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Abstract:
Oil price shocks have played a dominant role in the macroeconomic development of the world economy over the last twenty five years. In this paper a large, estimated, macro-economic world model with time varying trade weights, monetary and fiscal policy rules and explicit modelling of the behaviour of the OPEC countries is used for counterfactual analyses of oil price shocks. An alternative history with constant real oil prices is developed, showing that the recessions in the OECD area in 1974/75 and in 1980 would have been milder without the preceding oil price hike, while the 1982 recession seems unrelated to oil prices. A separate simulation indicates that the oil price drop in 1985/86 prevented a small recession from developing. The paper also shows that macroeconomic oil price effects vary considerably between the US, Germany and Japan according to the degree of oil dependence, trade with OPEC and the working of domestic labour markets. In particular there are notable differences in inflationary effects in Germany and the US. Results are tested against alternative specifications of monetary and fiscal policy rules.

Keywords: Oil price shocks, Macro-economic model, Policy rules

JEL classification: Q43, E37, E61

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Address: Ray Barrell, National Institute of Economic and Social Research,
2 Dean Trench Street, Smith Square, London SW1P 3HE, UK.

Knut A. Magnussen, Statistics Norway, Research Department,
P.O.Box 8131 Dep., N-0033 Oslo, Norway. E-mail: kam@ssb.no

1. Introduction

The two oil price hikes in 1973/74 and 1979/80 were dramatic and were both followed by the most severe recessions since World War II. It is not surprising therefore that the economic literature on oil price shocks has found evidence for a negative correlation between the oil shocks and economic activity, see e.g. Hamilton (1983) for a study of the US and Burbidge and Harrison (1984) for an international comparison. The oil price shocks have also frequently been related to the high rates of inflation observed in the 1970s and early 1980s. On the other hand recessionary tendencies started before the oil shocks and inflationary pressures were evident already in the late 1960s, in particular in the US. It is therefore not clear to which extent the oil shocks contributed to the business cycle slowdown and to consumer price rises. According to Darby (1982), the breakdown of the Bretton Woods agreement and lifting of price controls were probably also important factors behind this development. Bohi (1991), using a supply side approach, also doubts the role of energy price shocks in contributing to the worldwide recessions in the 1970s.

Less attention has been paid to the oil price decline in 1985/86. A reason could be that oil dependence diminished during the early 1980s, thereby reducing the impact of the shock. It is also likely that less interest is paid to an incident that possibly stimulated economic growth than to shocks that induced recessions. The literature on asymmetric effects of oil price shocks offers another explanation. Decreases in the oil price are found not to have the perceptive stimulating effects given by reversing an oil price rise, see e.g. Mork et al. (1994) for a multi-country study. However, these results are not obvious for all countries involved, and are contradicted by other researchers, see e.g. Tatom (1988). With this in mind, we find it interesting from a business cycle point of view to study the 1985/86 shock as well, even though our approach precludes the possibility of adding particularly strong insights to the asymmetric issue.

It is difficult to analyse effects of large and permanent oil price hikes. The main channels through which an oil price shock is transmitted to domestic prices obviously must be captured. After a while substitution effects may occur, and such mechanisms should also be taken care of. Since oil price hikes imply a transfer of revenues to oil producing countries and these revenues will be spent after some time, a framework for taking the behaviour of oil producing countries into consideration is needed. Oil shocks will also, at least after a while, be met by policy measures that may vary over time and between regions, and such policy reactions should be taken into account. In this study, we aim at approaching these challenges by utilising a macroeconomic world model, which comprises OPEC as

well as the G7-countries. Our approach is similar in nature to the studies by OECD (1980) and IMF (1990), but differs for instance in that the model includes time-varying trade and oil import weights.

A counterfactual oil price scenario which eliminates all shocks over the relevant period is created by use of the model, assuming economic policies follow reaction rules specified for short term interest rates, taxes and exchange rates. The counterfactual baseline is of interest in itself as accumulated effects of the three oil price shocks can be evaluated. In particular we look at the business cycle and inflationary development in the OECD area in the absence of oil shocks. The oil price drop in 1985/86 is also studied separately, eliminating (potential) effects from the two former shocks. Furthermore, the counterfactual scenario is used as a base for permanent and transitory oil price shocks starting in 1973/74. In these (stylised) shocks we focus in particular on effects for the US, Japan and Germany, and implications of the chosen fiscal and monetary policy rules are also investigated.

The outline of the paper is as follows. In the next section we look at the actual oil price shocks and the macroeconomic situation in which they took place in some more detail. Policy reactions and oil dependence are also considered briefly. Section 3 reviews the outcome of two former world model analyses of oil price shocks, while section 4 presents the model, the counterfactual history and model based effects of oil price shocks. Finally section 5 concludes the paper.

2. Oil price shocks, the macroeconomic development and policy reactions

A natural point of departure for a counterfactual analysis is the history itself. Hence, we start our discussion by a brief review of the actual oil price developments in the 1970s and the 1980s. In addition we look at the macroeconomic environment in which the shocks took place, what policies were undertaken and the degree of oil dependence in major countries. For a more detailed discussion of business cycle conditions and policy responses to the two oil shocks in the 1970s, see e.g. Hutchison (1991).

By the time of the first oil price shock in late 1973, the real dollar price of crude oil had been declining slightly during a period of 20 years. Economic agents were therefore accustomed to a relatively stable oil price, and the large oil price rise was not anticipated. OPEC counted for about 85 percent of world exports of oil and the organisation was then (as it is now) dominated by Saudi Arabia. The huge market power of the cartel had, however, not been used actively as a means of

seeking to maximise a monopolistic profit for the member states. An upward pressure on prices was initiated by production cutbacks following the Yom Kippur war, starting in October 1973. From the 3rd. quarter of 1973 to the 4th. quarter of 1974, the crude oil price (the average of Arabian light and Brent Blend) increased from 2.8 to 10.3 dollar a barrel, a rise of almost 270 percent. After this sudden and rapid rise, the nominal oil price remained largely unchanged for almost the next five years. It seems, however, that this first shock marked a change of behaviour of the OPEC.

The second oil price shock was generated by uncertainties in the oil market due to the political situation in Iran in 1978. Subsequently the Iranian revolution and the Iran-Iraq war moved the price upwards. Decisions taken at the OPEC meeting in late 1978 contributed to a considerable rise in the oil price, albeit not as rapid and large as the 1973-shock. After Iranian exports ceased in the beginning of 1979, other OPEC-countries started raising their prices substantially to levels beyond the official limits of the cartel, and the agreed 14.5 percent increase was reached in March 1979, half a year earlier than had been planned. The official OPEC price was raised further at the OPEC meeting in June the same year and subsequently the price continued the upward trend until the spring of 1980. In total the average oil price moved from around 13 dollars at the end of 1978 to around 31 dollars in the 3rd. quarter of 1980, an increase of 140 percent. In other words a larger shock in dollar terms, but smaller in percentage terms than the one in 1973/74.

The market for crude oil was considerably affected by the development in the 1970s. Oil consumption was reduced by the high price level and production in non-OPEC countries increased due to higher profitability. OPEC countries reduced their production in order to maintain the high price level and cutbacks were mainly undertaken by Saudi Arabia, the «swing» producer. However, during the 4th. quarter of 1985, Saudi Arabia changed policy and increased production of oil substantially. The oil price inevitably reacted by a sharp fall; the crude price fell from 27 dollars per barrel in 4th. quarter 1985 to 11 dollars in 3rd. quarter of 1986. Then the price recovered somewhat to around 16 dollar, a level which the price fluctuated around the following three years.

All three oil price shocks were preceded by a period of strong growth in economic activity, more pronounced before the first than before the second and third shock. In 1970/71 monetary policy shifted to a highly stimulative stance, driven by US initially and propagated through the fixed exchange rate. This contributed to the most rapid upswing since the 1950s. In the first half of 1973, the G7-growth rate of GDP was as high as 8.5 percent. However, activity began to slow partly because of more contractionary monetary policies and a substantial slowdown of economic activity

took place in the months before the oil price rise. The oil price shock in 1979/80 also occurred when growth in the OECD area was apparently slowing down, but after a period of more moderate growth than in the situation preceding the 1973-shock. In 1985 output was again slowing down after a GDP-growth for total OECD of almost 5 percent the foregoing year.

Contrary to the similarities of the cyclical phases in which the shocks took place, other macroeconomic factors varied considerably between the shocks. There was a pronounced upturn in unemployment from 1973 to 1985; while the unemployment rate in the OECD area was 3.5 percent in 1973, the corresponding figures were 5.2 percent in 1979 and 8.0 percent in 1985 respectively. The upward trend in unemployment was dominated by European countries. Current account balances in OECD countries turned from being positive in 1973, to become negative in 1979 and 1985. Consumer prices rose by 7.8 percent in 1973 and inflation accelerated sharply after the first oil price shock. In 1978 inflation was back at the 1973 level, but after the second shock inflation took off once again. Early in the 1980s OECD-inflation was curbed more effectively than after the first oil shock and came down to 4.5 percent in 1985.

