tax reform all dividends allowed by the reporting conventions. We deviate from this rule slightly and assume that in addition to replacement investment, also investment adjustment costs are financed by retained earnings and only the purchasing costs of new investments are financed with share issues. This assumption moderates the difference between our interpretation of the new and the old view strategies.

We have not considered here one of the important objects of the tax reform, which was to reduce the indebtedness of firms. If firms continue to follow the new view policy, the tax reform creates a minor incentive to increase indebtedness. But if the aim is to minimise the costs of capital, the regime shift reduces the pressure to use debt.

The analysis of the first order conditions shows that the shift in the financial strategy raises the value of the firms somewhat even without the tax reform. In addition to that comes the tax-reform-driven jump associated with financing of the investment adjustment costs, just as in the new view case. The aggregate revaluation of the old capital is not, however, as large as in the earlier simulations. Another main difference is that the tax reform and regime shift lowers the cost of capital and motivates firms to increase their capital stock. These differences imply that the initial consumption boom is mitigated. The long-term simulation results show that the higher capital stock allows for a smaller fall in wages and consumption.

Current household generations gain less by the reform due to the lower revaluation effect, but future ones suffer less because of the higher labour incomes. These incomes are based on the improved efficiency in investment conditions, since the required rate of return on investments falls close to the interest rate. The distortion in the saving decision is, however, again present and therefore the overall outcome is still negative in the long run. The overall welfare

outcome of the analysis is thus that the reform should not have been implemented at all independently of the financial strategy of the firms.

The next question is whether firms actually have carried out the regime shift. If we strictly follow the welfare of the current shareholder, it turns out that the regime shift will never be made even though it improves efficiency and reduces the loss of future households. This is because current households can benefit from the larger intergenerational resource shift from future households by continuing to follow the previous strategy. If we had allowed the firm to also finance the investment adjustment costs by share issues, the tax distortion in investment decisions would be totally abolished, but since this would also moderate the jump in share prices, the regime shift would be even less likely.

It is useful to next discuss some of the limitations of the study and suggestions for future development of the analysis. A natural candidate for improvements in any CGE study is to add a more detailed structure to the model and to carry out a more precise calibration. In our case one of the main tasks would be to distinguish the capital income subject to the described tax rules from that which is taxed some other way. This would mitigate the aggregate impacts of the reform markedly. Also, since the reduction in saving is large, introduction of precautionary saving might improve the quantitative accuracy of the results.

Another issue is to add more industries and household types to analyse intra-industrial and intragenerational incidence of taxation. The driving forces of the welfare outcomes could also be presented in more detail, as has been done by Fehr (1998). Last but not least, an interesting issue would be to study the aggregate impact of the financial market deregulation and the tax reform, especially the impact of increased foreign ownership of Finnish firms on the required rate of return on investments.

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Appendix 1 Some details of the model

A1.1 Pension system

The pension system relates pensions to earnings during working years. The normal pension is the share θ of a pension wage. The share θ depends generally on the number of working years but is here held constant. The pension wage is determined by the wage levels both during the persons' working years and pension years. Let the normal working time be:

$$1 - l^p = \frac{1}{T_w} \sum_{t=1}^{T_w} (1 - l_t) \qquad \text{(A1)}$$

and the pension wage:

$$w^p = \frac{\sum_{t=1}^{T_w} \Phi_t (1 - l_t) e_t w_t}{1 - l^p} , \qquad \text{(A2)}$$

where $\sum_{t=1}^{T_w} \Phi_t = 1$.

The pension z in period t is now:

$$z_t = \theta (1 - l^p)(w^p)^{\psi} (w_t)^{1-\psi} , \qquad \text{(A3)}$$

where $0 \leq \psi \leq 1$.

The weights Φ determine the pension rights averaging period. If the person has employment with one employer only, it roughly would mean that Φ_8 is equal to unity and all other weights are zeros. In practise, all coefficients are positive, but Φ_8 is the largest. The number of five-year working periods T_w is 8. The parameter ψ describes pension indexing: the used value $\psi = 0.5$ indicates that pensions are halfway indexed to current wages.

A1.2 Derivation of the connection between tax-adjusted Tobin's marginal q and average q in the new view case

We start from the first order condition of the shadow value of capital (equation 2.23), which is multiplied by the amount of capital stock K_t.

$$K_t\lambda_t = \begin{aligned}&\left\{\frac{1-\tau^D_{t+1}}{1-\tau^g_{t+1}}\Big[(1-\tau^F_{t+1})(p^F_{t+1}K_t(F_{K,t}-G_{K,t})-r^d_t bp^K_t K_t)-bp^K_t K_t+\tau^F_{t+1}dp^K_t K_t\Big]\right.\\&\left.+\frac{1-\tau^D_t}{1-\tau^g_t}bp^K_t K_t(1+r^d_t\frac{1-\tau^r_{t+1}}{1-\tau^g_{t+1}})+\lambda_{t+1}(1-d)K_t\right\}\left(1+r^d_t\frac{1-\tau^r_{t+1}}{1-\tau^g_{t+1}}\right)^{-1}.\end{aligned} \tag{A4}$$

Using the definition of the firm's debt (equation 2.7) and the accumulation condition of capital (2.16) yields:

$$K_t\lambda_t\left(1+r^d_t\frac{1-\tau^r_{t+1}}{1-\tau^g_{t+1}}\right) = \begin{aligned}&\frac{1-\tau^D_{t+1}}{1-\tau^g_{t+1}}\left\{(1-\tau^F_{t+1})\Big[p^F_{t+1}K_t(F_{K,t}-G_{K,t})-r^d_t B^F_t\Big]-B^F_t+\tau^F_{t+1}dp^K_t K_t\right\}\\&+\frac{1-\tau^D_t}{1-\tau^g_t}B^F_t(1+r^d_t\frac{1-\tau^r_{t+1}}{1-\tau^g_{t+1}})+\lambda_{t+1}K_{t+1}-\lambda_{t+1}I_{t+1}\end{aligned} \tag{A5}$$

