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**CORPORATE AND CAPITAL INCOME
TAX REFORM IN A NUMERICAL
OVERLAPPING GENERATIONS MODEL:
THE CASE OF FINLAND**

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ABSTRACT: The effects of the recent Finnish corporate and capital income tax reform are studied with a computable overlapping generations model. The capitalisation effect of the taxes considerably increases the older generations' wealth and welfare. Young and future generations suffer permanently from the induced lower real wage. The losses in production are large during the adjustment period, but the steady-state impact on capital stock is small. These results are sensitive to the assumptions regarding the tax rates prevailing prior to the tax reform, bequests and the degree of the openness of the economy.

KEY WORDS: computable overlapping generations model, corporate and capital income taxation

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TIIVISTELMÄ: Tutkimuksessa arvioidaan Suomen yritys- ja pääomaverotuksen muutoksen vaikutuksia sukupolvien väliseen tulonjakoon ja kokonaistaloudellisiin muuttujiin numeerisen sukupolvimallin avulla. Tulosten mukaan osinkotulojen verotuksen keventäminen ja myyntivoittoverotuksen kiristäminen lisäävät olemassaolevan pääomakannan arvostusta ja siten yritysten osakkeiden arvoa. Lyhyellä aikavälillä vanhempien ikäluokkien varallisuuden kasvu johtaa kulutuksen kasvuun, kotimaisen hinta- ja korkotason nousuun sekä vaihtotaseen alijäämään. Pitkällä aikavälillä nuorille ikäluokille ja tuleville sukupolville jää kasvanut ulkomainen velka sekä heikko vaihtosuhde ja siitä johtuva alentunut reaali-palkkataso. Pysyvät vaikutukset talouden pääomakantaan ja tuotannon tasoon ovat vähäiset, mutta sopeutumisjaksolla menetykset tuotannossa ovat huomattavat. Tulokset ovat herkäät muun muassa oletuksille perinnöistä, talouden avoimuuden asteesta ja ennen verouudistusta käytössä olleista veroasteista.

ASIASANAT: numeerinen limittäisten sukupolvien malli, yritys- ja pääomatulojen verotus

SUMMARY

This study evaluates the effects of the recent Finnish corporate and capital tax reform on inter-generational distribution and macroeconomic variables using a computable overlapping generations model. In this preliminary stage of the study the results should be interpreted more as a description of the mechanisms of the model than quantitative estimates of the effects of the reform. The study includes, however, many interesting findings, which have a certain correspondence to the Finnish boom and bust of the last ten years.

The corporate and capital income tax reform profoundly changed the foundation of operations for the Finnish firms. The effects of the reform were studied intensively already at the end of the last decade, but the analyses could not capture the essential saving and investment effects properly, because a dynamic general equilibrium model was not used. The central features of the model used in this study are households' utility maximising life cycle planning, maximisation of the value of the firms, slow adjustment of the capital stock, equilibrium in all markets in every period and the openness of the economy.

The results show that the main effects of the reform are caused by the capitalisation of the taxes to the value of the firms. Tightening the taxation of capital gains and easing the taxation of dividends increases the value of the existing capital stock and thereby the value of the firms' shares. The jump in the wealth of the older generations increases consumption in the short term considerably, which leads to a current account deficit and a jump in the domestic price and interest rate. The younger and future generations suffer a welfare loss because in the long run the foreign debt is higher, the terms of trade are weaker and the real wage is lower. Permanent effects on the capital stock and production are small, but the production losses during the adjustment period are significant.

The results are sensitive to the assumptions of: the tax rates prevailing before the reform, the way in which the market value of the firms is determined, the sectoral distribution of the share wealth, bequests and the openness of the economy. The next stages of the study will concentrate on improving the model to imitate the Finnish economy more closely and on a more extensive sensitivity analysis of the central assumptions. Also including the effects of the other parts of the Finnish tax reform and the liberalisation of the financial markets in the analysis would be rewarding if the objective is to give a more precise description the recent important institutional changes in Finland.

This study is a part of a joint project of The Research Institute of the Finnish Economy and the Ministry of Social Affairs and Health. Also the Academy of Finland and the Yrjö Jahnsson Foundation have contributed to the financing of the project. The aim of the project is to build a computable overlapping generations model describing the Finnish economy in order to analyse aspects of social security, taxation and the public debt.

YHTEENVETO

Tutkimuksessa arvioidaan Suomen yritys- ja pääomaverotuksen muutoksen vaikutuksia sukupolvien väliseen tulonjakoon ja kokonaistaloudellisiin muuttujiin numeerisen sukupolvimallin avulla. Nyt raportoitavassa ensimmäisessä vaiheessa on kuvattu pääpiirteittäin verouudistusta ja sen vaikutuksia yksinkertaisella malliversiolla. Tuloksiin tulee suhtautua tutkimuksen tässä vaiheessa pikemminkin esimerkkinä tämänyyppisten mallien sisältämistä vaikutusmekanismeista, kuin määrällisenä arviona verouudistuksen vaikutuksista. Jo tutkimuksen tässä vaiheessa saadaan kuitenkin esille useita mielenkiintoisia tuloksia, joilla on selvät yhtymäkohdat viime vuosien tapahtumiin Suomessa.

Verouudistus muutti voimakkaasti yrityksen toimintaympäristöä. Uudistuksen vaikutuksia tutkittiin laajalti jo 1980-luvun lopulla. Yritys- ja pääomatuloverotuksen vaikutusten kannalta keskeisiä investointi- ja säästämisspäätöksiä kuvaavaa dynaamista yleisen tasapainon mallia ei kuitenkaan ollut silloin käytettävissä. Tässä tutkimuksessa käytetyn sukupolvimallin keskeisiä piirteinä ovat kotitalouksien elinkaarisuunnittelu, yritysten arvon maksimointi, pääomakannan hidas sopeutuminen, markkinoiden jatkuva tasapainottuminen hintojen avulla ja talouden avoimuus.

Tutkimuksen mukaan verouudistuksen keskeiset vaikutukset johtuvat yritysten arvon noususta. Osinkotulojen verotuksen keventäminen ja myyntivoittoverotuksen kiristäminen lisäävät olemassaolevan pääomakannan arvostusta ja siten yritysten osakkeiden arvoa. Lyhyellä aikavälillä vanhempien ikäluokkien varallisuuden kasvu johtaa kulutuksen kasvuun, kotimaisen hinta- ja korkotason nousuun sekä vaihtotaseen alijäämään. Pitkällä aikavälillä nuorille ikäluokille ja tuleville sukupolville jää kasvanut ulkomainen velka sekä heikentynyt vaihtosuhde ja siitä johtuva alhainen reaali-palkkataso. Pysyvät vaikutukset talouden pääomakantaan ja tuotannon tasoon ovat vähäiset. Kuitenkin sopeutumisjaksolla menetykset tuotannossa ovat huomattavat.

Tulokset ovat herkäät muun muassa oletuksille ennen verouudistusta käytössä olleista veroasteista, yrityksen arvon määräytymisestä ja osakevarallisuuden jakautumisesta, perinnöistä ja talouden avoimuuden asteesta. Tutkimusta on tarkoitus jatkaa parantamalla mallin kykyä jäljitellä Suomen talouden toimintaa ja testaamalla perusteellisemmin tulosten herkkyyttä mallin eri ominaisuuksille. Tärkeä jatkotutkimuksen aihe olisi myös muiden verouudistuksen osatekijöiden, sekä luotonsäännöstelyn purkamisen ja pääomaliikkeiden vapauttamisen liittäminen analyysiin, jolloin kuva vuosikymmenen vaihteen institutionaalisten muutosten vaikutuksista kotitalouksien ja yritysten käyttäytymiseen tarkentuisi.

Tutkimus on osa Elinkeinoelämän tutkimuslaitoksen ja Sosiaali- ja terveysministeriön yhteishanketta, jonka tarkoituksena on rakentaa Suomen taloutta kuvaava sukupolvimalli ja analysoida sillä sosiaaliturvaan, verotukseen ja velkaantumiseen liittyviä kysymyksiä. Hanketta ovat rahoittaneet edellämäinittujen lisäksi Suomen Akatemia ja Yrjö Jahnnssonin säätiö.

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1. Introduction¹

The purpose of this study is to evaluate the intergenerational and growth effects of the capital and corporate income tax reform implemented in Finland during the years 1986-1994. Special attention is paid to the effects of the openness of the economy. The analysis is carried out using a computable overlapping generations model which is calibrated to imitate the Finnish economy (Lassila, Palm and Valkonen (1995)).

Reforms where the tax base is broadened and rates lowered have been common in OECD countries in recent years. In Finland the effects of the reform are especially profound, because the earlier system was highly distortive with the capital income being either tax-exempt or taxed with high marginal rates of personal income taxation. In the new system capital income tax rates are flat, low and equal.

