

Combining microsimulation and CGE models:

Effects on equality of VAT reforms

by

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Abstract:

Microsimulation models are apt to be the preferred instrument when applied, equality analyses of tax reforms in specific economies are undertaken. However, most of these models ignore general equilibrium effects, like changes in prices, and may therefore miss valuable information because of their partial nature. In this paper we combine a microsimulation model and a CGE model through feeding of CGE results on producer prices, pre-tax nominal incomes, wealth and transfers into the microsimulation model. The two main reforms studied are substitution of a uniform VAT rate on all goods and services (called the general VAT reform) and substitution of the non-uniform Norwegian VAT reform of 2001 (called the political VAT reform) for the previous, differentiated system. We find that the degree of equality is clearly increased with the political VAT reform and unchanged with the general VAT reform. Comparing these results with the case where CGE effects are not taken into account, i.e. a "traditional" microsimulation analysis, we find that equality is still increased with the political VAT reform while equality is now also increased with the general VAT reform instead of being unchanged.

Keywords: Microsimulation and CGE models, "Micro-macro" links, Indirect taxation, VAT reforms, Inequality.

JEL classification: D3, D58, D61, D63, H2

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1. Introduction

When evaluating tax reforms, effects on efficiency and equality are of prime interest. The standard tool for applied, efficiency analyses of tax reforms in specific economies is computable general equilibrium (CGE) models. Often these include only one representative consumer, making it impossible to study effects on equality between different households. CGE models with more than one consumer do exist but are likely to have only a small number of representative household groups. This fact may imply that the equality part of the analysis will tend to be too crude, as indicated by Bourguignon, Robilliard and Robinson (2005). Savard (2005) also stresses this point. Microsimulation models are therefore apt to be the preferred instrument when applied, equality analyses of tax reforms in specific economies are undertaken. However, most of these models ignore general equilibrium effects (like changes in prices), cf. Bourguignon and Spadaro (2005), and may therefore miss valuable information because of their partial nature.

Efficiency effects in the Norwegian economy of three indirect taxation reforms, made public revenue neutral by changes in the VAT rate, have earlier been analysed by Bye, Strøm and Åvitsland (2004). They employed a CGE model with one representative consumer, disregarding equality effects. In this paper we analyse effects on equality of the same three indirect taxation reforms. For this purpose, a microsimulation model of the Norwegian economy is used subsequent to the mentioned CGE model. Producer prices, pre-tax nominal incomes, wealth and transfers are all exogenous in this microsimulation model and percentage changes in such variables from the CGE analyses are fed into the microsimulation model. By combining microsimulation and CGE models in such a way, the equality analyses are enriched by taking into account potentially important information from the general equilibrium analyses. The main focus in this paper is then to compare the equality results from

this approach with the results from a "traditional" simulation of the microsimulation model, i.e. the case where CGE effects are not taken into account.

Davies (2004) offers a survey concerning research on complementing microsimulation with CGE or macroeconomic models for transition and developing economies¹. Davies (2004) writes that such complementing is being referred to as making "micro-macro" links and that this is an area of great current interest. He also writes that this literature is still at a stage where it is not clear what links are most appropriate and feasible. Davies (2004) distinguishes between two different approaches for merging CGE and microsimulation models: In the first approach the two model types are layered, while they are completely integrated in the second approach. Our procedure belongs to the former. Davies (2004) writes that the layered approach is interesting and promising and is still in an exploratory stage. He stresses the paper by Robilliard, Bourguignon and Robinson (2001) as the best example of the layered approach. This paper uses an extended version of the model found in Bourguignon et al. (2005).

Robilliard et al. (2001) analyse the effects on poverty and inequality of the financial crisis that hit Indonesia in 1997. They do this by combining a microsimulation model and a CGE model through feeding of CGE results into the microsimulation model. We analyse effects on equality in Norway of reforms in indirect taxation. Our method is also to combine a microsimulation model and a CGE model through feeding of CGE results into the microsimulation model, which is often called a top-down approach. However, our microsimulation model differs a lot from the one used by Robilliard et al. (2001). Their model focuses on the structure and functioning of labour markets, more specifically, the modelling of individual earning determinants and occupational choices. Our microsimulation model does not take into account such modelling but rather specifies, exogenously and in a very detailed manner, personal pre-tax incomes, wealth and transfers. In addition, an accurate modelling of

the personal tax system is part of our model; a feature that seems to be absent in the model in Robilliard et al. (2001). As opposed to Robilliard et al. (2001), we are then in a position to also take into account the effect on equality of changes in non-labour income, like for instance transfers and dividends, changes in wealth and thereby taxes, and changes in overall personal taxation.

The basis for the poverty and inequality measures in Robilliard et al. (2001) is real household income, that is total household income divided by a household specific price index. The construction of this price index is based on the disaggregation of expenditure into two goods, food and non-food. Our basis for the equality measure is total consumption expenditure divided by a household specific price index. The disaggregation of expenditure into 24 commodities is the basis for the construction of this price index. So, as opposed to Robilliard et al. (2001), we take fully into account the expenditure side.

In Robilliard et al. (2001) there is complete consistency between the CGE results on employment levels, wages and self-employment incomes and the corresponding microsimulation variables. This is achieved through imposition of additional restrictions in the microsimulation model.² However, the authors state that their methodology involves several ad hoc assumptions. Partly because of this, the linked model may not be fully coherent. Our procedure for combining the two models includes features that ensure a certain degree of consistency, but there is not complete consistency. In particular, the change in total private consumption expenditure is not identical in the CGE and microsimulation models. However, sensitivity analysis indicates that this last inconsistency is unimportant for our results on equality effects of policy reforms.³

¹ Another relevant review is given in Essama-Nssah (2005).

² There is also complete consistency between the CGE and microsimulation consumption prices but in this case imposition of restrictions is not needed.

³ The mentioned CGE model has earlier been integrated with a detailed microeconomic model of labour supply, see Aaberge, Colombino, Holmøy, Strøm and Wennemo (2004).

Distributional effects of taxes may be analysed at a specific moment in time or over the life cycle. Davies, St-Hilaire and Whalley (1984) find that variations in consumption's share of income are smaller in life cycle than annual data. This reduces the regressivity of taxes assumed to be born by consumption, like sales and excise taxes. In this paper we analyse distributional effects using a static microsimulation model to compare different steady state solutions of a dynamic CGE model.

The three reforms analysed in this paper are evaluated against a baseline scenario, which describes the Norwegian, non-uniform, system of indirect taxation in 1995. The first reform analysed is the general VAT reform, where all goods and services are subject to the same VAT rate. The second reform analysed is abolition of the investment tax, where the investment tax is set equal to zero. This reform is both analysed separately and as part of the general VAT reform. The third reform analysed is the political VAT reform. This reform introduces another non-uniform VAT system, of which a main characteristic is the halving of the VAT rate on food and non-alcoholic beverages. This VAT system was actually implemented in Norway in 2001. All the three reforms are in the CGE analysis made public revenue neutral by changes in the VAT rate.

We find that the degree of equality, measured by 1 minus the Gini-coefficient, is clearly increased with the political VAT reform and unchanged with the general VAT reform and abolition of the investment tax. When we compare these results with the case where general equilibrium effects are not taken into account, the equality results are the same for the political VAT reform and abolition of the investment tax. However, with the general VAT reform, equality is now increased as opposed to a zero effect on equality in the first case. Both including changes in producer prices and changes in pre-tax nominal incomes, wealth and transfers contribute to change the result from an increase in equality to unchanged equality. In other words, including general equilibrium effects in the microsimulation analysis is clearly important with the general VAT reform, but unimportant with the other two reforms.

Another finding is the importance of including general equilibrium changes in all the main income components and transfers. For example, with the general VAT reform only including changes in pre-tax incomes, excl. of dividends, and pre-tax wealth together with changed producer prices would have resulted in a clear decrease in equality. This is in sharp contrast to unchanged equality when also general equilibrium changes in pre-tax dividends and pre-tax transfers are included. Robilliard et al. (2001) do not take into account changes in non-labour income (like transfers and dividends).

