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BUSINESS CYCLES AND OIL PRICE FLUCTUATIONS: SOME EVIDENCE FOR SIX OECD COUNTRIES

by

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ABSTRACT

The correlations between oil-price movements and GNP/GDP fluctuations are investigated for the United States, Canada, West Germany, Japan, the United Kingdom, and Norway. Asymmetric responses to price increases and decreases are allowed for. Univariate correlations as well as partial correlations within a reduced-form macroeconomic model are considered. The clearest correlations are found for the United States, which also shows evidence of asymmetric responses. West Germany, Canada, and Norway show significant univariate, but not multivariate, correlations with oil price increases. The U.K. correlations are insignificant, and Japan shows no sign of correlation.

1. Introduction.

The disruptions in the world oil market during the 1970s and the subsequent business-cycle fluctuations set off a round of research on the macroeconomic effects of such price shocks. Theoretical explanations for the link between changes in oil prices and fluctuations in the overall economic activity level were presented (see e.g. Phelps (1978)), and a number of simulation studies were carried out (Pierce and Enzler (1974), Gordon (1975) and Mork and Hall (1980)). Empirical investigations of the relationship have also been undertaken by Darby (1982), Hamilton (1983), Burbridge and Harrison (1984) and Gisser and Goodwin (1986). For an oil importing country both theory and data point to a negative correlation between increases in petroleum prices and the overall activity level. According to Hamilton (1983), there were thus clear tendencies of stagnation in the US economy occuring 1/2 - 1 year after the two oil embargoes in the 1970s, as well as earlier in the postwar period. Similar impacts from the oil price shocks are estimated for other countries (Burbridge and Harrison (1984)).

During the winter of 1986, crude oil prices fell to an extent that rivaled the increases of the seventies. The findings in the literature mentioned above predicted that such a jump downward in prices would stimulate economic activity in oil importing economies. However, so far few signs of such positive effects on GDP has been observed in the OECD area. This experience raises two questions; (1) whether the correlations observed by Hamilton and others were spurious, in other words whether oil prices affect business cycles at all, and (2), if there is an effect, whether it is asymmetric. The asymmetry hypothesis , which says that the growth stimulus from an oil price decrease will not match the positive impacts triggered by an increase in prices is implied by Hamilton's (1988) model and has been tested by Loungani (1986) and Davis (1987). However, to some extent these studies had little power, because, at the time they were done, no substantial oil price declines had yet taken place. The turnaround in the oil market in 1986 thus provides us with a unique opportunity of examining the issue of asymmetry.

Using data through 1988:2 Mork (1988) finds significant evidence of asymmetric effects from oil price fluctuations in GDP growth in the United States. Mork obtains his results within the context of a vector autoregressive (VAR) model similar to Sims (1980) and Hamilton (1983). The present paper extends this type of approach to include Canada, West Germany, Japan, United Kingdom and Norway in addition to United States. A main objective of the analysis is to test for asymmetric effects of price changes in the various countries. By an intercountry comparison one may be able to focus e.g. on how the macroeconomic effects of price shocks depend on the relative dependence of oil import in the economy. Two countries - Norway and the United Kingdom - have experienced significant adjustments in their industrial structure, as they have moved from being oil importers to significant net exporters of crude oil. Testing the correlation between oil prices and GDP for these countries may thus shed further light on the question of asymmetric effects of price fluctuations.

2. Oil price fluctuations and macroeconomic performance: a brief synopsis of the theory.

From economic theory a number of channels and elements can be identified via which oil price changes may affect the economy's overall activity level. Obviously, a detailed discussion of the economic consequences of changes in oil prices will depend on the assumed "model" for the functioning of the economy. In particular, the time horizon of the analysis will be decisive for the extent at which the economy is able to adapt to changes in relative prices. For instance, in the very short run a jump upwards in the oil price will have immediate effects on the trade balance. In the longer run, this event will trigger some sort of adjustment in economic behaviour, either self-correcting by private agents or in terms of specific efforts taken by public authorities. By structural changes and adjustments to new relative prices, economic agents are able to reduce the loss of income caused by a worsening of the terms of trade. This may consist both of pure substitution responses and acceleration or changes in the rate of technical change. Expectations of the future development in oil prices are important for these responses; if a price change is believed to be "permanent", actions to tighten a gap and avoid imbalances may be taken immediately. - In this paper, focus is on the short to medium term effects of oil price changes, i.e. on business cycles. This means that we ignore long term growth effects via capital accumulation and technical change[1].

The effects of changes in oil prices on business cycles have been explored thoroughly in the literature, see e.g the references cited in the introduction. The main arguments in these studies are as follows: First, in a one-sector model of an oil importing country, oil can be treated as a "third" factor in an aggregate production function of the economy (capital is fixed in the short run). When the price of oil increases, this motivates substitution away from energy and material inputs (which will have increased their prices through increased commodity prices) and to a reduction in the supply of products. Unless labour and energy are not very close substitutes, the increased energy costs will also imply a negative shift in the marginal product of labour. These supply side effects occur whether wages are flexible or not. In an equilibrium model, the effect on actual employment depends on the elasticity of labour supply. Wage rigidity also may cause a fraction of the labour force to be "involuntarily" unemployed.

