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The welfare effects of housing taxation in a distorted economy: A general equilibrium analysis

Abstract:

Efficient capital taxation has been one of the most important objectives for large tax reforms implemented in several countries during the last decades. The Norwegian Tax reform of 1992 took a large step towards tax neutrality between the different capital types and uses. However, housing capital is still an exception. The marginal effective tax rate on housing is substantially lower than the marginal effective tax rates on other capital types and uses. In this paper the welfare effects of imposing a neutral system of housing taxation are analyzed by using an intertemporal disaggregated numerical model for the Norwegian economy. The tax reform implies a substantial increase in the tax revenue from housing taxation, and the welfare effects of different rebating alternatives for the additional tax revenue as lump sum rebating or reductions in other distortionary taxes, are considered.

Keywords: Capital taxation, Housing tax reform, Dynamic equilibrium analysis

JEL classification: D58, H21

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1. Introduction

Efficient capital taxation has been one of the most important objectives for large tax reforms implemented in several countries during the last decades.¹ The Norwegian Tax reform of 1992 took a large step towards tax neutrality between different capital types and uses. However, housing capital is still an exception. The marginal effective tax rate on housing is substantially lower than the marginal effective tax rates on other capital types and uses. The current system of housing taxation is characterized by a low imputed value of the house for taxation purposes combined with a low imputed rate of return. Together, this generates a low marginal effective tax rate on housing capital.²

The lenient taxation of housing capital has been criticized from an efficiency point of view. Too much capital is allocated to housing compared to other types and uses of capital, giving an efficiency loss for the economy. Therefore, increased housing taxation may have a positive welfare effect. From a public finance perspective there may exist welfare improving tax reforms which include increased taxation of housing and where some or all of the additional tax revenue is used for reducing other distortionary taxes. The last years focus on internationalization and mobile tax bases, introduces another argument for increased taxation of housing capital: Housing capital is not very mobile between countries or other tax jurisdictions. Increasing the tax burden on housing may be an additional source of financing public spending if other tax objects more easily are moved to low tax countries, and traditional tax bases are eroded.³

As pointed out by Goulder and Thalmann (1993) it is possible to have efficient capital allocation along different dimensions. Efficiency along one dimension may imply a lower degree of efficiency along another one. Two dimensions of efficient capital allocation are respectively intratemporal and intertemporal efficient capital allocation. When effective tax rates are equal across types and end uses of capital, net marginal products of capital tend to be equal, and total output and welfare are larger than when net marginal products differ. This is static or *intra-temporal efficiency* in capital taxation.

The gain from intratemporal efficiency must be compared to efficiency along the intertemporal dimension. To obtain the "modified Golden rule" allocation of consumption and total savings, the optimal marginal effective tax rate on all savings is zero, see e.g. Atkinson and Sandmo (1980) and

¹ Examples are the US Tax Reform Act of 1986, Slemrod (1990b), The Swedish Tax reform of 1991, Agell et al. (1998) and The Norwegian Tax reform of 1992, Holmøy and Vennemo (1995).

² The Ministry of Finance is preparing a housing taxation reform. This analysis was finished before the new system was presented.

³ For an overview of the rapidly increasing literature on tax competition see Wilson (1999) and Schjelderup (2000).

Judd (1999).⁴ This is *intertemporal tax neutrality* for a closed economy. In a small open economy with interest rate given in the world financial market, capital income taxation will also in this case drive a wedge between private return to capital and social return to capital, and savings are too low. The tax reforms of the last decades may have put too much attention to static neutrality in capital taxation and too little attention to intertemporal neutrality, Slemrod (1990a). Goulder and Thalmann (1993) showed that the US Tax Reform of 1986 which levelled the tax rates across the types and uses of capital (including a small increase in the taxation of housing), increased the intertemporal non-neutrality of the tax system since the average marginal tax rate on capital was higher after the tax reform.⁵

The presence of other distortions generated by the tax system must also be taken into account.⁶ The tax system generates inefficiency in the labor market through both direct and indirect labor income taxation. The US Tax Reform of 1986 increased the intertemporal non-neutrality of the tax system, but this negative contribution to welfare was more than outweighed by the intratemporal efficiency gain of levelling the capital tax rates and reducing the labor income tax, Goulder and Thalmann (1993).

Holmøy and Vennemo (1995) by using a static general equilibrium model with exogenous labor supply for the Norwegian economy, calculate that the Norwegian tax reform of 1992 extracted 40 per cent of the potential intratemporal welfare gain of a total neutral system of capital taxation. However, the analysis did not analyze the effects of neutral housing taxation separately, and did not assess the importance of intertemporal and labor market efficiency effects.

This paper analyses the welfare effects of imposing tax neutrality between housing capital and financial capital. This implies a substantial increase in the marginal effective tax rate on housing capital. Since there is a high degree of neutrality between real capital except housing and financial capital in the current tax system, the housing tax reform will also lead to approximate neutrality between the different types and uses of real capital. The housing tax reform will generate a substantial increase in the tax revenue, and different rebating alternatives for the additional tax revenue as lump sum rebating or reductions in other distortionary taxes, are also considered.

⁴ Judd (1999) shows that the optimal long run tax rate on capital is zero in a dynamic model with a revenue constraint.

⁵ Bovenberg and Goulder (1993) and Hougaard Jensen et al. (1996) also focus on intertemporal efficiency of capital taxation.

⁶ Sandmo (1988) analyses optimal taxation of consumer durables (housing) when distortionary labor taxation is present. If the compensated labor supply is a decreasing function of the price of durables, the optimal tax on housing capital is falling in the labor income tax rate. We are indebted to Agnar Sandmo for presenting this article to us.

The housing tax reform is analysed by using an intertemporal disaggregated general equilibrium model for the Norwegian economy. The model, which distinguishes between many industries, sectors, assets and input factors, is well designed for analyzing differences in capital taxation. Investments are determined by producers maximizing total discounted value of each firm, while the consumers maximize total discounted utility, giving an optimal consumption savings path. The economy is considered as a small open economy, which implies that domestic investments are not equal to domestic savings. As in Goulder and Thalman (1993) the consumer demand for housing services is derived from utility maximization. The analysis then takes care of housing capital both as an investment good and as a consumption good. The model also incorporates imperfect competition (the large group case of monopolistic competition, Helpman and Krugman (1985)), which is absent in other analyses of capital taxation reforms.

A neutral housing tax reform gives, as expected, an intratemporal efficiency gain. But with lump sum rebating of the additional tax revenue this efficiency gain is more than outweighed by the efficiency loss in the labor market and the intertemporal efficiency loss. The efficiency loss in the labor market is explained by lower labor supply following a substantial fall in the real wage rate caused by a higher price on housing services. The intertemporal efficiency loss is generated by lower total savings since total wealth (sum of real and financial capital) is reduced by the tax reform. This effect turns out to be small.

The paper analyses whether there are potential welfare improving tax reforms in the economy by using the tax revenue generated by the neutral housing tax reform to reduce either the marginal labor income tax or the marginal capital income tax. Lower marginal labor income tax outweighs the efficiency loss in the labor market generated by the housing tax reform. The main contributor to the welfare effect of lower marginal capital income tax is the love-of-variety effect. This effect is generated by the model of monopolistic competition and implies that variety is valued in its own right. Lower marginal capital income tax leads to an increase in the number of varieties, having a positive effect on welfare.

The paper is organized as follows; in section 2 an outline of the numerical model is provided. Section 3 provides data for the current system of capital taxation and discusses the conditions for neutrality. Section 4 specifies the policy alternatives, while section 5 discusses a priori different sources of welfare effects. Section 6 presents the numerical results, while section 7 concludes.

2. Basic features of the computable general equilibrium model

To analyze the welfare effects of policy reforms, we use a numerical intertemporal general equilibrium model for the Norwegian economy.⁷ The model gives a detailed description of taxes, production and consumption structures in the Norwegian economy. The model has 41 private and 8 governmental production activities, all listed in appendix A, and 17 consumer goods. The next sections briefly outline some of the important features of the model. A more detailed description of the model is found in Bye (2000) and Fæhn and Holmøy (2000).

