The Increase in World Prices of Commodities: Aggregate and Sectoral Adjustments in Canada

Yazid Dissou*

April 2007

Keywords: Energy prices, commodity prices, aggregate and sectoral impacts, dynamic general equilibrium modeling and Canada

JEL classification: C68, E30, F14, Q33, Q43, N72

* I would like to thank Serge Coulombe, Madanmohan Gosh, Someshwar Rao and seminar participants at Industry Canada for their very helpful comments and suggestions. Useful comments and editorial assistance from Chahreddine Abbes, Md. Faisal Deen Arif and Xiujun Li are also acknowledged. All remaining errors and omissions are mine. Email: ydissou@uottawa.ca

The Increase in World Prices of Commodities and Real Economic Activity in Canada

Summary

As a net exporter of oil and resource-based commodities, the recent up trend in the world prices of these commodities represents both an opportunity and a challenge for Canada. This study investigates the potential aggregate and sectoral effects of a sustained increase in these prices on the Canadian economy using a numerical multi-sector intertemporal general equilibrium model. Counterfactual simulation results suggest that these price shocks would be beneficial to the Canadian economy on an aggregate basis, as real GDP would increase during most periods and households would increase their consumption profile during all periods and would thereby improve their well-being. Nevertheless, the price increases would also shift resources toward export booming sectors and would lead to an appreciation of the real exchange rate that may not be beneficial to traditional manufacturing export industries.

Introduction

In this study, we analyze the potential impacts of the increase in the prices of natural resources and resource-based products on the real economic activity in Canada. In last couple of years, prices of natural resources and natural resource-based commodities have increased dramatically. For example, oil prices have more than doubled in the last two years. The prices of Brent and WTI have increased from U.S. $30 a barrel in early 2004 to more than U.S. $65 per barrel in September 2005.

The tendency towards oil price hikes in the world market is likely to continue in the near future for a host of reasons among which, rising exploration cost, increasing depletion rate, and inadequate discovery rate of new reserves coupled with the unstable international political atmosphere are a few to mention. All these facts make the expectation of prices to return under the threshold of U.S. $30 per barrel very low, even in the medium run. As far as the prices of other natural resources and resource-based products are concerned, the same trends are expected to be observed.

With a relatively well-diversified economy, Canada is one of the few net-exporters of natural resources among the OECD countries. Natural resource products represent a non-negligible share in Canadian total exports of goods (24% on average between 2000 and 2004). Interestingly, however, the Oil and Gas industry, the most important natural resource industry, constitutes less than 5% of overall Canadian GDP, while energy-intensive industries constitute a relatively larger share of the same. With such an economic structure, rise in oil prices introduces an interesting trade-off for Canada.

While the increase in oil prices could, in general, be positive because of the terms-of-trade improvement, energy-intensive industries could be adversely affected by the same shock. Oil being a primary source of energy in the economy, a rise in its prices would lead to a rise in the cost of production for the energy-intensive industry and hence would result in a loss of competitiveness. This, in turn, would stir up a change in the sectoral composition of the economy. The extent of such an adjustment, of course, would depend, among other factors, on the energy-intensity of the latter industries, on their ability to substitute away from fossil energy products and on the inter-industrial structure of the Canadian economy as a whole.

In addition to the increase in the production cost for the energy-intensive industry, non-oil-producing industries (irrespective of their energy-intensity) would also suffer from a potential appreciation in the real exchange rate. These industries would lose competitiveness, which would eventually shift resources from the affected sectors to the booming sectors. In this context, it is interesting to mention that an increase in the world prices of the other natural resources could also lead to the same phenomenon that is well documented and known in the literature as the "Dutch disease". This term historically refers to the change in the industrial structure in the Netherlands during the late 1950s and early 1960s following the discovery of natural gas reserves. The adjustment was triggered by an appreciation of real exchange rate that resulted in a booming natural gas export sector while simultaneously leading to a contraction of the export-manufacturing sector[1].

Besides, the prospect of resource shift from the manufacturing sector is another potential source of concern for policy makers as far as labour productivity growth is concerned. Indeed, when a boom in the resource sector shifts resources from the manufacturing sector that is the most productive in the economy, aggregate labour productivity growth may be reduced. This issue has been addressed by several authors, like van Wijnbergen (1984), Sachs and Warner (1995), and Rodríguez and Sánchez (2005), among others. They found that an export boom in the natural resource sector could reduce productivity growth in the economy.

In light of the potential adverse impacts on the economy due to a booming resource sector, it is worth emphasizing that the development of Dutch disease is not systematic. Its occurrence and the magnitude depend on the structure of the affected economy (namely the degree of diversification and the inter-industry relationships).

Several studies have been undertaken in most OECD oil-exporting countries to assess the relevance of Dutch disease[2]. While most of these studies found little evidence of Dutch disease, Stijns (2003) found that the increase in energy exports

[1] See Corden (1982) for a detailed review of the concept of Dutch disease.
[2] See Stijns (2003) for an interesting review of these studies.

could indeed affect manufacturing exports. Using a gravity model, he found that a one-percent increase in energy net exports in an energy exporting country could decrease its real manufacturing exports by 8 percent. As rightly noticed in the latter study, the main challenge of the studies that rely on econometric methods resides in separating the pure Dutch disease effects from the negative impacts on exports generated by the economic slow-down due to the energy price hike. Simulation models could however overcome at least one of these endogeneity problems by running counterfactual simulations that would keep the export demand constant.

Detailed recent analyses of the potential impacts of commodity price increase on the Canadian economy are scarce. The potential adjustment of the Canadian economy to a sustained increase in the world oil prices deserves a careful empirical assessment. This analysis is much needed in an international context where the rising growth in demand for natural resource-based products in China, India and other emerging economies would raise the real prices of these products. The price increase could lead to a shift of productive resources from high-tech manufacturing and knowledge-based service industries in Canada. These adjustments could have unintended consequences on economic adjustments, regional income disparities, productivity, etc. Ultimately, a good understanding of these potential impacts would be a good input in designing effective policy responses.

The few interesting existing studies on the impacts of oil price increase in Canada used macroeconomic models, which were more preoccupied with the aggregate economic impacts than with the sectoral adjustment processes. See for example Bayoumi and Mühleisen (2006), Hunt, Isard and Laxton (2001), Jimenez-Rodriguez and Sanchez (2005), and Gaudreault (2003). Since these models included only final goods and did not capture inter-industry transactions, they missed an important channel through which changes in oil prices could affect the economy. Specifically they were unable to capture adequately the cost-push effects of oil price increase.

Multi-sector dynamic general equilibrium models seem to provide a very good framework for the analysis of the potential impacts of an increase in oil and other commodity prices. An interesting characteristic of these models is their ability to trace the impacts of large policy changes in a particular industry or sector through-out the entire economy. Resulting changes in the structure of consumption, production and trade could then be understood correctly. General equilibrium models have been extensively used in Canada and other OECD countries to analyze the potential impacts of policies affecting energy prices such as climate change policies. See Dissou et al (2002), McKibbin et al. (2000), Rotemberg and Woodford (1996), and Wigle (2001), for further references on this.

In this study, we used a single-country, multi-sector dynamic general equilibrium model to analyze the potential short- and long-term impacts of the increase in the prices of oil, natural resources and resource-based products in Canada. We analysed the impacts on aggregate and sectoral variables of interest, such as GDP, household welfare, sectoral output, employment, investment, imports and exports, prices and real exchange rate. We ran two simulations related, on the one hand, to the increase in oil and gas prices, and on the other hand, to the increase in other natural resources and resource-based products. In addition, sensitivity analyses of the results were performed.

The remainder of the document is as follows. Next section presents an overview of the structure of the Canadian economy. Section 3 discusses briefly the model characteristics and the data. Section 4 analyzes the simulation results and the last section provides some concluding remarks.

2. A quick overview of the theoretical structure of the model

In this section, we present a thumbnail description of the model developed in order to run the simulations pertaining the increase in oil and commodities prices in Canada. The model shares similar modeling philosophy with several interesting contributions on multi-sector intertemporal general-equilibrium modeling for policy reform by Goulder and al. (1999), Keuschnigg and Kohler (1995), among others. It also shares several characteristics with the models presented in Dissou et al. (2002) and Dissou, Y. and V. Robichaud (2003) that were designed to analyze alternative climate change policies. However, the model used for this study differs from the above-cited models for its theoretical structure that does not incorporate any GHG[3]

[3] Greenhouse gases.

related features, like emissions, tradable permits and command and control policy instruments[4].

Although multi-sector intertemporal general equilibrium models are now commonly used in the literature, we believe that a short discussion on the main components of the specific model used in this study would be very useful for a good understanding of the following results. We have developed a multi-sector dynamic general equilibrium model with forward-looking behavior that features an explicit characterization of both the supply and demand sides of the Canadian economy. Eighteen industries and twenty commodities are considered, respectively, on the supply side, and on the demand side of the economy. (See Table 1 for a listing of industries and commodities). In contrast to one-sector macro-models, considering a sectoral disaggregation in analyzing commodity price increase is very useful, since it provides interesting insights related to the sectoral adjustments led by the changes in relative prices, while, simultaneously, accounting for the inter-industry relationships.

Population growth rate as well as technological progress is assumed exogenous, while households and firms derive their behaviors from an explicit intertemporal optimization program. In addition to firms and households, government is the other economic agent present in the model. Finally, all agents operate in a competitive framework. Canada is considered as a small-open economy that produces both tradable and non-tradable goods and takes prices as given in the world markets of goods and financial capital.