Furthermore, oil price shocks also affect the economy through aggregate demand effects. Unless other prices move sufficiently to offset the effect of increased energy prices, oil price fluctuations affect the overall price level, thus producing a real balance effect. This would add to the negative correlation between oil prices and the economic activity, either directly affecting consumption demand or indirectly limiting activity through the money market.

A third explanation of the postulated negative correlation points to the transfers of income between countries that takes

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[1] For this reason, the constancy of the coefficients in our model should be viewed as an approximation. The validity of this approximation may be questioned when we use data stretching over a time period of several decades.

place when oil prices go up. Oil producers have their incomes increased while consuming countries suffer from a reduction of terms of trade. If oil producers have smaller propensities to consume than have oil importing economies, one may see a general contraction in international trade and aggregate demand. The same argument can be augmented to include domestic income transfers as well if it can be assumed that domestic oil producers have relatively low propensities to spend (Horwich and Weimer (1984)).

3. Asymmetry in price responses.

So far, we have referred to the events in the 1970s and the more sluggish growth in oil importing countries resulting from increases in oil prices. Immediately, one would suggest that all the effects mentioned above are symmetric, in the sense that oil price declines should move real output by the same force as price increases, only in the opposite direction. Moreover, the effects following a price change should go in opposite directions for oil importers and exporters, respectively. However, as mentioned in the introduction so far there is little sign of an upswing in economic activity in oil importing countries after the shift in the oil market in 1985/1986. The postulated theoretical explanations arising from the events in the 1970s therefore need to be supplemented.

Clearly, a one-sector model for the economy bears severe shortcomings when discussing the effects on the economy of oil price changes. Various sectors have different energy intensities, and will therefore be affected differently by price changes. Moreover, some countries have important domestic oil industries. The heterogeneity between sectors and problems created by reallocation of factors of production as an explanation of asymmetry in oil price responses has been discussed recently by Hamilton (1988), Davis (1987), and Mork (1988). The essential argument is that in the short run, a sudden and significant change in relative prices may create structural imbalances in the economy and produce a negative drag on the activity level whatever is the direction of the price change. Parts of the labour force and capital stock may be unemployed, and thus the aggregate output of the economy is reduced, at least for some period. For an oil importer, these problems of idle capacities will strengthen the negative effects of a price increase discussed above. However, when the price falls, there will be forces working in different directions: terms of trade are improved, but the positive stimulus from this may, at least in the short run, be offset by various types of frictions and costs of reallocation between sectors. The total effect on GDP then becomes ambiguous[2].

An example of reallocation problems triggered by an oil price shock may be the development in the United States after prices went down. As a result, the US oil industry had to cut back on activity and employment in order to survive, as did state and local governments in oil-producing areas. At the same time, the struggling airline industry got an important relief from high fuel costs, and the automobile industry saw the prospect of a return to a trend of more and larger cars. However, to have capital and labour reallocated between sectors takes time and involves costs of adjustment. When relative prices move gradually, this may occur without too much disturbances. But when the economy is hit by dramatic price changes it is likely to run into bottlenecks of various kinds. Labour may e.g. be specialized for specific tasks, structural unemployment may arise, investments are irreversible or cannot be moved without frictions etc. Such imbalances will, at least temporarily, reduce the aggregate output of the economy.

For a net oil <u>exporting</u> country, a priori one would expect the effects on the economy from a price increase to be inverted compared to the impacts for a net importing country. Initially, a net exporter experience an improvement the terms of trade. If the increased incomes are absorbed in the economy, either directly affecting private behaviour or via a more expansionary economic policy, this creates a positive stimulus on the overall activity level. Calculations discussing the effects of price changes on the Norwegian economy (a significant net exporter of oil) are presented in Longva, Olsen and Strøm (1988).

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[2] As mentioned above, in the longer run an economy should be able to <u>benefit</u> from reallocation of resources.

Due to problems of reallocations there may be tendencies towards asymmetric effects between oil importers and oil exporters. For an oil exporting country, various kinds of frictions and misallocation of resources may dampen the positive stimulus on the activity level stemming from an increase in the oil price. These effects are closely related to the phenomena discussed in the literature under the name of "dutch disease", i.e. problems that may occur in an economy that has become dependent on incomes from petroleum activities (see e.g. Wijnbergen (1984)). A recent example of a country that may be said to be struck by "dutch disease" is Norway. For this country, as for United Kingdom - the other large North Sea producer - the two oil embargoes in the 1970s created a big boom both in the offshore - and supply industries. As a result of the absorption of the increased incomes in the economy there was a strong increase in the demand for sheltered goods and services in Norway and a contraction in traditional exposed sectors. When now prices have turned around again a persistent problem is that the development may be very difficult to reverse. The industrial structure, capital stocks and the labour market are adjusted to high energy prices, and a restructuring of the economy to the new situation may take time and be costly to the society. The impacts on the Norwegian economy of a significant fall in oil prices are discussed in Berger, Cappelen, Knudsen and Roland (1987).