Next steps are to use the first order conditions for labour (2.18) and investment (2.19) to get:

$$K_t\lambda_t\left(1+r^d_t\frac{1-\tau^r_{t+1}}{1-\tau^g_{t+1}}\right) = \begin{aligned}&\frac{1-\tau^D_{t+1}}{1-\tau^g_{t+1}}\Big\{(1-\tau^F_{t+1})\Big[p^F_{t+1}(K_tF_{K,t}+L^F_{t+1}F_{L,t+1})-(1+\tau^l_t)w_{t+1}L^F_{t+1}\\&-r^d_t B^F_t-p^F_{t+1}(K_tG_{K,t}+I_{t+1}G_{I,t+1})\Big]+\tau^F_{t+1}dp^K_t K_t-p^F_{t+1}I_{t+1}-B^F_t\Big\}\\&+\frac{1-\tau^D_t}{1-\tau^g_t}B^F_t(1+r^d_t\frac{1-\tau^r_{t+1}}{1-\tau^g_{t+1}})+\lambda_{t+1}K_{t+1}.\end{aligned} \tag{A6}$$

Utilising the homogeneity of production and investment adjustment technologies generates:

$$K_t\lambda_t\left(1+r^d_t\frac{1-\tau^r_{t+1}}{1-\tau^g_{t+1}}\right) = \begin{aligned}&\frac{1-\tau^D_{t+1}}{1-\tau^g_{t+1}}\Big\{(1-\tau^F_{t+1})\Big[p^F_{t+1}(F_{t+1}-G_{t+1})-(1+\tau^l_t)w_{t+1}L^F_{t+1}-r^d_t B^F_t\Big]\\&\Big|+\tau^F_{t+1}dp^K_t K_t-p^F_{t+1}I_{t+1}+B^F_{t+1}-B^F_t\Big\}\\&+\frac{1-\tau^D_t}{1-\tau^g_t}B^F_t(1+r^d_t\frac{1-\tau^r_{t+1}}{1-\tau^g_{t+1}})+\lambda_{t+1}K_{t+1}-\frac{1-\tau^D_{t+1}}{1-\tau^g_{t+1}}B^F_{t+1}.\end{aligned} \tag{A7}$$

Next we can use the definitions of earnings (2.10) and dividends (2.15) and divide both sides of the equation with the discounting factor:

$$K_t\lambda_t = \left(\frac{1-\tau^D_{t+1}}{1-\tau^g_{t+1}}D_{t+1} - \frac{1-\tau^D_{t+1}}{1-\tau^g_{t+1}}B^F_{t+1} + \lambda_{t+1}K_{t+1}\right)\left(1 + r^d_t\frac{1-\tau^r_{t+1}}{1-\tau^g_{t+1}}\right)^{-1} + \frac{1-\tau^D_t}{1-\tau^g_t}B^F_t. \tag{A8}$$

Solving (A8) forward and ruling out explosive path of firm's debt gives:

$$K_t\lambda_t = \sum_{s=t+1}^{\infty}\left(\frac{1-\tau^D_s}{1-\tau^g_s}D_s\right)\prod_{v=t+1}^{s}\frac{1}{1+r^d_{v-1}\left(\frac{1-\tau^r_v}{1-\tau^g_v}\right)} + \frac{1-\tau^D_t}{1-\tau^g_t}B^F_t. \tag{A9}$$

As we can see the first term on the right hand side of (A9) corresponds to the definition of the value of firms, V_t, presented in equation (2.9). Therefore, we finally get:

$$V_t = K_t\lambda_t - \frac{1-\tau^D_t}{1-\tau^g_t}B^F_t\ . \tag{A10}$$

A1.3 Time notations in the model

It is essential to describe precisely the conventions associated with the timing of flows and stocks in discrete time models. The timing notations are the more important the longer is the unit period in the model. In our model, stocks, which are inherited from the previous period and are in use during the current period t are denoted with the subscript $t-1$. The flow generated during the period is added to the stock at the end of the period.

For example, investment and depreciation of the capital stock during the current period do not affect production capacity until the next period. This feature is essential for the supply side reactions of the first period and imitates the practice of short-term models to keep the capital stock constant. The implications, however, differ since in a forward looking dynamic model this rigidity is understood to be temporary.

Another example is the debt stocks and interest rate flows. The current period saving and investment decisions affect the current period interest rate, which together with the end-of-period debt stock determines the interest payments executed in the beginning of the next period.

Taxation is carried out in the same period in which the income is available to be used or goods are consumed. The only exception is the capital gains taxation, which is based on the difference between the expected value of the firm at the end of the current period and the value of the firm in the beginning of the period. The surprise jump in the value of the firms at the time new information is released at the end of a period creates an obligation to pay the corresponding capital gains tax during the next period.

Appendix 2 Sensitivity analysis

As discussed in Section 2.2.5, sensitivity analysis is an essential part of any CGE simulation study due to uncertainty about the relevant model structure, functional forms and parameter values. In what follows, we concentrate on those features of the model, which we consider to be the most important for the implications of the study. These are the open economy assumptions and some preference and technology parameters. The macroeconomic outcomes of the simulations are presented in Tables A1 - A6 and the corresponding welfare results in Figures A1 - A6. Our aim is not to go into details but indicate some of the main outcomes.

The presented tables describes the results from the new steady state of the economy. The first column (*baseline*) describes the outcomes in the baseline case, where the terms of trade is endogenous and the domestic interest rate is determined from abroad. The second column (*smallopen*) assumes that the country is a price-taker also in the market for the export good. The third column (*portfolio balance*) gives the results from a model version in which the terms of trade is endogenous and the deviation of the foreign net debt from its initial level determines the interest rate differential between the domestic and the world market interest rate. In the last column the intertemporal substitution elasticity has been lowered from 0.5 to 0.4 (*low gamma*). The interest rate variable presents the level in percentage points, the current account surplus/GDP variable describes the relative deviation from the original equilibrium in percentage points, while the other variables describe per cent deviations.

In all the cases the new equilibrium is independent of the timing of announcement and implementation of the measure. The main problem in sensitivity analysis is that a shift in some parameter value almost always changes the initial equilibrium. Restoring the equilibrium is problematic, since it requires typically that also some other parameter value must be changed (see e.g. Bernheim et al. 1991). In our case the original equilibrium is the same only in the cases of an exogenous vs. endogenous interest rate, which are initially calibrated so that the domestic and foreign interest rates are equal. We have studied in detail the problems caused by the shift in the initial equilibrium and suggest that the results of the sensitivity analysis should be interpreted more qualitatively than quantitatively.

