UNIVERSITY OF ALBERTA

The Implications of Multilateral Trade Liberalization for Canadian Agriculture: A Computable General Equilibrium Evaluation

by

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The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled THE IMPLICATIONS OF MULTILATERAL TRADE LIBERALIZATION FOR CANADIAN AGRICULTURE: A COMPUTABLE GENERAL EQUILIBRIUM EVALUATION submitted by SHIFERAW ABEBE ADILU in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY IN AGRICULTURAL ECONOMICS.

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Abstract

This study evaluates the impacts of the Uruguay Round Agreement (URA) on Canadian agriculture using a computable general equilibrium model. The Canadian economy is divided into six agricultural and two non-agricultural sectors. Along with the URA policy commitments, two sets of anticipated world price changes predicted in studies of the global effects of the URA were introduced exogenously. Simulations show that the potential benefits/losses depend on the extent of anticipated world price changes. The "minimum" increases in world prices from global models are too small to offset the negative effects on Canadian agriculture of URA commitment reductions in tariffs, export subsidies and domestic support. If world prices were to change by the "maximum" level, however, Canadian agricultural producers gain from the URA. The sectors that benefit the most are wheat, other grains and processed foods, for which production and exports increase appreciably.

A third experiment is conducted to determine the extent of world price changes that would offset the negative effects on sectoral domestic production of the URA policy commitments. In most cases, these are closer to the minimum than the maximum predicted changes in world prices. If an equal probability is assumed for the occurrence of the minimum and maximum world price changes, the Canadian farm sector in aggregate has gained from the URA.

A comparison of the relative importance of the three URA policy commitments indicates that domestic support reduction is the most important and tariff reduction the least important in terms of their effect on domestic production, factor allocations and exports. Two further experiments involved attributing export subsidy reductions by

Canada to other reasons than the URA, and the introduction of compensatory transfers to agricultural households in the amount of the domestic support reduction commitment. The results show that export subsidy reduction is only important to the grain sectors, while compensatory transfers have substantial effects on household income. Finally, a recursive-dynamic analysis shows that the traces of important variables during the URA implementation period depend on the magnitude of the changes in world prices; these influences vary by sector.

To my parents who, though not educated themselves, made sure that I got education.

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1. INTRODUCTION

1.1 Introduction

Despite the importance of its historic role to Canadian economic development, and its continuing importance to linked industries, the direct contribution of the agricultural sector to the Canadian economy is relatively small. In terms of its share in the GDP and employment provision, the sector accounts for only three per cent of GDP and four per cent of the labour force. It follows that the grain sector has even a lower proportional contribution to aggregate income and employment in the Canadian economy. However, the share of the agricultural sector in total export revenue is substantial. In recent years, agricultural exports constituted 10 per cent of total Canadian export revenue; grain is an important component of Canadian agricultural exports (Carter, 1993). Most of Canada's grain is grown in the Prairie provinces; much of this is destined for exports, a fact which makes the world grain market of particular importance to these provinces. For instance during the 1983-1992 period, 75 per cent of the wheat and 35 per cent of the barley produced in Western Canada was exported (CWB, 1993).

Another factor also makes the export market important to grain producers. Since domestic demand for agricultural and food products is relatively stable, variations in farm prices and farm incomes are predominantly determined by situations in the international market, apart from weather influences or supply shifts that may occur for technological reasons (Tweeten, 1992). Wheat is the most important crop grown in Canada, typically followed by barley, rapeseed and oats. Export magnitudes of the grain types follow the same order as production volumes. Canada exports Western Canadian wheat and barley through the Canadian Wheat Board (CWB), which also has authority over domestic sales of these grains for human consumption. The Board's payments to producers are based on price pools for the major classes of grain, adjusted by grade and location. Export shipments are serviced by a system of delivery quotas and contracts, which allocate access to the primary elevator system[1].

The structure of the world market for grain includes relatively few countries that supply most of the grain which is internationally traded. Much export of grain is made through state agencies (in particular, by the Canadian and Australian Wheat Boards) or relatively large transnational grain trading firms. Thus, oligopolisic behaviour may occur among exporters. Many of the major importers buy grain through central buying agencies. Market power may, therefore, be exercised on both sides of grain transactions. The importance of export subsidies since the mid-1980s may indicate that price competition predominates competition among the oligopolistic suppliers. However, quality, grading and other aspects of service, such as credit, may be of importance; Australia and Canada, in particular, emphasize quality and grading to differentiate their products.

About 70 per cent of world trade in wheat and barley was subsidized in the late 1980s and early 1990s (CWB, 1992).[2] This market situation may have penalized less

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1 For a recent critical overview of the role of the CWB, see Veeman, Canadian Journal of Agricultural Economics, 1998.

[2]The rise in the magnitude of agricultural export subsidization during this period was mainly due to the introduction of the export enhancement program (EEP) by the United States. This was initiated, primarily, in retaliation to the European Community agricultural subsidy and export restitution programs.

subsidized exporters, such as Argentina, which lost market share. Until the Uruguay Round (UR) of the negotiations of the General Agreement on Tariffs and Trade (GATT), agriculture was largely outside the trade liberalization process. A major achievement of the Uruguay Round was, among other things, that it brought the liberalization of trade in agricultural products into the domain of GATT and the World Trade Organization (WTO).

The Uruguay Round Agreement (URA) to liberalize agricultural trade incorporates three main provisions; these relate to market access, export competition, and internal support.[3] Regarding market access, with the exception of a few countries, the participants agreed to convert all non-tariff trade restrictions into tariff restrictions. Furthermore, i) all tariffs are bound, in the sense that countries can not unilaterally raise these without consulting trade partners; and ii) countries allow minimum access opportunities, as through tariff rate quotas, thus allowing a minimum amount of imports to occur without tariffs or at lower levels of tariffs. The Agreement requires developed countries to reduce existing and new tariffs by 36 per cent on average, from the 1986-88 base period, over the six year implementation period of 1995 to 2001. A minimum tariff reduction of 15 per cent is required on each import item. Correspondingly, developing countries are required to make a overall tariff reduction of only 24 per cent, with a minimum requirement for each import item of 5 per cent, over a ten year period.

[3]A fourth component was made through the development of sanitary and phytosanitary provisions.

With respect to export competition, the URA banned the introduction of new subsidies on agricultural exports. Existing subsidies are being reduced both in terms of expenditure and volume. Developed countries are required to cut expenditures on subsidies by 36 per cent over the six year implementation period from the 1986-90 base level. At the same time, they have to reduce the volume of exports that obtain subsidies by 21 per cent over the same implementation period. Developing countries are required to reduce expenditure on subsidies by 24 per cent and to reduce the volume of subsidized exports by 14 per cent over a ten year period.

The URA has also put quantitative restrictions on certain types of domestic support. This in itself is a vital outcome, because domestic agricultural policies have impacts on international trade through their effects on production. The agreement called for a reduction over the six-year implementation period of 20 per cent in the total trade distorting-support by each of the developed countries, aggregated across all commodities from the 1986-88 base level. For developing countries, the corresponding figure is 14 per cent over a ten year period. If current support levels are less than 5 per cent for developed countries, and less than 10 per cent for developing countries, they are exempted from this provision.

Domestic support programs with no or minimal trade distorting effects on production were exempted from the reduction commitments. These "green box" programs include decoupled income support, safety-net programs, set-aside payments, regional and environmental aids, advisory services, and domestic food aid. The so-called "blue-box" measures or "direct payments under production-limiting programs" are also exempted from the domestic support reduction commitment. These include primarily the US deficiency payments and the new compensation payments under the reformed Common Agricultural Policy of the EU (IATRC, 1994). "Amber" programs include subsidies that distort production and trade and are subject to the 20 per cent reduction from the 1986-88 base level.

The agreements reached in these three main areas have different implications for different countries. Obviously, those nations that were previously most disadvantaged from distorted world markets are likely to benefit the most from the Agreement. Canada is claimed to be one of these countries. It is maintained by Canadian sources and others (e.g., Brooks and Kraft, 1994; Agriculture and Agri-Food Canada, 1993; provincial and federal officials, 1994) that the URA will improve the prospects of export prices and volumes of grain for Canadian grain producers.

1.2 Objective of the Study

The main objective of this study is to evaluate the implications of the Uruguay Round Agreement on Agriculture for Canadian agricultural producers. Apart from the benefits of a rules-based and more predictable trading environment, which the URA is expected to bring about, in practice, the benefits/losses to agricultural producers depend on how much world prices rise following the multilateral trade agreement. This thesis attempts to assess the gains/losses to Canadian agriculture that arise from alternative world price scenarios and URA-related domestic policy commitments.

Most previous studies on the effects of multilateral trade liberalization are global in their coverage and give only limited detail for individual countries. This thesis applies a Canada-specific model to evaluate in more detail the impacts of the URA on Canadian agriculture. Specifically, interest is focused on: i) quantifying the gains or losses from the multilateral trade agreements to Canadian grain producers; ii) evaluating the impacts of the multilateral trade liberalization on the non-grain agricultural and related non-farm sectors; iii) evaluating the implications for factoral income distribution and intersectoral transfer of factors of production; and iv) assessing the effects of compensatory transfers by which agricultural households are compensated for what they lose from domestic support reduction.

1.3 The Implications of Multilateral Trade Liberalization: A Literature Review

Numerous studies have been done on agricultural trade liberalization before and after the UR of the GATT negotiations. However, with the conclusion of the UR, the practical or empirical relevance of the studies done before the agreement differs from those done after the agreement. Those studies that were conducted before the beginning of the UR negotiations had some contribution, direct or indirect, towards the launching of the Round. Once the UR negotiations were launched, more empirical studies were conducted in part to provide information to negotiators regarding the stakes for each participating country in liberalizing agricultural trade. A common feature of the studies done before the conclusion of the UR is that most agreed that agricultural trade liberalization would have a positive and substantial impact on the economies of all participants. Did these studies achieve their objective of convincing policy makers in one way or another? The experience has been documented concisely by Rossmiller (1994). In his opinion, the economic studies had some influence.

Some major reasons for bringing agriculture within the provisions of GATT are discussed in IATRC (1994), Rossmiller (1994), Roningen and Dixit (1989), and Krugman (1992). Krugman (1992) provides an economic motivation for trade negotiations in general that is akin to mercantilism: each country sees imports as "bad" and exports as "good". At the same time, each believes that the "good" of exports outweighs the "bad" of imports. So they negotiate. Their strategy in negotiating will be to minimize imports (the "bads") and maximize exports (the "goods"). According to Roningen and Dixit (1989), a risk of an international subsidy war, primarily between the US and EC, combined with ever-increasing government expenditures required to sustain protectionist policies, were the major reasons for bringing agriculture into the GATT discussions. A related factor was that trade disputes involving agricultural products were difficult to settle without some formal legal framework (IATRC, 1994).

Baker et al (1989) points out an interesting circularity phenomenon that involves budget problems. The starting point is called the "farm problem" (i.e. the declining of the relative economic position of the farm sector). To alleviate this problem, governments advance budgetary support to the agricultural sector. This in turn induces more production, more surplus, and, hence, more exports. If many countries were engaged in subsidizing their agricultural sector at the same time, the world price of farm products would be depressed substantially. Lower export prices would mean lower farm incomes, which would have to be supplemented by budgetary assistance. Therefore, as Meilke and

Larue (1989) argue, all of the policy expenditures included in subsidy calculations do not accrue to farmers as net gains. Meilke and Larue's calculation is that 50 per cent of the agricultural policy expenditure in Canada, for example, was necessary to offset the price depressing effect of other countries' policies. According to Roningen and Dixit (1989), 65 per cent of agricultural policy expenditure by Canada was necessary to offset the price depressing effects of its own and other countries' policies.

The studies that were conducted on agricultural trade liberalization provide more than just intuitive results. By and large these studies employed highly sophisticated global simulation models to give quantitative results. A review of the studies done before the conclusion of the Uruguay Round is necessary in order to assess their methodological relevance. Moreover, their predictive power is not yet fully tested as the implementation of the URA is in its early stages.

Modelling exercises to simulate liberalized trade in many of the major studies involved the linking of country/region specific supply and demand relations of the main agricultural commodities. Such studies include Valdes and Zietz (1980), Burniaux and Waelbrock (1984), Anderson and Tyers (1987, 1988), OECD (1987), USDA (1987), Parikh et al (1988), Roningen and Dixit (1989), and Cahill (1991). Some of the important differences among these global models concerned their being general or partial equilibrium models (most are the latter) and whether they were dynamic or static, and the way in which dynamics were introduced. Other differences arise from the way policy interventions were modelled and the choice of elasticity estimates incorporated into the models (Gardner, 1988).

The simulation of agricultural trade liberalization followed the manner in which policy was introduced into the model. Some of the empirical studies used the concept of Producer and Consumer Subsidy Equivalents (PSEs and CSEs) as summary measures of government intervention. In other studies (e.g., Anderson and Tyers, 1988), distortions were measured via price transmission equations or elasticities. Policy changes, in either case, were then simulated by lowering the PSEs to zero, or by changing the price transmission equations. In most cases, a complete liberalization is simulated. The use of PSEs as a summary measure of policy was not, however, without criticisms (Gardner, 1988; Hertel, 1989; Meilke and Larue, 1989; Robinson, 1990). This is because the original PSE calculations by USDA and OECD did not differentiate between policies which affect incentives and those which do not. As such, PSEs may be used as approximations to policy effects when the experiment is to simulate complete liberalization, but not for cases of partial liberalization experiments (Robinson, 1990). An alternative to using PSEs is to consider only border measures, as represented by tariff equivalents, such as in Parikh et al (1988). One concern about the use of border measures is that they constitute only a subset of PSEs and have the disadvantage of ignoring government direct payments which have production-inducing effects. There is, however, some support for using border measures from empirical studies. These studies (e.g., Meilke and Larue, 1989) propose that the agricultural trade problem is mainly a demand side problem which is primarily affected by border measures. Still another alternative to using PSEs and border measures is to model policy interventions explicitly (e.g., Robinson et al, 1990).

For the purpose of this study, special interest is focused on the effects of agricultural trade liberalization on the world price of agricultural commodities. The importance of this effect derives from the fact that the compensation to producers for their loss due to the termination of agricultural support programs comes from world price changes. The price effect of liberalization depends on a host of factors, some of which have been incorporated in the simulation models mentioned above. A consensus seems to exist that the price of agricultural products would increase following liberalization. The following results are based on simulation results that assumed complete liberalization.

The most generous projection is obtained from the Static World Policy Simulation (SWOPSIM) results (Roningen and Dixit, 1989). Taking 1986/87 as a base year, multilateral trade liberalization by Industrial Market Economies (IMEs) was projected to raise average world agricultural prices by 22 per cent. Wheat, coarse grain, oilseeds and products, dairy products, ruminant meat and non-ruminant meat prices are each projected to rise by 36.7, 26.3, 6.4, 65.3, 21, and 12.4 per cent, respectively. These price increases are related to the level of support that each commodity was getting under the base scenario. The most important contributors to the price effect are the liberalizations by the US and the EEC. However, the same study projected average producer prices, defined as producer incentive prices (i.e., market prices and direct support payments alone) to decline for all countries, except for Australia and New Zealand. For Canada, producer prices for farm products as a whole were projected to decline by an average of 8 per cent from the status quo while producer prices of dairy products, wheat, coarse grain, and oilseeds and products were projected to decline by 27, 18, 26, and 4 per cent respectively.

Corresponding production quantities were also projected to decline, though by a much lower percentage.

Frohberg (1989) used SWOPSIM results (Roningen, 1988) and a 1986 base period. It was forecast that total agricultural output would increase in Canada by 7 per cent in year 2000, induced by a 4 per cent increase in agricultural prices. In Japan and EC, the other two countries or country groups included in the study, output projections were negative for year 2000. This result appears counter-intuitive; since per capita policy transfers to agriculture for the simulated period of 1986 were larger in Canada than in Japan and EC, Canada's farmers would be expected to be relatively more adversely affected by agricultural trade liberalization than the other two countries. The study by Cahill (1991) is based on a liberalization scenario and a base period which is very close to the final agreement of the UR. Using a Trade Analysis Simulation System (TASS), the study projected a modest increase in the world price of grains and oilseeds (a maximum of 5 per cent for wheat for the base period). Substantial changes were simulated for dairy products (maximum of 27 per cent). Other studies that used different base periods have obtained a qualitatively similar result regarding the positive impact of multilateral trade liberalization on world prices. These include Anderson and Tyers (1988), and Parikh et al (1988). The exception is the OECD (1987) study, which assumed a 10 per cent reduction in border protection by all industrial countries from a 1981 base. The projection from this assessment was for a fall in the world price of wheat and coarse grain for the year 1996.

A common conclusion of the majority of the studies previous to the UR is that the rise in world prices following trade liberalization would not fully compensate farmers for what they lose as a result of the removal of all distortionary policies from complete trade liberalization (Burniaux et al, 1989). From a sectoral viewpoint, partial liberalization could be preferred (Robinson, 1990). This is what actually occurred as a result of the URA on agriculture.

Due to the non-linear effect of policies, it would be inappropriate to extrapolate the results from the studies assessing complete liberalization into the partial liberalization scenario of the URA. Consequently, some studies have been conducted following the conclusion of the UR. Some of these studies focus on the interpretation of the commitments, while others venture to provide some preliminary quantitative findings. Many researchers are very critical of some aspects of the actual implementation of the URA. Consider the tariffication agreement, for example. Many countries have set the new tariff rates at such high levels that the level of protection is higher than that which existed during the base period of 1986-88 (Ingco, 1994; Hathaway, 1994; IATRC, 1994)[4]. This situation lowers the opportunity for Canada to expand its market in grain, say, in North Africa, Asia, and South America. On the other hand, Canada faces a lower level of protection for wheat and coarse grain in Japan (a reduction of 411.4 per cent and 445.9 per cent, respectively (Brooks and Kraft, 1994)). Canada also faces a lower level of protection for wheat in Brazil and the US (a reduction of 53 per cent and 14 per cent

[4]Theoretically, tariffication has the following advantages (Ingco, 1994; Shanahan, 1994; IATRC, 1994): i) it gives greater transparency with respect to trade measures that individual countries might take; ii) it removes the grey area techniques of import control; iii) it is easier to bind and reduce; iv) it renders better distribution of adjustment costs of world market shocks among countries; v) market signals can influence production and consumption decisions better through tariffs; vi) export subsidies can also be disciplined indirectly because of the possibility of reimporting; and vii) the world market will be more predictable and more stable. The last factor is of much importance for exporting countries like Canada.

respectively), but higher protection for coarse grain (an increase of 39 per cent and 4 per cent respectively). Protection is higher in the EC and Columbia for both wheat and coarse grains, and higher for coarse grain in South Korea (Ingco, 1994). Access into South Korea's wheat market improves for Canada as the flat tariff rate of 11.8 per cent for 1995 is further reduced to 9 per cent by the end of the implementation period (Brooks and Kraft, 1994)[5]. The periods compared in the above statistics are the base period 1986-88, relative to 1995.

The possibility of effective access into the Latin America market by Canada is made less probable because of the MERCOSUR trading arrangement which includes Argentina, Paraguay, Uruguay, and Canada's major importer of grain in that region, Brazil. However, it is important for Canada that the trading environment will be more predictable and rule oriented as a result of the market access agreement (Miner, 1994; IATRC, 1994; Government of Canada, 1994). The more stable trading environment will, as a by-product, make income safety net programs less important for countries like Canada (Meilke and Larue, 1989).

The tariff reduction agreement will not have its maximum effect in that the commitment for a 36 per cent reduction is a simple average reduction which has allowed countries to reduce tariffs on sensitive products by the minimum required amount of 15 per cent. The average 36 per cent reduction is then achieved by larger percentage cuts on items which are less politically sensitive. It is believed by some that the market access

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[5]South Korea purchases one third of its wheat import from Canada. This amounted to 12 per cent of Canada's exports to Asia for the period from 1990/91 to 1992/93 (calculated from CWB, 1993).

offered by Canada for grain is not likely to have a major negative impact on producers since Canada can satisfy domestic requirements with sufficient varieties (Brooks and Kraft, 1994). However, wheat imports can increase to substantial levels since tariff reductions on wheat imports are relatively high. The supply-managed commodities are highly protected by very high tariff equivalents, which, compared to the base (1986-88), increase protection levels by 100 per cent for dairy products and more than 200 per cent for poultry (Ingco, 1994).

It is generally believed that Canada's major gain from the URA lies in the export subsidy commitment, specially with respect to grain exports. In recent years the US and EC have substantially subsidized their agricultural exports. For example, on its 17.6 million tonnes of wheat exports in the 1993/94 crop year, the US applied an average $47.81/tonne subsidy (Brooks and Kraft, 1994). The gain from the export subsidy commitment comes via the increase in world price of those products which used to be highly subsidized. The intuitive explanation is that with the subsidy cuts, domestic prices in major exporting countries will decline, which in turn will increase domestic demand. The exportable surplus will decrease, thereby raising world prices. The price effect of the subsidy cuts will, however, be delayed toward the end of the implementation period, because the US and EC make the cuts from the 1991/92 levels, which were higher than the averages for the 1986-90 period (IATRC, 1994)[6].

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[6]The subsidy and market access commitments which the US has made may have some negative effects for Canada as far as the US market is concerned. The cut in subsidies for agricultural exports by the US will dampen domestic prices in the US, eroding the premium that was created in the domestic market and was exploited by Canada under CUSTA (Alston et al, 1994). The most favoured nations

Assuming that the change in the world price for wheat will be equal to the difference in the subsidy levels before and after the URA, Brooks and Kraft (1994) projected, for the final year of the implementation period, a $35/tonne increase in the non-subsidized market. A decrease of $5/tonne is assumed in the non-subsidized markets. They calculated the gain for Canada, if the price situation mentioned above were actually to be in place for the 1993/94 crop year. Their finding was that Canadian wheat producers would have gained $460 million US. The analysis of Brooks and Kraft (1994) is, however, partial. As they noted, their analysis does not incorporate supply and demand response dynamics that arise due to the rise in grain prices. Their results are also overestimates because they have not considered certain price-depressing factors that will likely be triggered by the URA. For instance, in the US, it is expected that grain production will increase as set aside land is brought back into cultivation (CARD-FAPRI, 1994).

Recent studies from Canadian sources report very favourable price projections due to the URA (Agriculture and Agri-Food Canada, 1993; provincial and federal officials, 1994). According to provincial and federal officials (1994) the price of wheat is projected tc increase by 10 to 25 per cent by the year 2000. Projections for oilseeds, dairy, and feed grains are 0 to 5 per cent, 5 to 10 per cent, and 0-10 per cent respectively. Whether domestic grain production will decrease in Canada as an outcome of the URA is not yet clear. The implication of the Canadian export subsidy commitment was the

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(MFN) tariff concessions which the US made will also erode the preferential treatment which Canada enjoyed under CUSTA.

reduction of expenditure under the Western Grain Transportation Act (WGTA), leading to producers having to pay larger rail freight costs. Subsequently, and largely for budgetary purposes, Canadian grain transportation subsidies were terminated. This can be expected to discourage production to some degree and so may more or less offset the incentive from higher world prices.

The third important provision of the URA puts quantitative restrictions on certain types of domestic support. Some major Canadian support programs were believed to be amber programs, including the National Tripartite Stabilization Program (NTSP), the Gross Revenue Insurance Program (GRIP), and the National Income Stabilization Account (NISA) (Brooks and Kraft, 1994). Huge reductions in these programs did not have to be made since there have been substantial cuts in these programs since the late 1980s.[7] In any event, some of them have been deleted for budgetary reasons or to avoid US countervail actions.

An advantage for Canada arising from the domestic support agreement is that amber programs can be modified into green programs. The process of replacing commodity-support programs by income safety-net programs was already underway in Canada (Miner, 1994). The URA added to the incentive to convert amber programs into green programs in order to be immune from the US countervail action.

What can be assessed from the studies reviewed above regarding the implications of the URA for the Canadian grain sector? One thing is clear; there is a welfare gain for

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[7]By the beginning of the implementation period of the URA, domestic agricultural support in Canada was 40 per cent below the 1986-1988 base level (OECD, 1996).

society at large. This appears to be true for Canada as for other industrialized economies. On the issue of the welfare of agricultural producers, there is less agreement and less clarity. Some of the studies that projected a welfare loss have assumed complete liberalization where current support programs are entirely terminated without their substitution by other green programs. Moreover, none of the studies have accounted for program cuts that are dictated by budgetary reasons. These cuts should be excluded from the analysis since they would be undertaken anyway. The case in point for Canada is the termination of WGTA. The effect of developments outside the URA on world prices also should not be included in this analysis since these would have taken place anyway, whether the URA applied or not. On the other hand, most quantitative studies that projected a substantial increase in world grain prices from liberalization have not considered certain factors that are related to the URA, such as the US release of accumulated stocks or the recultivation of set asides.

Given the above qualifications, on balance, Canadian grain producers are likely to benefit from the pure effect of the URA, if not immediately then eventually. The magnitude of the gain must be assessed in the light of the actual provisions of the agreement. Even more, however, needs to be done to assess the complete repercussions of the multilateral trade liberalization agreement. Specifically, the intersectoral impacts of the agreement have to be analysed. To gain a further understanding of the impact of the UR, the implications for factor transfers and returns will be analysed in this dissertation in a more detailed framework of the Canadian economy.

2. METHODOLOGY

2.1. Introduction

The main objective of this thesis is to analyse the effects of world price changes and domestic agricultural policy commitments arising from the UR agreement on Canadian agriculture. Consequently, a computable general equilibrium (CGE) model, in the tradition of trade policy-oriented-general equilibrium (GE) models, is developed to analyse the impact of the URA. A CGE model is chosen because of the suitability of this approach for policy analysis in a multisector framework. The approach enables us to analyse the impact of changes in agricultural policies and exogenous factors on the farm sector, as well as on the related non-farm sectors and the rest of the economy in an internally consistent way. Using CGE models has the advantage of taking account of general equilibrium effects of any economic influences, i.e., it takes account of both direct and indirect effects, and also accounts for the interaction of policy measures and other exogenous factors. A general equilibrium approach has an important advantage over a partial equilibrium analysis in situations where indirect effects and the interaction between policy measures and other exogenous factors are deemed to be significant, as could be the case for agriculture.

In the following sections, the theoretical underpinnings of applied general equilibrium models are first presented. The development of applied multisector models, including CGE models, is then discussed. Finally, the CGE model for Canada that was developed for the purpose of this study is formulated and solution procedures for the CGE model are discussed.

