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Documents

The problem with a risk premium in a non-stochastic CGE model

1. Introduction[1]

Empirical evidence shows that the average rate of return on shares over some time period is larger than the average rate of return on bank deposits. Given a reasonable assumption concerning the degree of risk aversion of the representative investor, part of this difference can be explained by risk associated with investment in shares (bank deposits are considered to be certain). In other words, the representative investor requires a risk premium when investing in shares. This feature of reality may be implemented in a computable general equilibrium (CGE) model by including a risk premium in the user costs of real capital. A problem shows up, however, if the CGE model is non-stochastic and does not explicitly include costs associated with risk. In this case, the risk premium will appear as an additional return on investments in real capital as compared with investments in financial capital, and not as a mere compensation for risk. This risk premium problem will be important when large reallocations between real and financial capital (i.e. a new composition of total wealth) are part of an analysis. It will then contribute to significant under- or overestimation of the change in welfare. Also, when large changes in total savings (i.e. a new level of total wealth) are part of an analysis, the risk premium problem will contribute to under- or overestimation of the change in welfare.

The mentioned risk premium problem is an example of a more general subject, namely that one aspect of reality is included in a numerical model but that aspect of reality, which explains the former, is omitted. Bergman (1990) points to different views concerning this: Some models incorporate features of the real world, which in a strict sense are inconsistent with Walrasian general equilibrium theory underlying CGE models. As an example he mentions the case where aggregate capital is modelled as homogenous and fully mobile, but differently remunerated across sectors. Another view is that the numerical model has to be entirely consistent with an explicit theoretical model. When ad hoc assumptions are incorporated, this may make model results more realistic but also difficult or impossible to interpret.

Fullerton and Gordon (1983) also state the problem with a risk premium in a model environment where costs associated with risk are not explicitly taken into account. They write that their "[…] individual utility functions implicitly include the utility provided from spending the risk premiums but do not explicitly subtract for the disutility of bearing risk" (p. 398). Fullerton and Gordon (1983) then calculate utility at the point where there is no risk. This calculation is undertaken *after* the model simulations. More specifically, they calculate consumption in the case where the consumers do not

[1] I would like to thank Geir H. Bjertnæs for useful discussions and Brita Bye and Taran Fæhn for reading and commenting on an earlier draft. I am, of course, fully responsible for remaining errors.

receive the risk premium appropriate for all the risk in the return on its capital but simultaneously do not bear any risk either.

In this paper I propose three different adjustment methods concerning the problem with a risk premium in a non-stochastic CGE model where costs associated with risk are not included. The three adjustment methods are of an ad hoc character, trying to ease the tension referred to above between the concerns of theoretical consistency on the one hand, and observed characteristics of the economy on the other. Two of the methods adjust the welfare measure *after* the model simulations[2], while the third method removes the risk premiums in the model simulations.

After presenting the three adjustment methods, I investigate their empirical implications. In that respect, I take an analysis of neutral taxation of housing, a policy experiment that leads to large reallocations from real to financial capital, as the starting point, see Bye and Åvitsland (2003). More specifically, the starting point is the case where the risk premium problem is not handled. The main analytical tool used in Bye and Åvitsland (2003) is Statistics Norway's model MSG-6, which is a non-stochastic CGE model with a risk premium, but without costs associated with risk.

The paper is organized as follows; section 2 describes the CGE model. Section 3 presents the welfare definitions in the non-adjusted and the three adjusted cases. Section 4 describes the baseline and policy scenario. Section 5 presents the social rates of return on capital in the non-adjusted and the three adjusted cases. Section 6 discusses the results and section 7 compares the adjustment methods and concludes.

2. Basic features of the CGE model MSG-6

The applied model is a numerical intertemporal general equilibrium model for the Norwegian economy.[3] It 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 17 consumption activities. 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).

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[2] Bye, Strøm and Åvitsland (2003) implement one of these and Bye and Åvitsland (2003) use a similar but more crude adjustment method.

[3] Different versions of the model have been developed by Statistics Norway since the early 1970s and are originally based on Johansen (1960). The models have been used routinely by the Norwegian Ministry of Finance for long-term forecasting and policy analyses for nearly four decades.

2.1. 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 malleable.[4] 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 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 behaviour support the existence of some domestic market power; see Klette (1994) and Bowitz and Cappelen (2001).

2.1.1. User costs of capital

The model of investment behaviour is described in Holmøy, Larsen and Vennemo (1993) and Holmøy, Nordén and Strøm (1994). The starting point is a standard arbitrage equation where the after-tax risk adjusted marginal return of investing in shares (equal to the after-tax marginal return of investing in shares minus a risk premium) is equal to the after-tax marginal return of investing in bank deposits (equal to the after-tax interest rate on deposits). 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 behaviour 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 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. The user cost of capital for housing only describes the costs associated with owner-occupied housing.[5]

There are two, exogenous risk premiums in the model; one associated with housing capital and the other associated with all other endogenous real capital stocks. The former is equal to 2.25 per cent while the latter is equal to 3.5 per cent.

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

[5] In Norway, approximately 80 per cent of the housing capital is owner-occupied.

2.2. Consumer behaviour

Consumption, labour supply and saving 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 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 labour income and net transfers). The distribution of full consumption on material consumption and leisure[6] is determined by an Origo adjusted Constant Elasticity of Substitution function (OCES). Total material consumption is allocated across 17 different consumption activities according to a nested OCES, see Holtsmark and Aasness (1995).[7] The consumption of housing services is one of these consumption activities. The uncompensated demand elasticity for housing services is equal to -0.71. 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 fulfilment of the following transversality condition: The limit value of the discounted value of net foreign debt must 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. The transversality condition regarding 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.

[6] The uncompensated wage elasticity of labor supply is 0.1 per cent, which is based on estimates of labor supply based on micro-data by Aaberge, Dagsvik and Strøm (1995). The corresponding compensated wage elasticity of labor supply is 0.49.

[7] The OCES specification implies that the income elasticities are not identical and equal to 1.

3. Welfare measure and risk adjustment

I investigate the following four situations:

a) *No adjustment case:* In this case, I employ the traditional welfare measure and do not handle the risk premium problem. Welfare, W, is then equal to:

$$(1)\ W_t = \sum_{t=0}^{\infty} \frac{FC_t}{(1+RHO)^t}$$

FC is full consumption measured in constant prices, consisting of material consumption and leisure, and RHO is the subjective rate of time preference, which is equal to the after-tax interest rate by assumption. Welfare is, in other words, equal to the sum of discounted full consumption.

b) *Recursive adjustment case I:* In this case, I undertake the following adjustment of the welfare measure:

$$(2)\ W_t = \sum_{t=0}^{\infty} \frac{FC_t - \frac{RISK_1 * VK_{1,t}}{PFC_t} - \frac{RISK_2 * VK_{2,t}}{PFC_t}}{(1+RHO)^t}$$

The new variables are: $RISK_1$ and $RISK_2$, the risk premium associated with housing and the risk premium associated with the endogenous real capital stock exclusive of housing, respectively, VK_1 and VK_2, the current value of housing capital and the current value of the endogenous real capital stock exclusive of housing, respectively, and PFC, the price of full consumption. $RISK_1$ is equal to 2.25 per cent and $RISK_2$ is equal to 3.5 per cent.

This adjustment method has earlier been employed by Bye, Strøm and Åvitsland (2003). The point is to subtract from full consumption the costs associated with risk. This is done *after* the model simulations; for this reason I call the method recursive. It is assumed that costs associated with risk per NOK real capital are equal to the risk premium. Since the return stemming from the risk premium is included in full consumption (FC), both the risk premium and costs associated with risk are then taken into account in the welfare measure. Since full consumption is measured in constant prices we must divide the risk premium multiplied by the current value of the real capital stock by the price of full consumption.

c) *Recursive adjustment case II*: In this case, the welfare measure is adjusted the following way:

$$(3)\ W_t = \sum_{t=0}^{\infty} \frac{FC_t - \frac{\sum_{i=type} \sum_{j=\sec} (BP_{i,j,t}^{incl} - BP_{i,j,t}^{excl}) VK_{i,j,t}}{PFC_t}}{(1+RHO)^t}$$

The new variables are $BP_{i,j}^{incl}$ which is the user cost of capital per NOK invested inclusive of the risk premium and $BP_{i,j}^{excl}$ which is the user cost of capital per NOK invested exclusive of the risk premium (the risk premium is set equal to 0). The different capital types are included in "i = type" and the industries having endogenous real capital stocks[8] are included in "j = sec".

In this case, I subtract from full consumption the difference between the user cost of capital inclusive and exclusive of the risk premium. Since full consumption, FC, comprises the return on real capital inclusive of the risk premium,

$$\frac{\sum_{i=type}\sum_{j=\sec} BP_{i,j,t}^{incl} VK_{i,j,t}}{PFC_t},$$

the adjustment replaces this return with the return on real capital exclusive of the risk premium,

$$\frac{\sum_{i=type}\sum_{j=\sec} BP_{i,j,t}^{excl} VK_{i,j,t}}{PFC_t}.$$

This adjustment is very similar to the *recursive adjustment case I*. The only distinction is that now full consumption is adjusted by means of the difference between the user cost inclusive and exclusive of the risk premium instead of only using the risk premium. Since the user costs of real capital are tax-corrected and the way the risk premium enters the user costs depends on these tax rules, the difference between the user cost inclusive and exclusive of the risk premium is not equal to the risk premium. This distinction will imply different welfare measures.