Oil price effects clearly depend on oil dependency, while on the other hand the use of oil is also affected by the price development. Oil dependency in the OECD area, measured as the use of oil equivalents relative to real GDP, declined somewhat from 1973 to 1979, see Fielike (1990). After the 1979/80 shock, the downward trend accelerated and in total oil dependence fell by 38 percent from 1973 to 1985. Over the same period, the total energy dependence declined by 21 percent, indicating a substantial substitution from oil products towards other sources of energy. Of the three countries concerned in this paper, the decline in oil dependence was more accentuated in Japan (a fall of around the OECD-average) than in the in the US and in Germany with a decline of 32.5 and 28 percent respectively. In the US the fall from 1973 to 1979 was considerable smaller than for the two other countries; 7 percent vs. 15-16 percent respectively. The dependence of total energy fell by the same amount as for oil in the US in this period, while substitution started in the early 1980s. In Germany and Japan, there were substitution effects already in the 1970s, according to the figures in Fielike (1990).

Policy reactions also vary between the oil shocks. Despite the difficulties in measuring discretionary fiscal actions, the common view seems to be that fiscal policies were more contractionary after the second than after the first shock for the major economies. While most countries seem to have stimulated activity in 1975, only Japan undertook expansionary discretionary actions in 1980/81, see

Shigehara (1982) for a discussion of the Japanese case. Monetary policy actions taken also seem to have been more decisive after the second than after the first oil price shock. Interest rates increased in most countries and were maintained at high levels for a longer period than after the first shock. For a more detailed discussion of policy response in the US and Germany, see Sachs (1982) and Lehment (1982).

3. Former world model analyses

As a point of reference we briefly review two former world model analyses, see OECD (1980) and IMF (1990). Differences in both the design of the shocks and the models make a comprehensive comparison somewhat difficult. The above studies also have a rather short horizon while we focus on the dynamic medium term development initiated by the shocks. Nevertheless, it is of importance to compare model based results with the outcome of fairly similar models analysing the same topic. In this section we consider assumptions and results of the two studies, while a comparison of main effects is undertaken in section 4.3.

In 1980 the OECD carried out an analysis of the possible impacts on the economies in the OECD area of the second oil price shock using the INTERLINK model, see OECD (1980). The crude oil price was assumed to remain unchanged in real terms after the mid-1970s, eliminating the price rise starting in 1979. Monetary policies were assumed to accommodate changes in nominal GNP without affecting real interest rates, while government wage expenditure, tax receipts and transfers were allowed to change endogenously. Exchange rates were assumed unchanged in nominal terms. Explicit «speed-limits» for OPEC import volume growth rates were imposed, such that OPEC import volumes were adjusted to incremental export receipts over more than two years. Arguments for restrictions on OPEC imports were e.g. limited port facilities and time needed for planning.

Results indicate that real GNP was reduced by 0.9 percent in 1979, by 3 percent in 1980 and by 1.5 percent in 1981 due to the oil price rise. The corresponding figures for the increase in the inflation rate were 1.6, 5 and 3.6 percent respectively. Total domestic demand was according to this analysis reduced by around half a percentage point more than GDP, implying an improvement of the real trade balance. The negative effect on imports was 2.9 percent a year, while exports decline by 1.4 percent, despite the effects of OPEC respending. However, the improvement in the real trade balance was outweighed by the terms-of-trade deterioration, leading to a reduction of the current account balance of 60 billion dollars in 1981 for the OECD area.

IMF used their world model, MULTIMOD, to simulate possible effects on the world economy of the temporary oil price rise following the Gulf war in 1990, see IMF (1990). The analysis, which was intended to be illustrative, investigated a 40 percent increase in the crude oil price from August 1990, representing an increase of 4 barrels in 1990 and 9 barrels in 1991. The model explicitly takes account of the effects on interest rates which will have to increase to maintain the money market equilibrium when real money balances decrease, while fiscal policies were not changed. The latter assumption can be justified by the highly temporary character of the shock.

Results for industrialised countries indicate a rise in inflation of 0.3 percent the first year and by 0.2 percent the second year. Short term interest rates increase by 0.75 percentage points in the second year, but the effects for long-term rates are smaller as the forward looking financial market expects a decline in short term rates after the initial shock. The terms of trade deterioration leads to a decline of real disposable income of 0.4 percent the first year and 0.7 percent the second year. The overall effect can be summarised by looking at the level of GDP which decreased by 0.2 percent the first year and by 0.3 percent the second year. The terms of trade loss contributed to a slight worsening of the current account for industrial countries in both years.

For developing countries, real GDP was found to increase by 0.2 percent the first year and the second year. The positive effect reflects the fact that a number of these countries are substantial net exporters of oil. The terms of trade improvement more than offsets negative effects of higher interest rates and lower demand from industrialised countries, and the current account improves slightly in both years.

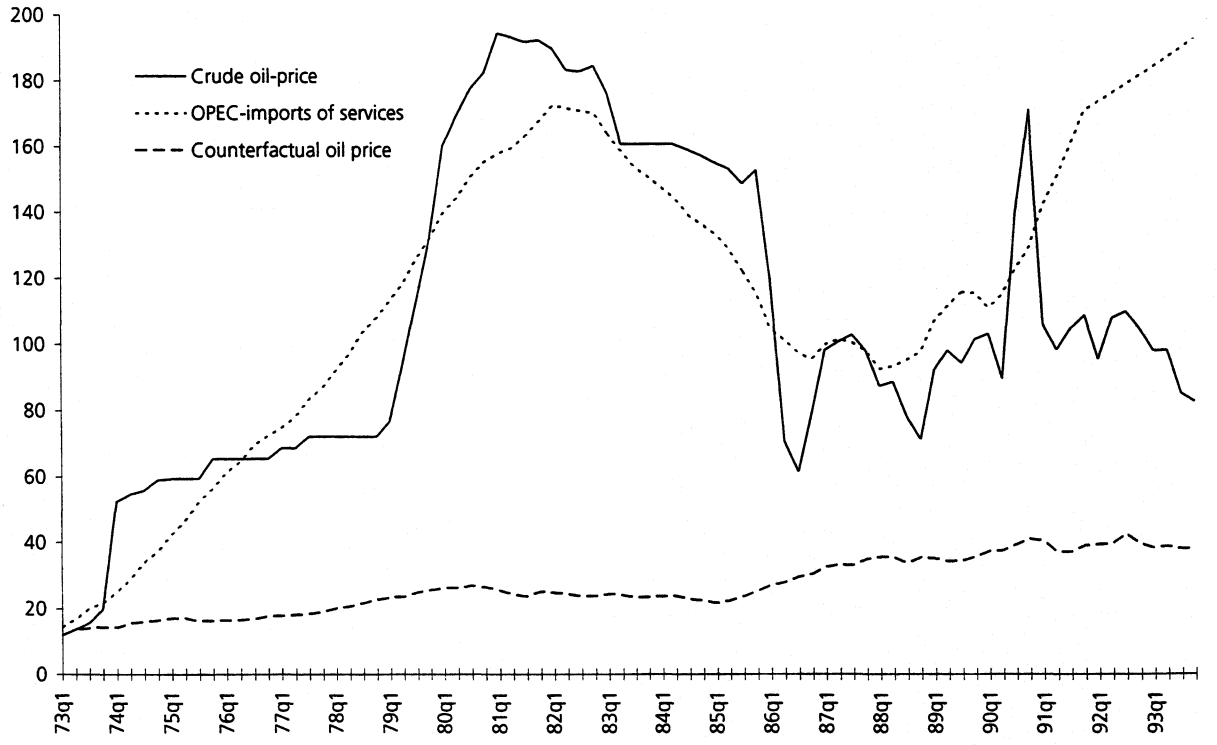
4. Simulation of oil price shocks

4.1. The model

This section gives a brief description of the NIGEM model which is used for simulations of the oil price shocks. NIGEM (National Institute Global Econometric Model) is a demand oriented, quarterly, macroeconometric model with fairly detailed specification of the major eight countries, smaller models for some other OECD-countries and trade modules for the remaining regions of the world. The model is based on one good and allows for some substitution out of labour when wages rise. A description of the structure of main equations of NIGEM is given in annex A, for a more detailed documentation of the model, see NIESR (1996).

The initial impact of a crude oil price rise in the model goes through higher import prices for OECD-countries and through higher export prices for oil producers, changing terms of trade in opposite directions. Trade prices feed into the domestic OECD economies through increased wholesale and consumer prices and nominal effects transmit to real variables in several ways, e.g. by reducing real income and wealth which decrease domestic demand and output. An important mechanism, also for medium term results, is the wage formation process, in particular to which extent real wages are rigid.

Chart 1. Crude oil price and OPEC imports of services (1987=100)



The analysis of oil price shocks brings into focus the behaviour of oil producers. The large change in the terms of trade gives oil producers significantly more revenue, and the impact of an oil price rise depends upon when they spend the revenues, what goods and services they buy, and from whom they buy. In earlier research on oil price shocks using the NIGEM model, see Barrell et al. (1990), it became clear that the specification of OPEC trade in both goods and services was important, and the model has been extended to take account of services trade in a more complete way. The OPEC countries export services to a rather limited extent, but they are major service importers, and their imports have varied with the real oil price, as can be seen from chart 1. In the model all service exports are driven by the demand for service imports from other countries, and hence a rise in OPEC service demand will raise exports from the major service providers. Data restrictions prevent us from being more specific about the recipients of extra expenditure, but we feel that it is safe to assume that the increase in spending is spread in proportion to shares in world service trade. It is also assumed that the OPEC countries (and other oil producers) target current balances, and hence spend increases in revenues slowly in the long run, see annex A for details of the specification.