2.1 Households

The representative household has preferences over consumption and leisure. It derives income from salaries, returns on financial assets and net transfers received from the government and the rest of the world. Transfers from the rest of the world are exogenous, while those received from the government are endogenous. The representative household pays sales taxes on commodities and income taxes on returns to primary factors of production.

[4] Readers interested in mathematical details should refer to the above-cited papers for more information.

The representative household maximizes an intertemporal utility function subject to a lifetime budget constraint, i.e. to a private wealth constraint that includes both human and financial wealth. Human wealth is the present value of the future stream of net-of-tax income and net transfers. Financial wealth, on the other hand, comprises of real domestic stock of physical capital and net holdings of claims against foreign residents.

The instantaneous utility in the intertemporal utility function is a logarithmic function that has a Cobb-Douglas formulation with aggregate of the consumption index and leisure as arguments. Through intertemporal optimization process, the representative household determines the optimal path of its consumption spending (consumption index), labour supply and saving. Within each period, using a cost-minimizing rule, it allocates consumption expenditures across goods and services within a nested CES utility function. As specified, the household preference representation allows for rich substitution possibilities among commodities especially, on the one hand, between the aggregates of energy and non-energy goods, and, on the other hand, among energy goods.

2.2 Firms

The representative firm in each of the eighteen industries is assumed a price taker that chooses its optimal levels of labour, intermediate inputs and investment so as to maximize the firm's stock market value, subject to both technological and capital accumulation constraints, in the presence of convex capital installation costs. Firm's stock market value is the discounted sum of current and future dividends and its investment expenditures are fund through retained earnings.

Capital, labour, energy and material inputs are combined to produce output using a constant-returns-to-scale technology as represented by the nested CES functions. Akin to the household optimization behavior, the specified representation of firm technology allows interesting substitution possibilities among the inputs used.

Physical capital stock of the firm increases from one period to the other with capital formation that accounts for new investment and physical capital depreciation. The presence of adjustments or capital installation costs introduces some rigidity in the reallocation of physical capital from one industry to the other in the sense that the firm cannot instantaneously change its capital stock to the desired level in the short run. In a given period, the capital stock is considered as given, as it is inherited from initial capital stock and past investment decisions. It follows that in any period the firm will only determine the optimal level of labour, intermediate inputs and investment in physical capital that will affect next period physical capital stock. It is important to note that the constant-returns-to-scale property of the technology does not imply a flat short-run supply curve because of capital installation costs.

The forward-looking behavior of the firm and the presence of adjustment costs make firm's current demand for investment goods sensitive to the expectations of future changes in prices. In particular, investment is a function of marginal version of *Tobin's q* and adjustment cost parameters.

The optimal values of the other production factors are chosen according to the rule found commonplace in static optimization problems that consists in equalizing the cost of the factor to its marginal product.

2.3 The government, trade and financial flows

The government derives revenue from taxes on commodities and on factor income, consumes goods and services and enacts lump-sum transfers to households. It is not allowed to run deficits; it is compelled to have in each period a balanced budget that is achieved by adjusting transfers to households accordingly. Government's real expenditures on commodities are set exogenously to their base-run values. They increase according to the population growth rate (including the technological progress).

In line with most computable general equilibrium models, the present model adopts the Armington approach of differentiation, on the one hand, between domestic goods and imports, and on the other hand, between domestic sales and exports. This differentiation appears to be necessary, at least on the demand side, in order to accommodate the evidence of cross hauling observed in trade data, i.e., where Canada imports and exports the same commodity. This observation is in contradiction with the implications of traditional trade models like the Heckscher-Ohlin model in which a two-way trade in a given commodity is impossible.

In that respect, the good produced by the representative firm is modeled as a CET-composite[5] of exports and domestic sales and the total domestic demand of each commodity is modeled as CES-composite[6] of imports and domestic goods. To account for the importance of Canada's trade relationship with the U.S. a second type of differentiation is introduced between traded goods, i.e., on the one hand, between exports to the U.S. and exports to the rest of the world (ROW) and, on the other hand, between imports from the US and imports from the ROW.

As Canada is considered as a small country in the world market, it considers foreign prices of imports and exports along with the world interest rate as given. The latter assumption implies that in each period, the net capital inflows to Canada are endogenous and they must offset any imbalance in the current account trade balance. Still, the real exchange rate has to adjust in order to achieve, over the long run, the sustainability of households' net claim over foreign assets. In other words, the real exchange rate would adjust to avoid a *Ponzi game* where the country could lend or borrow forever.

2.4 Equilibrium conditions, data and calibration

In equilibrium, in addition to the requirement that, within any period, all agents respect their budget constraints, domestic prices and the wage rate adjust to achieve balance between the supply of and demand for produced goods and labour. Moreover, on an intertemporal level, expected future prices must equal their realizations. The market clearing condition considered for the labour market assumes that the wage rate is flexible that labour can move freely among sectors.

The impacts of policy shocks analyzed in this model will be measured with respect to a reference situation labeled as the "base-run situation".

---

[5] Constant Elasticity of Transformation.

[6] Constant Elasticity of Substitution.

In the base-run situation, the economy is assumed to be in an initial steady state characterized by a constant growth rate of 3.2% (population growth rate and the rate of Harrod-neutral technological progress).

Calibration of the model is based on the structure of the Canadian economy as depicted by the social accounting matrix (SAM) in the year 2002 that we built. A SAM provides some useful information on the structural interdependence of an economy by showing the transaction flows between economic agents and production factors.

The year 2002's SAM was built using the same year's data from the Canadian input-output table, national accounts, trade statistics and government accounts. Among other characteristics, the SAM features a sectoral disaggregation of the Canadian economy into eighteen industries and twenty commodities. Tables 2 and 3 provide some characteristics of the SAM that might be useful for the understanding of the results.

Extraneous parameters required for the model calibration consist of substitution elasticities in household preferences, firm technology and Armington functions, and of adjustment cost parameters. It is important to note that since these extraneous parameters are point estimates of the true unknown parameters that are most often taken from econometric studies, there is no single "correct" value for each of them. This situation, therefore, calls for some sensitivity analyses of results in order to gauge the impact of uncertainty pertaining to model parameters[7]. The assumed elasticities are deemed conservative and are based on literature search on Canadian economy. See Tables 4 and 5 for the values of selected elasticities used in this study.

As is usual in most computable general equilibrium models, the calibration of the model entails the use of the base-run situation data and the extraneous behavioural parameters to find the values of the unobserved variables and other parameters, so as to replicate the base-run steady-state equilibrium using the model without a shock. In

[7] It is noteworthy to recall the reader's attention to the fact that this problem is not inherent to the calibration method used in this study alone. It is common to all analyses that rely on a point estimate of a true unknown parameter.

that equilibrium solution, all physical quantities should grow at the exogenous growth rate, while relative prices remain unchanged.[8]

The calibration of this multi-sector intertemporal general equilibrium model involves the dynamic aspects as well as the static aspects of the model. The methods used in this study follow the ones described in Dissou (2002).

3. Simulations results

3.1 Description of the simulations

In this section, we report two main simulation results related to the increase in world prices of oil products and resource-based commodities. In the first simulation, we consider a permanent 20 percent increase in the world prices of oil products, i.e., crude oil and refined petroleum products. In the second simulation, a permanent 20 percent increase in the world prices of resource-based commodities, i.e., other mining except Oil & gas and Coal, and lumber products is considered.

In addition to the above, we run three other simulations to perform some sensitivity analyses to assess the robustness of the qualitative findings in the simulation related to the increase in oil prices. In the first sensitivity analysis, we consider a combined 20% permanent increase in the world prices of oil and resource-based commodities. In the second, we consider a permanent 40-percent increase in the world prices of oil products. In the third, we assess the impacts of the values of trade elasticity parameters on the results of the simulation with 20% increase in oil prices.

Although numerical models such as the present one have the advantage of being able to handle simultaneous interdependencies that would have been otherwise impossible to consider in other analytical models, they often produce numerous and complex results that may confront one's initial intuition. In order to provide intuitive explanation of the results, we will focus on the main transmission channels at play and make an artificial distinction in our discussions firstly, between the short- and long-run impacts, and secondly, between aggregate and sectoral impacts. To avoid

[8] Stated differently, in the steady state, physical quantities expressed per efficiency unit of labour should be constant.

unnecessary repetition, detailed explanations will be provided for the first simulation alone. In the second, we will present the results and will focus our attention on the differences from those obtained in the first simulation.

We would also like to emphasize the fact that the results presented in this study are not forecasts; rather, they are the results of counterfactual simulations that, *ceteris paribus*, indicate the impacts on real economic activity of the price shocks considered. Finally, unless otherwise mentioned, all results are expressed in percentage deviations from their base-run values; they are not percentage growth between periods.

3.2 Simulation 1: Permanent 20% increase in the world (import and export) prices of oil products

In this simulation, the trajectory of world prices (exports as well as imports) of oil products is assumed to be annually 20 percent higher than the base-run situation. As Canada is a net exporter of oil products, this may initially seem to be only a positive terms-of-trade shock, which would in general lead to an expansion of the economy. The typical response of the economy to this type of shock could be predicted from the "Dutch disease" phenomenon, where the export boom would lead to an appreciation of the real exchange rate that would bid the prices of domestic goods up, making imports more competitive and consequently increasing their volume.