The adjustment method in c) and the method used by Fullerton and Gordon (1983) have the following features in common: Both methods are undertaken *after* the model simulations and calculate welfare at the point where the return stemming from the risk premiums is abolished.

d) *Endogenous adjustment case:* In this case, the welfare measure is adjusted by abolishing the risk premiums in the model simulations[9]. Therefore, I call it an endogenous adjustment. I can then use the traditional welfare measure, repeated in equation (4):

$$(4)\quad W_t = \sum_{t=0}^{\infty} \frac{FC_t}{(1+RHO)^t}$$

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[8] However, I have omitted Production of electricity since the user cost in this industry does not include any risk premium. This user cost differs conceptually from the others.

[9] The risk premiums are included in the calibration of the model in the benchmark year, though.

In this case, we can think of full consumption, FC, as representing the case where there is neither a risk premium nor costs associated with risk in the model. The *endogenous adjustment case* therefore resembles the *recursive adjustment case II.* However, an important difference is that the adjustment in case d) is undertaken *in* the model simulations and not afterwards.

4. Baseline and policy scenario

The *baseline scenario* is the same as the baseline scenario in Bye and Åvitsland (2003). The model is calibrated to the benchmark year 1992. The baseline scenario is simulated by keeping all exogenous variables constant at their benchmark values. This also comprises the risk premiums. 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. The steady state solution of the model is path dependent.

The baseline scenario is compared with a *policy scenario* where neutral taxation of housing is implemented. This policy scenario is the same as one of the policy scenarios in Bye and Åvitsland (2003). More specifically, the imputed rate of return on housing capital is increased from 2.5 to 7.25[10] per cent and the imputed value of the house for taxation purposes is increased from 25 to 100 per cent of the market value of the house. The reform is made public revenue neutral by reducing the surtax on labour income, implying a reduction in the average marginal tax rate on labour income from 40.2 per cent to 37 per cent. These changes are all implemented in the first year of simulation (1992), disregarding any announcement effects. The risk premium is included in the scenario. Both the resulting simulation's path and the long run stationary solution will differ from the baseline scenario.

5. Social rates of return

The results from the policy simulation imply reallocations between different capital types, each having its own social rate of return. These returns indicate the gains and losses from capital reallocations and are reported in this section as a basis for understanding the results of the policy simulation. In addition, the results from the policy simulation imply changes in total savings. The social rates of return also indicate the welfare effects of such a change. The social rates of return are reported for real capital exclusive of housing, for housing and for financial capital and refer to the long run results of the baseline scenario.

[10] With the *endogenous adjustment case*, the imputed rate of return on housing capital is increased from 2.5 to 5 per cent. This is so since neutrality implies an increase in this rate of return up to the point where it equals the interest rate (equal to 5 per cent) plus the risk premium (equal to 0 with the *endogenous adjustment case*).

The social rate of return on real capital is defined as the user cost of real capital per NOK invested less the economic depreciation rate (as opposed to the private rate of return which is an *after-tax* return). The question is then whether the risk premium should be subtracted or not in order to get an adequate picture of the social rates of return in the non-stochastic model. We distinguish between four different cases, each associated with the no adjustment case and the three adjustment cases, respectively:

a) *No adjustment case*: In this case, there is a risk premium in the model, but no costs associated with risk in the model. Accordingly, the risk premium should not be subtracted.

b) *Recursive adjustment case I*: In this case, there is a risk premium in the model, no costs associated with risk in the model, but the welfare measure is adjusted for costs associated with risk. The risk premium should then be subtracted. This is so since we implicitly have introduced costs associated with risk in the model by adjusting the welfare measure after the model simulations.

c) *Recursive adjustment case II*: In this case, there is a risk premium in the model, no costs associated with risk in the model, but the welfare measure is adjusted by means of subtracting the difference between the user cost of capital inclusive and exclusive of the risk premium. Since this adjustment method implicitly removes the risk premium in the model by replacing the user cost of capital inclusive of the risk premium with the user cost of capital exclusive of the risk premium, the relevant social rate of return is equal to the user cost of capital exclusive of the risk premium (per NOK invested) minus economic depreciation.

d) *Endogenous adjustment case*: In this case, there is neither a risk premium nor costs associated with risk in the model. Accordingly, the social rate of return is equal to the user cost of capital exclusive of the risk premium (per NOK invested) minus economic depreciation.

The social rates of return for these four cases are reported in table 1. The social rate of return associated with financial capital, which is equal to the interest rate, is also shown.

Table 1. Social rates of return. Per cent. No adjustment case, recursive adjustment case I and II and endogenous adjustment case. Long run results[1], baseline scenario.

Capital type	Social rate of return			
	No adjustment case	Recursive adjustment case I	Recursive adjustment case II	Endogenous adjustment case
Housing	4.6	2.3	2.9	2.9
Real capital excl. of housing[2]	8.3	4.8	4.4	4.4
Financial capital	5.0	5.0	5.0	5.0

1 This implies that the capital gains (losses) in the user cost formulas are equal to 0.

2 These social rates of return are calculated by taking a weighted average of the social rates of return associated with the different capital types and uses.

With the three adjustment cases we notice that the social rate of return on housing is much smaller than the other returns and that the social rate of return on real capital exclusive of housing is not very far from the social rate of return on financial capital. These returns are viewed as representing the correct ones, as opposed to the *no adjustment case,* where the social rate of return on housing is not very far from the social rate of return on financial capital and the social rate of return on real capital exclusive of housing is much larger than the social rate of return on financial capital.

6. Results

Simulations from Bye and Åvitsland (2003) are presented in section 6.1, more specifically, the case where the risk premium problem is not handled. These simulations are also underlying the results presented in section 6.2, but in this section the welfare measure is adjusted recursively. Section 6.3 presents analogous simulations, but for the case where the risk premiums are abolished in the model simulations.

6.1 No adjustment case

The results from the tax experiment where the inconsistency problem of including the risk premium is ignored, are reported in the first column of table 2. Full consumption and total welfare are both reduced in this case, the latter by 0.1 per cent.

Table 2. Long run effects. Percentage deviation from the baseline scenario. No adjustment case and endogenous adjustment case.

	No adjustment case	Endogenous adjustment case
Total welfare	-0.10	0.04
Full consumption	-0.16	0.00(3)
Material consumption	-0.20	-0.00(4)
Leisure	-0.09	0.02
Employment	0.10	-0.02
Total stock of real capital:		
Constant prices	-2.81	-2.73
Current prices	-2.92	-2.83
Total stock of real capital excl. of housing capital:		
Constant prices	0.16	0.15
Current prices	0.05	0.05
Housing capital:		
Constant prices	-12.77	-12.41
Current prices	-12.95	-12.58
Net national debt	-82.80	-17.75
Trade surplus	-9.50	-6.83
Price full consumption	5.90	5.75
Wage costs per hour (price of leisure)	5.63	5.71
Price of material consumption	6.07	5.78
User costs of capital, buildings:		
Other buildings	-0.21	-0.20
Housing	37.72	37.48

Bye and Åvitsland (2003) mention the following explanations of the results in this case where neutral housing taxation and reduced taxation of labour income are introduced:

- Increased taxation of housing leads to a large increase in the user cost of housing and thereby an increase in the consumer price of housing services and the price of material consumption. This leads to a decrease in the consumer real wage rate but since labour taxation is reduced the total reduction in the consumer real wage is small. This implies a decrease in labour supply[11]. Labour supply increases, however, due to a negative income effect because of reduced full consumption. This

[11] As earlier mentioned, the uncompensated and compensated wage elasticity of labour supply is equal to 0.1 and 0.49 per cent, respectively.

is so since reduced full consumption implies lower demand for leisure and thereby higher labour supply[12]. Increased labour supply leads to higher welfare.

- The large increase in the user cost of housing leads to lower demand for housing capital and increased demand for other goods and services, especially commodities such as purchases of cars, gasoline and beverages and tobacco. These are all commodities with high indirect taxes and reallocations towards these commodities contribute positively to welfare.

- Total savings, which are the change in net wealth (total real capital stock minus net national debt), are reduced by 0.8 per cent, equal to 21 billion 1992-NOK. Lower savings in housing underlie this. From an intertemporal, efficiency point of view, a social rate of return on savings in housing equal to the private rate of return on savings is optimal. Since we have not adjusted for the risk premium, reduced savings in housing imply lower, and not increased, welfare in the model. This is visualised in table 1 where the social rate of return on savings in housing (4.6 per cent) is larger, and not lower, than the private rate of return on savings (3.6 per cent, equal to the after-tax interest rate).

- Increased taxation of housing leads to a reallocation from housing capital to financial capital (reduced net national debt), mirrored by a lower export surplus. Since we have not adjusted for the risk premium, the model will not fully take into account the increase in welfare stemming from such a reallocation. This is visualised in table 1 where the model's "perception" of the social rate of return on housing capital is only 0.4 percentage points lower than the social rate of return on financial capital (in the baseline, i.e. before the neutralization).

- Increased taxation of housing also leads to some reallocation from housing capital to other real capital types. This implies an increase in welfare but the model will over-estimate this increase since we have not adjusted for the risk premium. This is visualized in table 1 where the difference between the social rate of return on real capital exclusive of housing and the social rate of return on housing is 3.7 percentage points as opposed to the "correct" social rates in the three adjustment cases where this difference is only 2.5 or 1.5 percentage points.