2.2. A Walrasian General Equilibrium Approach

The theory and development of a well-formalized model of general equilibrium dates back to the nineteenth century and the initial development of this approach by Leon Walras (1874, 1877).[1] The basis of the theory is that the collective actions of consumers and producers, whose desire is to maximize individual benefits, will bring the economy into a stable equilibrium in all markets. At the heart of the Walrasian model are the assumptions of (1) perfect competition and (2) that choices of economic agents can be derived from certain axioms of rationality (Arrow and Hahn, 1971).[2] The Arrow-Debreu general equilibrium model gives the modern version of the Walrasian system. This model, as outlined by Weintraub (1979), has the following features:

i) There are two classes of agents, called consumers and firms. Consumers have preferences over different bundles of final goods, while firms have preferences over output

[1] However, Adam Smith might also be credited for pointing out the ability of a competitive system to achieve an "efficient" allocation of resources. Since such an allocation of resources is the most important implication of general equilibrium theory, it could be maintained that general equilibrium theory originates with his work. Other classical economists, such as Ricardo, Mill, and Marx, have also contributed to fill some of the gaps in Smith's theory. However, the incoherence and inconsistency of their expositions of the workings of a competitive system aside, none of the classical economists can claim to have developed a true general equilibrium theory, at least, in one important sense: demand conditions have been denied any role in bringing the competitive systems into a general equilibrium. This oversight of the role of demand conditions results from the fact that classical economics essentially has a supply-oriented nature. Along the same thread, it can be argued that the classical economists' theory of resource allocation is defective because, with the preclusion of demand conditions, the reciprocating influences between prices and quantities were denied (Arrow and Hahn, 1971).

[2] Recent developments in applied general equilibrium theory have enabled the simulation of a market economy characterized by other forms of industrial organization, such as imperfect competition.

configurations which result in profits. The preferences of consumers are sufficiently regular that they can be represented by utility functions.

ii) Consumers earn incomes from the sale of factor services and distributed profits of firms.

iii) Consumers, taking product and factor prices as given, attempt to maximize utility subject to their income constraint, while firms, taking product and factor prices as given, attempt to maximize profits subject to a technology constraint.

Then, under certain economic restrictions, it can be shown that there exists a set of factor and product prices such that, if consumers and firms were to simultaneously optimize at those prices, the output and purchase of goods that would result entails those same prices. The allocation of goods that corresponds to the competitive equilibrium is called the competitive allocation.

While Walras did not rigorously solve his system of equations of general equilibrium, he argued for the existence of an equilibrium set of prices by showing that his system contained exactly as many independent equations as unknowns to be determined. The issue of stability, which is a major concern in equilibrium model building, is dealt with through Walras' theory of tatonnement. Suppose the markets are considered in some definite order. Equilibrium in the sequenced markets is effected by adjusting the corresponding prices in turn. Starting with the first market, such adjustment will ensure the equality of demand and supply in that market, given all other prices. However, the adjustment of the price in the first market will change supply and demand in all other markets. Repeating the adjustment process with the second and subsequent markets, we can see that by the end of the first round, only the last market is in equilibrium but none of the others need be. This is because the adjustment on subsequent markets will destroy the equilibrium achieved earlier on any one market. However, Walras argued that, since supply and demand functions for any given commodity are more affected by the changes in its own price than by changes in other prices, the markets should be more nearly in equilibrium than they were to begin with. With successive rounds the supply and demand in each market will tend to equality.

A more formal representation of the Walrasian system is provided as follows (Hansen, 1970). Let the number of goods produced in the economy be n, with q_i and p_i being the quantity and price, respectively, of the *i-th* good. Let the number of factors of production such as labour, land and capital be m, with w_l and v_l being the quantity and price, respectively, of the *l-th* factor of production. Following Walras, assume that all the n goods produced are goods for final use (this is a mere simplification). Consumers' utility maximization subject to their budget constraints yield demand functions of the type:

$$q_i = q_i(p_1, \ldots, p_n;\ v_1, \ldots, v_m); \qquad i = 1, \ldots, n \tag{1}$$

The system is in equilibrium when the price of each produced good is equal to its costs. Suppose b_{il} denote the technical coefficients measuring the quantity of factor of production l necessary for producing one unit of good i. Then the cost equation for the *ith* product is given by:

$$p_i = \sum_l b_{il} v_l \qquad i = 1, \ldots, n \tag{2}$$

i.e., price must be equal to total average costs (including payments for entrepreneurial services). So, in equilibrium, demand price must be equal to supply price (Marshall's condition). On the production side, the technical coefficients depend on the choice of production technique, which, in turn, depends on the factor prices (assuming profit maximization with constant returns to scale in production). The m*n possibilities of technical substitutions have equations of the form:

$$a_{ji} = a_{ji}(v_1, \ldots, v_m)^3; \qquad i = 1, \ldots, n; \quad j = 1, \ldots, m \tag{3}$$

Assume that the supply equations for factors of production have the same form as the demand equations for produced goods:

$$F_l = F_l(p_1, \ldots, p_n; v_1, \ldots, v_m); \quad l = 1, \ldots, m \tag{4}$$

Walras derived these equations through the same utility maximization that leads to the demand equations for consumer goods.

Equilibrium conditions for factors of production are given by:

$$F_l = \sum_i b_{il} q_i; \qquad l = 1, \ldots m \tag{5}$$

Unlike produced goods whose equilibrium conditions were cast in terms of prices, for factors of production, Walras used the condition that demand quantity be equal to supply quantity.

[3] The assumption of constant returns to scale implies that the choices of techniques do not depend on the scale of production, which, in turn, implies that the prices of produced goods do not affect the choice of technique via the demand for produced goods. Hence, the exclusion of output prices from these equations.

The assumptions of zero homogeneity of consumer demand functions and linear homogeneity of profits in prices implies that only relative prices are required in the Walrasian system, i.e., the absolute price level has no impact on the equilibrium outcome. Consequently, the prices in the system are relative prices -- the money prices of the goods in terms of the money price of an arbitrarily chosen commodity, say, commodity n, which serves as the numeraire commodity and the price of which is set to 1.

In the complete system, as formulated above, we have n prices of goods, n quantities of goods, m prices of factors of production, m corresponding quantities of these factors, and n*m technical coefficients, i.e., a total of 2n + 2m + n * m unknowns to be determined in the system. The system has also n price and n quantity equations of goods, m price and m quantity equations of factors, n * m equations of technical coefficients, and one additional equation for fixing the price of the numeraire good. Thus we have 2n +2m + n * m + 1 equations, giving one more equation than unknowns. However, Walras showed that one arbitrarily chosen equation can be deleted, since it can be seen that any one equation contains no additional information that is not contained in the rest of the system. The proof is made in terms of what was later known as Walras' Law, which states that for the system as a whole, at all prices of goods and factors, total expenditure on goods must equal total income from sales of productive factors, i.e.,

$$\sum_i p_i q_i = \sum_l w_l v_l; \qquad i = 1,\ldots,n; l = 1,\ldots,m \tag{6}$$

This condition has to hold since it is the summation of the budget constraints of individual consumers, which have to be satisfied all the time. It follows that:

$$q_n = \sum_j w_j v_j - \sum_i p_i q_i ; \qquad i = 1,\dots,n-1; j = 1,\dots,m \tag{7}$$

Therefore, if we know the supply functions of factors of production, v_j , and the demand functions, q_i, i = 1, ..., n-1, then we also know the demand function q_n, i.e., the system can be solved without including the equation:

$$q_n = q_n \ (p_1,\dots,p_n; v_1,\dots,v_m). \tag{8}$$

The determination of absolute money prices requires an additional equation, known as the equation of exchange for money, or Fisher's equation of exchange. Let p_n^m denote the money price of the numeraire commodity. The money prices of the other goods and factors can be expressed as: $p_n^m \ p_1,\dots,p_n^m p_{n-1}$ and $p_n^m v_1,\dots,p_n^m v_m$. Thus, we need to determine only p_n^m. Writing out Fisher's equation:

$$MV = PT; \tag{9}$$

where M denotes the quantity of money, V velocity (i.e., the average number of times a unit of money changes hands in a specified time period), P price level, and T the level of transaction. This equation can be rewritten as:

$$MV = \sum_i p_i^m q_i + \sum_j v_{mj} w_j = p_n^m (\sum_i p_i q_i + \sum_j v_j w_j) \tag{10}$$

where $p_i^m = p_n^m p_i$; $v_l^m = p_n^m v_l$. Given M,V,p_i,q_i,v_l and , w_l, we can determine p_n^m. Given p_n^m , all other money prices can be calculated.

It should be noted that even with the inclusion of the equation of exchange, the neutrality of money with respect to relative prices and quantities bought and sold is still maintained. The added equation is useful only to determine the money price of the numeraire commodity which, in turn, can be used to determine the money prices of all other commodities in the system. Therefore, the Walrasian system, with the addition of the equation of exchange, is dichotomous, in that money does not appear in the "real" part of the system. The dichotomy reflects the economic philosophy of the neoclassical economists that money is simply a "veil" which has to be removed to study the "real" part of the economy. The cases of free goods and goods not produced were not incorporated in Walras' general equilibrium system, although the integration of such cases requires only the alteration of the equality signs in the cost and equilibrium equations into inequality signs (Hansen, 1970).

2.3. Applied Multisector Models:

Applied multisector models are variants of general equilibrium models that attempt to operationalize the abstract Walrasian system. Leontief's input-output system (1941) was the first approximation of the Walrasian model that attempted to apply the theory of general equilibrium for empirical purposes. In its most basic form, an input-output system consists of a system of linear equations, each one of which describes the distribution of an industry's product throughout the economy. The multisectoral nature of input-output model results from the interdependence between the various sectors due to commodity flows between them.

A basic assumption in the development of an input-output model is that producers are efficient in the sense that they minimize the total cost of producing any output level. A fixed-coefficients-production function characterizes the technological assumption:

$$q_j = \underset{\{i,l\}}{Min}\left(\frac{q_{ij}}{a_{ij}}, \frac{F_{lj}}{b_{lj}}\right); i, j = 1,...,n; l = 1,...,m \qquad (11)$$

where q_j is the output of industry (or sector) j, q_{ij} the input from industry i to the production process of industry j, F_{lj} is the input of primary factor l to the production process of industry j, a_{ij} and b_{lj} are fixed coefficients showing, respectively, the minimum input from industry i and primary factor l required per unit output of industry j. The minimum requirements for intermediate and primary inputs and the assumption of efficient production imply that there will not be substitution between the inputs. Producers' demand functions for intermediate and primary inputs are, therefore, given, respectively, by:

$$q_{ij} = a_{ij} q_j \qquad (12)$$

and

$$F_{lj} = b_{lj} q_j; \text{ for all } i, j = 1,\ldots,n; l = 1,\ldots,m \qquad (13)$$

Prices do not appear in the above input demand equations because of the technological assumption that no substitution takes place between inputs.

The basic input-output model takes final demands as exogenous to the system, i.e., as determined outside of the model. We simply write:

$$Y_j = \overline{Y}_j, \qquad j = 1, \ldots, n \tag{14}$$

where Y_j is the exogenously determined final demand for the product of sector j. The final demand can be divided into a number of components, such as domestic consumption (both private and government), investment, and exports.

The last step in the development of a basic input-output model is the inclusion of a market-clearing condition for each sectors' output, which is given by:

$$q_i = \sum_{j=1}^{n} q_{ij} + Y_i \tag{15}$$

We substitute equations (12) and (14) in the last expression and solve to get industry output level as a function of the exogenously determined final demand. In matrix notation we get:

$$q = (I - A)^{-1} \overline{Y} \tag{16}$$

where q is an (n x 1) vector of the q_i, $\overline{Y}$ is an $(n \times 1)$ vector of the $\overline{Y}_i$, A is an $(n \times n)$ matrix of the input-output coefficients, A_{ij}, and I is an identity matrix. The essential use of input-output models is the determination, from the above system, of the levels of output in each sector under alternative final demand assumptions. Once the level of the individual outputs that are necessary to satisfy final demands are known, we can calculate the requirements of both intermediate and primary inputs. In particular, aggregate primary input demands are determined from equation (13) as:

$$F_l = \sum_{j=1}^{n} b_{lj} q_j, \qquad l = 1,\ldots,m, \tag{17}$$

or in matrix notation

$$F = Bq, \tag{18}$$

where F is an $(m \times 1)$ vector of the F_l, i.e., the aggregate demand for factor l, and B is an $(m \times n)$ matrix of the factor input coefficients, b_{lj} .

While the above system appears to determine only equilibrium quantities, but not equilibrium prices, it can be shown that relative output prices can also be determined from the system (Hansen, 1970; Parmenter, 1982). Invoking the price equals cost assumption (i.e., a zero profit condition), output price minus the cost on intermediate inputs equals the cost of primary inputs, i.e.,

$$p_i - \sum_j a_{j\,i} p_j = \sum_l b_{li} v_l \qquad i = 1,\ldots,n \quad l = 1,\ldots,m \tag{19}$$

where p_i is the unit price of the output of industry i and v_l is the unit price of primary factor l. Taking factor prices as exogenous, we can write:

$$v_l = \bar{v}_l \qquad l = 1,\ldots,m \tag{20}$$

Solving for output price, we obtain (in matrix notation):

$$p' = v'B \quad (I - A)^{-1} \tag{21}$$

where p' and v' are respectively $(1xn)$ and $(1xm)$ vectors of output and primary-factor prices.

The last expression gives output prices as the sum of value added generated in the production of all inputs used, directly and indirectly, in the production of a unit of output by the respective industry (or sector). The price equation can be used to project the effects on commodity prices of changes in primary-factor prices, which are taken as exogenous.

Linear Programming Models

By the mid-1970s, the most advanced multisectoral models were linear programming (LP) models that introduced choice and optimization. These were a natural complement to the input-output model that added optimization of some welfare function to the input-output production specification. The addition of the optimization process means that the model solves for the best final demand and resource allocation. However, economy-wide LP models are less attractive because of the assumptions built into these models. For example, in a LP trade model, the linear specification in aggregating imports and domestic goods or exports and domestic sales will lead to unrealistic specialization in the model solution so that a given country is either a buyer or a seller of a given commodity but cannot be both. A way of avoiding this outcome has been to include some constraints on an ad hoc basis (Taylor, 1975). However, even with different constraints to realistically approximate the set of feasible alternatives facing the real side of the economy, LP models cannot fully replicate a competitive resource allocation. The reason for this is that shadow prices which the models yield cannot be equated to market prices, because many implicit taxes and subsidies are incorporated in the shadow prices. It is also difficult to simulate the effects of changes in preexisting taxes or subsidies. To the credit of LP models, the shadow prices are useful in that they measure the trade-offs implicit in LP models and these trade-offs are of interest to policy makers, for example, in project analysis (Robinson, 1989). This advantage comes from the fact that the optimization process enables the exploration of the frontiers of the opportunity set facing the economy (Taylor, 1975).

2.4. Computable General Equilibrium Models

Both input-output (I-O) and LP models were largely used to deal with issues of sectoral allocation of investment and international trade. However, while I-O and LP models are consistent economy-wide representations, they do not have structures to accommodate market mechanisms through which incentive instruments such as taxes and subsidies affect the economy. This is basically the result of the dichotomy between the price system and the quantity system and/or the absence of substitution possibilities in production in most such models. The absence of market mechanisms limits the ability of such models to relate solution variables to actual policy decisions. Furthermore, the assumptions of fixed coefficients in production and cost-based prices, limit the use of these models to analyse the workings of a multimarket economy (Robinson, 1989).

The increasing concern about factoral and sectoral income distribution issues in the early 1970s was another factor that led to the evolution of applied multisectoral models that involved non-linear equations and endogenous prices (e.g., Adelman and Robinson, 1978; Lysy and Taylor, 1980). Unlike the I-O or LP models, these models, known as computable or applied general equilibrium models, introduced substitution between inputs in production and between goods in consumption. They also contain complete specifications of income flows in the economy.

A CGE model, which is an applied general equilibrium model that can be solved by computer software, is a simulation of the workings of a market economy where prices and quantities adjust to put the economy in equilibrium both in the product and factor markets. It is a realistic representation of the abstract Walrasian general equilibrium model of an economy (Shoven and Whalley, 1992).

The first step in constructing a CGE model is the identification of the economic agents whose behaviour is to be analyzed. These are usually households and firms. Government can also be included as an explicit agent, but without any optimization behaviour. Behavioural rules are then specified.[4] Firms maximize profits subject to a technological constraint which is represented by a constant-(or non-increasing)-returns-to-scale production function that allows substitution among the primary inputs. Primary input demands are, therefore, derived from first order conditions of profit maximization. Intermediate input demand is given by fixed input-output coefficients. Correspondingly, households' demands for goods are derived from utility maximization subject to a budget constraint.

[4] Although these behavioural assumptions are not included explicitly in the CGE model, they are useful to derive the demand equations of firms for factor inputs and households' demand for goods.

It follows that the equations of a CGE model are descriptions of the behaviour of economic agents in the markets for factors and commodities, as reflected in the manner of the generation and spending of income. Market demands, which the CGE model works with, are the sum of individual demands that satisfy such micro restrictions as continuity, homogeneity, and non-negativity. Supply equations are those representing the supply of goods and inputs. The supplies of goods are represented by production functions, whereby each commodity in the economy is associated with a producing industry or sector. The supply of primary inputs is usually fixed (given as exogenous) at the aggregate level. In addition to the market transactions that involve goods and services, transferral (such as subsidies and taxes) and financial transactions (such as the channelling of savings by the different agents to investment) take place between agents and can be included in the CGE model.

Third, the "rules of the game" are specified under which agents interact. These "rules" refer to how markets function. It is usually assumed that markets exist and operate under the rule of perfect competition. Finally, system constraints are defined. These constraints define the equilibrium conditions that must hold at the aggregate level but which are not taken into account by individual agents in making their decisions. Tied to the last requirement is the definition of equilibrium itself, which has to be defined in terms of the equilibrating variables of the model. In a market economy, prices are the equilibrating variables that vary to achieve market clearing, and equilibrium is defined as a set of prices that if attained, will result in the decisions of all agents that will jointly satisfy the system constraints.

Five classes of equations can constitute a CGE model. These are the price equations, the quantity equations defining the supply side of the model, income equations, expenditure or final demand equations, and equilibrium equations. A central characteristic of CGE models is that prices are treated as endogenous and their equilibrium values are determined within the system. As discussed earlier, this aspect of CGE models is an advantage in that the indirect effects of policy variables that impact through changes in prices (and thus quantities) are accounted for. The system solves for relative prices which are implied by the zero homogeneity of demand functions and linear homogeneity of profits in prices (Shoven and Whalley, 1992).

2.5. Applications of CGE Models in Agricultural Trade Policy Analysis

Traditionally, studies of agricultural policy and trade issues have involved partial equilibrium analyses. In recent years, however, more and more studies in these areas have used general equilibrium models. A general equilibrium approach is preferable, even when the agricultural sector constitutes a small fraction of the economy in situations where prices or exchange rates are changing and there is a strong linkage between the agricultural sector and the other sectors of the economy (Adelman and Robinson, 1986). A study by de Janvry and Sadoulet (1987) that analyzed alternative policies of agricultural prices and food subsidies showed that the results obtained from CGE models were different from those obtained from partial equilibrium models.

Applied general equilibrium trade models can be classified as multicountry and single-country models. The former are primarily used to analyse global issues.

Consequently, production and demand relations are specified for each of the participating countries. Single-country trade models are more appropriate to evaluate how developments in the world market and/or trade policy changes affect individual countries. When the focus is on a single country, cruder modelling is adopted for the rest of the world; the behaviour of the rest of the world is usually incorporated through import and export demand equations, along with the specifications of capital flows and other external sector characteristics. While single-country GE models are not useful to analyse multilateral trade policy issues at the global level, multicountry models provide less detail for any one particular country, for reasons of manageability and tractability. For example, in most multi-country applied studies that evaluated the effects of multilateral trade liberalization in agriculture, the non-agricultural sectors and, sometimes, the factor markets are not simulated (e.g., Anderson and Tyers, 1988, 1992; Robinson et al, 1990; Tyers, 1994; Frohberg, 1989; Cahill, 1991).

2.6. Solution Methods for General Equilibrium Models

There are four different techniques to solve a CGE model. Using the first, the solution for the CGE model is treated as finding a fixed point in a mapping of prices to prices via excess demand equations (Scarf, 1967).[5] The second method of solving a CGE model is

[5] Formally stated, the fixed point theorem asserts that given a non-empty, bounded and convex set, S, its continuous transformation into itself according to some function f, has a fixed point, $x \in S$ such that $x = f(x)$. Consider the Walrasian tatonnment process where prices are raised (or lowered) in proportion to the positive (or negative) excess demand for the given commodity at any given time of the competitive trading session. Assume that the proportionality factor, i.e., the degree of price flexibility, is the same for all commodities, and is proportional to the level of prices. Denote this proportionality factor by k. Then the price-adjustment equation for commodity j from period t to period t+1 of the trading session can be written as:

to treat the model as a collection of non-linear algebraic equations and to solve the system by a numerical solution technique (first used by Adelman and Robinson, 1978). The third method was initiated in the early days of the application of general equilibrium models when there were no appropriate software packages to solve a system of non-linear equations. In this case, the non-linear equations are linearized and the system is solved by simple matrix inversion (Johansen, 1960). Fourth, a non-linear programming model can be constructed and solved. The resulting shadow prices are then interpreted as market prices.

2.7. A Canada-Specific CGE Model:

In the present study, a single-country GE model is adopted. Due to the objective of this thesis, which is the analysis of the effects of multilateral trade liberalization on the Canadian grain sector, the model used differs slightly from most single-country applied studies done in the past. In most other single-country GE models, trade policy changes were modelled in terms of changes in tariff and non-tariff barriers (Miller and Spencer, 1977; Boadway and Treddenick, 1978; Whalley, 1982; Dervis, de Melo and Robinson, 1982; Dixon, Parmenter, Sutton, and Vincent, 1982). As discussed in the literature review, the UR multilateral agreement is expected to bring about world price changes for

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$$p_{j(t+1)} - p_{j(t)} = \lambda[\sum_k p_{k(t)}]\, E_{j(t)} \qquad j = 1,\ldots,n$$

where $E_{j(t)}$ is the excess demand for commodity j at time t, and where it is implicitly assumed that $P_{j(t+1)} > 0$.

In the price-adjustment process as captured by the above equation, the point at which $p_{(t)} = p_{(t+1)}$ is called a fixed point or a stationary price system. According to the above stated theorem; there exists at least one fixed point, provided that excess demand functions are all continuous.

certain agricultural products. These price changes can be treated to a large extent as exogenous to Canadian agriculture. Therefore, there is a need to simulate the effects of such price changes on Canadian agriculture, along with the effects of the direct policy changes which the Canadian government has committed itself to undertake pursuant to the UR agreement. Following the suggestion by Robinson et al (1990), this task is carried out within the single-country (Canada-specific) CGE model by relating domestic import and export prices to world import and export prices. The latter are generally treated as exogenous to the model. The exception is the world price of Canadian wheat exports for which a downward-sloping world demand curve is assumed to exist[6]. Anticipated world price changes of the commodities under consideration are taken from global studies and simulated together with domestic policy changes to obtain the comparative static results of the endogenous variables.

2.8. Model Specification[7]

The CGE model developed for and used in this thesis research study is much in line with the Walrasian system which solves for relative prices that obtain full employment and flow equilibria in all markets. The model is "elasticity structuralist" (Robinson, 1989), in that limited substitution elasticities are assumed in a variety of important relationships. In particular, imports and domestically produced goods of the same sectoral classification are

[6]The export demand function relates the world price of exports of Canadian wheat to the world price of export substitute of Canadian wheat, which is exogenous to the model. Consequently, world price changes for wheat are simulated in terms of the changes in the price of the export substitute of Canadian wheat.

[7] In developing the Canada-specific CGE model Robinson et al (1990) has been referred to extensively.

assumed to be imperfect substitutes. Likewise, exports and domestic sales of the same sectoral classification are imperfect substitutes. Thus the specification renders the domestic price system a larger autonomy by insulating it to some degree from changes in world prices of sectoral substitutes.

In applying the CGE model, the Canadian economy is divided into eight sectors, six of which are agricultural and two are non-agricultural. Categorization of the agricultural sectors was based on the trade shares of the respective commodities and the availability of data.[8] The sectors include: 1) wheat, 2) "other grains", 3) fruits and vegetables, 4) livestock, 5) milk and poultry, 6) "other agriculture", 7) food processing and 8) the "rest of the economy".

There are three primary factors of production and the aggregate supply of each is assumed to be fixed. These are labour, capital, and agricultural land. Agricultural land is specific to the agricultural sectors while labour and capital are assumed to be mobile among the eight sectors. Since capital is freely mobile, rental rates of capital are equalized across sectors. Therefore, the equilibrium position of the model defines a long run equilibrium.

2.8.1. Price Equations

Due to the differentiation between imports and import substitutes, and exports and goods delivered to the domestic market, numerous prices are associated with each sector of the

[8] The level of sectoral aggregation is also partly dependent upon the problem being studied. Thus, the sectoral aggregation or classification is such that within-class effects of policy or otherwise changes are less important to the research relative to between-class effects.

economy. Canada is considered a "small country" with respect to all imports, i.e., it can purchase as much as it wants without any bearing on the world prices of its imports. Thus, the domestic import price of commodity i, (PM_i) is given by the exogenously given world import price in US dollars (pwm_i) adjusted for tariff (t_{mi}) and the exchange rate (EXR):

$$PM_i = pwm_i * (1 + t_{mi}) * EXR \tag{22}$$

where t_{mi} is the tariff rate on imports of commodity i.

The domestic price of exports is specified symmetrically, where import tariffs are replaced by export subsidies. If PWE_i denotes the world price of an export commodity, and t_{ei} is the subsidy rate on the exports of sector i, then the domestic price of commodity i, PE_i , is given by:

$$PE_i = PWE_i * (1 + t_{ei}) * EXR \tag{23}$$

The "small country" assumption holds for the case of all Canadian exports but wheat. Canada's wheat exports are assumed to face a downward-sloping world demand curve. Therefore, for the wheat sector, PWE_i is endogenous.

The following two prices, P_i and PX_i define, respectively, the prices of the composite goods X_i and XD_i. Good X_i is an aggregate commodity composed of imports, M_i, and domestic supply, XXD_i, while XD_i is aggregated from exports, E_i, and domestic supply, XXD_i. As depicted below, Constant Elasticity of Substitution (CES) and Constant Elasticity of Transformation (CET) functions are specified to define the aggregate or composite commodities X_i and XD_i, respectively. Due to the homogeneity of the CES and CET functions that define the composite goods, their respective prices are defined as weighted averages of the prices of the goods that constitute the composite goods. Therefore, the value of the composite good is equal to the sum of the values of the component parts, irrespective of functional forms.

$$P_i = \left(\frac{M_i}{X_i}\right) PM_i + \left(\frac{XXD_i}{X_i}\right) PD_i \tag{24}$$

$$PX_i = \left(\frac{E_i}{XD_i}\right) PE_i + \left(\frac{XXD_i}{XD_i}\right) PD_i \tag{25}$$

where PD_i is the price of domestic goods sold on the domestic market.

Domestic suppliers make their decision based on the value-added price, which is the difference between the output price, PX_i, and the sum of indirect taxes net of production subsidies and the cost of intermediate inputs. Thus,

$$PVA_i = PX_i\left(1 - inx_i + sd_i\right) - \sum_j a_{ji} P_j \tag{26}$$

where for commodity i, PVA is the value-added price, inx_i is the indirect tax rate, sd_i is the subsidy rate, and a_{ji} are the fixed input-output coefficients. Given that the input-output coefficients are fixed, a rise in the value added price due either to changes in the output price or changes in the indirect tax and subsidy rates, will lead to a resource flow from other sectors to the sector whose relative value added price has risen.