The paper is organised as follows; section 2 gives a short description of the CGE model and microsimulation model employed in the analyses. Section 3 describes the policy experiments in more detail. Section 4 deals with how the CGE and microsimulation models are combined and evaluates our linking procedure. The numerical equality results are given in section 5, including some decompositions. Section 6 concludes.

2. Basic features of the models

2.1 The CGE model

The model employed in Bye et al. (2004) is a numerical intertemporal general equilibrium model for the Norwegian economy.⁴ 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 and 24 commodity groups. 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).

⁴ The model has been developed by Statistics Norway. Previous versions of the model have been used routinely by the Norwegian Ministry of Finance for long-term forecasting and policy analyses.

Producer behaviour and technology

The structure of the production technology is represented by a nested tree-structure of CES-aggregates. All factors are completely mobile and malleable⁵. The model of producer behaviour 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 behaviour 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 behaviour support the existence of some domestic market power, see Klette (1994) and Bowitz and Cappelen (2001).

Consumer behaviour

Total consumption, labour supply and savings result from the decisions of an infinitely lived representative consumer, maximizing intertemporal utility with perfect foresight. The consumer chooses a path of full consumption subject to an intertemporal budget constraint, which ensures 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 labour income and net transfers). The distribution of full consumption on material consumption and leisure is determined by a translated CES utility function, cf. Bye (2003). Total material consumption is allocated across 24 different commodity groups according to a complete demand system based on a five level nested utility tree. Each subutility function is a translated CES where the "minimum" consumptions are linear functions of the number of children and the number of adults in the household. Fixed costs are included and economies of scale in household production are thus taken into account. The aggregate demand functions are derived by exact aggregation across all households in the population, where the number of households, adults and children in Norway are the only demographic variables that enter the aggregate demand. The same aggregate demand function can also be derived from a representative, utility maximizing consumer,

⁵ Except in the production of electricity, see Holmøy, Nordén and Strøm (1994).

where the demographic variables then can be interpreted as exogenous preference variables for the representative agent. See Aasness, Bye and Mysen (1996) for a theoretical outline, Aasness and Holtmark (1993) for specification and calibration of an earlier version of the model, and Wold (1998) for a detailed description of the current model.

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.

2.2 The microsimulation model

We have used the model LOTTE-Konsum, developed at Statistics Norway, cf. Aasness (1995) for the basic outline of the microsimulation model and Aasness, Benedictow and Hussein (2002) for a recent application. LOTTE-Konsum calculates savings, total consumption expenditure, consumption expenditure for 24 commodity groups, the number of consumption units and price indexes for each household, taking into consideration that different households have different consumption patterns. LOTTE-Konsum also calculates different measures of distributional effects for the model population, which represents the entire Norwegian population. We have developed a specific version of the model for our particular application, in order to achieve approximate consistency with the CGE analysis.

LOTTE-Konsum is based on consumer theory and econometric analysis of consumer behaviour and standard of living, and welfare theory for aggregation of standard of living over households and individuals in a population. A model for direct taxes, LOTTE, is used as a pre-model for LOTTE-

Konsum. Personal pre-tax incomes, wealth and transfers are exogenous in this model, while personal tax payments are endogenous. The resulting disposable after-tax income from LOTTE is used as exogenous input into LOTTE-Konsum, cf. Aasness, Fjærli, Gravningsmyhr, Holmøy and Lian (1995). LOTTE uses a model population of approximately 15 000 households with about 40 000 individuals, weighted to be representative for the Norwegian population. Consumer prices are exogenous in the microsimulation model.

As a measure of the standard of living for each individual in a household, we use total consumption per consumption unit in the household.⁶ This implies that all persons belonging to the same household has the same standard of living, a relevant assumption in the absence of information about the internal distributions within the households.⁷ The households are considered as producers of standard of living for its members. We allow for the existence of economies of scale in the households, which means that the number of consumption units in a household is smaller than the number of persons in the household. For instance, a household consisting of two adults will need less than twice the income of a single adult to achieve the same standard of living. Furthermore, we assume that children need less consumption than adults to achieve the same standard of living. This is reflected in the model by a larger increase in the number of consumption units when a household is extended with an adult than with a child. This implies that large households, and families with children in particular, are relatively efficient as producers of standard of living.

⁶ The standard of living for household k , and all its members, in situation t is $w_{kt} = c_{kt}/e_k = y_{kt}/(P_{kt}e_k)$, where total consumption of the household (c_{kt}) is defined as $c_{kt} = y_{kt}/P_{kt}$, i.e. total consumption expenditure (y_{kt}) divided by a household specific price index (P_{kt}), and e_k is the number of equivalent adults in the household in base year prices. Aasness (1995) shows that this can be interpreted as a money metric utility.

The household demand system is used to derive a system of Engel functions in base year prices and predicting non-negative budget shares for 24 commodities, adding to one, for each of the 15 000 households in the model. These budget shares are used in Laspeyres price indexes (P_{kt}) for each household k and local tax reform t . Such price indexes are approximately equal to any utility-based price index for local reforms. It is the distribution of these price indexes, and the underlying distribution of budget shares, that determine the distributional effects of indirect taxes in our model. The household demand system used to generate the budget shares is the same as the one used in the CGE model, except for a modification in order to take into account corner solutions for some of the households. The microsimulation model is calibrated so that the macro budget shares for the 24 commodities are the same in the micro model and the CGE model in the base year.

⁷ This can be rationalized by a household maximin welfare function of the individual utilities, cf. Blackorby and Donaldson (1993). Like them we use *household* demand functions and aggregate *individual* well-being across the population.

An equivalence scale is used to calculate the number of consumption units in the households.⁸ There exists no generally accepted foundation for empirical determination of equivalence scales. Therefore, the choice of equivalence scale is a controversial subject, see e.g. Buhman, Rainwater, Schmaus and Smeeding (1988), Atkinson (1992) and Nelson (1993). In this paper we employ the so-called OECD-scale, which implies that if the cost of living for a one-person household is normalised to 1, the cost of keeping the standard of living constant when the household is expanded with an adult is 0.7, and with a child 0.5. Several empirical studies of Norwegian consumer expenditure surveys find support for the hypothesis that the OECD-scale provides a suitable approximation, see Bojer (1977), Herigstad (1979) and Røed Larsen and Aasness (1996). We also perform sensitivity analyses of policy results with respect to the choice of equivalence scale within a wide class of scales, cf. footnote 8 and 17 for details and Aasness (1997) for discussions of sensitivity analysis within this type of continuous class of scales.

3. Baseline scenario and policy alternatives

The VAT is a tax formally paid by the purchaser of a good or service. All the different stages in the production process are participating in the calculation and collection of the VAT. A company may either be a) subject to the VAT, meaning there is a VAT on its sales⁹ but VAT paid on the company's purchases of material inputs and investment goods are refunded or b) not subject to the VAT, meaning there is no VAT on its sales but the VAT paid on the company's purchases of material inputs and investment goods is not refunded. The destination principle also applies, meaning that exports subject

⁸ The number of consumption units in household k , in base year prices, is defined as $e_k = (1-f(e)) + ez_{1k} + f(e)z_{2k}$, where z_{1k} and z_{2k} are the number of children and adults respectively, e is the cost of living for a child relative to a single adult, and $f(e)$ is the cost of living for an additional adult relative to a single adult. The parameter e is assumed to lie in the interval $[0,1]$, see Aasness (1997) or Aasness et al. (2002) for details.

⁹ A special case is a VAT rate set equal to 0 (zero-rating).

to the VAT have a rate set equal to zero, while imports subject to the VAT have the Norwegian rate attached to it.