The structure of the paper is as follows. The Finnish capital and corporate taxation reform is next described briefly. The third section discusses tax reform modelling and depicts the way in which capital and corporate taxation have been implemented in this model. The fourth section presents the effects of changing the tax parameters one by one. In section five the overall analysis of the Finnish tax reform is presented. The main results and the political economy implications are presented as a conclusion to the study in the sixth section. The model is described in detail in the Appendix 1.

2. Capital and corporate taxation in Finland before and after the reform

The Finnish tax system was changed radically during the years 1986-1994. Very high marginal tax rates were lowered and the tax base widened in income taxation. Also the shift from sales tax to value added tax broadened the tax base. The motivations for the reform were both external and internal. Domestically the most compelling reason was the highly distortive nature of taxation. International pressures came through deepening economic integration to the other parts of Western Europe and the wave of tax reforms there, which intensified tax competition.

The capital income taxation before the reform was complicated. The main principle was to tax the incomes at very high marginal rates of personal income taxation. The majority of bank deposits and government bonds were, however, exempt from the tax and there were also tax-exempt ceilings in the personal capital income. It was also possible to include dividend income in this tax-free quota. Capital gains from financial assets, the holding period of which exceeded five years, were also exempt from taxation. The different treatment of the different investor groups, like personal investors, corporations and non-profit foundations, added to the complexity of the system.

¹ This discussion paper is a revised version of the paper presented at the Sixth International CGE Modeling Conference, University of Waterloo, Canada (October 26-28, 1995). I thank Jukka Lassila, Jouko Ylä-Liedenpohja, Vesa Kanninen and several others not mentioned for valuable comments and John Rogers for checking the language. The model used was built in co-operation with Eija Kauppi, Jukka Lassila and Heikki Palm. Financial support from the Ministry of Social Affairs and Health, the Academy of Finland and the Yrjö Jahnsson Foundation is gratefully acknowledged.

The nominal corporate tax rate was very high, but the generous allowances like inventory and investment reserves and accelerated fiscal depreciation reduced considerably the corporate taxes collected. Because the profitability of Finnish firms has been low, many of them were from time to time not able to use all the tax allowances, which led to a zero effective corporate tax rate.

The main idea of the capital and corporate tax reform was to separate capital income from earned income and to use low, flat, equal rates and a wide tax base. The nominal tax rate is now 25 per cent (28 per cent after January 1 1996) regardless of whether the tax base is interest income, dividend income, capital gains or corporate income. Because of the full imputation system, the effective dividend tax rate for a private individual is zero. In corporate taxation the effective rate is now close to the nominal rate because most allowances have been abolished and possibilities to use accelerated tax depreciation rates have been reduced. Therefore also the tax neutrality between industries has increased.

The earlier tax system heavily favoured debt and retained earnings as sources of investment finance. Finnish firms were indeed heavily leveraged, owing to the tax considerations as well as the prevalence of asymmetrical information. In this setting maximising the value of the firms calls for minimising dividends and repurchasing of the firm's shares.

Now the cost of capital is highest from the tax point of view when retained earnings are used, and of the same lower magnitude when either debt or share issues are used (in the no inflation case). This means that maximising the firm's value obliges the firm to maximise dividends and finance investments by using either debt or share issues. In Finland the upper limit for dividends is the income shown to the tax authorities. This is because dividends are required to be paid out of after-tax book income and the tax balance sheet of the firm must coincide with the commercial balance sheet drawn up for the shareholders (Kanniainen and Södersten (1994)).

3. Methodology of the study

3.1. Tax reform simulations with CGE models

There is already a long tradition in using computational general equilibrium models to study the effects of taxation (see e.g. survey by Pereira and Shoven (1988)). The models have been developed from simple static and theoretically oriented versions to include several industries or many types of households and sophisticated dynamics. The main obstacles to utilising the models comprehensively nevertheless relate to computational problems compelling users to limit the dimensions of the models.

The numerical tax studies focus often on the effects of changing the composition of the broad categories of taxation, like taxes on earned income, capital income and consumption (see e.g. Perraudin and Pujol (1991) or Söderlind (1990)). Taxation of different types of capital income has, however, considerably different consequences as will be seen later in this study. The possibility to disaggregate the incomes is important especially when the recent tax re-

forms are studied, because they have in many countries radically changed the terms of corporate finance.

A comprehensive evaluation of the effects of capital income taxation calls for a dynamic CGE model when growth is studied, since the transition paths of the capital stock and employment are of prime interest. The specification of investment dynamics in this and in other recent models follows the approach developed by Summers (1981), where the adjustment costs of investments induces a possibility to formulate a q theory type of investment behaviour. This has the advantage that capitalisation of taxes to firms' values and thereby to household wealth are captured.

Modelling households with overlapping generations is necessary when the welfare effects of a tax reform are studied carefully. As Auerbach and Kotlikoff (1987) noted, future generations may be better off after a tax reform just because the members of earlier generations have suffered and not because of improved efficiency. The above-mentioned wealth changes can be essentially different in different age groups because of the 'hump' shaped wealth profile implied by the life cycle model. The frequently used procedure of modelling the households as living infinitely misses the effects of a restricted planning horizon.

The welfare changes of the age groups raises also a question on the political economy of a tax reform. As a numerical OLG model gives the numbers of winners and losers after the measure, the conclusions about the credibility of the policy are straightforward (Lassila and Valkonen (1995)). If a majority of voters lose, it is difficult to carry out the tax reform in a democracy.

The costs of using a dynamic model and especially one with enough overlapping generations is that the computational problems restrict the amount of industries and household types. This limitation must be treated, however, as transitory since more efficient solution algorithms and computers will be available in future.

Many of the earlier CGE models used for tax analysis describe either a closed economy or a small open economy. These extreme choices do not leave any role to the reaction of the interest rate or the terms of trade in case of an external imbalance. A majority of recently built models have taken into account the important links between the terms of trade and welfare, see e.g. Broer and Westerhout (1993) and Jensen et al. (1993). Besides us, among the few that have allowed also foreign capital supply to be less than perfectly elastic to interest rate are Perraudin and Pujol (1991) and Goulder and Eichengreen (1989).

3.2. Modelling corporate finance

The basic problem in a perfect foresight model is that if any form of finance is favoured in taxation, that one should be used as much as possible. In case of retained earnings there is a natural maximum amount, but to incorporate a rising cost or a quantity limit with respect to share issues or debt financing in the model is not in line with the notions of perfect foresight and complete markets. Most of the studies have ended up using some more or less ad hoc modelling procedure.

The simplest way to solve the problem is to finance all investments with retained earnings and distribute the rest of the income to the shareholders. This leads to a volatile dividend behaviour and the dividends can turn out to be negative. A more developed version finances a fixed share of the replacement value of the firm's capital with debt (see e.g. Jensen et al. (1993)). In this case the marginal unit of the capital is financed with both debt and retained earnings.

Goulder and Summers (1989) used 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 accounting profit. Broer and Westerhout (1993) formulated a truly endogenous financing decision, where retained earnings, share issues and debt are all used. In this model the costs of increased use of the debt financing and Dutch tax parameters leads to a hierarchy of financing scheme. The rising costs are justified with agency costs. First the retained earnings are used together with the debt. When retained earnings are exhausted, debt is the sole financing method. When the cost of debt rises high enough, also share issues will be used.

In this version of the study we use debt and retained earnings as sources of corporate finance. The use of a target debt-to-equity ratio has gained more support than the hierarchical financing scheme in a recent Finnish empirical study (Hansen (1994)). The tax considerations support, however, that after the tax reform the marginal sources of investment finance should be share issues and debt as in the model by Goulder and Summers (1989). Also the simplifying method of using an effective corporate tax rate to capture the effects of all corporate tax allowances must be revised. For example, previously there were investment incentives which treated old and new capital differently. Detailed modelling of allowances might call for a fixed rate of inflation in the model.

3.3. Main features of the model

The theoretical basis in numerical overlapping generations models lies on lifetime utility maximising households, who make lifelong plans about their consumption and labour supply. In this model the enterprise sector consists of incorporated forward looking companies which maximise the value of their shares. If investments cause homogeneous adjustment costs, the maximisation can be shown to lead to Tobin's q type of investment behaviour. In addition to the amount of investments, the representative firm decides also about the use of labour and intermediate goods and production. Labour, goods and capital markets are competitive and prices balance demand and supply every period.

The model includes also a public sector, a pension institution and foreign agents. The public sector collects taxes and uses them to hire public sector workers and to pay the interest costs of the public debt. The pension institution collects contributions, gets capital income from pension funds and pays pensions.