Capital is assumed to be heterogeneous across sectors. Furthermore, the capital used in any one sector is treated as a composite factor, whose component parts are identified by sectors of their origin. A capital composition matrix is thus constructed to represent the composition of capital goods used by each of the sectors in the system. Along the columns of this matrix we read off the shares of capital, as identified by sector of origin, used by any one sector. The price of capital used by sector i, PK_i, is thus the weighted average of the costs of capital goods used in sector i, the weights being the capital shares, k_{ji}. More formally,

$$PK_i = \sum_j k_{ji} P_j \qquad (27)$$

Finally, since the model is Walrasian, in the sense that it determines only relative prices, we need to specify a numeraire price. This price can be defined in a number of alternative ways. The most common are the producer price index, the consumer price index, the GNP deflator, the exchange rate, and the wage rate. That the system can solve only for relative prices means that the choice of the numeraire has no effect on the solution value of any real variables. The GNP deflator, which is defined as the ratio of nominal GNP to the real GNP, is chosen in this case.

$$PINDEX = \frac{GNPVA}{RGNP} \qquad (28)$$

where $PINDEX$ is the numeraire price, $GNPVA$ is nominal GNP, and $RGNP$ is real GNP.

2.8.2. Quantity Equations

Technology:

Production technology in all sectors is represented by a Cobb-Douglas value-added function with labour and capital as its arguments; agricultural land is also a factor in the production functions of the agricultural sectors.[9] Thus:

$$XD_i = A_i \, L_i^{\alpha_i} \, K_i^{\beta_i} \, R_i^{1-\alpha_i-\beta_i} \quad (29)$$

where XD_i is the output of sector i, A_i is a shift parameter, L_i, K_i, and R_i are labour, capital stock, and agricultural land use respectively. The parameter A_i measures technological change. As specified in the production functions, this is Hicks neutral, output-augmenting productivity growth. Primary input demands are derived from first order conditions for profit maximization. These input demand functions are rearranged to have the following forms:

$$WF_f * fpd_{if} = PVA_i * \alpha_{if} * \frac{XD_i}{FCRDD_{if}} \quad (30)$$

where WF_f is average factor price and the subscript f stands for factor.

The fpd_{if} parameter is attached in an adhoc but realistic manner to WF_f to measure factor market distortions; it is a proportionality factor between the marginal revenue product of a factor in a given sector and the economy-wide average return for the same

[9] Two considerations in the choice of functional forms for demand and production relations are consistency with theoretical restrictions and analytical tractability. The Cobb-Douglas form is chosen for its simplicity in that it has a small numbers of parameters that have straightforward interpretations and can be calibrated from the base year data set.

factor (Robinson, et al, 1990). Note that in the absence of distortion, this parameter takes a value of 1, in which case there is the usual first order condition for profit maximization: $PVA_i * \partial XD_i / \partial FCRDD_{if} = \alpha_{if} * XD_i / FCRDD_{if}$. Note also that producers maximize profits measured in value added price, *PVA*, where $FCRDD_{if}$ is the demand for factor f by sector i.

Intermediate inputs are assumed to be demanded in all sectors according to fixed input-output coefficients, i.e.,

$$XD_{ij} = a_{ij} XD_j \qquad (31)$$

Summing over j (i.e., the receiving sectors), the above expression gives the supply of intermediate inputs by sector *i* as:

$$INT_i = \sum_j a_{ij} XD_j \qquad (32)$$

where INT_i denotes the total intermediate input supply by sector i.

Foreign Trade:

The specification of the import demand equations is reminiscent of the Armington model (1969), where domestically produced and imported goods of the same kind are viewed differently by consumers. Imports and domestically produced goods are sectorally aggregated into a composite good by a CES aggregation function.[10] Thus,

[10] In standard neoclassical trade models imports and domestic products of the same sectoral classification are treated as perfect substitutes so that the "law of one price" applies. The problem with these models is that simulated changes in trade policy and world prices tend to cause extreme specialization in production and large swings in domestic relative prices. In practice, changes in world prices are only partially transmitted to the prices of domestic goods of the same sectoral classification. The CES import aggregation specification allows for differentiation between imports and domestic goods, thus providing a realistic insulation of the domestic price system from changes in world prices (Robinson, 1990). Furthermore, a practical justification for assuming imperfect substitution between imports and

$$X_i = A_{mi}\left[\delta_{mi} M_i^{-\rho_{mi}} + (1-\delta_{mi})\, XXD_i^{-\rho_{mi}}\right]^{\frac{-1}{\rho_{mi}}} \quad (33)$$

where M_i denotes imports and XXD_i domestic supply by sector i. Consumers' demand for imports M_i is then determined from cost minimizing behaviour in purchasing the composite good and is given by[11]:

$$M_i = XXD_i\left[\frac{\delta_{mi}}{(1-\delta_{mi})} * \frac{PD_i}{PM_i}\right]^{\frac{-1}{(1+\rho_{mi})}} \quad (34)$$

With respect to its exports, Canada is assumed to be a price taker for all exports but one. For its wheat exports, Canada is assumed to face a downward sloping world demand curve. World demand for Canadian wheat is thus inversely related to the world wheat price with fixed price elasticities. Following Robinson et al (1990), the export demand equation for wheat takes the following form:

$$E_{ied} = A_{ied}\left[\frac{PWE_{ied}}{pwse_{ied}}\right]^{-\rho_{ied}} \quad (35)$$

where E_{ied} is the export demand for Canadian wheat, A_{ied} is the shift parameter in the export demand equation, $pwse_{ied}$ is the exogenous world price for substituting, and thus

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domestically supplied goods is that the model cannot be disaggregated to the extent that only homogeneous commodities are represented. That is, at the level of aggregation of commodities in most applied works, two-way trade ("cross hauling") cannot be precluded as is the case with the standard neoclassical trade model. In single-country models such as the one used in this dissertation, the CES specification has a problem in that it constrains the income elasticity of demand for imports to be one in every sector.

[11] The total cost of purchasing the composite good is given by $P_i\, X_i = PD_i\, XXD_i + PM_i\, M_i$. The consumer minimizes this cost subject to equation (33).

competing, exports from other countries, and ρ_{ied} is the elasticity of export demand for Canadian wheat.

For those export commodities which Canada is a price taker in the world market, a different specification is required. Due to the assumption of non-perfect substitution between goods produced for export and goods produced for domestic supply, each export sector is treated as a two-product firm producing an export good and a good to be delivered to the domestic market.[12] Transformation between the two types of the same good of transformation is reflected in a CET (constant elasticity) function, which defines a composite good, XD_i:

$$XD_i = A_{ei}\left[\delta_{ei}\, E_i^{\rho_{ei}} + (1-\delta_{ei})\, XXD_i^{\rho_{ei}}\right]^{\frac{1}{\rho_{ei}}} \tag{36}$$

Export supply, E_i is obtained by maximizing revenue from the sale of the composite good XD_i subject to equation (36). The export supply equation thus obtained is given by:

$$E_i = XXD_i\left[\frac{(1-\delta_{ei})}{\delta_{ei}}\,\frac{PD_i}{PE_i}\right]^{\frac{1}{(\rho_{eis}-1)}} \tag{37}$$

2.8.3. Income and Savings Equations

The income equations defined below describe, first of all, the flow of income from value added to institutions such as firms, workers and land-owners. Households are assumed to appropriate all the net incomes obtained by the workers and the land-owners, and

[12]The assumption of imperfect transformation between exports and goods destined for domestic market means the law of one price does not apply for all sectors with exports. The justification for this assumption is parallel to the one given for using the CES aggregation function above.

dividends from firms. Households derive income from other sources as well, such as the government and non-residents in the form of transfers and remittances. Defining factor incomes first, we have:

$$YFACTOR_f = \sum_i (WF_f * fpd_{if} * FCRDD_{if}) \tag{38}$$

where $YFACTOR_f$ denotes the income of factor *f*, WF_f the average factor price, and $FCRDD_{if}$ the amount of factor *f* demanded by (used in) sector *i*. The following three equations define institutional incomes as they relate to factor incomes:

$$YLABOR = \sum_i (fpd_{il} * WF_l * FCRDD_{il}) \tag{39}$$

$$YENTERP = \sum_i (fpd_{ic} * WF_c * FCRDD_{ic}) + NETGOVENT + NETENTROW * EXR - (ENTSAV + ENTTAX + DEPRECIA) \tag{40}$$

$$YAGLND = \sum_i (fpd_{ia} * WF_a * FCRDD_{ia}) \tag{41}$$

Where $YLABOR$, $YENTERP$, and $YAGLND$ denote, respectively, the incomes accruing to workers, firms, and agricultural land-owners. The subscripts *l*, *c*, and *a* stand respectively for labour, capital, and agricultural land. *ENTSAV* stands for enterprise (firm) saving; *ENTTAX* for tax amount on enterprises; *DEPRECIA* for depreciation allowance; *NETGOVENT* for net government transfer to enterprises; and *NETENTROW* for net enterprise transfer to the non-residents.

Household income is thus given by:

$$YHH = (YLABOR + YENTERP + YAGLND) + NETGOVHH + NETHHROW * EXR \tag{42}$$

where *YHH* denotes household income, *NETGOVHH* and *NETHHROW* denote, respectively, net transfers from government to households and net transfer from Canadian households to non-residents.

Government is treated as a passive agent; it derives income (revenue) in the form of taxes and foreign borrowing, i.e.,

$$GOVREV = TARIFF + INDTAXIN - SUBSD + INDTAXOUT + HHINCTAX + ENTTAX + NETGOVROW * EXR \quad (43)$$

where *GOVREV* denotes total government revenue, *INDTAXIN*, *SUBSD*, *INDTAXOUT*, *HHINCTAX*, and *ENTTAX* denote total indirect tax, total domestic subsidy, total sales tax, total household income tax, and total business tax, respectively, while *NETGOVROW* denotes net foreign borrowing.

Savings are made by households, enterprises, and the government. Government earns revenue through taxes and makes expenditures on consumption goods and transfers. The savings it makes (*GOVSAV*) are determined residually. Savings by enterprises (*ENTSAV*) depend on fixed enterprise saving rates, while savings by households (*HHSAV*) are determined by their propensity to save. Foreign saving (*FSAV*) is determined exogenously. Total saving (*SAVINGS*) is, then, the sum of the savings made by the different institutions, plus depreciation allowance (*DEPRECIA*), i.e.,

$$SAVINGS = HHSAV + ENTSAV + GOVSAV + DEPRECIA + FSAV * EXR \quad (44)$$

The depreciation allowance is determined by a fixed depreciation rate which varies across sectors.

The remaining equations that belong to the system of income equations are those that define the various taxes and subsidies. Sectoral tariff revenue and export subsidy are determined by multiplying the domestic value of imports and exports, respectively, by the appropriate tariff rates and export subsidy rates. The sectoral tariff revenues and export subsidy outlays are each summed over the sectors to obtain the total tariff revenue and total export subsidy that enter in the government revenue and expenditure equations. Indirect taxes and domestic subsidies are proportional to domestic production, the indirect tax rates and subsidy rates defining those proportions. Firms deduct depreciation allowance from capital income and add any net transfers and pay business tax on the balance, according to fixed business tax rates.

2.8.4. Expenditure and Investment Equations

The expenditure equations describe the other half of the circular flow of income in the economy; the first half is captured by the preceding income equations. The expenditure equations define the demands for goods by the various actors of the domestic economy. The relevant data are contained in the final demand section of the input-output table.

A fixed-expenditure-share function is specified to describe household demand for goods. Their demand for goods is a function of prices and household disposable income:

$$P_i * CONSDD_i = \left[\frac{conshr_i * (1 - mps)(1 - hhtr) * YHH}{(1 + itaxout)} \right] \tag{45}$$

where $CONSDD_i$ denotes household demand for good i, $conshr_i$ the consumption share for good *i*, and *itaxout* is the sales tax on consumption goods.

Government is assumed to apportion its total spending on goods ($GOVTOT$) between the various goods according to fixed expenditure shares, i.e.,

$$P_i * GOVDD_i = gles_i * GOVTOT \quad (46)$$

where $GOVDD_i$ is the demand for good i by the government, $gles_i$ denotes the fixed share of expenditure on good i in total government spending.

Investment is divided into two parts resulting in two different specifications to define both parts. The demand for inventory investment is assumed to be in fixed proportion to total domestic production, i.e.,

$$DST_i = dstr_i * XD_i \quad (47)$$

where DST_i denotes demand for new inventory by sector 1 and $dstr_i$ is the fixed coefficient which measures the proportionality between inventory demand and output. Total fixed investment ($FXDINV$) is determined as total investment minus total inventory investment. The allocation of total fixed investment among the various sectors is then made according to fixed shares ($kish_i$). More formally,

$$PK_i DK_i = kish_i * FXDINV \quad (48)$$

where DK_i is fixed investment by sector of destination.

Since capital is assumed to be heterogeneous across sectors, the demand for capital goods from a given sector is derived from the investment demands by sectors of destination using the capital composition coefficients. Denoting demand for capital goods by ID_i, we have:

$$ID_i = \sum_j ccm_{ij} * DK_j \quad (49)$$

where ccm_{ij} represents the value in the ith row and jth column of the capital composition matrix. This value measures the share of capital originating from sector i in the total capital use by sector j. It follows that, $FXDINV = \sum_i (PK_i * DK_i) = \sum_i (P_i * ID_i)$.

2.8.5. Equilibrium Conditions of the System

The equilibrium conditions are equations that define the system constraints which the model must satisfy in equilibrium. There are two market equilibrium conditions pertaining to the product and factor markets:

$$X_i = INT_i + CONSDD_i + GOVDD_i + ID_i + DST_i \tag{50}$$

$$\sum_i FCRDD_{if} = FS_f \tag{51}$$

Equation (50) describes the equilibrium condition that sectoral supply of the composite commodities must be equal to their demand. Implied in this linear equilibrium condition is the assumption of a full crowding out effect of government expenditure. Thus, for a given level of X_i, an increase in government deficit implies a decrease in private investment of equal magnitude. The equilibrating variables are the composite prices. Equation (51), on the other hand, states that aggregate demand for a factor ($\sum_i FCRDD_{if}$) must be equal to the exogenously set supply of the same factor (FS_f). Average factor prices adjust to match demand and supply of each factor.

In addition to the market clearing equation, equilibrium in the model requires balances in major macro-economic aggregates. These are: the government deficit, the balance of trade, and the saving-investment balance. The balance conditions, which are sometimes called closure rules, define notions of macro-economic equilibrium (Robinson et al, 1990), as follows:

$$GOVREV = GOVTOT + TEXPSUB + NETGOVENT + NETGOVHH + GOVSAV \tag{52}$$

$$\sum_i (PWM_i * M_i) = \sum_i (PWE_i * E_i) + + FSAV + NETENTROW + NETHHROW + NETGOVROW \tag{53}$$

$$SAVINGS = INVEST \tag{54}$$

In equation (52), *GOVTOT* (total government consumption), *TEXPSUB* (total export subsidy), *NETGOVENT* (net government transfers to enterprises), and *NETGOVHH* (net government transfers to households) are fixed exogenously, leaving the government deficit (*GOVSAV*) as the equilibrating variable. In the trade balance equation (equation 53), *FSAV* (foreign savings), *NETENTROW* (net enterprise transfers to non-residents, *NETHHROW* (net household remittances), and *NETGOVROW* are all exogenously fixed. Thus the balance of trade is set exogenously, the equilibrating variable being the nominal exchange rate. Finally, a "neoclassical" closure condition applies to the savings-investment balance in equation (54). Since the components of aggregate savings are determined either exogenously or residually, aggregate investment is determined by aggregate savings, that is, investment is savings driven.

In solving the above system, it has to be remembered that the equations that define the equilibrium conditions are not all independent, by Walras' Law. Therefore, one of them can be dropped.

2.9. Calibration and Solution Algorithm

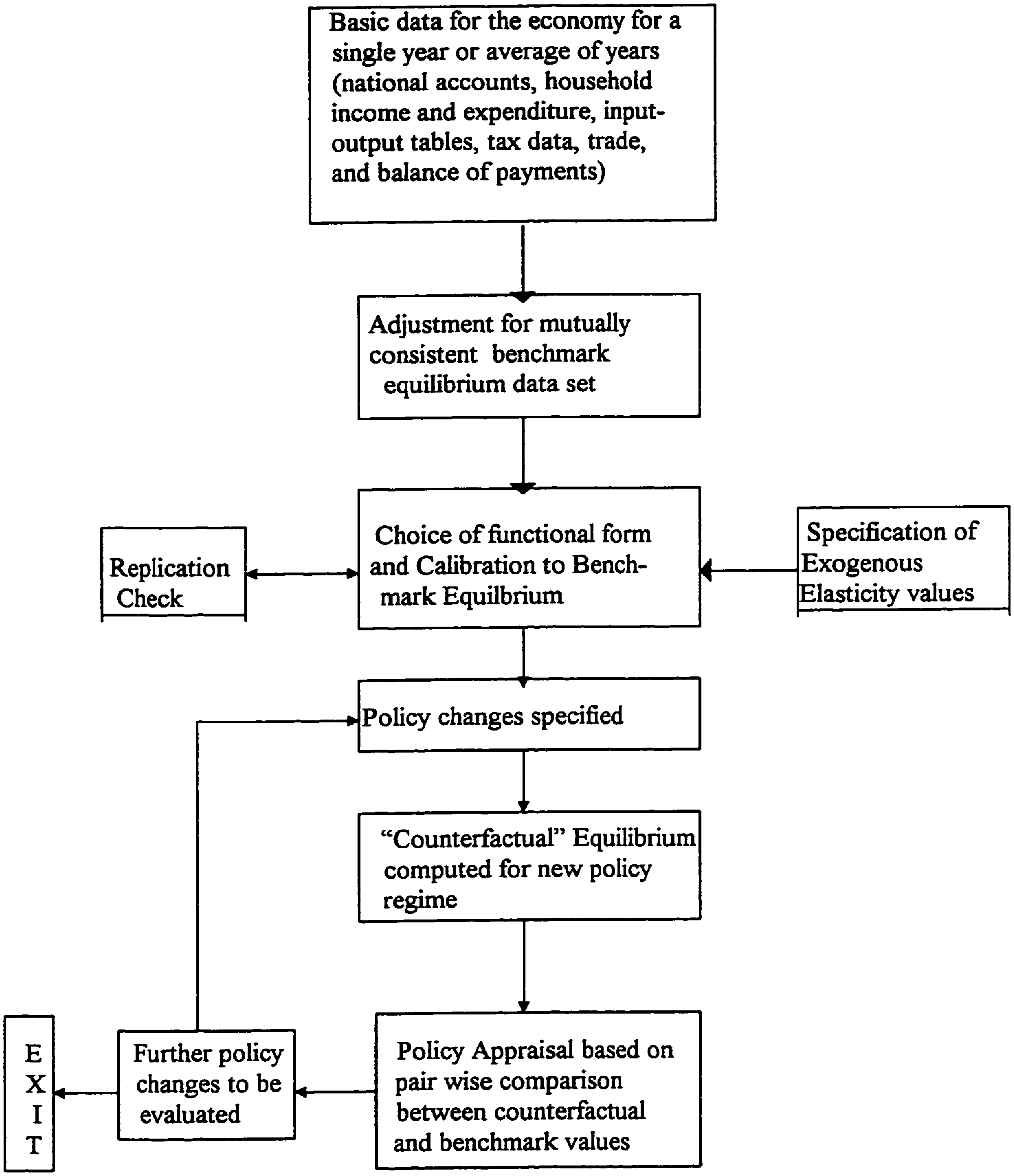
Once the model equations are specified, the next step is to determine the values of the model parameters that appear in the equations. There are two procedures to obtain these parametric values, specifically, stochastic and deterministic procedures. According to the first procedure, the equations of the system are estimated simultaneously by econometric techniques using time series data. If this procedure is possible, it has the advantage of allowing the researcher to conduct statistical tests regarding the estimated parametric values. Another advantage is that the parameters of the model would be calculated on the basis of average relationships exhibited between the dependent and the independent variables over a period of time. This renders the model equations more reliable in their representation of reality; consequently, out of sample projections should be more accurate. The problem with this procedure is one of feasibility; it is feasible only for small scale CGE models. For large scale CGE models, the econometric procedure is infeasible because the large number of parameters to be estimated poses a serious problem of degrees of freedom. In fact, for even moderately large CGE models, the number of parameters may be larger than the number of data points. To overcome this problem, one has to collect time-series data covering a very long period of time, which is costly or may be infeasible. The advantage of using long time series data may be negated if technical change has occurred over time. In addition, the econometric procedure may not be applicable for at least one technical reason. For complete general equilibrium models where market-clearing conditions for primary inputs are included, the likelihood function of the model will not be well defined. The market clearing conditions require that the primary inputs demanded by all sectors add up to the total available quantities. This equilibrium condition makes the factor demand functions dependent on each other, which means that the error terms are not independently distributed (Scarf and Shoven, 1984).

An alternative approach, which is followed in this study, is to apply the procedure known as calibration. For this purpose, a base period is chosen and for given functional forms of the equations included in the model, parameter values are calculated recursively, such that the solution of the model reproduces the observations of the base period. One implication of the procedure is that the model is not testable since the parameters are chosen in a deterministic way, i.e., in such a way that the model fits the data exactly.

Calibration is aided by literature search and occasionally by econometric estimation to fix the values of certain parameters, particularly the elasticities. For example, the values of the elasticities that appear or are implied in the CES and CET composite goods functions must be obtained from the literature search. It has to be noted, however, that there is not a general consensus regarding the values of most of the important elasticities. A fundamental and strong assumption in calibration is that the economy is in equilibrium in the base period. For this reason, if there are any inconsistencies in the data assembled in the Social Accounting Matrix (SAM), adjustment of the national accounts, (i.e., "bench-marking") will be necessary to satisfy the equilibrium conditions of the model. Once calibration is completed the general equilibrium model is used to perform different comparative static analyses; for this purpose, we change the exogenous variables by a percentage factor and observe their impact on the endogenous variables.

The solution method followed to solve our CGE model is to treat the model as a

Figure 2.8. A Flow Chart of Calibration Procedure and General Equilibrium Model Use



Source: Shoven and Whalley (1984).

collection of non-linear algebraic equations and solve the system using GAMS (General Algebraic Modeling System) and the MINOS solver. GAMS is a programming language which can interact with non-linear program solvers, of which MINOS is the one most widely used. The full representation of the CGE model is presented in Appendix 2.1, while the GAMS program of the model can be found in Appendix 2.2.

3. THE DATA AND ITS COMPILATION

3.1. Introduction

A very important but time consuming task in applying the CGE model in this case was the collection and organization of the data needed by the model. The problem involved in the process of organizing the data was two-fold. First, all the data required were typically not found from one source. Consistency in the data collected from different sources or publications was, therefore, a source of some concern, as consistency is a major requirement in the construction of a SAM on which the CGE model is based. Second, the data from the different sources were often not available in the format needed by the model. Thus in some cases they had to be manipulated in some way. Some data were not directly available and had to be derived from other data. Some basic assumptions had to be made in carrying out these tasks.

Two sets of data constitute the entire data requirement for a CGE model. First, basic data is collected for a single year. This data set has to include all the numerical information describing the economic accounts of the country for that year in a format needed by the modeler. These are income and expenditure accounts of agents in the model, such as households, as well as data on savings and investment, trade and balance of payments, and input-output data. The second set of data consists of key parameter values that reflect the structure of the economy. These are the various elasticity measures and calibrated parameters, such as ratios and rates.

In this study of the impact of multilateral trade liberalization on Canadian agriculture, the Canadian economy is divided into eight sectors. The grain sector is sub-divided into the two categories of wheat and "other grains" including oilseeds. Milk and poultry are grouped together. The remaining agricultural sectors consist of the livestock (other than dairy), the fruits and vegetables, and "other agriculture" sectors. The non-agricultural sector of the Canadian economy is represented by the food industries and the rest of the economy. Note that "other grains" include barley, oats, rye, corn, mixed grains, mustard seed, canola, soybeans and other oilseeds. Included in livestock are cattle, calves, and hogs. Fluid milk, poultry, and eggs are included in milk and poultry. The remaining agricultural activities and services related to agricultural activities are included under "other agriculture". These include field crops (such as potatoes, hay and straw, and raw tobacco), other live animals, honey and beeswax, nursery stock, flowers, mink skins (ranch undressed), raw wool, services incidental to agriculture, and others not included in the other sub-sectors. The food processing sector includes meat, dairy, and fish products, fruits and vegetables preparations, and other processed food products. The identification of the various agricultural sub-sectors follows the Statistics Canada convention whereby a sub-sector is identified by the commodity that constitutes more than 50 per cent of the activities of that sector.

3.2. Intermediate Inputs

The construction of a disaggregated input-output table where the agriculture sector is divided into six sub-sectors was the biggest challenge in the organization of the data for this model. It has to be remembered that the existing Statistics Canada input output table has agriculture as just one sector at the M (medium) level of disaggregation or as just two sub-sectors at the L (large) level of disaggregation. In constructing the disaggregated input-output table we mainly adopted the approach used by Thomassin and Andison (1987).

Thomassin and Andison (1987) used both the agricultural census data for 1981 and Statistics Canada's input output table in order to disaggregate the agriculture sector. The census provides data regarding expenditures on inputs by farm type. The input output table, on the other hand, contains total expenditure on inputs (i.e., input use) for agriculture, taken as one sector. In order to disaggregate input use by agriculture across sub-sectors (or farm types), first, the census expenditure values are converted into a percentage distribution by farm type. Let E_{ij} be the expenditure on input j (e.g., livestock) by farm type i (e.g., wheat). The percentage distribution (or share) of farm type i (i.e., wheat) in the total expenditure on input j (i.e., livestock) is given by:

$$S_{ij} = \left(E_{ij} \Big/ \sum_i E_{ij} \right) \tag{55}$$

where $\sum_i E_{ij}$ is the total expenditure on input j by all agricultural sectors as reported from the census. These percentages can then be applied onto the use matrix of Statistics Canada's input-output table. That is, if A_j, in the input-output table, represents the total use of input j (e.g., livestock) in agriculture, the share of farm type i (e.g., wheat) in the total use of input j is given by:

$$A_{ij} = S_{ij} * A_j \tag{56}$$

The purpose of using the "transformation" equation (55) is to make the census allocations of inputs consistent with the aggregate input data as contained in the Statistics Canada's input-output table.

In this study, the above procedure was applied on the 1991 agricultural census data and the national input-output table to construct the input-output portion of the SAM. The 1991 census was supplemented by useful data contained in the publication "Agricultural Financial Statistics" of the same year. The latter is published annually by Statistics Canada. Whereas earlier agricultural censuses contained information on input expenses, the 1991 agricultural census does not include this vital information. This information was derived from "Agricultural Financial Statistics". Major sources for the remaining data were "National Income and Expenditure Accounts", "Canadian Economic Observer", "Fixed Capital Flows and Stocks", and various other Statistics Canada publications. Tariff rates and export subsidy rates were taken from other studies on agricultural trade liberalization (Brooks and Kraft, 1994; Ingco, 1994; IATRC, 1994).

