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Did Norway Gain from the 1979-85 Oil Price Shock?

Abstract:
Macroeconomic effects of the high oil prices in the period 1979-85 for the Norwegian economy are considered. An alternative low oil price scenario is developed and effects of the oil shock are calculated as the deviation between actual history and the counterfactual base. International effects based on a world model are fed into a domestic model to analyse consequences for the Norwegian economy. Without imposing any changes in fiscal policies, negative effects from lower foreign demand and higher interest rates are dominating. However, as a major oil exporting country, we argue that the high oil prices spurred a substantial increase in Norwegian public spending. Effects of a more expansionary fiscal policy, based on a relatively conservative spending strategy, are shown to more than outweigh the negative initial impact on GDP. Possible outcomes for the business cycle development are also studied

Keywords: Oil price shocks, Macro-econometric models, Fiscal policy

JEL classification: Q43, E37, E61

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1. Introduction

The traditional result of an oil price rise is a terms-of-trade benefit for oil exporting countries and a loss for oil importing countries. Being a major oil exporter, Norway is accordingly likely to gain (loose) substantially from high (low) oil prices and effects for Norway therefore deviate fundamentally from other small western economies. These considerations are supported by the main results obtained in analyses of effects of oil price shocks that includes the Norwegian economy, see Berger et al. (1987) who focus on consequences of the oil price drop in 1986 by use of a macroeconomic model, Mork et al. (1994) who test for asymmetric effects of oil price shocks and Bjørnland (1996) who utilizes a VAR model to analyse effects of oil price changes. However, Norway is also an industrialized small open economy, very dependent upon trade with other western OECD-countries. Accordingly the country faces negative trade impulses from abroad in the wake of an adverse oil price shock. Trade effects are also likely to be significant: contrary to other major oil exporters (notably the OPEC countries) where non-oil exports have been of minimal importance, Norwegian non-oil exports has counted for 25-30 percent of GDP since the beginning of the 1980s, with European OECD-countries as main export markets. In addition, with a fixed exchange rate regime, a tightening of monetary policies internationally will transmit to the Norwegian economy through higher interest rates. Accordingly, the overall outcome of an oil price shock is not obvious and the purpose of this paper is to assess the relative strength of the opposing effects.

It is a widely accepted view that oil price shocks affect OECD economies negatively. Using a model based approach, the OECD e.g. finds strong negative effects of the second oil shock for western economies, see OECD (1980). Other studies are more doubtful to the role of oil prices in explaining the poor economic performance in the western world in the 1970s, see e.g. Darby (1982) and Burbidge and Harrison (1984), but still find negative effects on activity. In a recent paper, Bernanke, Gertler and Watson (1997) argue that the important part of the effects of oil price shocks in the US stems from a tightening of monetary policy, but there is no doubt about the existence of an overall negative oil price effect. On the other hand, the major concern in the oil price literature has been oil consuming countries in the OECD area, while it is clearly important to incorporate the spending behaviour of the major oil producers, most notably the OPEC countries, when assessing the world-wide outcome of oil shocks. Failing to take OPEC spending into account might overstate effects of oil price shocks, in particular in the long run.

In our analysis of the Norwegian economy we utilise two macroeconometric models; an aggregate model (NIGEM) for the world economy and a disaggregated large-scale model (KVARTS) for the domestic economy. The NIGEM model comprises fairly detailed descriptions of major OECD countries and also includes spending behaviour of the OPEC countries. International effects of importance for the Norwegian economy, such as export market growth, import prices and interest rates are easily extracted from the model. By combining the two models we obtain a consistent set of simulations and do not have to rely on arbitrary assumptions of international effects of the oil price shocks, as have been the case in former Norwegian studies, see e.g. Berger et al. (1987). However, we assume no feedback effects from the Norwegian economy to the outside world, which seems reasonable due to the small size of the economy.

Effects of the 1979-85 oil price shock are found by creating an alternative low-oil-price history which is compared to the actual development. Our analysis with the Norwegian model is undertaken in two main steps. In the first, the alternative scenario is made without changing any domestic fiscal policy measures. Compared to history we accordingly find effects of the oil shock in absence of a domestic policy response. The outcome shows negative overall effects for the Norwegian economy, with the main impetus stemming from foreign trade. However, this no-policy choice is not very realistic since both the national and in particular the public sector net debt are considerably higher in the low price scenario than what history reveals. In the second step we design a new alternative trajectory where fiscal policies are changed.

Fiscal policies in the counterfactual simulation are adjusted in accordance with a cautious overall spending strategy, implemented by somewhat arbitrary year to year changes in government expenditure and tax rates. With these policies implemented into our alternative scenario, results indicate that the negative external impulses of higher oil prices were more than outweighed by expansionary domestic effects. GDP is calculated to have increased by slightly more than 1½ percent, in the period 1979-86 and by 1 percent, in the succeeding seven years. As regards business cycles, the high oil prices seem to have dampened oscillations in the 1979-83 cycle, but aggravated fluctuations in the (much more pronounced) 1984-93 cycle.

The outline of the paper is as follows. After a brief discussion of the alternative oil price development and our method of investigation in section 2, we look at international effects of oil price shocks with

the NIGEM model in section 3. In section 4, we implement the international impulses and present results for the Norwegian economy, with and without domestic policy reactions. Section 5 concludes.

2. An alternative oil price scenario

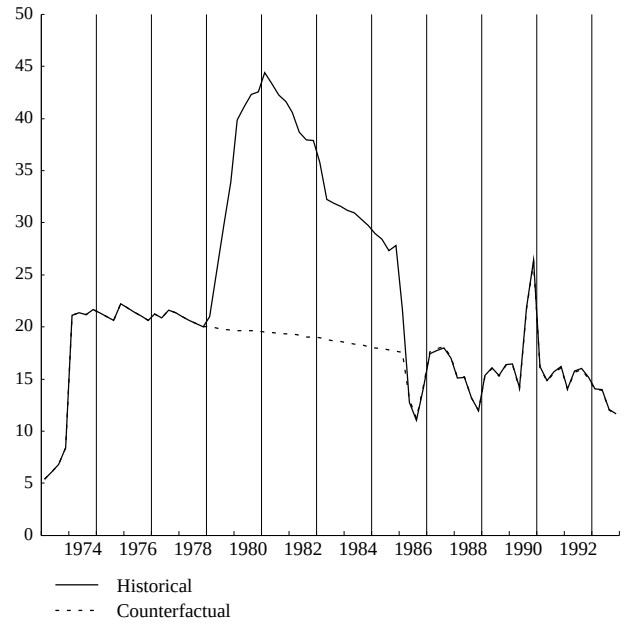
After the second world war the oil price remained fairly stable in USD until the OPEC I shock in 1973-74, caused by OPEC reactions to the Yom Kippur war, when the price suddenly quadrupled. After this shock the oil price soon stabilised at the higher level and remained broadly unchanged until the OPEC II shock in 1979, initiated by the Iran-Iraq war. This second shock took place over a longer period than the first and the oil price level was this time roughly doubled. In the early 1980s the oil price declined gradually, while a substantial increase in the Saudi Arabian production in the beginning of 1986 brought into place a rapid oil price drop, down to a lower level in real terms than what preceded the OPEC II hike. Then the oil price fluctuated around a slightly declining trend from 1987 to 1993. While OPEC I is often regarded as a permanent rise in the oil price level, caused by a change in the behaviour of the OPEC cartel, the second oil price shock can be viewed as temporary, since it was reversed in 1986.[1]

As our reference oil price, we deflate the average dollar price of Brent Blend and Arabian Light with a consumer price index for the G7-countries. The resulting real oil price is shown in figure 2.1. The period of high real oil prices from 1979 to 1986 will in the following be considered as a temporary oil price shock, referred to as OPEC II. By constructing a linear trend based on the observations from 1974-78 and 1987-93, we get a measure of the magnitude of OPEC II as the difference between the actual price and the trend in the period 1979-86.

Our approach in measuring possible effects of the high oil prices in the period 1979 to 1986, is to estimate how the economy had developed if the oil price had followed the alternative smooth path (the dotted line in figure 2.1) in this period. The point of departure is model simulations of the world economy and subsequently of the Norwegian economy, with historical values for all exogenous variables and with historical single equation residuals included in the models. Accordingly, the baseline simulation tracks the actual development perfectly.

[1] For a study of transitory and permanent oil price shocks supporting these considerations, see Green et al. (1993).

Figure 2.1 The real oil price[1]



[1] Nominal US dollar price deflated by a consumer price aggregate for the G7-countries

The next step is to calculate how the world economy might had developed if OPEC II had not occurred by simulating NIGEM with the counterfactual level of the oil price in the period 1979-86. Deviations from what actually took place are the basis for calculating the international impulses to the Norwegian economy. By changing these impulse variables (including the crude oil price) in KVARTS simulations, we get a picture of the economic development in Norway in the absence of OPEC II. Our estimates of the effects on the Norwegian economy are obtained as the differences from historical values.

In order to make the analysis of the OPEC II shock meaningful, the oil price has to be considered as exogenous. As the development in the oil price to a large degree has been a consequence of political actions taken by the OPEC countries, this seems to be a fair assumption.

3. International effects of OPEC II

The international effects of the oil price shock are studied through simulations on the NIGEM model (National Institute Global Econometric Model). NIGEM is a quarterly macroeconometric model, covering main OECD countries in detail and the rest of the world through trade relations. The model

is regularly used for forecasting purposes. Examination of oil price shocks has been undertaken with the model in Barrell, Gurney and Dulake (1990) and more recently in Barrell and Magnussen (1996). A brief overview of the model structure is given in appendix A, while a more detailed specification can be found in appendix A in Barrell and Magnussen (op.cit.).