Although it is clear that an increase in oil prices raises the demand for goods from outside the OECD, the pattern of demand will influence which countries benefit. Those with strong trade links with OPEC will benefit most. The pattern of exports to OPEC has changed over time, with countries such as Japan becoming less dependent on oil producers. It is important to take these changes into account and this is taken care of by implementing time varying trade weights into the model. Construction of the weights is based on observations for 1973, 1980, and 1987, and this information was utilised to calculate weights that best approximated the evolving historical pattern. The weights change in a trend like way, and they are not exactly consistent with the observed trade developments (except in the base year 1987). Technical details are contained in annex B. The volume of oil in imports is also important, as high oil importers will suffer a larger net loss of income. For countries where oil imports is separated from other imports, i.e. the US, Japan and the UK, this is taken account of by allowing the volume trade weights on oil imports to vary. For other countries, e.g. Germany, total imports (incl. oil) will be affected by the oil component of import prices, but oil weights do not vary over time. In the long run, there may be effects that we do not account for, as consumers substitute to less energy intensive products.

4.2 The Construction of an Alternative History

Undertaking counterfactual policy analysis when studying large and permanent shocks is particularly problematic. Actual history contains the reactions to the shocks we are considering, and we have to ensure that we model such reactions adequately. We could take actual history and strip off actual

events, and this procedure has been adopted in other historical counterfactuals, for instance in Barrell (1995). However, oil price shocks are particularly complex, and we prefer to construct an alternative history that is free of oil price shocks, and then analyse changes in the base scenario. We do this in part because the model does display asymmetric effects in some markets. Firstly, the response of the labour markets to shocks depend on the level of unemployment. Secondly, the effects of financial variables (long rates, equity prices etc.) depend upon asset holdings, and these depend upon history. Hence the effects of an oil price shock will be very dependent on the baseline used. The alternative history is interesting in its own right, and we discuss features of it below.

There are three important elements of our alternative; the assumption about oil prices, the setting of fiscal policy and the monetary regime in operation. Economic theory suggests that an exhaustible resource such as oil should rise in price over time, as the owners of the resource have the option to extract now, sell and invest elsewhere. Hence they should expect prices to be higher in future in order for them not to extract now. Indeed, real oil prices should rise by the amount of the real interest rate. However, we do not base the alternative history on this description of the oil market, but attempt to create a path where the real oil price stays at its 1973 3rd. quarter level throughout. The resulting alternative path for the nominal crude oil price is compared to the actual in chart 1.

The inflation rate and the level of prices are initially connected to the policy actions of the authorities. If the monetary authorities decide to maintain a given price target in the face of a supply generated inflationary shock then they may well cause output to fall. Hence, an alternative history without a supply shock has to consider the possible path for monetary policy. In this paper we assume that authorities use interest rates to target the money supply in the long run. The base target trajectory is the same as actual history, but the evolution of prices is much smoother than the observed price development, in part because we have removed supply side shocks, but also because our policy rule ensures that the authorities do not move rapidly. The rule is based on the long-run solution to 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. In the 1970s, nominal GDP in the US and Japan is essentially unchanged by the shock, and hence interest rates are around base, see chart 2. In the 1980s, there are positive interest rate effects in these countries. Throughout the simulation period German nominal GDP is below the base, largely because there is more real inertia in German than US and Japanese labour and product markets.

The long run stance of fiscal policy and the evolution of the public debt can be seen as determined by a government driven optimisation process, spreading the cost of investment and insurance across generations. Hence we can see no good reason for assuming that the government debt stock (in percent of GDP) desired in 1973 for 1993 should be affected by supply shocks. Accordingly we implement a deficit and debt targeting rule along the lines of that implemented on the IMF model, MULTIMOD. The rule can be written:

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

where T = tax payments, personal sector

PI = nominal personal income

PGDP = GDP-deflator

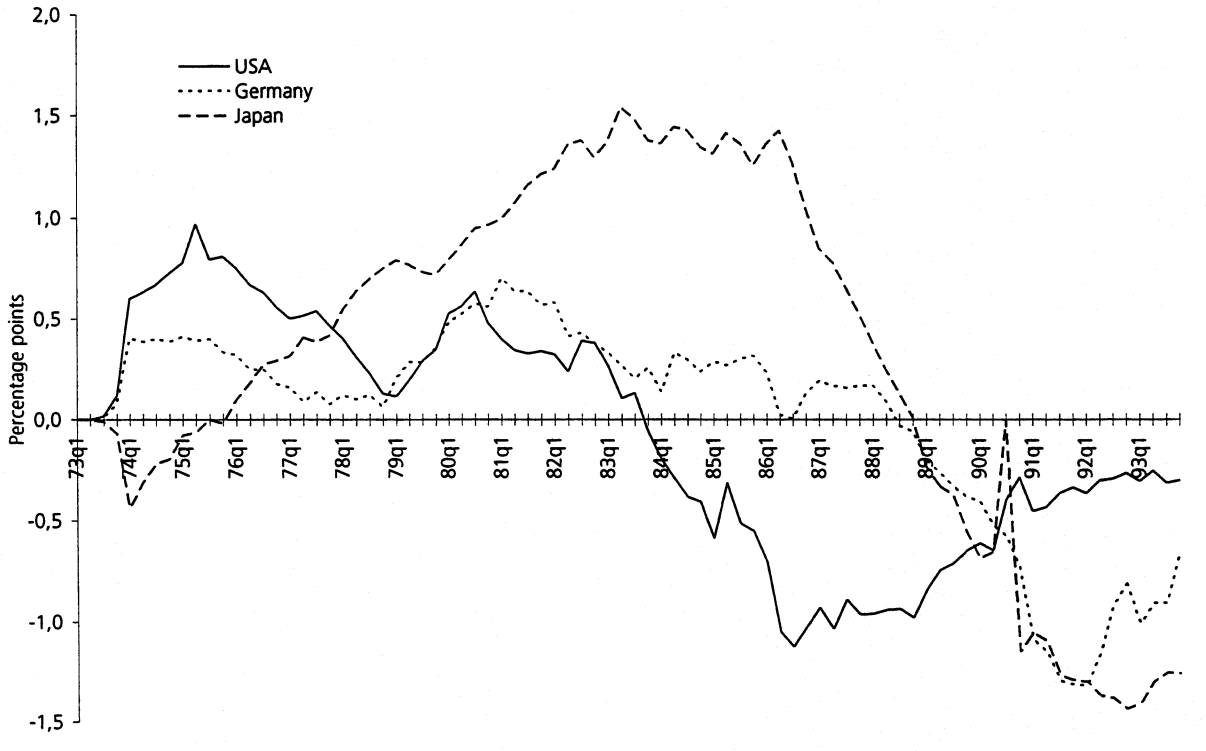
GB = government budget surplus, relative to nominal GDP

^{T} indicates base trajectory (target)

The 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 target1. Chart 2 shows deviations between actual and counterfactual history surpluses for the major economies. Budget balances are improved for all three countries in the beginning, but the effect turns negative in 1984 for the US and in 1989 for Japan and Germany. Overall the budget changes are small, maintaining the fiscal stance broadly unchanged for all three countries.

As section 4.3 below makes clear, if we do not utilise a fiscal solvency rule, but rather assume that tax rates are kept constant, then the oil price shock would have been accompanied by a significant, and potentially insolvent, fiscal expansion. To avoid this problem and to analyse the effects of oil price shocks alone, the solvency rule proves useful.

Chart 2. Alternative vs. actual history: Government budget surplus, percent of GDP



1 The solvency rule and its role in the model is more fully discussed in Barrell and Sefton (1996).

The model can be used with rational, model consistent, expectations in financial and labour markets, and for many pieces of policy analysis we think that it is sensible to utilise these options. However, we have not done so in the construction of our counterfactual history. To do so when stripping off the oil price rises in the 1970s would be tantamount to assuming that the future path of oil prices was fully anticipated in 1973. According to section 2, we do not think that it was, and hence we have assumed that reactions in goods and labour markets are more evolutionary, and that expectations of the future depend in part on recent history. Concerning exchange rates we have assumed that the real rates vs. US dollar are fixed. i.e. that nominal exchange rates depend on the price development in each country.

Chart 3 plots annual growth for output in the OECD under our alternative history, and compares it to actual history. It is clear that the oil shock deepened the 1974/75 recession to some extent, but that there would clearly have been a recession also without the oil price shock. There are relatively long lasting effects from the first oil price shock: growth rates are reduced in the period 1974 to 1981. However, the recession in 1982, after the second oil shock, appears to involve other factors. Even if we remove the effects of the oil price, there is hardly any a change in OECD output growth in the period 1982 to 1986, suggesting that other effects were reducing potential output in much of the OECD at this time. These effects may have been supply or demand shocks. According to chart 4, the GDP trend was altered by the first oil shock, but not by the second. Even if we remove the effects of oil on output, there is still a change in trend, indicating that the effects dominating after the second oil shock were supply oriented[2]. The effects of the negative oil shock in 1985/86 seem to be more in line with those occurring in the 1970s, with opposite signs, see chart 3. However, as effects of the former shocks accumulate and may have influenced the development also in the late 1980s, we will treat this shock separately below.

Chart 5 plots the actual and counterfactual paths for consumer price inflation in our scenarios, and it is clear that inflation in the OECD as a whole was higher as a result of the oil price shocks in the 1970s, while the 1985/86 shock helped bringing inflation down in the late 1980s. The inflationary effects of the oil shocks in the 1970s are, however, not very pronounced and this is an interesting result, despite the fact that inflationary pressures started earlier than the first oil shock. This results should also be seen in the light of the monetary assumptions that we use in the construction of our alternative history, implying a gradual monetary response.

[2] By using a VAR-approach to identify demand, supply and oil-price shocks, Bjørnland (1996) shows that demand shocks were dominating in the US in 1982, while supply shocks also played an important role in Germany in the same period.