The system of indirect taxation in 1995 (the benchmark year in both the CGE and microsimulation models) was characterized by a general liability to pay VAT on goods. There were few exemptions. There was no general liability to pay VAT on services but some were explicitly mentioned in the law and were to have a positive VAT rate. Many services were not subject to the VAT, however. Generally, the VAT rate was equal to 23 per cent. Paying of the investment tax was connected with paying of the VAT: If the company was subject to a VAT on its sales, and thereby did not pay any VAT on its material inputs or investment goods, an investment tax had to be paid. However, in addition several exemptions were specified in the investment tax Act.

The described system of indirect taxation in 1995, in addition to other taxes in the Norwegian economy, is implemented in the baseline scenario both in the CGE and microsimulation model.

The first policy alternative, called the general VAT reform, consists of a general VAT rate equal to 23 per cent on all goods and services¹⁰. In addition, there is VAT on the purchase of new investments in dwellings and cars, but there is no VAT on services from these consumer durables. The investment tax is simultaneously set equal to zero. The second policy alternative, called abolition of the investment tax¹¹, only sets the investment tax equal to zero.

The third policy alternative, called the political VAT reform, analyses the following characteristics of the actual, Norwegian VAT reform of 2001: Some more services are subject to the VAT, the general VAT rate is increased from 23 to 24 per cent and the VAT rate on food and non-alcoholic beverages is

¹⁰ The only exceptions from this are the banks' interest rate differential and non-profit institutions serving households where the VAT rate equals zero.

set equal to 12 per cent. In principle, the somewhat extended scope of the VAT should have led more companies to pay the investment tax. Since the investment tax was to be abolished later on, exemptions were introduced for the affected companies. The investment tax in the political VAT reform is therefore equal to the investment tax in the baseline scenario.

All policy alternatives are made public revenue neutral in the CGE simulations by changes in the VAT rate. The increase in the general VAT rate necessary to ensure public revenue neutrality is 1.05, 2.09 and 1.54 percentage points with the general VAT reform, abolition of the investment tax and the political VAT reform, respectively. For more details about the system of indirect taxation in the baseline scenario and the three policy alternatives, see Bye et al. (2004).

4. Combining the CGE and microsimulation model

In this paper we combine the CGE and microsimulation models by multiplying consumer prices, nominal pre-tax incomes, wealth and transfers in the microsimulation model by percentage changes in corresponding variables in the CGE model. The microsimulation model calculates personal taxes, after-tax household disposable income, total household consumption expenditure, household specific price indexes and standard of living of each person.

The two models have the following features in common: Both describe the Norwegian economy, the demand system for material consumption is almost identical in the two models, with the same 24 commodity groups, both are characterized by the VAT rates present in 1995 and both are calibrated to the benchmark year 1995. The latter fact, in addition to the fact that Bye et al. (2004) simulate the baseline scenario by keeping all exogenous variables constant at their benchmark values¹², imply that

¹¹ The investment tax was actually abolished in Norway in 2002.

¹² An exception is parts of the tax system, which are substituted by the tax code of 2000. There are not any major differences between the tax code in 1995 and the tax code implemented in the CGE model, though.

both models are characterized by 1995-prices. Two important differences between the CGE and microsimulation models are that the former has an endogenous leisure variable and is intertemporal, while the latter does not include any leisure variable and describes the situation in a particular year.

As already mentioned, we multiply microsimulation variables by percentage changes in corresponding CGE variables. These changes refer to changes from baseline scenario to policy alternative j in the CGE model's steady state.

$$(1) \quad MSV^{j,t} = \frac{CGEV^{j,t^*}}{CGEV^{base,t^*}} MSV^{base,t} \Leftrightarrow \frac{MSV^{j,t}}{MSV^{base,t}} = \frac{CGEV^{j,t^*}}{CGEV^{base,t^*}} .$$

$MSV^{j,t}$ and $MSV^{base,t}$ are the microsimulation variable in year t in policy alternative j and the baseline scenario, respectively. $CGEV^{j,t^*}$ and $CGEV^{base,t^*}$ are the CGE variable in year t^* in policy alternative j and the baseline scenario, respectively. In our case, t is equal to the base year (1995) in the microsimulation (and CGE) model. t^* is equal to the CGE analysis' steady state. Since Bye et al. (2004) simulate the baseline scenario by keeping all exogenous variables constant at their benchmark values the CGE model's steady state may be interpreted as representing the Norwegian economy in 1995 after it has "calmed down". The assumption we make is therefore that the ratio between a microsimulation variable in policy alternative j and baseline scenario in 1995 is equal to the corresponding ratio in the CGE model's "1995", that is the 1995-economy after it has "calmed down".

4.1 Consumer prices

There is perfect correspondence between the classification of goods and services in the CGE and microsimulation models. Linking consumer prices in the two models is therefore unproblematic. The numerical changes in consumer prices from the CGE analyses that are used as input in the microsimulation model, are presented in appendix A.

4.2 Income and wealth

As opposed to the CGE model, the microsimulation model contains a very detailed description of the tax system for personal taxpayers. This implies that the model also contains incomes and wealth at a very detailed level. In addition, the two models are based on data from different sources and there are differences in the definition of incomes in these two datasets, see Epland and Frøiland (2002).

Accordingly, there is no simple one-to-one correspondence between incomes and wealth in the microsimulation and CGE models.

We have chosen to use national incomes and wealth from the CGE model. We therefore implicitly assume that households receive constant shares of the different income and wealth components in both baseline and policy alternatives such that we can employ percentage changes in the mentioned variables as exogenous input into the microsimulation model¹³. Broadly speaking, we have linked incomes in the microsimulation and CGE models as shown in table 1. The numerical changes from the CGE analyses are shown in appendix A.

Table 1. Linking incomes in the microsimulation and CGE models

Microsimulation model	CGE model
Wage income	Total wage and salary payments net of social taxes for employees
Self-employed taxable income	Self-employed's risk-adjusted ¹⁾ , net ²⁾ , pre-tax ³⁾ return on real capital + calculated wage income for self-employed
Dividends	Limited liability companies' risk-adjusted ¹⁾ , net ²⁾ , pre-tax ³⁾ return on real capital
Interest income from foreign debtors and interest on loans to foreign creditors	Interest rate multiplied by net national debt

1) See Bye and Åvitsland (2003) and Bye et al. (2004) for an explanation of risk-adjustment in the CGE model.

2) That is after depreciation.

3) But after paying of VAT and/or investment tax on material inputs and investment goods.

¹³ In our CGE simulations, public sector's net savings and net wealth are unchanged from baseline scenario to policy alternative. This implies that changes in net national savings and net wealth are equal to the private sector's change in these variables.

We have linked wealth in the microsimulation and CGE models as shown in table 2. The numerical changes from the CGE model are reported in appendix A.

Table 2. Linking wealth in the microsimulation and CGE models

Microsimulation model	CGE model
Bank deposits abroad and debt abroad	Net national debt
Shares	Value of the real capital stock in limited liability companies
Value of dwellings for taxation purposes, private cars, self-employed's cars and machinery, self-employed's fishing boats	Value of dwellings, private cars, self-employed's cars and machinery, self-employed's fishing boats

In addition, expenses and some components of income and wealth in the microsimulation model are absent in the CGE model. We have chosen to keep these variables constant, including interest income from Norwegian debtors, interest on loans to Norwegian creditors¹⁴, domestic bank deposits and domestic debt.

A detailed description of assumptions and the linking of income and wealth in the two models are given in appendix B.1 and B.2.

4.3 Transfers

In the CGE model, the different transfers, that is pensions, sickness benefits, unemployment benefits, child benefits, other transfers from Central Government and other transfers from Local Government, automatically change as a result of changes in the wage rate, total wage payments or the price index of aggregate private consumption. The detailed linking of transfers in the two models is reported in appendix B.3. The numerical changes in transfers from the CGE analyses are reported in appendix A.