Another aspect that may be important in explaining asymmetric effects of price changes on the economy (and which may be part of the "story" discussed above) is the <u>economic policy</u> that accompanies a sudden change in oil prices. Following the dramatic increases in oil prices during the 1970s was a growing problem of inflation felt by many OECD countries. As a consequence, economic policy was more restrictive, and many economies went into the trap of "stagflation". Even if some adjustments in government policy certainly were necessary in oil importing countries, a general fear of inflation and lack of coordinative efforts in pursuing more expansionary policies probably played significant roles on their own in the years after the oil price shocks. There are good reasons to believe that economic policy is <u>asymmetric</u> in this respect, so that when prices decline this is not met by any "inflationary" policy in oil importing countries of the same magnitude as what was observed in e.g. Germany and the United Kingdom after prices jumped upwards in the 1970s.

Related to the question of how economic policy is influenced by an oil price shock is the aspect of uncertainty. Strong fluctuations in oil prices may imply increased uncertainty. This may have negative consequences on activity levels both in private businesses and through a more restrictive economic policy. The experiences from the price shocks during the last two decades will probably influence expectations for a long time to come.

4. Model, methodology and data.

From a theoretical point of view, it could be argued that the most preferable procedure for analyzing the effects on business cycles of oil price shocks is to utilize a complete, structural model of how the economy works. However, the literature does not single out one particular model for empirical testing, and the task of including all relevant elements and mechanisms in one framework is insuperable. Instead, we have chosen to specify a reduced form model, and to use empirical formulations that can provide useful information under a wide variety of circumstances. This was the philosophy underlying Hamilton's (1983) study of the oil price - GNP growth relationship in the US economy, using Sim's (1980) vector-autoregressive (VAR) model. Hamilton estimated a single reduced-form equation for GDP growth and applied univariate causality tests for examining the significance of oil price fluctuations. In the same tradition, Burbridge and Harrison (1984) estimated a complete VAR model, i.e. explaining also the change in the nominal price level, while the analysis of Mork (1988) was based on a single (VAR) GDP-growth equation. Both the latter studies focused specifically on the oil price as explanatory variable.

In this paper, we follow the approach of Hamilton and Mork and specify a reduced form regression model for GDP growth. Since our allowance for asymmetric responses introduces a nonlinearity in the model, it cannot be inverted by standard methods even if we had estimated reduced-form equations for all of the variables. Thus, in this sense, our model is not a true VAR model or even an equation from one; however, we do interpret our equation as a reduced-form model of GDP/GNP fluctuations.

Regarding the effects of the oil price on GDP, we carry out univariate tests as well as tests based on a more fully specified model. However, our model needs to be modified relative to that of Hamilton (1983) in order to accommodate our testing of asymmetry effects. The simple correlations are interesting because these estimates can be interpreted as the "total" effects of oil price changes, after policy and other domestic or international responses to the oil price change have affected real growth indirectly. On the other hand, in the multiple regressions the oil price coefficient is indicative of the "partial" effects of oil price changes. It is quite possible that the partial effects are negligible even if the simple correlations are non-zero. This could happen, for example, if oil price fluctuations have no real aggregate effects by themselves, but give rise to anti-inflationary policy measures with real economic impacts. Another example would be if a country does not experience real effects in a direct sense, but is significantly affected by trade with other countries. - It should be emphasized that the definition of "total" and "partial" effects are ambiguous, as they obviously depend on the specific model utilized. In Longva, Olsen and Strøm (1988) the concepts of total and partial energy price elasticities are defined and discussed within a disaggregated general equilibrium model, and estimates of energy price effects for the Norwegian economy are presented.

Our basic model is specified as follows. The data used are quarterly, and the variable on the left hand side of the VAR equation is, in each case, the country's real GDP growth rate. On the right hand side we always include a fourth-quarter distributed lag of real GDP growth. In addition, in each model version we specify four lags of the appropriate oil price variable, to be discussed in some detail below. For the univariate models this completes the variable list. The multivariate VAR equations include the following additional variables[3]:

- a short term interest rate variable
- the rate of change in real wages
- the unemployment rate
- the inflation rate
- the overall index of industrial production in the OECD area.

The latter variable was included by Burbridge and Harrison as a proxy for the interdependence between countries via foreign trade. Except for the unemployment rate and the interest rate all variables were included in the regressions with their yearly growth rates, calculated as 400 times the log change of the respective quarterly figures.

The main data source for the present study has been the OECD Main Economic Indicators (MEI). For Norway, we have utilized GDP figures from the Quarterly National Accounts, and information of unemployment is collected from a specific survey (AKU). Moreover, for this country no short term interest rate was listed in MEI, and an interest rate on long term bonds was then substituted for this variable[4]. Both unemployment rates and GDP figures for all the countries were adjusted for seasonal variations. - The starting dates for the available data series vary from series to series and from country to country. We decided to use the same estimation period for all countries, which, considering the lags and first-difference specification, limited our estimation period to 1967:2 - 1988:2. More detailed information on the data is given in Appendix 1.

4.1 Oil price variables.

The construction of a relevant oil price variable is very important in this kind of analysis. In our view, some of the

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[3] In some preliminary runs we also included the growth rate in import prices as an independent variable. However, to some extent international interactions were already represented by the index for OECD. When we in addition experienced insignificant coefficients for the import price variable, we decided to exclude this variable from the final version.