The possibility to participate in the international goods and capital markets has been extremely important to small countries like Finland. The extreme assumptions of a small open economy, where prices of tradable goods and the interest rate are fixed every period to the international level neglect the adjustment to an external imbalance through the terms of trade and the interest rate.

In this model import goods are imperfect substitutes for the domestic good. The relative prices affect the composition of the consumption, investment and intermediate goods. While the export demand is modelled to be price elastic, domestic firms cannot exploit the implied monopoly power, since they sell at marginal costs to both domestic and foreign customers (Broer and Westerhout (1993)). The supply of the foreign capital is modelled to be interest rate elastic. Interest rate reactions and changes in the terms of trade balance the current account gradually.

In the simulations a consumption tax is used to balance the public sector incomes and expenditures periodically. A more detailed description of the model can be found in the Appendix 1. The simulations have been carried out with a model version in which growth, bequests, public pensions and demographics have been excluded.

3.4. Calibration

The calibration has been carried out so as to get certain macroeconomic features such as the ratios of investments and exports to gross domestic product in line with the Finnish data. In this early phase of the study the calibration of the model is still very rough. Before more complete and precise work has been done the simulation results must be considered as merely pedagogic. The parameter values used are listed at the end of the paper.

4. Descriptions of the simulated effects of changing the tax parameters one by one

4.1. Taxes and the cost of capital in the model

In this model the capital stock is financed by retained earnings and debt in a fixed ratio, as noted above. This omits the effect of changes in corporate and capital income taxes for the financing mix. It is also important to note that the steady-state interest rate is determined abroad, and so is unaffected by tax parameters. In the model the tax parameters affect the behaviour mainly through the discount rate, the value of the firms and the cost of capital.

The effects of the corporate and capital income taxes to the costs of the capital can be seen in the steady-state marginal productivity condition of the capital¹:

$$p^F(F_K - G_K) = p^K \left[d + br^D + (1 - b)r^D \frac{1 - \tau^r}{(1 - \tau^g)(1 - \tau^f)} \right] + r^D \frac{1 - \tau^r}{1 - \tau^g} \xi d + \xi d^2$$

The left-hand side describes the value of the marginal product of capital (including the effects of the investment adjustment costs). The right-hand side includes the costs of the finance. The values of the two last terms, which are linked to the adjustment cost, are small. The important parameters are inside the brackets, where there is first the depreciation rate, then the interest cost of debt financed share of the capital and last the cost of capital financed by retained earnings. The cost of retained earnings increases when the capital gains tax or the corporate tax is raised and decreases when the tax on interest income is raised. The dividend tax does not have

¹ It is derived from the first order conditions of maximising the firms value, see page 23.

any effect on the costs in the steady state. The terms of trade affects through the price of the capital unit, which is a composite of the domestic and the imported good.

The following sections include the analysis of changing corporate and capital income tax rates in the way they were changed in the Finnish tax reform (see also the summary table in Appendix 2).

4.2. A corporate tax hike

A hike in the corporate tax rate reduces the possibility to distribute income to the shareholders and therefore lowers the value of the firm. Raising the tax rate also increases the required return on the proportion of capital financed by retained earnings. While the proportions are fixed, the overall return must rise, which calls for a permanently lower capital stock.

The existing generations suffer a loss in their lifetime wealth when the tax hike reduces the value of the firms. They have to compensate for this by increased saving. The initial fall in consumption and investment and the slow reaction of the domestic production lead to an excess supply in the markets of the domestic good, which lowers its price. Adjustment to the excess supply goes both via increased exports and more extensive domestic use of the home good. The resulting current account surplus lowers the domestic interest rate.

The initial price reactions have mixed effects on the saving and investment decisions. The fall in the interest rate and in the price of the composite consumption good and the knowledge that the price will be higher later dampen the households' incentives to save in the first few periods (see Bovenberg (1986) for a detailed analysis of the latter effect). For the firms the fall in the interest rate together with the investment adjustment costs delay the fall in the investments. The initial terms of trade reaction strengthens, however, the tax induced fall in investments by lowering the price of output while the price of the imported part of the investment good do not fall respectively.

Later, when the domestic production adjusts gradually to the lower optimal level and the need for the compensatory household saving decreases, the price of the domestic good rises. The lower capital stock induces lower marginal productivity of labour and the nominal wage falls. The real wage still rises, because increased tax revenues allow for a reduction in the value added tax rate, which is used to balance the state budget. Future generations gain from the reform because they can consume both leisure and the consumption good more. The older generations lose because of the negative wealth effect described above.

The possibility to participate in foreign goods and capital markets is decisive for the welfare results. When the current account surplus permanently increases the amount of foreign assets in the economy, the increased interest incomes are sufficient to keep the domestic demand high compared to the lower optimal level of the production. The export push needed is lower and therefore the home country can keep the domestic price level higher and benefit from the improved terms of trade.

4.3. An interest income tax hike

Tax on interest income determines the after-tax interest rate and therefore lowers also the required return on investing in firms' shares. The required marginal productivity of capital declines and the steady-state optimal capital stock is higher. Furthermore, the tax reduces the after-tax return on household saving and lowers the discount rate of the future incomes. The lower discount rate of the future dividends tends to raise the value of the firms.

Because the optimal amount of saving is now lower and the wealth has jumped, households increase consumption temporarily. When at the same time investments increase considerably, a current account deficit and a jump in the domestic price level follows. Now both the initial price and interest rate reaction mitigates the reduction in saving. The hike in the interest rate reduces the incentives to invest, while the price hike has the opposite effect.

After the adjustment period the terms of trade weaken permanently because the optimal production is now considerably larger with the larger capital stock and the temporary consumption boom has faded.

The welfare effects are not straightforward. The oldest generation gains because its wealth has increased marginally. The future generations gain also a little since the higher capital stock increases their real wage permanently. The generations in between suffer, however, because the wage level has not yet risen enough to compensate for the loss in capital income due to tightened taxation. The welfare improvement is now high enough that it can allow also a benefit to foreigners via weaker terms of trade.

There is also a steady-state utility effect which comes through the timing of the periodic utility changes. The utility losses are concentrated to the last periods of the life cycle because consumption is lower than before the tax reform due to the less favourable conditions of saving while the household is young. The real wage-based utility gains are originated during the working periods. When a new household considers the utility effects of the reform, it gives more weight to the near-by gains because of the time preference. The welfare gain for the future generations is thus conditional to measuring the welfare by a discounted sum of compensated variations.

4.4. A dividend income tax reduction

The 'new view of the equity finance' (see Sinn (1987)) predicts that a dividend tax has no effects on the steady state capital stock when it is financed by debt and retained earnings, as in our model. We found that a large fall in the tax rate induces a permanent weakening in the terms of trade and an increase in the labour supply, which have opposite effects on the optimal amount of capital, so that the steady state reduction is small.

The decrease in the dividend taxes increases nearly in the same proportion the value of the dividends to investors and the firms' stock market value. Households react to the huge jump in their wealth by consuming more. This leads to an initial current account deficit and to a hike in the interest rate and in the price of the domestic good. Both the reactions dampen again the initial jump in consumption. The interest rate increase reduces investments considerably, but

not enough to offset the reduced household saving and the consumption boom must be partly financed with foreign debt.

When the older generations have adjusted to the higher wealth, consumption falls. An improving current account induces a fall in the interest rate and investment and production revives. In the new steady state the terms of trade are weaker. Together with a marginally lower capital stock and higher labour supply they reduce the productivity of labour and the nominal wage level falls. In the model the proceeds from the dividend tax was an important part of the state revenues before the reform, so that the reduction of the tax rate must be compensated with a rise in the VAT rate. This reduces the purchasing power of the wages further.

The large jump in household wealth dominates the existing generations' welfare changes. The welfare gain is relatively bigger the older the generation is at the time of the tax reduction. The youngest generations and all the future generations lose because of the negative real wage effect.

4.5. A capital gains tax hike

The tax on capital gains raises the value of the dividends relative to capital gains obtained by the shareholder. At the same time it is also a tax on retained earnings. In the model the valuation effect dominates the effect of a smaller optimal capital stock on the firm's value. A more detailed explanation for this unexpected result can be found in Sinn (1987).

The positive wealth effect induces a peak in consumption. The fall in investments is, however, larger and an initial excess supply in the markets of the domestic good and a current account surplus follows. Now the first period decline in the interest rate and in the price of the domestic good increases the motivation to consume. The interest rate reaction delays the investment fall, but the price reaction supports the reduction.

After a few periods when the production has declined enough, the demand for the domestic good exceeds the supply and the price rises. The wage level decreases initially because of the lower capital stock and later also due to the increased labour supply. The older generations gain from the jump in stock prices, but the young and future generations suffer from the lower wage rate.