Chart 3. Alternative and actual history: GDP, OECD

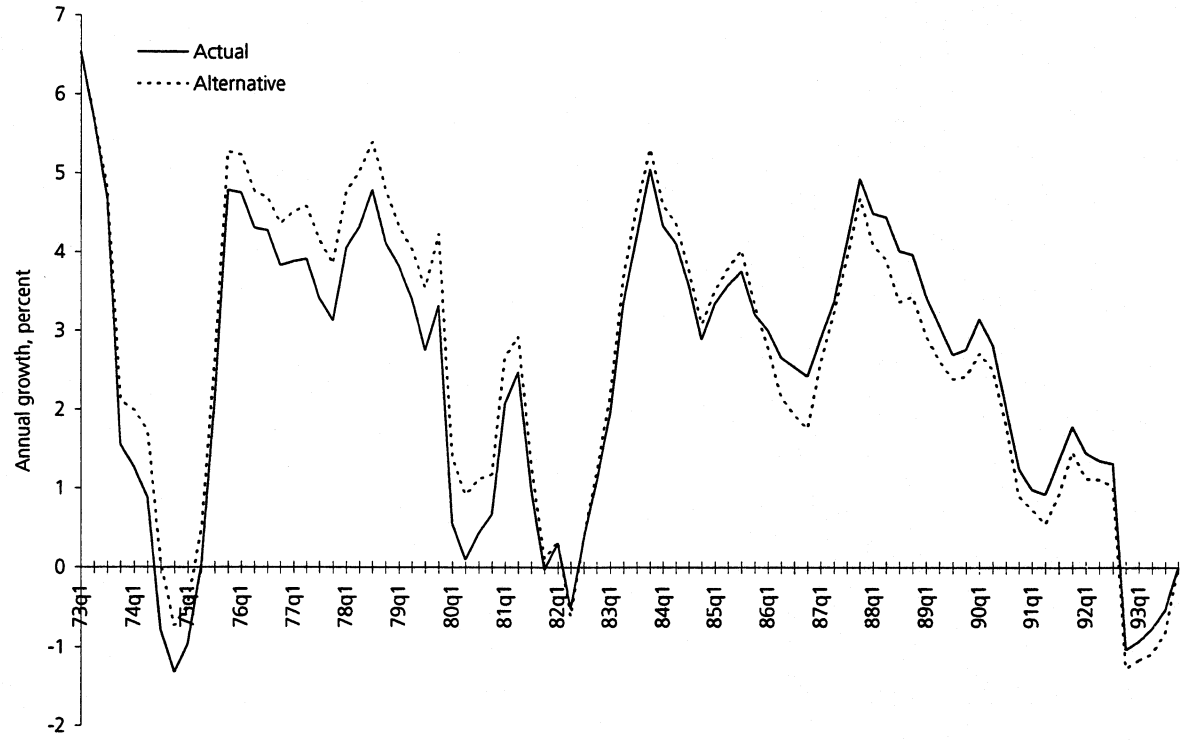


Chart 4. Alternative and actual history: GDP: OECD

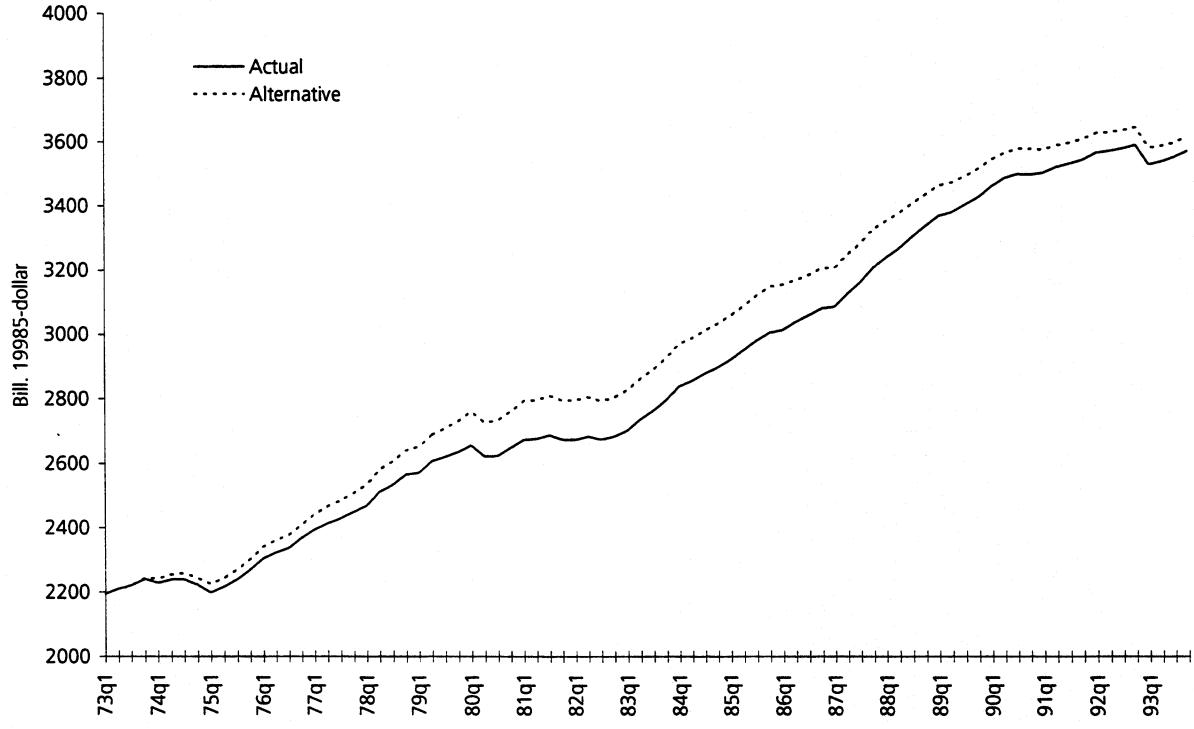
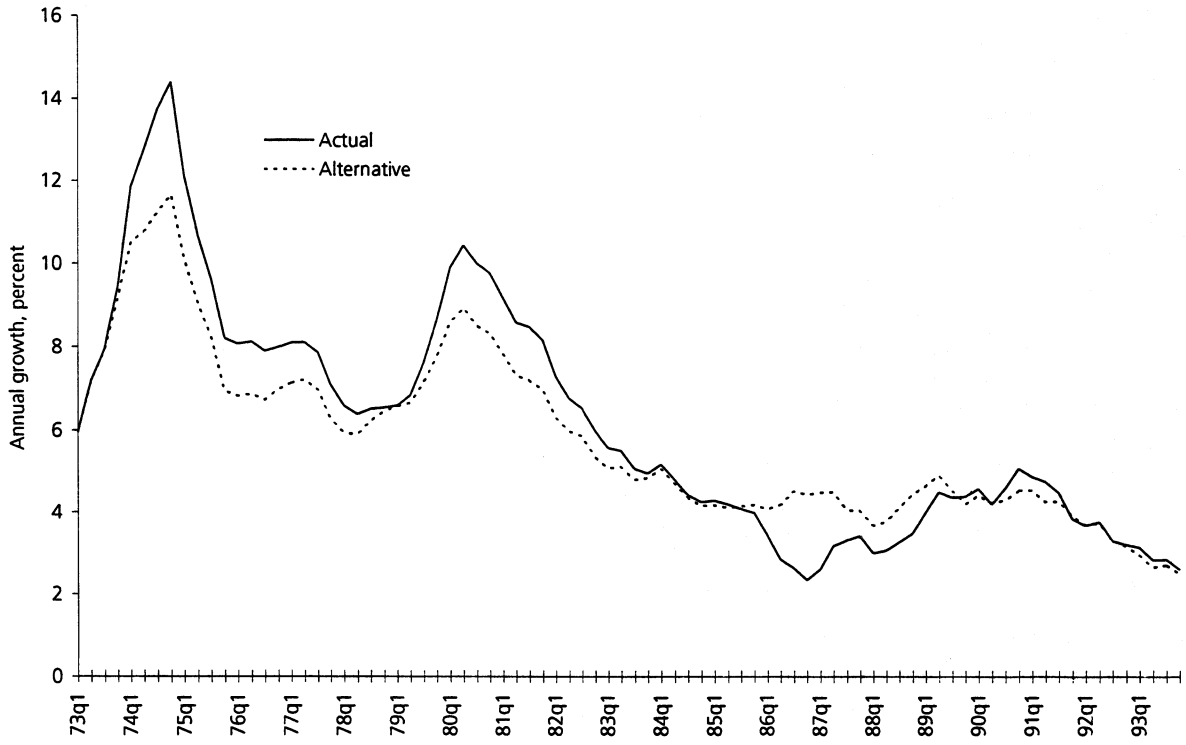