A2.1 Simulations based on changes in individual tax rates, macroeconomic results

Table A1 Sensitivity analysis 1: corporate income tax hike

	baseline	smallopen	portfolio balance	low gamma
Private production	-0.4	-0.5	-0.2	-0.4
Imports	0.0	-0.3	0.0	-0.1
Exports	-0.9	-0.9	-0.4	-0.8
Private consumption	0.1	0.0	0.0	0.1
Investment	-0.7	-0.8	-0.3	-0.7
Consumer price	0.2	0.0	0.1	0.2
Wages	-0.1	-0.4	0.0	-0.1
Employment	-0.1	-0.1	-0.1	-0.1
Terms of trade (producer price)	0.2	0.0	0.1	0.2
Household wealth	0.0	-0.3	-0.8	-0.1
Transfers	1.5	1.3	1.3	1.6
Interest rate	3.0	3.0	3.0	3.0

Table A2 Sensitivity analysis 2: interest income tax hike

	baseline	smallopen	portfolio balance	low gamma
Private production	4.8	5.2	0.0	4.9
Imports	-1.3	2.0	-2.1	-0.2
Exports	12.9	13.3	3.7	10.7
Private consumption	-3.4	-2.0	-2.4	-2.2
Investment	8.9	9.9	-0.2	9.0
Consumer price	-2.2	0.0	-0.7	-1.9
Wages	0.8	4.7	-1.1	1.5
Employment	0.9	0.8	0.1	0.9
Terms of trade (producer price)	-3.0	0.0	-0.9	-2.5
Household wealth	-23.8	-21.0	-11.5	-20.6
Transfers	-5.7	-2.3	0.7	-6.1
Interest rate	3.0	3.0	3.6	3.0

Table A3. Sensitivity analysis 3: cut in the dividend tax rate

	baseline	smallopen	portfolio balance	low gamma
Private production	0.5	0.6	-0.8	0.5
Imports	-1.1	-0.3	-1.1	-1.0
Exports	3.0	3.1	0.3	2.9
Private consumption	-1.2	-0.9	-0.8	-1.2
Investment	0.4	0.6	-2.0	0.4
Consumer price	-0.6	0.0	-0.1	-0.5
Wages	-0.9	0.0	-1.4	-0.9
Employment	0.5	0.4	0.2	0.5
Terms of trade (producer price)	-0.7	0.0	-0.1	-0.7
Household wealth	-1.0	-0.2	3.0	-0.8
Transfers	-5.5	-4.7	-4.5	-5.6
Interest rate	3.0	3.0	3.1	3.0

Table A4. Sensitivity analysis 4: introduction of a capital gains tax

	baseline	smallopen	portfolio balance	low gamma
Private production	-5.3	-5.3	-7.4	-5.3
Imports	-6.0	-6.2	-6.2	-5.9
Exports	-1.0	-1.1	-5.4	-1.2
Private consumption	-4.8	-4.9	-4.3	-4.7
Investment	-10.5	-10.5	-14.2	-10.4
Consumer price	0.2	0.0	1.0	0.2
Wages	-6.1	-6.4	-6.9	-6.0
Employment	-0.1	-0.1	-0.5	-0.1
Terms of trade (producer price)	0.3	0.0	1.4	0.3
Household wealth	-5.2	-5.5	0.5	-5.3
Transfers	0.0	-0.3	1.7	0.2
Interest rate	3.0	3.0	3.2	3.0

The common observation in all the tables above is that since in the small open economy case price reactions other than wage changes are ruled out, the quantities respond more to the tax reform than in the baseline case. Also, the shift in the wage rate is larger in most cases.

The outcomes from the portfolio balance model differ most strikingly. In cases where the personal capital income tax has been changed, the jump in the value of the firms leads to a temporary consumption boom, to a permanently larger foreign net debt and to a higher interest rate. On impact, saving does not fall as much but investments decline. This reaction is familiar to closed economy models: even in cases where the cost of capital has not changed directly because of taxation, a tax which cuts saving also reduces investments via a higher interest rate.

The lower intertemporal elasticity of substitution implies that the hump-shaped life-time income profile is smoothed less by saving and dissaving in the initial equilibrium. Thereby the response of saving to a reduction in the after-tax yield is also less pronounced.

Welfare results

Figure A1 shows that the main welfare effects of a corporate income tax rate hike are not sensitive to the openness of the economy. The international and intergenerational resource shifts to future generations are smallest if the interest rate and the price of the exported good do not deviate from the ones prevailing in international markets.

In the case of an interest income tax hike openness has an essential role. The portfolio balance model gives a somewhat subdued intergenerational transfer due to the dampening interest rate reaction. In the small open economy case the initial jump in share prices is smaller, giving less relief to the welfare loss caused by the smaller interest incomes.