5. The effects of the Finnish tax reform

5.1. The baseline case

Choice of the values of tax parameters

The tax reform was implemented over a period of 1986-1994. In the simulations the tax rates after the reform is, however, from the year 1996. The tax reform is treated in the model as if it is executed at once and as a surprise. The study of the interesting announcement effects is not

performed. These simplifications are based partly on the fact that the unit period in the model is five years.

The depreciation allowances are assumed to correspond to the real depreciation and all other tax allowances have been included by using effective corporate tax rates. These tax rates are calculated for Finland by Myhrman et al. (1995).

The corporate tax rate before the reform has been chosen to be 25 per cent, which is the average effective rate on real sector firms in 1981-1990. Because of the considerably reduced possibilities to adjust earnings to avoid taxation, the nominal tax rate of 28 per cent was used to describe the new rate.

Capital gains were tax-exempt in the earlier system when the holding period was more than five years. This zero tax rate was also used in simulations. In the new system the tax rate applied to nominal capital gains is 28 per cent. The capital gains are taxed in the model immediately when they arise. The complications due to effects of inflation or postponing the selling of the assets are not considered. The taxation treats gains and losses symmetrically in the model.

In the baseline simulations the investor was assumed to be a wealthy household, whose dividend income was taxed earlier with the high marginal rates of personal taxation. This can be justified by noting that in Finland 50 per cent of the dividends distributed to personal investors were paid to persons who represented 3 per cent of all the shareowners (Myhrman et al. (1995)). The chosen dividend tax rate is therefore 65 per cent. In the new system the full imputation leaves the personal investors' dividend income untouched.

The majority of households used tax-exempt deposits and government bonds when they invested earlier in interest-bearing assets. This was also the point of departure when the interest income tax rate before the tax reform was chosen for the model simulations. After the reform the tax rate was 28 per cent.

Table 1. TAX RATES BEFORE AND AFTER THE REFORM

	BASELINE		ALTERNATIVE ¹	
	before	after	before	after
Corporate tax	25	28	36	25
Interest income tax	0	28	36	25
Dividend tax	65	0(28)	36	25
Capital gains tax	0	28	0	15

¹⁾ Alternative refers to alternative choice of the relevant investor, see below.

The effects of the reform

The baseline simulation includes, as explained above, a huge drop in the dividend income tax, a minor hike in the corporate income tax and a large and equal increase in interest income and capital gains taxation. The results are presented in the following verbally, with a chart in page 11 and with the summary table in page 26.

The value of the firms after the reform is almost four times higher than before. This is due to both the easing of the dividend income taxation and tightening of the capital gains taxation. The enormous capitalisation effect raises household wealth, but at the same time the optimal amount of lifetime saving is lower than before because of the reduced after-tax return. An additional incentive to consume in the first period comes through a fall in the value added tax rate, which is induced by the profound increase in the capital gains tax revenues.

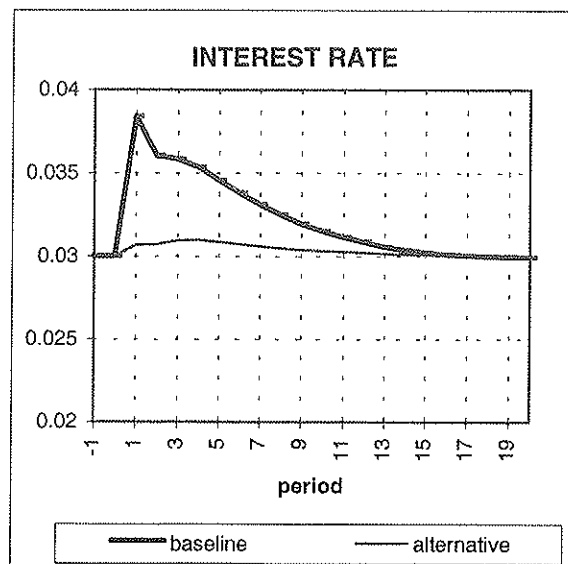
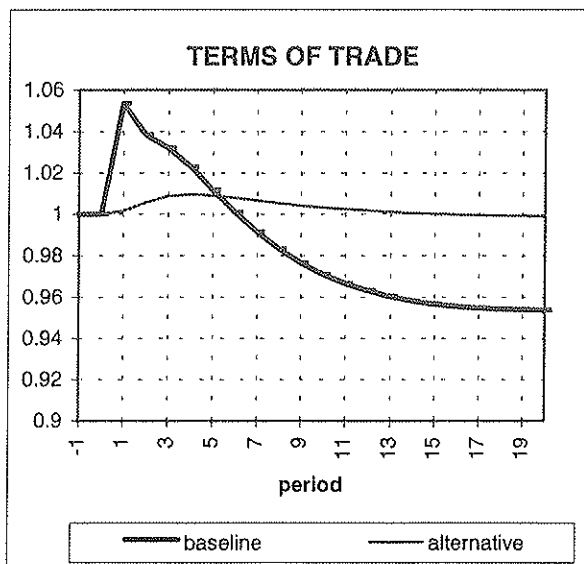
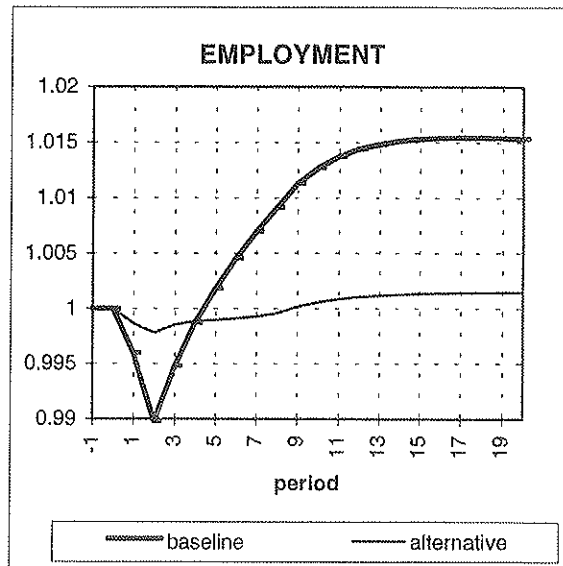
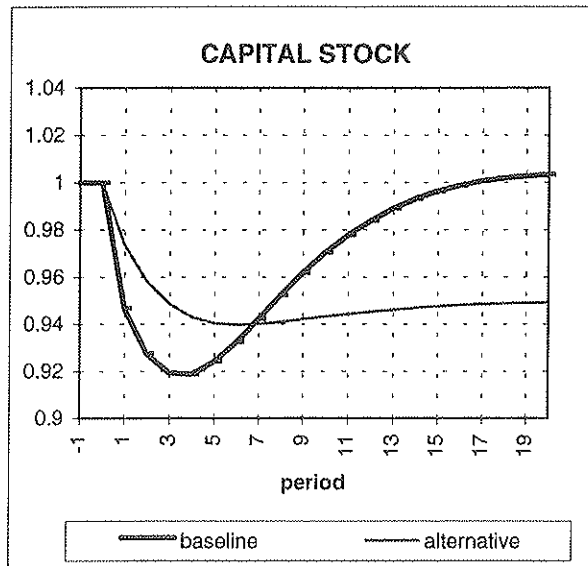
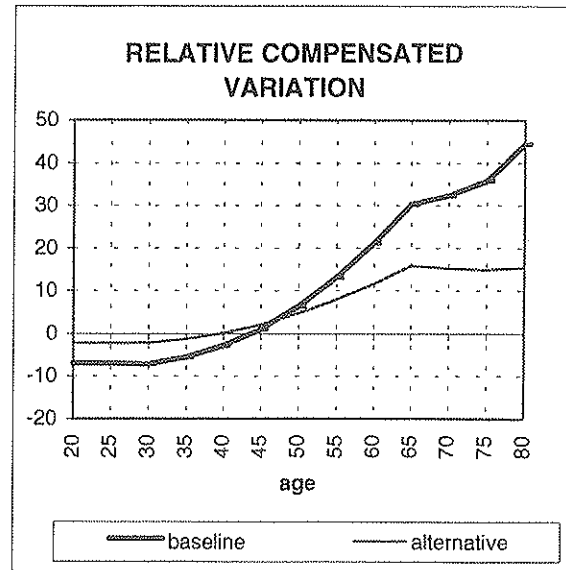
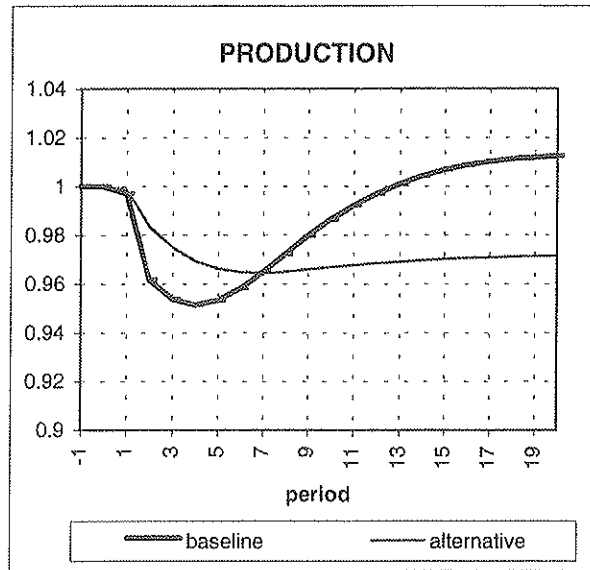
The result is initially a large jump in consumption, which generates an increase in imports and excess demand in the markets of the domestic good. Increased imports and decreased exports lead to a deep deficit in the current account and the interest rate leaps. The jump in the interest rate and in the domestic price dampen the incentive to consume. The minor hike in the corporate tax rate and the large jump in the interest rate reduces investments. After a few periods, when the consumption boom has weakened and the investments are still small, the domestic price declines. While the capital stock revives in the long term after the interest rate has fallen, servicing the cumulated foreign debt permanently reduces the incomes to be used in consumption.