However, this need not be the case in the present context. Indeed, because on the one hand, imports represent a non-negligible share of total domestic demand for oil products in Canada, and on the other hand, increases in energy prices have a negative impact on production costs, the increase in world prices of oil products would trigger other adjustments in the economy. This would dilute the typical results predicted by the Dutch disease theory. Caution is thus called for in the interpretation of the potential implications of the increase in oil prices on an oil-exporting country with a diversified manufacturing sector like Canada.

Aggregate impacts

Table 6 presents the aggregate impacts in this simulation and Figures 1 and 2 show the transitional dynamics of selected variables. As economic agents respond to relative prices in the present setting, the permanent increase in the world prices of oil products would trigger some income and substitution effects as well as changes in the rate of capital accumulation. Aggregate real GDP at factor cost decreases in the first year by 0.3 percent, but increases later on and settles in the long run at a level that is 0.4 percent higher than in the base run, as shown in Figure 1.

Alongside with changes in real GDP at factor cost that reflect changes in resource allocation in the productive sector, especially on income generation, we also provide the results of the impacts on real GDP at market prices. The latter impacts, which reflect adjustments on the demand side (expenditures on final demand), need not to be identical to those of real GDP at factor costs in a particular year, as expenditures on goods are not based on domestic income only. Domestic absorption is also affected by net foreign capital inflows. While changes in real GDP at market prices follow the same pattern as those of GDP at factor cost, figures in Table 6 suggest that their magnitudes are lower because of, among other factors, households' consumption smoothing behaviour. Indeed, in the present model, households are assumed to consume not according to their current income but their permanent income. Hence, they can smooth their consumption stream over time despite a temporary decline in their current income. Household real consumption increases in the first period by 0.2 percent and, in the long run, settles at a level that is 0.3 percent higher than in the base-run situation.

The increase in the world prices of oil products leads to a permanent increase in the consumption price index of about 1.2 percent. This change, in conjunction with a decrease in nominal wage rates, leads to a decrease in real wage rates that, in turn, would decrease household labour supply. Still, the decline in labour supply would be modest, as total employment would fall by about 0.2 percent in the first period. Overall, household welfare increases, as the measure of welfare change is positive, 0.24[9].

As expected, the increase in the world prices of oil products leads to the appreciation of the aggregate real exchange rate in the first period by 0.4% and with a lower magnitude in the subsequent periods. Total real exports drop in the first year by 1.1

[9] Note that measure of welfare change used in this dynamic framework encompasses the household's entire lifetime. See Dissou (2002) for discussions on this measurement.

percent and this decline continues further in time until it settles in the long run at a value that is 0.8 percent lower than in the reference situation (Figure 1). The pattern is similar for total real imports, although with a smaller magnitude, as they fall by only 0.1% in the first year for example. Finally, total real investment increases by 0.9 percent in the first year and increases slightly in the transitional period and finally settles in steady state at a level that is 0.8 percent higher than in the base run.

In general, the magnitudes of the impacts on aggregate variables reported so far are small; they are in line with the magnitude of the initial shock and they are not quite different from the ones obtained in other (macro) models. For example, an IMF (2004) study that used a single-sector dynamic general equilibrium model found that a permanent 20 percent increase in oil prices would have a negative impact on Canadian GDP (about -0.45 percent) in the first year. The magnitude of these aggregate impacts may be misleading as they hide wide sectoral adjustments. Following the increase in world prices of oil products, all sectors are not affected equally.

Sectoral impacts

Tables 7a-8b report the impacts on some relevant sectoral variables in selected years. A discussion on the sectoral and dynamic impacts of the shock will shed some light on these aggregate effects. On the supply side of the economy, oil price increases will induce some resource reallocation effects, with factors moving from other sectors to oil producing sectors. As shown in Table 7a, in the short run, sectoral GDP, employment and real investment increase in the Oil & Gas sector as well as in Petroleum Refining industries; and fall in all other sectors except the Power Generation industry[10].

As argued in the section on the model description, one of the key advantages of using an intertemporal framework is the ability to capture consistently the effects of changes in the values of future variables on investment. The permanent increase in oil prices provides additional incentives to invest in oil industries as the ratio of the shadow price of capital to its purchasing price has increased. In contrast, in the other

---

[10] Power Generation industry includes the production of hydroelectricity. Through substitution effects, the rise in oil prices induces an increase of hydroelectricity.

industries, the increase in energy cost reduces firms' incentives to invest; capital formation decreases in these sectors. As an illustration, investment increases in oil producing industries especially in Oil & Gas industry by 24 percent in the first year (Table 7a) and settles in the long run at a level that is 21 percent higher than in the base run. In non-oil producing industries, investment decreases in both the short and long run. For example in the first year, investment falls by 14.5 and 9.7 percent in Pulp & Paper and Smelting industries, respectively.

The adjustment in sectoral capital stocks, alongside with the sectoral shift of labour towards oil industries leads to a change in the sectoral value added. GDP at factor cost increases by 5.8 and 0.5 percent, respectively, in the Oil & Gas, and Petroleum Refining industries, and falls by 3.0 and 2.5 in Pulp & Paper and Smelting industries, respectively.

As a corollary to the shift of factors towards the oil industries, exports increase in these industries and fall in others. In reality, as indicated above, non-oil producing industries suffer not only from the resource shift towards oil industries, but they have also been adversely affected by an increase in their production costs through the increase in energy prices. Consequently, their exports decrease further than what would be required, if export prices of oil alone were only considered (i.e. without an increase in oil import prices).[11] The increase in exports of oil products is not sufficient to counter the decrease in foreign sales experienced by other industries. Thus, total real exports fall as mentioned in the discussion on aggregate results.

Considering the demand side, an increase in the prices of oil products leads to a decrease in their domestic uses by 3.0 and 5.1 percent for crude oil and refined petroleum products respectively in the first year (Table 8a). Because of the Armington differentiation between imports and domestic goods, imports of crude oil and refined petroleum fall by 6.8 and 10.6 percent respectively, while their domestic sales increase or decline by a lower magnitude of 2.6 and -4.0 percent respectively in the first period (Table 8a).

---

[11] In a non-reported simulation with a 20% increase in oil exports prices *alone, without import prices*, we found that output contraction in non-oil industries is less important.

Despite the increase in household consumption, total domestic demand falls in non-oil-producing industries mainly because of the decline in the demand for intermediate inputs. Apparently, output expansion in the oil industry has not generated sufficient demand for intermediate inputs that would counteract the decline in output suffered by non-oil producing industries.

Since domestic demand is a composite of domestic goods and imports, it is interesting to note that imports are less affected when total demand falls. For example, in the Pulp & Paper industry, the decrease of -1.1 percent in total demand is achieved through a reduction in the demand for domestic goods and imports by – 1.5 and -0.2 percent, respectively. Some industries, such as Cement, have even experienced an increase in their imports, while their domestic sales had seen a decline. This result is not surprising if one considers the fact that non-oil producing industries (especially energy intensive industries) suffer from, not only an increase in their production cost, but also from an appreciation of the real exchange rate.

As mentioned earlier, not all the typical effects of Dutch disease are observed in this scenario since we do not observe a boom in the non-traded sector that could be represented in this model by the Services industry. The reason for this is that, in addition to the increase in the prices of tradable goods, we find a negative shock that stems from the increase in energy prices. Nevertheless, analysing sectoral adjustment results, one could perceive a glimpse of the Dutch disease phenomenon in the sense that the non-tradable sector is relatively less affected than the manufacturing sector.

The sectoral adjustment described above certainly has some regional impacts, as the regional distribution of industries is not uniform across Canada. Though the present model does not have a regional disaggregation, we used the regional distribution of industries observed in 2002 in Canada in order to provide a ballpark overview of the regional impact of increases in oil prices on GDP at factor cost. It is worth noticing that these regional impacts do not take into account the resource constraint that each region could face. Table 9 presents impacts on regional GDP at factor cost. As expected, regions with high concentration of oil producing industries like Alberta, Newfoundland and Saskatchewan would benefit from the increase in oil prices.

Regions such as Ontario and Quebec that depend more on manufacturing industries would on the other hand undergo a decline in their output.

3.3 Simulation 2: Permanent 20% increase in the world (import and export prices) of primary resource products

In this simulation, the world prices (of exports and imports) of resource-based commodities, i.e., mining and lumber have been increased permanently by 20 percent in comparison to the base run. Table 10 presents the impacts on aggregate variables while the impacts on sectoral variables are shown in Tables 11a-12b.

The transmission mechanisms of this shock are roughly identical to the ones discussed in the previous simulation. The main difference in this case, however, is that there is no increase in production cost. Resource-based commodities, in general, do not have a significant share in terms of production cost in Canadian industries. It follows that we would observe a pure Dutch disease phenomenon, i.e., the booming export sector would expand, while the manufacturing sector would contract. As shown in Table 10, sectoral GDP increases in the booming sector (resource-based commodities) by 11.9% while it declines in the oil producing and manufacturing industries in the same period by respectively, 1.1% and 2.3%. Aggregate real GDP falls in the first period by 0.3% and increases later on to settle in the long run at a level that is 0.4 percent higher than in the base run (Figure 2). Thanks to the improvements in terms of trade and to the absence of a cost-push increase in prices, households increase their consumption in all periods in comparison to the base run situation. Their consumption profile is higher in this simulation than in the simulation with oil price increase, enabling them to enjoy a higher increase in welfare.