[4] Note that interest rates in Norway were subject to regulation in a large part of the observation period.

literature cited earlier has not given this enough attention. Different price concepts for oil exist, some are relevant for consumers, others for producers, and there are also differences between countries due to fluctuations in currencies, taxes and price controls. In Burbridge and Harrison (1984), the dollar world price of crude oil was used in the regressions for all countries. This price may be a good indicator of world market disturbances, but bear significant weaknesses as a measure of domestic costs and revenues, if taxes, subsidies, price controls or exchange rate fluctuations put wedges between the dollar crude price and the price paid or received by domestic consumers and producers. The price control schemes in the United States and Canada, the high and varying taxes on petroleum products in Europe, and the violent fluctuations in exchange rates since 1972 all are important examples of such wedges[5]. On this background, we considered the choice of oil price variable carefully for each country. The choices were based partly on a priori arguments and partly on empirical correlations undertaken. Obviously, this procedure biases our results somewhat in the direction of finding such a correlation.

For the United States, the alternatives were the world price of crude oil, measured as the spot price of "Arabian Light"[6], the US Producer Price Index (PPI) for crude oil, the PPI for petroleum products, and the PPI for crude oil corrected for price controls as constructed by Mork (1988). The latter index represents a chaining of the PPI for crude oil with the Refiner Acquisition Cost (RAC) (composite for imported and domestic oil), for which data are available since the early 1970s. Following Mork (1988), we decided that the latter price index is preferable to the unmodified PPI. Furthermore, we considered the world market crude price to be unsuitable, since United States had been sheltered from the world market by price controls during the

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5 For a study of the development of real prices of crude oil and petroleum products in OECD countries, see Huntington (1984).

6 Until the fourth quarter 1978, official sales prices ("posted prices") are used. Thereafter, spot prices are utilized as a better indicator for the market value of crude oil.

1970s. On a theoretical basis, the PPI for products should carry additional information as a cost indicator for oil consuming industries and households. Empirically however, there are a very close correlation between product prices and the combined PPI/RAC index. As a rather arbitrary choice between these two, we decided to use Mork's modified producer price series in our regressions for United States.

For Canada, Germany and Japan the choices were limited to the world oil price (in US dollar or converted to local currencies). For Germany and Japan the logical choice on a priori grounds was the PPI for petroleum products, since these countries import all their demanded oil. The situation for Canada is quite different, since this country has a significant domestic oil industry. In the same way as for the United States, one should then expect the PPI price for products to represent prices paid by consuming agents in the market, and the world price of crude to be the price received by the producers. However, the Canadian price policies may have caused considerable deviations between the world market price and the prices actually received by domestic producers. This may explain why we obtained a very weak correlation between changes in the world crude price and economic activity for Canada. We therefore decided to include the PPI price for products for Canada as well.

United Kingdom and Norway have undergone dramatic changes in economic structure during the observation period, as they have switched from being net importers of oil to being significant exporters. Our model specification for these countries should allow these transitions to be reflected in the estimation results. Since oil producers in the United Kingdom and Norway have been free to sell their oil at the world price, our data series for the world price of crude, converted into local currencies, should be a good indicator of the marginal revenue to crude oil producers. After the North Sea production having become substantial, one should expect a positive correlation between oil price fluctuations and changes in GDP. As for other countries, the domestic PPI for products should reflect the marginal price of oil in oil consuming activities.

After having experimented with quite a large number of different specifications for the United Kingdom and Norway, we settled on a model with three oil price variables included. In addition to the product price index, we also introduced two variables for the world price of crude in local currency, distinguished by that they take on zero values for the period before/after each country became net exporter of crude oil.

4.2 Measures of asymmetry in price responses.

So far, we have surpassed the question of how to specify the oil price variable in the regression models so that we are able to test for asymmetric effects of price fluctuations on economic growth. In the literature, various methods have been utilized. Loungani (1986) and Davis (1987) faced this problem by adding the squares of the lag changes in the price of oil in the equation to be estimated. Another possible solution is to undertake tests for structural changes between periods with mostly price increases and periods with falling prices. In this paper, we follow Mork (1988) in specifying price increases and price decreases as separate variables and estimating separate coefficients independently of each other[7].

More precisely, the above mentioned specification was used in the econometric models for United States, Canada, Germany and Japan. For the two net exporters of oil in our sample, United Kingdom and Norway, no distinction between variables for "price increases" and "price decreases" was made. The reason is that for these countries we had already used up degrees of freedom by distinguishing between producer - and consumer prices respectively as discussed below. Clearly, in a sufficiently detailed structural model one should be able to identify asymmetric effects of different kinds in the economy, in producer - as well as in consumer behaviour. On the other hand, in an aggregate reduced form type of model it may be impossible to identify effects both along the dimension of symmetry/asymmetry and with respect to the

[7] It may be noted that this distinction implies that the regression model is non-linear. This furthermore means that when specified as a vector-autoregressive model (VAR) it cannot be inverted by standard methods.

effects for consumers/producers. For the two oil exporting countries we believe that it is essential to capture the impacts from the significant structural changes that have taken place in their economies, as they have gone through the transition of becoming net oil exporters. This change of position will in itself imply that asymmetric effects have been into effect even if prices have moved in the same direction, and indications of the existence of asymmetry may therefore be obtained from the two oil price variables already included[8]. Clearly, to get good statistical estimates on the two specified price effects requires that the prices are not too strongly correlated.