Chart 5. Alternative and actual history: Consumer ecpenditure deflator, OECD

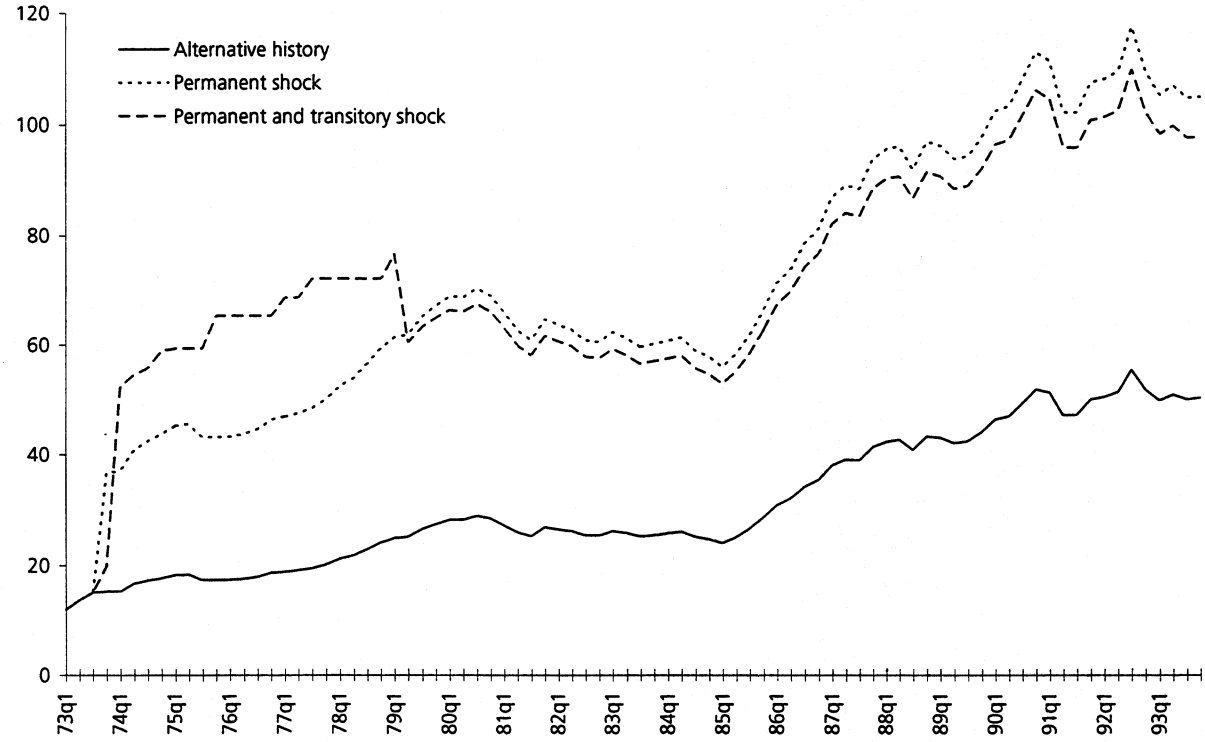


4.3 Permanent and Transitory Oil Price Shocks

A commonly used approach for analysing a single oil price shock counterfactually is to maintain the (nominal) price level at the time the shock occurs and simulate for some periods with the constant price level, see e.g. OECD (1980) and IMF (1990). Simulated results can then be compared with historical data. This approach is in line with our (counterfactual) treatment of the 1985/86 shock where the history serves as a base. However, in order to create stylised versions of the 1973/74 shock, we use the alternative history as our base, and study permanent and transitory increases in the oil price.

A notion often adopted for the analysis of time-series, is to differentiate between transitory and permanent shocks. Since the oil price development in the period 1973-93 seems to be closely connected to middle-east wars, one should expect that most shocks were found to be temporary. This view coincides with the results in Green et al. (1993), who study the oil price development over the last 130 years. According to this outlier-based time-series analysis, only a few shocks should be regarded as permanent over this period. The only one in the period we consider is the 1973/74 shock. More precisely, this price jump was found to be a coincidence of a temporary and a permanent shock, almost equal in size. The permanent shock can be associated with the change of behaviour of the OPEC cartel mentioned in section 2 of this paper.

Chart 6. Permanent and transitory shocks. Crude oil price (1987=100)



In one (stylised) shock we raise the crude oil price by 140 percent in 1973 (i.e. around half the actual price rise), which is the size of the permanent shock according to Green et al. (1993). The price is then kept roughly constant, in real terms, for the rest of the simulation period. Alternatively we also impose a temporary shock on top of the permanent one, see chart 6. The total increase is almost equal to the actual shock in 1973/74, but is only lasting for five years.

A permanent 140 percent increase in real oil prices

In our first scenario oil prices rise by 140 percent, and stay above our baseline permanently. Monetary and fiscal policies are the same as for construction of the alternative history, see section 4.2. The effects on output for the OECD as a whole are noticeable and the effects vary across countries, see table 1 and 2. In the US and Germany, the consumer price effects are very similar the first five years even if the price mechanisms are different; the initial import price effect is larger in the US, but the impact from import prices to wholesale prices is larger in Germany. The oil price rise gives a considerably smaller increase in consumer prices for Japan, despite a high degree of net oil imports.

Despite the equal price effect for the US and Germany until 1975, domestic demand is reduced more in the US. This highlights the role of domestic labour markets; there is a higher degree of real wage

inertia in Germany than in the US3. Real wages are flexible also in Japan, but since price effects are smaller in this country than in the US, output effects in the US is considerably stronger than in both the two other countries. This effect is strengthened by the export development; the US gains less than the two other countries by OPEC respending on services, which is due to the appreciation of the dollar. Domestic demand falls by more than output in all countries, with a wedge settling down at around half a percent of GDP, reflecting the net transfer of resources to foreign residents that follows from a change in the terms of trade. This effect is particularly notable in Germany.

Along with the reduction in output, unemployment increases rapidly in the US in the 1970s and reaches a maximum around 1.6 percent above base in 1980, see chart 7. During the 1980s unemployment is reduced again, but the process is slow. However, the strong rise in unemployment plays an important role in reducing inflation and consumer price effects essentially disappear after 10 years. The increase in unemployment (in absolute terms) is rather similar for Japan and Germany, implying a larger relative effect in Japan where the unemployment rate historically has been very low. However, for a given rise in unemployment, the downward pressure on wages is higher in Japan than in Germany which contribute to explain the persistency in consumer price effects in the latter country.

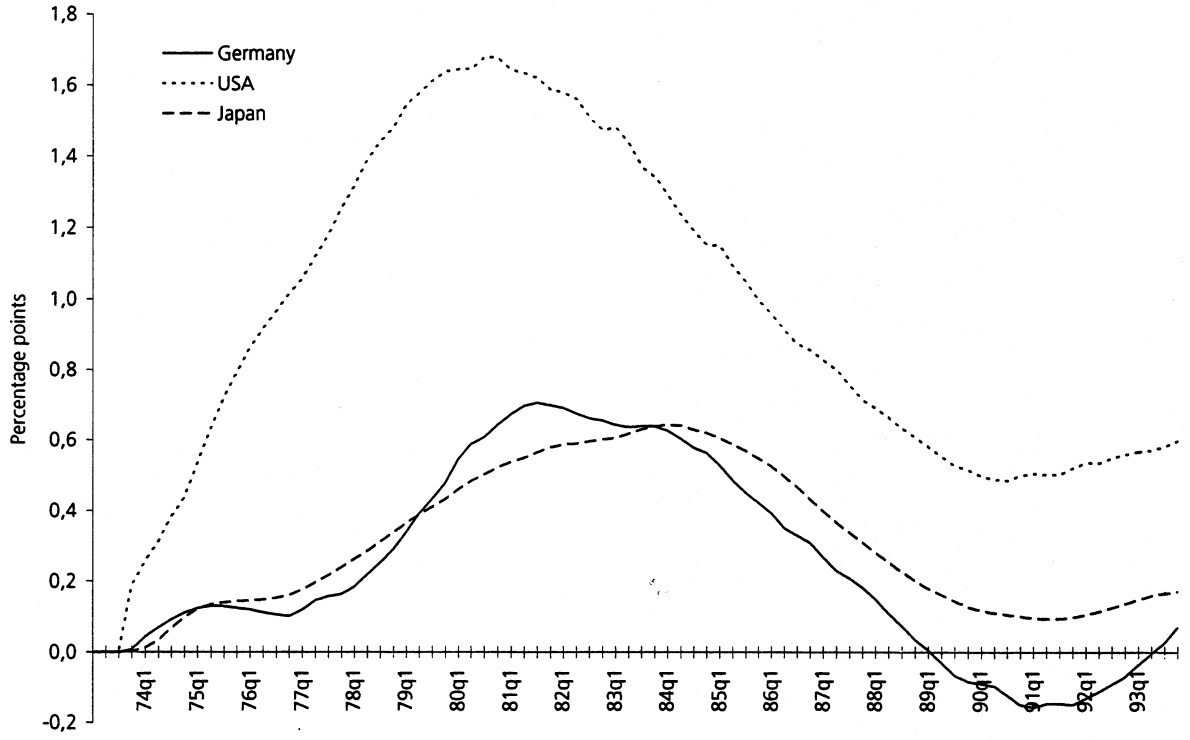
Table 1. Cumulative effects of a permanent 140 percent oil price shock starting in 1973q4

Year	USA			Japan			Germany		
	GDP[1]	DD[2]	CED[3]	GDP	DD	CED	GDP	DD	CED
1973	-0.2	-0.2	0.3	0.0	0.0	0.0	-0.1	-0.1	0.3
1974	-1.6	-1.9	2.4	-0.5	-0.5	1.0	-0.7	-0.9	2.1
1975	-2.6	-3.1	3.1	-0.4	-0.9	1.4	-0.9	-1.4	2.9
1976	-3.3	-3.9	3.4	-0.5	-1.2	1.4	-0.9	-1.8	3.3
1977	-3.9	-4.6	3.6	-0.7	-1.4	1.2	-1.1	-2.2	3.6
1978	-4.5	-5.2	3.3	-1.0	-1.5	1.0	-1.4	-2.6	3.8
1979	-4.9	-5.6	2.7	-1.2	-1.6	0.6	-1.8	-3.0	3.9
1980	-5.1	-5.7	2.1	-1.3	-1.6	0.0	-2.1	-3.3	4.0
1981	-4.9	-5.5	1.3	-1.2	-1.5	-0.6	-2.2	-3.6	3.9
1982	-4.8	-5.3	0.5	-1.1	-1.4	-1.1	-2.2	-3.6	3.9

[1]Gross Domestic Product [2]Domestic Demand [3]Consumer Expenditure Deflator

[3] Note, however, that flexible wages contribute to increase unemployment effects in this (demand oriented) model. Seen from the supply side, one may argue that flexible wages are necessary to prevent unemployment from increasing, see e.g. Bohi (1991).

