

The Changing Effects of Energy-Price Shocks on Economic Activity and Inflation

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- *Developments in energy markets in recent years have significantly affected the pace of expansion and inflation in the North American and, more generally, in the world economy. The prices of both crude oil and natural gas have surged since 1999, and California has experienced serious shortages of electricity.*
- *However, the adverse effects on the world economy of recent energy market developments are likely to be smaller than those arising from the oil-price shocks of the 1970s and early 1980s. The post-1999 increases in oil prices are, in real terms, considerably less than those experienced in the earlier period. The intensity of energy use in Canada and in other industrial economies has also declined markedly since the early 1980s.*
- *Canada's merchandise trade surplus in energy commodities and products (relative to GDP) has risen substantially since the early 1980s. Monetary policy is better anchored to avoid the inflationary spillovers of higher energy prices on the rest of the Canadian economy. As a result, the Canadian economy is better positioned to benefit from the increase in real income arising from positive terms-of-trade effects associated with higher prices for oil and natural gas.*
- *Since the autumn of 1999, most of the divergence between the total CPI and core inflation in Canada has been the result of these large increases in energy prices. To date, however, the pass-through of higher energy costs to the core CPI appears to have been small, as have second-round effects on wages and other prices.*

This article examines the changing effects of major energy-price shocks on overall economic activity and inflation in Canada. Large price increases for oil and natural gas can affect economic activity in various ways, through their effects on real incomes, costs, and uncertainty. Over the longer term, persistent rises in these prices can substantially alter the demand for and supply of oil-based products and natural gas.

The World Oil Market

High price volatility has been a long-standing characteristic of world oil markets, especially since the early 1970s. This volatility stems largely from the fact that the short-term responsiveness of both the demand for and the supply of oil and oil-based products to large price changes is low, so that relatively modest changes in the balance between demand and supply can result in large price movements. For instance, the global demand for oil is relatively insensitive to price movements in the short run, partly because significant demand responses often require modifications to equipment that uses oil-based products.¹ Private sector oil producers typically operate at capacity, limiting their ability to adjust supply in the short term. Additions to supply generally require exploration and development of new oil reserves and, occasionally, construction of new infrastructure to deliver the oil to market.

Some oil-exporting countries, most of which are in OPEC, have been willing to operate below their

1. The small short-term price elasticity of demand for oil and other forms of energy is confirmed by various time-series studies, such as the classic study by Berndt and Wood (1975). In addition, large-scale energy models typically assume a small short-term price elasticity, as in the National Modeling System developed and maintained by the Office of Integrated Analysis and Forecasting of the United States Energy Information Administration (Energy Information Administration 2001a).

production capacity in order to influence prices (Anderson 2000). In fact, OPEC has stated explicitly that it wishes to have stable prices.² Indeed, the series of production adjustments by OPEC members over the past three years was intended to move the world price of oil into a more stable and somewhat higher range. However, oil prices are highly sensitive to fluctuations in demand and supply, and the unpredictability of many of these demand and supply changes has made it very difficult for OPEC to achieve its price range objective. Furthermore, structural changes in the oil market since the mid-1980s have increased the volatility of prices (Lynch 2001). For instance, the amount of surplus capacity in all parts of the world oil industry (production, shipping, refining, and distribution) has diminished appreciably over this period. The stock-to-sales ratio in the U.S. refining industry has also decreased markedly in recent years with greater use of just-in-time systems of inventory management.

The demand for and supply of oil are clearly much more sensitive to persistent changes in real oil prices over the longer term than in the short run.³ For example, the large oil-price shocks of the 1970s and early 1980s contributed to the overall reduction in the intensity of energy use in Canada and other industrial economies over the past 20 years. They encouraged substitution away from oil-based products and towards other fuels (Box 1) and helped stimulate the development of oil supplies in non-OPEC countries. This has resulted in a marked rise in the world output share of non-OPEC countries other than the United States (Table 1).

Table 1
Share of World Petroleum Production

Country/ Region	Per cent share			
	1973	1981	1990	1999 (p)
OPEC	54.5	40.1	38.3	42.1
Canada	2.8	2.3	2.6	2.9
United States	16.5	15.3	12.2	9.0
Other non-OPEC	25.7	42.3	47.0	46.0

Source: United States Government, Energy Information Administration
p = preliminary

2. See for instance a recent speech by the president of the OPEC Conference (Kheilil 2001).

3. Cross-sectional empirical studies, such as Griffin and Gregory (1976) and Pindyck (1979), suggest a value of the long-run price elasticity of the demand for energy (in absolute terms) close to 1.