¹⁴ The pre-tax income concept used in the microsimulation model includes interest income but excludes interest on debt. Stipulated capital income stemming from housing is also excluded. Dwelling services are part of private consumption expenditure.

4.4 Leisure and savings

Leisure

Leisure is part of the utility function in the CGE model, but not in the microsimulation model. Higher (lower) incomes due to increased (lower) labour supply are fed into the microsimulation model but the corresponding decrease (increase) in leisure is not taken into account. Therefore, only the positive (negative) aspects of increased (decreased) labour supply are included in the microsimulation model.

Savings

There is a somewhat analogous problem concerning savings: In steady state, net savings in real capital are zero, but real capital wealth may have increased (decreased) from baseline scenario to a policy alternative due to positive (negative) savings in real capital earlier in the path. We employ changes in income and wealth from the CGE model's steady state when linking the microsimulation and CGE model. This means that only the gains (losses) from increased (decreased) savings in real capital are taken into account when we link the two models. A similar argument applies to financial savings.

4.5 Evaluation of the linking procedure

In order to evaluate our sequential linking procedure, we compare aggregate private consumption expenditure in current prices in the two models. Both the level in the baseline scenario and the change and percentage change from baseline scenario to the three policy alternatives are compared, see table 3.

Table 3. Aggregate private consumption expenditure. Current purchaser prices. Microsimulation results versus CGE results. Billion NOK and percentage change

	General VAT reform		Abolition of investment tax		Political VAT reform	
	Microsim.	CGE	Microsim.	CGE	Microsim.	CGE
VCB in baseline scenario	452.75	428.22	452.75	428.22	452.75	428.22
Change in VCB from baseline scenario	13.14	15.25	3.54	3.84	0.03	0.07
Percentage change in VCB from baseline scenario	2.90	3.56	0.78	0.90	0.01	0.02

VCB: Aggregate private consumption expenditure measured in purchaser prices.

Numbers from the baseline scenario apply to the year 1995 in the microsimulation model, while these numbers apply to the steady state in the CGE model. The steady state numbers may, as mentioned earlier, be interpreted as representing the economy in 1995 after it has "calmed down".

Concerning evaluation of our linking procedure, the impression is that it gives quite reasonable results. There is not complete consistency, visualized by the fact that the change in aggregate private consumption expenditure is not identical in the two models. The differences between the results from the CGE and microsimulation models are not significant, however, cf. footnote 18.

5. Results

The distribution of the standard of living over a population can be summarised in several ways. In this paper, we focus on the simple aggregated measure equality (E), defined as $(1 - G)$, where G is the Gini-coefficient¹⁵. The equality measure varies between 0 and 1, and the value increases when the distribution of the standard of living becomes more equal.

It is difficult to grasp whether a change in the degree of equality is large or not. We therefore "translate" a change in the degree of equality into a change in the standard of living per person, while

¹⁵ The Gini-coefficient is the most common measure of inequality in the economic literature, see Aaberge (2001) for an axiomatic foundation of the Gini-coefficient.

simultaneously keeping Sen welfare constant. Sen welfare is defined as: $S = WE$, where S is Sen welfare, W is average standard of living per person and E is the degree of equality, cf. Sen (1974) for an axiomatic basis. The average standard of living per person, W , is in this paper measured by the real consumption expenditure per equivalent adult, taken from the microsimulation model in 1995 and E is defined as above. When Sen welfare is to be unchanged from baseline scenario to the three policy alternatives, a reforms' increase (decrease) in equality must be compensated by a decrease (increase) in the standard of living per person. Appendix C may be consulted for details.

Table 4 shows the absolute change in the degree of equality from baseline scenario to the three policy alternatives for our main simulation, 1), and for different decompositions, 2) - 9). It also shows the change in the degree of equality "translated" into a change in the standard of living per person for given Sen welfare. All these numbers show that the interaction effect is close to 0, i.e. the sum of single-effects is almost identical to the effect of changing these variables simultaneously¹⁶.

Our main simulation, which is the case where all CGE effects are taken into account, (cf. 1) in table 4) shows that equality is clearly increased with the political VAT reform. With the general VAT reform the change in equality are close to 0. Abolition of the investment tax implies a small reduction in equality, but the effect is quite close to zero^{17,18}.

¹⁶ One exception is the general VAT reform where summing the equality effects of c, d and e, respectively, (cf. 4), 5) and 6) in table 4) is equal to -0.00072, while the effect on equality of changing the relevant variables simultaneously is equal to -0.00061 (cf. 8) in table 4).

¹⁷ All of these conclusions hold when we perform sensitivity analyses with respect to the choice of equivalence scale (cf. footnote 8).

¹⁸ Since our linking procedure does not ensure complete consistency, visualized by the fact that the change in aggregate private consumption expenditure is not identical in the two models, we have undertaken the following exercise: The main simulation of the general VAT reform (cf. 1) in table 4) is undertaken while simultaneously changing proportionally all incomes, wealth and transfers so that the resulting percentage change in aggregate private consumption expenditure in the microsimulation model is identical with the percentage change in the CGE model. The result shows that the change in equality is still close to 0 (-0.00005).

Table 4. Absolute change in the degree of equality from baseline scenario, for three policy reforms and for different decompositions. Translation of this into an absolute change in NOK (Euro¹) in the standard of living per person (W²) for given Sen welfare.

Changed exogeneous variables in the micro-sim. model	General VAT reform		Abolition of investment tax		Political VAT reform	
	Equality	Translated into W, NOK (Euro)	Equality	Translated into W, NOK (Euro)	Equality	Translated into W, NOK (Euro)
1) a+b+c+d+e	0.00012	-69 (-8)	-0.00040	228 (27)	0.00176	-1013 (-120)
2) a	0.00118	-677 (-80)	-0.00038	217 (26)	0.00157	-903 (-107)
3) b	-0.00045	259 (30)	0.00024	-137 (-17)	0.00013	-75 (-9)
4) c	-0.00231	1306 (155)	-0.00064	364 (43)	0.00001	-6 (-1)
5) d	-0.00089	506 (60)	-0.00026	148 (18)	-0.00002	11 (1)
6) e	0.00248	-1432 (-170)	0.00063	-361 (-43)	0.00005	-29 (-3)
7) a+b	0.00073	-418 (-50)	-0.00014	80 (9)	0.00170	-978 (-116)
8) c+d+e	-0.00061	347 (41)	-0.00026	148 (18)	0.00005	-29 (-3)
9) a+c+d+e	0.00057	-326 (-39)	-0.00064	364 (43)	0.00162	-932 (-111)

a: changed VAT rates on consumer goods and services

b: changed producer prices from the CGE simulations

c: changed pre-tax incomes, excl. of dividends (and transfers), and changed pre-tax wealth from the CGE simulations

d: changed pre-tax dividends from the CGE simulations

e: changed pre-tax transfers from the CGE simulations

1) The exchange rate used in the calculations is equal to 8.42 NOK per Euro.

2) W is equal to 130491 NOK (15498 Euro) in 1995.

When we undertake a "traditional" simulation of the microsimulation model, i.e. only changing the VAT rates (cf. 2) in table 4), the results for the political VAT reform and abolition of the investment tax are still respectively a clear increase and a small decrease in equality, where the latter is still quite close to zero. The inclusion of general equilibrium effects does not change the results, in other words. For the political VAT reform, the main explanation of the equality result in both cases seems to be the halving of the VAT rate on food and non-alcoholic beverages. This halving, together with the fact that persons with a low standard of living generally have a larger budget share of food than persons with a high standard of living, implies increased equality. With abolition of the investment tax the reason for

the small decrease in equality when general equilibrium effects are not taken into account, is the increase in the VAT rate on goods¹⁹. This increase, together with the fact that persons with a low standard of living generally have a larger budget share of goods, as opposed to services, than persons with a high standard of living, implies reduced equality.