From Statistics Canada's input-output tables, at the L-level, under the Input (Use) Matrix, the agricultural sector is divided into crops and livestock. The task in this study is to disaggregate these two sub-sectors into six sectors. The most straightforward approach is to disaggregate the livestock sector between milk and poultry, and livestock, while the crops sector is disaggregated between wheat, "other grains", fruits and vegetables, and other agriculture. However, this method was not followed because, from the data contained in the use matrix of Statistics Canada, it appears as though the two sub-sectors are specialized, in the sense that each sub-sector does not produce the products of the other. This is, however, unrealistic, and cannot be supported by the census data collected in 1991.The census data show that each sub-sector is a multi-product sector, although each is identified by one product which constitutes the major form of activity of the sector. The second approach is, therefore, to abandon the Statistics Canada input-output classification and aggregate the crops and livestock sectors into one agriculture sector. Then the agriculture sector is disaggregated into the six sub-sectors by using the Thomassin and Andison method discussed earlier.

Within the agriculture sector, it is assumed that crop inputs other than seeds are for feed purposes. Thus, livestock distribution, obtained from the 1991 census, was taken as the means to disaggregate these inputs among the agricultural sub-sectors. Seeds were distributed according to the proportions of acreage used in each farm type. Other agricultural inputs were distributed among the agricultural sub-sectors in proportion to the expenses incurred by each farm type (agricultural sub-sector) on those inputs. A similar approach was used to distribute the inputs originating from the food industries and the rest of the economy. The use of intermediate inputs in the non-agriculture sectors was directly taken from the Statistics Canada input-output table.

The input-output tables constructed by Statistics Canada are in rectangular format, where commodities are represented across rows, regardless of their sectoral origin, while industries are represented across columns. To convert the rectangular input-output format into a square format (where industries appear both across rows and columns), the following method is used[1]: Let q_{ij} be the amount of commodity i used as intermediate input in sector j. Since it is theoretically possible that this much of the intermediate input

[1] The conversion method is necessitated by and based on the assumption that the eight sectors of the model are multiproduct sectors.

originates from more than one sector, this has to be apportioned across the different sub-sectors according to some rule. Focusing on the Output (Make) Matrix, let S_{ij} be the amount of commodity *i* supplied (or produced) by sector *j*, and S_i the aggregate supply of commodity *i*[2]. Let B_{ij} denote the proportion (or share) of commodity *i* supplied (or produced) by sector *j*, i.e.,

$$B_{ij} = S_{ij} \; / \; S_i \tag{57}$$

Suppose there are *n* commodities and *m* industries (sectors). Then, we have an $n * m$ matrix of commodity shares, B_{ij}, and an $n * m$ matrix of intermediate inputs, q_{ij}. Let the transpose of the share matrix be denoted by B^T, and the use matrix by *Q*. The square matrix, *Q**, of the use table is thus derived by the formula:

$$Q^* = B^T * Q \tag{58}$$

Since final demands in the Statistics Canada constructs are also given in terms of commodities, these have to be converted in a like manner so that final demands are given in terms of industries (or sectors). In other words, the final demand matrix is given by:

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[2] Under the Make Matrix of Statistics Canada, as in the Use Matrix, agriculture is represented by crops and livestock at the L-level disaggregation. The two sub-sectors were lumped together and the six agricultural subsectors were derived in like manner as in the case of the use matrix. This time, however, data on revenue, not input expenses, from "Agricultural Financial Statistics" were used to obtain the S_{ij}.

In addition to agricultural products, the make or output column for agriculture includes forest products, meat, miscellaneous food, industrial chemicals, fertilizers, Pharmaceuticals, and other finance, insurance and real estate. These products were allocated among the 6 agricultural sectors in the following way: Revenue distribution on forest and maple products obtained in "Agricultural Financial Statistics " was used to disaggregate forest products. Proportions of revenue distribution from livestock sales were used to allocate meat, fertilizer, industrial chemicals and pharmaceuticals. Miscellaneous food was disaggregated in proportion to intermediate input supply from each of the agricultural subsectors to the food sector. Other finance, insurance, and real estate was disaggregated according to the distribution of miscellaneous income as contained in " Agricultural Financial Statistics".

$$F^* = B^T * F \tag{59}$$

where F denotes the final demand matrix as constructed by Statistics Canada.

An eight-sector input and final demand table and input-output coefficients for the Canadian economy for the 1991 base year are presented in Tables 3.1 and 3.2, respectively.

3.3. Primary input rewards, taxes and subsidies

Wages and Salaries, and Supplementary Labour Income: The 1991 census contains data on hired labour by farm type expressed in labour weeks. Assuming that wages are the same across farm types, the total wages and salaries in agriculture as reported in the use matrix, which amounted to $1845.6 million, was disaggregated across the agricultural sub-sectors in proportion to hired labour by farm type.

Supplementary labour income relates to employers contribution to pension funds, workers' compensation board fees and insurance premiums (Thomassin and Andison, 1987). In 1991 supplementary labour income in agriculture was $89 million. The distribution of this sum across the agricultural sub-sectors was made in proportion to the estimated total employment, specifically, on hired and operator's labour in each sub-sector. Data on operators' labour applied to agricultural activities is not reported in the 1991 census; this was derived from data on off-farm income and net operating income from farm activities contained in "Agricultural Financial Statistics". In order to determine the number of weeks operators spent on farm operations, the percentage of net operating income in total agricultural household income was multiplied by the total number of weeks in a year (i.e., 52). Numbers of operators in the different agricultural sub-sectors were obtained from the 1991 census. The two types of labour input -- hired and operator --, expressed in labour weeks were added together, and supplementary labour income was allocated across the six agricultural sub-sectors in proportion to total labour input across these sub-sectors.

Net Income, Unincorporated Business: First, this sum as reported in the use matrix of Statistics Canada for 1991 ($1568 million) was divided between labour income and capital income by the following decision rule: denote the sum of wages and salaries, and supplementary labour income by *LI*, and other operating surplus by *OOS*. Then, the proportion of LI in the sum of LI and OOS gives the portion of net unincorporated business income that is allocated to labour. Similarly, the portion that is allocated to capital was given by the proportion of *OOS* in the sum of *LI* and *OOS* (see Burniaux et al, 1990). The disaggregation across the agricultural sub-sectors was made in proportion to "Net income accruing to farm operators from farm production" as contained in " Agricultural Financial Statistics".

Other Operating Surplus (*OOS*): This value is a residual equal to the value of total output (Make matrix) less the value of all primary and intermediate inputs used in the production process (Use matrix). The $5394.7 million value of *OOS* was split between land and capital income according to the corresponding ratios of land and other capital assets to total fixed capital in agriculture following Guzel, 1990.

Taxes: Indirect taxes include Commodity Indirect Taxes (*CIT*) and "Other Indirect Taxes" ("*OIT*"). *OIT* is approximated by its major component, property tax, which in

Table 3.1. An Eight-sector Input and Final Demand Table for Canada 1991 (In Millions of Canadian Dollars)

	Wheat	Other grain	Fruits an vegetab.	Live-stocks	Milk and Poultry	Other Agric	Food Process.	Rest of Economy	**Total**	Consum tion	Invest-ment	Gov't expend.	Inventory investmt	Exports	Export subsidy	Imports	Import tariff	**Total fin. demand**	**Total dom. ss**
Wheat	9.751	23.066	0.931	319.586	204.942	13.778	455.351	40.563	**1067.967**	90.478	4.031	111.291	-53.301	1661.62	255.892	-73.001	-28.898	**1968.11**	**3036.07**
Other grain	13.155	31.116	1.244	435.739	271.661	18.784	445.480	97.856	**1316.035**	250.07	5.632	68.976	-51.431	800.823	80.003	-158.56	-47.330	**948.180**	**2263.22**
F and v	0.559	1.322	0.053	18.275	11.816	0.788	278.119	304.681	**615.615**	1931.03	1.059	27.844	-30.004	141.133	4.1843	-1381.8	-1.415	**692.075**	**1307.69**
Lvstk	20.143	47.645	1.452	851.431	223.770	36.649	3531.445	98.349	**4810.883**	852.806	52.813	102.460	150.693	1163.05	37.252	-222.78	-29.001	**2107.29**	**6918.18**
M and P	4.019	9.500	0.363	146.856	95.473	6.408	4641.223	150.445	**5054.29**	225.778	9.954	39.027	14.214	203.170	8.1873	-126.2	-20.998	**353.135**	**5407.42**
Other Ag	37.309	88.249	3.590	1210.407	796.982	52.188	255.382	464.106	**2908.21**	909.231	11.512	76.291	63.563	371.150	10.691	-318.43	-37.309	**1086.69**	**3994.91**
Food	18.93	43.75	2.93	992.56	973.75	56.21	6373.3	6661.1	**15122.5**	24529.4	320.587	108.208	374.662	5352.89	116.961	-5802	-332.27	**24668.4**	**39791**
Rest of eco	1739.91	1351.4	348.68	2004.9	1743.4	1529.89	11258.7	439458	**459435**	326431	127005	41135.3	-6558.8	154398	3.070	-163965	-3244.8	**475203**	**934638**
	1843.78	**1596.05**	**359.244**	**6979.75**	**4321.79**	**1714.69**	**27239**	**447275**	**490329**	**355220**	**127410**	**41669.4**	**-6090.4**	**164091**	**516.24**	**-172048**	**-3742**	**507027**	**997356**
Indirect tax	325.508	367.958	80.520	529.015	355.444	286.755	364.5	42409	**44718.7**										
Subsidies	-872.29	-773.54	-94.642	-737.151	-1054.7	-203.35	-293.3	-9503.3	**-13532.3**										
Labour	254.564	376.748	290.008	628.388	728.985	656.896	6530.9	286876	**296342**										
Capital	1119.19	528.968	625.481	414.536	954.522	1284.9	5949.85	167581	**178459**										
Land	365.328	167.042	47.079	103.634	101.398	255.015	0.000	0.000	**1039.5**										
	1192.3	**667.173**	**948.446**	**938.422**	**1085.63**	2280.21	**12552**	**487363**	**507027**										
Total dd	**3036.07**	**2263.22**	**1307.69**	**6918.18**	**5407.42**	**3994.91**	**39791**	**934638**	**997356**										

1991 amounted to $429 million ("Agricultural Financial Statistics"). While this amount is an understatement, in the absence of data on other types of taxes that are included in "*OIT*", it is deemed to be an acceptable approximation. Consequently, this sum was distributed among the agricultural sub-sectors in proportion to the "value of land and buildings" belonging to each sector as reported in the 1991 census. Total property taxes was deducted from total indirect taxes in the use matrix of Statistics Canada input-output table ($1945.2 million) to obtain the estimated amount of commodity indirect tax, which in turn is distributed among the sub-sectors according to the commodity indirect tax rates reported in Thomassin and Andison (1987).

Table 3.2. Input-Output Coefficients of the Canadian Economy

	Wheat	Other Grains	Fruits & Vegetab.	Live-stock	Milk & Poultry	Other Agric.	Food Process.	Rest of Economy
Wheat	0.003212	0.010192	0.000712	0.046195	0.03790	0.00345	0.01144	0.00004
Other Grains	0.004333	0.013748	0.000951	0.062985	0.05024	0.00470	0.01120	0.00010
Fruits & Vegetables.	0.000184	0.000584	0.000041	0.002642	0.00219	0.00020	0.00699	0.00033
Livestock	0.006634	0.021052	0.001111	0.123071	0.04138	0.00917	0.08875	0.00011
Milk & Poultry	0.001324	0.004197	0.000278	0.021228	0.01766	0.00160	0.11664	0.00016
Other Agriculture	0.012289	0.038993	0.002746	0.17496	0.14739	0.01306	0.00642	0.00050
Food Processing	0.006235	0.019331	0.002241	0.143471	0.18008	0.01407	0.16017	0.00713
Rest of Economy	0.57308	0.597114	0.266638	0.289802	0.32241	0.38296	0.28295	0.47019

[a] Calculated from Table 3.1

Subsidies: Subsidies have been made for cattle and calves, sheep and lamb, hogs, poultry, other live animals wheat, "other grains", milk unprocessed, eggs in shell, fruits, fresh, and vegetables, fresh (Thomassin and Andison, 1987). A total amount of $3735.7

millions in subsidies was expended for the agricultural sector in 1991 (Statistics Canada). This amount was extended in the form of program payments and other assistance (Statistics Canada, 1991). To distribute this sum across the sub-sectors, the distribution of "program payments" and other assistance contained in "Agricultural Financial Statistics" was used. For milk, data on direct subsidy payments from the " National Income and expenditure Accounts" was used to supplement the data from "Agricultural Financial Statistics". *Subsidies*: Subsidies have been made for cattle and calves, sheep and lamb, hogs, poultry, other live animals wheat, "other grains", milk unprocessed, eggs in shell, fruits, fresh, and vegetables, fresh (Thomassin and Andison, 1987). A total amount of $3735.7 millions in subsidies was expended for the agricultural sector in 1991 (Statistics Canada). This amount was extended in the form of program payments and other assistance (Statistics Canada, 1991). To distribute this sum across the sub-sectors, the distribution of "program payments" and other assistance contained in "Agricultural Financial Statistics" was used. For milk, data on direct subsidy payments from the " National Income and expenditure Accounts" was used to supplement the data from "Agricultural Financial Statistics".

3.4. Primary Input Use

The production functions in the CGE model are formulated in terms of quantities of the primary inputs. There are three primary inputs, namely, labour, capital and agricultural land. Data on capital stock and land use in the agricultural sub-sectors were obtained from the 1991 census. The census data were supplemented by data from "Capital Stocks and Flows", which is also the major source of data on capital stocks in the non-agricultural sectors. The quantity of labour in agriculture was derived from both the 1991 census and the 1991 national input-output table. The 1991 census contains data on the total number of weeks of hired labour and total wages and salaries for 1990. From these data the average weekly wage per person for 1990 was computed and this was then adjusted by the labour cost growth rate, as reported in Statistics Canada's "Canadian Economic Observer" for 1995, to obtain the average weekly wage rate per person for 1991. The value for total wages and salaries for the agricultural sector, as contained in Statistics Canada's input-output table, was divided by the average weekly wage rate to give the number of labour

Table 3.3. Primary Input Use and Returns in the Base Year of 1991 [a]

	Production (Million Dollars)	Labour ('000 Weeks of Labour	Capital Stock (Billion Dollars)	Land (Million Acres)	Wages (Million Dollars	Profits (Million Dollars)	Rent (Million Dollars)	Total Value Added (Million Dollars)
Wheat	3036.075	640. 493	10.405	258.23.4	254.564	1119.193	365.328	1739.084
Other Grains	2263.216	947. 913	13.586	2619.8.81	376.748	528.968	167.042	1072.758
Fruits and Vegetables	1307.690	729. 671	2.250	624..840	290.008	625.481	47.079	962.568
Livestock	6918.177	1581.05	17.202	2816.3.23	628.388	414.536	103.634	1146.558
Milk and poultry	5407.422	1834.155	8.907	7184..091	728.985	954.522	101.398	1784.905
Other Agriculture	3994.906	1652.776	6.514	4148..696	656.896	1284.895	255.015	2196.806
Food Processing	39790.95	12355.08	17.173	0.000	6530.896	5949.855	0.000	12480.75
Rest of Economy	935237.9	542708.7	1521.126	0.000	286875.8	167581.2	0.000	454457.1

[a] Compiled by the author from sources cited above.

weeks applied in the agricultural sector. Disaggregation of labour weeks across the agricultural sub-sectors was made in proportion to labour weeks reported in the 1991 census. Operators (owners) labour use on farm activities which is discussed in Section 3.2 is added to hired labour use to obtain the sectoral total labour uses. The sector-specific primary input use and the returns to these inputs for the base year are presented in Table 3.3. Disaggregation of labour weeks across the agricultural sub-sectors was made in proportion to labour weeks reported in the 1991 census. Operators (owners) labour use on farm activities which is discussed in Section 3.2 is added to hired labour use to obtain the sectoral total labour uses. The sector-specific primary input use and the returns to these inputs for the base year are presented in Table 3.3.

3.5. Import Tariffs and Export Subsidies:

The aggregate level of import tariff revenue for the Canadian economy is reported in both the "National Income and Expenditure Accounts" and the "National Input-Output Tables". Import tariff rates and export subsidies for the agricultural sub-sectors and the food industry were taken from several recent studies on agricultural trade liberalization (Brooks and Kraft, 1994; Ingco, 1994; IATRC, 1994). The tariff and export subsidy levels for the rest of the economy were determined residually. Since the tariff rates and export subsidies apply on commodities, not on sectors as such, the necessary adjustments have been made to convert these into sectoral tariff rates and export subsidies. The sectoral tariff revenues and export subsidies are indicated in Table 3.1, above.

3.6. Elasticities of Substitution

The last set of data required by the CGE model had to be sought from the literature search. These are the elasticities of substitution of the CES and CET functions, and the export demand equation. These measures are not explicitly indicated in the first two functions; they are implied in the exponents of those functions, which means that the choice of these measures determines the values of the exponents and hence the specifications of the functions.

Most of the values of the elasticities of substitution for our model were chosen from Adelman and Robinson (1988), Robinson (1990), Burniaux et al (1990), and Guzel (1990). The first two studies generally used lower values than the last two. For example, the highest elasticity of substitution used for either of the CES or CET functions by the first two studies was four. Burniaux et al (1990) used relatively higher elasticities in both the CES and CET functions for all products, the highest, 17, being in the CET function for manufactured products. Within agriculture, the minimum value is assigned in the CES function for livestock, and milk and poultry. In Guzel (1990) mainly intermediate estimates were used although the CES and CET elasticity estimates that apply for the milk and poultry sector were much smaller (0.6) than those used in the other studies. The elasticities estimates ranged from 0.6 to 5.0.

A technical aid in the choice of these values is a replication check, i.e., to check if the model can reproduce the base year data set as an initial solution. Furthermore, a preliminary sensitivity analysis on the model revealed that, from the range of previous estimates and choices in the literature, model sensitivity can be minimized by choosing values of elasticities of substitution that are more conservative. Consequently, these are listed as follows; the first listed of each of the pairs in the parentheses are values of elasticity of substitution in the CES functions, while the second pairs are corresponding values in the CET functions. The following values were selected: (4.0, 4.0) for wheat, (1.5, 1.5) for "other grains", (2.0, 4.0) for fruits and vegetables, (1.5, 1.5) for livestock, and milk and poultry, (4.0, 1.5) for other agriculture, (3.0, 3.0) for food, and (2.0, 2.0) for the rest of economy. The price elasticity of demand for Canadian wheat exports is set at 3.0. Robinson et al (1990) used 4.0 for the price elasticity of demand for US wheat exports. Assuming that this was correct, the choice of 3.0 assumes slightly more market power for the export of Canadian wheat by the CWB than for the exports of US wheat by large trading companies.

3.7. Social Accounting Matrix

An essential stage in the preparation of the data required by a CGE model is the construction of a Social Accounting Matrix (SAM). The SAM provides a convenient data framework for CGE models by bringing the input-output structure of the economy and macroeconomic values together in a consistent matrix. A SAM unifies national income and product accounts, which are the data basis for macro models, and input-output accounts, which underly multisector models, in one statistical framework.

Depending on the problem to be studied, the various accounts in a SAM can be specified at different levels of aggregation. Also, the definitions of the accounts in the SAM can vary from case to case. However, all SAMs satisfy the convention that along the rows are listed the incomes of the various agents, while the expenditures of the same agents are registered along the columns. A SAM is thus defined as a square matrix, with the totals of corresponding rows and columns always being equal. Table 3.4 presents the structure of the SAM at the required level of aggregation for our CGE model.

The requirement that the receipts of the various agents, read across the rows, must balance with the corresponding expenditures, read down the columns, has the implications that i) the revenue of producers is taken up by costs and distributed profits; ii) for each agent in the model, income is exhausted by expenditures, taxes and savings; and iii) for each commodity, demand equals supply (Robinson et al, 1990).

The row of the "commodity" account documents the supply of both intermediate and finished goods to the domestic users. Imports constitute some of the supply. Down the column of the "commodity" account we trace absorption, which consists of the value of domestic products sold on the domestic market and imports including tariffs. Along the second row, producers earn income from sales of products to domestic and foreign markets. The appearance of exports in the "activity" row, instead of the commodity row, is due to the model assumption of product transformation between those goods produced for domestic supply and those for export markets, with some constant measure of elasticity of transformation. Down column two, producers pay for intermediate inputs and the indirect taxes (net of production subsidies) on these inputs, and value added to owners of primary inputs.

Rows/columns 3 and 4 document value-added receipts of primary inputs and their distribution to the institutional actors. Note that unlike labour and land incomes, capital income does not accrue directly to households. A portion of this income is transferred to

Table 3.4. A Social Accounting Matrix (SAM) Format[a]

		EXPENDITURE									
		Suppliers		Value added		Institutional Actors					
		Commodity (1)	Activity (2)	Labour (3)	Capital (4)	Enterprises (5)	Households (6)	Government (7)	Capital (8)	World (9)	Row Totals
INCOME	Suppliers										
	(1) Commodity		Intermediate Demand				Household Consumptio	Government Purchase	Investment		Domestic Sales
	(2) Activity	Domestic Supply						Export Subsidies		Exports	Total Sales
	Value added										
	(3) Labour		Employee Compensation								Employee Compensation
	(4) Capital		Capital Income								Capital Income
	Inst. Actors										
	(5) Enterprise				Gross business Income			Transfers to Business			Enterprise Income
	(6) Households			Labour Income		Distributed Profits		Transfers to Households		Net foreign Remittance	Household Income
	(7) Govt.	Tariff	Indirect Tax			Business Profit tax	Household Income tax			Net foreign Transfers	Govt. Income
	(8) Capital					Business Savings & Depreciation	Household Savings	Government Savings		Net foreign Savings	Total Savings
	(9) World	Imports									Foreign Income
	Column Totals	Total Absorption	Total Costs	Employee Compens.	Capital Income	Enterprise Expenditure	Household Expenditure	Government Expenditure	Total Investment	Foreign Expenditur	

[a] This format has been taken from Robinson et al (1990)

households in the form of distributed profits which is registered as inter-institutional transfer. The cells that belong to the quadrant of rows and columns 5 to 9 describe net inter-institutional transfers. The macro balances -- government deficit, savings-investment, and the trade balance -- are represented by the accounts appearing in rows/columns 7 to 9. The last row and column give the sums of the various columns and rows. Table 3.5 presents the SAM for Canada constructed for and used in this study, with actual data from the 1991 base year.

Table 3.5. A Social Accounting Matrix for Canada in 1991 (in Billions of Dollars)[a]

		EXPENDITURE										
		Commodity	Activity	Labour	Capital	Land	Enterprises	Households	Government	Capital	World	Row Totals
	Commodity		490.329					355.961	40.928	121.32		1008.54
I	Activity	831.991							0.516		164.849	997.356
N	Labour		296.342									296.342
C	Capital		178.459									178.459
	Land		1.04									
O	Enterprise				178.459				27.301		-14.567	191.193
M	Households			296.34		1.04	75.89		152.741		3.573	529.586
	Government	3.742	31.186				15.015	140.468			-11.894	183.795
E	Capital						100.288	33.157	-37.691		30.844	126.598
	World	172.805										172.805
	Column Totals	1008.538	997.356	296.34	178.459	1.04	191.193	529.586	183.795	126.598	172.805	3685.71

[a] Compiled by the author

4. THE IMPLICATIONS OF MULTILATERAL TRADE AGREEMENTS FOR THE CANADIAN AGRICULTURE

4.1. Introduction and Background

In this chapter, the various comparative static results obtained from the CGE model used to assess the impacts of the Uruguay Round (UR) multilateral trade agreement on Canadian agriculture are presented and discussed. Model validation was conducted by solving the CGE model without introducing any changes into the system and checking if the model gives back the base year solutions of the system. The results, presented in Appendix 4.1.1, show that the model has successfully reproduced the bench-mark or base year values, including the base year Social Accounting Matrix (SAM).

The comparative static simulation experiments discussed below introduce changes in policy and world prices. The policy changes were taken from the general commitments of the UR agreement, and the world price changes were taken from projections of global studies.[1] More specifically, the simulation experiments include:

i) The UR policy change commitments by the Canadian government, including export subsidy reduction, tariff rate reduction, and domestic support reduction commitments.

ii) Projected world price changes for agricultural products.

Export subsidy expenditures were reduced by 36 per cent for agricultural and processed food products relative to base year (1986-1990) levels.[2] Unlike the URA provisions for

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[1]The CGE program developed to introduce the necessary policy and world price changes for the simulation experiments is presented in Appendix 4.1.2

[2] Within the food industry, the 36 per cent export subsidy reduction applies only to a subset of all processed food products (i.e., meat and dairy products). The export magnitude of these products for the base year amounted to some 27 per cent of the total exports of processed food. Consequently, the export subsidy reduction that applies to the entire food-processing industry is calculated to be 10 per cent.

export subsidy reductions, tariff rate reduction commitments were not uniform across sectors. This lack of uniformity is implied in the UR agreement. Signatories could apply the minimum cut in tariffs of 15 per cent to any specific item (i.e., tariff line) and could apply larger tariff reductions on imports of other products, in order to attain the required average tariff reduction of 36 per cent over all the imports of agricultural products. The 20 per cent reduction commitment on domestic support applies uniformly for each of the agricultural sectors. Based on the share of processed agricultural food products which received domestic support in the base year (i.e., the share of meat and dairy products), the average domestic support reduction that applies for the entire food industry was calculated to be six per cent. None of the policy commitments apply to the rest of the economy (RESTEC) sector.[3]

World price changes for agricultural products were taken from other studies of the global effects of multilateral trade liberalization, and introduced into the model exogenously. These projected world price changes are restricted to wheat, other grains, other agriculture, and processed foods including processed dairy and meat products. Since projected world price changes for these products vary greatly from one study to another, the various simulation experiments discussed throughout this study are conducted twice, once simulating the effect of "minimum" world price changes together with the policy changes mentioned in (i) above. The second simulation incorporates the effect of "maximum" world price changes and the same domestic policy changes. Table 4.1 summarizes the policy and world price changes simulated in this study.

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[3] However, outside of the URA on agriculture, it was anticipated that Canada will reduce the tariff rates on imports of those goods that compete with the rest of the economy products by 37.3 per cent over the same period of the implementation of the UR agreement (Wang, 1997).

Table 4.1. Summary of Policy and World Price Changes Used in Simulations[a]

Sector	Export Subsidy	Tariff Rate	Domestic Support	World Price Changes "Minimum"	World Price Changes "Maximum"
		Per cent			
Wheat	36	64.155	20	4	36.7
Other Grains	36	49.928	20	4	16.3
Fruits and Vegetables	36	15.000	20	0	0
Livestock	36	46.613	20	0	0
Milk and Poultry	36	37.141	20	0	0
Other Agriculture	36	15.000	20	4	10
Food Processing[b]	10	22.257	6	1	7.5
Rest of the economy	0	37.289	0	0	0

[a] The figures on tariff reduction commitments were as aggregated from the version 3 (pre-release) GTAP database and compiled for Zhi Wang (1997), with necessary adjustment for differences in sectoral classifications. The "minimum" world price changes were taken from Frohberg's projection results (1989), while the "maximum" prices were as reported in the SWOPSIM (Roningon and Dixit, 1989) model. Other projections, including those of Cahill (1991), and the Provincial and Federal Officials (1994) generally fall within the range as defined by the "minimum" and "maximum" price changes presented in this table for the product groupings used here. Note that the world price changes are assumed to apply for both export and import goods.