The North American Natural Gas Market

Natural gas markets in North America operate in a continental rather than a world context, owing chiefly to the high costs of transporting natural gas to end-users.⁴ Prices for natural gas in North America, like those for crude oil, are also subject to considerable variability, reflecting the sluggish response of both supply and demand to price changes at the commodity level. The response of demand to price changes at the commodity level is small, partly because of regulatory delays in adjusting consumer prices and a somewhat greater prevalence of long-term pricing contracts for end-users of gas than for users of oil products. The low short-term price elasticity of supply stems mainly from long lags in bringing new supplies—often found in remote areas—to market. Once again, the long-term price elasticities of supply and demand for natural gas are considerably higher than the short-run elasticities.

Over the long term, use of natural gas has risen relative to that for other fuels because of its environmental advantages and declines in the price of natural gas relative to that of other fuels (until recently). These advantages have led to the penetration of new markets in North America.

Over half of Canada's natural gas production is currently exported to the United States and accounts for close to 15 per cent of U.S. consumption (Energy Information Administration 2000). Exports of natural gas accounted for nearly 2 per cent of Canada's GDP (in current dollars) in 2000.

In general, the North American gas market has become increasingly integrated as linkages between the markets for natural gas, oil, and electricity grew, including the use of natural gas in new electricity-generation projects, and markets for natural gas and electricity were deregulated. Natural gas prices at the producer level in Canada were deregulated after 1985, although distribution and transmission tariffs on natural gas shipments continue to be regulated (National Energy Board 2000).

Selected Developments in World Energy Markets since 1997

World oil prices have continued to be volatile in recent years, mainly in response to fluctuations in global

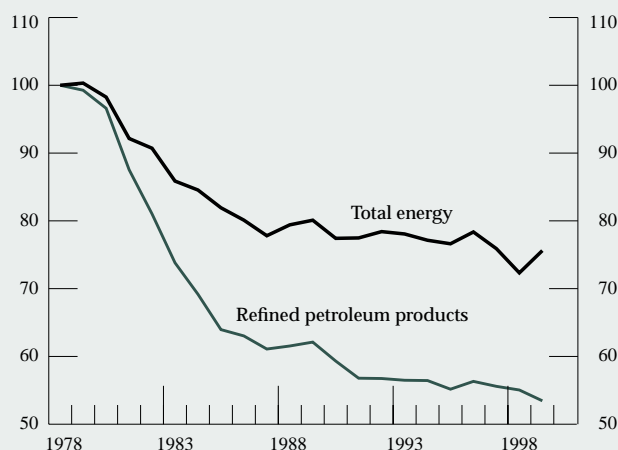
4. Natural gas markets in North America may become affected by developments in the rest of world over the longer term, to the extent that the United States becomes more dependent on imports of liquefied natural gas.

Box 1: The Changing Intensity of Energy Use in Canada

The energy price shocks of the 1970s and early 1980s led to energy-saving innovations and changes in the composition of demand that have contributed to subsequent, marked reductions in energy intensity in most industrial countries (International Monetary Fund 2000). In Canada, total final use of energy relative to real GDP fell by about 25 per cent between 1978 and 1999 (Chart 1).¹ The intensity of use of oil products declined much more than that of other forms of energy over this period,

Chart 1
Total Final Use of Energy per Dollar of Real GDP

Terajoules per 1992 dollar, 1978=100



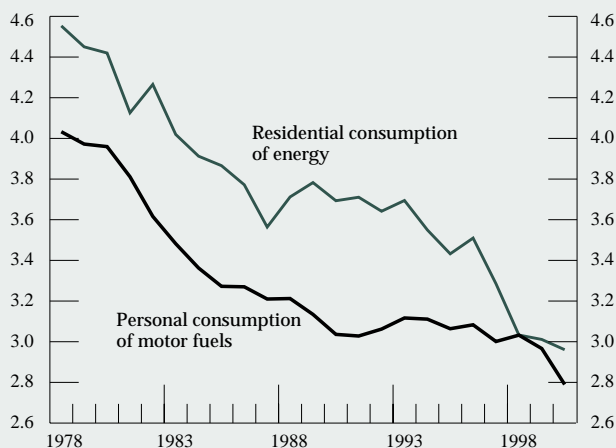
reflecting the substitution of cheaper forms of energy for oil products. Indeed, the use of natural gas (relative to output) fell by only about 10 per cent during this period, while the intensity of use of electricity remained little changed on balance. Personal consumption of motor fuels and energy for residential needs, relative to the volume of total consumer spending, declined by about 25 per cent and 33 per cent, respectively, between 1978 and 1999 (Chart 2).^{2,3} The reduction in energy use per unit of output was more muted in both the goods-