A startling feature of the adjustments observed in the manufacturing sector, as suggested by the sectoral results, is the unexpected output expansion in the Smelting industry. This result, however, seems not to be disturbing once we consider the adjustments that occurred in that industry and the Canadian inter-industry relationship. In reality, Smelting industry benefited from the increase in output by the “Other mining” industry via a lower domestic price paid for their products. The former uses the output of the latter industry as intermediate inputs, which constitute a significant share in their total material input costs. A decline in these costs spurs investments resulting in an expansion of the Smelting industry.

Table 13 reports on the impact of the permanent 20% increase in the world prices of resource-based commodities on regional real GDP at factor cost. As expected, provinces like Ontario and Quebec, which have a significant share of manufacturing industries, are the most affected. In the first year, their real GDP falls, respectively, by 0.6 and 0.4.

3.4 Sensitivity analysis

In order to assess the robustness of the qualitative results discussed above, we performed some sensitivity analyses. We ran three additional simulations. In the first, we considered a combined 20% permanent increase in the world prices of oil and resource-based commodities. Table 14 reports on the aggregate impacts and the effects on regional GDP are shown in Table 15. As expected, the combined effects of the price increases on most variables are more important. Real GDP expands in the petroleum and primary resource industries while it contracts in the manufacturing and the other industries. The aggregate real exchange rate appreciates, and a pattern similar to the one observed for real GDP is observed for real exports that decline on the aggregate level, while they increase in the booming industries. The increase in household consumption is more important and they enjoy a higher increase in their welfare. On a regional basis, oil-producing regions, like Alberta, Saskatchewan and Newfoundland, are the ones that would benefit the most from the combined increase in the prices of oil and resource-based products, as their real GDP would expand. The adjustment is mixed in the other regions; in some regions, real GDP would decline in the short run and expand later on in the long run. In contrast, in other regions real GDP would decline in all periods.

In the second sensitivity analysis, we considered a 40-percent increase in world oil prices instead of a 20 percent as discussed earlier. Table 16 reports on the aggregate impacts of this simulation. In general, aggregate variables move in the same direction, though with higher magnitudes, in comparison to the previous simulation. For example, GDP at factor cost falls more in the short run -0.8% vs. -0.3%

previously), but settles at a higher level a few periods later, for example, at 0.3% vs. 0.1% after ten years. The appreciation of the real aggregate exchange rate, however, is more severe in this simulation resulting in a greater fall in the total real exports. Non-booming industries, as expected, also experience a larger decrease in their output. Households, on the other hand, benefit more from the higher oil revenue as they experience a higher consumption stream leading to a welfare increase.

In the third sensitivity analysis, we respectively decreased and increased the substitution elasticity parameters (in the Armington CES and CET function) by 25 percent in all industries. With these modifications, we ran the simulation related to the 20 percent increase in world oil prices again. Table 17 reports on the aggregate impacts of these simulations. While the magnitudes of the impacts are slightly lower and larger with respectively lower and higher values of elasticity, the qualitative results obtained for the impact of oil prices on the Canadian economy are still valid.

Conclusions

In this paper, we have investigated the potential effects of a sustained increase in the world prices of oil products and resource-based products on the Canadian economy. We used a multi-sector intertemporal general equilibrium model that makes it possible to trace out the short- and long-run adjustment of aggregate and sectoral variables. We ran two main simulations related to the increase in import and export prices of oil products on the one hand, and resource-base commodities on the other.

The simulation results suggest that both shocks would be beneficial to the Canadian economy since, because of the improvement in Canadian terms of trade, real GDP would increase during most periods and the consumption profile would be higher in all periods. Household's welfare change would be positive. For example, a permanent 20-percent increase in world oil prices would in the long run lead to a 0.4 percent increase in GDP at factor cost in comparison to the reference situation, even though this variable declines slightly in the short run. The results also suggest that the magnitude of the long-run impact depends on the magnitude of the price change.

As expected, the increase in the prices of these tradable goods would shift resources (labour and capital) towards the export booming sectors and lead to an appreciation of the real exchange rate, which in turn would hurt traditional manufacturing exports. Contrary to prior studies that used one-sector models, results from this multi-sector analysis suggest that not all industries will be affected in similar ways. A permanent 20-percent increase in world oil prices would have in the long run positive and negative impacts on real GDP in, respectively, the petroleum and manufacturing industries. Exports in these industries would follow the same trend.

Yet, caution should be exerted in jumping to the conclusion that an increase in oil prices would create a pure Dutch disease phenomenon in Canada. While this study held constant export demand for Canadian goods in the non-booming sector, the reported impacts on sectoral variables also account for one type of endogeneity: the cost-push effect of the oil price increase on domestic industries. The decline in exports experienced by traditional manufacturing industries, especially the energy–intensive ones, could not therefore be attributed to a pure Dutch disease effect. Nevertheless, the simulation results suggest that when oil prices increase, traditional manufacturing industries could suffer from, not only appreciation of the real exchange rate, but also from the domestic slowdown led by the increase in production cost.

The sectoral adjustments, triggered by the increase in world prices of oil and resource-based commodities, would have some consequences on regional income. In general, resource-based regions like Alberta and Newfoundland would benefit from the terms of trade improvement, while regions with a heavy concentration of traditional manufacturing industries would undergo a slight decline in their income.

Finally, it is worth calling the reader's attention to the fact that the results reported in this study are not forecasts. They are rather counterfactual simulation results that were obtained while keeping certain variables constant. For example, the central bank reaction to price increase that may be critical to economic agents' behaviour has not been modelled. Moreover, the induced technological change and the innovation processes that could be triggered by the increase in oil prices and potential supply bottlenecks in resource industries in Canada have not been considered in this analysis. The actual figures of the impact of oil price increase on economic activities may be different from the ones presented in this study.

References

Bayoumi and Mühleisen (2006) Energy, The Exchange rate, and the Economy: Macroeconomic Benefits of Canada's Oil Sands Production, IMF WP/06/70

Corden, W. M. (1982) "Booming Sector and Dutch Disease Economics: Survey and Consolidation", *Oxford Economic Papers*, 36, 359-380

Dissou, Y. (2002): "Dynamic Effects in Senegal of Regional Trade Agreement among UEMOA Countries," *Review of International Economics*, 10, 177-199.

Dissou, Y., C. MacLeod and M. Souissi (2002) "Compliance Cost to the Kyoto Protocol and Market Structure in Canada: A Dynamic General Equilibrium Analysis", *Journal of Policy Modeling*, vol. 24, pp. 751-779

Dissou, Y. and V. Robichaud (2003) *Contrôle des émissions de GES à l'aide d'un système de permis échangeables avec allocation basée sur la production: Une analyse en équilibre général calculable*, Department of Finance Working Paper 2003-18, Ottawa, Canada.

Gaudreault, Carl (2003) *Le prix de l'énergie et l'activité économique au Canada*, Department of Finance Working Paper 2003-14, Ottawa, Canada

Goulder, L. H., and al. (1999): "The Cost- Effectiveness of Alternative Instruments for Environmental Protection in a Second-Best Setting," *Journal of Public Economics*, 72, 329-360.

Hunt, B., P. Isard and D. Laxton (2001) *The Macroeconomic Effects of Higher Oil Prices,* IMF Working paper, WP/01/14.

Jimenez-Rodriguez, R. and M. Sanchez (2005) "Oil Price Shocks and Real GDP Growth: Empirical Evidence for Some OECD Countries" *Applied Economics,* 37, 201-228

IMF (2004) *GEM: A New International Macroeconomic Model*, International Monetary Fund, Washington D.C.

Keuschnigg**,** C, and W. Kohler (1994): "Modeling Intertemporal General Equilibrium: An Application to Austrian Commercial Policy", *Empirical Economics*, 19, 1, pp. 131-64.

McKibbin, W. J., et al. (2000) Emissions Trading, Capital Flows and the Kyoto Protocol, *Energy Journal*, vol. 21, suppl., pp. 287-334

Rodríguez, R. J. and M. Sanchez (2005), "Oil price shocks and real GDP growth: empirical evidence for some OECD countries." *Applied Economics,* 37, pp. 201-228.

Rotemberg, J. J., and M. Woodford. (1996) "Imperfect Competition and the Effects of Energy Price Increases on Economic Activity," *Journal of Money, Credit and Banking,* 28 pp. 549-577.

Sachs, J.D. and A.M. Warner (2001) "The curse of natural resources." *European Economic Review*, 45 pp. 827-838

Stijns (2003) An Empirical Test of the Dutch Disease Hypothesis Using Gravity Model of Trade, Mimeo, University of California at Berkeley.

van Wijnbergen, S. (1984) "The 'Dutch disease': a disease after all?" *Economic Journal*, 94, pp. 41-55

Wigle, R. (2001): "Sectoral Impact of Kyoto Compliance," *Industry Canada Research Publications Program*, WP 34.