Figure A1 Sensitivity of generational welfare effects, corporate income tax hike

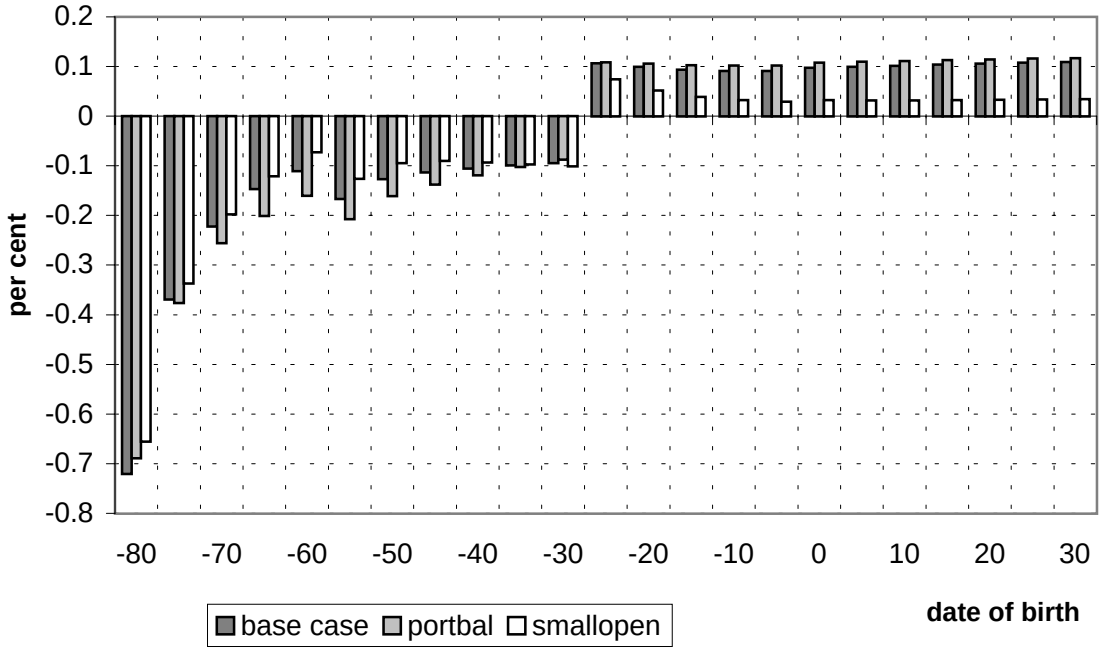


Figure A2 Sensitivity of generational welfare effects, interest income tax hike

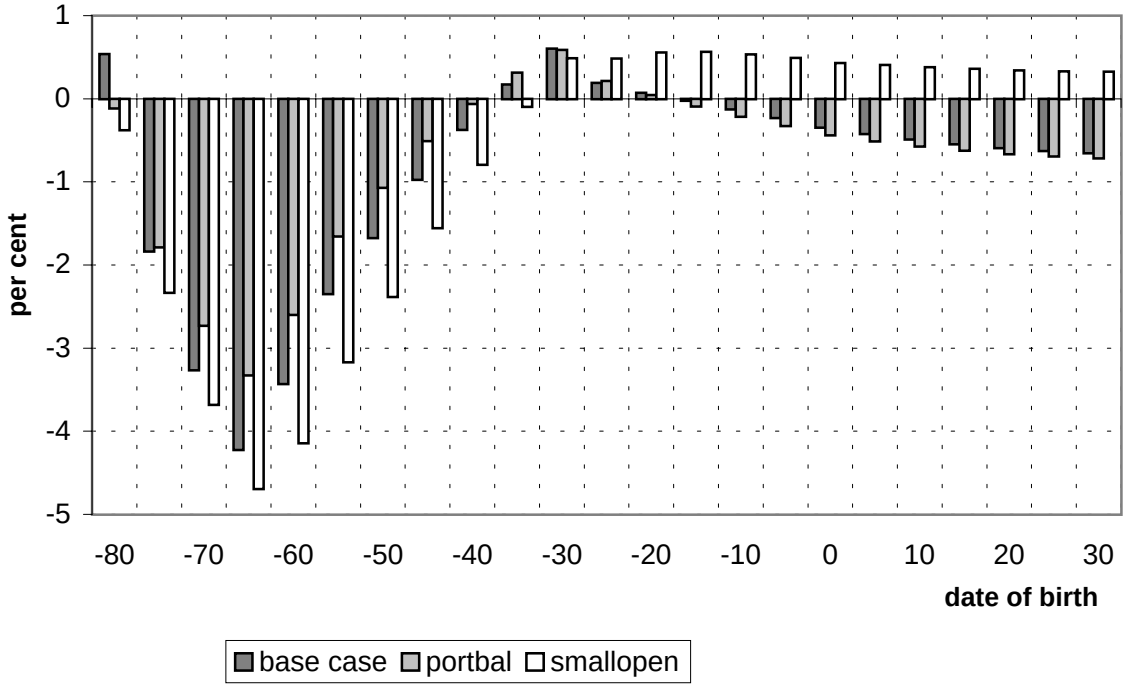


Figure A3 Sensitivity of generational welfare effects, reduction in dividend tax

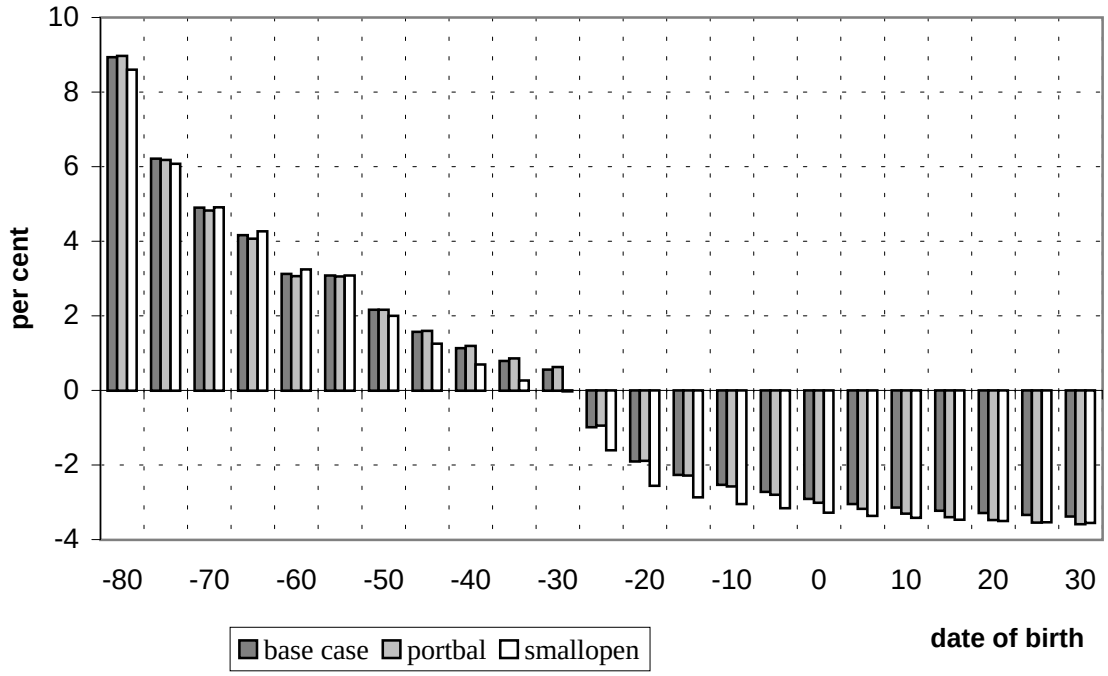
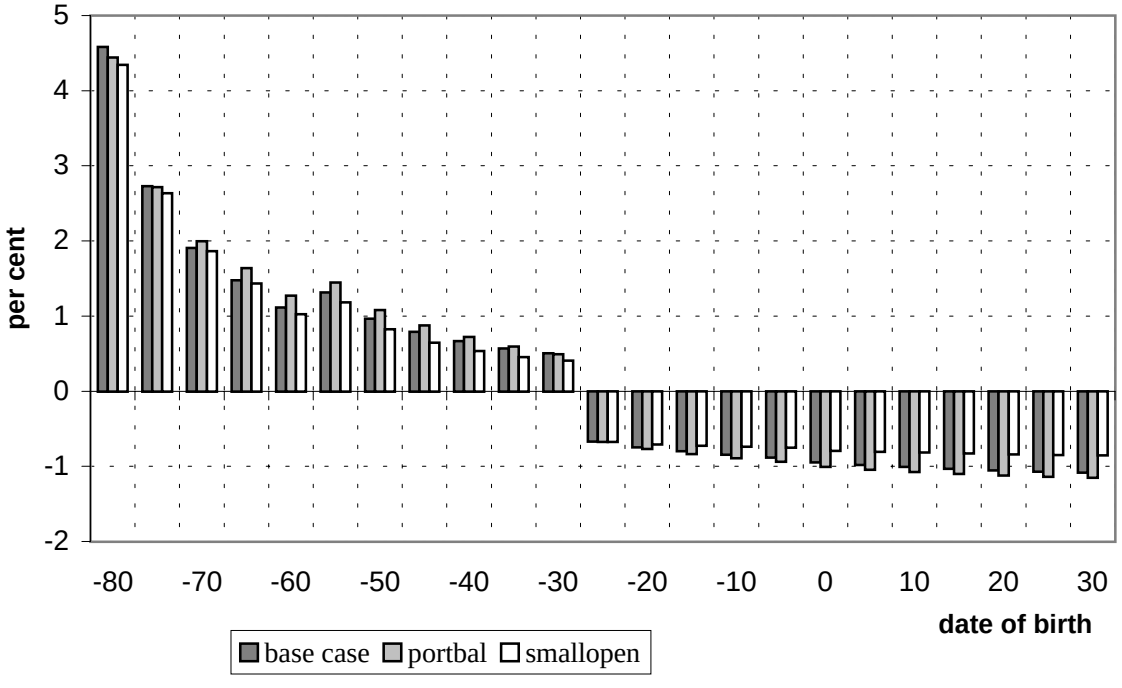