International effects are found by using the same version of the NIGEM model as in Barrell and Magnussen (1996), including modelling of OPEC's spending behaviour and time-varying trade weights. Fiscal and monetary policies can be handled by policy rules in NIGEM, making policy variables endogenous. In this analysis we have applied the same two rules as utilised in the main simulations undertaken by Barrell and Magnussen, i.e. solvency constrained fiscal policy and short term interest rates determined by monetary targeting rules. Personal taxes, the fiscal policy measure, are raised gradually (with the same speed of adjustment for each country) in the case of a widening budget deficit. Interest rates can be seen as positively linked to nominal GDP, with country specific impact coefficients. A formal description of the two rules is given in appendix A, while a comparison with alternative policy options can be found in Barrell and Magnussen (op.cit). Real effective exchange rates are assumed to be unaffected of the oil shocks, linking nominal fluctuations to inflation differentials.

On the macroeconomic level oil price changes imply a transfer of income from oil producers, notably OPEC countries, to net oil importers in the OECD area. An oil price increase in accordance with the alternative scenario outlined in the previous section gives a negative impulse to domestic demand in OECD economies, while consolidated exports from OECD countries are stimulated by increased demand from oil producers. Domestic and inter-OECD effects dominates for most OECD-countries leading to an overall reduction in output, while the direct effects from the oil prices contributes to increase consumer prices, see table 3.1.

The net effect of the oil shocks varies, amongst other factors, according to the size of oil imports, the working of the domestic labour markets and of trade with OPEC. Substitution away from oil will occur as import prices rise, in accordance with the size of oil import weights and of country specific import price elasticities. The degree of real wage flexibility influences the relative size of GDP and inflation effects for each country: flexibility favours (negative) GDP effects on behalf of inflation effects. OPEC countries are substantial service importers, hence the oil price rise will benefit major

exporters of services. Exports of goods to OPEC are, however, of minor importance for the G7-countries[2].

From table 3.1 we can see that consumer price effects are strongest and most prolonged in the UK. There are significant effects in Germany as well, in particular in the beginning of the period, but these effects are reversed. In the US price effects are small and are more than reversed after 1985.

Table 3.1. Effects of the OPEC II oil price shock.
Percent difference from base unless otherwise noted

Period	Nominal oil price	GDP			Consumer prices			Exchange rate
	USD	USA	Germany	UK	USA	Germany	UK	DM/USD[1]
1979	39.4	-0.4	-0.1	0.0	0.7	0.5	0.5	0.0
1980	115.6	-1.8	-0.3	0.2	2.6	2.2	2.0	0.2
1981	127.5	-2.7	-0.1	0.5	3.1	3.5	3.9	0.6
1982	109.5	-3.0	-0.2	0.6	2.9	4.5	5.6	1.5
1983	81.4	-2.9	-0.3	0.4	2.2	5.4	7.0	2.8
1984	72.4	-2.7	-1.1	0.0	1.5	6.0	8.2	3.2
1985	62.6	-2.5	-2.1	-0.5	0.8	6.4	9.0	5.5
1986	6.7	-1.7	-3.3	-1.0	-0.7	5.6	8.8	6.6
1987	0	-1.1	-3.9	-1.6	-1.6	4.3	8.0	7.1
1988	0	-0.6	-3.9	-1.7	-2.0	3.1	6.9	7.0
1989	0	-0.3	-3.4	-1.6	-2.2	2.0	5.6	6.5
1990	0	0.0	-2.4	-1.3	-2.3	1.1	4.5	5.8
1991	0	0.2	-1.3	-1.0	-2.3	0.6	3.7	5.2
1992	0	0.4	-0.4	-0.6	-2.2	0.4	3.1	3.4
1993	0	0.5	0.3	-0.3	-2.1	0.5	2.9	3.7

[1] Positive sign means weaker DM.

Negative GDP-effects are substantial in the US in the period 1979-86, while only minor effects can be seen for Germany and the UK. There is substantial inertia in the German economy and the major negative effects occur after the reversal of the oil shock in 1986. Wages in the US are not increased in line with consumer prices, while there is more real wage rigidity in the German and in particular in the UK labour market. In the UK GDP-effects are slightly positive in the beginning, due to the importance of the oil sector for the UK economy.

In a business cycle context, results show that much of the 1980-recession in the US would have been prevented without the sharp rise in the oil price. Similarly, GDP-growth rates would have been lower

[2] The size of the export weights for these countries are in the range of 1.0 to 4.2 percent.

in 1986 if the oil price had not dropped this year. In Germany, results are rather different due to the stronger real wage rigidity in this economy. In the early 1980s, there is hardly any effect of the oil price shock at all, while the delayed effect contributes to lower growth rates in 1986 compared to the case without an oil price drop. For the UK, the oil price development had no major impact on economic cycles in the 1980s.

The exchange rate effects reflect, by assumption, differences in bilateral consumer prices. With stronger impact on prices in Germany than in the US, the DM (as well as other European currencies) inevitably had to weaken in order to keep real exchange rates constant.

4. Norway and OPEC II

4.1. Links to the international economy

International effects of the oil price increase are transmitted to the Norwegian economy through several links, the most important one being the petroleum sector. Foreign demand for manufactures is significant for Norwegian exports, and import prices are important both for domestic inflation, imports as well as for price competitiveness for export industries. Finally, given the fixed exchange rate regime, short-term interest rates can be seen as determined internationally.

An indicator of foreign demand for Norwegian export products is constructed by weighting together import of goods among the main trading partners. An indicator for import prices is constructed by using export prices country-weighted by shares of Norway's import. The most important trading partners are (in order of significance) Sweden, the UK, Germany, Denmark and the US[3]. In total these countries receive almost 80 percent of Norwegian non-oil exports. Details on construction and application of trade weights are described in appendix C.

In NIGEM export prices are given in local currencies. Ecport price effects in Norwegian trading partner countries are weighted together by using import weights. To achieve effects on Norwegian import prices in Norwegian kroner we utilize the effective exchange rate. Assumptions regarding the exchange rate are discussed in section 4.2. NIGEM contains bilateral dollar exchange rates for each country. If we assume (to begin with) that the Norwegian effective exchange rate is unaffected by the

[3] Of these, Sweden and Denmark are not included in our version of NIGEM. In appendix C we argue that a reasonable remedy is to expand the German weight with the weights for Sweden and Denmark.

oil shock, we can use the dollar rates to obtain effects on the dollar/NKr exchange rate. Bilateral dollar rates were weighted together by using competitiveness weights according to appendix C. The obtained dollar/NKr rate was used to calculate the oil price in Norwegian kroner.

Another important link between Norway and the international economy is the short term interest rate. Norway had a fixed exchange rate regime in the period of investigation, but with several devaluations in the period 1982-86. The stabilisation target for the Norwegian krone was a trade weighted currency index from 1978-90, with an adjustment of weights in 1982. From 1990 to 1993 the target was an ECU-index. In this study we have ignored these changes, as they would only have minor impact on our results, and we have used ECU interest rates to determine Norwegian short term interest rates.

Since all EU-countries are assumed to follow German monetary policy, the change in Norwegian short term interest rates will also follow the German rate. Domestic interest rates are also affected by the inflation differential between Norway and ECU-countries. Since price effects of the oil shocks differ among the European countries, we construct an ECU price index for this purpose, see appendix C for details.

Effects on Norwegian export markets from the oil price shocks are negative during the entire period. This is due to lower domestic demand in the major trading partner countries. Demand effects are strongest in the US, but there are also negative impulses coming from Japan and the UK[4]. For Germany and France there is only a small negative impact. In general export market effects are stronger than aggregate GDP effects for the same countries, which is due to country specific import elasticities being greater than 1[5].

With stronger effects on prices than GDP, nominal GDP in Germany increases in the beginning of the period and interest rates therefore have to be raised. However, the interest rate effects are small with a maximum of 1.4 percentage points increase from base in 1983. Consumer prices increase in the entire period, and have a hump-shaped profile with a maximum impact in 1985. Export prices in Norway's main trading partners increase more than consumer prices.

[4] Effects on imports are dominated by oil imports. Imports exclusive of oil, which might be a better indicator for Norwegian export market indicators for non-oil products, would obviously have given a smaller impact on Norwegian exports.

[5] The elastisities tend to increase with the size of the economy.

Table 4.1. Effects of the OPEC II oil price shock.
Percent difference from base, unless otherwise stated

Period	Imports of goods, trading partners	Export prices for trading partners	Consumer prices, ECU	Interest rates, ECU. Percentage points
1979	-0.2	0.3	0.4	0.1
1980	-0.4	3.1	1.8	0.5
1981	-0.6	6.6	3.3	0.9
1982	-0.4	8.3	4.7	1.3
1983	-0.9	8.9	5.9	1.4
1984	-2.0	9.2	6.8	1.3
1985	-3.3	9.0	7.5	1.1
1986	-4.9	6.4	7.2	0.6
1987	-5.8	4.3	6.2	0.1
1988	-5.9	3.6	5.3	-0.3
1989	-5.5	3.0	4.2	-0.4
1990	-4.6	2.4	3.3	-0.4
1991	-3.6	2.2	2.6	-0.2
1992	-2.4	2.2	2.1	0.0
1993	-1.2	2.6	1.9	0.2

4.2. Implementation of the alternative oil price in KVARTS simulations

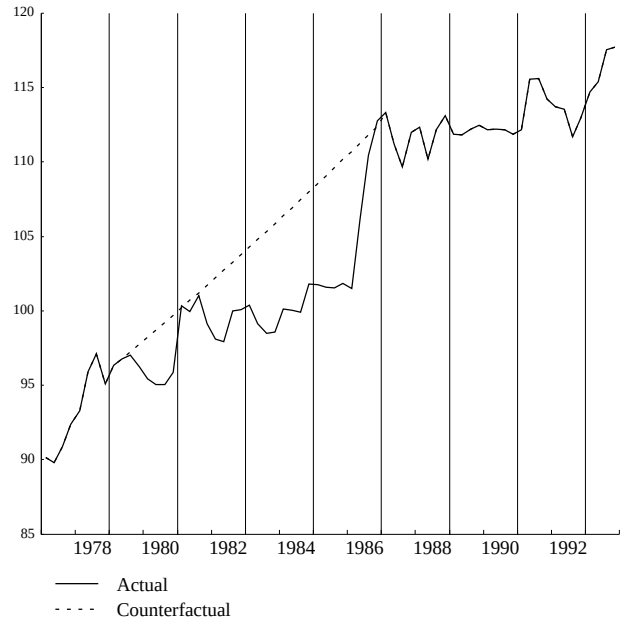
The effects on the Norwegian economy from direct and indirect impulses of the oil price shock are analysed through counterfactual simulations on the KVARTS model, developed by Statistics Norway. The model is a disaggregated large scale econometric model used for regular forecasting of the Norwegian economy. A brief presentation of the model is given in appendix B while a more detailed description of the model and its properties is given in Biørn et al. (1987) and more recently in Hove and Eika (1994), also including the historical tracking performance of the model.