1. Final use of energy includes energy products consumed by non-energy firms, governments, and households. It would exclude the use of energy products for non-energy uses, such as petrochemical feedstocks.

2. In the case of motor fuels, higher energy prices had also led to government-mandated increases in the fuel efficiency of automobiles.

3. The former Statistics Canada data on consumer spending, which valued expenditures at 1992 prices, are used in Chart 2.

Chart 2
Real Personal Consumption of Energy as a Percentage of Real Total Consumer Expenditures



producing and services-producing sectors, although here again there was a very pronounced substitution away from petroleum products towards other forms of energy.

Energy intensity has always been higher in Canada than in the United States, partly because of climate differences, larger distances between major centres, and the availability of low-cost energy sources such as hydroelectric power. In 1998, final-use energy intensity was estimated to be about 50 per cent higher in Canada than in the United States, and the energy-intensity gap had widened since the late 1970s. In particular, the energy intensity of Canada's business sector is much higher than that of the U.S. business sector. This partly reflects differences in industrial structure, some of which could be attributed to the availability of low-cost hydroelectric power in Canada. Resource-based production (including such manufacturing industries as pulp and paper and metal smelting and refining), which is a particularly heavy user of energy, accounts for a much larger share of aggregate output here in Canada than in the United States. The gap in energy intensity between the business sectors of the two countries has widened somewhat in recent years, partly owing to the increasing importance of high-technology activity (a low user of energy compared with many industrial sectors) in the U.S. economy.

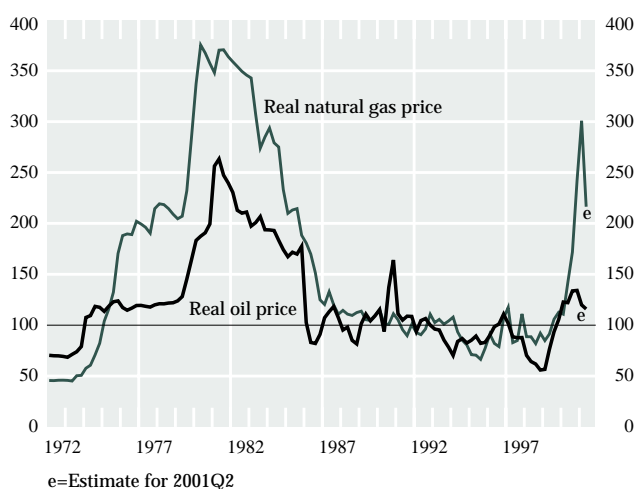
demand. The West Texas Intermediate benchmark price fell by over 40 per cent between June 1997 and December 1998, chiefly because of a sharp decline in Asian demand and unusually mild winter weather conditions in North America and Europe during 1997–98. In real terms, the price of oil was at an extremely low level at the end of 1998 (Chart 1).⁵ Real oil prices more than doubled between the end of 1998 and November 2000 as world demand recovered, following a rebound in activity in many of the Asian economies and very robust economic growth in the United States. Moreover, OPEC countries cut production during 1999, while additions to supply in the non-OPEC regions were relatively modest. Both of these latter developments occurred in response to the earlier period of very low prices. Since the autumn of 2000, crude petroleum prices have eased somewhat, as the effects on the world supply-demand balance of last year's production increases by OPEC and a slowdown in world economic growth have become more evident.⁶ Even so, gasoline prices in the United States surged in April and May of this year (Box 2), before falling back in June and early July.

Natural gas prices in the North American market have surged since early 2000. U.S. consumption of natural gas, after a period of virtually no growth between 1996 and 1999, in part owing to unusually mild winters, increased very strongly last year. This substantial rise in demand reflected both strong economic growth and a return to more normal weather conditions (Energy Information Administration 2001b). In addition, natural gas consumption by electricity generators continued to grow considerably, in part the result of the increasing use of this fuel in new generating plants. At the same time, lower cash flow in the North American petroleum industry in 1998 following low oil and natural gas prices had resulted in reduced drilling and, therefore, limited the supply response in 2000. Spot prices for natural gas have eased somewhat since early 2001, reflecting milder-than-usual weather conditions in much of North America.