The labour market effects are complicated. The older rich employees' reduction in labour supply dominates the scene in the first few periods. When time passes the effect fades. The next working generations have to accept a lower wage because of the reduced capital stock. They supply more labour, however, since they have to save for the old age with weaker after-tax return on savings (this effect would be smaller if there were a public pension system). Even when the capital stock recovers in the steady-state, the marginal product of labour stays under the initial level because of the lower output price and increased labour supply.

The tax reform has surprisingly little effect on the required marginal productivity of capital in the steady-state. This is because the dividend tax rate has no effect and the effects of raising the interest income tax rate and capital gains tax rate by the same amount cancel each other out in the cost of capital formula. The negative effects of higher corporate taxes and low domestic price level are compensated with higher labour supply and therefore the steady-state effect is a slight increase in production. The production losses during the adjustment period are, however, significant.

The intergenerational changes in welfare are huge: for the oldest generations the jump in stock prices gives a large welfare gain. The gain is biggest for the retired generations, but also the middle-aged workers benefit. The largest losses are directed to the yet unborn generations, which are burdened with a large external debt, weak terms of trade and a low wage rate. The utility measure in the chart in page 11 shows relative compensated variations by generations measured as $100 \cdot (\ln E_s - \ln E_c)$, where E denotes discounted lifetime consumption expenditure, s refers to the simulation run and c is the consumption necessary to achieve the baseline utility at simulation prices.

**THE EFFECTS OF THE TAX REFORM IN THE BASELINE CASE AND IN THE
ALTERNATIVE CASE OF MARGINAL TAX RATES**



5.2. Alternative cases

Tax rates of the marginal investor

Choosing a wealthy household as being the investor who determines the required after-tax return is an extreme choice, because there are many alternative groups which all were subject to a considerably lower dividend tax rate. Another extreme case could be a household whose dividend incomes were low enough to be included in the tax-exempt quota of the capital income taxation in the earlier tax system. Then the dividend tax rate was zero.

Another alternative is a domestic institution like a firm (firms' capital incomes were lightly taxed, which has led to a considerable institutionalisation of the firms' ownership, see Myhrman et al. (1995)). Also Kanninen and Hernesniemi (1994) assumed institutions as marginal investors, when they evaluated the effects of the Finnish tax reform on the value of listed companies with a sophisticated partial equilibrium model.

In our model the possible institutional owners would be firms or pension funds. Pension funds do not own noteworthy amounts of firms' shares in Finland. It is also difficult to model the incentives which motivate productive companies to invest in other firms' shares. We replicated the study of Kanninen and Hernesniemi (1994) with our general equilibrium model assuming that the tax rates they used could be applied to private individuals. This assumption is not necessarily far from the truth, because these tax rates lie between of the extreme values of the former personal tax rates.

Kanninen and Hernesniemi used the corporate tax rate from the years 1992 (36%) and 1993 (25%) as relevant tax rates also for dividend and interest incomes. For capital gains the chosen rate was zero before the reform and 15 per cent after. The latter was justified by a discounting effect, which comes via postponing the tax payment to the selling day of the asset.

Compared to the baseline simulations this setting has several important differences. The fall in the dividend tax rate and a hike in capital gains tax rate are now considerably smaller. Now both the tax rate on corporate income and on interest income fall instead of rising. The fall in the capital gains tax rate mitigates the effects of the reduction in the dividend tax rate on the value of the firms. This time the fall in the corporate income tax rate and in the interest income tax rate cancel each other out in the cost of capital formula. Tightened taxation of capital gains raises the required return on capital financed by retained earnings. Therefore the optimal capital stock is considerably smaller in the steady-state.

Kanninen and Hernesniemi estimated that the stock market prices in relation to the repurchase costs of the capital stock have risen 27 per cent because of the tax reform. In our case the jump is about twofold. The difference can be explained partly due to the general equilibrium effects.

For the households the main differences compared to the baseline case are a smaller wealth effect and a rise in after-tax return on savings. The jump in household consumption is less pronounced, as well as the current account deficit and the interest rate reaction. The welfare effects are similar to those in the previous case, except that they are much smaller. The growth effects are now negative because of the fall in the capital stock.

Household portfolios

Households are in this perfect foresight model indifferent towards investing in firms' shares or in government bonds. The arbitrage condition guarantees that the after-tax yield is equal ex ante. In the baseline simulation it has been assumed that the households have shares and bonds in their portfolios in the same proportion. Then also the change in stock prices treats different amounts of the wealth in relatively the same way.

The interesting point here is that households have negative net wealth in the early periods of their life cycle. If this debt is tied to the value of the market portfolio, a decrease in the firms' value reduces the indebtedness of the youngest generations. When at the same time the wealthy generations suffer a capital loss, a decline in stock market prices smoothes the wealth distribution and vice versa.

Another possibility to model the portfolio composition is to divide the existing shares equally to all generations irrespective of their wealth. Then the change in stock prices leads to an equal absolute change in the value of all generations' wealth portfolios.