To obtain a picture of the economic situation in Norway without the OPEC II oil price shock, we change the values of exogenous variables in the counterfactual simulation of the Norwegian economy according to the calculations based on the NIGEM simulation results. The impact of the alternative oil price on export market indicators, the nominal interest rate and the rate of inflation abroad are used directly. More problematic are the import prices, as they are the effect of a combination of world market prices and the exchange rates.

As previously discussed all import price effects are calculated given an unaffected effective NKr nominal exchange rate. However, with a much lower oil price than actual, it seems unreasonable to assume the exchange rate to remain unaffected. The historical pattern of the exchange rate shows a

slight depreciation in the period 1978-86 (see figure 4.1). The real effective exchange rate also depreciated in the beginning of this period, but then appreciated as the high and increasing oil revenues accumulated. After the oil price drop in 1986, the NKr was devalued by 9.2 percent, for thereafter to remain stable for a long period. In our alternative scenario we instead let the currency depreciate gradually from the second half of 1979 to the end of 1986, see figure 4.1. This also implies a weaker real exchange rate compared to history in the period 1979-85 in our two simulations of the alternative history.

Figure 4.1. Effective NKr exchange rate index[1]



[1] Weighted average of NKr exchange rates, where weights reflects importance for the Norwegian economy. Official stabilisation target in the "fixed" exchange rate regime 1978-1990.

As a basic assumption in all simulations and in contradiction to the assumptions embedded in Berger et al. (1987), we keep investments and production in the oil-sector unaffected by the changes in the oil price. This assumption is not trivial, but seems to be a reasonable limitation of the analysis. The technology in offshore petroleum extraction implies that the performance of oil production is heavily linked to the production capacity. Except for small adjustments in the timing of maintenance work, optimal capacity utilisation for the oil companies is hardly flexible at all. The fact that there are long time lags from the decision to develop new oil fields to production start up, implies that it could take a long time for an oil price impulse to affect Norwegian oil production. In a study of oil investments in

the North Sea, Favero and Pesaran (1994) highlights the importance of the lengthy time lags (as long as five to six years) from price changes to effects on oil supplies.

As the government controls oil production through a system of concessions and since we in the counterfactual simulation peg the real oil price to the actual from the second half of 1986, an assumption of unaffected oil extraction is not very unreasonable in the short to medium term perspective. The effects of changes in oil prices on the level of oil exploration are often assumed to be much quicker than on the level of capacity/production. The assumption that OPEC II did not affect this kind of investment (and thereby medium to long-term production) is probably more questionable. The level of exploration investments is, however, also influenced by the authorities, both directly through licensing and indirectly since an oil company's exploration activities may affect its possibility of obtaining future licences.

4.3. Effects of OPEC II with no fiscal policy response in Norway

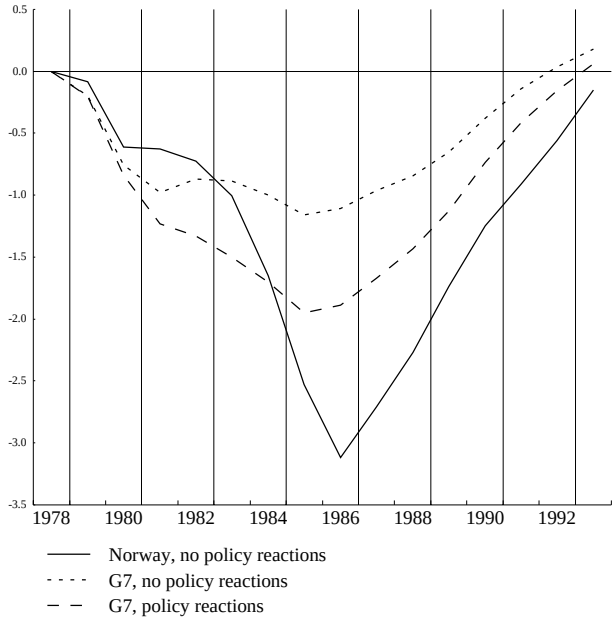
In order to illustrate the effects of the high oil prices on the Norwegian economy we first keep fiscal policies unaffected. All international effects as described in table 4.1 are implemented, as well as the assumptions about the exchange rate and the oil sector outlined in the previous section. The main effects of this simulation are presented in table 4.2, while more details are given in appendix D.

Higher oil prices reduce demand from traditional export markets and from households, the latter as a consequence of declining real disposable income and increased interest rates. On average exports fall by 2.5 percent and household consumption decreases by almost 2 percent in the first half of the simulation period, compared to the alternative scenario. There is also a decline in gross fixed investments, contributing to a fall in GDP of around 1.5 percent. Despite a somewhat smaller impetus from export demand in the period 1987-93, the size of the GDP-effect remains the same and the overall average decline is equal to 1.4 percent.

The evolution over time for the GDP-effect is displayed in figure 4.2, showing that the maximum impact of 3.3 percent is reached in 1986. In order to make a comparison with other countries, we have also undertaken a NIGEM-simulation without fiscal policy rules in place. The outcome of this simulation for the G7-countries, together with the results for the case with fiscal solvency rules, is also presented in the figure.

The pattern of the GDP-effects is fairly similar in Norway and the G7-countries in the first five years of the simulation, as well as in the last five year period. However, the effects in the intermediary period and in particular the peak-reaction is considerably more pronounced in Norway than in the G7-countries. The reason is probably connected to the higher degree of openness of the Norwegian economy than the average for the G7-countries. From table 3.1 we saw that there are significant differences among the G7 countries, and results for Norway do not deviate much from GDP-effects in Germany and the UK (countries with large export sectors) in the mid-1980s. In the US, however, GDP-effects are stronger in the first part of the simulation period, and also turn positive after 1990, while they remain negative in Norway.

Figure 4.2. Effects of OPEC II on GDP in percent. Norway and the G7-countries



Consumer price effects in Norway are rather distinct in this simulation, with an average price increase of 4 percent in the period 1979-86, see table 4.2. In the remaining part of the simulation, price effects decline and the average outcome for the overall period is 2.5 percent. In line with GDP-results, the maximum effect on consumer prices appears first in the US, and is showing up later in the UK and Germany than in Norway. Also with respect to the level of the maximum CPI-effect Norway is placed in the middle, with a higher impact in the US and lower maximum consumer price effects in the UK and Germany. On this background, it seems fair to say that the macroeconomic effects on the

Norwegian economy of oil price shocks do not differ substantially from other industrialized countries as long as fiscal policies remain unchanged.

However, being an oil nation Norway obviously gained revenues from the OPEC II shock. The oil companies increased their profits substantially due to the high oil prices, and the government was able to retain large parts of the oil rent (revenues exceeding normal return to production factors) from taxation and through direct ownership in the oil industry and in oil fields. Accordingly, there were positive financial effects both for the government sector and on the national level. From table 4.2 we see that under the "no-policy-change" assumptions, the OPEC II reduces the 1993-level of net debt in the public sector and for Norway in total corresponding to 51.7 and 37.8 per cent of GDP respectively.

The mirror image of these improvements of public finances is a low oil price scenario with similar increases in public debt. Accordingly the counterfactual scenario with no policy response seems unreasonable. Equivalently we find it plausible to assume that fiscal policies were affected by the oil price shock. In the following section of the paper we argue that both government spending and tax policies probably responded to the oil shock and we outline a set of possible fiscal policy reactions.

Table 4.2. Effects of OPEC II on Norwegian economy without policy reactions in Norway. Deviation between historical and counterfactual simulation with low oil prices

	1979-93	1979-86	1987-93	1986	1993
Gross domestic product[1]	-1.4	-1.4	-1.3	-3.1	-0.2
Unemployment rate[2]	0	0.2	-0.2	0.4	-0.7
Consumer price index[1]	2.5	4.0	1.4	4.0	0.3
Budget balance[2]	3.9	4.7	2.9	3.0	4.1
Current balance/GDP[2]	5.7	7.3	3.8	5.8	3.4
Net foreign debt/GDP[2]	-35.2	-28.7	-42.5	-43.9	-51.7
Net public debt/GDP[2]	-22.3	-14.0	-31.8	-29.2	-37.8

[1] Percent deviation
[2] Percentage points deviation

4.4. A possible fiscal policy response

The conclusion of the previous section was that fiscal policies probably reacted to the oil shock, due to the obvious positive consequences for public finances. Accordingly, fiscal policy changes should

be implemented in the counterfactual scenario. There is, however, also another reason why the authorities might like to change their fiscal policy in a low oil price simulation. Business cycles in Norway would have been affected and therefore also the timing of an optimal use of stabilisation policy variables. With interest rates tied up by the stable exchange rate policy, fiscal policy was the only stabilisation measure. Accordingly, a less expansive financial policy seems reasonable in 1981-84, since the slump of the Norwegian economy is dampened in the low oil price scenario,

In general fiscal policies could within a model framework be changed in two different ways. The first is to use policy reaction functions, linking fiscal policy to variables describing the development of the economy. However, the composition of governing parties in Norway has changed considerably during the last 30 years. To estimate time invariant policy reaction functions would therefore most likely turn out to be very difficult. Instead of relying on policy rules, we have redesigned the fiscal policy in a more ad hoc, but also in a more transparent way.