6.2 Recursive adjustment cases

6.2.1 Recursive adjustment case I

The simulations, and explanations of these, are the same as in the *no adjustment case*. But the welfare measures differ since welfare is now recursively adjusted according to equation (2). This is meant to compensate for the fact that the model will not fully take into account the increase in welfare stemming from the mentioned reallocation from housing capital to financial capital and that the model

[12] The income effect associated with changed full consumption must be distinguished from the income effect constituting the difference between the uncompensated and compensated wage elasticity of labour supply. The former represents the income effect stemming from the economy-wide effects of reallocations, while the latter is restricted to represent the income effect stemming from a change in the consumer real wage rate.

will overestimate the mentioned reallocation from housing capital to other real capital types. In addition, the adjustment implies that the welfare effect of reduced savings in housing will be positive instead of negative. Because of this adjustment we can imagine that the social rates of return in table 1 under the heading "recursive adjustment case I" are the ones applying in the model. This means that the difference between the social rate of return on housing capital and financial capital increases to 2.7 percentage points. Also, the social rate of return on savings in housing is smaller, and not larger, than the private return on savings. When full consumption is adjusted, the change in total welfare is equal to 0.54 per cent. The change in total welfare in this case becomes positive and the difference between this welfare change and the welfare change in the *no adjustment case* is as large as 0.64 percentage points.

Figure 1 shows full consumption in the *no adjustment case* (i.e. FC_t, see equation (1)) and figure 2 shows adjusted full consumption in the *recursive adjustment case I* (i.e. $FC_t - \frac{RISK_1 * VK_{1,t}}{PFC_t} - \frac{RISK_2 * VK_{2,t}}{PFC_t}$, see equation (2)) for both the baseline and shift scenario (policy scenario).

Figure 1: Full consumption.
No adjustment case.
Baseline and shift scenario. Constant prices, million NOK.

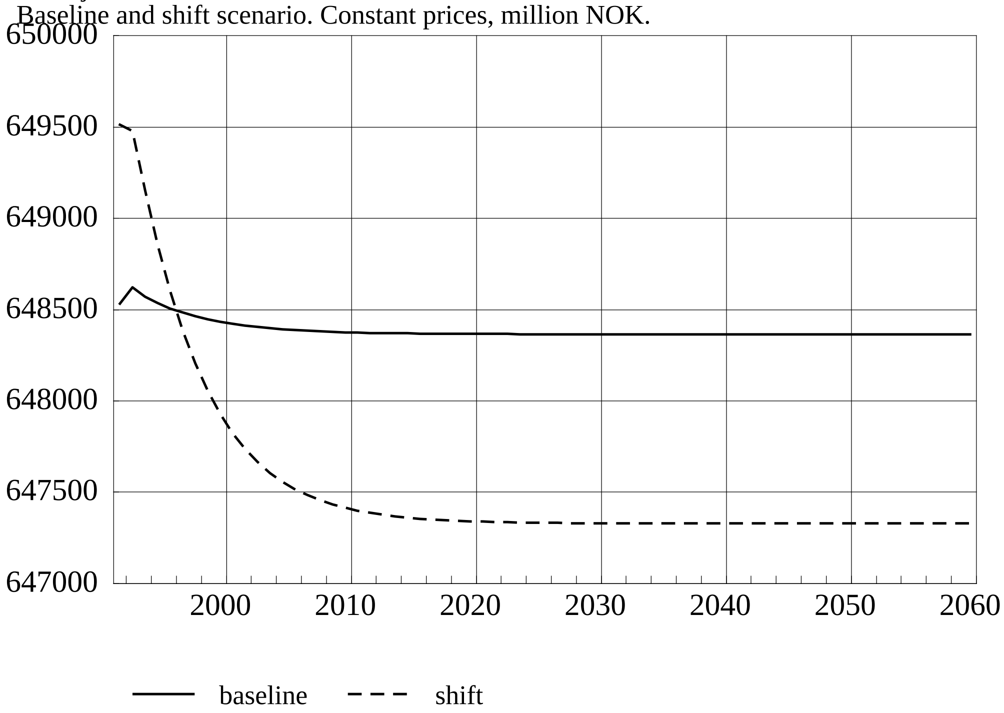
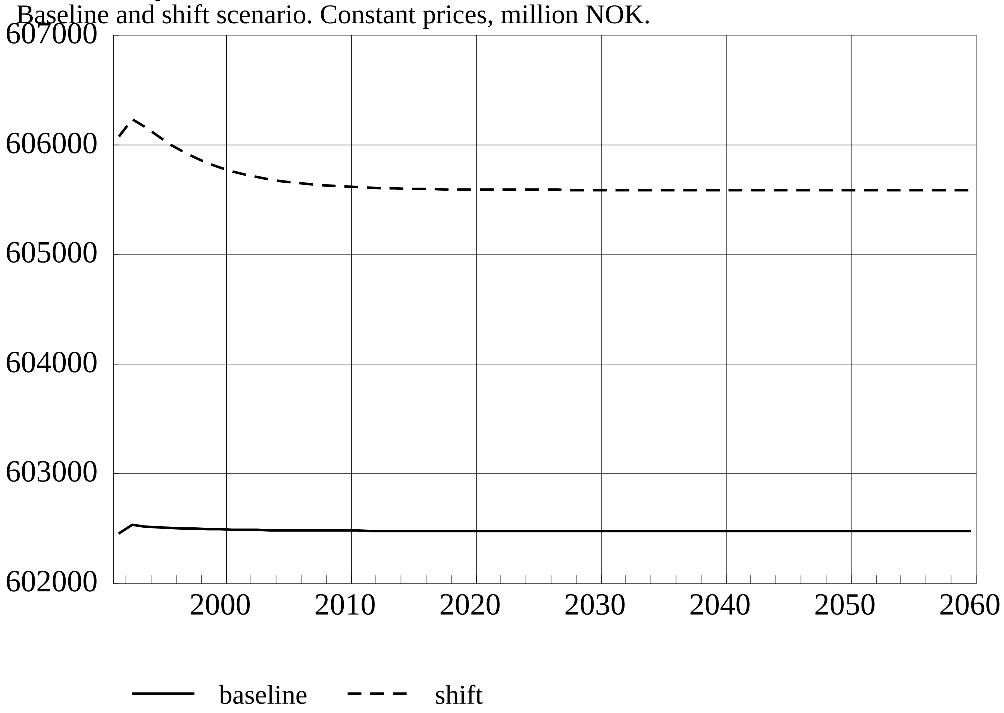


Figure 2: Adjusted full consumption.
Recursive adjustment case I.
Baseline and shift scenario. Constant prices, million NOK.



Full consumption is adjusted 45.9 billion NOK downwards in the baseline scenario and 41.7 billion NOK downwards in the shift scenario in the long run. This implies that adjusted full consumption is larger in the shift scenario than in the baseline scenario, as opposed to the *no adjustment case* where full consumption is smaller in the shift scenario than in the baseline scenario. Inspecting the adjustment terms and their components, see figure 3 to 7, we notice that both the adjustment term associated with housing (i.e. $\frac{RISK_1 * VK_{1,t}}{PFC_t}$, see figure 3) and the adjustment term associated with real capital exclusive of housing (i.e. $\frac{RISK_2 * VK_{2,t}}{PFC_t}$, see figure 4) are smallest in the shift scenario. In other words, *both* the two adjustment terms contribute to change the sign of the total welfare effect even though a first thought would be that only the adjustment term associated with housing should do this. In the *no adjustment case* the model underestimates the social return associated with the reallocation from housing capital to financial capital, while it overestimates the social return associated with the reallocation from housing capital to other real capital types. But in the shift scenario the price of full consumption (i.e. PFC_t) is higher than in the baseline scenario (see figure 5). So even though the current return (or costs) associated with real capital exclusive of housing and the risk premium (bearing of risk) (i.e. $RISK_2 * VK_{2,t}$) is larger in the shift scenario than in the baseline scenario (because of a higher stock of real capital exclusive of housing, see figure 6), the real value (measured in terms of the price of full consumption) will nevertheless be smaller.

Figure 3: Adjustment term housing.
Recursive adjustment case I.
Baseline and shift scenario. Real value, million NOK.

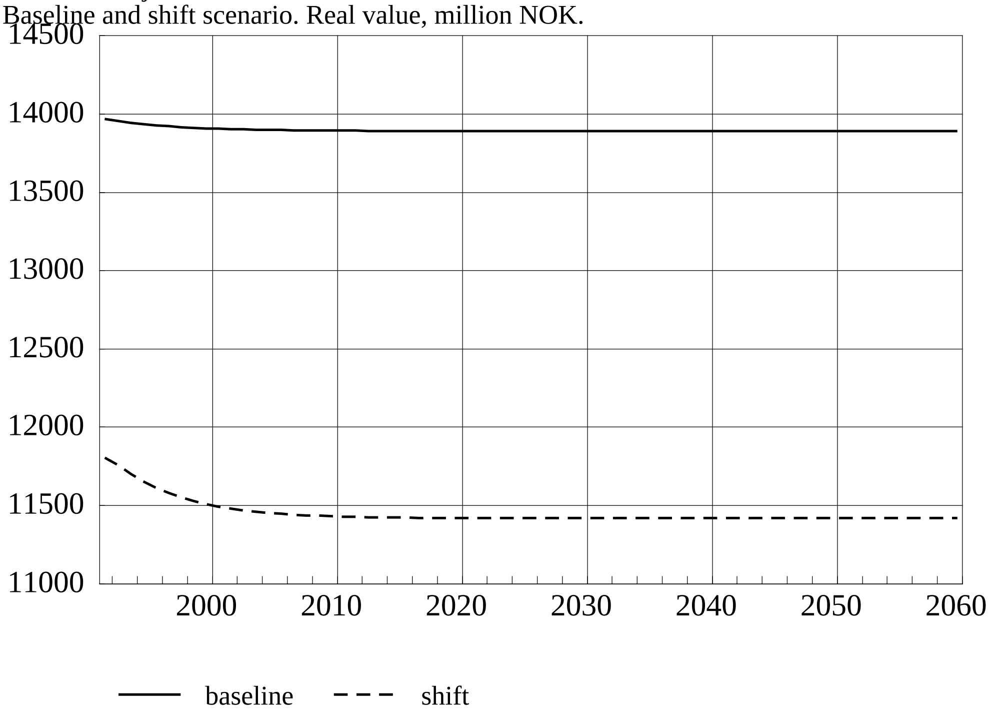


Figure 4: Adjustment term real capital excl. of housing.
Recursive adjustment case I.
Baseline and shift scenario. Real value, million NOK.