[b] Note that processed dairy products are in the Food sector, as are meats, other than poultry. At the maximum, world prices of dairy products and meats are projected to increase by some 65 and 21 per cent, respectively (Roningon and Dixit, 1989).

4.2 Scenario 1: The Effects of Changes in Domestic Policy and "Minimum" Increases in World Prices

The analyses of the effects of the policy changes follow the nature of the set up of the CGE model. Exogenous shocks affect quantity ("real") variables, causing imbalances between supply and demand in the respective markets. The equilibrating variables, that is, the domestic endogenous prices, then adjust in the system to establish new equilibria in the various markets. Consequently, most price changes are triggered by changes that took place in the quantity variables, while the resulting equilibrium real values are to be explained in terms of the adjustments (or changes) in the price variables. A second point is that in a general equilibrium framework, the solution values for the endogenous variables naturally contain both direct and indirect effects of the introduced shocks. The indirect effects on individual variables are essentially reflected back from the resource constraints that represent the equilibrium conditions of the model. In any event, it is hard to establish exact causality relationships between the shocks and the chain of repercussions. However, it is safe to assume that the direct effects are reasonably bigger than the indirect effects; this underscores the stability condition of the system. To this extent, an approximate causality relationship can be established between the shocks and the chain effects of these. Any interpretation of the CGE results based on the direct effects of the shocks will have to be seen in this light.

The reduction in domestic support is expected to affect domestic production (XD) negatively. Since domestic support is entered into the model as a negative indirect tax on production, this primarily changes (i.e., lowers) the value added price. Since in the model producers maximize their profits based on the value added prices for their products, the effect of the reduction in domestic support on domestic production will be negative.

The lowering of tariff rates leads to an increase in imports and thus some increase in the composite domestic supply (X). This effect is reflected on domestic production via the goods market equilibrium condition. Other things remaining constant, a reduction in tariffs leads to a decrease in domestic production (XD), the extent of which is determined by the substitutability allowed in the model between domestic goods and imports.

The immediate effect of a reduction in export subsidies is to discourage exports.

Since goods delivered to the domestic market and goods delivered to the export market are entwined in a CET function, some of the drop in exports will be picked up by deliveries to the domestic market, to the extent that transformation parameters of the CET function allow. Given the additional effect of reductions in import tariffs, the effect of export subsidy cuts on domestic production will be negative. Finally, a rise in world prices will have an opposite effect on domestic production by encouraging exports and discouraging imports.

From results reported in Tables 4.2.2 and 4.2.3, it can be seen that the Uruguay Round Agreement on agriculture would have a negative effect on Canadian agriculture if world prices were to increase only by the minimum amount. That is, the "minimum" increases in world prices from trade liberalization are too small to offset the negative effects of the policy changes (i.e., the reductions in production associated with reduced tariffs, domestic support and export subsidy). Domestic production declines in all the agricultural and the food sectors below the base year (1991) level (see Table 4.2.2). The largest drop in production occurs in the other grains sector, which compared to base year level, declines by 13.7 per cent. The second largest drop in production (9.6 per cent below base year level) occurs in the wheat sector. The other agriculture sector experiences the lowest decline of 0.6 per cent in domestic production. Aggregate domestic agricultural production declines by close to 5 per cent. Domestic production in the rest of the economy sector rises by about two tenth of one per cent.

The changes in sectoral production in agriculture reported here are consistent with the changes in sectoral value added prices (PVA). In Scenario 1, PVA declines in all the agricultural sectors. In the wheat and other grains sectors, this price declines by 2.0 and

1.4 per cent, respectively (see Table 4.2.1). The value added terms of trade for agriculture (AGTOTVA) decline by 0.2 per cent below the base year level (see Table 4.2.3). The changes in exports are more pronounced than the changes in production, particularly in the agricultural sectors. For other grains, wheat, milk and poultry, livestock, and fruits and vegetables, exports (E) decline by 28.7, 12.2, 10.3, 9.8, and 9.2 per cent, respectively. On the other hand, the exports of other agriculture rise by 3.6 per cent. This result might derive from the fact that export subsidies and domestic support in other agriculture were sufficiently small in the base period, that their reduction was more than made up for by the increase in the world prices. Furthermore, the domestic price of exports (PE) of other agriculture increases above base year level. While the price of other agriculture delivered to the domestic market (PD) also rises in Scenario 1, the rise in PE is larger than the increase in PD, providing the incentive to increase the exports of other agriculture. Note that the domestic price of exports (PE) of wheat and other grains also rise in Scenario 1 but PD rises even more than PE that the export magnitudes of these products decline below base year levels. (PD is directly affected by the changes in domestic support and export subsidies. Since a reduction in domestic support discourages domestic production, it pushes PD up in equilibrium. The reduction in export subsidies, on the other hand, discourages exports in favor of deliveries to the domestic market, thereby depressing PD. The stronger of these two effects, which in this case is the effect of the change in domestic support determines the direction of the change in PD. The domestic price of domestically produced goods (PD) increases for all but the rest of economy products. Aggregate agricultural exports decline by 13.2 per cent. Exports of non-agricultural products rise by close to one per cent above base year level.

Import levels (M) of almost all products increase compared to levels in 1991 base year. This is greatest for milk and poultry, which increase by 28.3 per cent. This may be indicative of the higher level of protection accorded to this sector under the base scenario. It is also consistent with the 13 per cent fall in the domestic price of imports (PM) of milk and poultry, the largest fall in PM for all products. Wheat imports increase by 22.6 per cent, the second highest increase. This follows from the simulated high reduction in tariffs on wheat imports. Imports of the remaining agricultural products also increase except other agriculture, though modestly. Imports of other agriculture decline by close to 16 per cent. Note that the domestic price of imports (PM) does not decline for all products in Scenario 1. However, where PM increases, the increase in PD is larger, giving an incentive to import more. Aggregate imports of agricultural products increase by 1.4 per cent, while aggregate imports of non-agricultural products increase by 0.6 per cent above base year levels.

Comparison of changes in import levels reported above with the minimum access commitments is not straightforward since the simulation results are in value terms while the minimum access commitments apply to quantities. Due to differences in the units of measurement, it was only possible to aggregate minimum access commitments according to the sectoral classification of the simulation model for wheat and other grains. Canada's minimum access commitment for wheat is 227,000 MT, which exceeds the 171,865 MT increases in imports that results in Scenario 1. Imports of other grains in the base year are dominated by imports of corn. On the other hand, the minimum access commitment is made for barley in the amount of 399,000 MT, which exceeds the 56,910 MT increases in the imports of other grains in Scenario 1.

Table 4.2.1. Results of Simulation 1: Sectoral Prices and Percentage Changes from Base Values[a]

	PX	%Δ	PD	%Δ	P	%Δ	PVA	%Δ	PK	%Δ	PE	%Δ	PM	%Δ	PWE	%Δ	PWM	%Δ
Wheat	1.04	4.14	1.05	5.43	1.05	4.81	0.56	-1.98	1.00	-0.04	1.03	3.37	0.99	-1.09	0.94	8.62	0.96	4.00
Other Grains	1.06	5.77	1.09	8.49	1.08	7.63	0.47	-1.42	1.00	-0.01	1.01	0.83	1.02	2.13	0.95	4.00	1.00	4.00
Fruit & Vegetables	1.01	1.15	1.01	1.36	1.01	0.86	0.73	-0.41	1.00	-0.08	0.99	-0.63	1.00	0.43	0.97	0.00	1.00	0.00
Livestock	1.04	3.47	1.04	4.32	1.04	4.06	0.16	-0.76	1.00	0.22	0.99	-0.71	0.99	-1.53	0.97	0.00	0.96	0.00
Milk & Poultry	1.04	4.38	1.05	4.59	1.04	4.04	0.33	-0.46	1.00	0.02	0.99	-1.00	0.87	-13.0	0.96	0.00	0.71	0.00
Other Agriculture	1.01	0.54	1.00	0.23	1.01	0.58	0.54	-1.05	1.00	-0.06	1.03	3.38	1.04	4.39	1.01	4.00	1.04	4.00
Food Processing	1.01	1.19	1.01	1.18	1.01	0.93	0.31	0.11	1.00	0.17	1.01	1.22	1.00	-0.46	0.99	1.00	0.93	1.00
Rest of the economy	1.00	0.03	1.00	-0.05	1.00	-0.09	0.49	0.13	1.00	-0.09	1.00	0.44	1.00	-0.28	1.00	0.00	0.98	0.00

[a] The simulation involved the full reduction of export subsidies, import tariffs and domestic support pursuant to the Uruguay Round Agreement, and "minimum" changes in world prices of agricultural products. The symbol " % Δ " stands for percentage change in the value of the respective variable from the base value of the same variable. The base values for sectoral prices are presented in Appendix 4.1.1.

Table 4.2.2. Results of Simulation 1: Sectoral Output and Disposition, and Percentage Changes from base Values[a]

	XD	% Δ	INT	% Δ	CONS-DD	% Δ	INVE-ST	% Δ	INVEN TORY	% Δ	GOV-DD	% Δ	E	% Δ	M	% Δ
Wheat	2.75	-9.57	1.04	-2.83	0.09	-4.48	0.00	5.07	-0.05	9.57	0.11	-4.59	1.68	-12.2	0.13	22.59
Other Grains	1.95	-13.7	1.28	-2.89	0.23	-6.98	0.01	7.90	-0.04	13.71	0.06	-7.09	0.63	-28.7	0.22	4.60
Fruit & Vegetables	1.27	-2.56	0.61	-0.86	1.92	-0.73	0.00	1.10	-0.03	2.56	0.03	-0.85	0.13	-9.21	1.38	0.10
Livestock	6.64	-4.00	4.70	-2.22	0.82	-3.79	0.06	4.32	0.15	-4.00	0.10	-3.90	1.08	-9.76	0.27	5.96
Milk & Poultry	5.25	-2.87	4.97	-1.70	0.22	-3.77	0.01	4.30	0.01	-2.87	0.04	-3.89	0.19	-10.3	0.19	28.32
Other Agriculture	3.97	-0.60	2.82	-3.12	0.91	-0.46	0.01	0.83	0.06	-0.60	0.08	-0.57	0.40	3.65	0.30	-15.9
Food Processing	39.14	-1.64	14.96	-1.11	24.33	-0.80	0.32	1.18	0.37	-1.64	0.11	-0.92	5.39	-1.55	6.34	3.29
Rest of the economy	936.4	0.19	459.6	0.03	327.9	0.21	127.2	0.16	-6.57	0.19	40.43	0.09	156.7	1.00	168.8	0.50
Agriculture	21.84	-4.75	15.41	-2.27	4.18	-1.89	0.09	4.07	0.10	6.51	0.41	-3.80	4.11	-13.2	2.48	1.39
Non-agriculture	975.5	0.114	474.5	-0.01	352.2	0.138	127.5	0.16	-6.21	0.299	40.54	0.087	162.1	0.91	175.1	0.599

[a] The simulation involved the full reduction of export subsidies, import tariffs and domestic support pursuant to the Uruguay Round Agreement, and "minimum" changes in world prices of agricultural products. The symbol " % Δ " stands for percentage change in the value of the respective variable from the base value of the same variable. Base year values are presented in Appendix 4.1.1. Values are in billions of constant Canadian dollar

Private consumption of agricultural products, including those supplied by the food processing sector, declines following the simulation of the policy and minimum world price changes (see Table 4.2.2). For agricultural products, private consumption declines in the range of 0.5 per cent, for other agriculture, to 7.0 per cent, for other grains. Aggregate private consumption of agricultural products declines by nearly 2 per cent. This outcome is consistent with the changes in the CES price (P), which is the price of the composite consumption good (X). For other grains, P rises by 7.6 per cent, the highest increase in all sectoral CES prices. For wheat, fruits and vegetables, livestock, milk and poultry and other agriculture, P rises by 4.8, 0.9, 4.1, 4.0, and 0.5 per cent, respectively. In contrast, the domestic consumption of the products of the rest of the economy increases somewhat compared to the base year level. This increase in private domestic consumption of non-agricultural products may be explained in terms of the comparative price advantage for these products relative to the agricultural products. From Table 4.2.4, we observe that the domestic-price-terms-of-trade for agriculture (AGTOTPX) improves by 3.2 per cent. Changes in the government's purchase of consumption goods exhibit the same pattern as changes in private consumption.

Table 4.2.3 summarizes the effects on factor allocations and the returns to those factors of the URA under the assumption of minimum increases in the world prices of agricultural products. Under Scenario 1, the demand for labour and capital decline in all agricultural sectors, the highest decline occurring in the other grains sector. Labour demand in this sector declines by 15.1 per cent while capital demand declines by 14.9 per cent. In the wheat sector labour and capital demand decline by 11.5 and 11.4 per cent, respectively. In the livestock, and milk and poultry sectors the demand for labour

Table 4.2.3. Results of Simulation 1: Sectoral Value Added, Factor Use, and Factor Incomes, and Percentage Changes from Base Values[a]

	VAL-ADDM	% Δ	VAL-ADDF	% Δ	LABR	% Δ	YF-LABR	% Δ	CAP-TL	% Δ	YF-CAPTL	% Δ	AG-LND	% Δ	YFAG-LND	% Δ
Wheat	1.19	-0.12	1.54	-11.4	0.57	-11.5	0.23	-11.4	9.22	-11.4	0.99	-11.4	25.22	-2.34	0.32	-11.4
other grains	0.68	2.46	0.91	-14.9	0.81	-15.1	0.32	-14.9	11.56	-15.0	0.45	-14.9	24.55	-6.29	0.14	-14.9
Fruit & Vegetables	0.94	-1.01	0.93	-2.95	0.71	-3.15	0.28	-2.95	2.18	-2.96	0.61	-2.95	0.67	6.92	0.05	-2.95
Livestock	1.03	9.96	1.09	-4.73	1.50	-4.92	0.60	-4.73	16.38	-4.74	0.40	-4.73	29.56	4.96	0.10	-4.73
Milk & Poultry	1.23	13.35	1.73	-3.32	1.77	-3.52	0.71	-3.32	8.61	-3.33	0.92	-3.32	7.65	6.51	0.10	-3.32
Other Agriculture	2.29	0.20	2.16	-1.64	1.62	-1.85	0.65	-1.64	6.41	-1.65	1.26	-1.64	4.50	8.36	0.25	-1.64
Food Processing	12.38	-1.38	12.29	-1.53	12.14	-1.73	6.43	-1.53	16.91	-1.54	5.86	-1.53	0.00	0.00	0.00	0.00
Rest of the economy	488.9	0.31	455.9	0.32	543.3	0.12	287.8	0.32	1526	0.31	168.12	0.32	0.00	0.00	0.00	0.00
Agriculture	7.36	3.49	8.37	-6.02	6.97	-5.59	2.78	-5.40	54.36	-7.64	4.63	-6.03	92.14	0.00	0.96	-7.72
Non-agriculture	501.4	0.272	468.2	272	555.5	0.074	294.2	0.28	1543	0.292	173.79	0.258	0.00	0.00	0.00	0.00

[a] The simulation involved the full reduction of export subsidies, import tariffs and domestic support pursuant to the Uruguay Round Agreement, and "minimum" changes in world prices of agricultural products. The symbol " % Δ " stands for percentage change in the value of the respective variable from the base value of the same variable. Values are in billions of constant Canadian dollars. The base values are presented in Appendix 4.1.1.

declines by 4.9 and 3.5 per cent, respectively, while the demand for capital in these sectors decline by 4.7 and 3.3 per cent, respectively. The demand for labour and capital decline modestly in the remaining two agricultural sectors. Aggregate labour and capital demand in agriculture decline by 5.6 and 7.6 per cent, respectively. These economy-wide mobile factors are not picked up by the food industry either, as the latter experiences a decline of 1.7 and 1.5 per cent in labour and capital demand, respectively.

In contrast, primary factor employment increases for both labour and capital in "the rest of the economy" sector, where labour and capital demand increase by 0.1 and 0.3 per cent, respectively. The value added terms of trade (AGTOTVA) deteriorates for agriculture by 1.5 per cent under the simulation scenario (see Table 4.2.4). According to the long run assumption regarding factor mobility, factors are attracted toward the sector(s) with relatively higher value added prices or better value added terms of trade, which in our case happens to be "the rest of the economy" sector.

Since agricultural land is specific to agricultural activities, its intersectoral mobility takes place within the agriculture sector. Agricultural land use decreases in the wheat and other grains sectors by 2.3 and 6.3 per cent, respectively, and increases in the remaining agricultural sectors (see Table 4.2.3). This outcome may be explained in terms of the relative changes in value added prices among the agricultural sectors. In Table 4.2.1, we observe that the other grains and wheat sectors, in that order, are the two agricultural sectors where the value added prices decline the most under the simulation scenario. Factor market clearing condition requires that, in equilibrium, aggregate factor supply equals aggregate factor demand. Thus, the decline in demand for agricultural land in the other grains and wheat sectors is counterbalanced by an increase in demand of equal magnitude of the same factor in the remaining agricultural sectors which experience relatively lower declines in value added prices than the former two.

Projected changes in labour and capital returns are similar to the changes in the demand for these factors. Thus, the maximum decline in labour and capital income takes place in the other grains and wheat sectors; both decline by 14.9 per cent in the other grains sector and by 11.4 per cent in the wheat sector. Labour and capital incomes in the livestock, milk and poultry, fruits and vegetables, other agriculture, and food sectors each decline by 4.725, 3.317, 2.950, 1.643, and 1.530 per cent, respectively. Note that because of the technological assumption of constant returns to scale in production, the exponents of the Cobb-Douglas production functions for each sector represent factor income distributive shares. Since these parameters are treated as fixed in the simulation experiments, the percentage changes in factor returns are the same across factors within a sector. Consequently, percentage changes in agricultural land income across the agricultural sectors are the same as those for labour and capital. In agriculture, aggregate returns for labour, capital, and agricultural land decline by 5.4, 6.0, and 7.7 per cent, respectively. In the food processing sector, labour and capital income each falls by 1.5 per cent, while each of these increase by 0.3 per cent in the "rest of the economy sector.

The first four columns of Table 4.2.3 give the comparative static values and percentage changes in value added, both at market prices and at factor cost. The assumption of constant returns to scale in production implies that value added at factor cost (VALADDF) is the sum of factor incomes. As a result, the percentage changes in VALADDF across sectors are the same as those of factor incomes. Regarding value added at market prices, we make two observations: first, due to the high level of domestic subsidy in agriculture relative to indirect taxes, value added at market prices (VALADDM) differs substantially from value added at factor costs in most of the agricultural sectors in the base period. Second, due to this difference in value added measures, the effects of the simulated policy and world price changes on VALADDM and VALADDF are different.[4] For agriculture, on average, VALADDM increases by 3.5 per cent while for the non-agriculture sector it rises by 0.3 per cent.

The effects of the simulated policy and world price changes on aggregate variables, such as gross national product (GNPVA), total household income (YHH), and government revenue (GOVREV), are summarized under Table 4.2.4. The aggregate variables show very small changes from base values as a result of the UR policy commitments and "minimum" world price changes. GNPVA in value added terms increases by less than a tenth of a per cent, while total investment demand (INVEST) increases by 0.3 per cent.[5] The positive change in investment demand in agriculture is mainly contributed by the positive changes in inventory investment. Government revenue declines by 0.2 per cent. Household income tax and household savings each increase by a tenth of a per cent as does total household income. Total tariff revenue declines by 35.5 per cent while total domestic support and export subsidy expenditures decline by 5.7 and 29.9 per cent respectively. Both enterprise savings and business tax

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[4] In the formula for the calculation of VALADDM, domestic support is entered as a negative indirect tax rate. The reduction in domestic support affects VALADDM positively. The CET price (PX) also enters into the calculation as a multiplicative factor. Since PX has risen in all sectors under the simulation scenario, the effect on VALADDM is positive. Therefore, for modest declines in XD and value added prices, the effect of the simulated changes on VALADDM could be positive unlike in the case of VALADDF. For example, in the livestock, and milk and poultry sectors where the reductions in value added price and domestic production are relatively small, VALADDM rises by 10 and 13.4 per cent respectively.

[5] The difference between total savings and aggregate investment is the sales tax on investment goods. This amount is included in the INDTAXOUT variable, which also includes taxes on consumption goods.

Table 4.2.4. Results of Simulation 1: Aggregate Variables and Miscellaneous Parameters, and Percentage Changes from Base Values[a]

Variable	Value	% Δ	Variable	Value	% Δ	Variable	Value	% Δ
EXR	1.004	0.435	TARIFF	2.416	-35.45	ENTSAV	17.963	0.043
GNPVA	510.74	0.095	HHINCTAX	101.61	0.119	GOVSAV	-37.811	-0.319
YHH	530.22	0.119	ENTTAX	15.021	0.043	SAVINGS	126.76	0.130
GOVREV	183.49	-0.167	SUBSD	12.768	-5.650	FXDINV	127.73	0.247
INDTAXIN	44.760	0.092	TEXPSUB	0.362	-29.895	INVEST	121.63	0.258
INDTAXOUT	44.311	0.114	HHSAV	33.196	0.119	DEPRECIA	82.436	0.126
			Agriculture's Terms of Trade					
AGTOTPX	103.30	3.30	AGTOTE	95.821	4.487			
AGTOTVA	79.833	-1.481	AGTOTM	99.549	0.425			

[a]The simulation involved the full reduction of export subsidies, import tariffs and domestic support commitments pursuant to the Uruguay Round Agreement, and "minimum" changes in world prices of agricultural products. The symbol "% Δ" stands for percentage change in the value of the respective variable from the base value of the same variable. Base year values are presented in Appendix 4.1.1. Values are in billions of Canadian dollars.

revenue increase by 0.05 per cent each. Exchange rate depreciates by 0.4 per cent above the base period level.

4.3 Scenario 2: The Effects of Changes in Domestic Policy and "Maximum" Increases in World Prices

The second simulation experiment discussed in this section involves the assumption that world prices for agricultural products change as a result of the URA by the "maximum" amount as indicated in Table 4.1. The policy change commitments with respect to reductions in tariffs, export subsidies, and domestic support remain the same as under Scenario 1. Tables 4.3.1- 4.3.4 give the comparative static results and percentage changes from base year levels of the various endogenous variables. Given the wide difference between the "minimum" and "maximum" world prices simulated under the two experiments, it is not surprising that the two simulations yield very different results.

Given the policy commitments, if world prices of agricultural products were to increase by the maximum amount, the URA on agriculture would affect domestic production (XD) positively in all agricultural sectors except for fruits and vegetables (see Table 4.3.2). The highest increase in XD occurs in the wheat sector which, compared to base year levels, increases by 41.1 per cent. The next highest increase in XD is in other grains (by 16.5 per cent). Aggregate agricultural production increases by 9.1 per cent above the 1991 base level. Although production in the food industry increases by close to 6 per cent, output in the non-agriculture sector as a whole drops by 0.2 per cent. Reflective of the changes in sectoral output is the changes in sectoral value added price (PVA) presented in Table 4.3.1. PVA rises in all sectors except in the rest of the economy sector. Corresponding to the output results, the largest rise in PVA is for wheat, followed by that of the other grains.

Under this scenario, exports increase and imports decline in those sectors for which positive world price changes were simulated. More specifically, the wheat, other grains, and other agriculture sectors increase their exports by 59.4, 36.3, and 15.1 per cent, respectively. Imports of wheat, other grains, and other agriculture decline by 60.5, 8.5, and 22.534 per cent, respectively. Likewise, exports of processed foods rise by 25 per cent and their imports drop by 11.2 per cent. In the remaining agricultural sectors, exports decrease and imports increase. For example, exports of fruits and vegetables decline by 17.2 per cent, while imports of these increase by 2.6 per cent. In the livestock, and milk and poultry sectors, exports decline by 6.4 and 5.9 per cent, respectively, while imports of these products increase by 14.8 and 39.9 per cent, respectively. Exports of agricultural products increase on average by close to 30 per cent, while aggregate agricultural imports decline by 1.1 per cent. These results are consistent with the changes in the domestic prices of exports (PE) and imports (PM). Looking at Table 4.3.1, we observe that the domestic price of exports (PE) has increased in Scenario 2 for those sectors that exhibited increases in their exports, and vice versa. The domestic price of imports (PM) increase in those sectors with reduced imports. These domestic prices of tradables depend partly on the world prices and partly on the applicable tariff or export subsidy rates. PE increases the highest in the other grains sector while PM increases the highest for wheat. Note that the world price for Canadian wheat is determined endogenously. World price changes for wheat are simulated in terms of changes in the price of a substitute product (*pwse*) which is introduced into the model exogenously (see Equation 35). Due to the exponential form used to define the world export demand function for Canadian wheat, the minimum and maximum changes in *pwse* have non-proportional effects on the world price for Canadian wheat (PWE); as *pwse* changes by larger percentages, PWE changes proportionally by diminishing percentages.

Productive investment demand by sector of origin (ID) increases in all but in the rest of the economy sector. Aggregate ID for agriculture increases by 3.7 per cent, while this increases by 0.8 per cent in the non-agricultural sector. Both private and government consumption of all products except those produced by the rest of the economy decline under Scenario 2 of URA-related domestic policy changes and "maximum" increases in world prices (see Table 4.3.2). The decline in domestic consumption of agricultural products, while the domestic consumption of non-agricultural products increases can be explained in terms of the comparative price advantage of non-agricultural products over

Table 4.3.1. Results of Simulation 2: Sectoral Prices and Percentage Changes from Base Values[a]

	PX	%Δ	PD	%Δ	P	%Δ	PVA	%Δ	PK	%Δ	PE	%Δ	PM	%Δ	PWE	%Δ	PWM	%Δ
Wheat	1.07	7.21	1.00	0.31	1.02	1.84	0.60	4.15	1.00	-0.21	1.11	10.5	1.29	29.1	1.01	17.0	1.26	36.7
Other Grains	1.08	7.62	1.05	4.47	1.06	5.56	0.49	3.03	1.00	-0.17	1.12	11.9	1.13	13.4	1.06	16.3	1.11	16.3
Fruit & Vegetables	1.02	2.18	1.03	2.59	1.01	1.00	0.74	1.04	1.00	-0.21	0.99	-1.36	1.00	-0.31	0.97	0.00	1.00	0.00
Livestock	1.04	3.97	1.05	5.05	1.05	4.73	0.17	1.72	1.00	0.14	0.99	-1.44	0.98	-2.25	0.97	0.00	0.96	0.00
Milk & Poultry	1.05	4.90	1.05	5.15	1.05	4.56	0.33	1.15	1.00	-0.10	0.98	-1.73	0.86	-13.6	0.96	0.00	0.71	0.00
Other Agriculture	1.02	2.40	1.02	1.72	1.02	2.33	0.56	2.30	1.00	-0.12	1.09	8.54	1.10	9.59	1.07	10.0	1.10	10.0
Food Processing	1.01	1.20	1.00	0.19	1.01	0.90	0.31	0.05	1.00	0.06	1.07	6.94	1.05	5.17	1.05	7.50	0.99	7.5
Rest of the Economy	1.00	-0.10	1.00	-0.05	1.00	-0.23	0.49	-0.01	1.00	-0.23	1.00	-0.30	0.99	-1.02	1.00	0.00	0.98	0.00

[a] The simulation involved the full reduction of export subsidies, import tariffs and domestic support pursuant to the Uruguay Round Agreement, and "maximum" changes in world prices of agricultural products. The symbol " % Δ" stands for percentage change in the value of the respective variable from the base value of the same variable. Base year values are presented in Appendix 4.1.1.