From a theoretical viewpoint, the policy question is how to design a spending strategy for consumption of an unknown transitory windfall income, accruing over time. It is often argued that spending should be increased in line with the real rate of return to the additional petroleum wealth, allowing for an infinitely higher consumption level. The problem in practice is that the government do not know the future path of the extra oil income, and therefore have to rely on some sort of a spending rule. A backward looking approach to the problem is for the government to spend an amount equal to the real rate of return to the accrued revenues. In this case the (additional) use of oil revenues would increase gradually (compared to baseline) as long as the public income from the petroleum sector increases, to a level consistent with the rate of return to the total accrued revenues in the high oil price period. Such a rule should be regarded as a particularly careful spending strategy, since expected future oil revenues are disregarded completely.

Introducing forward looking behaviour could change the spending policy considerably. First, assume perfect foresight, i.e. that the government knows the future oil price development, including the technological development and the size of the oil reserves. Then spending should be adjusted instantaneously by an amount consistent with the real rate of return to the expected revenues. The new level would be somewhat lower than the end-point level from the backward looking approach, since spending in that case was «underoptimal» in the beginning. However, perfect foresight should not be

viewed as a reasonable assumption, but can nevertheless serve as a useful benchmark for optional spending policies.

An alternative would be to base this analysis on price expectations. Assume that changes in actual oil prices is the only factor behind revisions over time in the expected petroleum wealth. Then one might link the increase in public spending to actual changes in the government's expected permanent income from the petroleum sector, which in Norway is an observable variable. The immediate reaction to the oil price rise would in this case be an enormous increase in spending, since the new price level would be assumed to go on forever and provide a huge overall increase of revenues. The downward adjustment of spending would not occur until the oil price starts falling, and then spending would have to be much lower than in the case of the other strategies, due to the large overspending in the period with high oil prices.

Our assumed effect on the economic policy in terms of tax reduction and increased public consumption is clearly stronger (around the double) than the backward looking rule suggests, but follows the idea of a gradual increase in spending. On the other hand, the chosen policy mix is considerably lower than what would follow from using the expected permanent income of the petroleum wealth, based on the governments own oil price forecasts. As an example, in 1981 the implemented fiscal changes count for only around 10 percent of the outcome of the latter rule, when assuming that the government's expected permanent income[6] is revised according to oil price changes only. A downward adjustment of government demand in the wake of the oil price fall in 1986 is implemented and must be seen in relation to the long term influence of the oil price shock. With a 7 percent real discount rate (which was the officially used rate in Norway), the real increase in government spending with our imposed policy changes in place, corresponds approximately to the real rate of return to the increase in public sector net claims towards the end of the simulation period.

Our implemented adjustment of government demand can be seen in figure 4.3. The actual spending growth was moderate in 1979 indicating that the expected increase in permanent income from the petroleum wealth did not boost public spending by much this year. The strong growth in public spending the following two years, with unemployment stable at a low level, could be considered as an indication of high oil prices fuelling public demand. In the counterfactual simulation we therefore reduced growth in real purchases by 2.5 percentage points in the years 1980-81. In the period 1982-85

[6] Estimates of the government's expected permanent income of the petroleum wealth is taken from Aslaksen et al. (1990).

the reduction was 1.5 percentage points, while growth in real spending was reduced by 1 percentage point in 1986.

Economic policy was actually tightened in the years after the decrease of the oil price in 1986 partly as a reaction to a decline in expected petroleum wealth, and partly as a delayed reaction to the overheated mainland economy. In the beginning this was mainly executed through increased taxes, cf. Bowitz and Hove (1996). In 1988 however, the growth in public demand was reduced by almost 3.5 percentage points. In the counterfactual simulation we therefore increased the growth rates of real public spending in 1988 and 1989 by 2.5 percentage points.

Since the choice of changes in growth rates for government spending may seem somewhat arbitrary, we also undertake a sensitivity test with two sets of different assumptions. In alternative A growth rates of public spending are decreased by 0.5 percentage points in the period 1980-86. In 1988-89 growth rates are increased by 2.2 percentage points each year, which makes the increase in net financial assets large enough so that the (extra) yield covers the implicit permanent increase in public spending, also after 1993. In alternative B, growth rates were changes with the same magnitude, but in opposite direction.

The direct tax-system changed a lot during the period we are studying. As seen in figure 4.4, both average tax rates for households and (an indicator of) marginal direct tax rates for wage-earners were reduced substantially from 1980 to 1984. During the subsequent years tax rates were increased again and were in 1987 close to the 1980-level. The actual reduction in average taxes after 1980 was introduced with reference to «a dynamic tax policy», intended to stimulate growth and thereby also tax income. However, this policy change would probably not have been implemented in absence of the (extra) oil revenues, and can thus be interpreted as a transfer of some of the increased public petroleum income directly to the Norwegian households. In our counterfactual simulation we accordingly keep average direct taxes paid by households more or less constant in percent of total nominal income from 1980-86. Marginal tax rates are also maintained at their 1980 level in the same period. In this way we also avoid effects from the actual increase in average tax rates in 1987 in the counterfactual simulation.

Figure 4.3. Real public consumption and investments. Growth from previous year in percent

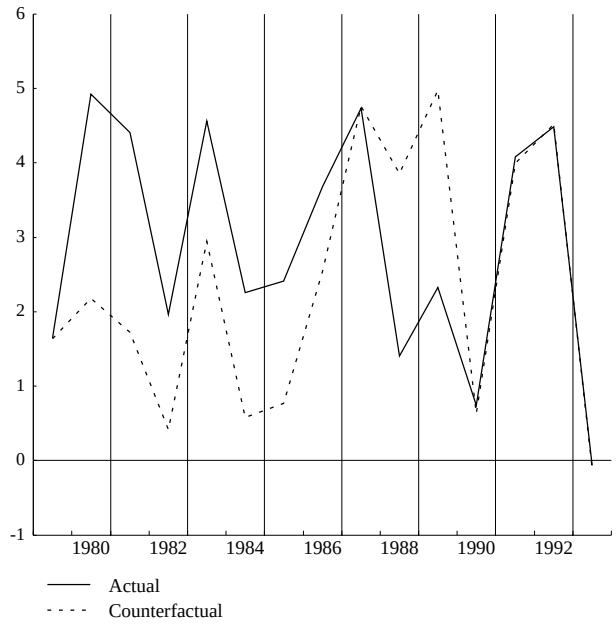
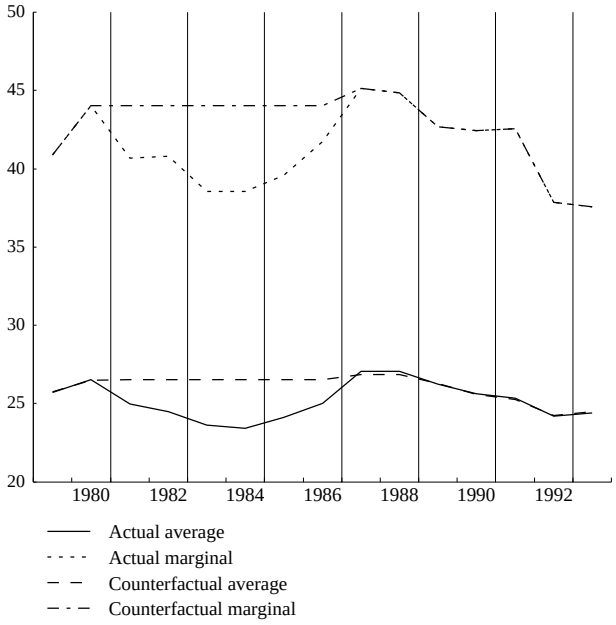


Figure 4.4. Average and marginal tax rates. Percent



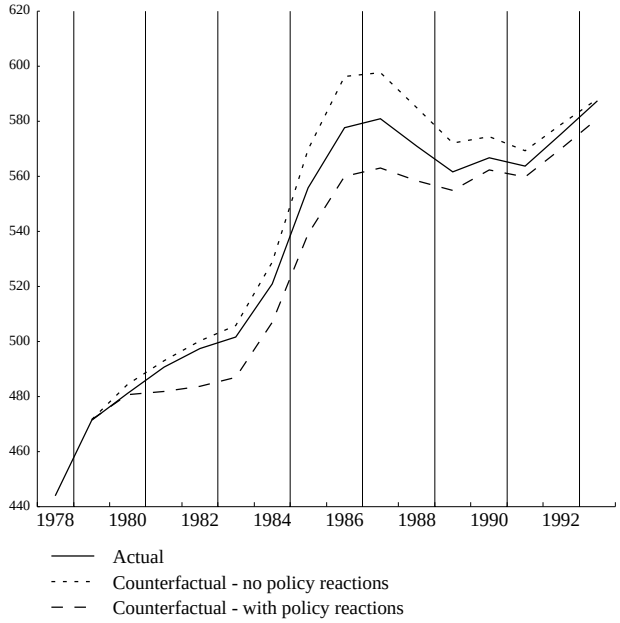
4.5. Effects of OPEC II with fiscal policy reactions in Norway

In the following we present the simulation results describing how the Norwegian economy was affected by the OPEC II oil price shock when fiscal policy responses are taken into account. We start with a discussion of overall effects, then turn to look at results in more detail.