5. The "real" price is calculated as the ratio of the U.S.-dollar price to the chain-weighted U.S. GDP deflator, reflecting the fact that energy is used broadly by both consumers and firms. The current-dollar oil price used for the calculation of the real oil price in Chart 1 is the West Texas Intermediate price at Cushing, Oklahoma. The current-dollar natural gas price used to calculate the real natural gas price is an export unit value measure quoted by the National Energy Board, which reflects movements in spot prices with a lag of several months.

6. More recently, OPEC announced cutbacks in production of close to 10 per cent, which came into effect on 1 April 2001.

Chart 1
Real Prices of Energy Commodities
1987–96=100



Despite the higher cost of crude oil over the past two years, its price, in real terms, is still much lower than the peaks experienced during the early 1980s. Much of the rise in the real price of oil during 1999 could be considered a return to the average level experienced over the 1987–96 period. The subsequent increase through 2000, while considerable, was still much less than the net jump of about 170 per cent between the end of 1973 and the end of 1982.

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The Effects of Increased Energy Prices on Economic Activity in Canada

In analyzing the effects of substantial increases in energy prices on overall economic activity in Canada, it is useful to distinguish between temporary and more persistent price changes. Increases that are perceived

Box 2: The Recent Jump in Gasoline Prices

Gasoline prices surged in both the United States and Canada in April and May of this year, even though crude oil prices remained well below the peak levels reached last autumn. A number of factors have contributed to this recent volatility in North American gasoline prices.

U.S. gasoline inventories were very low this spring, partly because stocks of heating oil at the start of the last heating season were down, and this led refineries to focus on producing heating oil last winter (Energy Information Administration 2001c). As well, the growing specialization of gasoline products in the United States arising from environmental requirements in areas with air-quality problems has contributed to increasingly frequent price surges in those regions. Finally, the U.S. refining

industry is currently operating at very high levels. All these developments have contributed to the growing dependency of U.S. regional markets on distant suppliers, with the result that it takes longer to replenish stock levels in these markets, and any large price increases in response to temporary changes in demand or supply can be more persistent.

The early spring period is usually one of the tightest times of the year for U.S. gasoline markets, as refineries complete their usual maintenance programs in the face of rising seasonal demand. Indeed, as gasoline production increased, prices fell back in June and early July. Even so, continued constraints on capacity and distribution raise the risk of further volatility in prices in coming months.

to be long-lasting would be expected to have a significantly greater impact on the volume of purchases of new energy-using equipment and on the supply decisions of both energy and non-energy producers than those that are perceived to be temporary.

It is also helpful to distinguish between the macroeconomic and sectoral economic effects of a large energy price increase (Box 3). The macroeconomic effects would stem from such factors as changes in Canada's terms of trade, the demand for Canadian exports, and an increase in the level of uncertainty felt by Canadian households and firms.⁷ A large relative price change will also have important sectoral and regional effects, arising initially from changes in the distribution of

income between the users, producers, and owners of the energy resources.

Macroeconomic effects

A large oil-price increase would first result in a substantial redistribution of real income from oil-importing countries to oil-exporting countries, as the terms of trade of oil importers decrease and the terms of trade of oil exporters rise (*terms-of-trade effect*).⁸ For example, the rise of nearly US\$10 per barrel in the price of oil between the third quarter of 1999 and the end of 2000 is estimated to have reduced the aggregate income of the developed countries by about 0.4 per cent, other things equal.⁹ In contrast, Canada, currently a net

7. The adjustment of Canadian real economic activity to large energy-price movements will also be affected by the response of the real exchange rate. Earlier empirical work undertaken at the Bank for the 1972-91 period indicated that increases in real energy prices led to a real depreciation of the Canadian dollar (Amano and van Norden 1995). Over that period, the positive effects of higher energy prices for energy exporters may have been more than offset by negative effects on other sectors of the Canadian economy (Lafrance and van Norden 1995). However, it is much less clear that energy-price changes had much impact on the Canadian real exchange rate in the 1990s (Laidler and Aba 2001).