Figure A4 Sensitivity of generational welfare effects, capital gains tax hike



The future generations gain, since there is no negative shift in terms of trade and the intergenerational shift of resources is bigger. When the price effect is missing, the equilibrium capital stock is larger and real wage higher, which more than compensate the welfare loss due to the lower yield on saving.

The overall utility results do not markedly change in cases of simulated dividend tax reduction and introduction of a capital gains tax, if the assumptions about the openness of the economy are changed. The most interesting innovation is the smaller welfare gain of a few currently young generations and the larger loss of some future generations in the small open economy case presented in Figure A3. These outcomes are due to the dampened real wage reaction. The base case results seems to be very often in between the outcomes of portfolio balance model and small open economy model independently of the tax policy measure.

A2.2 Simulations of the overall reform

Macroeconomic results

The sensitivity analysis is expanded here to also cover the elasticity of substitution between capital and labour in production (*low beta*) and elasticity of substitution between leisure and consumption (*low rho*). Both elasticities are lowered from value 0.8 to 0.6. The impacts of the shift in capital/labour elasticity to the capital/labour ratio were neutralised by adjusting the share parameter in the production function. The numbers in tables indicate again the impacts in the new equilibrium.

As explained in Section 5.1, the driving forces of the tax reform in the new view case are the capitalisation of tax changes into the value of the firms and the fall in the after-tax yield on household saving. If the outcomes of the reform are supposed to be sensitive to alternative price formation processes or values of key behavioural parameters, their impact must be linked to the reactions to these driving forces.

Table A5. Sensitivity analysis 5: the overall tax reform in the new view case

	baseline	smallopen	portfolio balance	low gamma	low beta	low rho
Private production	1.2	1.7	-8.0	1.3	1.6	0.7
Imports	-7.7	-3.6	-9.9	-6.6	-7.6	-7.8
Exports	16.9	17.4	0.1	14.4	17.3	16.6
Private consumption	-8.9	-7.3	-8.2	-7.8	-9.2	-8.7
Investment	0.2	1.4	-16.1	0.4	0.8	-0.4
Consumer price	-2.9	0.0	0.0	-2.5	-2.9	-2.8
Wages	-5.4	-0.7	-9.8	-4.7	-5.7	-5.2
Employment	1.6	1.5	0.2	1.6	1.7	1.2
Terms of trade	-3.8	0.0	0.0	-3.3	-3.9	-3.8
Household wealth	-27.8	-24.5	-8.5	-24.6	-28.1	-21.7
Transfers	-14.0	-9.9	-4.4	-14.4	-15.3	-10.2
Interest rate	3.0	3.0	4.1	3.0	3.0	3.0

Since the findings of the base case and alternative open economy assumptions were discussed already in Section 5.3, we concentrate on the cases where the reactions of households and firms are dampened by lowering the substitution elasticities. Table A5 shows that the lower elasticity of substitution between consumption of various periods (*low gamma*) gives a more subdued reaction to the fall in the after-tax yield on saving and thereby more wealth and consumption.

With lower substitutability between capital and labour (*low beta*) the increased labour supply depresses the wage rate more. The results of lower substitutability between leisure and consumption (*low rho*) are in odds with expectations, since it seems that now the substitution effect dampens the income effect in labour supply more than in the baseline case.

This interpretation is, however, incorrect. It is the weaker income effect which causes employment to increase less. The pressure to increase labour income is smaller due to the smaller loss in capital revenues and transfers.

Table A6. Sensitivity analysis 6: the overall tax reform in the regime shift case

	baseline	smallopen	portfolio balance	low gamma	low beta	low rho
Private production	3.1	3.7	-4.5	3.2	3.1	2.5
Imports	-5.0	-1.0	-6.7	-3.9	-4.9	-5.2
Exports	16.1	16.6	2.0	13.7	15.7	15.5
Private consumption	-6.7	-5.1	-5.7	-5.6	-6.7	-6.6
Investment	4.4	5.7	-9.4	4.6	4.1	3.8
Consumer price	-2.8	0.0	-0.4	-2.4	-2.7	-2.7
Wages	-2.8	1.9	-6.2	-2.1	-2.6	-2.5
Employment	1.4	1.3	0.3	1.4	1.6	1.0
Terms of trade	-3.7	0.0	-0.5	-3.2	-3.6	-3.5
Household wealth	-26.1	-22.8	-8.7	-22.8	-26.1	-19.8
Transfers	-12.0	-7.9	-3.3	-12.4	-13.0	-8.1
Interest rate	3.0	3.0	3.9	3.0	3.0	3.0

Sensitivity analysis of the regime shift simulation is presented in Table A6. In this case tax capitalisation is less intense and there is an additional driving force generated by the lower cost of capital. The larger capital stock helps to limit the fall in wages caused by the increased labour supply. In a small open economy wages are also supported by the fixed export price. In the portfolio balance model the interest rate jump hits investments, but supports at the same time saving so that the higher capital income more than compensates the loss in labour income and both goods and leisure are consumed more than in the baseline case.