Overall macroeconomic effects

With the assumptions described in the previous section, the effects on the level of activity of reduced world market demand and increased interest rates are more than offset by the positive effects of a more expansionary domestic economic policy, see table 4.3 and figure 4.5 which also includes the outcome in the no-policy case. In 1979 and 1980 effects are negligible, but thereafter real GDP in Norway is substantially increased as a result of higher oil prices. The largest GDP-effect is found in the period 1982-87, with a peak of 2.4 percent observed in the latter year. The high oil price level from 1979 to 1986 increases GDP by 1.6 percent on average in that period, and by 1.1 percent on average the following seven years according to our simulation. On average for the entire period GDP is increased by 1.3 percent.

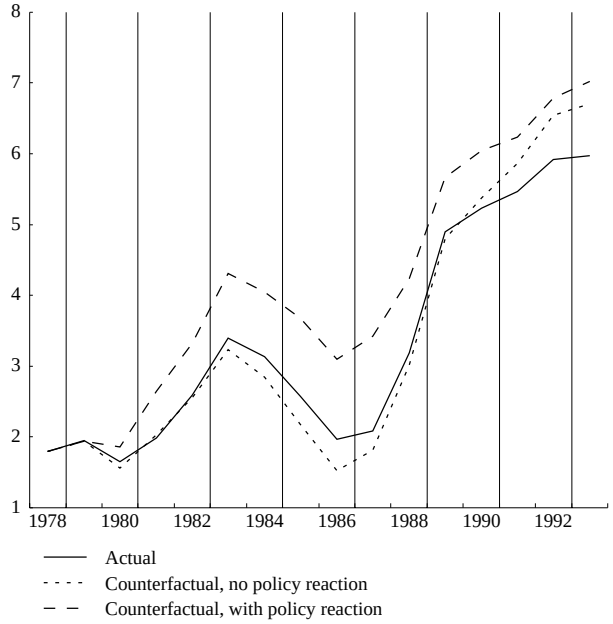
Figure 4.5. GDP Mainland-Norway. Billions 91-NKr



According to our simulations, the upswing in activity stimulates employment and reduces unemployment, see table 4.3 and figure 4.6. On average for the period 1979-93 the number of

employed persons rises by 2.3 percent. Due to discouraged worker effects, amplified by increased activity in sectors dominated by female employees, the work force increases by 1.4 percent in the same period. Accordingly the rate of unemployment is reduced by 0.8 percentage points on average.

Figure 4.6. Unemployment rate. Percent of the labour force



Our sensitivity analysis shows that in case A, i.e. with less expansionary policy in the early 1980s, the overall impact on GDP is 0.3 percentage points lower. This is due to the assumption that public spending is increased on a permanent basis (i.e. beyond 1993) in this scenario, making the overall changes within the simulation period negative. In alternative B there is an increase of the GDP effect of the 0.3 percentage points, showing that the symmetric changes in government spending transmit to GDP. From these results, it seems fair to say that with any reasonable fiscal policy response, GDP is raised due to the high oil price.

Despite the difference in methodological approach, it is of interest to compare the GDP-effects with those in Bjørnland (1996), who identify demand, supply and oil price shocks in a VAR-model. At first sight it seems as the positive oil price effect in the early 1980s in her study is smaller than the negative effect following the oil price drop in 1986 (see her figure 6, p. 24). This could lead to the interpretation that the overall effect of OPEC II was negative for the Norwegian economy. However, there is (according to the same figure) also a clearly positive demand shock effect on GDP in the early

1980s, but no negative effect after 1986. Accordingly, the result might be due to a problem in distinguishing between policy effects stemming directly from the oil price impulse and from other forces acting (e.g. discretionary fiscal policy).

The oil price shock in detail

The high oil prices had a negative influence on traditional export industries through reduced world market demand and a loss of competitiveness as wage costs in Norway grew more than in trading partner countries, see figure 4.7. The likely effect of an appreciation of the real effective exchange rate in the years with high oil prices, compared to baseline, is a further deterioration of price competitiveness in the period 1979 to 1986. For the entire simulation period, high oil prices caused a reduction of export of traditional goods of 4.6 percent.

Table 4.3. Effects of OPEC II on the Norwegian economy, with policy reactions in Norway Deviation between historical and counterfactual simulation with alternative oil prices. Figures in percent unless otherwise noted

	1979-93	1979-86	1987-93	1986	1993
Private consumption	2.0	2.7	1.2	4.1	0.3
Government consumption	8.6	7.8	9.4	13.7	8.4
Gross fixed investments	1.5	1.7	1.2	3.5	0.5
Exports	-3.4	-3.3	-3.5	-5.9	-2.1
Imports	0.9	1.5	0.4	2.6	0.2
Gross domestic product	1.3	1.6	1.0	2.4	0.8
-mainland Norway	1.8	2.1	1.5	3.2	1.1
Employment	2.2	2.1	2.4	3.4	2.3
Labour supply	1.4	1.3	1.4	2.2	1.1
Unemployment rate[1]	-0.8	-0.7	-1.0	-1.1	-1.1
Average borrowing rate[1]	0.6	0.9	0.3	1.4	0
Households' saving ratio[1]	0.3	1.0	-0.6	1.2	-0.4
Households' real disposable income	2.0	3.4	0.5	5.0	-0.2
Hourly wage rate	3.6	5.3	2.5	6.0	0.5
Consumer price index	4.1	4.9	3.5	5.7	2.1
Prices, dwellings	12.2	12.6	11.9	16.6	5.6
Export prices, total	10.8	18.3	4.1	8.1	4.0
Export prices, traditional goods[2]	4.9	6.1	3.7	3.4	3.5
Import prices, traditional goods[2]	3.1	4.2	2.2	2.8	1.8
Budget balance/GDP[1]	2.5	3.3	1.7	0.8	2.0
Current balance/GDP[1]	3.3	5.3	0.9	2.0	1.3
Net public debt/GDP[1]	-15.9	-10.6	-22.0	-20.3	-24.8
Net foreign debt/GDP[1]	-25.2	-25.5	-24.8	-35.8	-26.1

[1] Percentage points deviation
[2] Total exports of goods excluding crude oil, natural gas, ships and oil platforms

Figure 4.7. Total effects of OPEC II in percent

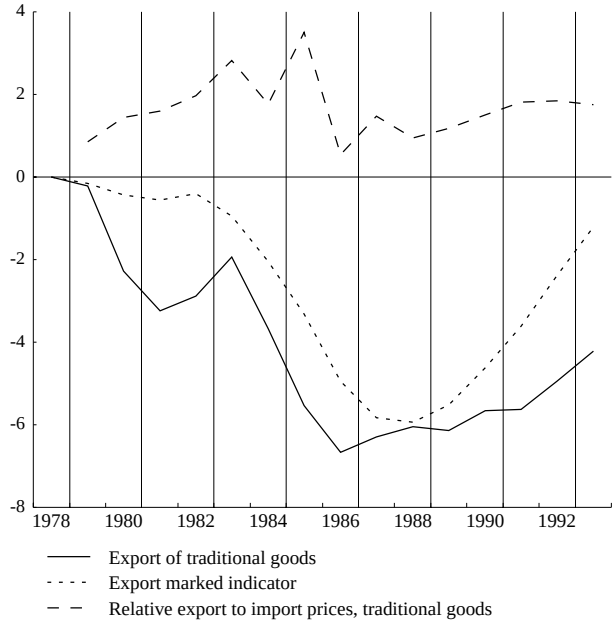
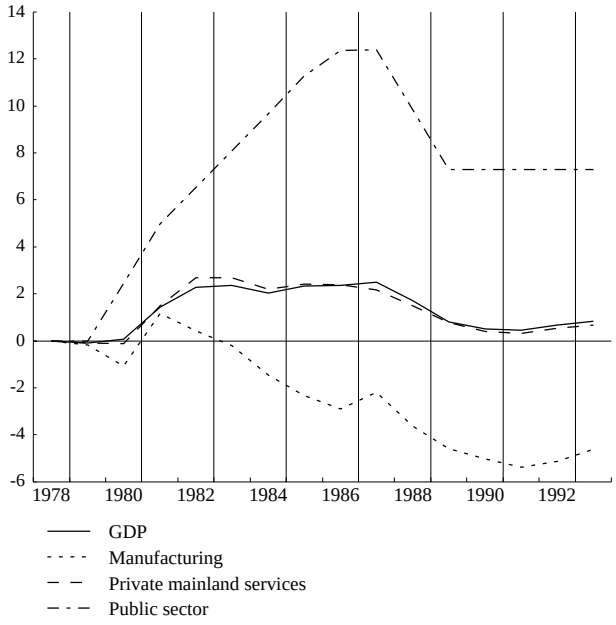


Figure 4.8. Total effects of OPEC II on value added in percent

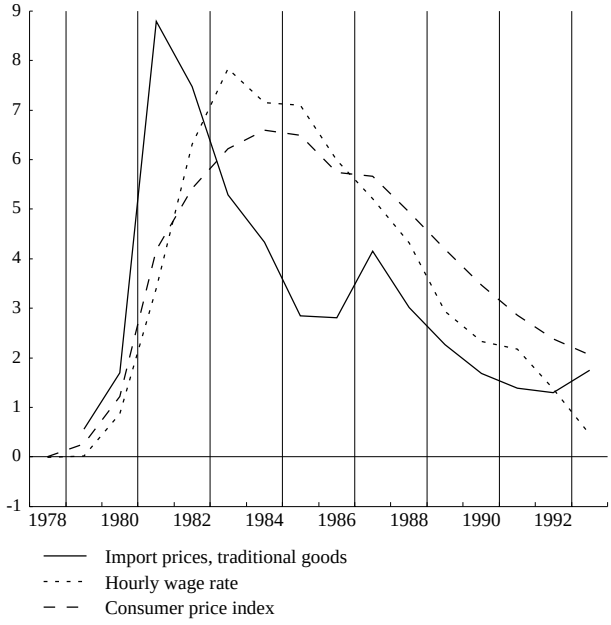


The increase in domestic demand for manufacturing products is not strong enough to compensate for the loss of export, and so manufacturing production is reduced as a result of the high oil prices, see figure 4.8. At the end of the simulation period, almost 8 years after the oil price went down to the pre

OPEC II level, manufacturing production in Norway was still substantially lower than what would have been the case with the alternative low oil price scenario. This long lasting effect is partly a result of the persistence of the initial effect on world market demand. However, the main explanation is to be found in the working of the Norwegian economy. As investments in manufacturing industries become smaller due to reduced demand and profitability, the stock of real capital is reduced also in a longer term perspective. This causes a loss of price competitiveness as well as a direct negative supply-side effect on exports, mainly in energy/capital intensive industries. The effect of the high oil prices on the activity in private mainland service sectors is positive from 1981, following closely the overall GDP effect. The effect on activity in the public sector that follows from our assumptions can also be seen in figure 4.8. The high oil price from 1979 to 1986 contributed to increase the share of GDP produced in the public sector by about 1 percentage point in the longer term.