8. The real income effect may be amplified or dampened by the impact of the oil-price change on the net flow of profits accruing on the stock of net direct foreign investment in the global oil and gas industry. In 2000, Canada's cumulated direct investment in the energy and metallic minerals sectors of other countries was about 25 per cent higher than the cumulated foreign direct investment in Canada's energy and metallic minerals sectors. Data for the energy sector itself are unavailable. A further reservation regarding these data is that they are recorded at book rather than market values.

9. This estimate is based on recent calculations published by the International Monetary Fund (2000).

Box 3: The Effects of Changing Energy Prices on Aggregate Economic Activity

- *Terms-of-trade:* Following an energy price change, there is a redistribution of real income between energy-exporting and energy-importing countries. An additional real-income effect would arise from the net flow of profits associated with each country's share of the cumulated net foreign direct investment in the global energy industry.
- *Foreign demand:* Changes in world energy prices have an impact on the aggregate demand of a given country's trading partners and, hence, on the demand for its exportable goods and services.
- *Uncertainty:* Large movements in energy prices affect the confidence of both households and businesses, thus increasing the level of uncertainty.
- *Cost:* Changing energy prices affect the costs of non-energy producers and the real incomes of households.
- *Energy supply:* Movements in energy prices have both short- and long-term effects on energy supplies.

exporter of oil, is estimated to have experienced a gain in real income of about 0.4 per cent as a result of this price increase.¹⁰ The increase of about 135 per cent in natural gas prices between the third quarter of 1999 and the end of 2000 is estimated to have increased Canada's real income by about 1.4 per cent, while lowering that of the United States by some 0.15 per cent. The additional net export revenues from oil and gas could be expected to result in higher profits for the exporting firms. For the provincial governments that own these resources, the result would be increased royalties and income taxes, and the federal government would receive higher corporate income taxes. Households that own equity in oil and gas companies would also benefit from capital gains on this equity.

Canada's exposure to gains and losses of real income through fluctuations in the price of energy commodities has increased since the early 1980s, because our net trade surplus in energy commodities and products, relative to GDP, has risen considerably (Table 2).¹¹ In particular, exports of natural gas have increased relative to GDP, following the development of new fields

10. The estimate for Canada, based on 1999 data, takes account of the direct effect of the oil-price increase on Canada's merchandise trade balance.

11. For Canada, trade in energy commodities includes crude oil, natural gas, coal, refined petroleum products, and electricity. In the case of the United States, all of these items are included except for electricity.

Table 2
Net Trade Balance in Energy Commodities and Products

As a percentage of GDP

Country	1973	1981	1991	1999	2000
Canada	0.5	0.6	1.1	2.0	3.3
United States	-0.6	-2.5	-0.9	-0.7	-1.2

Sources: Statistics Canada, U.S. Department of Commerce (Bureau of Economic Analysis)

and the expansion of pipeline capacity (Dion 1999–2000). On the other hand, the U.S. net deficit in energy commodities (as a percentage of total GDP) in 1999 was largely unchanged from that of the early 1970s.

Since most of Canada's important trading partners are net importers of oil, a large rise in oil prices could be expected to lower demand for all of Canada's exports to the United States and other oil-importing countries (*foreign-demand effect*). Since most of these countries have substantially reduced their use of oil-based products (relative to GDP) since the early 1970s, this foreign-demand effect should be considerably smaller than that for a similar-sized oil-price increase during the 1970s. The impact on the demand for Canadian goods and services of large increases in the price of oil

or other energy commodities might also be affected by factors other than changes in their real incomes. To the extent that Canadian industry is more energy intensive than its foreign competitors (Box 1), the costs of and prices charged by Canadian firms would rise in relation to those of foreign firms, adding to the downward pressure on demand for Canadian goods and services (a *cost effect*). As well, the demand for those Canadian goods that use a relatively high amount of energy would be adversely affected, a good example being large, fuel-inefficient motor vehicles.

Canada's exposure to gains and losses of real income through fluctuations in the price of energy commodities has increased since the early 1980s, because our net trade surplus in energy commodities and products, relative to GDP, has risen considerably.

A large and persistent increase in oil prices might be expected to result in a rise in economic uncertainty, especially when the rise in price is not simply a rebound from an earlier price decline (*uncertainty effect*—Hamilton 2000). Households and firms might find it difficult to assess whether the oil price increase is temporary or permanent and would therefore become less sure about both the long-term costs of equipment that uses oil-based products or other forms of energy and about the near-term outlook for the economy as a whole. Reduced confidence could lead to a further decrease in aggregate demand through the postponement of business investment and purchases of many big-ticket consumer items.