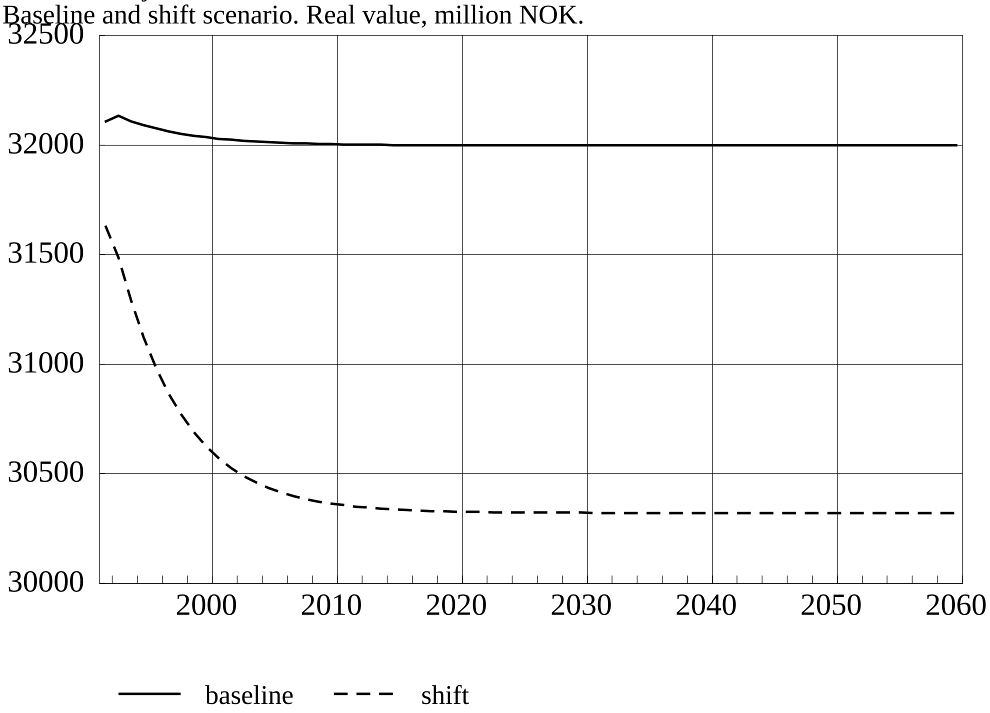


Figure 5: Price full consumption.
No adjustment case and recursive adjustment case I and II.
Baseline and shift scenario. Index.

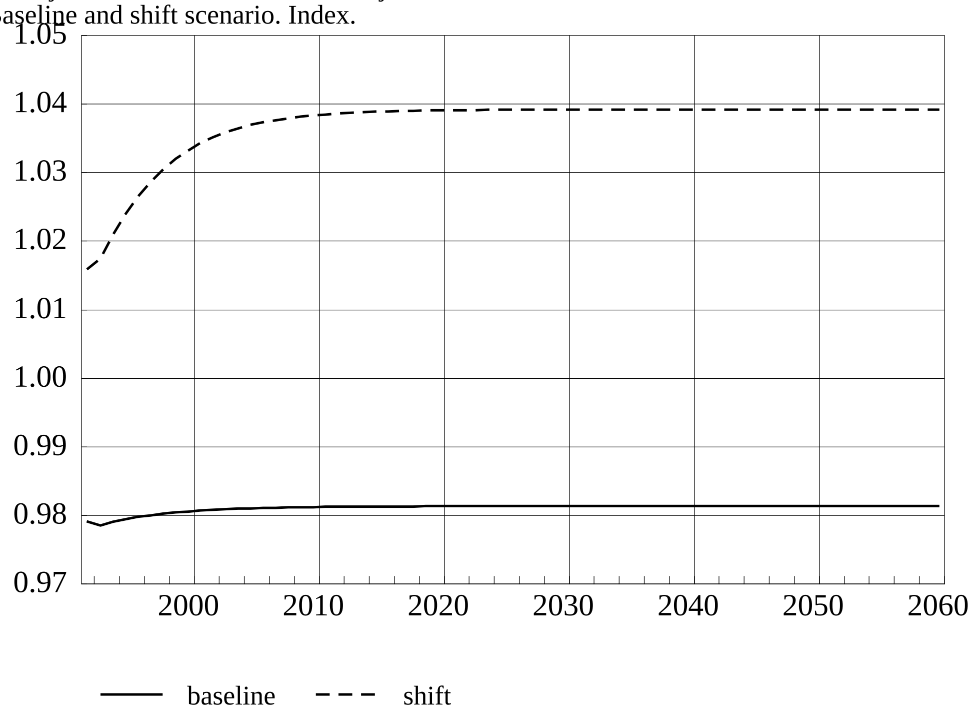


Figure 6: Real capital excl. of housing.
No adjustment case and recursive adjustment case I and II.
Baseline and shift scenario. Current prices, million NOK.

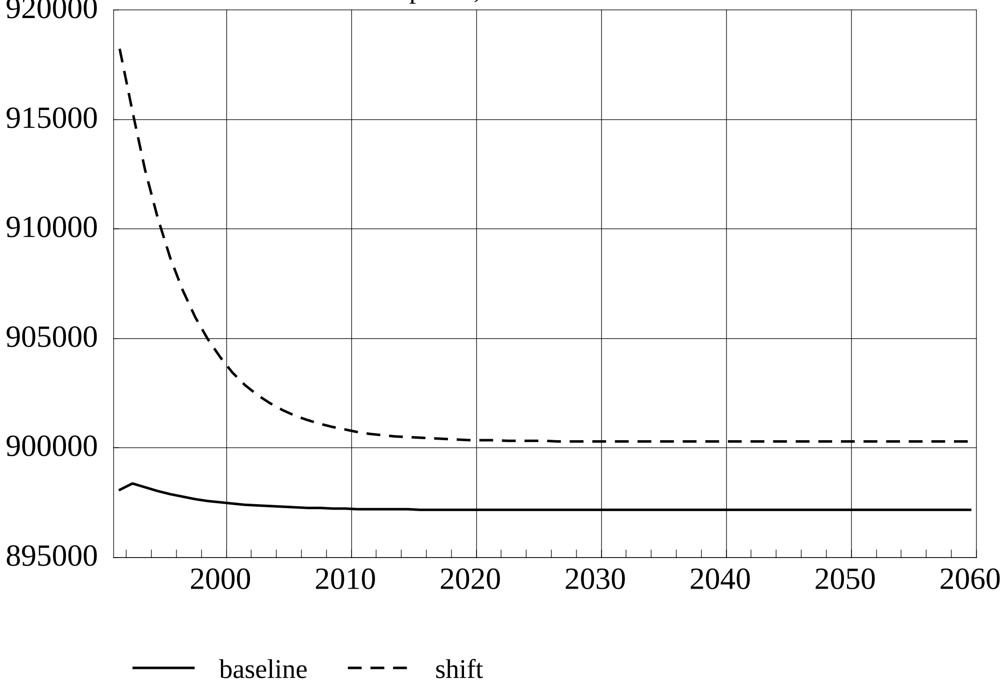
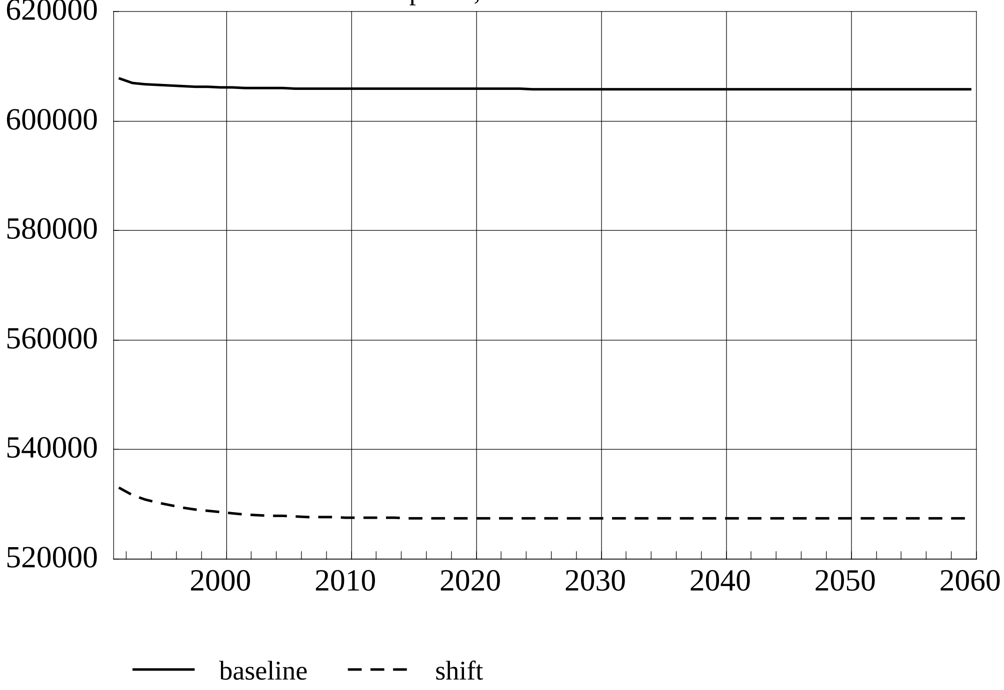


Figure 7: Housing capital.
No adjustment case and recursive adjustment case I and II.
Baseline and shift scenario. Current prices, million NOK.