Table 1: Sectoral disaggregation in the model

Industries	Commodities
Agriculture	Agriculture
Oil & gas	Crude oil
	Natural gas
Coal	Coal
Other mining	Other mining
Power generation	Power generation
Gas pipelines	Gas pipelines
Lumber	Lumber
Wood industries	Wood industries
Pulp & paper	Pulp & paper
Paper manufacturing	Paper manufacturing
Cement	Cement
Iron & steel	Iron & steel
Smelting	Smelting
Chemicals	Chemicals
Petroleum refining	Petroleum refining
Other manufacturing	Other manufacturing
Transport industries	Transport industries
Services	Services
	Non-competitive imports

Table 2: Selected sectoral characteristics of the Canadian Social Accounting Matrix

	Share in total domestic demand		Share in total supply	
	Imports	Domestic good	Domestic supply	Exports
Agriculture	11.0	89.0	81.4	18.6
Crude oil	57.7	42.3	36.1	63.9
Natural gas	0.0	100.0	53.9	46.2
Coal	79.5	20.6	23.2	76.8
Other mining	31.8	68.2	44.0	56.0
Power generation	2.5	97.5	87.3	12.7
Gas pipelines	6.7	93.4	69.1	30.9
Lumber	12.9	87.1	38.9	61.1
Wood industries	21.0	79.0	44.9	55.1
Pulp & paper	32.4	67.7	25.1	74.9
Paper manufacturing	30.6	69.4	73.5	26.5
Cement	20.0	80.0	76.8	23.2
Iron & steel	37.2	62.8	70.8	29.2
Smelting	55.7	44.4	27.4	72.6
Chemicals	56.3	43.7	49.7	50.3
Petroleum refining	14.1	85.9	80.1	19.9
Other manufacturing	67.5	32.5	35.3	64.7
Transport industries	12.1	87.9	81.1	18.9
Services	4.5	95.5	94.4	5.7
Non-competitive imports	100.0	0.0	0.0	0.0

Source: Statistics Canada and Author's calculations

Table 3: Selected industry characteristics of the Canadian Social Accounting Matrix

	Share of sectoral GDP at factor cost in gross output	Share in sectoral GDP at factor cost of	
		Labour	Capital
Agriculture	38.1	41.5	58.5
Oil & gas	67.2	12.9	87.1
Coal	60.7	49.1	50.9
Other mining	56.2	40.8	59.2
Power generation	67.7	24.9	75.1
Gas pipelines	71.9	19.0	81.0
Lumber	34.4	53.3	46.7
Wood industries	37.7	53.8	46.2
Pulp & paper	37.5	40.3	59.7
Paper manufacturing	39.8	65.4	34.6
Cement	43.1	49.1	50.9
Iron & steel	33.7	63.8	36.3
Smelting	25.2	43.3	56.7
Chemicals	33.5	45.2	54.8
Petroleum refining	6.8	48.7	51.3
Other manufacturing	31.2	53.3	46.7
Transport industries	48.1	75.9	24.1
Services	56.0	69.1	30.9

Source: Statistics Canada and Author's calculations

Table 4: Selected values of technology parameters used in the model

Substitution elasticities between:	
Aggregate of value-added-energy and aggregate of other inputs	0.5
Labour and aggregate of capital and energy	0.8
Capital and total aggregate of energy inputs	0.5
Electricity and non-mobile fossil energy inputs	0.5
Fossil energy inputs	0.5
Refined petroleum products	0.5
Material inputs and mobile energy inputs	0.5
Mobile energy inputs	0.5
Capital adjustment cost parameter	4-12

Source: Various studies

Table 5: Trade substitution elasticities

	Elasticity of substitution between			
	Aggregate of imports and domestic good	**Aggregate of exports and domestic good**	**Imports from the U.S. and imports from the rest of the world**	**Exports to the U.S. and exports to the rest of the world**
Agriculture	1.5	1.5	2.25	2.25
Crude oil	0.7	0.7	1.05	1.05
Natural gas	0.7	0.7	1.05	1.05
Coal	0.95	0.95	1.43	1.43
Other mining	0.95	0.95	1.43	1.43
Power generation	1.5	1.5	2.25	2.25
Gas pipelines	0.7	0.7	1.05	1.05
Lumber	0.6	0.6	0.9	0.9
Wood industries	0.6	0.6	0.9	0.9
Pulp & paper	0.9	0.9	1.35	1.35
Paper manufacturing	0.9	0.9	1.35	1.35
Cement	1.1	1.1	1.65	1.65
Iron & steel	0.9	0.9	1.35	1.35
Smelting	0.8	0.8	1.2	1.2
Chemicals	0.9	0.9	1.35	1.35
Petroleum refining	0.7	0.7	1.05	1.05
Other manufacturing	0.5	0.5	0.75	0.75
Transport industries	1.5	1.5	2.25	2.25
Services	1.5	1.5	2.25	2.25

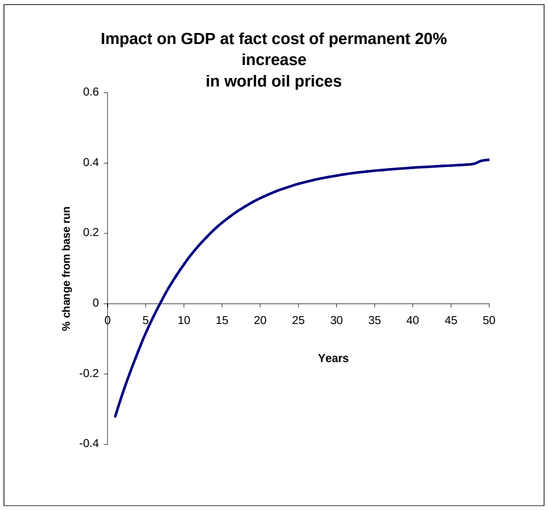
Source: Anabi, Decaluwe and Lemelin (2003)

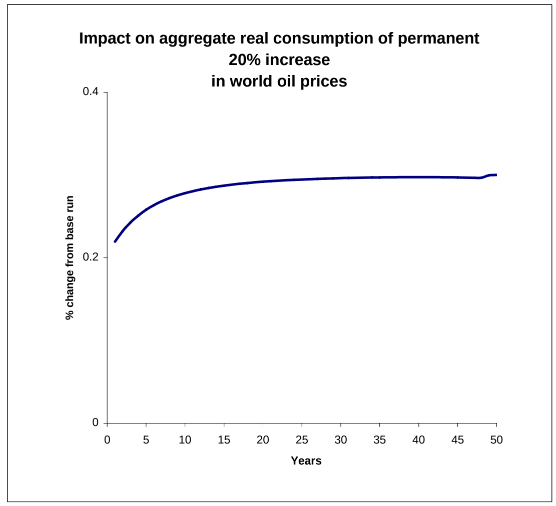
Table 6: Impacts of 20% permanent increase in world prices of oil on selected aggregate variables
Percentage deviation from base-run

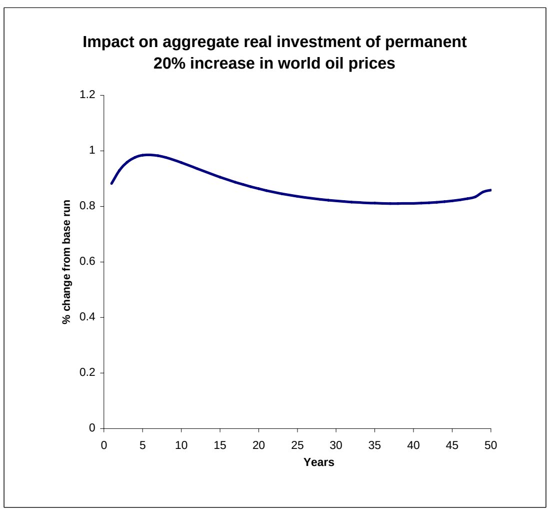
	After 1 year	After 5 years	After 10 years
GDP at market prices	-0.2	-0.1	0.0
GDP at factor cost	-0.3	-0.1	0.1
Petroleum industries	4.9	9.9	13.9
Primary resource industries	-1.7	-2.9	-3.9
Manufacturing	-1.6	-2.3	-2.7
Other industries	-0.4	-0.3	-0.3
Employment	-0.2	-0.2	-0.1
Household consumption	0.2	0.3	0.3
Consumption price index	1.3	1.2	1.2
Total real investment	0.9	1.0	1.0
Total real exports	-1.1	-1.2	-1.1
Petroleum industries	6.5	13.0	18.0
Primary resource industries	-1.9	-3.3	-4.5
Manufacturing	-1.8	-2.8	-3.4
Other industries	-2.5	-2.5	-2.5
Total real imports	-0.1	-0.2	-0.3
Petroleum industries	-7.5	-7.5	-7.4
Primary resource industries	-1.4	-2.4	-3.0
Manufacturing	0.0	-0.2	-0.3
Other industries	1.8	1.8	1.7
Real exchange rate*	-0.4	-0.3	-0.2
Measure of welfare change		0.24	

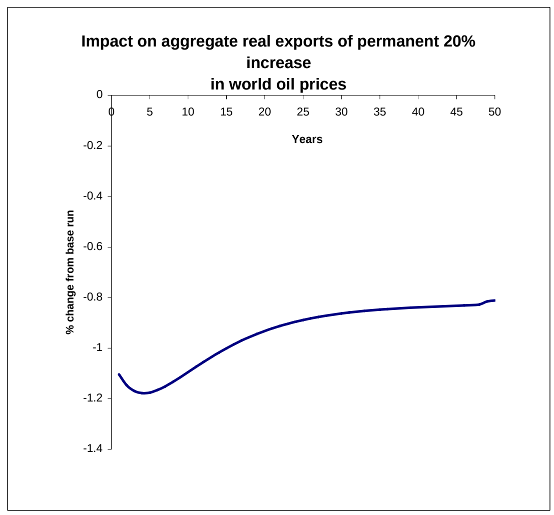
** A positive sign corresponds to a depreciation of the real exchange rate*
Source: simulation results