Increased activity and the general upswing in domestic as well as foreign prices boosted nominal wage-growth compared to baseline in the period 1980-83, see figure 4.9. The maximum of an 8 percent increase was reached in 1983. Thereafter reduced labour productivity in the manufacturing sector (which is wage-leading) induced a gradual decline of the effects on nominal wages. Labour productivity is affected by the contraction of world market demand and the loss of price competitiveness. By the end of the simulation period wage effects had vanished almost completely.

Figure 4.9. Total effects of OPEC II in percent



As the growth in oil prices immediately affects consumer prices through rising fuel prices, the consumer real wage is decreasing during the first three years of the simulation. Thereafter the effects of the tighter labour market dominate, lifting the real consumer wage level in the following five years. In the last six years of the simulation period the real consumption wage is somewhat reduced again.

In spite of an immediate decrease in real interest rates and a boost of employment from 1980, there is no instantaneous response to private consumption, see figure 4.10. Reduced real consumption wages in the first three years prevents consumption from rising. However, as the effect on employment is growing and the negative real wage effect becomes smaller and turns positive, private consumption increases rapidly in 1981 and 1982. For the next four years there is no further increase in private consumption, and after the tightening of the fiscal policy in the wake of the oil price drop in 1986, the positive consumption effect is gradually reversed towards the end of the simulation period. Effects on investments in Mainland-Norway follow to a large extent the same path as the private consumption effect, but with a one year delay. It is mainly public investments and housing investments that contribute to this development. Private business investments are only increasing in the period 1982-84 and from 1986 this sector's capital stock is reduced due to the high oil prices.

Figure 4.10. Total effects of OPEC II in percent

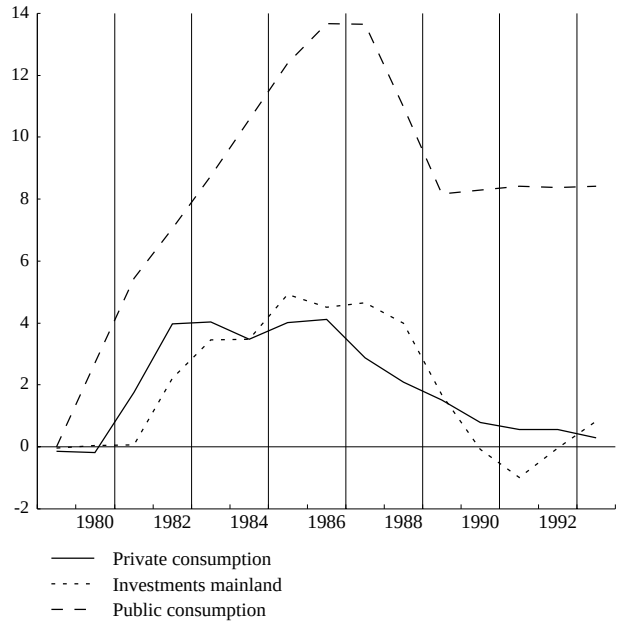
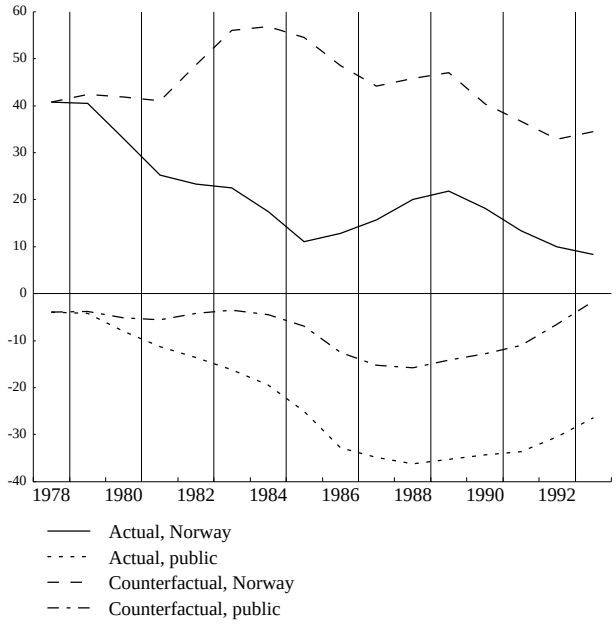


Figure 4.11. Net debt in percent of GDP. Alternative oil price: with policy reactions



An increase in the export value of petroleum products due to the increase in the oil price clearly dominates the reduction of real exports with respect to the current account balance. On average the current balance increases by 3.3 percent of nominal GDP, causing a reduction in Norway's net foreign debt by 25 percent of GDP at the end of the simulation period, see figure 4.11. Our assumptions regarding policy reactions improve the budget balance in the entire period. This causes an increase in net public claims equivalent to about 25 percent of GDP in 1993.

4.6. Business cycle effects in Norway

The Norwegian economy was in the 1980s and beginning of the 1990s caracterized by the strongest cyclical fluctuations since World War II. To analyse sources behind this development is therefore of particular interest and accordingly we here assess the contribution from the 1979-85 oil price shock to the business cycle development.

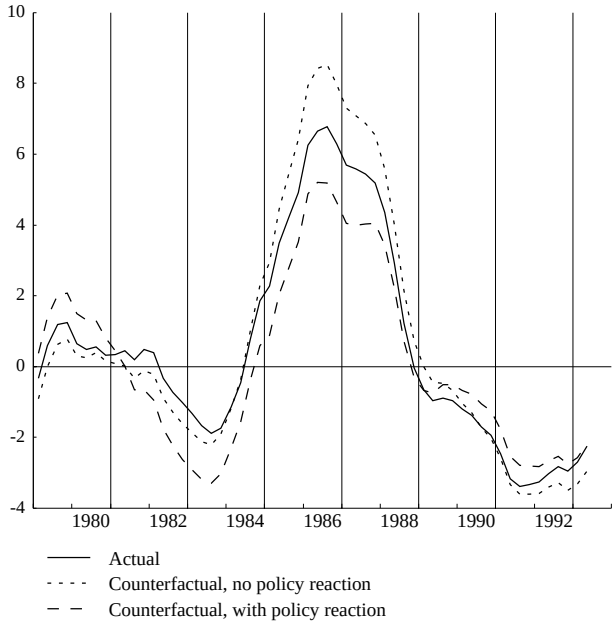
The method of investigation is a de-trending procedure. Cyclical movements of GDP Mainland-Norway are defined as the deviation between actual values and a trend, constructed by using a Hodrick-Prescott (HP) filter, see Hodrick and Prescott (1980). The procedure is undertaken both for the actual development and in the counterfactual simulations with alternative oil prices with and without policy reactions. To obtain an overall positive trend in the historical series, the λ-parameter in

the HP-filter must be given a high value (we have chosen 100 000). For a more detailed description of the methodology and arguments for the choice of the high λ-value, see e.g. Bowitz and Hove (1996). As can be seen from figure 4.12 the period 1979 to 1993 covers almost two complete cycles for the actual development of GDP Mainland-Norway. The level of activity was somewhat above trend in 1979-81 and more pronounced so in 1984-88. In the same way the depression after 1988 was much deeper than in 1982-83.

As indicated above the effects of the 1979-86 oil price shock in a business cycle perspective should be divided into two. Based on our assumption of the effects on economic policy, OPEC II dampened the cycles until 1984, while the oscillations in the rest of the period were augmented. In the period 1979-83 the mean absolute percentage deviation from trend (MAPD) of GDP Mainland-Norway was reduced by 50 percent, while in the most turbulent period, from 1984 to 1993, OPEC II lead to an increase of 30 percent, see table 4.4.

In the period 1979-83, there were no effects from the high oil prices on cyclical movements in the case with no policy reactions. However, the isolated effects of OPEC II in the period 1984-1993 are to reduce the oscillations by almost as much as they are enlarged in the case with policy reactions.

Figure 4.12. GDP Mainland-Norway. Deviation from trend in percent. λ = 100 000



To check the sensitivity with respect to the λ-value in the de-trending, we have also performed the procedure with the more commonly used value of 1600. The main qualitative conclusions remain unchanged but the total effect (with policy reactions in place) for the period 1979-93 as a whole is changed: with our preferred high λ-value the oscillations of GDP Mainland-Norway measured by MAPD was enlarged by OPEC II, while they were unaffected with a λ-value of 1600.