Table 4.3.2. Results of Simulation 2: Sectoral Output and Disposition, and Percentage Changes from base Values[a]

	XD	% Δ	INT	% Δ	CONS-DD	% Δ	INVE-ST	% Δ	INVEN TORY	% Δ	GOV-DD	% Δ	E	% Δ	M	% Δ
Wheat	4.284	41.11	1.115	4.458	0.089	-1.72	0.004	1.315	-0.08	-41.1	0.109	-1.80	3.057	59.44	0.040	-60.5
Other Grains	2.637	16.50	1.369	4.103	0.237	-5.19	0.006	5.017	-0.06	-16.5	0.065	-5.27	1.201	36.28	0.188	-8.50
Fruits & Vegetables	1.247	-4.63	0.632	2.655	1.913	-0.91	0.001	0.478	-0.03	4.626	0.028	-0.99	0.120	-17.2	1.419	2.630
Livestock	7.015	1.427	5.057	5.127	0.814	-4.43	0.055	4.188	0.153	1.427	0.098	-4.51	1.123	-6.38	0.289	14.77
Milk & Poultry	5.614	3.818	5.337	5.587	0.216	-4.28	0.010	4.022	0.015	3.818	0.037	-4.36	0.199	-5.86	0.206	39.88
Other Agriculture	4.213	5.446	3.002	3.212	0.889	-2.20	0.012	1.807	0.067	5.446	0.074	-2.28	0.440	15.07	0.276	-22.5
Food Processing	42.14	5.897	15.54	2.762	24.28	-0.81	0.322	0.379	0.397	5.897	0.105	-0888	6.843	24.96	5.450	-11.2
Rest of the Economy	930.8	-0.41	459.4	-0.01	328.2	0.307	126.1	-0737	-6.53	0.413	40.49	0.226	153.9	-0.83	170.7	1.621
Agriculture	*25.01*	*9.088*	*16.51*	*4.694*	*4.159*	*-2.34*	*0.088*	*3.714*	*0.071*	*-24.4*	*0.411*	*-3.28*	*6.141*	*29.62*	*2.419*	*-1.11*
Non-agriculture	*972.9*	*-0.16*	*474.9*	*0.077*	*352.5*	*0.229*	*126.4*	*-0.74*	*-6.14*	*0.795*	*40.59*	*0.223*	*160.7*	*0.049*	*176.1*	*1.171*

[a] The simulation involved the full reduction of export subsidies, import tariffs and domestic support pursuant to the Uruguay Round Agreement, and "maximum" changes in world prices of agricultural products. The symbol " % Δ" stands for percentage change in the value of the respective variable from the base value of the same variable. Base year values are presented in Appendix 4.1.1. Values are in billions of constant Canadian dollars.

goods of the agricultural sectors. Observe from Table 4.2.4 that the domestic-price-terms-of-trade for agriculture (AGTOTPX) has increased by 4.8 per cent. Taking agricultural products alone, private consumption of wheat and other grains decline less under the "maximum" world price change scenario than under the "minimum" world price change scenario, while the reverse is the case for the remaining products.[6]

In Table 4.3.3 are presented the comparative static effects of the URA on value added, factor demand, and factor incomes under the assumption of maximum increases in world prices. Both value added measures increase in all but the fruits and vegetables, and the rest of the economy sectors. The largest increase in value added comes from the wheat sector where VALADDM increases by 67.1 per cent while VALADDF increases by 46.9 per cent. In the other grains sector VALADDM and VALADDF rise by 45.8 and 20 per cent, respectively. Total value added at factor cost increases by an average of 14.5 per cent in agriculture and declines by 0.3 per cent in the non-agriculture sector.

Percentage changes in sectoral demand for labour and capital inputs are closely related to the changes in sectoral value added at factor cost. Thus by far the largest percentage increase in the demand for the two primary inputs occurs in the wheat sector where the demand for labour and capital increases by 47.2 and 46.6 per cent, respectively. After the wheat sector, the other grains sector increases its demand for the two factors by 20.2 and 19.7 per cent, respectively. The demand for labour in the other

[6] The explanation for this outcome lies in the formula for calculating the CES composite goods price (P) that enters the domestic consumption functions. This price is a weighted average of import price (PM) and domestic good price (PD), with (M/X) and (XXD/X) as weights. Consequently, changes in the world prices of goods affect P through their positive effects on the component prices (i.e., PM and PD) and negative effects on the weights. In other words, the positive price effect of world price changes on the CES prices is moderated by the negative quantity effect. It turns out that, under scenario 2, due to the fall in the imports of wheat and other grains and hence the fall in the corresponding import shares (M/X), the CES prices of these products rise relatively less than under simulation 1. This results in more domestic consumption of wheat and other grains under simulation 2 than 1.

agriculture increases by 8 per cent and the demand for capital by 7.6 per cent. Labour and capital demand increase respectively by 5 and 4.8 per cent in the milk and poultry sector, and by 6 and 5.7 per cent in the livestock sector. In agriculture, aggregate demand for labour and capital increases by 10 and 15.1 per cent, respectively. In the food processing sector, demand for labour increases by 6.1 per cent and for capital by 5.7 per cent.

The specificity of agricultural land to agricultural activities means that the change in demand for agricultural land need not follow the same pattern as the demand for labour and capital. Consequently, the demand for agricultural land increases only in the wheat sector by 22.9 per cent. In the fruits and vegetables sector, demand for agricultural land declines by 20 per cent. In the livestock, milk and poultry, other agriculture, and other grains sectors, the demand for land declines by 14.4, 12.9, 10.5 and 0.4 per cent, respectively.

Under Scenario 2, aggregate returns to agricultural land increase the highest of all the returns to primary factors. In agriculture, returns to land increase by 22.3 per cent, and returns to capital and to labour by of 15.6 and 9.9 per cent, respectively. In the non-agriculture sector, both labour and capital incomes slightly decline by 0.3 per cent each, although in the food processing sector alone they increase by close to 6 per cent each.

The effect of domestic policy and "maximum" world price changes on important macro variables is summarized under Table 4.3.4. Nominal GNP at value added prices

Table 4.3.3. Results of Simulation 2: Sectoral Value Added, Factor Use, and Factor Incomes, and Percentage Changes from Base Values[a]

	VAL-ADDM	% Δ	VAL-ADDF	% Δ	LABR	% Δ	YF-LABR	% Δ	CAP-TL	% Δ	YFCA-PTL	% Δ	AG-LND	% Δ	YFAG-LND	% Δ
Wheat	1.992	67.10	2.555	46.96	0.942	47.15	0.374	46.96	15.25	46.6	1.645	47.0	31.48	21.9	0.537	46.96
Other Grains	0.973	45.85	1.288	20.03	1.139	20.18	0.452	20.03	16.27	19.7	0.635	20.0	26.09	-0.43	0.200	20.03
Fruit & Vegetables	0.932	-1.71	0.927	-3.63	0.704	-3.51	0.279	-3.63	2.163	-3.87	0.603	-3.63	0.500	-20.1	0.045	-3.63
Livestock	1.119	19.22	1.183	3.174	1.633	3.306	0.648	3.174	17.70	2.92	0.428	3.17	24.10	-14.4	0.107	3.174
Milk & Poultry	1.342	23.66	1.874	5.009	1.928	5.143	0.765	5.009	9.330	4.75	1.002	5.01	6.259	-12.9	0.106	5.009
Other Agriculture	2.504	9.801	2.370	7.871	1.785	8.009	0.709	7.871	7.011	7.61	1.386	7.87	3.713	-10.5	0.275	7.871
Food Processing	13.32	6.108	13.24	5.951	13.11	6.086	6.920	5.921	18.15	5.69	6.304	5.92	0.000	0.00	0.000	0.000
Rest of the Economy	485.4	-0.41	452.6	-0.40	541.2	-0.28	285.7	-0.40	1511.	-0.65	166.9	-0.40	0.000	0.00	0.000	0.000
Agriculture	*8.862*	*24.61*	*10.20*	*14.55*	*8.132*	*10.11*	*3.228*	*9.968*	*67.73*	*15.1*	*5.698*	*15.6*	*92.14*	0.00	*1.271*	*22.26*
Non-agriculture	*498.7*	*-0.25*	*465.9*	*-0.23*	*554.2*	*-0.14*	*292.6*	*-0.26*	*1529*	*-0.58*	*173.2*	*-0.19*	*0.000*	0.00	*0.000*	*0.000*

[a]The simulation involved the full reduction of export subsidies, import tariffs and domestic support pursuant to the Uruguay Round Agreement, and "maximum" changes in world prices of agricultural products. The symbol "% Δ " stands for percentage change in the value of the respective variable from the base value of the same variable. Base year values are presented in Appendix 4.1.1. Values are in billions of constant Canadian dollars.

Table 4.2.4. Results of Simulation 2: Aggregate Variables and Miscellaneous Parameters, and Percentage Changes from Base Values[a]

Variable	Value	% Δ	Variable	Value	% Δ	Variable	Value	% Δ
EXR	0.997	-0.304	TARIFF	2.416	-35.45	ENTSAV	18.117	0.900
GNPVA	509.406	-0.166	HHINCTAX	101.57	0.081	GOVSAV	-38.510	-2.173
YHH	530.016	0.081	ENTTAX	15.150	0.900	SAVINGS	125.34	-0.992
GOVREV	183.008	-0.428	SUBSD	12.768	-5.650	FXDINV	126.76	-0.513
INDTAXIN	44.871	0.341	TEXPSUB	0.362	-29.90	INVEST	120.72	-0.498
INDTAXOUT	44.242	-0.042	HHSAV	33.184	0.081	DEPRECIA	81.802	-0.645
		Agriculture's Terms of Trade						
AGTOTPX	104.802	4.802	AGTOTE	101.34	10.507			
AGTOTVA	85.157	5.089	AGTOTM	101.28	2.175			

[a] The simulation involved the full reduction of export subsidies, import tariffs and domestic support pursuant to the Uruguay Round Agreement, and "maximum" changes in world prices of agricultural products. The symbol "% Δ" stands for percentage change in the value of the respective variable from the base value of the same variable. Values are in billions of Canadian dollars.

declines though by a fraction of a per cent.[7]

Total household income and household savings each increase by less than a tenth of a per cent. Government revenue and government savings decrease by 0.5 and 1.8 per cent, respectively, while enterprise savings increase by 0.9 per cent. Total savings decline by 0.9 per cent.

4.4 Scenario 3: The "Break-even" World Price Changes

For several reasons, it is of interest to pursue an alternate approach to world price changes than in the preceding two scenarios. First, there are wide differences between the "minimum" and "maximum" changes in world prices, simulated in the previous two scenarios. Second, very different results obtain from the two simulations. In addition,

[7] This outcome contrasts with the one under Scenario 1. The explanation is that the macro variables are sensitive to situations in the rest of the economy sector. This sector, being by far the largest of the eight sectors in the model, decisively dominates the comparative static results of the macro variables. Under Scenario 2, the rest of the economy sector exhibits a decline in PVA and XD, which, in spite of the positive changes in these variables in almost all the remaining sectors, ultimately resulted in a decline in GNPVA. The same influence of the rest of the economy sector is reflected in total investment, which, under the current simulation scenario, exhibits a decline of one half a per cent.

the world price changes are introduced exogenously and there is no theoretical basis to justify one set of price changes to another set. Thus, it is of interest to determine the percentage changes in world prices which, together with the URA-related domestic policy commitments used in the previous two simulations, would leave Canadian agricultural producers neither "worse off" nor "better off" by some criterion. The required changes in world prices that would leave Canadian farmers unaffected by the URA are termed the "break-even" world price changes.

Two considerations of this alternative approach are in order. First, the state of being "worse off" or "better off" is measured in terms of changes in sectoral domestic production (XD). It is maintained that the response of farmers to the simultaneous changes in world prices and domestic policies is better reflected in their decision of how much to produce, than any other measure in the context of our CGE model. Given the assumption that the base year defines an equilibrium state in production as, in any other economic activity, a zero change in domestic production (XD) under the present exercise would imply that producers are neither "worse off" nor "better off" as a result of the simultaneous changes in world prices and domestic policies. Second, two experiments are conducted in this scenario. In the first of these, the world prices of crops, "other agriculture" and processed livestock (i.e., meat) and dairy products that are included in the food processing sector are adjusted. Thus the objective of Experiment 1 is to find the required world price changes that would counterbalance the effects of the simulated domestic policy changes for producers in the wheat, other grains, other agriculture and food processing sectors; these are the sectors for which international price changes were assumed to occur as a result of the URA, as simulated in Scenarios 1 and 2.

Consequently, the results of Experiment 1 may be compared to the outcomes of the preceding two Scenarios. In the second experiment, the world prices of all agricultural products are adjusted. In each case, a Walrasian tatonnement type procedure has been adopted to determine the "break-even" prices. In this procedure, the domestic policy parameters are set at the levels implied in the URA commitments. The world prices of the relevant commodities are then adjusted up and down on a piecemeal basis until the model reproduces the relevant (XD) base-year values for the specific sectors.

Table 4.4 presents the results of the two experiments in terms of percentage changes in the world prices of agricultural products that would be required to offset the negative effects of UR-related domestic policy changes on domestic agricultural production. These policy changes include Canada's commitments under the URA to reduce domestic agricultural support, export subsidies, and import tariffs as summarized in Table 4.1.

From Experiment 1, a 10.8 per cent rise in the world prices of Canadian wheat is required to offset the effect of the domestic agricultural policy changes on Canadian wheat producers. The world price of other grains must increase by 10.6 percent to leave the producers of "other grains" unaffected by the policy changes. Required world price changes for producers in the other agriculture and food processing sectors are 3.9 and 2.5, respectively.[8] Notice that most of the computed break-even prices lie within the range of

[8] Note that the food sector also processes products other than livestock and dairy products. Since the world prices of these other food products are assumed to remain fixed, the 2.5 per cent average sectoral increase in Experiment 1 understates the world price increase for processed livestock (i.e., meat) and dairy products. To estimate the increase actually required in the world price of processed livestock and poultry products, it is necessary to multiply 2.5 by the reciprocal of the share of meat and dairy products in total exports of processed food products. By a conservative estimate, the world price of meat and dairy products would be three times as high, i.e., would need to increase by 7.5 per cent, in terms of this particular experiment.

Table 4.4. "Break-even" Changes in World Prices

Commodity	Experiment 1	Experiment 2
	Per cent	
Wheat	10.829	10.865
Other Grains	10.586	10.318
Fruits and Vegetables	0.000	2.640
Livestock	0.000	5.889
Milk and poultry	0.000	12.974
Other Agriculture	3.918	1.880
Food Processing	2.530	2.299
Rest of the economy	0.000	0.000

world price projections from studies of global effects of the URA. Furthermore, the break-even prices are closer to the minimum than the maximum projections. If the two sets of world price projections were to occur with equal probability, then the Canadian agricultural producers in aggregate would have gained from the URA.

More recent estimates and projections of world price changes by OECD (1996) tend to conform with the maximum world price increases thereby validating the above conclusion. For example, taking 1990-94 as a base period, world prices of wheat, coarse grain, oilseeds, butter, and skim milk powder were estimated to have increased, respectively, by 76, 43, 27, 59.5, and 45.3 per cent in 1995. The OECD (1996) projections of world prices for the same commodities for 1996 are 34, 28, 38, 43.8, and 54 per cent increases, respectively. Likewise, for 1997 these prices are projected to increase by 37, 34, 22, 34.5, and 63 per cent, respectively. Relatively modest increases are estimated or projected for poultry meat prices, while modest declines are estimated or projected for other meat prices from 1995 to 1997. All prices are projected to increase in 2000 compared to the 1990-94 base period. The determination of how much of the favourable world price changes arise from the URA policy commitments is outside the scope of this study. However, even after accounting for other factors that contributed to the substantial rise in world prices, the contribution of the multilateral trade liberalization due to the URA can be expected to be closer to the maximum than the minimum world price scenario considered in this study.

The break-even world price changes cited above offset the effect of the policy changes on domestic production (XD) for the four sectors, namely the wheat, other grains, other agriculture, and food processing sectors. In these sectors, XD remains unaffected from the simulated policy changes as long as world prices change by the indicated amounts. Domestic production (XD) in the remaining four sectors, however, changes. This declines in the agricultural sectors and slightly increases in the rest of the economy sector (see Table 4.4.1).

Exports increase and imports decline for the wheat, other grains, other agriculture and food processing sectors, for which world prices increase. Opposite changes take place in the exports and imports of the other agricultural sectors. The factor allocation results are of interest. In the wheat, other grains, and other agriculture sectors, the demand for agricultural land tends to increase while the demand for labour and capital declines in this scenario. In the food processing sector, where agricultural land is not a factor of production, the demand for capital increases and the demand for labour declines. In the rest of the economy sector both capital and labour demand increase. In the fruits and vegetables, livestock, and milk and poultry sectors, demand for both factors declines (see Table 4.4.2).

In Experiment 1, as in Scenarios 1 and 2, world price changes taken from global

Table 4.4.1 Results of Simulation 3 and 4: Percentage Changes in Sectoral Output and Disposition from base Values[a]

	XD		INT		CONSDD		INVEST		INVENTORY		GOVDD		E		M	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Wheat	0.00	0.00	-1.11	0.00	-4.44	-4.71	4.78	5.02	0.00	0.00	-4.54	-4.80	0.84	0.39	-4.51	-1.96
Other grains	0.00	0.00	-1.22	0.00	-5.74	-5.95	6.23	6.41	0.00	0.00	-5.84	-6.04	2.65	1.30	-5.12	-3.48
Fruits & Vegetables	-3.22	0.00	-0.10	0.00	-0.82	-2.09	0.95	2.22	-3.22	0.00	-0.92	-2.19	-11.6	1.11	0.71	-2.84
Livestock	-2.80	0.00	-0.56	0.00	-4.00	-3.11	4.29	3.29	-2.80	0.00	-4.09	-3.20	-9.08	1.99	8.01	-1.56
Milk & Poultry	-1.41	0.00	-0.11	0.00	-3.95	-3.82	4.24	4.06	-1.41	0.00	-4.04	-3.92	-9.39	10.31	30.94	8.99
Other Agriculture	0.00	0.00	-1.55	0.00	-1.05	-1.16	1.19	1.25	0.00	0.00	-1.15	-1.25	3.01	-0.16	-12.1	-3.33
Food Processing	0.00	0.00	-0.26	0.00	-0.86	-0.76	0.99	0.85	0.00	0.00	-0.96	-0.86	4.11	3.64	-0.34	0.26
Rest of the economy	0.03	0.00	0.01	0.00	0.22	0.22	0.10	-0.14	0.03	0.00	0.12	0.12	0.55	0.47	0.75	0.79
Agriculture	-1.36	0.00	-0.67	0.00	-2.04	-2.47	3.97	3.37	-3.68	0.00	-3.75	-3.73	-2.00	1.38	0.71	-2.08
Non-agriculture	0.03	0.00	0.00	0.00	0.15	0.15	-0.09	-0.14	0.03	0.00	0.12	0.12	0.67	0.58	0.71	0.77

[a] The simulations involved "break-even" world price changes for selected agricultural products and UR-related reduction of export subsidies, import tariffs and domestic support. The symbol "% Δ" stands for percentage change from base value, while 1 and 2 represent Experiment 1 and Experiment 2, respectively. Base year values are presented in Appendix 4.1.1. Values are in billions of constant Canadian dollars.

studies of trade liberalization are restricted to a subset of agricultural products. In Experiment 2, "break-even" world price changes are determined without constraining the commodities for which prices change. Thus, in the current experiment, the world prices of all commodities except for the products of the rest of the economy are adjusted so as to leave the sectoral production levels (XD) of agricultural and the food processing sectors unaffected from URA-based changes in domestic policy.[9] For this to occur, the world price of wheat has to rise by 10.9 per cent, while the world prices of other grains, other agriculture and processed food products have to rise, respectively, by 10.3, 1.9, and 2.3 per cent (see Table 4.4). The largest increase in world prices -- close to 13 per cent rise -- is required for milk and poultry. Since this sector is relatively highly subsidized and protected in the base period, this outcome is consistent with expectations. World prices for fruits and vegetables and livestock have to increase by 2.6 and 5.9 per cent, in order to offset the effects of domestic policy changes on production in those sectors.

Other results from Experiment 2, specifically the effects on the various endogenous variables are briefly discussed here. Domestic production (XD) does not change in any sector (see Table 4.4.2) (Value added prices uniformly change by close to zero per cent in all sectors). The sectoral demand for intermediate inputs also remains unchanged. Since domestic production is unchanged in each sector, the assumption of profit maximization dictates that resource allocations also remain unchanged in each

[9] The constant world price assumption for the rest of the economy sector is not unrealistic. Due to the sheer size of this sector, the weighted world price for products from the sector can be expected to remain constant over the period, which the simulation applies. Indeed, the present simulation experiment gives a zero per cent change in the output of this sector for a zero per cent change in corresponding world price.

Table 4.4.2. Results of Simulation 3 and 4: Percentage Changes in Sectoral Value Added, Factor Use, and Factor Incomes from Base Values[a]

	VALADDM		VALADDF		LABR		YFLABR		CAPTL		YFCAPTL		AGLND		YFAGLND	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Wheat	12.83	13.15	-0.15	0.10	-0.27	0.00	-0.15	0.00	-0.24	0.00	-0.15	0.10	0.91	0.00	-0.15	0.10
Other grains	20.68	20.95	-0.08	0.10	-0.20	0.00	-0.08	0.00	-0.17	0.00	-0.08	0.10	0.98	0.00	-0.08	0.10
Fruits & Vegetables	-1.25	2.11	-3.19	0.10	-3.30	0.00	-3.19	0.00	-3.27	0.00	-3.19	0.10	-2.16	0.00	-3.19	0.10
Livestock	12.23	15.59	-2.80	0.10	-2.91	0.00	-2.80	0.00	-2.88	0.00	-2.80	0.10	-1.77	0.00	-2.80	0.10
Dairy & Poultry	15.78	17.55	-1.38	0.10	-1.49	0.00	-1.38	0.00	-1.47	0.00	-1.38	0.10	-0.33	0.00	-1.38	0.10
Other Agriculture	1.81	1.95	-0.04	0.10	-0.15	0.00	-0.04	0.00	-0.12	0.00	-0.04	0.10	1.03	0.00	-0.04	0.10
Food Processing	0.25	0.25	-0.10	0.10	-0.01	0.00	-0.10	0.00	0.02	0.00	-0.10	0.10	0.00	0.00	0.00	0.00
Rest of the economy	0.13	0.10	-0.14	0.10	0.02	0.00	-0.14	0.00	0.05	0.00	-0.14	0.10	0.00	0.00	0.00	0.00
Agriculture	8.53	9.81	-1.03	0.10	-1.40	0.00	-1.29	0.00	-1.28	0.00	-0.96	0.10	0.00	0.00	-0.64	0.10
Non-agriculture	0.13	0.10	0.14	0.10	0.02	0.00	0.13	0.00	0.05	0.00	0.13	0.10	0.00	0.00	0.00	0.00

[a] The simulations involved "break-even" world price changes for selected agricultural products and UR-related reduction of export subsidies, import tariffs and domestic support. The symbol "% Δ" stands for percentage change from base value, while 1 and 2 represent Experiment 1 and Experiment 2, respectively. Base year values are presented in Appendix 4.1.1. Values are in billions of constant Canadian dollars.

sector. Hence, no change occurs in sectoral demands for primary inputs. Factor returns, and thus by implication, value added at factor cost are also unchanged (see Table 4.4.2).

Exports increase in almost all sectors since the adjusted world price changes should have a greater positive impact on exports than the negative impact of export subsidy reductions. (In other words, the world prices were adjusted not just to offset the negative impact of export subsidy reductions, but also to offset the negative impacts of domestic support and tariff reduction on production. While domestic support reductions have a direct effect on domestic production (XD), their effect on exports is indirect. Exports rise most in the milk and poultry sector (by 10.3 per cent), and least in other agriculture (by -0.2 per cent). Imports of all agricultural products decline, except for milk and poultry products. Since the tariff rate on milk and poultry products is relatively high in the base year (i.e. 1991), its reduction more than offsets the negative effect of increased world prices on imports. Exports and imports of processed food increase, respectively, by 3.6 and 0.3 per cent.

4.5 Individual Effects of Domestic Policy Changes

So far we have considered the combined effect of changes in tariffs, export subsidy, and domestic support, along with anticipated changes in world prices. Since the three policy changes were introduced simultaneously, the results discussed above do not tell us any thing about the individual (or partial) effects of these policies. Making comparisons between their effects is virtually impossible. It is of considerable interest to disentangle somewhat the effects of the various components of the policy changes. The purpose of the present section is to compare the effects of the individual domestic policy changes on selected endogenous variables. The absolute effects of the individual policy changes are not of particular interest in themselves, since they have limited practical relevance as far as the objective of this study is concerned, which is the assessment of the combined effect. Consequently, the focus is on the relative effects of the various policy components.[10]

Tables 4.5.1 and 4.5.2 report the partial effects of changes in each of the three domestic policies on selected quantity variables. From Table 4.5.1, we observe that tariff reductions alone have mixed effects on the domestic production of the various sectors. In the wheat, milk and poultry, and food processing sectors, output (XD) declines due to the individual (or partial) effect of tariff reductions, while XD increases in the remaining sectors. This outcome contrasts somewhat with the partial effects of export subsidy and domestic support reductions. The effects of the latter on XD are negative in the agricultural and food processing sectors. Following reductions in each of export subsidies and domestic support, the decline in output in the wheat, milk and poultry, and food processing sectors is larger in each case than those resulting from tariff reductions. Therefore, producers in the agricultural and food processing sectors are less "worse off" i.e., are "better off" (in terms of domestic production levels) under tariff reduction than under either of export subsidy and domestic support reduction.

Taking agriculture as a whole, the effect of tariff reductions on domestic production is almost nil (-0.07 per cent), while the effect of export subsidy reductions is larger (-2.1 per cent), and the effect of domestic support reductions (-5.1 per cent) is

[10] Furthermore, world price changes are abstracted from in the present discussion. In the context of assessing the relative effects of the changes in the individual policies, it is inconsequential, for all but the wheat sector, whether world price changes are introduced into the simulations along with the policy changes. However, since the world price of wheat is determined endogenously, this may interact with the individual policy changes. This built-in interaction need not be confounded by introducing world price changes.

even greater. For Canadian agriculture, domestic support programs are considerably more important than are export subsidies.