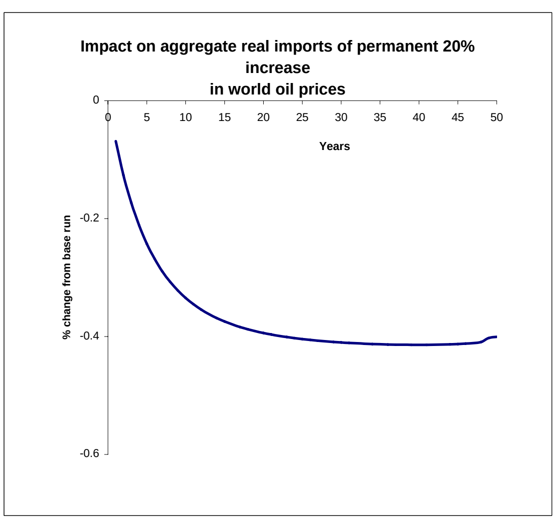
Figure 1: Impacts of 20% permanent increase in world oil prices on various variables











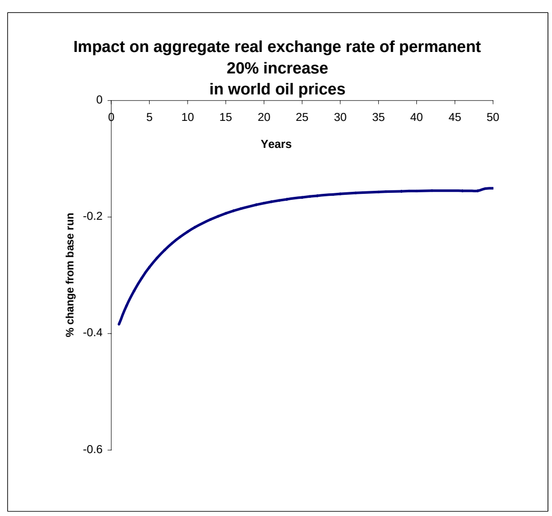


Table 7a: Impact of 20% permanent increase in world prices of oil on selected sectoral industry variables after one year
Percentage deviation from base-run

	Gross output	Sectoral GDP	Employment	Real investment
Agriculture	-2.0	-2.5	-2.1	-5.7
Oil & gas	5.3	5.8	7.9	24.0
Coal	-1.7	-2.1	-2.1	-6.8
Other mining	-1.6	-1.9	-2.1	-6.0
Power generation	0.1	0.1	0.3	0.1
Gas pipelines	0.2	0.1	0.7	5.2
Lumber	-1.9	-1.6	-2.3	-6.0
Wood industries	-1.1	-1.1	-1.5	-3.2
Pulp & paper	-2.6	-3.0	-2.9	-14.5
Paper manufacturing	-0.9	-0.9	-1.1	-3.4
Cement	-0.8	-1.0	-1.0	-2.2
Iron & steel	-1.5	-1.8	-1.8	-4.8
Smelting	-2.1	-2.5	-2.6	-9.7
Chemicals	-1.8	-2.3	-2.1	-4.9
Petroleum refining	-2.5	0.5	2.0	5.1
Other manufacturing	-1.4	-1.4	-1.6	-6.3
Transport industries	-1.5	-2.1	-1.2	-2.7
Services	-0.2	-0.3	-0.1	0.0

Source: simulation results

Table 7b: Impact of 20% permanent increase in world prices of oil on selected sectoral industry variables after 10 years
Percentage deviation from base-run

Industries	Gross output	Sectoral GDP	Employment	Real investment
Agriculture	-3.3	-3.5	-3.3	-4.2
Oil & gas	15.3	15.9	15.8	22.0
Coal	-4.4	-4.4	-4.7	-6.8
Other mining	-4.1	-3.9	-4.6	-6.4
Power generation	-0.1	0.2	-0.4	-0.7
Gas pipelines	3.5	3.5	3.9	6.0
Lumber	-4.2	-3.9	-4.4	-5.6
Wood industries	-2.2	-2.0	-2.3	-2.9
Pulp & paper	-6.2	-6.0	-6.3	-8.0
Paper manufacturing	-1.9	-1.6	-1.8	-2.1
Cement	-1.1	-1.0	-1.3	-1.5
Iron & steel	-2.5	-2.3	-2.7	-3.4
Smelting	-6.0	-6.0	-6.3	-9.0
Chemicals	-2.3	-2.1	-2.6	-3.0
Petroleum refining	-0.2	1.9	3.0	4.0
Other manufacturing	-2.5	-2.5	-2.6	-3.1
Transport industries	-1.5	-1.8	-1.2	-1.2
Services	-0.1	-0.1	-0.1	-0.1

Source: simulation results

Table 8a: Impact of 20% permanent increase in world prices of oil on selected sectoral trade variables after one year

Percentage deviation from base-run

	Total real supply	Real exports	Real domestic supply	Real total domestic demand	Real imports	Sectoral real exchange rate*
Agriculture	-2.0	-3.4	-1.6	-1.4	0.2	-1.2
Crude oil	9.5	13.1	2.6	-3.0	-6.8	15.5
Natural gas	2.1	2.4	1.9	1.9	0.0	0.7
Coal	-1.7	-1.9	-0.7	0.2	0.5	-1.3
Other mining	-1.6	-1.6	-1.5	-1.6	-1.5	0.0
Power generation	0.1	-2.3	0.4	0.5	3.2	-1.8
Gas pipelines	0.2	-1.4	0.9	1.0	3.2	-3.3
Lumber	-1.9	-2.1	-1.6	-1.6	-1.1	-0.8
Wood industries	-1.1	-1.4	-0.8	-0.7	-0.1	-1.1
Pulp & paper	-2.6	-2.9	-1.5	-1.1	-0.2	-1.6
Paper manufacturing	-0.9	-1.6	-0.7	-0.4	0.2	-1.0
Cement	-0.8	-1.6	-0.6	-0.4	0.4	-0.9
Iron & steel	-1.5	-1.9	-1.3	-1.1	-0.8	-0.6
Smelting	-2.1	-2.2	-1.8	-1.7	-1.5	-0.5
Chemicals	-1.8	-2.2	-1.3	-0.8	-0.5	-1.0
Petroleum refining	-2.5	3.1	-4.0	-5.1	-10.6	11.7
Other manufacturing	-1.4	-1.7	-0.8	-0.1	0.2	-1.9
Transport industries	-1.5	-4.2	-0.9	-0.5	2.4	-2.2
Services	-0.2	-1.9	0.0	0.0	1.9	-1.3

Source: simulation results

** A positive sign corresponds to a depreciation of the real exchange rate*

Table 8b: Impact of 20% permanent increase in world prices of oil on selected sectoral trade variables after 10 years

Percentage deviation from base-run

	Total real supply	Real exports	Real domestic supply	Real total domestic demand	Real imports	Sectoral real exchange rate*
Agriculture	-3.3	-5.1	-2.9	-2.7	-0.6	-1.5
Crude oil	20.7	26.7	8.7	-0.6	-6.7	23.5
Natural gas	11.1	15.3	7.2	7.4	0.0	9.8
Coal	-4.4	-4.9	-2.6	-0.7	-0.2	-2.6
Other mining	-4.1	-4.2	-3.8	-3.8	-3.4	-0.4
Power generation	-0.1	-1.0	0.1	0.1	1.1	-0.7
Gas pipelines	3.5	2.1	4.1	4.3	6.2	-2.9
Lumber	-4.2	-4.7	-3.4	-3.4	-2.0	-2.4
Wood industries	-2.2	-2.9	-1.5	-1.2	0.0	-2.4
Pulp & paper	-6.2	-7.0	-3.6	-2.4	0.0	-4.2
Paper manufacturing	-1.9	-3.2	-1.4	-0.9	0.3	-2.0
Cement	-1.1	-2.1	-0.8	-0.6	0.5	-1.2
Iron & steel	-2.5	-3.1	-2.2	-1.8	-1.4	-1.0
Smelting	-6.0	-6.5	-4.7	-3.7	-2.9	-2.4
Chemicals	-2.3	-2.8	-1.8	-1.3	-0.9	-1.1
Petroleum refining	-0.2	7.6	-2.3	-3.7	-11.3	15.4
Other manufacturing	-2.5	-3.0	-1.5	-0.6	-0.1	-3.0
Transport industries	-1.5	-4.1	-0.9	-0.5	2.4	-2.2
Services	-0.1	-1.8	0.0	0.1	1.9	-1.3

Source: simulation results

** A positive sign corresponds to a depreciation of the real exchange rate*

Table 9: Impact of 20% permanent increase in world prices of oil on provincial GDP at factor cost
Percentage deviation from base-run

Provinces	After one year	After 5 years	After 10 years
Newfoundland	1.2	2.8	4.0
Prince Edward Island	-0.5	-0.5	-0.4
Nova Scotia	-0.2	0.1	0.3
New Brunswick	-0.5	-0.5	-0.4
Québec	-0.6	-0.7	-0.7
Ontario	-0.6	-0.7	-0.7
Manitoba	-0.5	-0.4	-0.4
Saskatchewan	0.5	1.6	2.4
Alberta	0.9	2.2	3.2
British Columbia & Territories	-0.4	-0.2	-0.1
Canada	-0.32	-0.08	0.11