2.1. Producer behaviour and technology

The structure of the production technology is represented by a nested tree-structure of CES-aggregates given in figure B.1, appendix B. All factors are completely mobile and malleable⁸. The model of producer behavior is described in detail by Holmøy and Hægeland (1997). The model incorporates both the small open economy assumption of given world market prices, and avoids complete specialization through decreasing returns to scale. Producer behavior in an industry is generally specified at the firm level. All producers are considered as price takers in the world market, but have market power in the home market. Empirical analyses of Norwegian producer behavior support the existence of some domestic market power, see Klette (1994) and Bowitz and Cappelen (1994). The entry-exit condition for the marginal firm requires that the after tax pure rents equal fixed costs.

2.1.1. User costs of capital

The model of investment behavior is described in Holmøy, Larsen and Vennemo (1993) and Holmøy, Nordén and Strøm (1994). The starting point is a standard arbitrage equation where the marginal return of investing in shares is equal to the marginal return of investing in bank deposits (equal to the interest rate on deposits plus a risk premium). Based upon this equation the value of the firm, as seen from the representative investor's point of view, is derived. The manager of the firm is then assumed to maximize this value with respect to real capital. This results in the expression for the user costs of capital. The dynamics due to intertemporal behavior are captured by model consistent capital gains in the user costs of capital.

The model distinguishes between three different kinds of real capital; buildings, machinery and transport equipment. For housing (buildings in the production sector Dwelling Services) the user cost

⁷ The model has been developed by Statistics Norway, and earlier versions of the model have been used routinely by the Norwegian Ministry of Finance for long-term forecasting and policy analyses.

⁸ Except in the production of electricity, see Holmøy, Nordén and Strøm (1994).

formula is derived in Berg (1989) in a similar way as for the other user costs. But, as opposed to the user cost of capital for all other capital types and uses, it is assumed that real investment in housing is financed by loans only, see appendix B, equation (B.1). The user cost of capital for housing only describes the costs associated with owner-occupied housing.⁹

2.2. Consumer behaviour

Consumption, labor supply and saving result from the decisions of an infinitely lived representative consumer, maximizing intertemporal utility with perfect foresight (the model of consumer behavior is described in more detail in appendix B.2). The consumer chooses a path of full consumption subject to an intertemporal budget constraint requiring that the present value of full consumption in all future periods does not exceed total wealth (current non-human wealth plus the present value of after tax labor income and net transfers). The distribution of full consumption on material consumption and leisure is determined by an Origo adjusted Constant Elasticity of Substitution function (OCES), Bye et al. (2001). Total material consumption is allocated across 17 different consumer goods according to a nested OCES, see Holtmark and Aasness (1995).¹⁰ The consumption of housing services (rents) is one of these consumer goods. The price of housing services is mainly determined by the user cost of owner occupied housing.

2.3. The government and intertemporal equilibrium

The government collects taxes, distributes transfers, and purchases goods and services from the industries and abroad. Overall government expenditure is exogenous and increases at a constant rate equal to the steady state growth rate of the model. The model incorporates a detailed account of the government's revenues and expenditures. In the policy experiments it is required that the nominal deficit and real government spending follow the same path as in the baseline scenario, implying revenue neutrality in each period.

Intertemporal equilibrium requires fulfillment of the two transversality conditions; the limit value of the present value of net foreign debt and real capital respectively, must both be zero, as time goes to infinity. The model is characterized by a path dependent steady state solution. A necessary condition for reaching a steady state solution is equality between the net of tax interest rate and the consumer's rate of time preference, at least in the last part of the simulation period.¹¹ Firms determine their net

⁹ In Norway, approximately 80 per cent of the housing capital are owner-occupied.

¹⁰ The OCES specification implies that the income elasticities differ from 1, see also figure B.2, appendix B.

¹¹ See appendix B.3 for further details.

investments by maximising total discounted value of each firm, given the transversality condition for the value of real capital. The other transversality condition, regarding the net foreign debt, is fulfilled by adjusting the optimal level of full consumption for the representative consumer, see Bye and Holmøy (1997) for a description of the numerical solution procedure.

3. Neutrality and initial conditions concerning capital

For all real capital types with the exception of housing, a *neutral* system of capital taxation is characterized by equality between the depreciation rate for taxation purposes and true economic depreciation.¹² For housing, the neutrality condition implies that the value of the house for taxation purposes equals the market value of the house and the imputed rate of return on dwellings equals the nominal interest rate plus a risk premium, see appendix B.1 for further details. Then there is neutrality between the taxation of returns from real and financial capital and there will be no efficiency gain of reallocating savings between real and financial investments (or between the different types and uses of real capital). With such a neutral system of capital taxation changes in the ordinary capital income tax will not affect the marginal return on investment in real capital relatively to the marginal return on investment in financial capital.

During transitions, there may be large positive or negative capital gains. If this is the case, the non-neutrality between real capital excl. of housing and financial capital will be large due to deviations between the depreciation rate for taxation purposes and the economic depreciation rate. If the capital gains or losses are small the degree of non-neutrality is also small. Concerning housing, the degree of non-neutrality is large since both the imputed tax value and the imputed rate of return are low in the current tax system compared to the market value of the house and the rate of return on other investments.

The marginal effective tax rates on the tax objects give a measure of the degree of distortions in the initial tax system. Goulder and Thalmann (1993) define the marginal effective tax rate (METR) on a tax object as the difference between the social (pre-tax) rate of return and the private rate of return after all taxes, divided by the social (pre-tax) rate of return. The social rate of return is equal to the user cost of capital per NOK net of economic depreciation and the risk premium¹³. Dispersions in the

¹² In addition all investments must be financed by loans and there is no taxation on a preceding year basis.

¹³ When calculating the social rates of return the risk premium is subtracted since we look upon risk as a real social cost (and the risk premium is just a compensation for this cost). Since our numerical general equilibrium model is not a stochastic one, it will not "share our opinion", though. The model will rather interpret the risk premium as an additional return on real capital (as compared with financial capital). The risk premium for real capital exclusive of housing is equal to 3.5 per cent while the risk premium for housing is equal to 2.25 per cent. The simulated welfare effects can be adjusted for the effect of the risk premium, see section 6.4 and appendix B.3 for further details.

Table 1. METRs and corresponding social rates of return. Long run^{a)}. Per cent

Capital type	METR	Social rate of return
Housing	-55.2	2.3
Buildings and constructions excl. of housing ^{b)}	29.1	5.1
Real capital exclusive of housing ^{b)}	24.8	4.8 ^{c)}
Financial capital	28.0	5.0

a) The capital gains (losses) in the user cost formulas are equal to 0.

b) The METRs associated with buildings and constructions excl. of housing and real capital exclusive of housing are calculated by first taking a weighed average of the social rates of return associated with the different capital types and uses.

c) The social rates of return on machinery are lower than the social rates of return on buildings and constructions excl. of housing and transport equipment. This is due to favourable depreciation allowances for taxation purposes.

METRs measure how far the tax system is from intratemporal efficiency while the magnitude of the METRs is a measure of how far the tax system is from intertemporal neutrality.

Table 1 shows METRs and the corresponding social rates of return for some capital types. The tax code in the model represents the system of the 1992 tax reform updated, by means of some minor changes, to the tax code of 2000.

The METR associated with housing strongly differs from the others. This reflects that the current Norwegian capital tax system is close to intratemporal neutrality with the exception of the taxation of dwellings. Also note that the social rate of return on housing is less than half of the social rate of return on other buildings and constructions.¹⁴ The capital tax system is not characterized by intertemporal neutrality since the METRs are not equal to 0.

4. The policy experiments

We compare four different tax regimes.

The baseline scenario or the *non-neutral tax scenario* (Alternative 1) is a simulation of the current (2000) Norwegian system of housing taxation.

The *neutrality scenario* (Alternative 2) is a simulation of the total neutral housing tax system as outlined above. The revenue effects are offset by lump sum transfers. A neutral housing tax system implies that the imputed rate of return on housing capital is increased from 2.5 to 7.25 per cent, while the imputed tax value of the house is increased from 25 to 100 per cent of the market value of the house. The neutral housing tax reform implies that the METR on housing will increase from -55.2 per cent to 28.0 per cent.

¹⁴ The individual social rates of return on buildings and constructions excl. of housing are between 4.5 and 5.7 per cent.

The *labor income tax rebating scenario* (Alternative 3a) is the neutral housing tax system as in Alt. 2, but the additional tax revenue is redistributed through lower marginal tax rate on labor income.