Following the tariff reductions, imports of all commodities increase except for fruits and vegetables, and other agriculture. Why imports of the latter decline is not immediately clear. A general reasoning in the context of a general equilibrium model is that, for these two product groups, the indirect effects of tariff reduction are stronger than and work in the opposite direction to the direct effects. More specifically, in spite of the tariff reductions, the import prices of the two product groups increase following tariff reductions, leading to less imports of these products. The rise in the domestic prices of imports of the two product groups is effected by the rise (or depreciation) of the exchange rate which more than offsets the effects of the tariff reduction on the prices of these products. In support of the last point, two background facts can be mentioned which render tariff reduction relatively weak in affecting the imports of these products. First, in the simulation, tariff reductions for the two product groups were set at the minimum level of 15 per cent. Second, among the various agricultural products, these two categories have the lowest tariff rates in the base period.

Exports increase in all sectors following tariff reductions but decline following reductions in export subsidies and domestic support. In all but the wheat sector, exports are discouraged more by domestic support reductions than by export subsidy reductions. In fact, for agricultural exports as a whole, the effect of domestic support reductions is one and half times the effect of export subsidies. The changes in exports due to the separate effects of the three policy changes can be usefully related to changes in XD to

Table 4.5.1. Results of Simulations 5, 6, and 7: Individual Effects of Domestic Policy Changes on Sectoral Output and Disposition[a]

	% Change in XD due to the Change in			% Change in CONSDD due to the Change in			% Change in INVEST due to the Change in			% Change in GOVDD due to the Change in			% Change in E due to the Change in			% Change in M due to the Change in		
	TAR	*ESUB*	*DSUB*	*TAR*	*ESUB*	*DSUB*	*TAR*	*ESUB*	*DSUB*	*TAR*	*ESUB*	*DSUB*	*TAR*	*ESUB*	*DSUB*	*TAR*	*ESUB*	*DSUB*
Wheat	-0.36	-7.02	-7.87	0.83	-0.98	-4.32	-1.20	1.25	5.21	0.61	-0.97	-4.24	0.40	-10.7	-9.68	19.2	3.41	15.0
Other Grains	0.60	-7.67	-15.3	0.56	-1.27	-7.05	-0.93	1.54	8.31	0.34	-1.26	-6.98	2.06	-18.7	-31.9	2.19	1.30	7.44
Fruit & Vegetables	0.35	-0.22	-2.26	-0.12	0.03	-0.59	-0.27	0.22	1.27	-0.33	0.04	-0.51	1.42	-3.36	-5.80	-0.37	-0.15	0.23
Livestock	0.10	-0.79	-4.12	0.43	-0.27	-3.83	-0.81	0.53	4.68	0.21	-0.26	-3.75	0.88	-2.48	-8.74	1.97	-0.08	2.74
Milk & Poultry	-0.60	-0.35	-2.86	0.62	-0.04	-4.24	1.00	0.29	5.12	0.40	-0.03	-4.16	0.09	-2.39	-8.75	22.3	-0.28	3.91
Other Agriculture	0.08	-0.48	-2.76	0.07	0.26	-0.48	-0.45	-0.01	1.15	-0.15	0.27	-0.39	0.55	-1.42	-3.27	-1.09	-1.71	-1.20
Food Processing	-0.07	-0.26	-2.35	0.53	-0.09	-1.20	-0.91	0.34	1.89	0.31	-0.08	-1.12	1.45	-0.96	-5.55	3.68	0.02	2.00
Rest of the economy	0.00	0.08	0.21	0.19	0.01	0.00	-0.58	0.26	0.67	-0.02	0.02	0.09	0.65	0.18	0.46	0.53	-0.05	-0.14
Agriculture	-0.07	-2.11	-5.08	0.13	-0.08	-1.87	-0.80	0.52	4.47	0.25	-0.47	-3.62	0.86	-8.76	-12.9	2.16	-0.11	1.73
Non-agriculture	0.00	0.07	0.11	0.22	0.00	-0.08	-0.58	0.25	0.67	-0.02	0.02	0.08	0.68	0.14	0.26	0.64	-0.05	-0.07

[a] TAR, ESUB, and DSUB stand, respectively, for tariffs, export subsidy, and domestic support. Percentage changes are taken from base year values that are presented in Appendix 4.1.1. Values are in Billions of constant Canadian dollars.

better explain some of the change in production. In particular, the rise in XD in some sectors following reductions in tariffs is partly due to the rise in exports, for which domestic prices increase following the tariff reductions, mainly owing to the depreciation of the exchange rate.

Domestic consumption of almost all products increases with tariff reduction, but declines with domestic support reductions. In both instances this occurs for straightforward reasons; in the first case, consumers' budget relaxes through improved real purchasing power, while in the second case consumer expenditure diminishes because of the inverse effect of domestic support reductions on domestic prices, via their effect on domestic production.

Theoretically, cuts on export subsidies are expected to lead to an increase in domestic consumption through their effect of lowering the domestic price of exports. However, the results of our simulation of export subsidy cuts suggest that this holds only if export subsidy cuts affect production less than they affect prices. As it turns out, export subsidy cuts discourage domestic production in some sectors so much that not only exports, but also deliveries to the domestic market (XXD), decline pushing the domestic price (P) upward for all products except for fruits and vegetables and other agriculture. This ultimately shrinks domestic consumption of all products except for fruits and vegetables and other agriculture. Overall, therefore, consumers also appear to benefit more from tariff reduction than export subsidy reductions. As for the effect of domestic support reductions on households, we can not make a priori (or theoretical) predictions. Obviously, domestic support outlays are partly funded through taxes. Households will benefit if cuts in agricultural support relieve some of their financial burden. On the other hand, cuts in agricultural support can raise domestic prices, affecting households as consumers negatively. It follows that the effect of any change in domestic support to agriculture on households is an empirical issue. This not only has to assess effects on consumption (which is negative for all products in the present context), but also the effects on household income, and household savings. An attempt is made to address this issue in the next chapter.

Table 4.5.2 summarizes the individual effects across sectors of the three policy changes on value added at factor cost and on primary factor demands. The separate (or individual) effects of the three policy changes are not the same both across factors and across sectors. Labour and capital demand declines, as does sectoral output, with the reduction in export subsidy and domestic support, the larger of the effects coming from the reductions in domestic support. Demand for capital and labour decline with tariff reductions in the wheat, milk and poultry, and food processing sectors. However, capital and labour demand in these sectors drop less from the tariff reduction than from export subsidy and domestic support reductions.

The three policy changes have different effects on sectoral demand for agricultural land. Tariff reductions affect the demand for agricultural land the same way that they affect demand for labour and capital. Demand for agricultural land declines in the wheat, and milk and poultry sectors, while it increases in the remaining four sectors. On the other hand, following reductions in export subsidy and domestic support, agricultural land demand declines in the wheat and other grains sectors while this rises in the remaining four sectors. Overall, the sectoral effects on agricultural land demand,

Table 4.5.2. Results of Simulations 5, 6, and 7: Individual Effects of Policy Changes on Sectoral Value added and Factor Demand[a]

	% Change in VALADDF due to the Change in			% Change in LABR due to the Change in			% Change in CAPTL due to the Change in			% Change in AGLND due to the Change in		
	TAR	*ESUB*	*DSUB*	*TAR*	*ESUB*	*DSUB*	*TAR*	*ESUB*	*DSUB*	*TAR*	*ESUB*	*DSUB*
Wheat	-0.067	-8.106	-9.935	-0.339	-8.176	-9.897	-0.342	-8.023	-9.721	-0.410	-3.086	-0.403
Other grains	0.888	-8.461	-16.713	0.614	-8.482	-16.678	0.611	-8.379	-16.516	0.542	-3.461	-7.899
Fruit & Vegetables	0.627	-0.528	-2.905	0.354	-0.551	-2.865	0.351	-0.439	-2.675	0.282	4.905	7.371
Livestock	0.377	-1.286	-5.090	0.104	-1.308	-5.051	0.101	-1.197	-4.866	0.032	4.106	4.954
Dairy & Poultry	-0.322	-0.691	-3.550	-0.594	-0.713	-3.509	-0.596	-0.602	-3.321	-0.664	4.734	6.658
Other Agriculture	0.361	-1.142	-4.031	0.088	-1.164	-3.991	0.086	-1.053	-3.804	0.017	4.258	6.126
Food Processing	0.208	-0.287	-2.485	-0.064	-0.309	-2.444	-0.067	-0.197	-2.254	0.000	0.000	0.000
Rest of the economy	0.274	0.064	0.097	0.002	0.042	0.139	-0.001	0.154	0.334	0.000	0.000	0.000
Agriculture	0.235	-3.246	-6.631	-0.021	-2.565	-6.127	0.043	-3.927	-7.978	0.000	0.000	0.000
Non-agriculture	0.273	0.055	0.028	0.000	0.034	0.082	-0.002	0.150	0.305	0.000	0.000	0.000

[a] TAR, ESUB, and DSUB stand, respectively, for tariffs, export subsidy, and domestic support. Percentage changes are taken from base year values that are presented in Appendix 4.1.1. Values are in Billions of constant Canadian dollars

whether positive or negative, are greatest for domestic support reductions. The mildest effect on agricultural land demand comes from tariff reductions.

The partial effects of the three policy changes on factor demand are seen in factor remuneration and value added at factor cost. As pointed out in earlier sections, the percentage changes in value added at factor cost also reflect the changes in factor rewards effected by the three policy changes. Overall, the least negative or most positive impacts on value added at factor cost and factor incomes come from the tariff reductions. In contrast, reductions in domestic support have the highest negative impact on the same. Aggregate agricultural value added at factor cost declines by 6.6 per cent due to domestic support reduction. Export subsidy reductions have about half that effect (-3.2 per cent) on aggregate agricultural value added at factor cost.

5. A REASSESSMENT : THE "NET" EFFECT OF THE URUGUAY ROUND AGREEMENT

In this chapter, the impact of the UR agricultural trade agreement on Canadian agriculture is reassessed by considering three issues that were not dealt with in the preceding analyses. Budget related pressures and reconsideration of some facets of government programs for agriculture has occurred during the 1990s. The replacement of production-inducing support programs by programs that have provided transfers to farmers but have had less explicit effects on inducing production or are less likely to attract countervail (i.e., are "green") has been one outcome of the Canadian government policy for agriculture for some time. Export subsidies have also been reduced, or entirely removed, most notably with the Western Canada grain transportation subsidy program, a change that was undertaken primarily for budgetary reasons. Introducing these two considerations into the analysis can be expected to change the results to at least some extent. Furthermore, the exclusion of policy changes that would have been carried out by the Canadian government, regardless of the Uruguay Round Agreement (URA), may enable us to assess the "pure" or "net" effect of the URA on the Canadian agriculture. The third issue considered relates to the reliability of the estimates and concerns the sensitivity of the model to the choice of elasticity parameters. A sensitivity analysis is undertaken to address this concern.

The first two considerations raised above were introduced into the model in the following way. Regarding export subsidies, since the extent to which the cuts in these would have occurred for budgetary reasons alone cannot be known with certainty, we have assumed that the 36 per cent cut in export subsidies simulated in the previous chapter would have been made regardless of the UR.[1] That is, the effects of the policy commitment with respect to export subsidy reductions are not attributed to the URA. These effects were "netted out" from the overall impact of the URA by first simulating export subsidy reductions alone, and taking the counterfactual results as a base scenario for simulating the changes in world prices and remaining domestic policies.

Adjustment for the changing focus of government programs from production inducing ("amber") programs to other programs considered to be consistent with the "green box" concept of the Agricultural Agreement is handled simply. Compensatory transfers to households of the same dollar amount as the commitment cuts in domestic support programs were introduced into the model, simultaneously with the reduction commitments for tariffs, export subsidies and domestic support, and the changes in world prices.

5.1. Netting Out the Effect of Export Subsidy Reductions

As in most of the experiments reported in the previous chapter, two simulations (involving the "minimum" and "maximum" world price change assumptions) are conducted in considering the exclusion of the effects of the export subsidy reductions shown in Table 4.1 on Canadian agriculture. In each case, export subsidy reductions are first simulated alone. Taking the results from this simulation as the base levels, the other changes in policy and world prices are simulated in a second round. These results are summarized in Tables 5.1.1a to 5.1.4b. While these results are of interest in their own

[1] The level of budget-imposed reductions in export subsidy may differ from 36 per cent. However, for the purpose of assessing the "pure" effect of the UR agreement, larger cuts than 36 per cent cannot be considered since this is the maximum level of export subsidy cut simulated in the previous chapter. Those results are to be compared with the results obtained in this chapter.

right, for the purpose of this study they provide more insight when compared with the results of previous simulations (Scenarios 1 and 2) that included the effects of export subsidy reductions.[2] These are reported in the last chapter.

5.1.1. Scenario 4: Netting Out the Effect of Export Subsidy Reductions Under the Assumption of "Minimum" Increases in World Prices

From Tables 5.1.1a and 5.1.1b, we observe that the URA affects Canadian agriculture negatively if world prices change only by the "minimum" amount. This is true even when the effects of the export subsidy commitment reductions are netted-out or excluded (i.e., ignored). Domestic production (XD) falls below base year levels in the agricultural and food processing sectors, but this time the fall in XD in most of these sectors is less than the fall when export subsidy reductions were included into the analysis. In the other grains and wheat sectors, production declines the highest, respectively, by 9.3 and 7.2 per cent below the 1991 base levels (see Table 5.1.1a). However, compared to results under the scenario that incorporates the effects of export subsidy reductions (i.e., Scenario 1), the output level under Scenario 4 (i.e., the "exclusion" scenario) is larger by 4.4 and 2.3 per cent in the two sectors, respectively. In the remaining sectors, netting-out the effects of export subsidy reductions under the assumption of "minimum" increases in world prices brings about only modest improvements in the level of production. At the aggregate level, agricultural output increases by about one per cent under the "exclusion" scenario than under the "inclusion" scenario. There appears to be no noticeable changes

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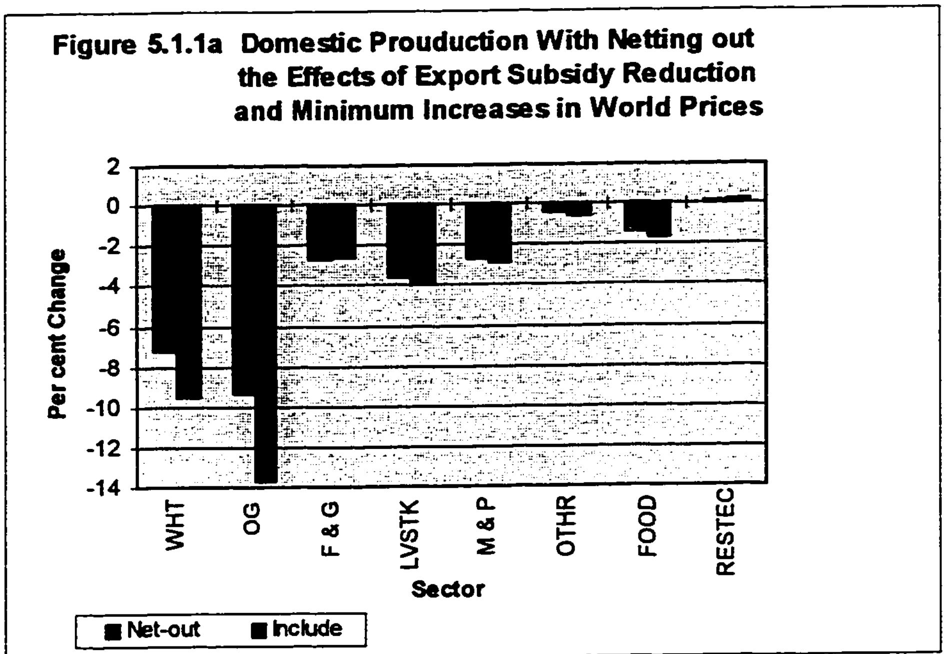
[2] For identification purposes we designate the scenarios in which export subsidy reductions are treated as UR enforced commitments (i.e., Scenarios 1 and 2 in Chapter Four) as "inclusion" scenarios. In contrast, the scenarios in which export subsidy reductions are treated as budget enforced and their effects "netted out" or excluded from the analysis of UR commitments are designated as "exclusion" or " net-out" scenarios. These are Scenarios 4 and 5 discussed in this chapter.

Table 5.1.1a. Results of Simulation 8: Sectoral Output and Disposition, and Percentage Changes from base Values[a]

	XD	%Δ	INT	%Δ	CONS DD	%Δ	INVE-ST	%Δ	INVE NTOR	%Δ	GOV-DD	%Δ	E	%Δ	M	%Δ
Wheat	2.82	-7.23	1.04	-2.46	0.09	-2.94	0.00	3.27	-0.05	7.23	0.11	-3.06	1.74	-9.14	0.12	16.10
Other Grains	2.05	-9.30	1.28	-2.51	0.24	-4.58	0.01	5.05	-0.05	9.296	0.07	-4.70	0.71	-18.9	0.21	1.41
Fruit & Vegetables	1.27	-2.71	0.61	-0.75	1.92	-0.76	0.00	1.01	-0.03	2.71	0.03	-0.88	0.13	-9.71	1.39	0.20
Livestock	6.67	-3.61	4.72	-1.93	0.82	-3.46	0.06	3.83	0.15	-3.61	0.10	-3.58	1.09	-9.01	0.27	5.76
Milk & poultry	5.27	-2.63	4.98	-1.48	0.22	-3.58	0.01	3.96	0.01	-2.63	0.04	-3.70	0.19	-9.82	0.19	28.15
Other Agriculture	3.98	-0.39	2.83	-2.71	0.90	-0.58	0.01	0.82	0.06	-0.39	0.08	-0.70	0.40	3.64	0.30	-15.2
Food Processing	39.23	-1.42	14.97	-0.98	24.36	-0.68	0.32	0.93	0.37	-1.42	0.11	-0.81	5.42	-1.03	6.33	3.12
Rest of Economy	936.0	0.15	459.5	0.02	327.8	0.21	127.1	0.03	-6.57	-0.15	40.43	0.08	156.6	0.91	168.9	0.52
Agriculture	22.05	-3.81	15.46	-1.97	4.19	-1.68	0.09	3.45	0.10	3.60	0.41	-2.94	4.27	-9.95	2.47	0.98
Non-agriculture	975.2	0.08	474.5	-0.01	352.2	0.14	127.4	0.04	-6.20	-0.24	40.53	0.08	162.0	0.84	175.2	0.62

[a] The reported results pertain to the simulation of domestic support and tariff reductions along with "minimum" world price changes. The symbol "%Δ" stands for percentage change from the 1991 base year values. The base year values are presented in Appendix 4.1.1. Values are in billions of Canadian dollars.

in the output level of the non-agriculture sector with netting out the effects of export subsidy reductions (see Figure 5.1.1a).

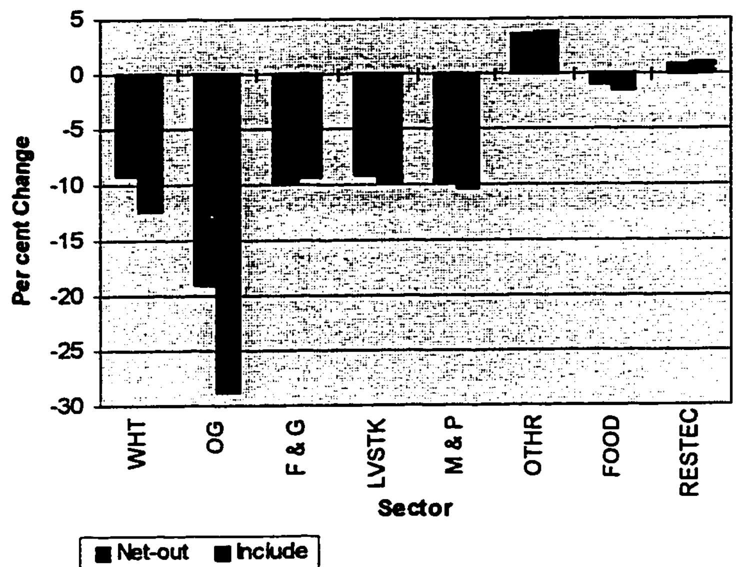


WHT = Wheat, OG = Other grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and Poultry, OTHR = Other agriculture, FOOD = Food Processing, RESTEC = the rest of the economy

Net-out = The effects of export subsidy reduction are excluded
Include = The effects of export subsidy reduction are included (= Scenario 1)

It is to be expected that the exclusion of the effects of export subsidy reductions has the strongest impact on exports in general, and on exports of those sectors with relatively high export subsidies in the base year in particular. Consequently, wheat exports improve by 3 per cent under the "exclusion" scenario over the levels under the "inclusion" scenario (cf. Table 5.1.1a with Table 4.2.2). Exports of other grains fall below the base year level, but by 10 per cent less when the effects of export subsidy reductions are netted out. The exclusion of the effects of export subsidy reduction generally has only marginal effects on the exports of the remaining sectors, bringing less

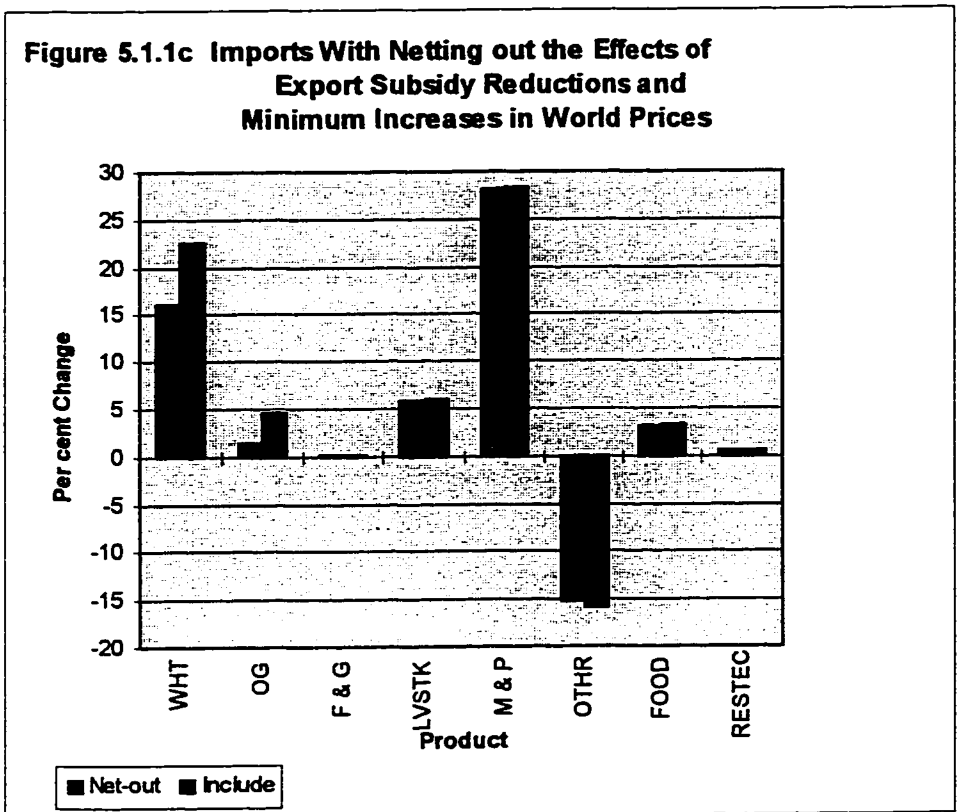
Figure 5.1.1b Exports With Netting out the Effects of Export Subsidy Reductions and Minimum Increases in World Prices



WHT = Wheat, OG = Other grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and Poultry, OTHR = Other agriculture, FOOD = Food Processing, RESTEC = the rest of the economy

Net-out = The effects of export subsidy reduction are excluded
Include = The effects of export subsidy reduction are included (= Scenario 1)

than one per cent increase over the levels of Scenario 1, in which the effects of export subsidy reductions are included. Aggregate agricultural exports decrease by 3.3 per cent less when the effects of export subsidy reductions are excluded from the analysis than when they are included. Noticeable changes in import levels occur only with respect to wheat and other grains. Compared to the inclusion scenario (i.e., Scenario 1), imports of wheat and other grains decrease by 6.5 and 3.2 per cent in Scenario 4. Under the "exclusion" scenario and "minimum" increases in world prices, agricultural imports increase by less than one per cent; otherwise, they rise by 1.4 per cent. Imports of non-agricultural products generally remain unaffected by the present scenario. This is also true of the imports of agricultural products other than wheat and other grains (see Figure 5.1.1c).



WHT = Wheat, OG = Other grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and Poultry, OTHR = Other agriculture, FOOD = Food Processing, RESTEC = the rest of the economy

Net-out = The effects of export subsidy reduction are excluded
Include = The effects of export subsidy reduction are included (= Scenario 1)

Factor demand outcomes are not significantly altered with the exclusion of the effects of export subsidy cuts from the overall effect of the URA (cf. Table 5.1.1b with Table 4.2.3). In accordance with the changes in domestic production, the biggest changes in labour and capital demand are registered in the other grains and wheat sectors. If

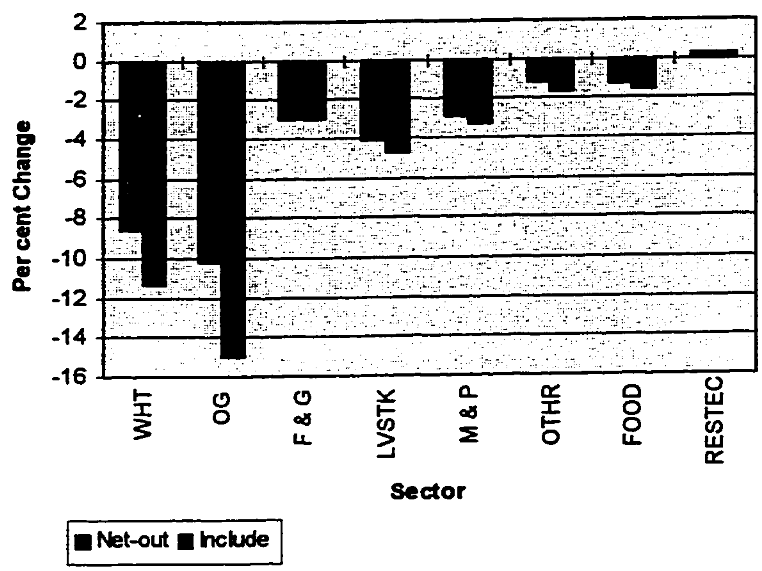
Table 5.1.1b. Results of Simulation 8: Value Added, Factor Demand and Factor Incomes, and Percentage Changes from Base Values[a]

	VAL-ADDM	%Δ	VAL-ADDF	%Δ	LABR	%Δ	YF-LABR	%Δ	CAP-TL	%Δ	YF-CAPT	%Δ	AG-LND	%Δ	YFAG-LND	%Δ
Wheat	1.18	-0.91	1.59	-8.54	0.59	-8.72	0.23	-8.54	9.51	-8.59	1.02	-8.54	25.35	-1.82	0.33	-8.54
Other grains	0.68	1.46	0.96	-10.2	0.85	-10.4	0.34	-10.2	12.19	-10.3	0.48	-10.2	25.26	-3.61	0.15	-10.2
Fruit & Vegetables	0.94	-1.05	0.93	-2.95	0.71	-3.15	0.28	-2.95	2.18	-3.01	0.61	-2.95	0.65	4.18	0.05	-2.95
Livestock	1.03	10.24	1.10	-4.11	1.51	-4.30	0.60	-4.11	16.48	-4.16	0.40	-4.11	28.99	2.94	0.10	-4.11
Milk & poultry	1.23	13.69	1.73	-2.91	1.78	-3.11	0.71	-2.91	8.64	-2.97	0.93	-2.91	7.49	4.22	0.10	-2.91
Other Agriculture	2.30	0.66	2.17	-1.12	1.63	-1.32	0.65	-1.12	6.44	-1.17	1.27	-1.12	4.41	6.15	0.25	-1.12
Food Processing	12.41	-1.15	12.32	-1.29	12.17	-1.49	6.45	-1.29	16.94	-1.35	5.87	-1.29	0.00	0.00	0.00	0.00
Rest of Economy	488.8	0.29	455.8	0.29	543.2	0.09	287.7	0.29	1525	0.24	168.1	0.29	0.00	0.00	0.00	0.00
Agriculture	7.36	3.50	8.49	-4.61	7.06	-4.39	2.81	-4.20	55.45	-5.79	4.70	-4.61	92.14	0.00	0.98	-5.74
Non-agriculture	501.2	0.25	468.1	0.25	555.4	0.06	294.2	0.26	1542	0.22	174.0	0.24	0.00	0.00	0.00	0.00

[a] The reported results pertain to the simulation of domestic support and tariff reductions along with "minimum" world price changes. "%Δ" stands for percentage change from the 1991 base year values. The base year values are presented in Appendix 4.1.1. Values are in Billions of Canadian dollars.

export subsidy reductions are not attributed to the URA under the assumption of minimum increases in the world prices of agricultural products, labour and capital demand each declines by 4.7 per cent and 2.8 per cent less, respectively, in the other grains and wheat sector. In almost all the remaining sectors, labour and capital demand improve by less than one per cent with the exclusion of the effects of the export subsidy reductions. The demand for agricultural land declines less in the wheat and other grains sectors -- the two land extensive sectors -- under the "exclusion" scenario than under the "inclusive" scenario, but at the expense of less demand for land in the remaining agricultural sectors.