Chart 7. Effects of a permanent oil price shock: Unemployment rate



Overall, the OECD current account in percent of GDP deteriorates, and that of OPEC (in percent of exports) improves, but eventually revenues are spent, and both move back to the base trajectory, see charts 8 and 9. There is some overshooting in this process. Assets build up in OPEC immediately, but it take some time before the revenues from oil begin to be spent. This slow process of the disbursement of revenues, which inevitably mirrors events in the world, imparts a ten year cycle to demand, and hence the effects of the shock reverberate for some years.

Compared to OECD (1980), in which a shock of similar size (140 percent) is analysed, the output effects for the OECD-area in our simulation are of the same in size the first year, but considerably smaller the second and third year, see table 2. Even after five years, the NIGEM effects are less than half the INTERLINK effects after three years. The effects on consumer prices are almost the same in the two studies the first year, but again the second and third year effects deviate considerably, the cumulative effect after three years being three times as high as in our simulation. The large discrepancies do not seem to stem from differences in effects of OPEC respending as the wedge between domestic demand and output is relatively similar to the effects in table 1. The larger increase in domestic demand is probably connected to wage formation. Since the INTERLINK model from the late 1970s must have been based on data from that decade, affecting the modelling of prices and wages.

Chart 8. Effects of oil price shocks: Current account balance, OECD. Percent of GDP

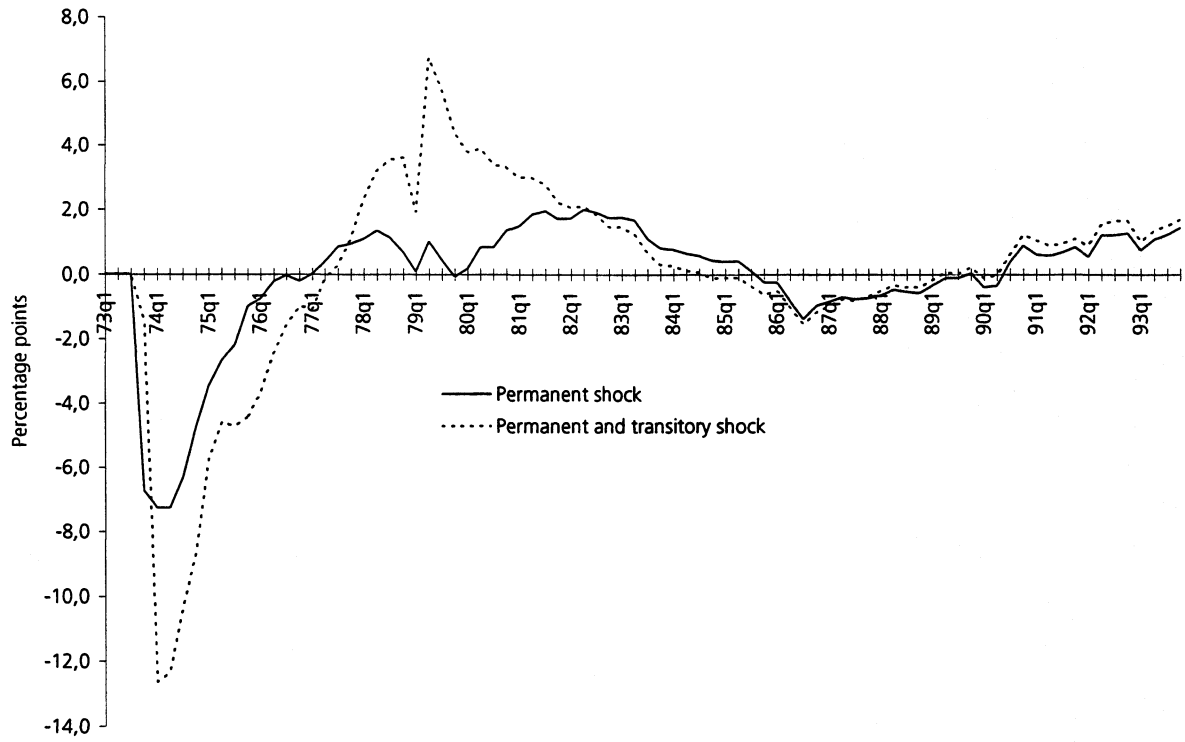
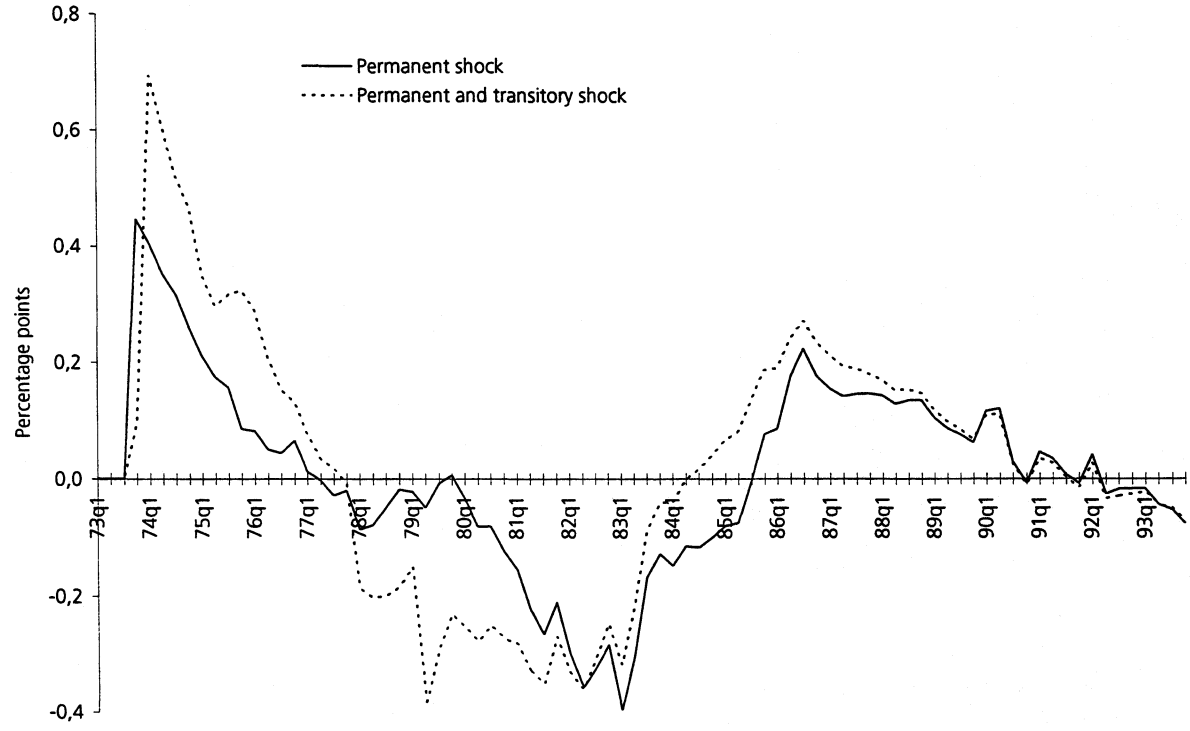


Chart 9. Effects of oil price shocks: Current account balance, OPEC. Percent of export



The oil price shock in IMF (1990) amounts to 40 percent and we have multiplied effects by 3.5 to make them comparable to our and OECD's 140 percent shocks4. It turns out that the GDP effects in the NIGEM and MULTIMOD simulations are similar the first year, while the effects in the latter study is somewhat stronger the second year, see table 2. On the other hand, consumer price effects are smaller in the IMF study. In general it seems that the IMF results are more in line with our results than what is the case for the OECD study. The fact that this study was undertaken in 1990, suggests that the wage formation process embedded in the model is more similar to that of NIGEM than what was probably the case with the INTERLINK model, which at that time was relatively Keynesian with a poorly specified supply side and no policy rules. It is hard to explain the observed deviations from results and assumptions only, they cannot e.g. be traced back to the use of a solvency rule in our simulation as this rule increases GDP-effects and hardly change inflation effects in the short run5.

Table 2. Cumulative effects of oil price shocks for OECD. GDP/GNP and Consumer prices.

NIGEM, GDP		INTERLINK, GNP		MULTIMOD, GDP	
1974	-0.7	1979	-0.9	1990	-0.7
1975	-1.0	1980	-3.8	1991	-1.8
1976	-1.3	1981	-5.4		
1977	-1.7				
1978	-2.1				
NIGEM, Consumer prices		INTERLINK, Consumer prices		MULTIMOD, Consumer prices	
1974	1.7	1979	1.6	1990	1.1
1975	2.5	1980	6.6	1991	1.8
1976	2.9	1981	10.2		
1977	3.2				
1978	3.3				

A permanent and a transitory shock

Our second scenario looks at the effect of a combination of shocks. The first oil shock is decomposed into a transitory component that last only five years, and a permanent component, as described in the previous section. The initial oil price shock is larger, and hence the impact on output is greater, but the relative effects between the three countries are much the same as in table 2. As can be seen from table 3,

[4] Note that this is only a valid transformation if the model is linear, and results should therefore be interpreted somewhat cautiously.