The *capital income tax rebating scenario* (Alternative 3b) is the neutral housing tax system as in Alt. 2, but the additional tax revenue is redistributed through lower marginal capital income tax.

5. Anticipated welfare effects

Goulder and Thalmann (1993) identify three main effects contributing to the total welfare effect of a tax reform; The *intra-temporal efficiency effect* between different capital types and uses, the *inter-temporal efficiency effect* and the *labor market efficiency effect*. The last effect is encompassed by the *tax interaction effect*¹⁵, Parry et al. (1999), who also identify the *revenue recycling effect* of revenue neutral tax reforms. In this analysis it is the efficiency gain from using the additional housing tax revenue to reduce distortive tax rates.

Alt. 2 (neutral housing tax with lump sum rebating) will increase intra-temporal efficiency compared to Alt. 1 (non-neutral housing tax) since the social marginal rate of return on housing capital will be approximately equal to the social marginal rates of return on other types and uses of capital. However, higher taxation of housing will generate a tax interaction effect through the rise in the price of housing services and the price of total material consumption. The real wage rate will fall, having a negative effect on labor supply. Employment will probably fall and labor market efficiency will be reduced. The initial distortion in the labor market is substantial due to the high marginal tax on wage income and the high level of indirect taxation. A tax reform which increases the total tax wedge in the labor market will contribute to lower welfare. Savings will be reallocated from real to financial capital. The overall effect on total savings (sum of real and financial capital) and then inter-temporal efficiency is not apriori made clear. The total welfare effect is uncertain, and it is apriori not obvious that the expected positive effects from increased intra-temporal efficiency are large enough to outweigh the negative contribution to welfare from reduced labor market efficiency.

¹⁵ Parry et al. (1999) identify three components constituting the tax interaction effect. The first is the efficiency loss from the reduction in labour supply occurring when tax increases raise goods prices and reduce the real wage rate. Lower labour supply reduces the revenue from labour taxes, and the cost of replacing this revenue by increasing the formal tax rates is the second component of the tax-interaction effect. These higher taxes may rise the price of government spending. In order to keep government real spending constant it is necessary to raise more revenue. The third component is the efficiency loss from raising this additional revenue.

Alt. 2 will produce additional revenue, which can be used for either reducing the marginal tax on labor income (Alt. 3a) or to reduce the marginal capital income tax (Alt. 3b). Alt. 3a will improve labor market efficiency through a positive effect on the after-tax real wage rate and labor supply, while intratemporal and intertemporal efficiency may not be much affected. The effect of lower marginal capital income tax (Alt. 3b) is more uncertain. With a neutral system of capital taxation changes in the ordinary capital income tax will not affect the marginal return on investment in real capital relatively to the marginal return on investment in financial capital. On the other hand the marginal capital income tax may influence total welfare through the following two channels: First, lower capital income tax influences the representative consumers distribution of savings and consumption over time. The return on savings increases, consumption is postponed due to the intertemporal substitution effect and savings increase which contribute positively to welfare. Second, after-tax profit for the firms increases when the capital income tax is reduced. The entry-exit condition determining the number of firms requires equality between the fixed costs and the after-tax profit of the marginal firm. In Alt. 3b the number of firms will probably increase. Since each firm in a production sector produces their own specific variety of the sector's composite good, an increase in the number of firms is equivalent to an increase in the number of varieties. Both consumers and producers value variety in its own right. Compared to Alt. 2 both these tax reforms will generate an additional welfare gain through the positive revenue recycling effect, but the overall welfare effect compared to the current tax system represented by Alt. 1 is apriori uncertain.

6. Numerical results

6.1. Baseline alternative

The effects of the different policy alternatives are measured as deviations from the baseline scenario (Alternative 1). The model is calibrated to the benchmark year 1992. We simulate the baseline scenario by keeping all exogenous variables constant at their benchmark values except the tax system, which is substituted by the tax code of 2000. The economy adjusts along a saddle point stable path, and in the long run the economy reaches a steady state solution with constant growth rate and relative prices.¹⁶ The steady state solution of the model is path dependent. In the other policy simulations both the path and the long run stationary solution differ from the baseline scenario. The tax reforms are implemented immediately, minimizing announcement effects.

¹⁶ The steady state solution is reached after approximately 35 periods.

6.2. A comparison of policy alternatives: Results

Long run effects - lump sum rebating

The tax reforms have large effects on user costs of capital, especially in the short run, generating transitional dynamics. To simplify the exposition we start with the long run effects given in Table 2, while section 6.5 analyses the transitional dynamics in more detail.

Table 2. Long run effects. Percentage deviation from the baseline scenario (Alt. 1)

	Neutral housing tax, lump sum rebating (Alt. 2)	Neutral housing tax, labor income tax rebating (Alt. 3a)	Neutral housing tax, capital income tax rebating (Alt. 3b)
Full consumption	-0.41	-0.16	-0.25
Material consumption	-0.96	-0.20	-0.74
Leisure	0.51	-0.09	0.57
Employment	-0.58	0.10	-0.65
Housing capital	-13.73	-12.77	-13.19
Total stock of real capital	-3.26	-2.81	-3.18
User cost of housing services	38.16	37.72	37.40
Consumer price of housing (flow)	25.69	25.53	25.21
Export surplus	-11.41	-9.50	-11.24
Wage costs per hour	0.97	0.26	1.55
Price of leisure (net of tax wage rate)	0.97	5.63	1.55
Price of material consumption	6.25	6.07	6.23
Total welfare	-0.32	-0.08	-0.16

Full consumption which indicates the representative consumer's utility is reduced by 0.41 per cent, while total welfare measured by total discounted utility is 0.31 per cent lower. The reduction in full consumption has a negative income effect on the demand for material consumption and leisure. Concerning leisure, this negative income effect is more than outweighed by the positive substitution effect generated by the fall in the real wage rate. The economic mechanisms at work are the following: The user cost of housing services increases by 38.16 per cent, inducing a substantial increase in the consumer price of housing. This is the major explanation for the increase in the price of material consumption of 6.25 per cent¹⁷ and the fall in the real wage rate.

Higher user cost of housing leads to lower demand for housing capital, and in the long run capital is reallocated from real to financial capital, mirrored by a lower export surplus. Lower real wage rate induces a negative substitution effect on labor supply, and the producer wage rate rises to increase the labor supply, but not enough to outweigh the fall in the real wage rate. Total employment is reduced

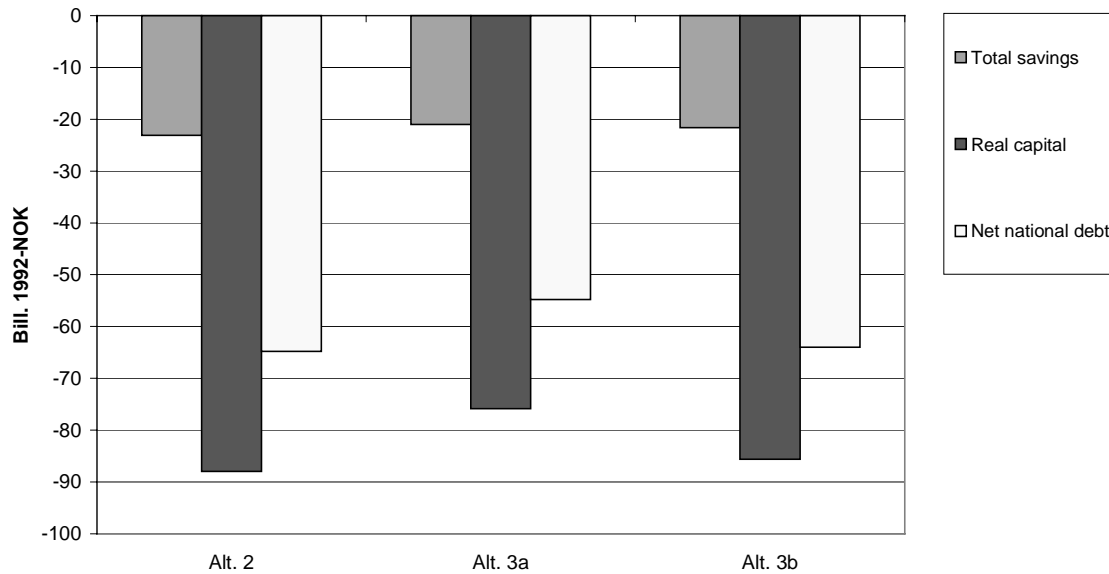
by 0.58 per cent, which increases the labor market inefficiency. The production cost curves shift upwards, export is reduced at given world market prices and the domestic product prices increase except for commodities as wood products and fuels for heating purposes, which experience large reductions in consumer demand. Both these commodities are closely connected to the consumption of housing services. The tax reform gives reallocations within the aggregate material consumption, and especially the consumption of commodities such as purchases of cars, gasoline and beverages and tobacco increases. These are all commodities with high indirect taxes and reallocations towards these commodities contribute negatively to overall welfare. Higher domestic product prices induce substitution away from domestic products, which together with increased demand for other commodities than housing, wood products and fuels for heating purposes, lead to higher imports. Domestic production of most commodities is reduced.