However, with the general VAT reform, the inclusion of general equilibrium effects is important for the results. For this reform, equality is increased when CGE effects are not taken into account as opposed to almost unchanged equality when such effects are included. Increased equality when general equilibrium effects are not included can be explained by introduction of VAT on more services. This, together with the fact that persons with a low standard of living generally have a smaller budget share of services than persons with a high standard of living, results in increased equality.

Which components from the general equilibrium analysis contribute to change the result from an increase in equality to a zero effect on equality? Answers can be found in rows 3-9 of table 4. We see that taking account of changed producer prices (b), changed pre-tax incomes, exclusive of dividends, and changed wealth (c), and changed dividends (d) contribute to reduced equality. On the other hand, changed pre-tax transfers (e) contribute to increased equality. The effect on equality of the former changes (i.e. b, c, and d) outweighs the effect on equality of the latter change (i.e. e), resulting in the stated overall zero effect on equality instead of increased equality.

Explanations of the partial effects above are as follows: Pre-tax incomes, exclusive of dividends, (where wage income is a major component) increase in the CGE simulations. This, taken together with the fact that wage income generally constitutes a smaller share of income for persons with a low

¹⁹ Remember that a public revenue neutral increase in the VAT rate on goods and *some* services is part of the reform that abolishes the investment tax.

standard of living than for persons with a high standard of living, explains the reduction in equality. Dividends are increased in the CGE simulations, implying reduced equality since dividends generally constitute a smaller share of income for persons with a low standard of living than for persons with a high standard of living. In the CGE model many transfers depend upon wages (wage indexation). Since wages are increased in the CGE simulations, transfers are then automatically also increased, and equality increases because transfers generally constitute a larger share of income for persons with a low standard of living than for persons with a high standard of living.

A point worth stressing is the importance of including general equilibrium changes in all the main income components and transfers. For example, with the general VAT reform only including changes in pre-tax incomes, excl. of dividends, and pre-tax wealth together with changed producer prices would have resulted in a clear decrease in equality (the sum of 4) and 7) in table 4 is equal to - 0.00158). This is in sharp contrast to almost unchanged equality when also general equilibrium changes in pre-tax dividends and pre-tax transfers are included. Robilliard et al. (2001) do not take into account changes in non-labour income (like transfers and dividends).

Table 4 also provides a decomposition of the effects on equality of abolition of the investment tax. Taking into account changes in producer prices (b) increases equality, but this is offset by the negative effect of increased dividends (d). Increased pre-tax incomes, exclusive of dividends, and changed wealth (c) contribute substantially to decreased equality, but this is offset by the effect of increased transfers (e). Thus in this policy reform the different "general equilibrium effects", cancel each other out, implying that the effect on equality is the same in the full analysis (cf. 1) in table 4) and the simple approach (cf. 2) in table 4). However, the sizes of the partial equilibrium effects are relatively important, and neglecting effects from e.g. transfers would have given a substantially more negative effect on equality of this policy reform.

Table 4 also shows the detailed decomposition of the effects on equality from the political VAT reform. We notice that the inclusion of general equilibrium effects is of no importance concerning the equality results. This is due to small changes in the variables from the CGE analysis, cf. table A.1. - A.5. in appendix A.

6. Concluding remarks

In this paper we have used a microsimulation model of the Norwegian economy subsequent to a CGE model to analyse effects on the degree of equality of three indirect taxation reforms. Efficiency effects of these three reforms have earlier been analysed by Bye et al. (2004) by employing a CGE model with one representative consumer.

Consumer prices, pre-tax nominal incomes, wealth and transfers are all exogenous in the microsimulation model and percentage changes in such variables from the CGE analyses are fed into the microsimulation model. By combining CGE and microsimulation models in such a way, the equality analyses are enriched by taking into account potentially important information from the general equilibrium analyses.

The three reforms analysed in this paper are evaluated against a baseline scenario which describes the Norwegian, non-uniform, system of indirect taxation in 1995. The first reform analysed is the general VAT reform, where all goods and services are subject to the same VAT rate. The second reform analysed is abolition of the investment tax, where the investment tax is set equal to zero. This reform is both analysed separately and as part of the general VAT reform. The third reform analysed is the political VAT reform. This reform introduces another non-uniform VAT system, of which a main characteristic is the halving of the VAT rate on food and non-alcoholic beverages. This VAT system

was actually implemented in Norway in 2001. All the three reforms are in the CGE analysis made public revenue neutral by changes in the VAT rate²⁰.

We find that equality is clearly increased with the political VAT reform. Concerning the general VAT reform and abolition of the investment tax the changes in equality are close to 0. When general equilibrium effects are *not* taken into account, the equality results survive with the political VAT reform and abolition of the investment tax. This is not the case with the general VAT reform, where the zero effect on equality is turned into an increase in equality. Both the inclusion of changed producer prices and changed pre-tax nominal incomes, wealth and transfers contribute to this alteration of the equality result.

A priori the only case where the inclusion of general equilibrium effects is irrelevant to the overall equality results, is the one where these effects are small. The political VAT reform is an example of such a case, as pointed out above. In all other cases a microsimulation analysis with the inclusion of general equilibrium effects will have to be carried out in order to know how these effects influence the equality results. With the general VAT reform the inclusion of general equilibrium effects changes the equality result substantially, while with abolition of the investment tax the different general equilibrium effects cancels each other out.

Another finding is the importance of including general equilibrium changes in *all* the main income components and transfers. For example, with the general VAT reform only including changes in pre-tax incomes, excl. of dividends, and pre-tax wealth together with changed producer prices would have resulted in a clear decrease in equality. This is in sharp contrast to unchanged equality when also

²⁰ Bye et al. (2004) find that welfare is increased with the general VAT reform, while it is reduced with the other two reforms; the political VAT reform experiencing the largest reduction.

general equilibrium changes in pre-tax dividends and pre-tax transfers are included. Robilliard et al. (2001) do not take into account changes in non-labour income (like transfers and dividends).

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Simulated changes in consumer prices, income, wealth and transfers

Table A.1. Consumer prices when producer prices are endogenous.

Percentage changes from baseline scenario. Long run effects

	General VAT reform	Abolition of investment tax	Political VAT reform
Food	1.289	1.373	-7.015
Beverages and tobacco	0.790	1.434	-0.789
Electricity	2.441	0.055	1.777
Fuels	2.253	1.302	1.922
Petrol and Car Maintenance	2.602	1.304	2.764
Clothing and Footwear	0.576	1.296	2.113
Goods for Recreation Activities	0.725	1.377	2.070
Furniture and Durable Consumer Goods	1.722	1.261	1.923
Electrical Household Equipment	0.757	1.395	2.076
Health Services	20.322	0.172	-0.134
Medicines and Medical Goods	0.640	1.229	1.879
Gross Rents	0.343	0.546	1.547
User Cost of Cars etc.	0.634	1.321	1.954
Road Transport etc., Local	18.905	-0.107	0.615
Road Transport etc., Long-distance	18.329	-0.062	0.669
Air Transport etc.	16.315	0.644	-0.186
Railway and Tramway Transport, Local	15.315	0.486	0.897
Railway Transport, Long-distance	15.488	0.481	0.871
Water Transport, Local	23.780	0.089	0.231
Water Transport, Long-distance	23.916	0.045	0.115
Postal and Telecommunication Services	1.496	0.470	2.029
Other Goods	6.300	0.917	1.612
Other Services	9.796	0.990	1.641
Direct Purchases Abroad by Resident Households	0.00	0.00	0.000

Table A.2. Consumer prices when producer prices are constant.**Percentage changes from baseline scenario. Long run effects**