5. Empirical results.

5.1. Correlation between real growth and oil prices only.

Table 1 summarizes the empirical results for the specifications with oil prices and real GDP growth only. Let us first consider the outcomes for United States, Canada, Germany and Japan, i.e. the results in the first four columns in Table 1. Remember also that the econometric specification is identical for these four countries. In the table only the sums of individual lag coefficients for the oil price variables are reported. In addition, in the row next to each of these, exclusion F-statistics for the respective group of coefficients are listed with marginal significance levels in parenthesis. - For three of these countries the calculations carried out confirm the hypothesis that there is a significant negative correlation between increases in oil prices and the subsequent impacts on the overall activity level. The effects are significant at a 5 % level for United States and Germany and borderline significant for Canada. For the United States, these results are consistent

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[8] A special form of "exogenous" asymmetry may be relevant in this type of model, namely if there are tendencies of differences in lags between crude price movements and changes in product prices when oil prices increase and decrease respectively. Typically, one may expect a rather close correlation (say one to two quarters) between changes in the two variables when crude prices go up. On the other hand, when crude prices turn downward, both private oil companies and governments may act to slow down the fall in product prices.

with the previous studies Hamilton (1986) and Mork (1988).

Table 1: Univariate results.

	U.S.A.	Canada	F.R.G.	Japan	U.K.	Norway
Oil price increases						
1. Sum of coefficients	-0.10	-0.20	-0.11	0.01		
2. Exclusion test, F(4,72)	3.47	2.41	3.84	0.72		
3. p-value	0.012	0.057	0.007	0.579		
Oil price decreases						
4. Sum of coefficients	0.004	0.07	0.03	-0.01		
5. Exclusion test, F(4,72)	1.27	0.37	0.62	1.10		
6. p-value	0.291	0.833	0.647	0.363		
Test of pairwise equality						
7. F(4,72)	1.92	1.09	2.86	1.00		
8. p-value	0.117	0.368	0.030	0.412		
Joint exclusion test						
9. F(8,72)	2.28	1.41	2.10	0.90		
10. p-value	0.031	0.208	0.047	0.523		
Crude price while net importer						
11. Sum of coefficients					-0.02	-0.02
12. Exclusion test, F(4,68)					0.56	0.84
13. p-value					0.692	0.505
Crude price while net exporter						
14. Sum of coefficients					0.05	0.13
15. Exclusion test, F(4,68)					0.59	2.48
16. p-value					0.671	0.052
Product prices						
17. Sum of coefficients					-0.14	-0.18
18. Exclusion test, F(4,68)					0.57	3.02
19. p-value					0.685	0.024
Joint exclusion test						
20. F(12,68)					0.71	2.07
21. p-value					0.736	0.031
Standard error of regression	3.84	3.78	4.90	4.59	6.34	11.46

Moreover, the results for Canada and Germany roughly confirm those obtained by Burbridge and Harrison (1984). The authors also found reasonable correlation effects for Japan. As seen from Table 1, however, we have been unable to detect any significant effect from oil price increases on GDP for this country. Actually, the sign of the estimated sum of coefficients has the opposite sign of what we expected, although the coefficients are not significantly different from zero. It is not clear what may explain this deviating relation for the Japanese economy. One possibility is the special social organization of productive activities in this country which may have resulted in an increased competitiveness relative to other Western countries after the two oil crises. Furthermore, the Japanese economy appears to have been able to take advantage of the increased energy scarcity in the 1970s in a much better way than did other OECD countries, such as in production and exportation of fuel-efficient automobiles. The conscious attempts of the Japanese government in 1973-74 to avoid conflicts with the oil exporting countries may also be noted.

The third row in Table 1 shows the estimated accumulated effects on the GDP growth rate in the various countries of declines in real oil prices. These coefficients are positive on average, as expected, for the United States, Canada and Germany. It is interesting that the coefficients are much smaller in absolute value than the corresponding effects of increased prices. The calculations give some support to the theory of asymmetric effects of oil price fluctuations. However, the estimated effects from price decreases are not significantly different from zero for any country.

For the fourth country, Japan, the calculations yielded a negative coefficient for a decreasing oil price, but again the result is not very sharp. In principle, high cost of adjustments may turn the net effect negative. However, as mentioned above, a priori one may rather assume the Japanese economy to be relatively flexible, and thus adjustment costs to be moderate compared to other countries.

The overall small estimated effects of price declines may be evaluated in light of the hypothesis of asymmetric price effects on economic activity. On the one hand, a fall in oil prices implies improved profits and opportunities to expand for oil consuming industries. For a net importer of oil, the terms-of-trade effect is also unambiguously positive. However, as discussed above, in the short run, a significant change in relative prices may involve various types of costs of adjustment in the economy. This will work in the opposite direction and partly outweigh the positive stimulus on economic activity. The net effect may be close to zero.

The statistical test of pairwise equality of the coefficients for increases and decreases is rejected on a 5 % level for the United States and Germany, but not for Canada and Japan, as shown by the F-statistics in row seven. For the latter countries we also are unable to reject the hypothesis that all the oil-price coefficients are zero (cf. the ninth row).