Source: simulation results

Table 10: Impacts of 20% permanent increase in world prices of resource-based products on selected aggregate variables
Percentage deviation from base-run

	After 1 year	After 5 years	After 10 years
GDP at market prices	-0.3	-0.2	-0.1
GDP at factor cost	-0.3	-0.2	-0.1
Petroleum industries	-1.1	-1.7	-2.2
Primary resource industries	11.9	25.0	36.9
Manufacturing	-2.3	-3.0	-3.2
Other industries	0.0	0.1	0.1
Employment	-0.5	-0.4	-0.3
Household consumption	1.2	1.0	0.9
Consumption price index	1.8	1.9	2.0
Total real investment	1.0	1.2	1.3
Total real exports	-1.8	-1.6	-1.1
Petroleum industries	-1.6	-2.4	-3.1
Primary resource industries	21.0	37.6	52.1
Manufacturing	-3.0	-3.6	-3.6
Other industries	-2.8	-2.7	-2.7
Total real imports	0.7	0.7	0.8
Petroleum industries	0.9	1.2	1.5
Primary resource industries	-14.3	-17.0	-18.3
Manufacturing	0.3	0.3	0.4
Other industries	3.6	3.9	4.3
Real exchange rate*	-1.3	-1.4	-1.5
Measure of welfare change		0.53	

** A positive sign corresponds to a depreciation of the real exchange rate*
Source: simulation results

Figure 2: Impacts of 20% permanent increase in world commodities prices on various variables

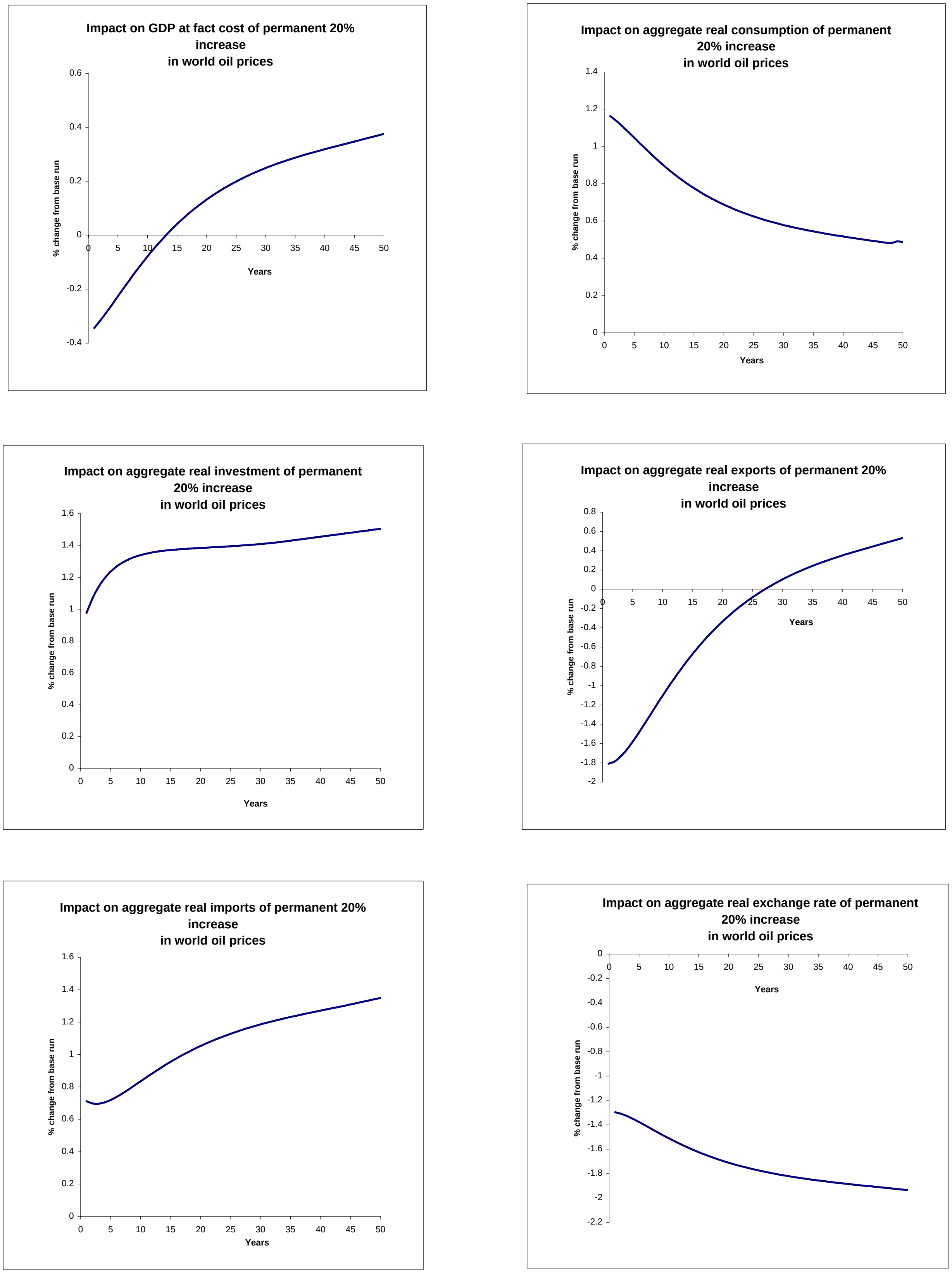


Table 11a: Impact of 20% permanent increase in world prices of resource-based products on selected sectoral industry variables after one year
Percentage deviation from base-run

	Gross output	Sectoral GDP	Employment	Real investment
Agriculture	1.4	1.5	1.5	7.8
Oil & gas	-1.2	-1.3	-1.7	-3.5
Coal	-2.1	-2.3	-3.0	-11.2
Other mining	10.8	11.8	15.9	51.8
Power generation	-0.1	-0.1	-0.6	0.5
Gas pipelines	-0.2	-0.1	-1.1	-2.2
Lumber	16.1	12.1	20.1	51.1
Wood industries	-0.2	-0.7	-1.2	0.9
Pulp & paper	-2.1	-2.8	-3.0	-4.9
Paper manufacturing	-1.0	-1.1	-1.6	-3.0
Cement	-1.4	-1.3	-1.8	-2.2
Iron & steel	-2.6	-2.9	-3.3	-7.2
Smelting	-8.3	-7.8	-8.8	-8.6
Chemicals	-2.0	-2.4	-2.7	-7.1
Petroleum refining	0.2	0.0	-0.4	0.3
Other manufacturing	-2.2	-2.2	-2.7	-9.3
Transport industries	-0.9	-1.0	-1.2	-1.9
Services	0.0	0.0	-0.1	1.2

Source: simulation results

Table 11b: Impact of 20% permanent increase in world prices of resource-based products on selected sectoral industry variables after 10 years
Percentage deviation from base-run

Industries	Gross output	Sectoral GDP	Employment	Real investment
Agriculture	4.9	4.8	4.8	7.7
Oil & gas	-2.3	-2.4	-2.5	-2.8
Coal	-7.8	-8.0	-8.3	-12.2
Other mining	39.0	39.2	41.3	63.5
Power generation	0.4	0.4	0.1	1.1
Gas pipelines	-1.3	-1.3	-1.8	-2.0
Lumber	36.6	34.2	37.3	51.2
Wood industries	2.9	0.9	0.8	2.1
Pulp & paper	1.2	-0.1	-0.1	2.5
Paper manufacturing	-1.1	-1.5	-1.6	-1.4
Cement	-0.6	-1.0	-1.1	-0.5
Iron & steel	-3.5	-4.0	-4.1	-4.5
Smelting	0.9	-0.4	-0.6	7.1
Chemicals	-4.1	-4.5	-4.4	-5.5
Petroleum refining	0.3	0.0	-0.1	0.4
Other manufacturing	-3.5	-3.8	-3.9	-4.4
Transport industries	-1.0	-1.1	-1.2	-0.9
Services	0.1	0.0	0.0	0.3

Source: simulation results

Table 12a: Impact of 20% permanent increase in world prices of resource-based products on selected trade variables after one year
Percentage deviation from base-run

	Total real supply	Real exports	Real domestic supply	Real total domestic demand	Real imports	Sectoral real exchange rate*
Agriculture	1.4	-2.0	2.2	2.7	6.6	-2.9
Crude oil	-1.3	-1.8	-0.5	0.3	0.8	-1.9
Natural gas	-1.0	-1.9	-0.3	-0.3	0.0	-2.3
Coal	-2.1	-2.3	-1.2	-0.4	-0.2	-1.1
Other mining	10.8	18.4	0.2	-5.2	-15.3	19.4
Power generation	-0.1	-2.0	0.2	0.2	2.4	-1.5
Gas pipelines	-0.2	-0.6	-0.1	-0.1	0.4	-0.7
Lumber	16.1	22.8	4.1	1.9	-11.8	28.9
Wood industries	-0.2	-0.4	0.0	0.1	0.4	-0.7
Pulp & paper	-2.1	-2.4	-1.2	-0.8	0.1	-1.4
Paper manufacturing	-1.0	-2.1	-0.7	-0.3	0.7	-1.5
Cement	-1.4	-2.9	-0.9	-0.5	1.1	-1.9
Iron & steel	-2.6	-3.4	-2.3	-1.8	-1.2	-1.3
Smelting	-8.3	-9.0	-6.4	-4.9	-3.7	-3.6
Chemicals	-2.0	-2.7	-1.3	-0.6	0.1	-1.6
Petroleum refining	0.2	-0.4	0.4	0.5	1.3	-1.2
Other manufacturing	-2.2	-2.8	-1.1	0.0	0.5	-3.4
Transport industries	-0.9	-3.2	-0.4	0.0	2.6	-2.0
Services	0.0	-2.9	0.2	0.4	3.4	-2.1