We also notice that the adjustment term associated with housing capital, see figure 3, contributes more to the changed sign of the welfare effect than the adjustment term associated with real capital exclusive of housing, see figure 4. This is so since the difference between the adjustment term associated with housing in the baseline and shift scenario is larger than the corresponding difference concerning the adjustment term associated with real capital exclusive of housing.

6.2.2 Recursive adjustment case II

The simulations, and explanations of these, are the same as in the *no adjustment case.* But the welfare measures differ since welfare is now recursively adjusted according to equation (3). We can then imagine that the social rates of return in table 1 under the heading "recursive adjustment case II" are the ones applying in the model. This means that the difference between the social rate of return on housing capital and financial capital is equal to 2.1 percentage points. Also, the social rate of return on savings in housing is smaller, and not larger, than the private return. When full consumption is adjusted this way, the change in total welfare is equal to 0.44 per cent.

The change in total welfare in this case becomes positive and the difference between this welfare change and the welfare change in the *no adjustment case* is as large as 0.54 percentage points. Figure 8 shows adjusted full consumption in the *recursive adjustment case II* (i.e. $FC_t - \frac{\sum_{i=type}\sum_{j=\sec}(BP^{incl}_{i,j,t} - BP^{excl}_{i,j,t})VK_{i,j,t}}{PFC_t}$) for both baseline and shift scenario. As compared with the *no adjustment case*, full consumption is adjusted 44 billion NOK downwards in the baseline scenario and 40.4 billion NOK downwards in the shift scenario. This implies that adjusted full consumption is larger in the shift scenario than in the baseline scenario, as opposed to the *no adjustment case* where full consumption is smaller in the shift scenario than in the baseline scenario. Inspecting the adjustment terms and their components, see figure 9, 10 and 5 to 7, we notice the same thing as in the *recursive adjustment case I*, namely: Not only the adjustment term associated with housing (i.e. $\frac{(BP^{incl}_{10,83,t} - BP^{excl}_{10,83,t})VK_{10,83,t}}{PFC_t}$, where 10 represents building capital and 83 represents the industry Dwelling Services, see figure 9) but also the adjustment term associated with real capital exclusive of housing (i.e. $\frac{\sum_{i=type}\sum_{j=\sec}(BP^{incl}_{i,j,t} - BP^{excl}_{i,j,t})VK_{i,j,t} - (BP^{incl}_{10,83,t} - BP^{excl}_{10,83,t})VK_{10,83,t}}{PFC_t}$, see figure 10) contributes to change the sign of the total welfare effect. As in the *recursive adjustment case I*, this is explained by a higher price of full consumption (i.e. PFC_t) in the shift scenario than in the baseline scenario (see figure 5).

As opposed to the *recursive adjustment case I*, the adjustment term associated with housing capital does not contribute more to the changed sign of the welfare effect than the adjustment term associated with real capital exclusive of housing in the long run. This is due to the adjustment term associated with housing which exhibits a smaller change between the baseline and shift scenario than in the *recursive adjustment case I*. This is so since the difference between housing's user cost (per NOK invested) inclusive and exclusive of the risk premium is smaller than the risk premium itself. In the short run, however, the same pattern as in the *recursive adjustment case I* applies: The adjustment term associated with housing capital contributes more to the changed sign of the welfare effect than the adjustment term associated with real capital exclusive of housing, cf. figure 9 and 10. The difference is not as large as in the *recursive adjustment case I,* though, because of the above mentioned smaller change in the adjustment term associated with housing.

Figure 8: Adjusted full consumption.
Recursive adjustment case II.
Baseline and shift scenario. Constant prices, million NOK.

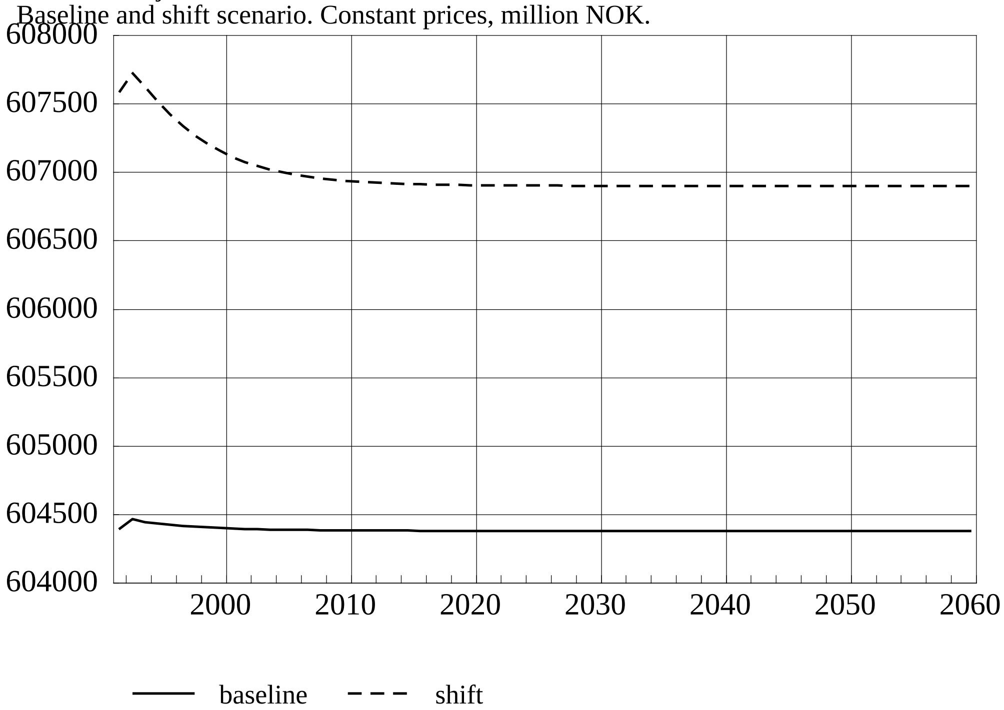


Figure 9: Adjustment term housing.
Recursive adjustment case II.
Baseline and shift scenario. Real value, million NOK.

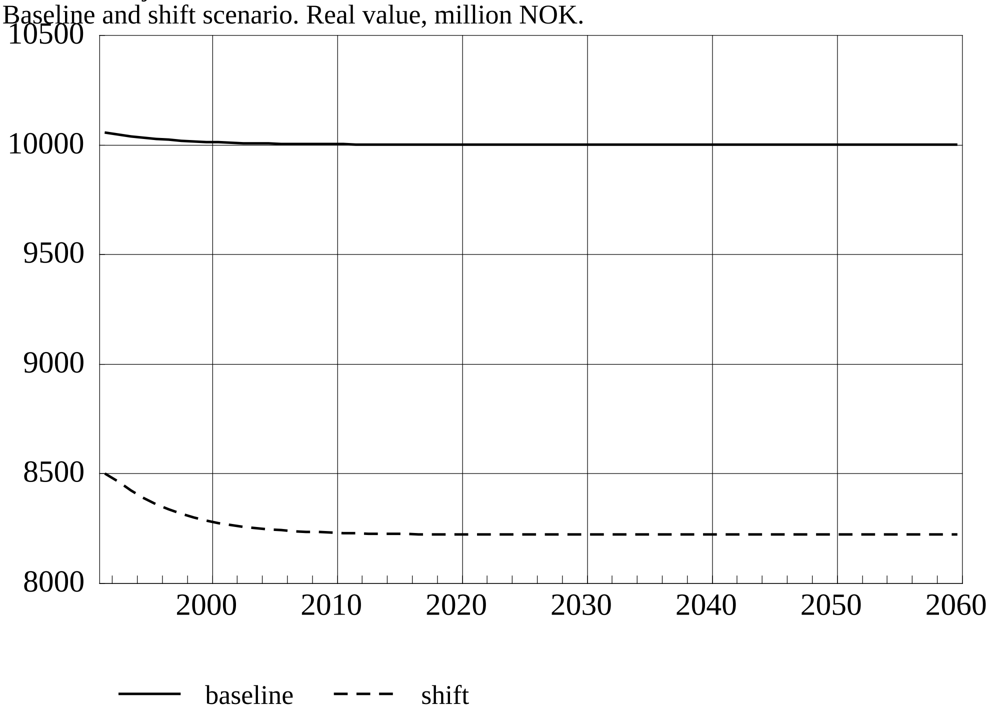
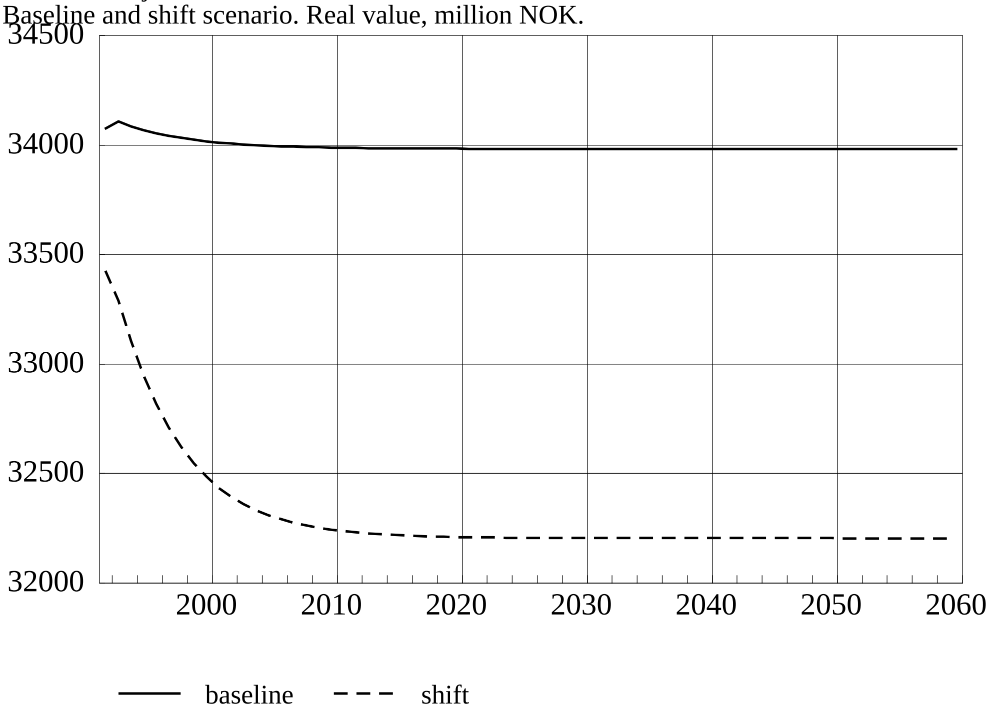