The real capital stock is reduced by 87.9 billion 1992-NOK (3.26 per cent) mainly due to the fall in housing capital of 85 billion 1992-NOK (13.73 per cent), while the net national debt is reduced by 64.8 billion 1992-NOK. The increase in financial savings is not large enough to outweigh the fall in the real capital stock and total savings, which are the change in net wealth (total real capital stock minus net national debt), are reduced by 0.88 per cent, equal to 23.1 billion 1992-NOK. The large reduction in housing capital implies a more efficient composition of the stock of real capital, and there is an efficiency gain along this intratemporal dimension.¹⁸ To summarize, the main contributor to the welfare loss with Alt. 2 is lower employment which outweighs the gains from a more efficient composition of the capital stock. This supports the results in Sandmo (1988) which states that the optimal tax on consumer durables such as housing is lower than the neutral rate when distortionary labor taxation is present. In the next section we analyse whether there exist welfare improving tax reforms which include neutral housing taxation combined with either reductions in the marginal wage tax or the capital income tax.

¹⁷ The budget share of housing is 0.26.

¹⁸ The housing tax reform is also implemented in a version of the model where the total stock of real capital, labour supply and the current account are exogenous, and have the same values as in the baseline scenario. The intratemporal efficiency effects of reallocating real capital between real capital types and uses are then in focus. The effect on private consumption is positive, due to a reallocation of housing capital to other types and uses where the marginal return on real capital is higher.

Figure 1. Changes in wealth. Deviations from Alt. 1. Billion 1992-NOK



6.3. Different redistribution alternatives

Lower marginal labor income tax

The housing tax reform gives an additional tax revenue of approximately 11.5 billion 1992-NOK. In this alternative (Alt. 3a) the top tax on labor income is reduced by 10 percentage points in both levels, giving a reduction in the average marginal tax rate on labor income of approximately 3 percentage points, from 40.2 per cent to 37 per cent.

As in Alt. 2, full consumption falls, but only by 0.16 per cent while total welfare is 0.08 per cent lower, see table 2.¹⁹ The increase in the net of tax wage rate due to lower marginal tax rate nearly outweighs the increase in the price of material consumption following the increase in the price of housing services, such that the net of tax real wage rate is only slightly reduced compared to the baseline scenario. The negative income effect on leisure demand is then only slightly modified. Employment increases by 0.1 per cent while the equilibrium producer wage rate increases by 0.26 per cent. The reversion of the negative labor supply effect is the major explanation for the positive effect on full consumption in Alt. 3a compared to Alt. 2, supporting the results in Sandmo (1988).

¹⁹ We have also simulated the partial effect of reducing the marginal wage tax rate from 0.41 to 0.37, financed by lump sum withdraw. This tax reform generates a welfare gain of 0.22 per cent. Combined with the positive intratemporal efficiency effect of reallocating real capital from housing to financial capital, the overall welfare effect of Alt. 3A is negative. The major explanation for this welfare loss is the existence of the risk adjustment term in the user costs of capital, see section 6.5.

Lower marginal capital income tax

In this alternative the housing tax reform is made revenue neutral by reducing the marginal capital income tax from 28 per cent to 22 per cent. Comparing Alt. 2 and Alt. 3b the fall in full consumption is reduced by nearly 40 per cent. There are only minor changes in total savings, the composition of total savings and employment. However, an important difference between Alt. 3b and Alt. 2 is the importance of the love-of-variety effect.²⁰ After-tax profit for the firms increases when the capital income tax is reduced. The entry-exit condition determining the number of firms requires equality between the fixed costs and the after-tax profit of the marginal firm. In Alt. 3b the number of firms increases by 3.3 per cent on average, compared to a reduction of 0.5 per cent in Alt. 2. Since each firm in a production sector produces their own specific variety of the sector's composite good, an increase in the number of firms is equivalent to an increase in the number of varieties. Both consumers and producers value variety in its own right. Given the level of spending on the composite good and the price of the available varieties, utility is increasing in the number of varieties. Analogously, "productivity", and thereby output, increases with the number of (input) varieties.²¹ The love-of-variety effect contributes negatively to the domestic product prices, which are at the same level as in Alt. 2 in spite of the higher costs due to a larger increase in the wage rate and a smaller fall in the user costs of capital in Alt. 3b. Compared to the baseline scenario GNP falls by 1.07 per cent in Alt. 2 and 0.94 per cent in Alt. 3b, mirroring the positive "productivity" effect of the love-of-variety effect.

6.4. Total welfare and risk adjustment

The traditional welfare measure, total discounted value of full consumption, is lower in all three policy alternatives. But this measure must be adjusted for the risk premium associated with investments in real capital. This risk premium does not have its counterpart in any costs associated with risk, and real capital's social rate of return will be too high in the model, as pointed out in section 3. The risk premium adjusted welfare measure adjusts the traditional measure of welfare for such costs, see appendix B.3 for further details.

Reallocating savings from housing to financial saving will have a positive effect on total welfare. The risk premium adjusted welfare measure takes this efficiency gain fully into account. So even though the reduction in total savings which occurs in all the policy alternatives implies an efficiency loss

²⁰ The domestic market structure is formalised by the Large Group Case of Monopolistic Competition, Helpman and Krugman (1985). In our model, however, firms are heterogenous with respect to total factor productivity in the differentiated industries.

²¹ The increase in productivity is modified, though by the productivity heterogeneity of the firms, which implies that the entering firms are less efficient than the existing ones.

along the intertemporal dimension, the new composition of total savings between real and financial capital implies an efficiency gain. The magnitude of this efficiency gain is approximately 0.2 per cent points in terms of total discounted value of full consumption. This implies that the welfare loss in Alt. 2 is reduced and the welfare losses in Alt. 3a and 3b are changed into risk premium adjusted welfare gains.

Even though the risk premium adjusted welfare gains in Alt. 3a and 3b are quite small, the analyses confirm that there exist welfare improving tax reforms in the Norwegian economy that include introduction of a neutral housing tax reform, combined with reductions in the marginal income tax on either labor or capital. Reducing the marginal labor income tax gives the largest risk premium adjusted welfare gain. Goulder and Thalmann (1993) obtained a larger welfare gain in their analysis of the US 1986 tax reform which included both a somewhat higher taxation of housing capital and lower taxation of labor income. The tax reforms are not directly comparable, though. The US tax reform also included a leveling of the capital tax rates between all industries, except housing, which still after the reform has a low marginal effective tax rate. In Goulder and Thalmann (1993) the leveling between the industries contributed much more to the welfare gain than the small increase in the marginal effective tax rate on housing. This positive effect is roughly cancelled out by the welfare loss along the intertemporal dimension due to an increase in the total METR on capital. Therefore, without the reduction in labor taxation the welfare gain of the US tax reform would have been approximately zero.²²

6.5. Transitional dynamics

A neutral housing tax reform generates short run effects through the capital markets that differ substantially from the long run effects. To illustrate the transitional dynamics we concentrate on the effects of Alt. 2 with lump sum rebatement since this is the most transparent tax reform with respect to the dynamics.

The tax reform is implemented in the first year of simulation and generates a substantial increase in the user costs of housing (Figure 1), the demand for housing capital is reduced and the stock of housing capital falls by nearly 10 percent. 2.5 per cent is physical depreciation, while the rest is sold to other sectors. The negative shift in the demand for housing implies lower demand for goods from the construction sector, and the price of new investments in buildings (flow price) which is equivalent to

²² The US tax reform also implied a revenue loss. If lump sum taxation (or Pigouvian taxation) would not have been available, the only way to obtain a revenue neutral tax reform would have been to increase distortionary taxes, which had contributed negatively to total welfare.

the price of existing housing capital, immediately falls, see Figure 2. This price fall makes it profitable for other sectors to expand their building capital.