The models for the United Kingdom and Norway are specified to capture the effects of the change in economic structure in these countries as they have moved to become net oil exporters. The results for these countries may also shed additional light on the asymmetry hypothesis. If we focus first on the figures for the United Kingdom, we see that the positive effect on GDP from crude oil prices is rather weak and insignificant. One possible explanation for this may be the existence of asymmetric effects, i.e. that structural changes in the British economy have counteracted the positive income effects from increased oil prices. The coefficient for the product price is negative, as expected, but again the significance is poor. In fact, we are unable to reject the hypothesis that all oil price coefficients are zero, cf. Table 1.

For Norway, the picture is the same as for the United Kingdom with respect to the sign of the coefficients. However, the positive effect on the GDP growth rate from oil price increases (during the period as a oil exporter) is much stronger - the sum of the coefficients is 0.13 as opposed to 0.07 for the United Kingdom. Moreover, for Norway this influence is statistically significant. The impact of the product prices is estimated to be more or less the same in the two countries, but again the Norwegian effect is determined more accurately. The higher significance for Norway is remarkable given the much higher residual variance in this equation.

The differences in magnitude and significance between these two countries may be discussed from different points of view. One explanation may be that the relative importance of oil in the economy is much smaller in the United Kingdom than in Norway. An equally important factor is probably differences in economic policy pursued in the two countries during much of the observation period. In Norway, economic policy in the latter part of the 1970s was expansionary and consciously directed towards avoiding large increases in unemployment. Some of the expected future oil incomes was spent "in advance", and while other countries experienced stagnation, this policy obviously worked to keep up growth in Norwegian GDP. The results from the estimation of multivariate models presented in the next section may help to clarify this question.

5.2 Results with all variables included.

Table 2 summarizes the estimates for the oil price variables when all macroeconomic variables listed above are included in the regression models. The coefficients sums and exclusion tests for the macroeconomic variables are given in table 3. From the first row of Table 2 we first notice that the effects of oil price increases for the four "oil importing" countries have become more ambiguous. For the United States the estimate from the simple correlation seems robust; an at least borderline significant negative coefficient of around -0.1 is confirmed by the present calculations. Regarding the impacts on GDP growth from decreasing oil prices, a somewhat stronger effect is found for the United States compared to the simple oil price-GDP model. This estimate is strikingly different from that of increases, and pairwise equality is rejected unambiguously. Thus, the United States continues to show evidence of asymmetric price effects on the overall activity level.

However, the results for Canada and Germany are markedly affected by the inclusion of additional variables. For Germany the GDP effect of increasing oil prices is reduced in absolute terms and has become statistically insignificant. More noticeably, for Canada the sum of coefficients is positive in the multivariate model, although with a low value for the test variable. Explanations for this unexpected result for Canada, which deviates considerably from the one for the United States, may be sought along different lines. First, a large domestic production and the strong regulations of petroleum activities is clearly an important part of the picture. Canadian energy policy may have been adjusted to external events in the markets. Second, a high positive coefficient for the OECD industrial production is obtained in the multivariate regression model (together with Japan, the highest effect among the countries included). This partly reflect Canada's heavy dependence on United States as a trading partner.

Table 2: Multivariate results.

	U.S.A.	Canada	F.R.G.	Japan	U.K.	Norway
Oil price increases						
1. Sum of coefficients	-0.10	0.21	-0.05	0.08		
2. Exclusion test, F(4,52)	2.26	1.46	0.88	0.38		
3. p-value	0.075	0.229	0.485	0.823		
Oil price decreases						
4. Sum of coefficients	0.08	0.18	0.01	-0.04		
5. Exclusion test, F(4,52)	2.27	1.24	0.79	0.59		
6. p-value	0.074	0.304	0.535	0.672		
Test of pairwise equality						
7. F(4,52)	3.87	0.50	1.44	0.57		
8. p-value	0.008	0.734	0.233	0.689		
Joint exclusion test						
9. F(8,52)	4.81	2.98	1.57	1.12		
10. p-value	0.0002	0.008	0.156	0.367		
Crude price while net importer						
11. Sum of coefficients					0.001	-0.04
12. Exclusion test, F(4,48)					2.14	0.89
13. p-value					0.090	0.477
Crude price while net exporter						
14. Sum of coefficients					0.05	0.10
15. Exclusion test, F(4,48)					1.78	1.35
16. p-value					0.148	0.265
Product prices						
17. Sum of coefficients					-0.03	-0.07
18. Exclusion test, F(4,48)					0.03	1.34
19. p-value					0.998	0.269
Joint exclusion test						
20. F(12,48)					1.25	1.22
21. p-value					0.279	0.300
Standard error of regression	3.27	3.22	4.45	4.34	5.88	11.68

Altogether, the different findings for Canada can then be interpreted in the following way: oil price increases may benefit (or at least does not hurt) the Canadian economy in a direct sense because of the country's oil industry. Taking account of both policy actions and the response from export markets, however, the total effect may be negative, as indicated by the simple correlations.

For Germany, the effect of the OECD activity level plays a less important role in explaining the observed GDP-fluctuations. Instead, the inflation rate comes out with a rather high negative coefficient. This probably reflects the anti-inflationary policy that has been pursued in Germany in long periods since the first oil price shock.

Regarding the effects of decreasing oil prices, Canada now shows no sign of asymmetry: in a partial sense, price declines hurt as much as increases are beneficial. For Germany, however, there are only minor changes in coefficient values from the simple correlations. For this country there are still some indications of asymmetric effects (although the test criterion must be relaxed considerably, see row 5 of Table 2).