Figure 10: Adjustment term real capital excl. of housing.
Recursive adjustment case II.
Baseline and shift scenario. Real value, million NOK.



6.3 Endogenous adjustment case

In this section we first compare the baseline scenario in the *endogenous adjustment case (d)* where the risk premiums are abolished (the risk premiums are included in the calibration of the model in the benchmark year, though) with the baseline scenario in the *no adjustment case (a)* in order to investigate whether the former economy differs a lot from the latter. We consider the baseline economy in the *no adjustment case* to give a more realistic, or the "correct", picture of the Norwegian economy since this scenario includes the empirical fact that the average rate of return on shares over some time period is larger than the average rate of return on bank deposits. Secondly, we analyse the effects of the change in housing taxation and labour taxation in the *endogenous adjustment case* (where the risk premiums are abolished) as compared with the effects in the *no adjustment case*.

6.3.1 Comparing the baseline scenario in the no adjustment case and the endogenous adjustment case

Figure 11 to 16 show the current value of the endogenous real capital stock exclusive of housing capital, the current value of housing capital, net national debt, employment, the consumer real wage rate and full consumption in the baseline scenario for the no adjustment and endogenous adjustment cases.

A characteristic feature of the variables' paths in the two cases is that the path is almost constant with the *no adjustment case*, while it is first increasing or decreasing and then settled down on a higher or lower level with the *endogenous adjustment case*. This is so since the *endogenous adjustment case* is characterized by inclusion of the risk premiums in the calibration of the model in the benchmark year even though they are abolished in the simulations. This implies a "jump" in the variables in the first years of simulation, as seen in figure 11 to 16.

Figure 11: Real capital excl. of housing.
No adjustment case and endogenous adjustment case.
Baseline scenario. Current prices, million NOK.

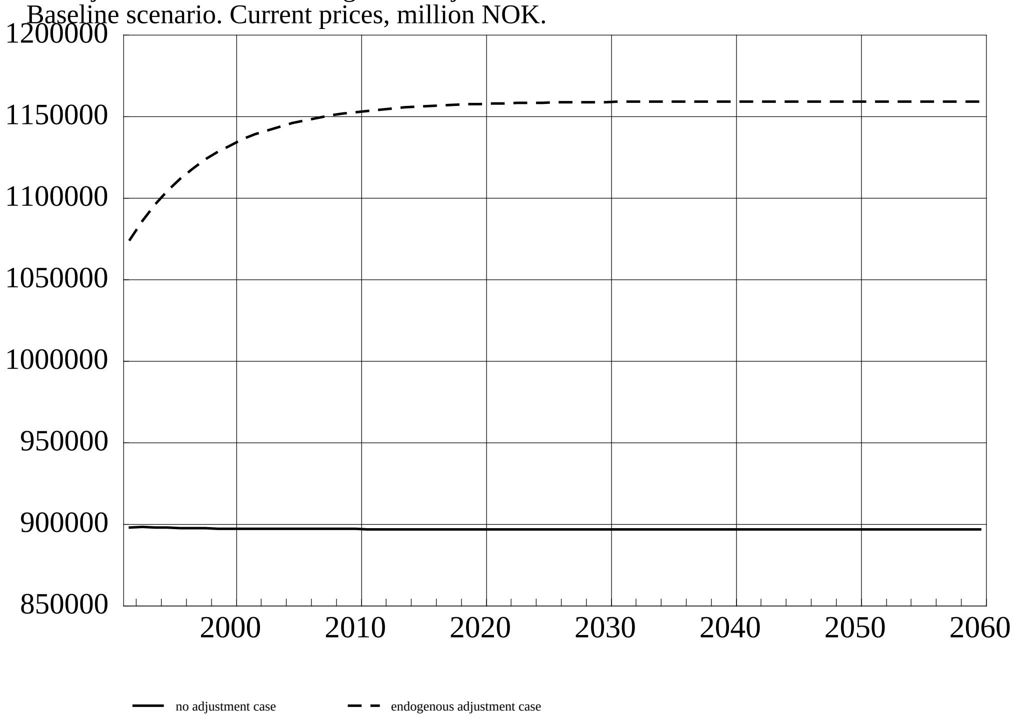


Figure 12: Housing capital.
No adjustment case and endogenous adjustment case.
Baseline scenario. Current prices, million NOK.

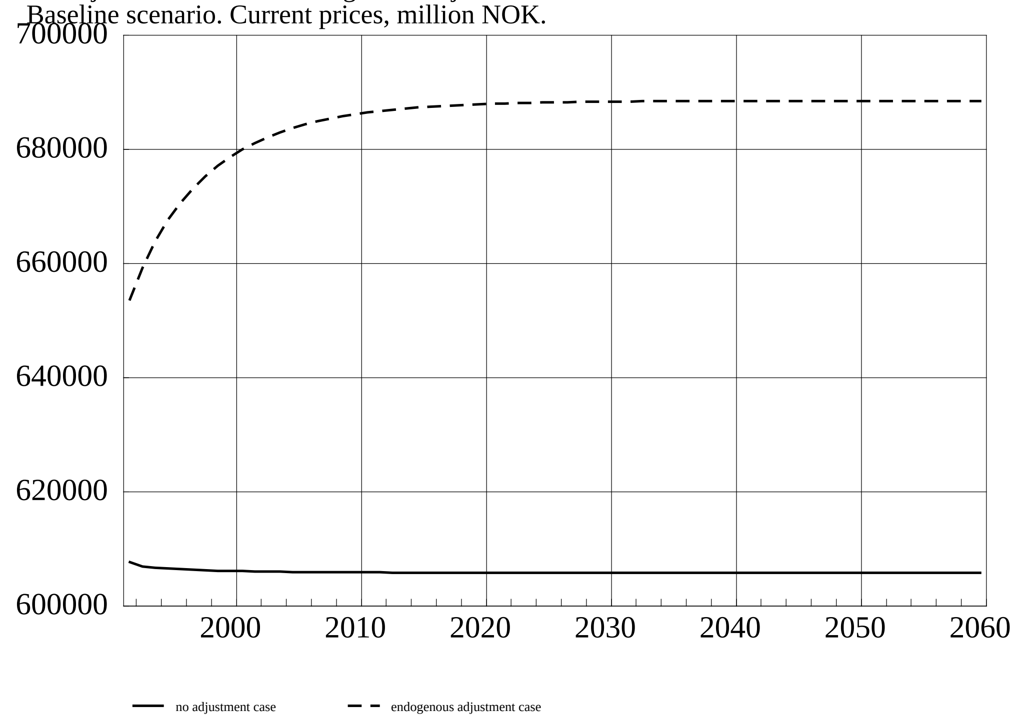


Figure 13: Net national debt.
No adjustment case and endogenous adjustment case.
Baseline scenario. Current prices, million NOK.