	General VAT reform	Abolition of investment tax	Political VAT reform
Food	1.363	1.652	-7.082
Beverages and tobacco	0.847	1.676	-0.816
Electricity	3.611	1.494	1.823
Fuels	2.464	1.623	1.979
Petrol and Car Maintenance	3.952	1.498	2.665
Clothing and Footwear	0.872	1.724	2.104
Goods for Recreation Activities	0.898	1.698	2.072
Furniture and Durable Consumer Goods	2.081	1.603	1.956
Electrical Household Equipment	0.904	1.704	2.078
Health Services	24.050	0.000	0.000
Medicines and Medical Goods	0.937	1.692	1.871
Gross Rents	0.752	0.104	0.127
User Cost of Cars etc. Road Transport etc., Local	0.807	1.596	1.947
Road Transport etc., Long-distance	24.050	0.000	0.000
Air Transport etc.	23.444	0.044	0.054
Railway and Tramway Transport, Local	24.050	0.000	0.000
Railway Transport, Long-distance	24.050	0.000	0.000
Water Transport, Local	23.675	0.027	0.033
Water Transport, Long- distance	24.050	0.000	0.000
Postal and Telecommunication Services	2.271	1.592	3.217
Other Goods	6.458	1.268	1.636
Other Services	13.369	0.781	1.521
Direct Purchases Abroad by Resident Households	0.000	0.000	0.000

Table A.3. Nominal incomes. Percentage changes from baseline**scenario. Long run effects**

	General VAT reform	Abolition of investment tax	Political VAT reform
Total wage and salary payments net of social taxes for employ- ees	3.674	1.014	0.000
A: Wage and salary payments net of social taxes for self- employed ¹⁾ in agriculture	3.796	0.921	0.054
B: Wage and salary payments net of social taxes for self- employed ¹⁾ in forestry	3.754	0.925	0.048
C: Wage and salary payments net of social taxes for self- employed ¹⁾ in fishing	3.203	0.750	0.039
D: Wage and salary payments net of social taxes for self- employed ¹⁾ in the rest of the industries ²⁾	3.979	1.110	-0.146
Return on real capital for self- employed in agriculture; pre- tax ³⁾ , risk-adjusted ⁴⁾ , net of depreciation + A	2.719	0.580	0.038
Return on real capital for self- employed in forestry; pre-tax ³⁾ , risk-adjusted ⁴⁾ , net of deprecia- tion + B	1.555	0.214	0.019
Return on real capital for self- employed in fishing; pre-tax ³⁾ , risk-adjusted ⁴⁾ , net of deprecia- tion + C	2.968	0.694	0.034
Return on real capital for self- employed in the rest of the industries ²⁾ ; pre-tax ³⁾ , risk- adjusted ⁴⁾ , net of deprecia- tion+D	4.352	1.221	-0.095
Return on real capital in limited liability companies; pre-tax ³⁾ , risk-adjusted ⁴⁾ , net of deprecia- tion	5.281	1.543	0.112
Interest rate multiplied by net national debt	43.111	11.158	-4.008

1) We assume that the wage rate received by self-employed is equal to the wage rate received by employees.

2) That is all private production sectors, with the exception of agriculture, forestry, fishing, dwelling services, production of electricity, oil and gas exploration and drilling, production and pipeline transport of oil and gas, ocean transport and imputed service charges from financial institutions.

3) But after paying of VAT and/or investment tax.

4) See Bye and Ávitsland (2003) and Bye et al. (2004) for an explanation of risk-adjustment in the CGE model.

Table A.4. Nominal wealth. Percentage changes from baseline

scenario. Long run effects

	General VAT reform	Abolition of investment tax	Political VAT reform
Net national debt	43.111	11.158	-4.008
Value ¹⁾ of real capital stock ²⁾ in limited liability companies	5.112	1.571	0.115
Market value ³⁾ of dwelling capital	1.719	0.672	0.717
Market value ³⁾ of cars	5.386	0.772	0.280
Market value ³⁾ of cars and ma- chinery ²⁾ for self-employed	-4.094	-2.346	-0.105
Market value ³⁾ of fishing boats for self-employed	1.379	0.595	0.009

1) Measured in purchaser price indexes, exclusive of VAT and/or the investment tax.

2) Comprising all private production sectors, with the exception of dwelling services, production of electricity, oil and gas exploration and drilling, production and pipeline transport of oil and gas, ocean transport and imputed service charges from financial institutions.

3) Measured in purchaser price indexes, inclusive of VAT and/or the investment tax.

Table A.5. Transfers. Percentage changes from baseline scenario.

Long run effects

	General VAT reform	Abolition of investment tax	Political VAT reform
Pension	3.821	0.943	0.067
Sickness benefits etc.	3.674	1.014	0.000
Unemployment benefits	3.674	1.014	0.000
Child benefits	3.821	0.943	0.067
Other transfers, Central Gov- ernment	3.821	0.943	0.067
Other transfers, Local Govern- ment	3.142	0.915	0.266

The symbol and name of the microsimulation variables (MSV) are first mentioned. Next, the symbol and name of the corresponding CGE variables (CGEV) are written down. This means that all microsimulation variables under the heading 1) MSV are exogenously changed by the percentage change in the variable under the heading 1) CGEV, and so forth. Assumptions made are then clarified, together with other comments. B.1 deals with income variables, B.2 with wealth variables and B.3 with transfer variables.

B.1 Combining income variables in the CGE and microsimulation models

1) MSV

K2101, wage income and unemployment benefits for employees

K21013, of this: wage income only into the basis for calculation of member's premium to the National Insurance Scheme

K2102, income entitled to the seaman's deduction

K2103, income stemming from child care in one's own home

K2104, profit from payments in kind

K2105, other income stemming from labour

K2401, children's wage income (children under 13 years of age)

K1607, calculated personal income limited liability company, liberal occupation

K1608, calculated personal income limited liability company, other industry

K3212, contribution to private/public Norwegian pension scheme in connection with the employment

XEKSTRA, adjustment of personal income

XELF, own wages in an enterprise

XGLF, basis for deduction of wages

XKAG, basis for return to capital

XKN, corrected self-employed, taxable income

XLAKT, wage costs concerning active owners

1) CGEV

y_{ww} , total wage and salary payments net of social taxes

2) MSV

K1601, calculated personal income one-man enterprise, primary industry

K1604, calculated personal income partner-assessed company, primary industry

K1612, part of wage income/pension stemming from enterprise from which the person in question receives calculated personal income, primary industry

K1701, remuneration for work to partner in partner-assessed company where personal income is not calculated, primary industry

2) CGEV

$$ww_{11}l_{s11} + ww_{12}l_{s12} + ww_{13}l_{s13}$$

ww_j is wage per hour to wage earners in production sector j in current prices and net of social taxes, l_{sj} is number of hours worked by self-employed in production sector j , $j = 11$ (agriculture), 12 (forestry) and 13 (fishing).

3) MSV

K1602, calculated personal income one-man enterprise, liberal occupation

K1605, calculated personal income partner-assessed company, liberal occupation

K1613, part of wage income/pension stemming from enterprise from which the person in question receives calculated personal income, liberal occupation

3) CGEV

$$ww_{85}ls_{85}$$

85 is the industry other private services.

4) MSV

K1603, calculated personal income one-man enterprise, other industry

K1606, calculated personal income partner-assessed company, other industry

K1614, part of wage income/pension stemming from enterprise from which the person in question receives calculated personal income, other industry

K1702, remuneration for work to partner in partner-assessed company where personal income is not calculated, other industry

4) CGEV

$$\sum_{j \in PP \setminus \{PW, 11, 12, 13, 85\}} ww_j ls_j$$

PP is all private production sectors and PW is the private production sectors 71 (Production of electricity), 68 (Oil and gas exploration and drilling), 64 (Production and pipeline transport of oil and gas), 60 (Ocean transport), 83 (Dwelling services) and 89 (Imputed service charges from financial institutions).