The implications of lower intertemporal (*low gamma*) and intratemporal (*low rho*) substitution of consumption and leisure are similar to those in the new view case. The *low beta* results demand more explanation. Imitation of the initial equilibrium requires that the lower substitution elasticity must be compensated with a lower contribution of capital in production in order to reach the same K/L ratio. The lower contribution parameter dominates in the formation of the marginal product of labour. Hence, labour is more productive in the margin. Therefore the same increase in goods production can be generated by increasing the amount of labour more and the amount of capital less than in the baseline case while still not

losing as much in wages. Compared to the corresponding new view simulation the difference is the increase in the capital stock which raises the marginal product of labour further.

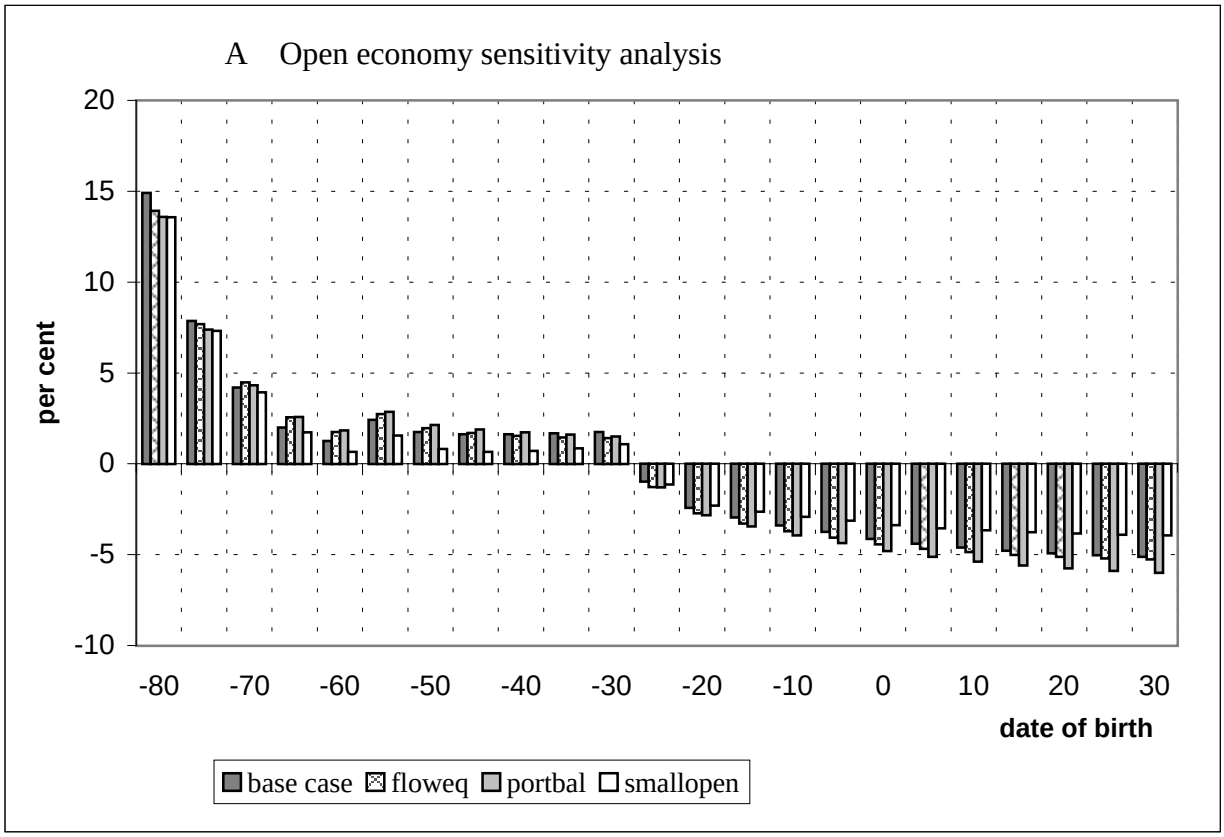
Welfare results

Figures A5 and A6 indicate that the outcomes of the sensitivity analysis from the point of view of welfare are largely independent of the chosen financial strategy. Ruling out the initial rise in the price of the export good (*smallopen*) reduces the welfare gain of the working-age households both due to the dampened jump in stock prices and the lower real wage. But since the long-term deterioration in the terms of trade is also avoided, the welfare loss of future generations is smaller. If firms shift their financial strategy, the share price jump is even smaller and there are some current generations which lose. As in all other cases the larger bequests raise the welfare of the 50-55 year-old generation.

Low intertemporal substitution seems to increase the welfare gain of the elderly households living at the time of the implementation of the tax reform. This is, however, due to the smaller amount of bonds in the household portfolios in the initial calibrated equilibrium and the following larger jump in household wealth. A similar but reversed interpretation problem applies to the low substitution between consumption of goods and leisure: The lower welfare gain of the elderly is due to their larger bond wealth, which dampens the relative impact of the share price jump in total income.

Taking into account the problems associated with the changed initial equilibrium leads to the conclusion that the welfare outcomes are quite robust to changes in key behavioural parameters and the openness of the economy. The macroeconomic results are, however, sensitive to the price formation mechanisms.