Figure 2. User cost of housing. Percentage deviation from the reference path

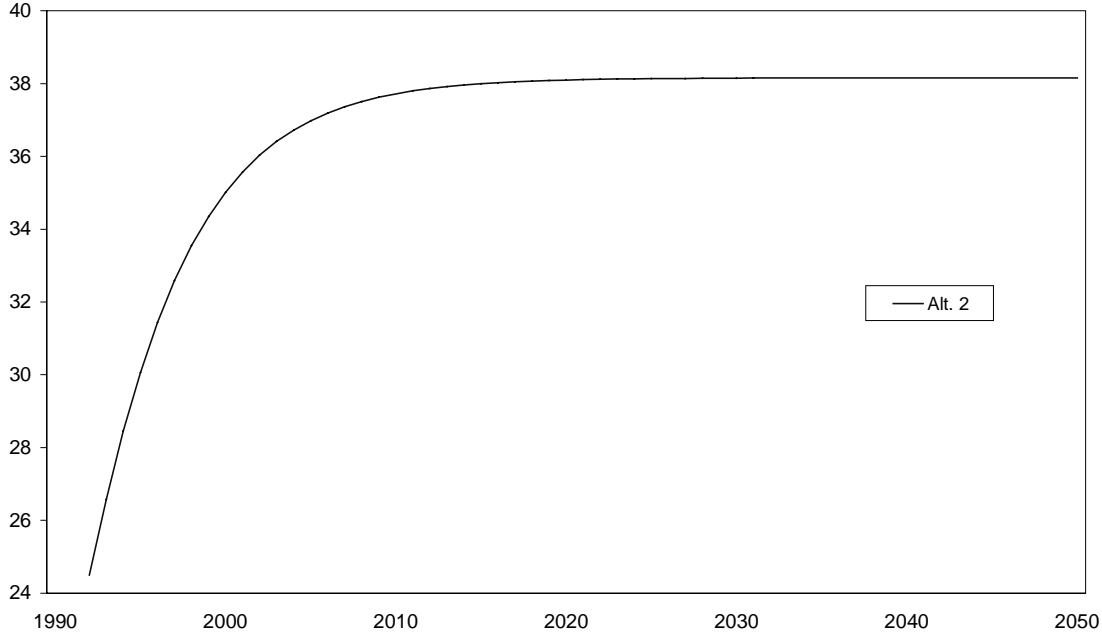
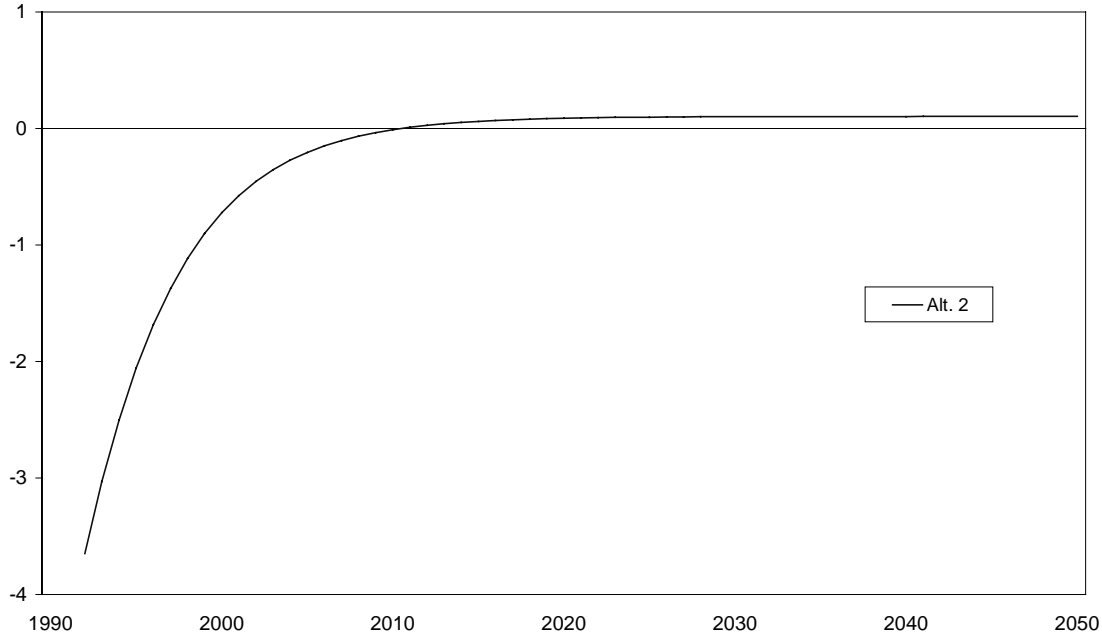


Figure 3. Price of new investments in buildings. Percentage deviation from the reference path



Lower activity in the construction sector has a negative effect on labor demand, and the equilibrium wage rate immediately falls. This has a negative effect on the firms' costs, the cost curves shift downward and export deliveries expand in all industries. Along the transitional path the demand for labor increases from the new lower level due to higher demand for replacement investment, after the initial reduction in the stock of building capital and the corresponding reduction in the activity in the construction sector. Following the immediate fall in the price of new investments in buildings, this price increases (see Figure 3) along the path due to an increasing wage rate. In the long run the equilibrium wage rate is higher while export is lower compared to the baseline scenario. The reduction in the stock of real capital is mirrored by higher net foreign investments, but as pointed out in section 6.2, the reduction in real investments is not fully offset by higher foreign investments, and total savings (the sum of real and financial capital) are lower.

The effect on full consumption along the transitional path is composed of an income effect which is constant along the whole path, and an intertemporal substitution effect generated by the dynamics in the price of full consumption. In this case the income effect is negative (the marginal utility of wealth is higher, see appendix B.2 for further details of the modeling of household behavior). The price of full consumption increases along the path due to the increase in both the price of material consumption and the wage rate, which contributes to the substitution of full consumption forward in time. The sum of the income and substitution effects is a fall in full consumption along the path.

6.6. Sensitivity analyses

6.6.1. Interest rate related intertemporal substitution of full consumption

A necessary condition for reaching a stationary solution is equality between the subjective rate of time preference and the after-tax interest rate.²³ This equality is assumed to hold for the whole simulation period in all the policy alternatives. In Alt. 3b the tax rate on interest income is reduced which implies that the rate of time preference is exogenously shifted upwards such that the equality is maintained from the beginning of the simulation period. This implies that interest rate related intertemporal substitution is absent.

In this sensitivity analysis we analyze the tax reform in Alt. 3b but at the same time do not adjust the rate of time preference upwards in the first part of the simulation period.²⁴ When the net of tax interest

²³ For further details, see Appendix B.3.

²⁴ The necessary stationarity restriction is implemented from 2051.

rate increases given the rate of time preference, consumption is postponed due to intertemporal substitution. The time paths of different variables deviate considerably from the paths in Alt. 3b, but the effect on the welfare measure²⁵ is negligible, which implies that interest rate related intertemporal substitution is not important for the overall welfare effect. These are the same findings as in Bye, Holmøy and Strøm (1999) which analyze interest rate related intertemporal substitution in further detail.

6.6.2. *Immobile housing capital*

In the policy simulations housing capital is mobile and both new and old dwellings are bought and sold at the price of new dwellings, which is mainly determined in the Construction sector. It may seem quite unrealistic that housing capital can easily be transformed into buildings for industrial production. In this section we therefore analyze the importance of considering housing capital as immobile, implying that the sector Dwelling Services is not allowed to sell second-hand housing capital to other sectors, it can only depreciate. The price of second hand housing capital is then determined by equilibrium in the housing market, and may deviate from the price of new dwelling services, following the introduction of a neutral housing tax reform, see Bye et al. (2001) for further details. There will be no new investments in housing capital until the price of existing housing capital equals the price of new dwellings.