[5] With country specific effects available for the INTERLINK and MULTIMOD studies it would probably have been easier to detect causes for the different results.

US output is some six percent below the base after five years, around 1.5 percentage points more than it would have been without the transitory component of the shock. The external wedge (the difference between the changes in output and domestic demand) is correspondingly greater as more resources have to be transferred to non-OECD residents. The effects on prices are also larger in the short run, but the decline in inflation is accelerated in the early 1980s by the removal of the transitory component of the initial shock.

The removal of the transitory component increases the cyclical effect of the oil price shock. As can be seen from charts 8 and 9, the effects on OECD and OPEC balances are initially greater with this shock, and just as the excess assets held by OPEC are being disbursed there is a sharp deterioration in the current account, pushing OPEC into a larger deficit. The effects on the cycle can be seen by comparing output in this and the previous analysis.

Table 3. Cumulative effects of a permanent and a transitory oil price shock starting in 1973q4.

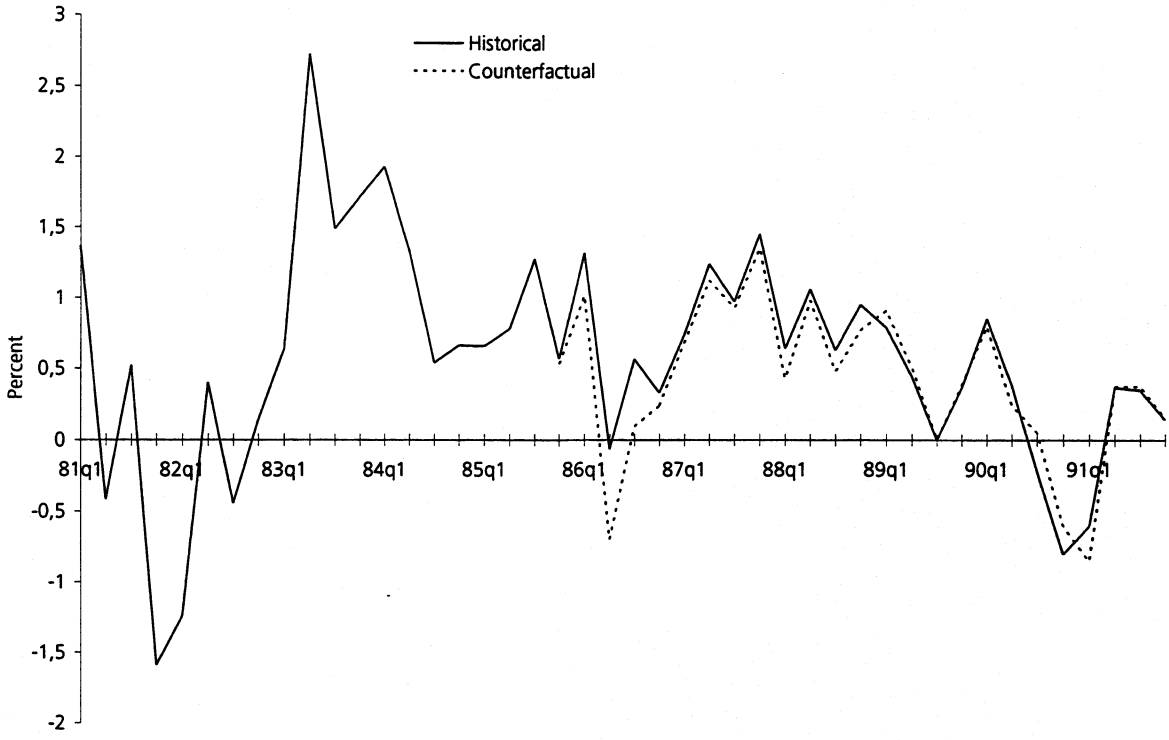
Year	USA			Japan			Germany		
	GDP[1]	DD[2]	CED[3]	GDP	DD	CED	GDP	DD	CED
1973	-0.1	-0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
1974	-1.8	-2.2	3.0	-0.6	-0.6	1.0	-0.7	-1.0	2.5
1975	-3.4	-4.0	4.2	-0.6	-1.2	1.9	-1.0	-1.7	3.9
1976	-4.5	-5.3	4.9	-0.5	-1.8	2.1	-1.0	-2.3	4.9
1977	-5.4	-6.4	5.2	-0.9	-2.2	2.0	-1.2	-3.0	5.6
1978	-6.1	-7.0	4.5	-1.3	-2.4	1.8	-1.5	-3.5	5.9
1979	-6.2	-7.0	3.0	-1.5	-2.4	0.9	-2.1	-4.0	5.7
1980	-5.9	-6.6	1.6	-1.7	-2.3	-0.2	-2.7	-4.4	5.3
1981	-5.4	-6.0	0.5	-1.6	-2.0	-1.1	-3.0	-4.7	5.1
1982	-5.0	-5.5	-0.5	-1.5	-1.7	-1.9	-3.1	-4.7	4.8

[1] Gross Domestic Product. [2] Domestic Demand. [3] Consumer Expenditure Deflator.

Not allowing the 1985/86 shock to happen

The effects of oil price shocks depend in part on the nature of the conjuncture when they occur, as is clear from our discussion above. We thought it useful to construct another alternative history in order to analyse the effects of the fall in the oil price in 1985/86. This analysis involves taking actual history to 1985 and then keeping the real oil price fairly constant thereafter.

Chart 10. GDP, USA. Historical and counterfactual. Quarterly growth rates



If oil prices had not fallen in 1985/86 the emerging deflationary pressures would have accumulated, and as can be seen from chart 10, output growth would have been considerably lower in the US in 1986. Even if it would not have been a recession in American terms (i.e. two consecutive quarters with fall in GDP), a business cycle downturn would certainly have occurred in 1986, periodically placed in the middle of the recessions in the early 1980s and the early 1990s. The growth rates from the 2nd. to 4th. quarter of 1986 are -0.7, 0.1 and 0.2 respectively in the simulated trajectory. For the OECD-area GDP-growth in 1986 is reduced from 2.9 to 1.8 percent according to our results, i.e. below the potential (or average) growth rate.

The oil price fall may also have raised the strength of the cycle observed at the end of the decade. The fall in the oil price reduced current balances for OPEC in the short run. However, OPEC countries reacted slowly to the loss of revenue, and hence their demand for imports (of goods and services) fell gradually. As the OECD economies reached a cyclical peak in 1989, OPEC imports were at low levels, and were still falling, contributing to the strength of the downturn.

The importance of alternative policy rules

In order to gauge the importance of the policy rules utilised in the above simulations we undertook two further analyses. In the first we repeated our 140 percent permanent shock but assumed that the authorities targeted the real interest rate rather than the money balances. The initial interest rate response to the rise in oil prices is much more marked, as can be seen from chart 11, and the initial impact on output is therefore also larger while the initial effects on prices are smaller. In the long run, the effects on output and prices are quite similar in the two cases, as can be seen by comparing table 1 and table 4. However, the slower evolution described by money targeting seems a more reasonable approximation to actual events following the first oil shock. In particular this applies to Japan where the price level is reduced with real interest rate targeting.

Table 4. Cumulative effects of a permanent 140 percent oil price shock starting in 1973q4. Real interest rate targeting.

Year	USA			Japan			Germany		
	GDP[1]	R3M[2]	CED[3]	GDP	R3M	CED	GDP	R3M	CED
1973	-0.2	1.7	0.4	0.0	0.0	0.0	-0.1	1.2	0.3
1974	-3.3	0.5	2.0	-1.2	1.2	0.9	-2.0	1.4	2.0
1975	-3.4	-0.1	1.8	-1.3	-0.6	0.7	-2.4	0.0	2.3
1976	-3.7	0.2	1.9	-0.9	-0.7	0.1	-2.2	-0.1	2.3
1977	-4.3	0.1	2.1	-0.7	-0.4	0.4	-2.0	-0.1	2.1
1978	-4.6	-0.5	1.8	-0.7	-0.1	-0.6	-1.6	-0.1	2.0
1979	-4.6	-0.3	1.5	-0.8	-0.2	-0.7	-1.3	0.1	2.0
1980	-4.7	-0.4	1.2	-0.9	-0.4	-1.1	-1.1	0.2	2.2
1981	-4.4	-0.4	0.8	-0.9	-0.4	-0.8	-2.0	0.3	2.4
1982	-4.3	-0.4	0.5	-0.9	-0.5	-1.7	-1.0	0.4	2.7

[1] Gross Domestic Product [2] Short term interest rate [3] Consumer Expenditure Deflator

The impact of the solvency rule can be judged from a comparison of table 5 and table 1. We took our 140 percent oil price shock, kept monetary targeting in place, but assumed that tax rates (and not the deficits) were constant. This resulted in a significantly more expansionary fiscal policy in all countries with large and persistent inflationary effects in both the US and Germany. Note also that inflationary effects are almost similar for the two countries, even in the long run. Government debt stocks rise by more than 40 percent in the US and by more than 15 percent in Germany and Japan after 20 years (see table 5). In both cases it seems that the debt stock is on an unsustainable course and fiscal policy would have to be changed. As financial markets monitor these aggregates, risk premia and financial crises could develop if debt stocks are not stabilised. Hence our preference for analyses using a solvency rule.