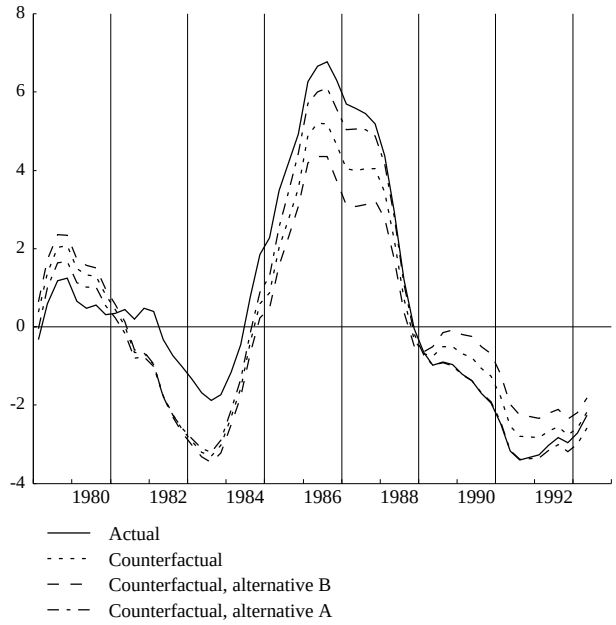
Table 4.4. Mean Absolute Percentage Deviation[1] (MAPD) GDP Mainland-Norway

		1979-1983	1984-1993	1979-1993
λ= 100 000:	Actual	0.8	3.0	2.3
	Smooth oil price, no policy reactions	0.8	3.6	2.7
	Smooth oil price, policy reactions	1.6	2.3	2.1
λ=1600:	Actual	1.0	1.4	1.3
	Smooth oil price, no policy reactions	1.2	1.6	1.5
	Smooth oil price, policy reactions	1.4	1.2	1.3

[1] Average of absolute value of percent difference from trend (HP-filter) in smoothed values of seasonal adjusted series.

In evaluating these results one has to be particularly concerned with respect to the effects of the design of the alternative fiscal policy. Another timing of policy reactions than what we have implemented would of course have influenced the results. The magnitude of the policy impulses also matter and in our alternative A, i.e. with less expansive policy reactions in the beginning, the MAPD is 1.8 percent for the period 1979-83, i.e. somewhat higher than in our main scenario. In 1984-93 but MAPD is lower than in the base case (1.9 percent). In alternative B, the MAPD is 1.5 for the first period and 2.8 for the latter, which is close to the MAPD for the actual cycle. Figure 4.13 displays the two alternatives together with the actual and the main scenario cycle. The conclusion that the high oil price dampened cycles in the early 1980s seems very robust to the choice of fiscal policy. It also seems reasonable to claim that oscillations were augmented in late 1980s/early 1990s, although this conclusion is not as powerful as for the first period.

Figure 4.13. GDP Mainland-Norway. Deviation from trend in percent. λ = 100 000



5. Conclusions

The aim of this paper has been to analyse effects of the high oil prices in the first half of the 1980s on the Norwegian economy. Since Norway is a small open economy, it is vital to investigate external effects in a consistent way, and we utilised a world model for this purpose. Results show that the high oil prices in the period 1979-86 had a rather persistent effect on demand from Norwegian trading partners: in 1993 imports were still lower than what had been the case with a smooth real oil price path. The increase in the oil price level also lifted interest rates in OECD-countries, and in particular German rates which are of main importance for the Norwegian economy. The partial effects of these external impulses were undoubtedly contractionary for the Norwegian economy according to our results.

Because of the significant production and exports of oil, Norway received a windfall gain from the increase in oil prices. As the government accrues most of the oil rent, we argue that higher oil prices stimulated government spending. By our assumption of a long term increase in public demand of 8-9 percentage points, net public claims are by the end of the simulation period increased by almost 25 percent of GDP, compared to the alternative low oil price scenario. Accordingly, the spending strategy can be viewed as cautious.

With these assumptions embedded into our model based analysis, the boost of domestic demand more than offsets the contractive impulses from abroad. On average over the period 1979-93 GDP increases by 1.3 percent. With respect to the business cycles the effects from OPEC II can be divided into two parts. Until 1984 the effect from oil price shock was to reduce the magnitude of the fluctuations: increased public spending dampened the depression in 1982-83. However, bright expectations with respect to the oil wealth pushed up public spending when the Norwegian economy were about to overheat in the middle of the 1980s and oscillations were amplified. The downturn that followed in the subsequent years was stronger and deeper due to reduced public demand in the wake of the oil price drop in 1986.

The temporary increase in the oil price lead to increased private and public consumption, and to reduced unemployment, hence welfare was undoubtedly improved. These positive effects on the Norwegian economy could still be seen in the longer term (towards the end of the simulation period). In addition the increase in net public claims should provide future welfare gains as well. Viewed against a slight increase in economic fluctuations, we accordingly conclude that Norway both in short and in the long run gained considerably from the OPEC II oil price shock.

References

Aslaksen, I., K.J. Brekke, T.A. Johnsen and A. Aaheim (1990): «Petroleum resources and the management of national wealth» in O.Bjerkholt, Ø.Olsen and J.Vislie (eds.): *Recent Modelling Approaches in Applied Energy Economics,* London: Chapman and Hall.

Barrell, R., A.Gurney and S. Dulake (1990): The World Economy, *National Institute Economic Review* **115**, 22-43.

Barrell, R. and K.A.Magnussen (1996): Counterfactual analyses of oil price shocks using a world model, Discussion Papers 177, Statistics Norway.

Barrell, R., N. Pain and I. Hurst (1996): German Monetary Union: An Historical Counterfactual Analysis, *Economic Modelling* **13**, 499-518.

Berger, K., Å. Cappelen, V. Knudsen and K. Roland (1987): «The effects of a fall in the price of oil: the case of a small oil exporting country» in H. Motamen (ed.): *Economic Modelling in the OECD Countries,* London: Chapman and Hall.

Bernanke, B.S., M. Gertler and M. Watson (1997): Systematic monetary policy and the effects of oil price shocks, *Brookings Papers on Economic Activity* **1**, 91-157.

Biørn, E., M. Jensen and M. Reymert (1987): KVARTS - A quarterly model of the Norwegian economy, *Economic Modelling* **4**, 77-109.

Bjørnland, H.C. (1996): The dynamic effects of aggregate demand, supply and oil price shocks, Discussion Papers 174, Statistics Norway.

Bowitz, E. and S.I. Hove (1996): Business cycles and fiscal policy: Norway 1973-93, Discussion Papers 178, Statistics Norway.

Burbidge, J. and A. Harrison (1984): Testing for effects of oil-price rises using vector autoregressions, *International Economic Review* **25**, 459-483.

Darby, M. R. (1982): The Price of Oil and World Inflation and Recession, *The American Economic Review* **72**, 738-751.

Favero, C.A. and M.H. Pesaran (1994): Oil investment in the North Sea, *Economic Modelling* **11**, 308-329.

Green, S. L., K. A. Mork and K. Vaage (1993): An outlier-based time-series analysis of the price of crude-oil over the past 130 years, Working Paper 39, Norwegian School of Management.

Hodrick, R.J. and E.C. Prescott (1980): Postwar U.S. business cycles. An empirical investigation, Working paper 451, Carnegie-Mellon University.

Hove, S.I. and T. Eika (1994): KVARTS: Modellen bak prognosene (KVARTS: The model behind the forecasts), *Økonomiske analyser* 1994, 9, 33-46.

Mork, K.A., Ø. Olsen and H.T. Mysen (1994): Macroeconomic responses to oil price increases and decreases in seven OECD countries, *Energy Journal* **15**, 19-35.

OECD (1980): The Impact of Oil on The World Economy, *Economic Outlook* **27**, 114-130.

Statistics Norway (1973): *Utenrikshandel, hefte II*, tabell V, NOS A665.

Statistics Norway (1983): *Utenrikshandel, hefte II*, tabell 16, NOS B493.

Statistics Norway (1993): *Månedsstatistikk over utenrikshandelen*, desember, tabell 16.

Appendix A

The NIGEM model

NIGEM (National Institute Global Econometric Model) is an aggregate quarterly macroeconometric model, used regularly for forecasting purposes. The model has also been employed for various policy analyses, i.e. a counterfactual study of the German unification, see Barrell, Pain and Hurst (1996). In this appendix we give a brief overview of the model structure, while a more detailed specification can be found as an appendix A in Barrell and Magnussen (1996.).

NIGEM is demand oriented, one good model, with a short-term Phillips curve effect and neo-classical long term properties. Identical theoretical structures are imposed for the G7 countries, but empirical results determine the actual model for each country. In the trade block import of goods is linked to total final domestic expenditure and relative prices, while export of goods depends on foreign market growth and relative prices. Trade with services is treated separately and is a function of foreign demand and real effective exchange rates. Domestic demand comprises consumption functions, in which private expenditure depends on real disposable income and real wealth, and private real investment, which depends positively on GDP and negatively on (nominal) interest rates. Employment is a function of real wages and GDP, while real wages in general are dependent on productivity and unemployment, founded on a standard bargaining framework. Wholesale prices depend in general on unit labour costs, import prices and capacity utilisation. Consumer prices are determined by unit labour costs or wholesale prices, as well as indirect taxes. In addition import price effects occur in some countries.

Oil price changes influence domestic prices through several channels. Both export and import price equations include oil prices directly, and there are indirect effects to producer and consumer prices. A special version of the model has been adapted for historical analyses of oil price shocks, which includes time varying trade weights affecting import prices, export market indicators and relative export prices. These weights are constructed based on observed data for 1973, 1980 and 1987 respectively. An exponential function is used for interpolation and weights changes in a trend like way. The OPEC block embodies a link between oil prices and imports of goods and services, securing that oil revenues are spent gradually over time.