Simultaneously implementing the neutral housing tax reform with lump sum rebating and immobility of housing capital gives a welfare loss of 0.31 per cent compared with the baseline scenario. The "negligible" welfare "gain", compared with Alt. 2, of imposing this mobility restriction on housing capital is explained as follows: The restriction on dwelling services turns out to be binding only in the first four years following the tax reform. From the fifth year the development in the different variables is approximately equal in the mobile and immobile cases. The slightly smaller welfare loss in the immobile case is therefore explained by the different effects in the first years of simulation. The most important difference is the less negative effect on labor supply in the immobile case compared to Alt. 2. In the immobile case the increase in the user cost of housing is smaller since the price of used housing decreases more than the price of new investments in the mobile case, generating a smaller increase in the price of material consumption. The fall in the real wage rate is smaller having a smaller effect on labor supply, compared to Alt. 2.

²⁵ The discount rate employed in all the present value calculations is 5 per cent.

6.6.3. *Non-neutral housing tax*

We also analyse whether the welfare effect is linear in the housing tax reform. More specifically, the tax value is doubled from 0.25 to 0.5 (with full neutrality the tax value is 1) and the imputed rate of return is increased from 2,5 per cent to 7,5 per cent (as in the full neutrality case). This is combined with a revenue neutral fall in the average marginal wage tax rate to 0.387. With this tax reform there is a small welfare gain measured by total discounted full consumption (not risk premium adjusted).

7. Concluding remarks

Efficient capital taxation has been one of the most important objectives for large tax reforms implemented in several countries during the last decades. The Norwegian Tax reform of 1992 took a large step towards tax neutrality between different capital types and uses. However, housing capital is still an exception. The marginal effective tax rate on housing is substantially lower than the marginal effective tax rates on other capital types and uses. The lenient taxation of housing capital has been criticized from an efficiency point of view. Too much capital is allocated to housing compared to other kinds of capital, giving an efficiency loss for the economy. Therefore, increased housing taxation may have a positive welfare effect. From a public finance perspective there may exist welfare improving tax reforms which include increased taxation of housing and where some or all of the additional tax revenue is used for reducing other distortionary taxes. Increasing the tax burden on housing may also be an additional source of financing public spending if other tax objects more easily are moved to low tax countries, and traditional tax bases are eroded.

This paper analyses the welfare effects of imposing tax neutrality between housing capital and financial capital. This implies a substantial increase in the marginal effective tax rate on housing capital. Since there is a high degree of neutrality between real capital except housing and financial capital in the current tax system, the housing tax reform also gives approximate neutrality between the different types and uses of real capital. The housing tax reform is analysed by using an intertemporal disaggregated general equilibrium model for the Norwegian economy.

A neutral housing tax reform gives an intratemporal efficiency gain. But with lump sum rebating of the additional tax revenue this efficiency gain is more than outweighed by the efficiency loss in the labor market and the intertemporal efficiency loss. The efficiency loss in the labor market is explained by lower employment following a substantial fall in the real wage rate caused by a higher price on housing services. The intertemporal efficiency loss is generated by lower total savings. This effect turns out to be small.

There are potential for welfare improving tax reforms in the economy if the tax revenue generated by the neutral housing tax reform is used to reduce either the marginal labor income tax or the marginal capital income tax. Lower marginal labor income tax outweighs the efficiency loss in the labor market generated by the housing tax reform. The main contributor to the welfare effect of lower marginal capital income tax is the love-of-variety effect which is generated by the model of monopolistic competition.

The welfare effects of the different tax reforms are quite small. But in a world of increasing international mobility of input factors, firms and commodities, the welfare gains of reducing either the marginal labor income tax or the marginal capital income tax, may be underestimated in the model simulations. The analyses then support the argument that the directions of new tax reforms must incorporate higher tax burden on less mobile tax bases as housing combined with lower tax burden on more mobile or elastic tax bases.

References

- Aaberge, R., J. K. Dagsvik and S. Strøm (1995): Labour supply responses and welfare effects of tax reforms, *Scandinavian Journal of Economics* 97 (4), 635-659.
- Agell, J., P. Englund and J. Södersten (1998): Incentives and redistribution in the welfare state: The Swedish tax reform, New York: St. Martin's Press; London: Macmillan Press.
- Alfsen, K. H., T. A. Bye, and E. Holmøy (1996): MSG-EE: An Applied General Equilibrium Model for Energy and Environmental Analyses, *Social and Economic Studies* 96, Oslo: Statistics Norway.
- Atkinson, A.B. and A. Sandmo (1980): Welfare implications of the taxation of savings, *The Economic Journal* 90, 529-549.
- Auerbach, A.J. (1989): The deadweight loss from "non-neutral" capital income taxation, *Journal of Public Economics* 40, 1-36.
- Berg, S. A. (1989): Norske skattekliver 1988, NOU 1, vedlegg 3B, The Ministry of Finance.
- Bovenberg, A. L. and L. H. Goulder (1993): Promoting investment under international capital mobility: An intertemporal general equilibrium analysis, *Scandinavian Journal of Economics* 95 (2), 133-156.
- Bowitz, E. and Å. Cappelen (1994): Prisdannelse og faktoreterspørsel i norske næringer," *Social and Economic Studies* 85, Oslo: Statistics Norway.
- Bye, B. (2000): Environmental tax reform and producer foresight: An intertemporal computable general equilibrium analysis, *Journal of Policy Modeling* 22 (6), 719-752.
- Bye, B., and E. Holmøy (1997): Household behaviour in the MSG-6 model, *Documents* 97/13, Oslo: Statistics Norway.
- Bye, B., E. Holmøy and B. Strøm (1999): Virkninger på samfunnsøkonomisk effektivitet av en flat skattereform: Betydningen av generelle likevektseffekter. *Rapporter* 99/26, Statistics Norway.

- Bye, B., B. Strøm and T. Åvitsland (2001): Neutral housing taxation and MSG6 - Some model respecifications, Forthcoming as *Document*, Statistics Norway.
- Fæhn, T. and E. Holmøy (2000): "Welfare effect of trade liberalisation in distorted economies: A dynamic general equilibrium assessment for Norway". In Harrison, G. W. et al (eds): *Using dynamic general equilibrium models for policy analysis*, North-Holland, Amsterdam.
- Goulder, L. H. and P. Thalmann (1993): Approaches to efficient capital taxation: Leveling the playing field vs. living by the Golden Rule, *Journal of Public Economics* 50, 169-196.
- Helpman, E. and P. Krugman (1985): *Market structure and foreign trade: Increasing returns, imperfect competition and the international economy*, Cambridge: MIT Press.
- Holmøy, E., B. M. Larsen and H. Vennemo (1993): Historiske brukerpriser på realkapital, *Rapporter 93/9*, Statistics Norway.
- Holmøy, E., G. Nordén, and B. Strøm (1994): MSG-5, A complete description of the system of equations, *Rapporter 94/19*, Oslo: Statistics Norway.
- Holmøy, E. and H. Vennemo (1995): A General Equilibrium Assessment of a Suggested Tax Reform in Capital Income Taxation, *Journal of Policy Modeling* 17:531-556.
- Holmøy, E., and T. Hægeland (1997): Aggregate Productivity Effects and Technology Shocks in a Model of Heterogeneous Firms: The Importance of Equilibrium Adjustments, *Discussion Paper 198*, Oslo: Statistics Norway.
- Holtmark, B., and J. Aasness (1995): Effects on consumer demand patterns of falling prices in telecommunication, *Working Paper 1995:8*, Oslo: Center for International Climate and Environmental Research (CICERO).
- Hougaard Jensen, S. E., S. B. Nielsen, L. Haagen Pedersen and P. Birch Sørensen (1996): Tax policy, housing and the labour market: An intertemporal simulation approach, *Economic Modelling* 13, 355-382.
- Judd, K. L. (1999): Optimal taxation and spending in general competitive growth models, *Journal of Public Economics* 71, 1-26.
- Klette, T. J. (1994): Estimating price-cost margins and scale economies from a panel of micro data, *Discussion Papers 130*, Oslo: Statistics Norway.
- Mysen, H. T., (1991): Substitusjon mellom olje og elektrisitet i produksjonssektorene," *Rapporter 91/7*, Oslo: Statistics Norway.
- Parry, I. W. H., R. C. Williams III, L. H. Goulder (1999): When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorted Factor Markets, *Journal of Environmental Economics and Management* 37, 52-84.
- Sandmo, A. (1988): The taxation of household durable goods, *Finnish Economic Papers* 1, No 1, 13-24.
- Schjelderup, G. (2000): Globalisering og økonomisk politikk: Vinnere og tapere, Mimeo, Norges Handelshøyskole.
- Slemrod, J. (1990a): Optimal taxation and optimal tax systems, *Journal of Economic Perspectives* 4, No 1, 157-178.
- Slemrod, J. (eds) (1990b): Do taxes matter? The impact of the Tax Reform Act of 1986, Cambridge, Mass. and London: MIT Press.