Open economy features

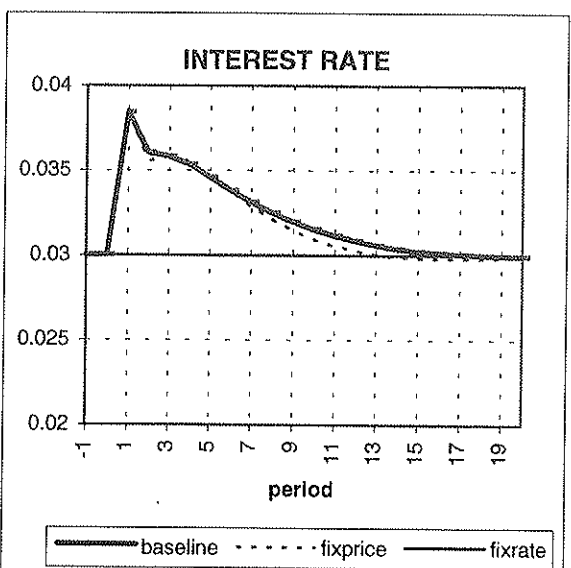
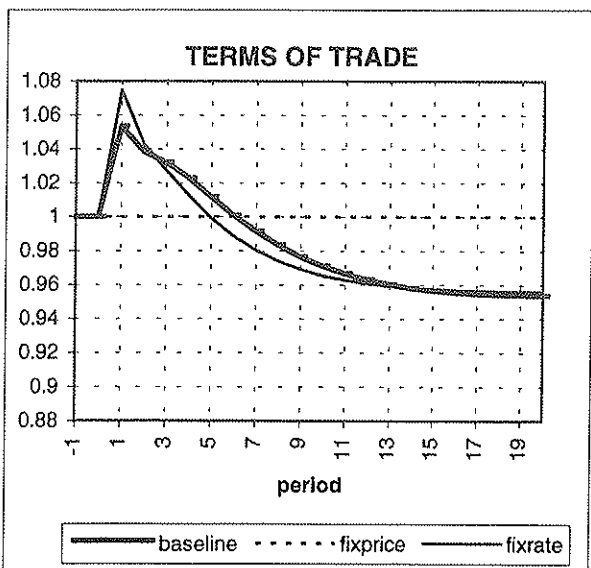
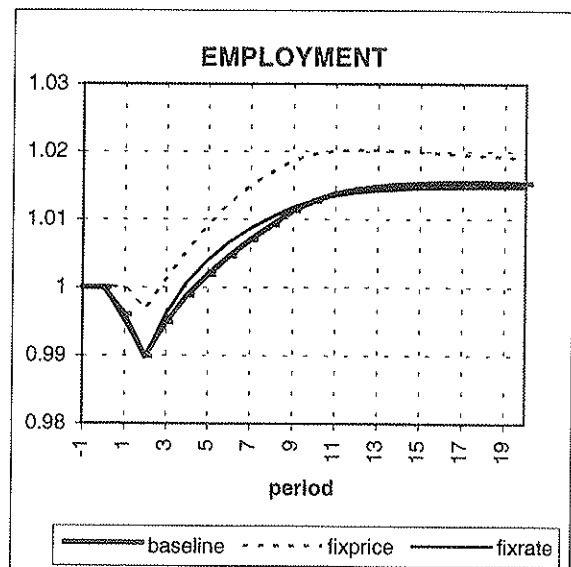
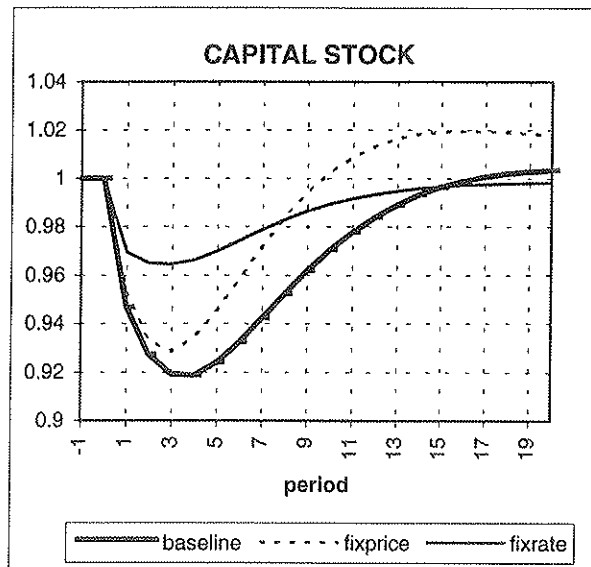
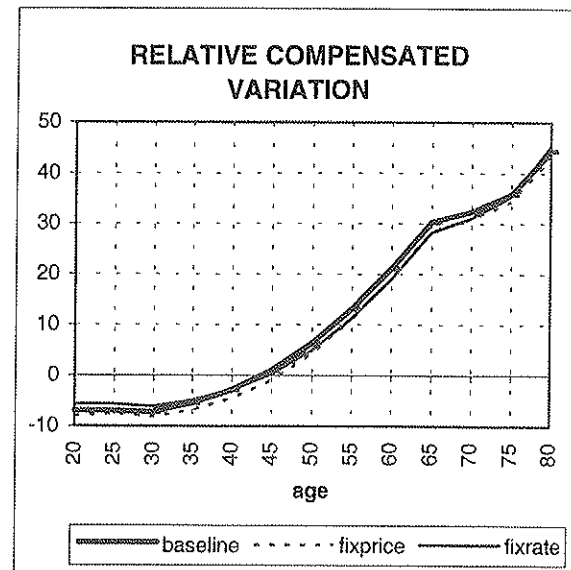
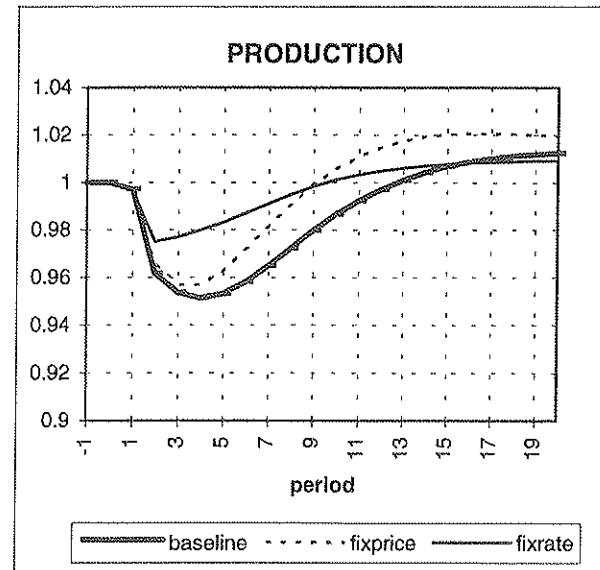
The studies of tax reforms with open economy models have revealed that the earlier welfare results are not necessarily valid, if the analysis is restricted to the welfare changes of domestic households. For example, Perraudin and Pujol (1990) notes that substituting a lump sum tax for a wage tax can reduce the domestic welfare if the export demand is inelastic. Also in the study of Broer and Westerhout (1993) changes in tax rates induces unexpected welfare results.

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

In the baseline simulation the export elasticity was low (-4 in five years). We simulated alternatively the tax reform using an assumption of perfectly elastic export demand. Besides the sensitivity considerations it is also justified by the fact that it is difficult for a small country to produce permanent changes in its terms of trade.

When the export demand is perfectly elastic, the domestic price level is fixed to the foreign prices, and there are no negative terms of trade effects as in the baseline case. For firms this means that the required marginal productivity is lower in the steady-state, because the price of the composite investment good does not this time rise above the price of the output. The induced higher capital stock raises also the marginal productivity of labour and therefore the wage level. The higher domestic price level gives an additional increase in the real wage, because it raises the nominal wage level more than it raises the price of the composite consumption good, which includes also an imported part. For those reasons the tax reform reduces the real wage rate less than in the baseline case.

THE EFFECTS OF THE TAX REFORM IN THE BASELINE CASE AND IN THE ALTERNATIVE OPEN ECONOMY CASES



The fixed price level generates also a lower initial jump in the value of the firms. This is because the additional dividends, which were justified in the baseline case by a higher debt level in the first period, are not there to be distributed. Also the higher price level reduces the welfare gain of the oldest generations compared to the baseline case. In the new steady state the loss of the younger generations is now smaller because of the higher real wage.

We simulated also the effects of the tax reform using an alternative assumption about the determination of the domestic interest rate. The original idea of modelling the supply and demand of foreign capital to be less than perfectly elastic to changes in the interest rate comes from Perraudin and Pujol (1991). As joining a currency union might be an option for Finland in the future, it was interesting to study the effects of fixing the interest rate to the foreign rate.

The steady-state effects in endogenous and exogenous interest rate simulations were not remarkably different. This is partly due to the fact that the steady-state interest rate is in both cases the foreign rate. When the interest rate does not react to the initial current account deficit, the temporary fall in capital stock and production is smaller. Therefore the current account deficit as well as the jump in the price of the domestic good is larger. The drastic reaction of the terms of trade balances the current account faster than in the baseline case, so that the foreign debt is about the same. The welfare effects both in the short and in the long term are approximately of the same magnitude in both alternatives. It is important to note, however, that the initial rise of the domestic interest rate in the baseline case gives a welfare gain for foreigners, because the home country has a large net foreign debt.

Another interesting point is that the tax-free interest rate might have been the relevant equilibrium interest rate in Finland before the tax reform, because short-term money markets were undeveloped and capital movements were restricted. After the liberation of capital movements and domestic money markets, covered interest rate parity links domestic and foreign interest rates (the interest rates are before-tax rates, because of the prevalent residence principle in taxation of international interest incomes). As a result the equilibrium interest rate might have risen considerably. Modelling of this phenomenon is left to future versions.

The liberalisation of capital movements have also increased rapidly the foreign ownership of Finnish listed companies. In the model the ownership of shares is restricted to domestic households. Allowing for the foreign ownership like Goulder and Eichengreen (1989), would transfer part of the capitalisation effects of the tax reform to foreign households.

6. Conclusions

6.1. Welfare, growth and the political economy of the reform

The results of this study imply that in the tax reform a small growth effect was achieved with a large intergenerational transfer from the young and unborn generations to the old wealthy households. The scale of the results might be questionable, but the overall tendency is not. Sinn (1987) notes that shareholders should exploit the markets by asking for a cut in the dividend tax rate and offering a hike in the capital gains rate instead. This is just which have been done in the Finnish reform.

One might wonder why the young generations have accepted this huge intergenerational transfer. The most likely answers are firstly, that these effects are largely unknown and secondly, that the young households expect to inherit part of the increased wealth. Our perfect foresight pure life-cycle model gives an additional explanation: a majority of the living generations gain in this reform and the future generations cannot protest.

One might ask next if there is some limit to this behaviour. Will the negative general equilibrium effects be so high in some level of the capital income taxation that the majority will not want to raise the taxes any more? Which are the most important features of the economy that determine the equilibrium voting level? These questions (which were considered in the case of pension policy in Lassila and Valkonen (1995)) remain to be answered in the next stage of the study.

The simulations reveal the importance of the model structure, when capital and corporate taxation is studied. Disaggregation of the capital incomes and the related taxes are essential to the results. The very important wealth effects via changes in the value of the firms cannot be studied properly without forward looking investment decisions and the adjustment costs of investments. Also the restricted time horizon of the households' decisions is significant for the results.