Figure A5 Sensitivity of generational welfare effects, overall reform in the new view case



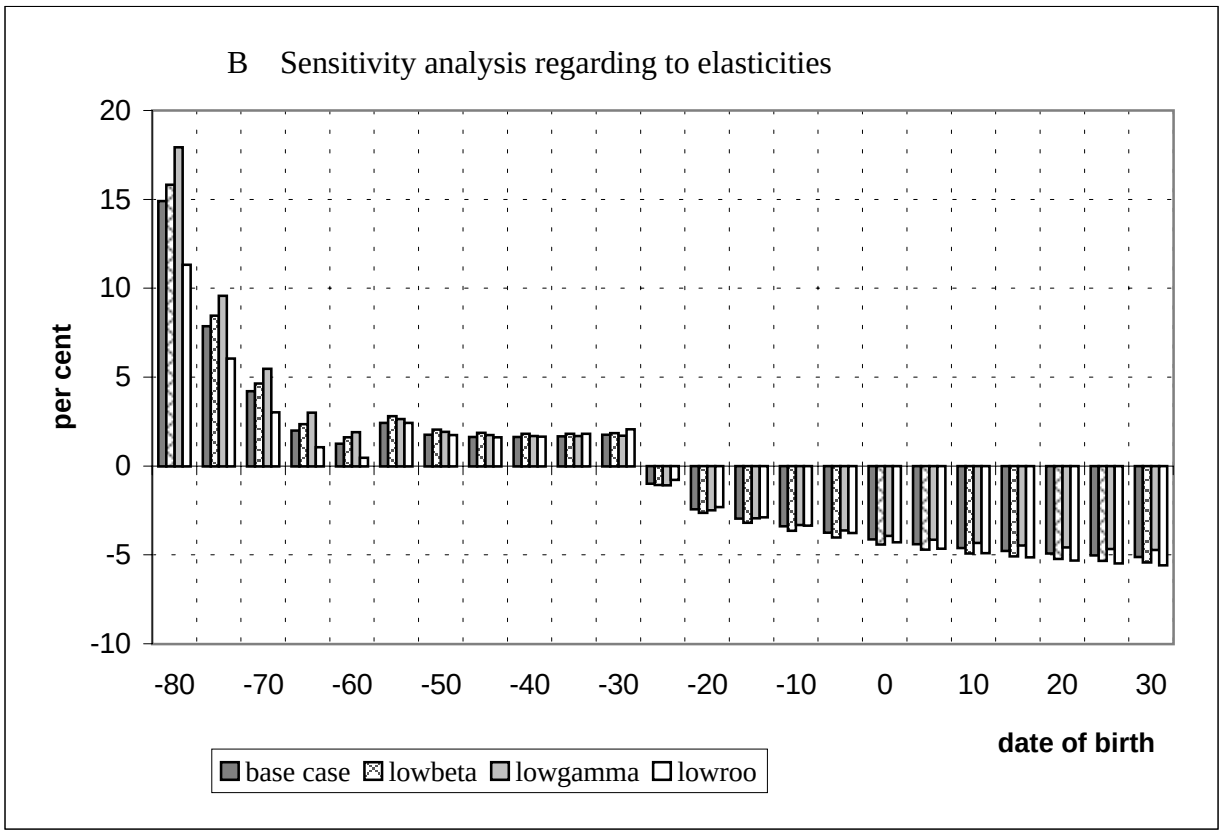
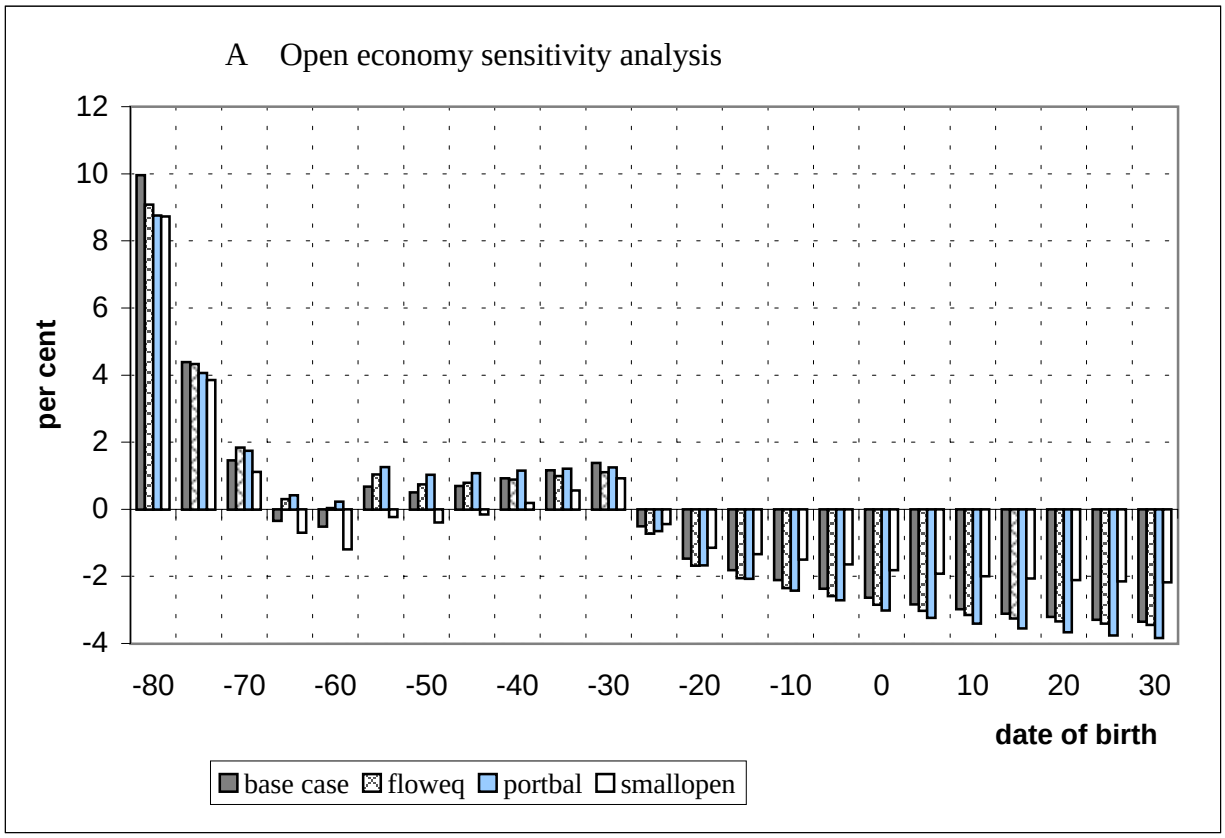
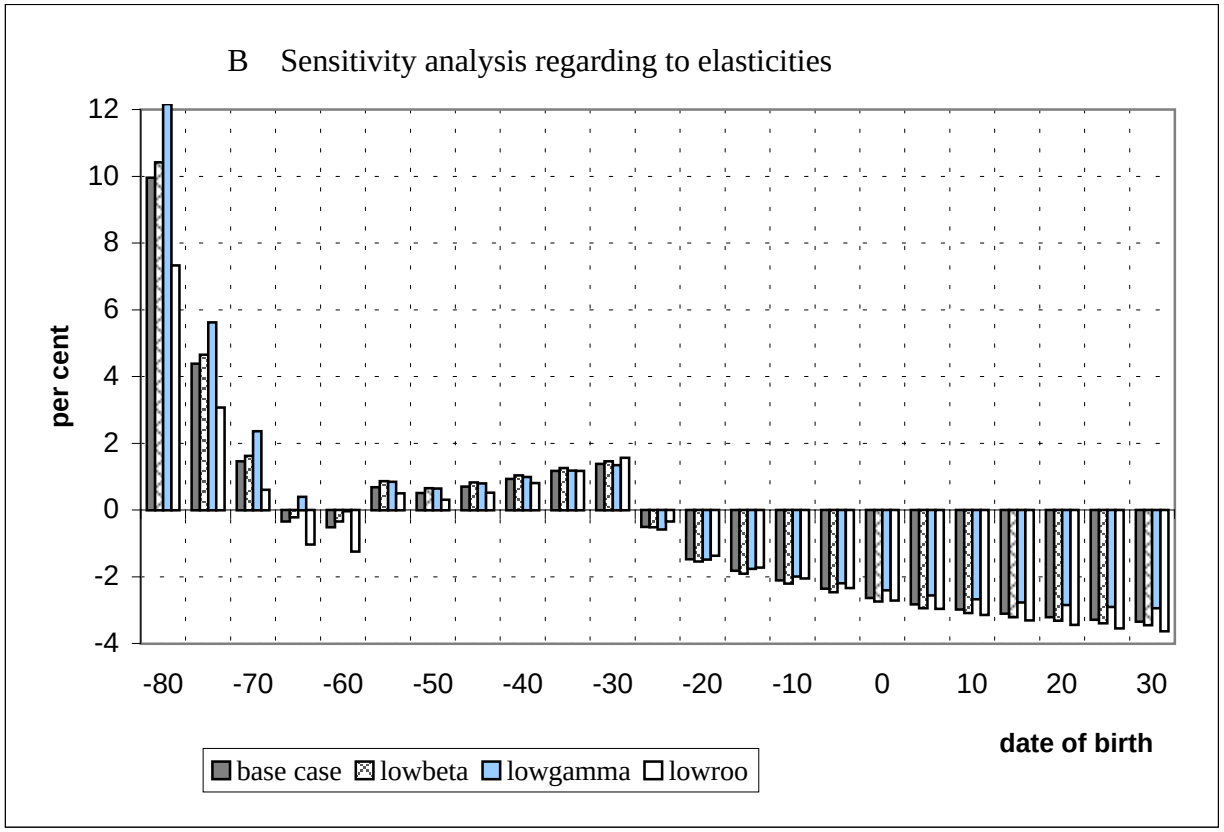