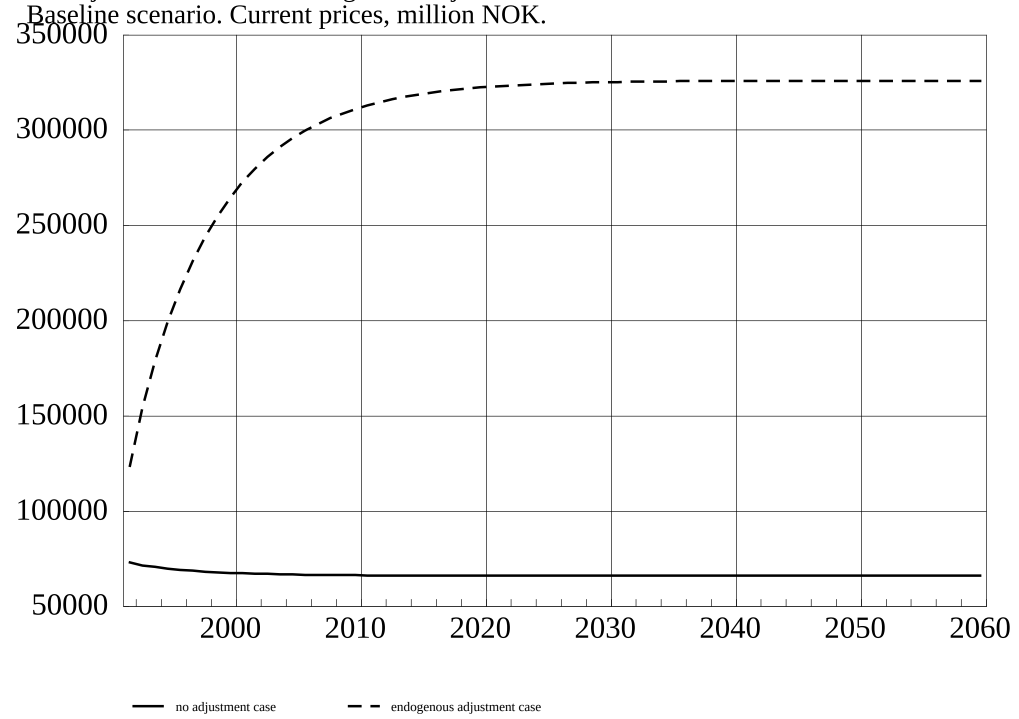


Figure 14: Employment.
No adjustment case and endogenous adjustment case.
Baseline scenario. Thousand man-hours.

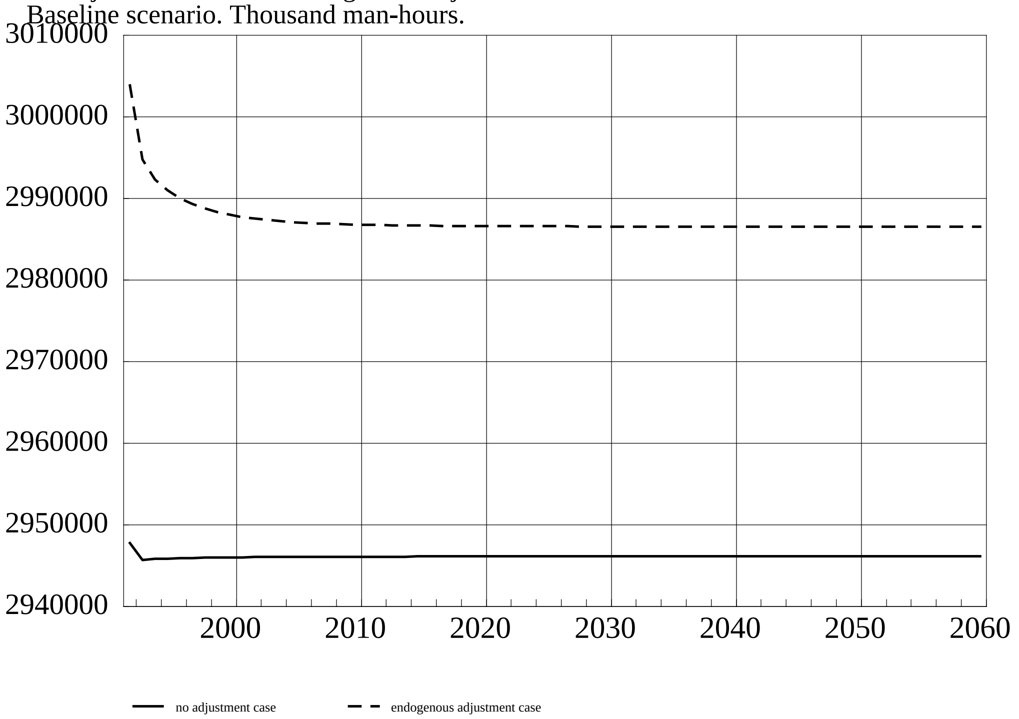


Figure 15: Consumer real wage rate.
No adjustment case and endogenous adjustment case.
Baseline scenario. Indices.

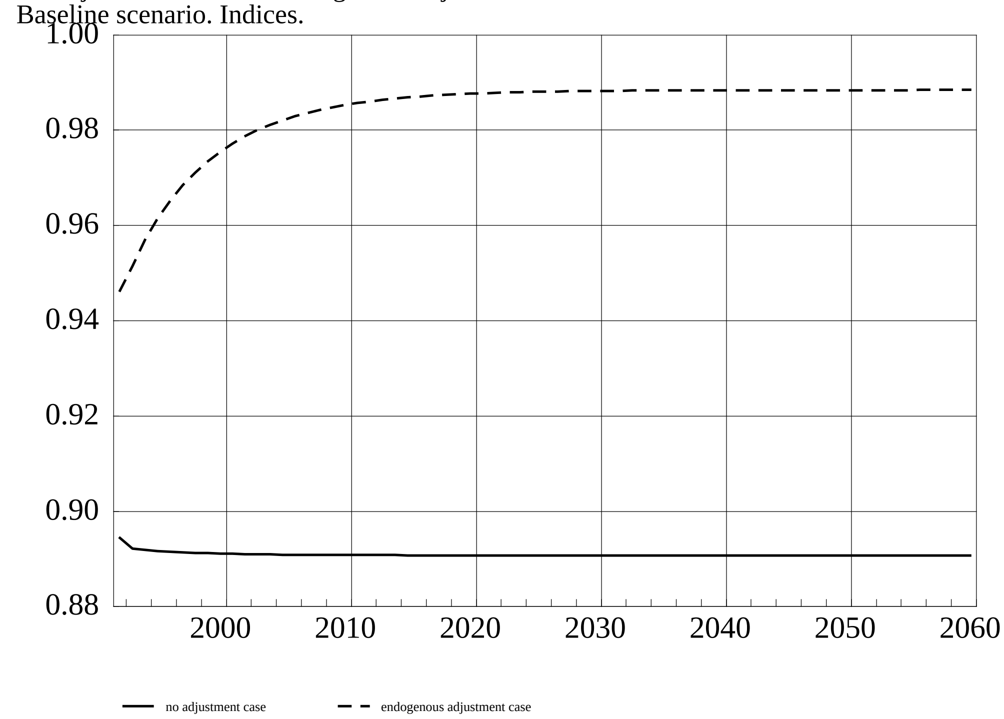
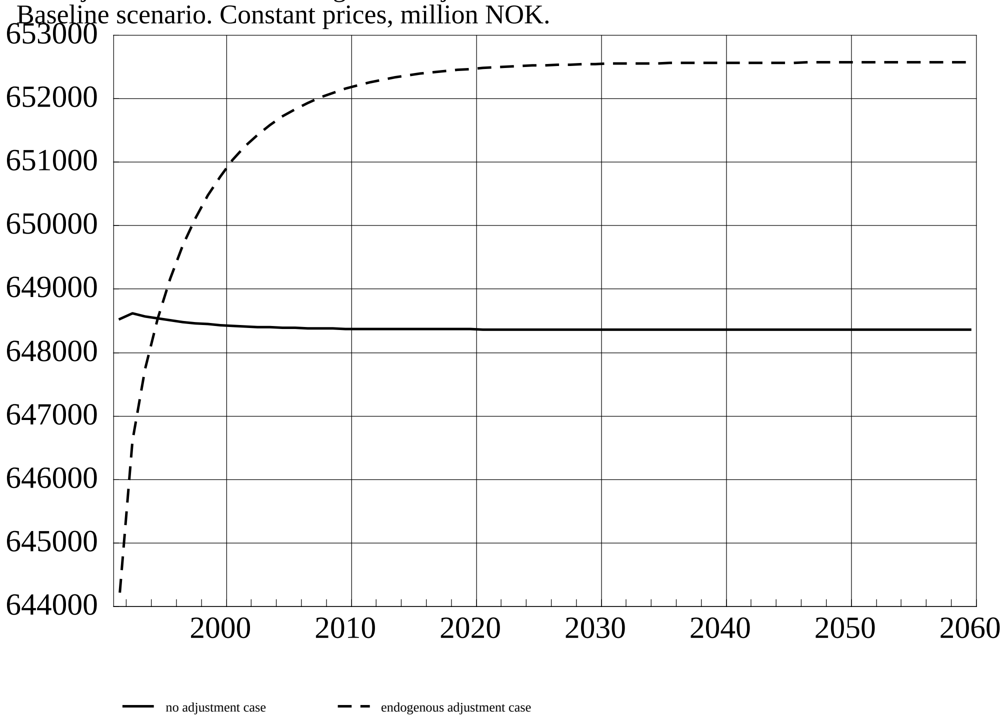


Figure 16: Full consumption.
No adjustment case and endogenous adjustment case.
Baseline scenario. Constant prices, million NOK.



We notice from figure 11 to 13 that the economy in the *endogenous adjustment case* consists of more real capital (both more housing capital and more other types of real capital) and less financial capital (more net national debt). This is due to lower user costs of real capital because of abolition of the risk premiums. Total wealth (the difference between real capital and net national debt) is also larger. Figure 14 shows that employment is higher in the *endogenous adjustment case*. This is so since the consumer real wage rate is higher, see figure 15, because of a lower price of material consumption due to the lower user costs of real capital. We also notice that full consumption is higher in the *endogenous adjustment case* as compared with the *no adjustment case*, except for the first few years, see figure 16. Increased full consumption implies increased demand for leisure and thereby lower labour supply. This effect on labour supply is outweighed by the positive effect on labour supply of the higher consumer real wage rate, however.