5) MSV

K2701, self-employed, taxable income, agriculture

5) CGEV

$$sse_{11} \sum_{i=10,40,50} (bp_{i,11} - \hat{\delta}_{i,11} - risk) pjb_i k_{i,11} + ww_{11} ls_{11}$$

sse_{11} is the share of self-employed in agriculture, $i = 10, 40$ and 50 are respectively buildings, cars and machinery, $bp_{i,11}$ is the user cost of capital type i per NOK invested in agriculture, $\hat{\delta}_{i,11}$ is the depreciation rate of capital type i in agriculture, $risk$ is the risk premium, pjb_i is the purchaser price index, exclusive of VAT and the investment tax, for new investment, capital type i and $k_{i,11}$ is the capital stock of type i in agriculture in constant prices.

6) MSV

K2702, self-employed, taxable income, forestry

6) CGEV

$$sse_{12} \sum_{i=10,40,50} (bp_{i,12} - \hat{\delta}_{i,12} - risk) pjb_i k_{i,12} + ww_{12} ls_{12}$$

7) MSV

K2703, self-employed, taxable income, fishing

7) CGEV

$$sse_{13} \sum_{i=30,50} (bp_{i,13} - \hat{\delta}_{i,13} - risk) pjb_i k_{i,13} + ww_{13} ls_{13}$$

30 is the capital type ships and fishing boats.

8) MSV

K2704, other self-employed, taxable income (inclusive of liberal occupation)

K27041, self-employed, taxable income, partnership company

8) CGEV

$$\sum_{j \in PP \setminus \{PW, 11, 12, 13\}} sse_j \sum_{i=10, 40, 50, 30, 80} (bp_{i,j} - \hat{\delta}_{i,j} - risk) pjb_i k_{i,j} + \sum_{j \in PP \setminus \{PW, 11, 12, 13\}} ww_j ls_j$$

80 is the capital type aircraft.

There is a clear coherence between income types 2) to 8) since self-employed, taxable income both consists of capital income and the self-employed's labour income and calculated personal income is meant to reflect the self-employed's labour income. The above expressions for the self-employed's labour income part of self-employed, taxable income and for the calculated personal income are therefore identical. We assume that the self-employed's wage rate is equal to the wage rate received by employees.

All private production sectors with the exception of 71 (Production of electricity), 68 (Oil and gas exploration and drilling), 64 (Production and pipeline transport of oil and gas), 60 (Ocean transport), 83 (Dwelling services) and 89 (Imputed service charges from financial institutions) are included in the above calculations. 68 (Oil and gas exploration and drilling), 64 (Production and pipeline transport of oil and gas) and 60 (Ocean transport) are excluded because of a constant real capital stock and no user costs of real capital attached to them. 89 (Imputed service charges from financial institutions) are not included since there is no real capital stock there. 83 (Dwelling Services) are excluded since this is an artificially constructed private production sector directly attached to private consumption. We have chosen to omit 71 (Production of electricity) since the user cost of capital in this industry differs conceptually from the other user costs and since real capital is "almost exogenous".

Concerning item 5) to 8), we use the net return on real capital for self-employed as an approximation to the self-employed's capital income part of self-employed, taxable income. The net return in these

expressions is generally before paying of taxes. An exception is paying of the VAT and the investment tax since we employ the purchaser price index of new investments exclusive of VAT and the investment tax. We then think of the difference between the net return on real capital employing respectively the purchaser price index inclusive and exclusive of the VAT and the investment tax as representing the paying of these two taxes. Since the microsimulation model only deals with personal taxes the VAT and the investment tax on inputs are not part of this model.

Gross production in agriculture, forestry and fishing is exogenous in the CGE model. Therefore changes in employment and real capital may only take place through substitution effects, and not through scale effects.

In the microsimulation model, the calculated personal income is either exogenous, as in item 2) to 4), or computed by means of individual variables, as in item 1) (the variables starting with the letter X). The former constitutes the largest part. For practical reasons, we assume that all the "X-variables" in 1), even though they are divided into the two categories primary industry and other industry, are changed by the change in employees' wage income. The self-employed's endogenous calculated personal income will then change by roughly the same percentage.

9) MSV

K3104, dividends from shares giving the right to refundment

K31041, of this: dividends from funds of shares

9) CGEV

$$\sum_{j \in PP \setminus \{PW\}} sllc_j \sum_{i=10,40,50,30,80} (bp_{i,j} - \hat{\delta}_{i,j} - risk) pjb_i k_{i,j}$$

$sllc_j$ is the share of limited liability companies in production sector j.

Concerning item 9), we use the percentage change in net return on real capital for limited liability companies as an approximation to the percentage change in dividends. As was the case for items 5) to 8), we employ the purchaser price index of new investments exclusive of VAT and the investment tax. In addition, we assume that other taxes than the VAT and the investment tax paid by the limited liability company constitute a constant share of the net return on real capital. We may then think of the percentage change in the expression above as representing the percentage change in the after-tax net return on real capital in limited liability companies. As stated earlier, the microsimulation model only applies to personal taxes.

10) MSV

K3106, income from abroad

K3302, interest on debt to foreign creditors

10) CGEV

$renu \times ngu$

$renu$ is the nominal annual interest rate on positive financial investment in the international capital market and ngu is net national debt.

We only have numbers for net national debt. We assume that the individual components, debt and claims, change by the same percentage as the net variable.

11) MSV

K3101, interest on deposits in domestic banks

K3102, other interest: outstanding claims, bonds etc.

K3301, interest on debt to Norwegian creditors

We have chosen to keep these variables constant in the microsimulation model since we do not know the percentage change in debt to Norwegian creditors and claims on Norwegian debtors.

12) MSV

K3107, dividend from abroad

This variable is kept unchanged since the corresponding CGE variable is exogenous.

13) MSV

K2805, taxable gain by selling real property

K3105, taxable gain by selling Norwegian and foreign shares

K3117, gain, gain and loss account

K3118, gain, empty/void negative balance, group A-D

K3306, deductible loss by selling real property

K3308, deductible loss by selling shares

K3317, loss, gain and loss account

K3318, loss, empty positive balance group A-D

All these variables are kept unchanged since the capital gains in the CGE model are equal to 0 in steady state.

14) MSV

K3217, deficit in primary industry

K3218, deficit in other industries

K3219, deficit in partnership companies

K3220, deficit by hiring out real property

K3221, nonlocal deficit

K3309, self-employed's deficit from a previous year that is possible to carry forward

All these variables are kept unchanged since no companies in the CGE model have deficits in equilibrium (companies with deficits have left the industry).

15) MSV

K2804, net income by hiring out real property, not in connection with self-employment

This variable is kept unchanged since all dwellings are owner-occupied and sites are not included in the CGE model.

16) MSV

K1505, unused refund deduction from 1994

K2601, received own contributions, annuities, provisions made for a retiring farmer on handing over the farm to his heir or successor etc.

K2602, received contributions etc. to children under 17 years of age

K2603, other contributions, annuities, provisions made for a retiring farmer on handing over the farm to his heir or successor etc.

K2803, part owner's share of income in housing company (not percentage income)

K3103, return on the savings part of life insurance

K3108, other income

K31081, nonlocal income (not assessed on a percentage basis)

K3202, actual expenses in order to acquire income

K3207, extra expenses for board and lodging incurred when working away from home

K3208, travels to/from working place

K3209, travel expenses when visiting home

K3210, parents' deduction

K3211, trade union dues

K3213, seaman's deduction

K3214, special deduction associated with income from fishing

K3215, self-employed's premium to voluntary extra national insurance for sickness benefits in the National Insurance Scheme

K3303, alimony and accommodation and support provided by the new owner of landed property for its former owner inherent in real property with the exception of land/forest

K3304, share of deductible expenses in housing company

K3305, deductible premium for private pension scheme

K3307, other deductions

K12, loan from "Statens Lånekasse" assigned this year

K13, total paid to "Statens Lånekasse" this year

K14, of this interest paid to "Statens Lånekasse" this year

K16, interest balance in "Statens Lånekasse" at the end of the year

K45, tax-free payments

Concerning item 16), none of the variables exist in the CGE model. We have chosen to keep them all unchanged.