Steigum, E. Jr. (1993): "Accounting for long run effects of fiscal policy by means of computable overlapping generations models," in S. Honkapohja and M. Ingberg (eds.) *Macroeconomic modelling and policy implications*, Amsterdam: Elsevier Science Publishers B.V.

Svendsen, I. (1990): Importmodell i MODAG og KVARTS, *Rapporter 90/20*, Oslo: Statistics Norway.

Wilson, J. D. (1999): Theories of tax competition, *National Tax Journal* 52, 269-304.

Table A.1. Production Activities in MSG-6

MSG-6 Code	Production Activities
11	Agriculture
12	Forestry
13	Fishing
14	Breeding of Fish
21	Fish Products
22	Meat and Dairy Products
16	Grain, Vegetables, Fruit, Oils, etc.
17	Beverages and Tobacco
18	Textiles, wearing Apparel and Footwear
26	Furniture and Fixtures
27	Chemical and Mineral Products, incl. Mining and Quarrying
28	Printing and Publishing
34	Manufacture of Pulp and Paper Articles
37	Manufacture of Industrial Chemicals
41	Gasoline
42A	Diesel Fuel
42B	Heating Fuels, Paraffin, etc.
43	Manufacture of Metals
46	Manufacture of Metal Products, Machinery and Equipment
47	Hired Work and Repairs
48	Building of Ships
49	Manufacture and repair of oil drilling rigs and ships, oil production platforms etc.
55	Construction, excl. of Oil Well Drilling
60	Ocean Transport - Foreign
63	Finance and Insurance
66	Crude Oil
67	Natural Gas
68	Services in Oil and Gas Exploration
69	Pipeline Transport of Oil and Gas
71	Production of Electricity
72	Power Net Renting
73	Sales and Distribution of Electricity
75	Car and Other Land Transportation
76	Air Transport
77	Railroads and Electrical Commuters
78	Ocean Transport - Domestic
79	Post and Tele Communication
81	Wholesale and Retail Trade
83	Dwelling Services
85	Other Private Services
89	Imputed Service Charges from Financial Institutions
	Government Input Activities
	Central Government
92C	Defense Exclusive of Military Submarines and Aircraft
92U	Military Submarines and Aircraft
93S	Central Government Education and Research
94S	Central Government Health-Care and Veterinary Services etc.
95S	Other Central Government Services
	Local Government
93K	Local Government Education and Research
94K	Local Government Health-Care and Veterinary Services etc.
95K	Other Local Government Services

B.1. The user cost of housing capital

$$(B.1) \quad c_t = \left\{ (1 - \tau_t) i_t^{lh} + \hat{\delta}_t - \dot{q}_t + \tau_t \theta_t^r \theta_t + \tau_t^w \theta_t - \tau_t^w \right\} q_t$$

where

$$i_t^{lh} = i_t^d + \omega_t^h$$

$$\dot{q}_t = \frac{q_{t+1} - q_t}{q_t}$$

c is the user cost of housing²⁶, τ is the ordinary income tax, i^{lh} is the nominal pre-tax interest rate on housing loans, $\hat{\delta}$ is the physical depreciation rate, \dot{q} is the expected change in the price of new investments in buildings, θ^r is the imputed rate of return on housing, θ is the value of the house for taxation purposes as a share of the market value of the house, τ^w is the wealth tax rate and q is the price of new investments in buildings. i^d is the nominal pre-tax interest rate on deposits and ω^h is the risk premium associated with investments in dwellings²⁷. Subscript t denotes time period.

The first term in equation (B.1) is the after-tax interest costs associated with investments in housing, the sum of the second and third term shows the economic depreciation, the fourth term expresses the payment of the ordinary income tax concerning the imputed capital income from housing, and the sum of the fifth and sixth term expresses the payment of the wealth tax²⁸.

Neutrality implies that (we suppress the subscript t) i) $\theta^r = i^{lh}$ and ii) $\theta = 1$. The expression for the user cost of capital is then reduced to

$$(B.1') \quad c = \left\{ i^{lh} + \hat{\delta} - \frac{\dot{q}}{q} \right\} q \Leftrightarrow \frac{c}{q} - \hat{\delta} + \frac{\dot{q}}{q} - w^h = i^d$$

²⁶ In Berg (1989) the property tax rate is included in the user cost formula. However, the property tax rate is set equal to 0 in both the baseline and shift scenarios since this tax rate is optional for the municipalities and not all of the municipalities choose to employ it.

²⁷ Empirically, the average rate of return on real investments is normally higher than the average rate of return on financial investments, which can be interpreted as a risk averse attitude of the investors. According to Holmøy, Nordén and Strøm (1994) the risk premium is set equal to the difference between the interest paid on loans and the interest received on bank deposits.

and there is neutrality between the taxation of returns from real and financial investment.

B.2 Consumer behavior

In year t the representative consumer chooses a path of “full consumption”, F , by maximizing intertemporal utility given by

$$(B.2) \quad U_t = \sum_{s=t}^{\infty} (1 + \rho)^{t-s} \frac{\sigma_F}{\sigma_F - 1} F_s^{\frac{\sigma_F - 1}{\sigma_F}}$$

subject to the intertemporal budget constraint, see Bye and Holmøy (1997) for further details. σ_F is the intertemporal elasticity of substitution in full consumption. The intertemporal utility maximization gives the demand for full consumption

$$(B.3) \quad F_s = \left[\frac{1 + r(1 - t^D)}{1 + \rho} \right]^{\sigma_F t} (\lambda PF_s)^{-\sigma_F},$$

where r is the world market interest rate on financial wealth, t^D is the tax rate on capital income, λ is the marginal utility of wealth and PF is the ideal price index of full consumption. Full consumption is a CES-composite of material consumption, C , and leisure, LE . The corresponding ideal price index is given by

$$(B.4) \quad PF_s = \left[\alpha_C PC_s^{(1-\sigma_C)} + (1 - \alpha_C) \left(\frac{PLE_s}{1 + g} \right)^{(1-\sigma_C)} \right]^{\frac{1}{1-\sigma_C}},$$

where PC is the price index of material consumption and PLE is the price of leisure (net of tax wage rate) measured in efficiency units such as labour, implying that the price of leisure must be adjusted with g , the factor augmenting technical change. σ_C is the elasticity of substitution between material consumption and leisure, and α_C is the intensity parameter for material consumption. In each period full consumption is distributed between leisure and material consumption, see Bye et al. (2001) for further details.

B.3 Risk adjusted total welfare

²⁸ Note that the user cost of housing may be underestimated since it is assumed that total taxable wealth may be reduced by the total difference between the market value and the imputed tax value. But taxable wealth can not be reduced to less than 0; negative wealth does not imply negative wealth tax.

We have chosen the following procedure to adjust the numerical results' welfare level for the effect of the risk premium.

$$(B.5) \quad W^* = NVFCNY - 0.035 * NVK - 0.0225 * NVKH$$

W^* is risk adjusted total welfare, NVFCNY is total welfare, NVK is the discounted value of the endogenous capital stock less housing capital and NVKH is the discounted value of the housing capital. 0.035 is the risk premium associated with the endogenous capital stock exclusive of housing capital and 0.0225 is the risk premium associated with housing capital. The risk-adjustment is implemented in both the baseline scenario and the shift scenarios.

B.4 Intertemporal equilibrium

A necessary condition for reaching a steady state solution is

$$(B.6) \quad 1 + r(1 - t^D) = (1 + \rho)(1 + g)^{\frac{1}{\sigma_F}}$$

which is a “razor’s edge” condition since r , t^D , ρ and g which determines the long run (steady state) growth rate of the economy, are all considered as exogenous. In the analyses, equation (B.6) is assumed to hold at all points in time, except in one of the sensitivity analyses see section 6.6.1.