Figure A6 Sensitivity of generational welfare effects, overall reform in the regime shift case





Appendix 3 List of model variables and parameters

Variables

	FIRMS
K	capital stock of firms
Y	gross production of the domestic good
G	installation costs
F	net production of the domestic good
p^F	price of the value added
V	market value of firms' shares
D	dividends
B^F	firms' debt
I	investments
E^A	earnings
M	share issues
λ	shadow value of capital
q	Tobin's marginal q
	PRODUCT MARKETS
i^d	demand of the domestic good in investment use
i^m	demand of the imported good in investment use
p^K	price of the composite investment good
c^d	demand of the domestic good in consumption use
c^m	demand of the imported good in consumption use
p^C	price of the composite consumption good
v^d	demand of the domestic good in intermediate use
v^m	demand of the imported good in intermediate use
p^v	price of the composite intermediate good
p^d	price of the domestic good
p^m	price of the imported good
	FOREIGN TRADE AND INTEREST RATE
X	exports
m	imports
A^f	net foreign assets
r^d	domestic interest rate
	LABOUR MARKETS
L^F	private employment
L^G	public employment

L	aggregate labour supply
w	wage rate
	ONE HOUSEHOLD
c	consumption
l	leisure
u	periodic utility
U	lifetime utility
z	pension
n	bequest
s	transfer
	AGGREGATES
C	consumption
W	aggregate household wealth
N	bequest
B^h	household bonds
	PENSION SYSTEM
τ^l	employer's pension contribution
l^p	average leisure
w^p	pension wage
Z	aggregate of paid pensions
H	value of the pension fund's assets
	GOVERNMENT
B^g	public debt
S	transfers
	OTHER VARIABLES
Q	gross domestic product
T^W	last period of working-age

Parameters

personal income tax	τ^w	0.28
value added tax	τ^C	0.25
dividend income tax	τ^D	0.13 - 0
interest income tax	τ^r	0 - 0.28
capital gains tax	τ^g	0 - 0.28
corporate income tax	τ^F	0.25 - 0.28
bequest tax	τ^B	0.1
depreciation rate (yearly)	d	0.09
installation cost parameter	ξ	2
share of the value of firms' capital financed by debt	b	0.6
share parameter of the dividend policy	a	1
input-output coefficient for the composite intermediate good input	ζ	0.1
labour share parameter of the value added production function	ε	0.35
elasticity of substitution between labour and capital	β	0.8
scale parameter for net production	A	1
share parameter of domestic good for consumption	υ^C	0.75
share parameter of domestic good for investment	υ^K	0.75
share parameter of domestic good for intermediate use	υ^v	0.75
elasticity of substitution between imported and domestic good in consumption	σ^C	0.99
elasticity of substitution between imported and domestic good in investment	σ^K	0.99
elasticity of substitution between imported and domestic good in intermediate use	σ^v	0.99
scale parameter of export demand	x	0.6
price elasticity of export demand	σ^X	-4
foreign interest rate (yearly)	r^f	0.03
sensitivity parameter of capital movements	ϖ	3
elasticity of intertemporal substitution of consumption	γ	0.5
elasticity of substitution between consumption and leisure	ρ	0.8
rate of time preference (yearly)	δ	0.0185
leisure preference parameter	α	0.81
bequest preference parameter	μ	1.6
age-dependent working efficiency	e	0.6 - 1.2
share of full pension to pension wage	θ	0.6
pension indexing parameter	ψ	0.5
pension rights averaging period	Φ	0.02 - 0.86