B.2 Combining wealth variables in the CGE and microsimulation models

17) MSV

K4601, taxable assets abroad

K4803, debt to foreign creditors

17) CGEV

ngu

Concerning item 17), the same comments and assumptions as for item 10) apply. In addition, we assume that taxable assets abroad mainly consists of bank deposits and not shares.

18) MSV

K4101, bank deposits

K4104, bonds registered in "Verdipapirsentralen"

K4105, other bonds

K4106, outstanding claims

K4801, debt to Norwegian creditors

Since we have chosen to keep the variables in 11) unchanged, we also keep the variables in 18) constant.

19) MSV

K4107, value for taxation purposes of shares in Norwegian companies registered in "Verdipapirsentralen"

K41071, of this: unit in unit trust

K4108, value for taxation purposes of other shares in Norwegian companies

K4109, other securities

19) CGEV

$$\sum_{j \in PP \setminus \{PW\}} sllc_j \sum_{i=10,40,50,30,80} pjb_i k_{i,j}$$

Concerning item 19), we use the percentage change in the value of real capital in limited liability companies as an approximation to the percentage change in the mentioned share values. The value is measured exclusive of VAT and the investment tax. This is so since we think of the market value of shares as a sum of discounted dividends and these dividends are in item 9) measured exclusive of VAT and the investment tax.

20) MSV

IKB, gross value for taxation purposes, own dwelling property (inclusive of flats in housing co-operatives organized for one particular project only)

IKH, gross value for taxation purposes, cottages

K4301, share of housing company's value for taxation purposes

K4302, value for taxation purposes, own dwelling

K4303, value for taxation purposes, cottage

20) CGEV

$$pj_{10,83} k_{10,83}$$

where $pj_{10,83}$ is the purchaser price index, inclusive of VAT, for new investments in dwellings and cottages in the production sector Dwelling services and $k_{10,83}$ is dwellings and cottages in the same production sector. We assume that the value for taxation purposes concerning housing constitutes a constant share of the market value of housing from baseline scenario to the different policy

alternatives. IKB and IKH are used as basis for calculation of capital income stemming from housing. This capital income is not part of the pre-tax income concept in the microsimulation model but is used as basis for calculation of income taxes. K4301, K4302 and K4303 are used as basis for calculation of wealth taxes in the microsimulation model.

21) MSV

K4204, private cars, motor cycles

21) CGEV

$$pc_{30}hc_{31}$$

where pc_{30} is the purchaser price index for cars inclusive of VAT and hc_{31} is households' stock of cars in constant prices.

22) MSV

K4401, occupational cars, machinery and fixtures

22) CGEV

$$\sum_{j \in PP \setminus \{PW\}} sse_j \sum_{i=40,50} pj_{i,j} k_{i,j}$$

where $pj_{i,j}$ is the purchaser price index of new investments inclusive of VAT and/or the investment tax, capital type i , production sector j .

23) MSV

K4404, ships and fishing boats

23) CGEV

$$\sum_{j=13,14,78} sse_j p_{j30,j} k_{30,j}$$

where 78 is Coastal and inland water transport.

24) MSV

K4403, stock of goods

K46013, real property abroad (not taxable)

These two variables are kept unchanged since stock of goods and purchase/sale of real capital abroad are exogenous in the CGE model. In addition, sites are not part of the model.

25) MSV

K1504, inheritance, gift

K4102, cash amount and cheques

K4103, free amount, cash amount

K4201, furniture and other movables

K4202, pleasure boats, value < 50 000 NOK

K4203, pleasure boats, value > 50 000 NOK

K4205, caravans

K4304, value for taxation purposes of other real property and forests

K4402, cattle, fur-bearing animals, reindeer

K4501, premium fund, private pension scheme

K4502, gross repurchase value life insurance

K4503, share owner's share of housing company's other wealth

K4504, other taxable wealth

K4802, share owner's share of debt in housing company

K15, debt in "Statens Lånekasse" at the end of the year

None of these variables exist in the CGE model. We have chosen to keep them unchanged.

B.3 Combining transfer variables in the CGE and microsimulation models

26) MSV

K2201, pension from the National Insurance Scheme

K22012, additional payment concerning pension

K2202, other pension, "tjenestepensjon", annuities and private pension insurance, provisions made for a retiring farmer on handing over the farm to his heir or successor in agriculture and forestry

K2204, "ektefelletillegg"

K2301, spouse's pension, National Insurance Scheme

K2302, spouse's other pension

K44, paid out "avtafestet pensjon" (AFP)

26) CGEV

$RU611 + RU612 + RU613$

where RU611 is old-age pension from the Central Government Pension Fund, RU612 is other old-age pension and RU613 is disability pension. The percentage change in $RU611+RU612+RU613$ is equal to the percentage change in WWA, the average wage per man-year for wage earners.

27) MSV

K2705, sickness benefits, liberal occupation

K2706, sickness benefits, primary industry

K2707, sickness benefits, other industry

ENGANGST, once-and-for-all benefit concerning birth

27) CGEV

RU630, sickness benefits etc.

28) MSV

K2107, unemployment benefits to self-employed

28) CGEV

RU650, unemployment benefits

In the microsimulation model, sickness and unemployment benefits have their own entries concerning self-employed. For employees, these benefits are included in their wage income. However, the percentage change in respectively RU630 and RU650 is equal to the percentage change in YWW, the total wage and salary payments net of social taxes.

29) MSV

child benefit

benefit to little children

breadwinner deduction

29) CGEV

RU640, child benefits

The percentage change in RU640 is equal to the percentage change in WWA.

30) MSV

K11, scholarship from "Statens Lånekasse" assigned this year

K21, housing benefit from "Husbanken"

K2604, children's pension to children under 17 years of age

K34, basic benefit

K35, relief benefit

30) CGEV

RU659, other transfers, Central Government

The percentage change in RU659 is equal to the percentage change in WWA.

31) MSV

K38, social security benefits

31) CGEV

RU666, other transfers, Local Government

The percentage change in RU666 is equal to the percentage change in PC, the National Account price index for aggregate private consumption.

Interpretation of the magnitude of a change in the degree of equality based on a Sen welfare function

We define the Sen welfare function as

$$(1) \quad S = WE,$$

where S is Sen welfare, W is average standard of living per person and E is a measure of equality. In this paper, we use $E = 1-G$, where G is the Gini-coefficient. Sen (1974) may be conferred for an axiomatic basis of (1) when $E = 1-G$. W is in this paper measured by the real consumption expenditure per equivalent adult (taken from the microsimulation model in 1995).

We investigate a change from situation 0 to situation 1, using symbols:

$$(2) \quad \Delta S = S_1 - S_0, \quad \Delta W = W_1 - W_0, \quad \Delta E = E_1 - E_0.$$

Equations (1) and (2) imply $\Delta S = S_1 - S_0 = W_1 E_1 - W_0 E_0 = (W_0 + \Delta W)(E_0 + \Delta E) - W_0 E_0 = W_0 \Delta E + \Delta W E_0 + \Delta W \Delta E - W_0 \Delta E$, thus

$$(3) \quad \Delta S = W_0 \Delta E + \Delta W E_0 + \Delta W \Delta E.$$

Equation (3) and $\Delta S = 0$ imply that $\Delta W E_0 + \Delta W \Delta E = -W_0 \Delta E$, i.e. $(E_0 + \Delta E) \Delta W = -W_0 \Delta E$, thus

$$(4) \quad \frac{\Delta W}{W_0} = \frac{-\Delta E}{E_1}.$$

This means that if the degree of equality is increased by ΔE , the standard of living per person can be reduced by $\frac{\Delta E}{E_1} 100$ per cent and simultaneously keeping Sen welfare unchanged.