For Japan, even in the univariate model we were unable to detect any significant GDP-energy price correlation. The multivariate model does not add much to the picture for this country.

Coming then to the oil exporting countries, we notice first that for United Kingdom, the estimated effects of the oil price variables included still have the expected sign, but the statistical fit is poor. Furthermore, the coefficient for the product price is much smaller than in the univariate case. For Norway, the introduction of more explanatory variables in the model has lead to less significant energy price effects. Both the specified price coefficients have retained their signs and magnitudes from the simple correlation model, although both have become insignificant, especially the positive income effect of the crude price. The explanation for this outcome may of course be simply the loss of degrees of freedom in the regression. However, one may also stress a couple of interesting features from the estimated coefficient values of the macroeconomic variables. First, the OECD production indicator has obtained a rather high positive value, cf. Table 3. This may be interpreted as an indication of the contra-cyclical economic policy that was conducted during the 1970s and early 1980s in Norway. The expansionary policy measures taken in this period may also explain the very strong positive correlation between GDP and the unemployment rate for Norway.

Table 3: Results for non-oil variables.

	U.S.A.	Canada	F.R.G.	Japan	U.K.*	Norway*
OECD index of industrial production:						
1. Sum of coefficients	-0.24	0.24	0.08	0.50	0.13	-0.48
2. Exclusion test, F(4,52)	0.80	1.23	1.28	2.94	0.25	0.42
3. p-value	0.529	0.308	0.290	0.029	0.909	0.791
Inflation:						
4. Sum of coefficients	-0.32	0.07	-0.26	-0.56	-.03	0.08
5. Exclusion test, F(4,52)	1.79	0.28	0.91	2.26	2.63	0.80
6. p-value	0.145	0.888	0.467	0.075	0.046	0.533
Interest rate:						
7. Sum of coefficients	-0.76	-1.30	-0.87	0.02	-0.89	-1.33
8. Exclusion tests, F(4,52)	3.54	7.56	0.94	0.33	0.97	1.17
9. p-value	0.013	0.000	0.450	0.855	0.432	0.336
Unemployment:						
10. Sum of coefficients	0.87	1.13	-0.58	-4.24	0.49	2.69
11. Exclusion tests, F(4,52)	4.96	4.45	1.46	0.84	1.70	0.64
12. p-value	0.002	0.004	0.227	0.508	0.166	0.634
Real wage changes:						
13. Sum of coefficients	-0.23	0.33	-0.09	0.06	0.02	0.46
14. Exclusion test, F(4,52)	0.20	2.35	0.89	0.59	1.81	1.08
15. p-value	0.939	0.066	0.477	0.674	0.143	0.379

*For the United Kingdom and Norway, the degrees of freedom for the F-statistics are 4 and 48.

6. Summary and conclusions.

The purpose of the present work has been to investigate the relation between oil price fluctuations and business cycles. A particular emphasis has been on the hypothesis of asymmetric effects on GDP of changes in oil prices. Possible theoretical explanations for asymmetry have been discussed. An aggregate, reduced form type of model has been specified and estimated for a number of countries which differ, in particular, with respect to the net trade position. Consistent with the findings of previous authors in this field, the empirical results show significant correlations between oil prices and GDP growth for the United States. For this region, we also find strong support for asymmetric price effects. For the other countries included in the study, the conclusions are not as sharp as for the United States. When linking changes in GDP growth to fluctuations in oil prices only, significant correlations are found for Canada and Germany. However, in the more elaborate model including also a set of other macroeconomic variables, the significance of the oil price variables more or less disappear. This should not be too surprising. One problem with the kind of analysis we have carried out is of course the data used in the estimations. As mentioned above, specific efforts have been undertaken to construct a relevant oil price variable for the United States. Moreover, within the multivariate model there may be problems both with degrees of freedom and multicollinearities between the explanatory variables. In particular, we have pointed out that both regulations of domestic energy markets (Canada) and specific economic policy measures triggered by events in the oil market may affect economic activity via some of the specified variables.

The study also include calculations for two countries, United Kingdom and Norway, that have moved into a net export position for oil during the observation period. For these countries, one should expect opposite effects on GDP growth when oil prices change compared to an oil importing country. However, structural changes and adjustment costs may dampen the stimulus from e.g. increasing prices on petroleum. This may be part of the explanation why the estimated effects from oil prices on growth in United Kingdom are so weak. For Norway, on the other hand, strong correlations are obtained in the simple correlation model. The size of the oil sector and the expansionary economic policy pursued in the 1970s are probably important underlying factors. As for most of the other countries, the direct effects from oil price fluctuations become less significant when the other macroeconomic variables are included.

References.

Berger, K., Å. Cappelen, V. Knudsen and K. Roland (1986): The Effects of a Fall in the Price of Oil: The Case of a Small Oil Exporting Country. In Motamen, H. (ed) (1987): Economic Policy in OECD Countries, Chapman & Hall.

Burbridge, J. and A. Harrison (1984): Testing for the Effects of Oil Price Rises Using Vector Autoregressions, International Economic Review, 25.

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

Davies, S.J. (1987): Allocative Disturbances and Specific Capital in Real Business Cycle Theories, American Economic Review, Papers and Proceedings, 77.