Table 5. Cumulative effects of a permanent 140 percent oil price shock starting in 1973q4. No fiscal solvency rule.

Year	USA			Japan			Germany		
	GDP[1]	DEBT[2]	CED[3]	GDP	DEBT	CED	GDP	DEBT	CED
1973	-0.2	0.1	0.4	0.0	0.2	0.0	-0.1	0.1	0.3
1974	-1.5	1.3	2.5	-0.5	-0.2	1.0	-0.6	1.1	2.2
1975	-2.2	3.4	3.3	-0.4	-0.6	1.4	-0.6	2.9	3.0
1976	-2.5	3.4	3.9	-1.2	-0.5	1.3	-0.5	4.5	3.8
1977	-2.8	5.9	4.7	-0.6	0.2	1.3	-0.5	5.8	3.8
1978	-3.2	8.8	5.2	-0.8	0.8	1.2	-0.7	7.0	4.3
1979	-3.3	12.2	5.3	-1.0	1.6	0.9	-1.0	8.3	4.7
1980	-3.4	15.6	5.6	-1.0	2.7	0.5	-1.3	9.7	5.1
1981	-3.2	19.8	5.7	-0.9	3.9	0.1	-1.3	11.1	5.3
1982	-2.9	23.6	5.9	-0.8	5.2	-0.3	-1.1	12.5	5.7
1987	-1.5	33.7	6.9	-0.2	10.9	-1.0	-1.3	19.4	8.1
1992	-0.8	41.2	9.1	-0.7	17.5	-1.2	-1.2	18.0	11.1

[1] Gross Domestic Product [2] Government debt [3] Consumer Expenditure Deflator

5. Concluding remarks

Undertaking counterfactual model based analyses poses several questions to the researcher, e.g. how will policies change, are the counterfactual scenarios reasonable etc. In this paper we have gone some way in identifying effects of oil price shocks. In doing so we rely on policy rules making interest rates, exchange rates and fiscal policies (tax rates) endogenous. Whether these policy rules would have been followed in absence of (or in response to) oil shocks we cannot know, but we argue that they give reasonable results. In addition, the use of rules for government policies is favourable in that results do not depend on arbitrary, discretionary policy assumptions imposed by the researcher. On the other hand, it is important to show effects of the rules: we have done this by presenting results of using two sets of monetary and fiscal policy options.

With our preferred policy rules, an alternative history with constant real oil prices from 1974 shows that the first and the second oil price shock added to recessionary tendencies, while there seems to have been other supply shocks contributing to the stagnation in 1982. In 1985/86, however, the oil price drop prevented a small recession from developing and contributed to the long lasting economic upswing in industrial countries throughout the 1980s. Our alternative history also shows that the oil

Our analysis of a permanent oil shock starting in the 4th. quarter of 1973 shows interesting differences between the US, Japan and Germany as regard macroeconomic effects. Consumer price effects are considerably smaller in Japan than in the two other countries, due to the closed nature of the economy and hence a lower degree of feed through from import prices to the domestic economy. Hence, output effects are small in Japan, despite a high degree real wage flexibility. For Germany and the US, consumer price effects are remarkably similar in the short run. However, real wage inertia gives a weaker reduction in output and employment for the US than for Germany. In the long run, the most important result is that consumer price effects are reversed in the US (with fiscal solvency imposed), due to the large rise in unemployment, and in Japan because of the stronger effect from unemployment to wage formation. In Germany, consumer price effects are more persistent.

A critical factor for historical simulations is that structures of the economies change over time, and we have taken this into account by letting trade weights and oil imports (for some countries) vary. However, other structures may also have changed. In particular our comparison with a former study by the OECD indicates that wage formation is such a candidate, and wage effects are essential to our results. If changes have evolved gradually over time, they may be hard to detect by testing for structural breaks. Wage and employment equations which are estimated over the simulation period would then represent some average of the actual development. In addition wage formation itself may also have been affected by the oil price shocks. In further work, one should aim at taking such effects into consideration.

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Annex A. A description of main equations in the model

This annex describes main equations in the model. We focus on variables that are important for long run solutions, and the equations are written in generic form. Explanations of variable names are given successively, adding unexplained variables only. For country specific details about coefficients, short term variables etc., see NIESR (1996).

A1. G7-countries

Export price, goods: PXG = pxg(CPX, P, RX)

PXG = Export price for goods, USD terms

CPX = Competitive price

P = Wholesale price (domestic)

RX = Dollar exchange rates for domestic currency

Import price, goods: PMG = pmg[PXG (other countries), WDPi, RX]

PMG = Import price for goods, domestic currency

WDPi = World market prices, e.g. WDPO, the crude oil price

Wholesale prices: P = p(PM, ULT, CU, WDPO)

ULT = Unit trend labour costs (manufacturing)

CU = Capacity utilisation

Consumer prices: CED = ced(PM, P and/or ULT, ITR)

CED = Consumer price deflator

ITR = Indirect taxes

Wages: W = w(Z, U, CED)

W = Wage rate

Z = Labour productivity

U = Unemployment

Employment: EE = e(GDP, W/CED)

EE = Employees in employment

Private consumption: C = c(RPDI, RW, R3M, ΔCED)

RPDI = Household real disposable income

RW = Net financial wealth

R3M = Short term interest rate

Housing investment: IH = ih(RPDI, R3M)

Business investment: IB = ib(GDP, LR)

GDP = Gross Domestic Product

LR = Long term interest rates

Exports of goods: XG = xg(S, PX/CPX or ULT/CPX)

S = Export market growth

Exports of services, value: XSV = xsv(WDS, RCED)

WDS = Rest of the world demand for services

RCED = Real effective exchange rates in terms of consumer prices

Imports of goods: MG = mg(TFE, PM/P), less oil for Japan and the US

TFE = Total final demand

Imports of oil: MO = mo(TFE, WDPO/P), applies to the US and Japan

Imports of services, value: MSV = msv(GDP, RCED)

GDP: GDP = C + IH + IB + G + DS + XG + XSV/CED - MG - MO - MSV/CED

G = Government consumption and investment

DS = Change of stocks

Current account balance (in USD values):

CBV = PXG·XG + XSV - PMG·RX·MG - MSV - PMG·RX·MO + IPDC - IPDD

IPDC = Interest, profits and dividends, credits

IPDD = Interest, profits and dividends, debits

A2. OPEC

Exports of services, value: OPXSV = opxsv(WDMS)

WDMS = World demand for services

Import of services, value: OPMSV = opmsv(OPMGV)

OPMGV = Imports of goods, value

Net asset accumulation: OPNA = [RWNA - WNA(-1)] - OPCBV(-1) - MDCBV(-1)

RWNA = Rest of the world's net assets

OPCBV = OPEC current account balance

MDCBV = Current account balance, Miscellaneous developing countries

Interest, profits and dividends, debits: OPIPDD = opipdd(WDPO)

Interest, profits and dividends, credits: OPIPDC = opipdc(OPNA, OPCBV)

Current account balance (in USD):

OPCBV = OPXV - OPMV + OPXSV - OPMSV + OPIPDD + OIPDPC + OPIVA

OPXV = Exports of goods6, value

OPMV = Imports of goods, value

OPIVA = Net transfers to abroad

Annex B. The contruction of time varying trade weights

Trade flow matrices for the 20 countries/blocks included in the model were constructed for 1973, 1980, and 1987 and this information was utilised to calculate trade weights which vary over time. The calculated weights develop according to an exponential function and change in a trend like way. If a representative weight is denoted α, we have:

(B2.1) $\alpha_t = \beta_{87q4} \cdot \exp[\gamma \cdot (t - T)]$

where β_{87q4} is the weight in the 4.th quarter og 1987, γ is a parameter and T is the base quarter (1987q4). Accordingly, weights are not exactly consistent with observed trade developments except

[6] Export and import equations for OPEC are similar to those of the G7-countries and are not reported.

in 4.th quarter of 1987. If γ is positive, the share will grow over time, while a negative exponent causes the trade share to fall. The weights are constrained to always sum to one by determining the weight for the largest competitor partner residually.

The way weights are constructed might cause problems if they were used for projections a long way into the future, but they serve the purpose of estimating the actual trade development over a historical period. Weights comprise the following variables for the major countries:

Import prices; weights on other countries/blocks export prices
Export markets; weights on imports in foreign countries/blocks
Effective exchange rates: weights on other countries/blocks exchange rates
Relative export prices; weights on foreign countries/blocks export prices

Table B2.1. Examples of time varying trade weights

	1973q1	1980q1	1987q4	1993q4
US import prices[1]				
- Canadian export price	0.375	0.327	0.283	0.252
- German export price	0.124	0.117	0.110	0.105
German exports markets[2]				
- Import into US	0.084	0.089	0.095	0.100
- Import into France	0.130	0.125	0.121	0.117
- Import into OPEC	0.033	0.030	0.027	0.025
US effective exchange rate[3]				
- Japanese yen	0.190	0.226	0.270	0.313
- German mark	0.185	0.133	0.094	0.071
German relative export prices[4]				
- US export prices	0.145	0.129	0.114	0.104
- Japanese export prices	0.064	0.085	0.114	0.146
- French export prices	0.131	0.125	0.118	0.113
- UK export prices	0.110	0.109	0.108	0.107

[1] Weights for Japanese export price are determined residually
[2] Weights for imports from EFTA are determined residually
[3] Weights for Canadian dollar are determined residually
[4] Weights for EFTA export prices are determined residually

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Statistics Norway
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Tel.: + 47 - 22 86 45 00
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