I conclude that the baseline economy described by the *endogenous adjustment case* differs a lot from the "correct" economy in the *no adjustment case*. This fact *may* weigh against the *endogenous adjustment case.*

6.3.2 Effects of the tax shift

Table 2, column 2, shows the results for the *endogenous adjustment case*. Even though the baseline economy in the *no adjustment case* and *endogenous adjustment case* differs a lot, we notice that several of the percentage changes are quite similar[13]. This is in accordance with earlier results, cf. Holmøy, Strøm and Åvitsland (1999). In simulations on a simpler version of the CGE model it is shown that such percentage changes are not much influenced by the choice of baseline scenario. Therefore, the large difference between the "correct" baseline economy in the *no adjustment case* and the baseline economy in the *endogenous adjustment case* does not seem to be any major drawback to the endogenous adjustment method. However, an important difference between the results of the no adjustment and endogenous adjustment cases is the change in employment, see table 2. Regarding this variable, there is an increase in the *no adjustment case* and a small decrease in the *endogenous adjustment case*. This is commented on below.

The economic mechanisms at work (the same as in the *no adjustment case*) are the following:

- The consumer real wage rate experiences a small reduction; this reduction is even smaller than in the *no adjustment case,* and the negative effect on labour supply is therefore also smaller. Since full consumption increases (slightly), demand for leisure also increases and labour supply is reduced. This is in contrast to the *no adjustment case* where full consumption decreases, demand for

[13] The differences are larger earlier in the path, though.

leisure also decreases and labour supply increases. All in all, labour supply is slightly reduced in the *endogenous adjustment case* implying a negative effect on welfare.

- Concerning the composition of material consumption, the same pattern as in the *no adjustment case* applies; reallocations towards commodities like purchases of cars, gasoline and beverages and tobacco. This contributes to higher welfare.

- Total savings are reduced by 0.9 per cent, equal to 24.8 billion 1992-NOK. Lower savings in housing underlie this. As opposed to the *no adjustment case* this will imply increased welfare in the model since the social rate of return on savings in housing is lower (equal to 2.9 per cent) than the private return on savings[14] (equal to 3.6 per cent) when the risk premium is abolished.

- There is a reallocation from housing capital to financial capital. As opposed to the *no adjustment case* the model will fully take into account the increase in welfare stemming from this reallocation when we assume that there are no risk or risk premiums in the model economy. Table 1 shows these social rates of return.

- There is also some reallocation from housing capital to other real capital types. As opposed to the *no adjustment case* the model will not overestimate the increase in welfare stemming from this reallocation when we assume that there are no risk or risk premiums in the model economy. Table 1 shows the social rates of return.

All in all, full consumption is slightly increased in the *endogenous adjustment case* and total welfare is 0.04 per cent higher than in the baseline scenario. Disregarding effects of capital reallocations and changes in savings, the change in labour supply seems to be the most important difference between the no adjustment and endogenous adjustment cases. However, it cannot explain the reversed, positive sign of the welfare effect. This is so since labour supply is increased with the *no adjustment case* and therefore implies increased welfare, while labour supply is slightly reduced with the *endogenous adjustment case* and therefore implies reduced welfare. The fact that the positive welfare effects of reallocating housing capital to financial capital is fully taken into account in the *endogenous adjustment case* therefore seems to explain the reversed sign of the total welfare effect. In addition, reduced savings in housing correctly imply increased welfare in the *endogenous adjustment case*, as opposed to reduced welfare in the *no adjustment case*. Since the change in full consumption is incorrect with the *no adjustment case* because of the incorrect social rates of return on real capital, the change in labour supply will also be incorrect, as opposed to the *endogenous adjustment case* where the correct social rates of return are included when calculating the effect on full consumption.

[14] When the social rate of return on savings in housing is lower than the private rate of return on savings, the marginal effective tax rate (defined 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) is negative. In other words, savings in housing are subsidised.

7. Comparison of the adjustment methods and concluding remarks

The two main proposed ways of dealing with the risk premium problem in this document, the recursive and endogenous adjustment cases, give very different results. When nothing is done about the risk premium problem, the percentage change in total welfare is equal to -0.10. Corresponding numbers for the *recursive adjustment case* are 0.54 (case I) and 0.44 (case II) per cent while the change in total welfare is equal to 0.04 per cent with the *endogenous adjustment case*. All adjustment methods imply that the change in total welfare becomes positive.

However, there are advantages and disadvantages associated with each of the adjustment methods. Concerning the two recursive adjustment methods, they both suffer from the fact that the adjustment of full consumption does not have any repercussions on variables in the model. Specifically, the non-existent repercussion on labour supply is a serious shortcoming since there is a large tax wedge in the labour-leisure choice, implying important effects on total welfare of changes in labour supply. Such repercussions are taken into account with the endogenous adjustment method since the adjustment in this case is undertaken *in* the model simulations by abolishing the risk premiums. In fact, based on the social rates of return on capital (see table 1) the *recursive adjustment case II* should have resulted in the same effect on total welfare as the *endogenous adjustment case*. The lacking repercussions from the adjustment of full consumption with the *recursive adjustment case II* may be an important explanation of the divergent results. Compared with the *endogenous adjustment case*, the *recursive adjustment case II* over-estimates the change in welfare.

The *endogenous adjustment case* is characterized by a baseline scenario that deviates from the actual Norwegian economy. A first thought would be that this is a drawback since one is concerned with welfare effects of policy reforms in actual economies. However, the effects on several of the variables, measured in percentage changes, are quite similar in the no adjustment and endogenous adjustment cases. This is in accordance with earlier results, cf. Holmøy, Strøm and Åvitsland (1999). In simulations with a simpler version of the model it is shown that such percentage changes are not much influenced by the choice of baseline scenario. Therefore, the large difference between the "correct" baseline economy in the *no adjustment case* and the baseline economy in the *endogenous adjustment case* does not seem to be any major drawback to the endogenous adjustment method. An important difference between the results of the no adjustment and endogenous adjustment cases is the change in employment. But this change is considered to be incorrect with the *no adjustment case* since the change in full consumption is incorrect. In contrast, these changes are considered to be correct with the *endogenous adjustment case*.

Summing up and concluding, the endogenous adjustment method seems to be preferable to the two recursive methods presented in this document. This is so since the disadvantage of a baseline scenario that deviates from the actual, Norwegian economy seems to be much less of a problem than the lack of repercussions from the recursive adjustment of full consumption[15]. In addition, with the *endogenous adjustment case* it is reassuring to know that the adjustment is undertaken *in* the model simulations, automatically implying correct, or consistent, social rates of return on real capital everywhere in the model.

Finally, I will stress that the problem with a risk premium in a non-stochastic CGE model where there is no costs associated with risk, refers to policy analyses where large reallocations between different capital types, or large changes in savings, are an important element. Policy analyses that do not contain such elements can disregard the risk premium problem. Also, projects where the objective is to make a baseline scenario that shall describe the actual, economic development can disregard the risk premium problem since a realistic picture of the actual economy is clearly more important than having correct, or consistent, social rates of return in such a situation.

References:

Aaberge, R., J. K. Dagsvik and S. Strøm (1995): Labour supply responses and welfare effects of tax reforms, *Scandinavian Journal of Economics* **97**, 635-659.

Berg, S. A. (1989): *Norske skattekiler 1988,* NOU 1, vedlegg 3B, Ministry of Finance.

Bergman, L. (1990): "The Development of Computable General Equilibrium Modeling" in L. Bergman, D. W. Jorgenson and E. Zalai (eds.): *General Equilibrium Modeling and Economic Policy Analysis*, Basil Blackwell, Oxford, UK.

Bowitz, E. and Å. Cappelen (2001): Modeling income policies: some Norwegian experiences 1973-1993, *Economic Modelling* **18**, 349-379.

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, Statistics Norway.

[15] However, remember that with the *endogenous adjustment case* the risk premiums are only abolished in the model simulations and not in the calibration of the model in the benchmark year. To investigate the significance of this has been beyond the scope of this document.

Bye, B., B. Strøm and T. Åvitsland (2003): Welfare effects of VAT reforms: A general equilibrium analysis, Discussion Papers 343, Statistics Norway.

Bye, B. and T. Åvitsland (2003): The welfare effects of housing taxation in a distorted economy: A general equilibrium analysis, *Economic Modelling* **20**(5), 895-921.

Fullerton, D. and R. H. Gordon (1983): "A Reexamination of Tax Distortions in General Equilibrium Models" in M. Feldstein (ed.): *Behavioral Simulation Methods in Tax Policy Analysis,* A National Bureau of Economic Research Project Report, The University of Chicago Press, Chicago and London.

Fæhn, T. and E. Holmøy (2000): "Welfare effect of trade liberalisation in distorted economies: A dynamic general equilibrium assessment for Norway" in G. W. Harrison et al. (eds): *Using dynamic general equilibrium models for policy analysis*, North-Holland, Amsterdam.

Holmøy, E. and T. Hægeland (1997): Aggregate Productivity Effects and Technology Shocks in a Model of Heterogeneous Firms: The Importance of Equilibrium Adjustments, Discussion Papers 198, Statistics Norway.

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, Statistics Norway.

Holmøy, E., B. Strøm and T. Åvitsland (1999): Empirical characteristics of a static version of the MSG-6 model, Documents 99/1, Statistics Norway.

Holtsmark, B. and J. Aasness (1995): Effects on consumer demand patterns of falling prices in telecommunication, Working Paper 8, Center for International Climate and Environmental Research, Oslo.

Johansen, L. (1960): *A multi-sectoral study of economic growth,* Contributions to economic analysis 21, North-Holland, Amsterdam.

Klette, T. J. (1994): Estimating price-cost margins and scale economies from a panel of micro data, Discussion Papers 130, Statistics Norway.

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