The possible quantitative importance of this uncertainty effect may help explain why several empirical studies have found an asymmetry in the relationship between oil-price changes and real GDP growth in the United States. The size of the adverse impact on aggregate output arising from oil-price increases seems to have been larger (in absolute terms) than was the positive effect on activity of comparable oil-price reductions, while increases had not had as severe an effect on GDP when the price increase was only a

recovery from an earlier decrease (Balke, Brown, and Yücel 1999; Hamilton 2000).

It is important to recognize that it is quite difficult to quantify the net effect of higher oil and natural gas prices on Canadian aggregate economic activity. The terms-of-trade effect could be offset in whole or in part by the effects on foreign demand, costs, and uncertainty. As well, the degree of additional uncertainty arising from such shocks is difficult to predict, as is the impact of variations in confidence on the real economy.

As previously noted, Canada's real income is estimated to have increased by about 1.8 per cent as a direct result of improved terms of trade resulting from the combination of a rise of US\$10 per barrel in the price of oil and an increase of 135 per cent in natural gas prices. If the marginal propensity to spend on private goods and services¹² is assumed to be between 0.5 and 0.75 and the marginal propensity to import is about 0.4,¹³ then the impact of the higher terms of trade on Canadian real GDP might be an increase of 0.5 to 0.8 per cent over a horizon of one to two years (other things being equal).

Estimates published by the IMF and the OECD suggest that a persistent oil-price increase of about US\$10 per barrel could reduce real GDP in the United States by between 0.2 and 0.6 per cent in the first year of the shock (Box 4). A lower bound for the impact of reduced U.S. demand on Canadian real GDP could be a decrease in a range between 0.1 and 0.3 per cent (under the assumption that the elasticity of Canadian GDP with respect to U.S. demand can be proxied by Canadian exports to the United States as a share of Canada's real GDP).¹⁴ However, there is a significant risk that this elasticity might be as high as 1.0, since Canadian exports to the United States are heavily concentrated in such postponable items as motor vehicles and machinery and equipment. The range for the foreign-demand effect on Canada's real GDP could therefore be between 0.1 and 0.6 per cent.

12. The marginal propensity to spend is the ratio of the change in spending to a change in income. Spending is defined as final domestic demand, excluding the government wage bill.

13. The marginal propensity to import is proxied by imports (excluding automotive products) as a share of spending. Imports of automotive products are excluded because they are mainly affected by exports of automotive products.

14. The impact of the surge in natural gas prices on U.S. activity, based on the earlier estimate of a real-income effect of only 0.15 per cent, would likely be relatively small.

Box 4: The Impact of Higher Oil Prices on Global Economic Activity

When macroeconomic models of the global economy are used to estimate the impact of persistent increases in oil prices on world output, researchers attempt to take account of the key short-term and longer-term channels of influence on aggregate demand and supply, as well as the potential effects on inflation and financial markets. In such exercises, it is typically assumed that central banks in the industrial countries continue to target core inflation and that fiscal policy is passive (International Monetary Fund 2000).¹ The results in the adjacent table demonstrate that a large oil-price increase would still represent a substantial adverse shock to the world economy, although there is considerable variation with regard to the estimated short-run effects on activity in the industrial economies. For instance, a rise of US\$10 per barrel could cause a reduction in output in the industrial economies in the first year of as little as 0.2 per cent or as much as 0.4 per cent. It is also important to note that a large oil-price increase would likely have a considerably smaller adverse effect on world output than would have been the case in the 1970s and

1. Oil-producing countries are usually assumed to only gradually adjust their spending in response to their higher level of revenues.

early 1980s, owing to the reduced dependency of these economies on oil products. For instance, Brown (2000) suggests that the U.S. economy may now be about half as sensitive to oil-price increases as it was in the early 1980s.

Impact of a Permanent US\$10 per Barrel (or 50 per cent) Increase in the Price of Crude Oil on Real Global GDP—Alternative Estimates

Percentage of GDP

	First year	Second year	Fifth year
World GDP			
IMF	-0.4	-0.6	-0.2
All industrial countries			
IMF	-0.4	-0.6	-0.2
OECD	-0.2	-0.2	na
United States			
IMF	-0.6	-1.6	-0.4
OECD	-0.2	-0.2	na
Brown (2000)	-0.3	na	na

Sources: International Monetary Fund (2000) and Brown (2000).