Furthermore, the alternative simulations showed the importance of modelling carefully the openness of the economy and the choice of the pre-reform tax rates. The endogenous interest rate profoundly deepens the negative effects of the tax reform on the capital stock and production during the adjustment period. Endogenising the terms of trade has considerable permanent effects on the capital stock and welfare.

6.2. Future extensions

There is a long list of possible improvements and extensions to the analysis, which have partly been mentioned above. Even though endogenising the firms' investment financing decision is difficult in a perfect foresight model, a more careful modelling of the corporate finance could be rewarding.

In this initial phase of this study, the decision making of the firm is represented by a listed company which produces one type of good for domestic use and exports. The interesting implications of taxation for resource allocation between industries will be studied with the next version of the model, which includes also a service sector. Adding a non-corporate enterprise sector would downsize the effects of capital taxation, because a large share of the owners' revenues are taxed as labour income.

Also smoothing the effects of taxation would mitigate the initial effects of the reform. While in the model the capital gains are taxed on accrual and the government budget is balanced periodically, the large capital gains induce an additive incentive to consume in the first period by increasing the capital gains tax revenues and decreasing thereby profoundly the value added tax rate.

Another important point related to tax revenues is the relationship between marginal and average tax rates. Before the reform various investors were taxed with different rates and also the tax-free quota of the capital incomes increases the difference between marginal and average rates. In the simulations the highest marginal tax rates were used to calculate the tax revenues of the government, which caused undue variations in the incomes. The problem could be alleviated by introducing a progressive capital income taxation scheme to describe the tax system before the reform.

The model has for the moment also just one type of household, which excludes the possibility of studying the intragenerational effects of the tax reform. Because changes in the capital income taxation induce also large changes in household wealth, it would be very interesting to try to capture the effects of different portfolios inside of a generation.

The different amount of wealth is likely to be reflected also in the bequest motive, see e.g. Jappelli (1995). Furthermore, the poor households could be modelled as credit constrained. In this version of the model the domestic households are the sole owners of the firms. Sharing the ownership with other sectors would mitigate the real effects of the tax reform. Also introducing a pension system would affect the results.

The open economy assumptions are extremely important as was shown above. It would be important to study how the results change if the terms of trade effects were modelled as being transitory. Improvements in calibration and a more extensive sensitivity analysis of the central elasticities is also necessary.

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Appendix: The model

Household behaviour

Households maximise the utility from consumption and leisure in different periods. The life-cycle plan is the solution to the following problem.

$$\max_{C,L} \sum_{t=1}^T \frac{1}{1-\frac{1}{\gamma}} \frac{U_t^{1-\frac{1}{\gamma}}}{(1+\delta)^{t-1}}$$

subject to budget constraint

$$\sum_{t=1}^{T_w} (1-L_t) e_t w_t (1-\tau^w - \tau^e) R_t + \sum_{t=T_w+1}^T Z_t (1-\tau^w) R_t - \sum_{t=1}^T C_t P_t (1+\tau^c) + \sum_{t=1}^T R_t B_t = 0$$

and subject also to the determination of pensions Z . U is the periodic utility

$$U_t = (C_t^{1-\frac{1}{\rho}} + \alpha_0 L_t^{1-\frac{1}{\rho}})^{\frac{1}{1-\frac{1}{\rho}}}$$

and R is the discount factor

$$R_t = \prod_{s=1}^{t-1} \frac{1}{(1+r_s(1-\tau^r))}$$

C is consumption, P its price, L is leisure, and of the constant parameters γ is the elasticity of intertemporal substitution, δ is the rate of time preference and ρ is the elasticity of substitution between consumption and leisure. The model includes also a bequest motive and the possibility of liquidity constraints on households, but these options are not used in this study. The households do receive bequests B , however, from older people dying before the age of 80. The number of periods T is 12: the unit period is five years. A life-cycle plan is made at the age of 20, people retire at 60 and live until 80.

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

$$1-L_p = \frac{1}{T_w} \sum_{t=1}^{T_w} (1-L_t)$$

and

$$w_p = \sum_{t=1}^{T_w} \beta_t (1-L_t) e_t w_t / (1-L_p) \quad \text{where} \quad \sum_{t=1}^{T_w} \beta_t = 1$$

The pension Z in period t is now

$$Z_t = \theta(1 - L_p)w_p^\lambda w_t^{1-\lambda} \quad \text{where} \quad 0 \leq \lambda \leq 1$$

The weights β determine the pension rights averaging period. If the worker stays in one firm, the averaging period consists of the last four years, which roughly would mean that β_8 is equal to unity and all other weights are zeros. In practise, due to moves between firms and also to some technical reasons all coefficients are positive, but β_8 is the largest. T_w is 8 in the baseline scenarios.

The term e_t describes work efficiency, which varies with age. It makes the life-cycle wage-income profile hump-shaped. Parameter λ describes pension indexing: $\lambda = 0$ means that pensions are fully indexed to current wages.

The budget constraint says that discounted lifetime wage and pension income equals discounted consumption expenditure. Households start with no wealth and leave no wealth upon death. The terms τ^w , τ^c and τ^r are tax parameters and τ^e is the employees' pension contribution rate. The actual equations of the model are the first-order conditions derived from the optimisation problem.

The household sector consists of twelve households, of different age, in each period. Total consumption, labour supply, pensions received and taxes paid are aggregated from individual household decisions.

Firms

A representative small firm produces the domestic good using capital inherited from the previous period, intermediate goods and labour. Infinite horizon decisions of investment, employment and use of intermediate goods are made to maximise firm's market value. The firm takes the prices, demand of production and supply of factors at given prices, production technology and taxation as given. Intermediate and capital goods are costs minimising CES composites of domestic and imported goods. Investments are financed by retained earnings and debt.

Production structure can be described as follows:

$$Y_t = F(K_{t-1}, L_t) - G(I_t, K_{t-1}) + \zeta Y_t$$

$$G(I_t, K_{t-1}) = \xi \frac{I_t^2}{K_{t-1}}$$

The use of the composite intermediate good is determined as a fixed proportion of gross production. The production function F is a CES function of capital and labour. In the process of installing new capital some of the production is lost as investment adjustment costs. These installation costs depend positively on the investments and negatively on the amount of capital. Both the adjustment costs and the substitutability of capital for labour are important determinants of the firm's reaction to unexpected changes in the external environment.

Domestic households consider bonds and firms' shares as perfect substitutes in their portfolios. The arbitrage condition between after-tax returns on bonds and shares is:

$$r_t^D(1 - \tau_t^r)V_{t-1} = (1 - \tau_t^d)D_t + (1 - \tau_t^g)(V_t - V_{t-1})$$

where the left-hand side describes the invested amount yielding the domestic after-tax interest rate. On the right-hand side the first term is the after-tax dividend income and the second term the after-tax capital gain.

The arbitrage condition can be transformed to a form where the market value of the shares equals the present value of expected future dividends, adjusted for capital income taxes:

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

The dividends are a residual from the firm's cash flow identity:

$$D_t = (1 - \tau_t^f) \left[p_t^F (F_t - G_t) - (1 + \tau_t^l) w_t L_t - r_t^D B_{t-1}^c \right] - p_t^k I_t + \tau_t^f d p_{t-1}^k K_{t-1} + (B_t^c - B_{t-1}^c)$$

where the dividend in period t is determined by after-tax profits before depreciation minus investment expenditure plus depreciation allowances, which corresponds to real depreciation plus any increase in corporate debt. In this simple version all other allowances are included by using an effective average corporate tax rate. Corporate debt is preferred when financing investments, but its use is limited to a fixed ratio of the replacement value of corporate capital.