Gisser, M. and T.H. Goodwin (1986): Crude Oil and the Macroeconomy: Tests of Some Popular Notions. Journal of Money, Credit, and Banking 18(1), 95-103.

Gordon, R.J. (1975): Alternative Responses to External Supply Shocks, Brookings Paper of Economic Activity, 1

Hamilton, J.D. (1983): Oil and the Macroeconomy Since World War II, Journal of Political Economy, 91.

Hamilton, J.D. (1987): A Neoclassical Model of Unemployment and the Business Cycle, University of Virginia, the United States.

Horwich, G. and Weimer (1984): Oil Price Shocks, Market Response and Contingency Planning, American Enterprise Institute, Washington D.C.

Huntington, H.G. (1984): Real oil prices from 1980 to 1982. The Energy Journal, 5.

Longva, S., Ø. Olsen and S. Strøm (1988): Total Elasticities of Energy Demand Analyzed Within a General Equilibrium Model, Energy Economics, 20.

Loungani, P. (1986): Oil Price Shocks and the Dispersion Hypothesis. Review of Economics and Statistics 58, 536-539.

Mork, K.A. and R. Hall (1979): Energy, Prices, Inflation and Recession, 1974-1975, The Energy Journal, 1.

Mork, K.A. (1985): Where's the Boom? The Oil Price Decline and the US Economy in 1986: A Reassessment of the Theories of the 1970s. Owen Graduate School of Management, Vanderbilt University, Nashville, the United States.

Mork, K.A. (1987): The Boom that Wasn't: Evidence from 1986-87 on the Macroeconomic Effects of Oil Price Fluctuations. Working Paper No. 87-29, Owen Graduate School of Management, Vanderbilt University, Nashville, the United States.

Phelps, E.S. (1978): Commodity-Supply Shock and Full-Employment Monetary Policy. Journal of Money, Credit, and Banking 10(2), 206-221.

Pierce, J.L. and J.J. Enzler (1974): The Effects of External Inflationary Shocks, Brookings Paper of Economic Activity, 1

Sims, C.A. (1980): Macroeconomic and Reality. Econometrica, 48.

van Wijnbergen, S. (1985): Oil Discoveries, Intertemporal Adjustment and Public Policy. In Bjerkholt, O., E. Offerdal and S. Strøm: Macroeconomic Prospects for a Small Oil Exporting Country. Martinus Nijhoff Publishers, Dordrecht.

Appendix 1: Variables and data sources.

Except for the unemployment rate and the interest rate, all variables have been included in the regression with their yearly growth rates, calculated as 400 times the log change of the respective quarterly figures. The length of the available time series varied between variables and from country to country. We decided to use the same time period for all countries, 1967:2 - 1988:2.

Real GNP/GDP.

For United States, Canada, Japan and Germany we have used the Gross National Product in constant prices (seasonally adjusted). The source here has been OECD Main Economic Indicators (MEI). For United Kingdom and Norway we have used data on Gross Domestic Product (in constant prices and seasonally adjusted) available in MEI and from the quarterly National Accounts from the Central Bureau of Statistics, Norway respectively.

Interest rate.

For United States, Canada and United Kingdom we have used the "treasury bill rate", for Germany "rates on 3-months loans, Frankfurt" and for Japan "call money rate", all available in MEI. For Norway we have used a long term interest rate (yield on government bonds (-1985:3)) available in MEI and "effektiv rente på statsobligasjoner" from the quarterly journal "Penger og kreditt" issued by Bank of Norway.

Real wages.

For all countries except United Kingdom and Japan we have used "hourly earnings". For United Kingdom we have used "weekly earnings" and for Japan "monthly earnings". All data-series are seasonally adjusted and available in MEI.

Unemployment rate.

For all countries except Norway we have used figures for "unemployment as percent of total labour force" in MEI, seasonally adjusted. For Norway we have used an equivalent measure from a quarterly labour force sample survey (AKU, Central Bureau of Statistics).

Inflation rate.

The inflation variable was constructed by dividing GNP/GDP at current prices by GNP/GDP at constant prices (GNP/GDP deflator). The source for all countries except Norway is MEI. For Norway the data source is the quarterly National Accounts from the Central Bureau of Statistics.

Overall index of industrial production in the OECD-area.

The same index for total OECD production available in MEI has been used for each country.

Oil price variables.

For United States, we have used a producer price index (PPI) for crude oil corrected for price controls constructed by Mork (1988). This index represents a chaining of the PPI for crude oil with the refiner acquisition cost (composite for imported and domestic oil).

For Canada, Germany and Japan we have used the PPI for petroleum products (for Japan petroleum and coal) available in MEI.

For Norway and United Kingdom, we have used the PPI for petroleum products. The Norwegian index is available in MEI, while the UK index represents a chaining of the PPI for petroleum and coal products until 1974 (MEI) with the PPI for petroleum products from Business Statistics Office (Department of Trade and Industry). In addition, we have used the world price of crude oil (Arabian Light) measured in local currencies. Until 1978:4 "posted prices" have been used (OPEC-publication: Annual Statistical Bulletin). Thereafter "spot prices" (OPEC Bulletin) have been applied.

All oil price variables have been deflated with the producer price index (MEI) for the various countries.

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