The monetary policy rule utilized in this paper is based on the long-run solution in the estimated money demand equations in the model. In order to avoid instability, differences between actual and target money stocks are removed slowly. The speed of adjustment depends on the flexibility of the wage-price system and will hence vary between countries; there is e.g. considerably more nominal inertia in the European economies than in the US and Japan. The rule can be written:

(1) $R3M = a + b \cdot GDP - c \cdot (M^T/CED)$

where R3M = the short term (3 month) interest rate
GDP = Gross Domestic Product
M^T = targeted money stock (equal to historical level)
CED = the consumer expenditure deflator
a, b and c = positive parameters

A reduction in the oil price initially lowers prices and raises income in the OECD, and the overall effect on the difference of money demand from the target stock depends upon the total effect of the shock on nominal GDP.

The fiscal solvency rule ensures, together with the monetary rule, that the debt stock target is asymptotically achieved in the long run, and the income tax rate is used to achieve the target. The rule can be written:

(2) $T = T(-1) \cdot [PI/PI(-1)] + 0.2 \cdot [P_{GDP}(-1) \cdot GDP(-1)] \cdot [GB^T(-1) - GB(-1)]$

where T = tax payments, personal sector
PI = nominal personal income
P_{GDP} = GDP-deflator
GB = government budget surplus, relative to nominal GDP
^{T} indicates base trajectory (target)

Appendix B

The KVARTS model

The KVARTS model is a disaggregated large scale macroeconometric model of the Norwegian economy, including 18 production sectors and 25 commodities. Important exogenous variables are international interest rates and inflation, import prices (including the oil price), investments and production in energy production and primary industries, fiscal policy instruments and export markets growth.

The exchange rate is exogenous in KVARTS, reflecting that Norwegian kroner in general for a long time was pegged to a basket of foreign currencies. The domestic short term money market interest rate is modelled in a modified Uncovered Interest rate Parity (UIP) relation, where the real rate in Norway equals the real interest rate in the «currency basket countries» in the long run. In the short run there are effects from changes in the current account as well as from adjustment lags. Average interest rates for households follow the money market rate in the long run.

Production behaviour is based on a monopolistic competition framework. Norwegian exports of the different commodities depend on demand from trading partners and relative prices, while the stock of real capital/capacity utilisation plays a role for some of the commodities. Import shares and export prices are also modelled econometrically. Private consumption depends mainly on household real income and real wealth, while investments by sector are determined by value added and profits. Wage formation is based on a bargaining framework, with wages in three sectors of the economy being homogenous of degree one in consumer prices, producer prices and an alternative wage. The real wage depends on unemployment in a non-linear way. Production follows from an input-output system balancing demand and supply, taking changes in inventories as exogenous.

The model’s marginal properties are base and time dependent. In particular, dummies for credit regulation alter the size of wealth and income elastisities in the private consumption function in the mid 1980s. Furthermore, non-linear unemployment effects in wage equations make effects dependent on the initial level of unemployment. Short-term GDP-multipliers in case of a fiscal expansion are higher after liberalisation of credit markets and are inversely related to the level of unemployment. Due to reduced cost competitiveness and substitution out of labour, long-term multipliers depend positively on the initial level of unemployment.

With an unemployment rate at about 5 percent (around the average rate in Norway from 1986-96) and without regulations in the credit market, a permanent increase in public demand corresponding to 1 percent of GDP, increases GDP by 1 percent after a year. The maximum impact of 1.3 percent is reached after 3 years, while after 21 years the GDP multiplier has fallen to 0.9 percent. The effects on nominal as well as real wages are at this level of unemployment slow, gradually rising to 1 percent after 16 years.

A permanent increase of 1 percent in the level of all exogenous import- and export prices brings in the long run nominal wages as well as consumer prices up by 1 percent as well. With the same baseline as described above, the process is slow, increasing nominal wages by 0.1 percent after a year and by 0.5 percent after 2 1/2 years. Within such a time span real consumption wages are reduced compared to base, while the opposite is the case in the longer term. GDP increases mainly due to increased net exports. The maximum impact of 0.3 percent is reached after 2 1/2 years, while after 8 years the GDP-effect is close to zero.

Appendix C

Linking the two models

Trade weights for the Norwegian economy are constructed by using data for exports and imports by country in value terms from the trade statistics, excluding oil and oil related products. Weights were calculated for the years 1973, 1983 and 1993 so that time trends could be investigated. Even though such trends were identified for some countries, we used the average weights for the three periods in our simulations. These are presented in table C1.

Table C1. Norwegian export and import weights, percent

Country	Exports, traditional goods[1]				Imports, all goods			
	1973	1983	1993	Average	1973	1983	1993	Average
Sweden	20.7	26.9	16.9	21.5	21.9	26.8	19.3	22.7
Denmark	11.4	9.5	8.7	9.9	8.1	7.7	10.3	8.7
Belgium	2.4	2.8	3.0	2.7	3.4	3.1	3.3	3.2
France	3.7	5.5	8.9	6.4	6.3	3.3	6.0	5.5
Italy	3.3	3.3	6.0	3.2	1.7	3.1	3.8	3.6
Netherlands	5.0	5.9	7.7	6.2	6.7	3.3	5.8	5.6
UK	26.2	17.6	17.0	20.3	13.0	12.5	12.4	12.6
Germany	16.4	16.6	19.0	17.3	17.6	17.6	18.1	17.8
Japan	1.9	2.7	3.9	3.1	9.7	6.6	6.5	7.6
USA	8.1	9.1	7.8	8.3	7.8	10.9	10.9	9.9
Canada	-	-	-	-	3.8	2.1	2.8	2.9
Sum	100.1	99.9	99.9	99.9	100.0	100.0	100.2	100.0

[1] Excluding crude oil, natural gas, ships and oil platforms.
Source: Calculations based on Statistics Norway (1973, 1983, 1993).

In forming aggregates for export markets and import prices, there is a problem that Sweden and Denmark, which are among the main trading partners of Norway, are not treated as separate countries in our version of the NIGEM-model. Sweden is included in the EFTA-aggregate which also includes Norway, while Denmark is part of the rest-of-EU group, consisting in addition of Ireland, Greece, Luxembourg and Portugal. Using these two aggregate groups as proxies for Sweden and Denmark are, however, not very satisfactory. Both groups include countries that are of little or no importance for Norwegian exports and the presence of Norway in the EFTA group also causes problems since the Norwegian economy differ from the remaining countries in this group.

On this background, we have chosen to increase the trade weight for Germany with the weights for Sweden and Denmark. The Danish economy is very strongly linked to the German, both through trade and interest rates, and the economic development of the two countries would normally be highly correlated. Sweden is not as closely linked to Germany, but both countries have much of the same industrial structure and both receives raw material input from important export sectors in Norway.

Bilateral dollar rates were calculated by using effective exchange rate weights, utilized for calculation of cost competitiveness in manufacturing. Since the NIGEM model does not include countries as Austria, Finland, Sweden, Denmark and Switzerland, the weights for these countries were added to the German weight. The countries with largest weight are then Germany (45.2 percent), United Kingdom (14.7 percent), the US (11 percent) and France (9.2) percent.

ECU-inflation was calculated by using ECU weights, with some modifications. The weight for Denmark is included in the German weight and we have excluded three countries (Ireland, Greece and Portugal) of minor importance. These countries are neither included separately in the NIGEM model. The weight for Germany is then 33.8 percent, for France 19.9 percent, for Britain 13 percent, around 10 percent for Italy, the Netherlands and Belgium and 5.5 percent for Spain.

Appendix D

Effects of OPEC II with no policy reactions in Norway: detailed results

Table D1. Effects of OPEC II on Norwegian economy - no policy reactions in Norway. Deviation between historical and counterfactual simulation with alternative oil prices. Figures in percent unless otherwise noted

	1979-93	1979-86	1987-93	1986	1993
Private consumption	-1.9	-1.7	-2.0	-3.7	-0.9
Government consumption	0.2	0.2	0.3	0.4	0.2
Gross fixed investments	-2.2	-2.2	-2.2	-5.5	1.5
Export	-2.2	-2.5	-1.9	-4.4	-0.7
Imports	-2.7	-2.8	-2.6	-5.0	-0.7
Gross domestic product	-1.4	-1.4	-1.3	-3.1	-0.2
-mainland Norway	-1.4	-1.3	-1.5	-3.1	-0.1
Employment	-0.3	-0.4	-0.1	-1.3	1.0
Labour supply	-0.3	-0.3	-0.3	-0.8	0.2
Unemployment rate[1]	0	0.2	-0.2	0.4	-0.7
Average borrowing rate[1]	0.5	0.7	0.2	1.1	0
Households' saving ratio[1]	0.2	0.3	0.2	1.5	-0.5
Households' real disposable income	-1.8	-1.6	-1.9	-2.6	-1.5
Hourly wage rate	-0,6	2.3	-2.4	0.5	-3.5
Consumer price index	2.5	4.0	1.4	4.0	0.3
Prices, dwellings	-4.7	-1.6	-7.2	-10.2	-1.6
Export prices, total	10.1	17.8	3.2	7.1	3.1
Export prices, traditional goods[2]	3.1	5.3	2.0	1.7	1.9
Import prices, traditional goods[2]	3.1	4.2	2.2	2.8	1.7
Budget balance/ GDP[1]	3.9	4.7	2.9	3.0	4.1
Current balance/ GDP[1]	5.7	7.3	3.8	5.8	3.4
Net public debt/ GDP[1]	-22.3	-14.0	-31.8	-29.2	-37.8
Net foreign debt/ GDP[1]	-35.2	-28.7	-42.5	-43.9	-51.7

[1] Percentage points deviation
[2] Excluding crude oil, natural gas, ships and oil platforms