Source: simulation results

** A positive sign corresponds to a depreciation of the real exchange rate*

Table 12b: Impact of 20% permanent increase in world prices of resource-based products on selected trade variables after 10 years
Percentage deviation from base-run

	Total real supply	Real exports	Real domestic supply	Real total domestic demand	Real imports	Sectoral real exchange rate*
Agriculture	4.9	1.3	5.7	6.2	10.2	-2.9
Crude oil	-2.6	-3.5	-1.1	0.4	1.4	-3.6
Natural gas	-2.0	-3.7	-0.6	-0.7	0.0	-4.6
Coal	-7.8	-9.0	-4.1	-0.1	1.0	-5.6
Other mining	39.0	56.4	12.7	1.5	-18.8	35.0
Power generation	0.4	-2.4	0.8	0.9	4.2	-2.2
Gas pipelines	-1.3	-2.3	-0.9	-0.8	0.6	-2.1
Lumber	36.6	49.3	11.5	7.5	-16.7	46.2
Wood industries	2.9	3.9	1.7	1.3	-0.5	3.5
Pulp & paper	1.2	1.4	0.7	0.4	0.0	0.8
Paper manufacturing	-1.1	-2.2	-0.6	-0.1	1.0	-1.8
Cement	-0.6	-2.1	-0.2	0.3	1.8	-1.8
Iron & steel	-3.5	-4.6	-3.0	-2.3	-1.4	-1.9
Smelting	0.9	1.3	-0.2	-1.0	-1.7	1.9
Chemicals	-4.1	-5.6	-2.6	-0.9	0.4	-3.5
Petroleum refining	0.3	-0.8	0.6	0.8	2.0	-2.0
Other manufacturing	-3.5	-4.4	-2.0	-0.4	0.5	-5.1
Transport industries	-1.0	-4.1	-0.3	0.2	3.7	-2.6
Services	0.1	-3.0	0.3	0.5	3.8	-2.3

Source: simulation results

** A positive sign corresponds to a depreciation of the real exchange rate*

Table 13: Impact of 20% permanent increase in world prices of resource-based products on provincial GDP at factor cost
Percentage deviation from base-run

Provinces	After one year	After 5 years	After 10 years
Newfoundland	0.1	0.6	1.1
Prince Edward Island	0.0	0.3	0.4
Nova Scotia	-0.1	0.1	0.2
New Brunswick	0.0	0.3	0.6
Québec	-0.4	-0.4	-0.3
Ontario	-0.6	-0.6	-0.6
Manitoba	-0.2	-0.1	0.0
Saskatchewan	0.1	0.5	1.0
Alberta	0.0	0.4	0.9
British Columbia & Territories	-0.1	0.2	0.4
Canada	-0.34	-0.23	-0.08

Source: simulation results

Table 14: Sensitivity analysis - Impacts of 20% permanent increase in world prices of oil and resource-based products on selected aggregate variables
Percentage deviation from base-run

	After 1 year	After 5 years	After 10 years
GDP at market prices	-0.4	-0.3	-0.1
GDP at factor cost	-0.6	-0.3	0.0
Petroleum industries	3.8	7.7	10.7
Primary resource industries	10.3	21.3	31.1
Manufacturing	-3.7	-4.9	-5.3
Other industries	-0.4	-0.2	-0.2
Employment	-0.6	-0.5	-0.4
Household consumption	1.2	1.2	1.1
Consumption price index	2.9	3.0	3.1
Total real investment	1.8	2.0	2.1
Total real exports	-2.7	-2.5	-1.9
Petroleum industries	5.0	10.0	13.7
Primary resource industries	19.2	32.9	44.6
Manufacturing	-4.5	-5.9	-6.3
Other industries	-5.0	-4.8	-4.9
Total real imports	0.6	0.5	0.5
Petroleum industries	-6.7	-6.5	-6.2
Primary resource industries	-15.4	-18.7	-20.4
Manufacturing	0.4	0.2	0.2
Other industries	5.2	5.4	5.8
Real exchange rate*	-1.5	-1.5	-1.5
Measure of welfare change		0.73	

** A positive sign corresponds to a depreciation of the real exchange rate*
Source: simulation results

Table 15: Impacts of 20% permanent increase in world prices of oil and resource-based products on provincial GDP at factor cost
Percentage deviation from base-run

Provinces	After one year	After 5 years	After 10 years
Newfoundland	1.4	3.2	4.7
Prince Edward Island	-0.5	-0.2	-0.1
Nova Scotia	-0.3	0.1	0.5
New Brunswick	-0.5	-0.1	0.1
Québec	-1.0	-1.0	-0.9
Ontario	-1.1	-1.2	-1.2
Manitoba	-0.7	-0.5	-0.3
Saskatchewan	0.6	2.0	3.1
Alberta	0.9	2.5	3.8
British Columbia & Territories	-0.4	0.0	0.3
Canada	-0.61	-0.28	0.03

Source: simulation results

Table 16: Sensitivity analysis - Impacts of 40% permanent increase in world prices of oil on selected aggregate variables
Percentage deviation from base-run

	After 1 year	After 5 years	After 10 years
GDP at market prices	-0.5	-0.3	-0.2
GDP at factor cost	-0.8	-0.2	0.3
Petroleum industries	9.4	21.6	32.1
Primary resource industries	-4.1	-6.9	-9.4
Manufacturing	-3.8	-5.5	-6.4
Other industries	-0.8	-0.6	-0.5
Employment	-0.6	-0.5	-0.3
Household consumption	0.9	1.0	1.0
Consumption price index	3.1	3.0	3.0
Total real investment	2.1	2.5	2.4
Total real exports	-3.0	-3.1	-2.9
Petroleum industries	12.0	27.5	40.5
Primary resource industries	-4.5	-8.0	-10.8
Manufacturing	-4.4	-6.7	-8.1
Other industries	-5.7	-5.8	-6.0
Total real imports	0.3	-0.1	-0.3
Petroleum industries	-13.0	-12.7	-12.4
Primary resource industries	-3.3	-5.6	-7.1
Manufacturing	0.3	-0.1	-0.4
Other industries	4.6	4.5	4.6
Real exchange rate*	-1.4	-1.3	-1.2
Measure of welfare change		0.70	

** A positive sign corresponds to a depreciation of the real exchange rate*

Source: simulation results

Table 17: Impacts of 10% permanent increase in world prices of oil on selected aggregate variables: sensitivity analysis on trade substitution elasticities

Percentage deviation from base-run

	After 1 year			After 5 years		
	Low elasticities	**Base elasticities**	**High elasticities**	**Low elasticities**	**Base elasticities**	**High elasticities**
GDP at market prices	-0.16	-0.18	-0.20	-0.09	-0.10	-0.11
GDP at factor cost	-0.27	-0.32	-0.36	-0.07	-0.08	-0.10
Petroleum industries	4.42	4.90	5.25	8.41	9.94	11.27
Primary resource industries	-1.70	-1.74	-1.75	-2.68	-2.90	-3.09
Manufacturing	-1.46	-1.62	-1.73	-1.96	-2.31	-2.62
Other industries	-0.34	-0.41	-0.46	-0.25	-0.31	-0.37
Employment	-0.17	-0.20	-0.23	-0.14	-0.17	-0.19
Household consumption	0.19	0.22	0.26	0.23	0.26	0.29
Consumption price index	1.31	1.26	1.21	1.27	1.22	1.18
Total real investment	0.72	0.88	1.02	0.78	0.98	1.18
Total real exports	-0.96	-1.10	-1.22	-1.01	-1.18	-1.32
Petroleum industries	5.83	6.54	7.09	10.80	13.01	15.00
Primary resource industries	-1.86	-1.89	-1.89	-3.09	-3.35	-3.55
Manufacturing	-1.66	-1.84	-1.98	-2.41	-2.84	-3.21
Other industries	-1.97	-2.46	-2.91	-1.97	-2.49	-2.98
Total real imports	-0.09	-0.07	-0.03	-0.22	-0.24	-0.24
Petroleum industries	-6.65	-7.48	-8.06	-6.44	-7.48	-8.27
Primary resource industries	-1.34	-1.39	-1.43	-2.14	-2.40	-2.62
Manufacturing	0.04	0.04	0.05	-0.12	-0.15	-0.18
Other industries	1.39	1.80	2.20	1.35	1.75	2.15
Real exchange rate*	-0.44	-0.38	-0.34	-0.34	-0.29	-0.25

Source: simulation results

** A positive sign corresponds to a depreciation of the real exchange rate*

Base elasticities' refers to the simulation with base elasticity values

Low elasticities' refers to the simulation with 25% lower than base elasticity values

Base elasticities' refers to the simulation with 25% higher than base elasticity values