The OECD estimates were taken from International Monetary Fund (2000). Estimated effects of oil-price increases on real GDP reported in these studies were for smaller increases than in the above table. It was assumed for the purposes of this article that the relationship between the oil-price increase (in US\$ per barrel) and the percentage change in real GDP was linear.

na = not available

The combined impact on Canada's real GDP of both the terms-of-trade and foreign-demand effects is thus rather uncertain, ranging from a decrease of 0.1 per cent to an increase of 0.7 per cent. Moreover, no attempt has been made to quantify the size of either the uncertainty or cost effects, both of which would be negative. With this latter point in mind, the estimated impact of the recent increases in oil and natural gas prices on Canada's real GDP is likely to be small and positive.

Sectoral effects

Large price increases for either crude oil or natural gas would also significantly affect the costs of Canadian non-oil and gas producers and the real incomes of households (*cost effect*), resulting in a transfer of income to Canadian producers of oil and natural gas.

The impact on rates of profitability of higher costs for oil or natural gas, while varying widely across industries, would be negative for most non-oil and gas industries. The short-run impact on Canadian aggregate economic activity of the cost effect would likely be negative, on the assumption that oil and gas producers would raise their investment spending more gradually than other firms and households would reduce their expenditures.¹⁵

If oil and gas producers expect these price increases to be long-lasting, they are more likely to increase their investment spending on exploration and development and, at the margin, to bring higher-cost oil reserves

15. Part of the reduction in spending both by non-oil and gas producers and households may well continue into the longer term.

into production (*energy-supply effect*). All the same, the lag between a price rise and an increase in investment spending (especially for conventional oil and gas drilling) tends to be fairly short, since cash flow is an important determinant of capital spending in this industry. For example, investment expenditures by the oil and gas industry surged by over 25 per cent in 2000 as a result of higher oil and natural gas prices. A further gain of more than 8 per cent is predicted for this year, according to Statistics Canada's latest survey of investment intentions (Statistics Canada 2001).¹⁶

If and when households and firms become more confident that the price increases for oil and natural gas will persist, they will be more likely to purchase new, more-energy-efficient equipment. Over the longer term, spending on oil and gas would therefore decline. For example, consumers will tend to choose durable goods that help to reduce their use of oil-based products or natural gas. Businesses might also be expected to conserve on their use of oil and natural gas over the longer term. There might therefore be substantial substitution of both labour and capital for energy following a large oil-price increase, although it may take many years for the full impact of these energy-substitution effects to take place (Rasche and Tatom 1977; Atkeson and Kehoe 1999). Finally, a substantial and persistent increase in the real price of energy might reduce the economic value of much of the existing stock of capital (Berndt 1984). If there is a significant and long-lasting decrease in the demand for the output of energy- and capital-intensive industries because of the higher price of oil, then the economic value of the associated capital stock might be much lower. There does seem to be evidence from U.S. data that such reallocative effects from past large oil-price increases had important and persistent adverse effects on economic activity in the United States, because it took considerable time to correct the mismatch between the actual and desired distribution of labour and capital across sectors (Davis and Haltiwanger 1999).

This suggests that large and long-lasting changes in real energy prices can lead to significant reallocations of labour and capital across sectors. In particular, large and persistent increases in oil and natural gas prices

could result in substantial increases in the production of these commodities at the expense of marked reductions in manufacturing activity, other things being equal.¹⁷ Nevertheless, aggregate output could still be expected to be higher in the long run, given Canada's comparative advantage as a producer of these energy commodities.

The Effects of Energy-Price Shocks on the Price Level and on Inflation

A substantial part of the usual variation between the 12-month rate of change in Canada's total consumer price index and the change over the same period in core inflation (the CPI excluding the eight most volatile components and the effect of changes in indirect taxes on the remaining CPI components) reflects fluctuations in the prices of energy commodities. Indeed, the large increases in the prices of gasoline, fuel oil, and natural gas at the consumer level largely explain why CPI inflation in Canada has been well above core inflation since the autumn of 1999.

The first-round effects on the total CPI of large changes in the price of crude oil, while still considerable, have diminished since the early 1980s, in part because the average consumer has cut down his/her use of gasoline and fuel oil. On the other hand, over this same period, the weight of natural gas expenditures in total consumer spending has, on balance, changed very little.