The firm chooses the optimal path of investment, use of labour and intermediate goods to maximise the current period after-tax dividend and the firm's value at the end of the period. If there are no unexpected shocks, there is no need to revise the optimal plan and it will be followed forever. Capital depreciates at a constant annual rate of d . The constraints of the maximisation are the initial capital stock and an equation describing its dynamics:

$$K_t = K_{t-1}(1 - d) + I_t$$

Three of the four first order conditions of the constrained optimisation are used as model equations. The first implies that investments should be carried out until the marginal benefit from an additional unit of investment is as large as the marginal cost. The marginal cost includes the price of a unit of capital plus the installation cost. The condition can be transformed to a q-theory investment equation:

$$I_t = \frac{\left(\frac{1 - \tau_t^g}{1 - \tau_t^d} q_t - p_t^k \right) K_{t-1}}{(1 - \tau_t^f) \xi p_t^F}$$

The optimality condition of capital says that capital should be installed until the after-tax return of an additional unit is large enough to cover the expenses of carrying the capital to the next period. These expenses include interest, depreciation and the change in the replacement price of capital. This condition is transformed to an equation describing the path of the shadow value of the capital:

$$q_t = \left(\frac{1-\tau_{t+1}^d}{1-\tau_{t+1}^g} \right) \left[(1-\tau_{t+1}^f)(p_{t+1}^F(F_K - G_K) - r_{t+1}^D b p_t^K) - b p_t^K + \tau_{t+1}^f d p_t^K \right] \\ + \frac{1-\tau_t^d}{1-\tau_t^g} b p_t^K \left(1 + r_{t+1}^D \frac{1-\tau_{t+1}^r}{1-\tau_{t+1}^g} \right) + q_{t+1}(1-d) \frac{1}{1+r_{t+1}^D \frac{1-\tau_{t+1}^r}{1-\tau_{t+1}^g}}$$

In a steady state this marginal productivity condition of capital can be written as:

$$F_K - G_K = \frac{p^K}{p^F} \left[d + b r^D + (1-b) r^D \frac{1-\tau^r}{(1-\tau^g)(1-\tau^f)} \right] + r^D \frac{1-\tau^r}{1-\tau^g} \xi d + \xi d^2$$

Inside of the brackets there is the depreciation rate d , the interest cost of debt-financed share b of the capital stock and cost of capital financed by retained earnings. The two terms after brackets are based on adjustment costs linked to replacement investments.

The third condition says that the marginal benefit of an extra unit of labour should cover wage costs plus the employer's social security contribution:

$$p_t^F F_L = (1 + \tau_t^L) w_t$$

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

The market value of the firm is linked to the shadow value of the capital in the leveraged firm as follows:

$$V_t = K_t q_t - \frac{1-\tau_t^d}{1-\tau_t^g} B_t^c$$

where B_t^c is the firm's debt. This link has been derived using the homogeneity of production and capital installation technologies. The value of the firm jumps whenever unexpected news about the firm's future profitability comes to the market. Households are the main owners of the firms and changes in their wealth changes life-cycle plans immediately.

Pension fund

Pensions are paid by a fund. It collects contributions both from workers and employers. The latter's rate is endogenous and balances the budget each period.

Government sector

The government collects various taxes and uses the proceeds to pay interest on outstanding debt and to employ civil servants to produce public services. These services are provided free of charge and are not taken into account in individual utility considerations.

The model includes many possibilities to balance revenues and expenditures of the government every period. An endogenous value added tax rate is used most often, because it induces little changes in the intergenerational incidence of taxation. From the expenditure side it is possible to endogenise the number of government employees. There is also a possibility to let the government run a deficit or a surplus in the budget, but then a transversality condition must be determined so that the public debt does not blow up.

Foreign sector

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 the foreign demand:

$$X_t = ex \left(\frac{p_t^D}{p_t^M} \right)^{\sigma^E}$$

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

The imported good is used in consumption, investments and as an intermediate good in production. Its price is determined in the international markets. It is an imperfect substitute for the home-made good. The demand conditions are described with a CES structure.

The supply of foreign capital depends on the domestic interest rate. The current account deficit lifts the domestic rate above international rates.

$$r_t^D = \frac{CA_t}{\varpi} + r_t^F$$

The sensitivity of the domestic interest rate to differences in saving and investment can be changed in the model by the adjusting parameter ϖ . The extreme values of the parameter allows, on the one hand, for perfect capital mobility and, on the other, for a financially closed economy.

Markets

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

In the markets of the domestic good the 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 the domestic agents is determined by a cost minimising CES structure. The export demand conditions are explained above. The equilibrium condition which determines the price of the domestic good is thus:

$$Y_t = Y_t^D + I_t^D + C_t^D + X_t$$

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

$$M_t = Y_t^M + I_t^M + C_t^M$$

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

The fourth markets are the capital markets. In these 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. The foreign agents are restricted to participate only in the bond markets. Total savings are a sum of domestic savings and foreign portfolio investments. The domestic interest rate r_t^D balances the markets.

The parallel stock equilibrium can be written as:

$$W_t + H_t = V_t + B_t^c + B_t^g + FA_t$$

where W_t is the household wealth, H_t is the value of the pension fund assets, V_t is the market value of the firm, B_t^c is the firms' debt, B_t^g is the public debt and FA_t is the net foreign assets of the country.

EFFECTS OF THE TAX REFORM¹Corporate tax

period	I	K	Y	V	L	W	C	P	X	M	CA	R
1	-0.2	-0.1	0	-2.6	0	0.2	0	-0.1	0.3	-0.1	0.1	0
5	-0.4	-0.4	-0.2	-2.6	0	0.1	0	0.1	-0.2	-0.1	0	0
30	-0.5	-0.5	-0.3	-2.6	0	0	0	0.1	-0.4	-0.1	0	0

Interest income tax

period	I	K	Y	V	L	W	C	P	X	M	CA	R
1	3.5	1.8	-0.1	5.4	-0.2	4.9	2.5	1.7	-6.6	3.4	-2.2	0.3
5	6.7	6	3.2	5.9	0.5	5.2	-0.4	-0.9	3.6	1.6	-0.6	0.1
30	7.9	7.9	4.8	6.1	0.7	6.3	-1	-1.9	7.8	1.2	0	0

Dividend tax

period	I	K	Y	V	L	W	C	P	X	M	CA	R
1	-4.8	-2.4	-0.9	276.3	-2.1	-4.3	9.5	2	-7.7	5.1	-2.7	0.4
5	-4.4	-4.6	-2.9	275.8	-0.2	-9.9	-0.3	1	-4	-1.2	-2.4	0.4
30	-0.1	-0.1	0.4	278.9	1	-9.2	-8.7	-2.5	10	-6.2	0	0

Capital gains tax

period	I	K	Y	V	L	W	C	P	X	M	CA	R
1	-7.3	-3.6	0	27.6	0.1	3.8	4.5	-0.7	2.7	0.1	0.5	-0.1
5	-10	-9.4	-5.3	26.6	-0.3	-2.9	0.2	1.5	-6.1	-2.6	-0.5	0.1
30	-9.2	-9.2	-5.3	27	0.4	-4	-3.7	0.8	-3	-5	0	0

Combined effects

period	I	K	Y	V	L	W	C	P	X	M	CA	R
1	-10.7	-5.3	-0.3	370.1	-0.7	18.5	27.4	5.3	-18.8	15.9	-8.4	1.1
5	-7.1	-7.6	-4.7	372.9	0.3	-10.5	-2.6	1.2	-4.5	-3.5	-4.3	0.6
30	0.3	0.3	1.3	381.6	2.5	-10.5	-15.8	-4.6	20.7	-11	0	0

¹ I=investment, K=capital stock, Y=value added in corporate sector, V=value of the firms, L=employment, W=real wage, C=consumption, P=terms of trade, X=exports, I=imports, CA=current account/GDP, R=interest rate. Relative deviation from the steady state solution in percents, except CA and R, which are percentage point deviations.

LIST OF VARIABLES

K	capital stock of the firms
Y	gross production of the domestic good
G	installation costs
F	value added
V	value of the firms
D	dividends
B^c	firms' debt
I	aggregate investment
I^D	demand of the domestic good in investment use
I^M	demand of the imported good in investment use
C	aggregate consumption
C^D	demand of the domestic good in consumption use
C^M	demand of the imported good in consumption use
Y^D	demand of the domestic good in intermediate use
Y^M	demand of the imported good in intermediate use
E	exports
I	imports
CA	current account deficit
FA	net foreign assets
r^D	domestic interest rate
p^D	price of the domestic good
p^M	price of the imported good
p^C	price of the composite consumption good
p^K	price of the composite investment good
p^F	price of the value added
q	shadow price of the capital
τ^I	employer's pension contribution
H	value of the pension fund's assets
B^g	public debt
τ^C	value added tax
W	household wealth
L	aggregate labour supply
w	wage rate
U	utility
Z	pension

PARAMETER VALUES

personal income tax	τ^w	0.3
dividend income tax	τ^d	0
interest income tax	τ^r	0.28
capital gains tax	τ^g	0.28
corporate income tax	τ^f	0.28
employee's pension contribution	τ^e	0
depreciation rate	d	0.09
installation cost parameter	ξ	1
share of the value of firms' capital financed by debt	b	0.7
input-output coefficient for the composite intermediate good input	ζ	0.1
labour share parameter of the value added production fuction	ε	0.36
elasticity of substitution between labour and capital	β	0.8
share parameter of domestic good for consumption	v^C	0.7
share parameter of domestic good for investment	v^K	0.7
share parameter of domestic good for intermediate use	v^I	0.7
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^I	0.99
scale parameter of export demand	ex	0.6
price elasticity of export demand	σ^E	-4
foreign interest rate	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	0.75
rate of time preference	δ	.077

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