B.5 Data and parameters

The model is calibrated to the 1992 national accounts. For the production functions the elasticities of substitution between machinery and energy, the elasticity of substitution between the energy-machinery aggregate and labor and the elasticity of substitution between the modified real value added and various material inputs (see figure B.1.), are adjusted to parameters of a Generalized Leontief (GL) cost function estimated on time-series data from the national accounts, see Alfsen et al. (1996). The elasticities of substitution between electricity and fuel oil in the energy aggregate are based on CES-function estimates on time series data by Mysen (1991). Most of these elasticities of substitution are smaller than 1. The elasticities of substitution between non-polluting and polluting transports, and the corresponding elasticities between the modified real value aggregate and various material inputs are set to 0.5, for all industries.

In the model of producer behavior the elasticities of transformation between deliveries to the domestic and foreign market are set equal to 4. The elasticities of scale in different industries are then calibrated to 0.83, given the elasticities of transformation. The elasticities of substitution between domestic

products and imported goods are partly based on estimated parameters (see e.g. Svendsen (1990)), but adjusted upwards such that all are around 4. For further details of the calibration of the model of producer behavior, see Holmøy and Hægeland (1997).

In the consumer model the intertemporal elasticity of substitution, σ_F , equals 0.3, Steigum (1993). Econometric estimates of σ_F vary considerably between different sources, and 0.3 is in the lower end of the range of the estimated parameters. The uncompensated wage elasticity of labor supply is 0.1 percent, which is based on estimates of labor supply for married women and men on micro-data by Aaberge, Dagsvik and Strøm (1995). This is consistent with the calibrated elasticity of substitution between material consumption and leisure of 0.6, and the share of leisure in the full consumption aggregate of 0.4, see also Bye, Holmøy and Strøm (1999) for details. The calibration of the parameters in the complete demand system for material consumption is based on detailed econometric studies using both micro and macro data, see Holtmark and Aasness (1995).

Figure B.1. Production technology

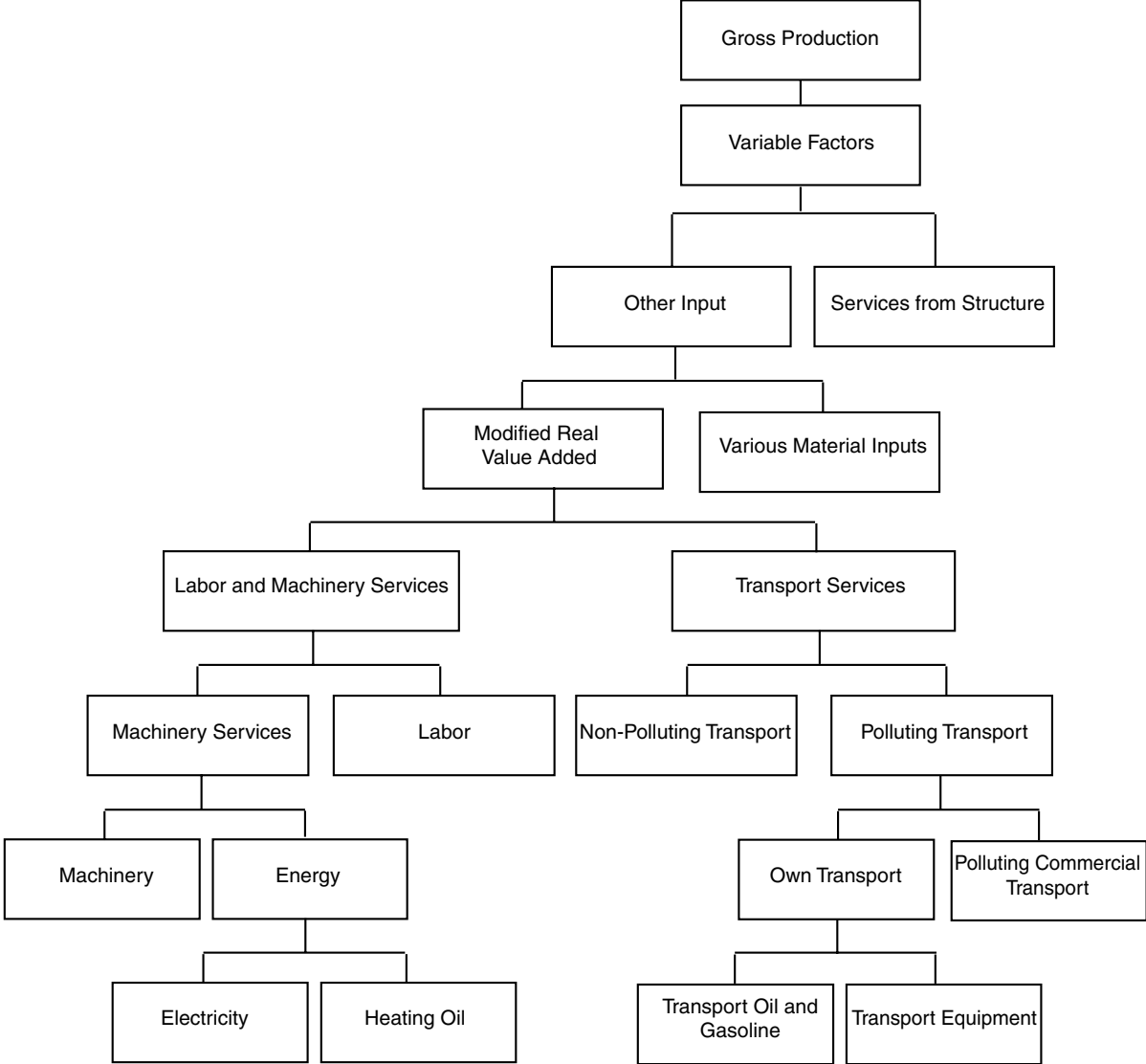
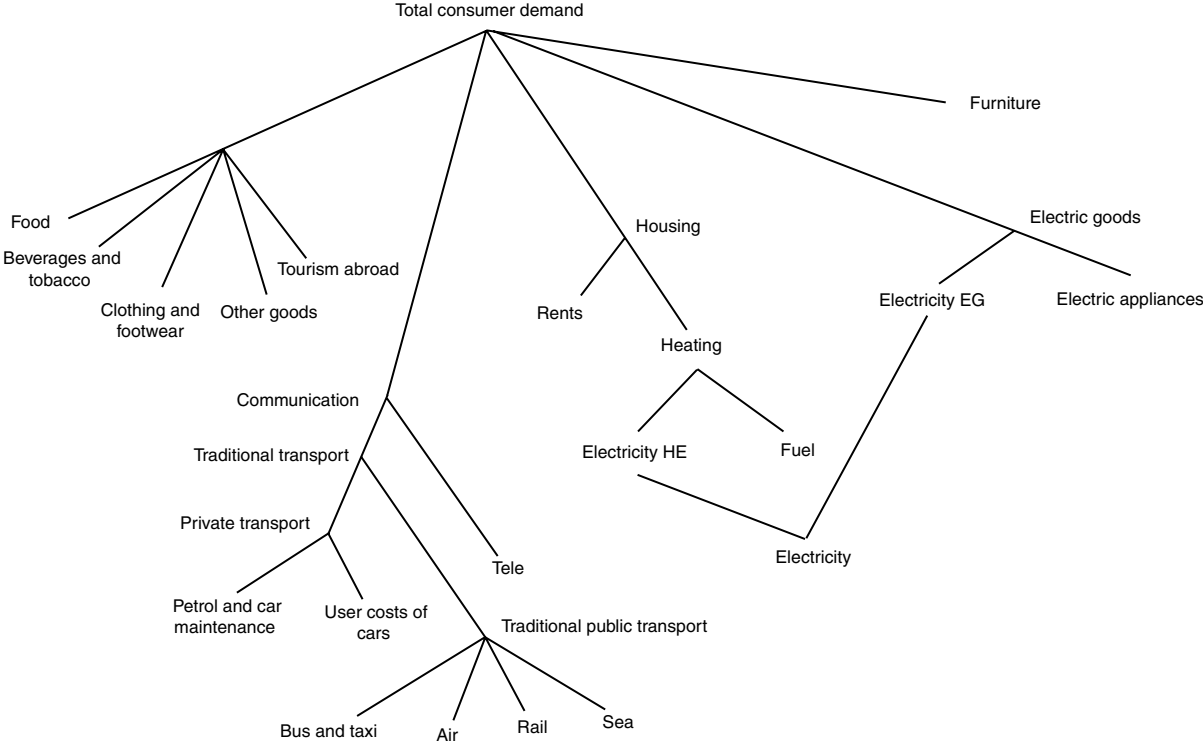


Figure B.2. Material Consumption



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