Large changes in the prices of energy commodities could also have first-round effects on certain other CPI components, such as air and surface transportation, which are highly energy-intensive. Increases in the prices of oil and natural gas might also have significant second-round spillovers on wages and other prices if the first-round, cost-based effects on the total CPI lead to a rise in the expected rate of inflation.

Following the very large oil-price shock of 1973-74, there was evidence of substantial second-round effects on wages and other prices in many industrial economies (International Monetary Fund 2000). Inflationary pressures were already strong in the global economy, the oil-price shock was extremely large in real terms, and central banks in many countries effectively accommodated much of the second-round effects on wages and prices through their conduct of monetary

16. This survey was conducted from October 2000 to the end of January 2001. If the cash flow of oil and gas firms turns out to be much stronger than expected at the time of the survey, the results may well underestimate the level of investment spending that will be undertaken by the industry this year.

17. Formal modelling of the effects of resource-price shocks on the major sectors of the Canadian economy is provided in Stuber (1988) and Macklem (1993).

policy. Indeed, the interaction between the oil-price shock, accommodative monetary policies, and relatively inflexible labour markets was thought to have contributed to the sharp jump in unemployment in a number of industrial economies through unsustainable levels of real wages (Bruno and Sachs 1985).

The long lags in the pass-through of higher energy costs to the core CPI and the lack of significant second-round effects from the recent sharp rise in energy prices on core inflation in Canada and in other industrial countries may be indicative of how the low-inflation environment in recent years has changed price-setting behaviour.

The long lags in the pass-through of higher energy costs to the core CPI and the lack of significant second-round effects from the recent sharp rise in energy prices on core inflation in Canada and in other industrial countries may be indicative of how the low-inflation environment in recent years has changed price-setting behaviour.¹⁸ When a central bank's commitment to keeping inflation low over the medium term is highly credible, firms may be less likely to pass on higher costs to households by raising prices, at least until they are fairly certain that the cost change will last. Indeed, recent empirical evidence suggests that the persistence of inflationary shocks has declined in the low-inflation environment (Taylor 2000). Such behaviour makes it less likely that large changes in the prices of energy commodities will affect inflation expectations and, therefore, the inflation rate over the longer term.

18. The degree of pass-through of exchange rate changes to the core CPI also appears to have diminished considerably in Canada and other industrial countries in the 1990s (Bank of Canada 2000).

The first-round effects on the core CPI of the substantial rises in crude oil and natural gas prices since late 1999 are also estimated to have been small to date—less than 0.1 per cent over the past year. Since the initial rise in crude oil prices through much of 1999 was largely a recovery from abnormally low price levels in the preceding year, the majority of firms would have perceived energy costs through most of 1999 as relatively normal.¹⁹ While the estimated long-run effect of a permanent increase of 50 per cent in crude oil prices (about the size of the change in oil prices between the third quarter of 1999 and the end of 2000) on the core CPI is estimated to be about 0.4 to 0.6 per cent,²⁰ it seems likely that such price changes will be spread over several years. The presence of longer-term contracts and credible monetary policy may have helped slow down the pass-through of higher energy costs to prices. If the recent high level of energy prices does persist over the longer term, firms may be able to offset some of these higher energy costs through such means as energy conservation.

In most industrial countries, there has been little evidence that the recent sharp rise in energy prices has had significant second-round effects on wages and other prices (International Monetary Fund 2000). In Canada, second-round inflationary effects also appear to have been limited to date. While the underlying rate of growth in labour compensation rose in 2000, so did productivity growth, at least in the first half. The year-over-year rise in unit labour costs in the business sector remained moderate, at least until the end of last year.²¹

19. Since the downturn in crude oil prices during 1998 was short-lived, it is likely that the subsequent temporary cost reductions were not passed into the core CPI. As the energy-cost increases through most of 1999 represented only a recovery to more normal levels, no cost-related core CPI adjustments would have necessarily been needed.

20. The estimated long-run effect of a 50 per cent permanent rise in crude oil prices on the core CPI is based on a simulation with Statistics Canada's input-output price model. These calculations assume that there is full pass-through of the higher cost of crude oil into consumer prices and no substitution efforts by either firms or consumers. The estimated effect on the former core CPI would have been slightly smaller.

21. Part of the increase in the year-over-year rise in unit labour costs in Canada at the end of 2000 may have been the result of a cyclical slowdown in the growth of labour productivity.

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