Figure 5.1.1d Value Added With Netting out the Effects of Export Subsidy Reductions and Minimum Increases in World Prices



WHT = Wheat, OG = Other grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and Poultry, OTHR = Other agriculture, FOOD = Food Processing, RESTEC = the rest of the economy

Net-out = The effects of export subsidy reduction are excluded
Include = The effects of export subsidy reduction are included (= Scenario 1)

Figure 5.1.1d (above) compares sectoral value added at factor cost (and therefore factor remuneration) under the two scenarios, namely, the "exclusion" and the "inclusion" scenarios with minimum increases in world prices. Value added and factor returns decline below base levels in all but the "rest of the economy" sector. However, except in the fruits and vegetables sector, where there is no any noticeable difference, value added at factor cost and factor incomes decline less when the effects of export subsidy reductions are netted out than when these effects are not netted out. The largest changes in value added and factor incomes are recorded in the other grains and wheat sectors, in that order, where the changes are comparable to those for labour and capital demand.

5.1.2. Scenario 5: Netting Out the Effects of Export Subsidy Reductions Under the Assumption of "Maximum" Increases in World Prices

In this section, we discuss how the exclusion of the effects of export subsidy commitment reductions change the implications of the URA for Canadian agriculture assuming that world prices increase by the "maximum" amount. In other words, Scenario 5 is the same as Scenario 4, except that the world prices are assumed to increase by the "maximum" amount. As mentioned in the beginning of this chapter, the exclusion of the effects of export subsidy reduction presupposes that these reductions would take place regardless of the URA, for budgetary reasons.

With the maximum increases in world prices, wheat production (XD) increases by 44.7 per cent, compared to the base year level, if the effects of export subsidy reductions are netted out. Domestic production of other grains rises 27.1 per cent above the base year level (see Table 5.1.2a). Therefore, given the assumption of maximum

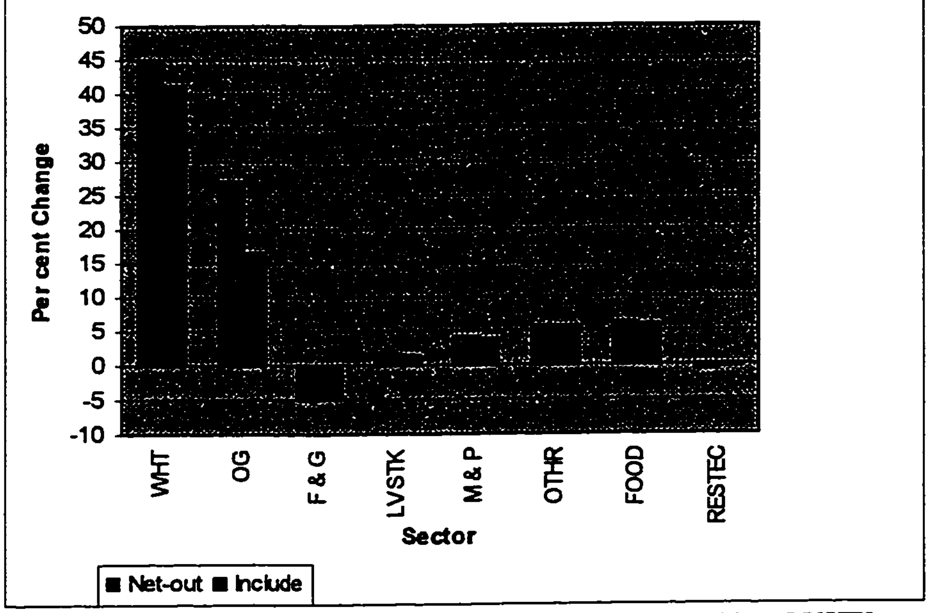
Table 5.1.2a. Results of Simulation 9: Sectoral Output and Disposition, and Percentage Changes from base Values[a]

	XD	%Δ	INT	%Δ	CONS-DD	%Δ	INVE-ST	%Δ	INVENTORY	%Δ	GOV-DD	%Δ	E	%Δ	M	%Δ
Wheat	4.39	44.66	1.12	4.99	0.09	-0.16	0.00	-0.52	-0.08	-44.7	0.11	-0.24	3.15	64.43	0.04	-62.5
Other Grains	2.88	27.05	1.38	4.66	0.25	-2.06	0.01	1.41	-0.07	-27.1	0.07	-2.13	1.41	60.02	0.18	-12.1
Fruit & Vegetables	1.24	-4.93	0.63	2.76	1.91	-0.96	0.00	0.29	-0.03	4.93	0.03	-1.04	0.12	-18.1	1.42	2.81
Livestock	7.05	1.87	5.08	5.50	0.82	-4.13	0.06	3.60	0.15	1.87	0.10	-4.20	1.13	-5.62	0.29	14.67
Milk & poultry	5.63	4.07	5.35	8.83	0.22	-4.11	0.01	3.58	0.02	4.07	0.04	-4.19	0.20	-5.44	0.21	39.79
Other Agriculture	4.22	5.71	3.02	3.84	0.89	-2.44	0.01	1.81	0.07	5.71	0.07	-2.52	0.44	14.89	0.28	-21.4
Food Processing	42.23	6.12	15.56	2.90	24.36	-0.69	0.32	0.01	0.40	6.12	0.11	-0.77	6.87	25.52	5.44	-11.3
Rest of Economy	930.0	-0.50	459.3	-0.04	328.2	0.30	125.8	-0.98	-6.53	0.50	40.49	0.22	153.6	-1.00	170.8	1.66
Agriculture	25.41	10.82	16.57	5.09	4.17	-2.13	0.09	2.97	0.07	-31.2	0.42	-2.32	6.45	36.22	2.42	-1.24
Non-agriculture	972.2	-0.23	474.8	0.06	352.5	0.23	126.1	-0.97	-6.13	0.90	40.59	0.22	160.5	-0.10	176.2	1.21

[a] The reported results pertain to the simulation of domestic support and tariff reductions along with "minimum" world price changes. The symbol "%Δ" stands for percentage change from the 1991 base year values. The base year values are presented in Appendix 4.1.1. Values are in billions of Canadian dollars.

changes in world prices, the two sectors produce, respectively, 3.5 and 10.6 per cent more under the "exclusion" scenario than under the "inclusion" scenario (i.e., Scenario 2). Production in the remaining sectors responds similarly whether export subsidy reductions are included or not (cf. Table 5.1.2a with Table 4.3.2; also see Figure 5.1.2a). The effects on sectoral exports of the exclusion of reduction commitments in export subsidies from the analysis are more important under the current simulation environment, which includes the "maximum" world price changes, than under Scenario 4. For instance, exports of other grains increase by 60 per cent above and over the base year level. This level is 23.7 per cent higher than the level that obtains when the effects of the reductions in export subsidies are included into the analysis (see Figure 5.1.2a).

Figure 5.1.2a Domestic Production With Netting out the Effects of Export Subsidy Reduction and Maximum Increases in World Prices

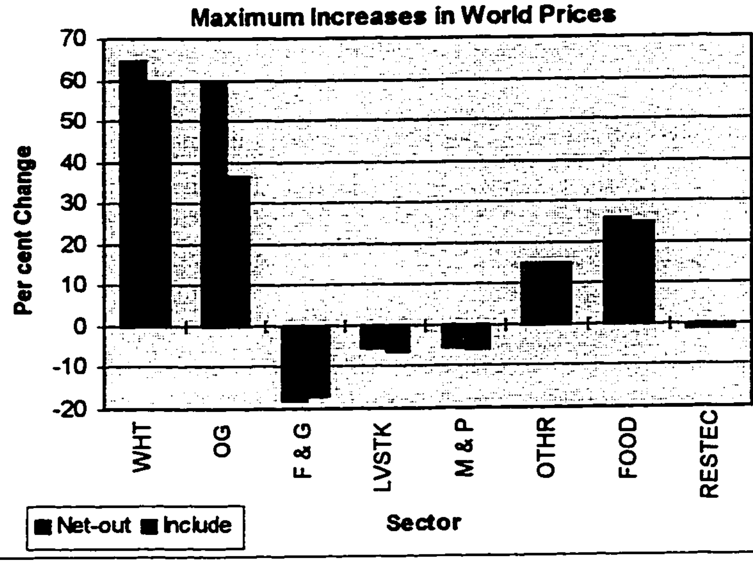


WHT = Wheat, OG = Other grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and Poultry, OTHR = Other agriculture, FOOD = Food Processing, RESTEC = the rest of the economy

Net-out = The effects of export subsidy reduction are excluded
Include = The effects of export subsidy reduction are included (= Scenario 2)

Netting out the effects of export subsidy reductions improves wheat exports by 5 per cent under the assumption of maximum changes in world prices, pushing the export level to be 64.4 per cent higher than the base year level. The exports of livestock and of milk and poultry, while still below base year levels, nevertheless, improve marginally when the effects of export subsidy reductions are netted out. Total agricultural exports increase by 36.2 per cent above and over the base year level under the current "exclusion" scenario. This level is to be compared with the 29.6 per cent increase under

Figure 5.1.2b Exports With Netting out the Effects of Export Subsidy Reductions and Maximum Increases in World Prices



WHT = Wheat, OG = Other grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and Poultry, OTHR = Other agriculture, FOOD = Food Processing, RESTEC = the rest of the economy

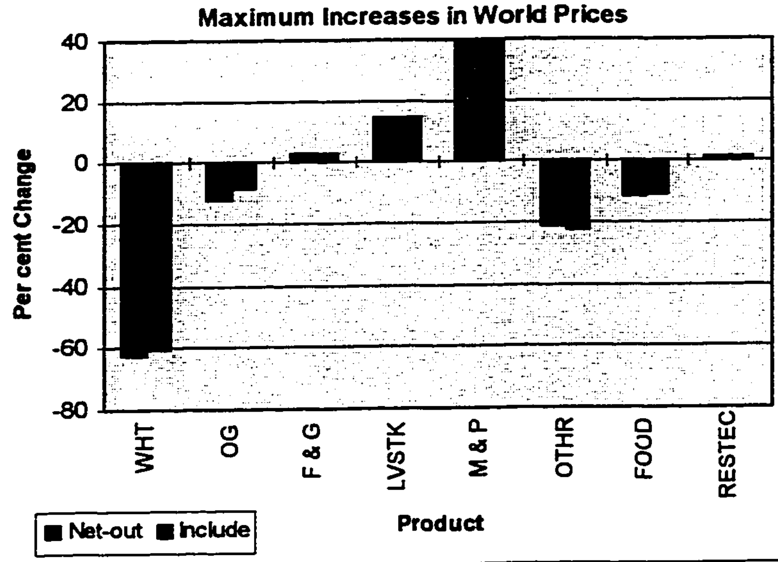
Net-out = The effects of export subsidy reduction are excluded
Include = The effects of export subsidy reduction are included (= Scenario 2)

the "inclusion" Scenario 2, which incorporates export subsidy cuts into the analysis.

Import levels of most products do not change noticeably in Scenario 5 from those obtained in Scenario 2. The exceptions are again wheat and other grains. Imports of wheat and other grains decline, respectively, by 2.0 and 3.6 per cent more with the exclusion than with the inclusion of the effects of the export subsidy cuts (see Figure 5.1.2c).

Labour and capital demand configurations under the "exclusion" scenario are similar to those of domestic production. The effect on the demand for labour and capital of the exclusion of the reductions in export subsidies from the total effect of the URA is noticeably important only in the other grains and wheat sectors. In these two sectors, the assumptions about changes in world prices are also important. Under the assumption of maximum changes in world prices, labour, and capital demand increase, respectively, by 12 and 5 per cent in the other grains sector, and by 5 per cent each in the wheat sector, when the effects of the reductions in export subsidy cuts are netted out from the analysis

Figure 5.1.2c Imports With Netting out the Effects of Export Subsidy Reductions and Maximum Increases in World Prices



WHT = Wheat, OG = Other grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and Poultry, OTHR = Other agriculture, FOOD = Food Processing, RESTEC = the rest of the economy

Net-out = The effects of export subsidy reduction are excluded
Include = The effects of export subsidy reduction are included (= Scenario 2)

relative to the situation when they are included, as in Scenario 2.

The demand for agricultural land in the other grains sector increases by 5.3 per cent more under the present simulation scenario than under Scenario 2. Compared to results in Scenario 2, under the "exclusion" scenario, with the assumption of maximum increases in world prices , the demand for agricultural land increases marginally in the wheat sector. The demand for agricultural land in the remaining sectors declines more under Scenario 5 than under Scenario 2 (cf. Table 5.1.2b with Table 4.3.3).

Factor incomes, and hence value added at factor cost, increase in the wheat and other grains sectors due to the URA under the assumption of maximum increases in world prices. Furthermore, the effect of the URA on factor incomes in these two grain sectors is more favourable when the reductions in export subsidies are not attributed to the URA than otherwise (see Figure 5.1.2d). In almost all the remaining sectors, factor incomes and value added at factor cost also increase more with the exclusion than the inclusion of the effects of export subsidy cuts into the analysis. However, this is only a marginal increase. Value added from agriculture improves by about 3 per cent more under the current scenario than under Scenario 2.

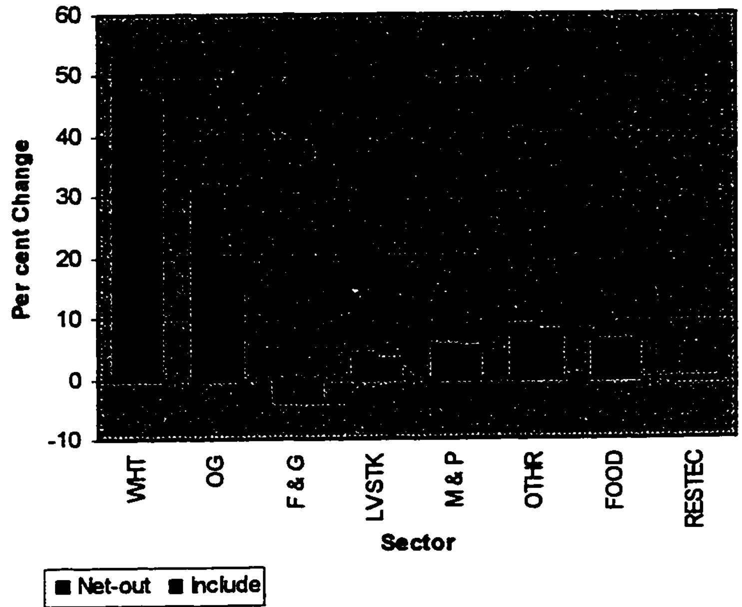
Overall, the implications of the URA for most Canadian sectors are not affected by whether export subsidy reductions are attributed to the Agricultural Agreement or to budgetary pressures. The exceptions are the wheat and the other grains sectors. If we assume that export subsidy reductions were made for budgetary reasons, that is, not due to the URA, then wheat and other grains producers will be harmed less or benefit more from the UR agreement. Whether they lose or gain depends on the extent of world price changes.

Table 5.1.2b. Results of Simulation 9: Value Added, Factor Use, and Factor Incomes, and Percentage Changes from Base Values[a]

	VAL-ADDM	%Δ	VAL-ADDF	%Δ	LABR	%Δ	YF-LABR	%Δ	CAP-TL	%Δ	YFCA PTL	%Δ	AG-LND	%Δ	YFAG LND	%Δ
Wheat	1.99	66.60	2.64	52.05	0.98	52.29	0.39	52.05	15.77	51.55	1.70	52.05	31.25	21.01	0.56	52.05
other Grains	1.01	50.67	1.41	31.79	1.25	32.00	0.50	31.79	17.85	31.36	0.70	31.79	27.48	4.88	0.22	31.79
Fruit & Vegetables	0.93	-1.82	0.93	-3.71	0.70	-3.55	0.28	-3.71	2.16	-4.02	0.60	-3.71	0.48	-23.4	0.05	-3.71
Livestock	1.12	19.74	1.19	4.02	1.65	4.19	0.65	4.02	17.83	3.68	0.43	4.02	23.31	-17.2	0.11	4.02
Milk & poultry	1.35	24.18	1.88	5.54	1.94	5.71	0.77	5.54	9.37	5.20	1.01	5.54	6.04	-16.0	0.11	5.54
Other Agriculture	2.52	10.57	2.39	8.71	1.80	8.88	0.71	8.71	7.06	8.36	1.40	8.71	3.59	-13.5	0.28	8.71
Food Processing	13.35	6.35	13.25	6.20	13.14	6.37	6.94	6.20	18.18	5.85	6.32	6.20	0.00	0.00	0.00	0.00
Rest of Economy	485.01	-0.48	452.3	-0.48	541.0	-0.32	285.5	-0.48	1509	-0.80	166.8	-0.48	0.00	0.00	0.00	0.00
Agriculture	8.92	25.36	10.45	17.37	8.32	12.59	3.30	12.41	70.04	18.98	5.84	18.45	92.14	0.00	1.31	26.31
Non-agriculture	498.35	-0.31	465.6	-0.30	554.1	-0.17	292.4	-0.33	1527	-0.73	173.1	-0.25	0.00	0.00	0.00	0.00

[a] The reported results pertain to the simulation of domestic support and tariff reductions along with "maximum" increases in world price. The symbol %Δ stands for percentage change from the 1991 base year values. The base year values are presented in Appendix 4.1.1. Values are in billions of Canadian dollars.

Figure 5.1.2d Value Added With Netting out the Effects of Export Subsidy Reductions and Maximum Increases in World Prices



WHT = Wheat, OG = Other grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and Poultry, OTHR = Other agriculture, FOOD = Food Processing, RESTEC = the rest of the economy

Net-out = The effects of export subsidy reduction are excluded
Include = The effects of export subsidy reduction are included (= Scenario 2)

5.2 Incorporating Compensatory Transfers

Agricultural producers do not have to sustain the full impact of the commitment reductions in domestic support programs since it is possible for domestic support programs to be redesigned as "green" programs. Thus producers' incomes can be supplemented by specified programs, which if categorized as "green," will be exempt from countervail.

The effects of the possible reclassification of base period expenditures on "amber" or similar domestic support programs is handled by introducing into the CGE model a lump sum transfer from government to households of the dollar amount of the commitment reduction in domestic support.[3] Since these transfers are assumed to accrue by and large to households engaged in agricultural activities, we need to disaggregate the single household category used so far in the model into two types: agricultural and non-agricultural households. Other variables that are identifiable by household type also need to be disaggregated. These include the marginal propensity to save, government transfers, household transfers to other institutions, household income taxes, employment, interest and dividends, and rent incomes.

5.2.1 Scenario 6: The Effect of Compensatory Transfers Under the Assumption of "Minimum" Increases in World Prices

The focus of this section is the analysis of how compensatory transfers could mitigate the negative impacts of the URA on households engaged in agricultural and food processing activities. The compensatory transfers are simulated along with the three policy changes, under the assumption of minimum increases in the world prices of agricultural products.

The compensatory transfers, by their nature, do not affect production directly. Their presumably proportional effects on sectoral production come from the demand side of the model. These transfers first affect household income positively and consequently affect private consumption. They also affect the government deficit from two directions: one, through their effect on household income taxes, which increase with household income, and the second, through government spending, which now includes the compensatory transfers to households.

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[3] In practice, reductions in support given through "amber" programs in Canada had already exceeded commitment reductions by the beginning of the implementation period of the UR agreement (IATRC, 1994).

To determine the extent to which such compensatory transfers can ameliorate the condition of agricultural and processed food producers, we compare the results under the present scenario (designated here as the "transfer" scenario) with the scenario where no compensatory transfers are made (designated as the "no transfer" scenario). Note that the "no transfer" scenario is Scenario 1 the results of which were discussed in the previous chapter in section 4.2

A marked impact of the compensatory transfers is on agricultural household incomes, which improve on average by close to 13 per cent. Savings by agricultural households also increase by the same magnitude. Changes in the income and savings of non-agricultural households are marginal. Government revenue improves by a tenth of one per cent. However, government savings worsen by a six-tenths of one per cent, thereby depressing overall savings by about four-tenths of one per cent (compare Table 4.2.4 and Table 5.2.1).

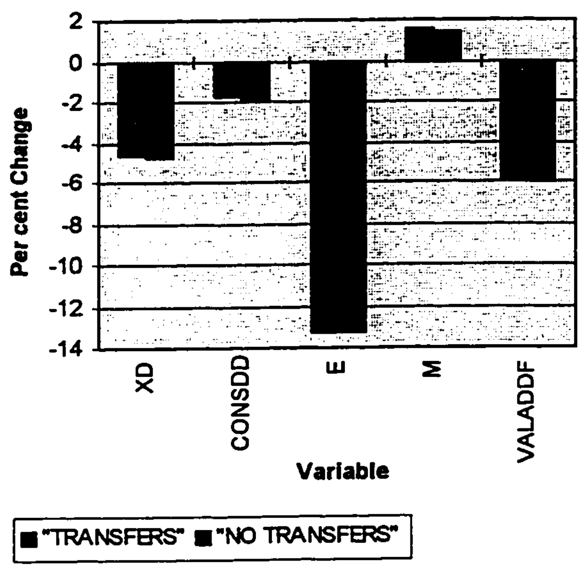
Table 5.2.1. Results of Simulation 10: Aggregate Variables and Miscellaneous Parameters, and Percentage Changes from Base Values[a]

Variable	Value	% Δ	Variable	Value	% Δ
YHH("AGHH")	7.870	9.380	GOVREV	183.67	-0.068
YHH("NAGHH")	523.114	0.138	ENTTAX	15.022	0.048
HHSAV("AGHH")	0.492	9.380	INDTAXOUT	44.346	0.192
HHSAV("NAGHH")	32.753	0.138	ENTSAV	17.964	0.048
HHINCTAX("AGHH")	1.522	9.380	GOVSAV	-38.393	-1.865
HHINCTAX("NAGHH")	100.233	0.138	SAVINGS	126.23	-0.293
NETGOVHH("AGHH")	3.688	25.405	INVEST	121.12	-0.167
NETGOVHH("NAGHH")	149.82	0.012	DEPRECIA	82.434	0.123

[a] In this simulation experiment, households are compensated dollar for dollar for what they lose in domestic support reduction. World prices are assumed to change by the "minimum" amount. Values are in billions of dollars. The symbol "%Δ" stands for percentage change from base year levels, while "AGHH" and "NAGHH" stand for agricultural and non-agricultural households, respectively.

The effects on other variables are, however, minimal in the agriculture sector, and almost nil in the non-agriculture sector. Figure 5.2.1 compares the "transfer" and "no transfer" simulation results for selected variables pertaining to the agriculture sector. Very slight differences occur in private consumption and imports of agricultural products, where the compensatory transfers improve the first by 0.14 per cent and the second by 0.12 per cent more relative to the situation under the "no transfer" scenario. Agricultural production and value added at factor cost each increase by close to a tenth of one per cent with compensatory transfers than without them. Note that the effects on value added at factor cost also represent the effects on each of the primary factor returns.

Figure 5.2.1 The Effect of Compensatory Transfer on Selected Variables With Minimum Increases in World Prices



5.2.2 Scenario 7: The Effect of Compensatory transfers Under the Assumption of "Maximum" Increases in World Prices

The relative effects of compensatory transfers essentially remains the same under the current scenario (i.e., Scenario 7) which differs from the Scenario 6 only in the assumption about the magnitude of anticipated world price changes.[4] The largest effect of the compensatory transfers is on household income of agricultural producers (see Table 5.2.2). Compared to the "no compensation" scenario, the income of agricultural households increases by 13.5 per cent. Government revenue improves while government savings remain the same as under Scenario 6.

Table 5.2.2. Results of Simulation 11: Aggregate Variables and Miscellaneous Parameters, and Percentage Changes from Base Values[a]

Variable	Value	% Δ	Variable	Value	% Δ
YHH("AGHH")	8.171	13.562	GOVREV	183.19	-0.329
YHH("NAGHH")	522.611	0.042	ENTTAX	15.151	0.906
HHSAV("AGHH")	0.511	13.562	INDTAXOUT	44.277	0.037
HHSAV("NAGHH")	32.721	0.042	ENTSAV	18.118	0.906
HHINCTAX("AGHH")	1.580	13.562	GOVSAV	-39.092	-3.718
HHINCTAX("NAGHH")	100.136	0.042	SAVINGS	124.81	-1.415
NETGOVHH("AGHH")	3.688	25.405	INVEST	120.20	-0.924
NETGOVHH("NAGHH")	149.82	0.012	DEPRECIA	81.799	-0.648

[a] In this simulation experiment, households are compensated dollar for dollar for what they lose in domestic support reduction. World prices are assumed to increase by the "maximum" amount. Values are in billions of Canadian dollars. The symbol " %Δ" stands for percentage change from base year levels, while "AGHH" and "NAGHH" stand for agricultural and non-agricultural households, respectively.

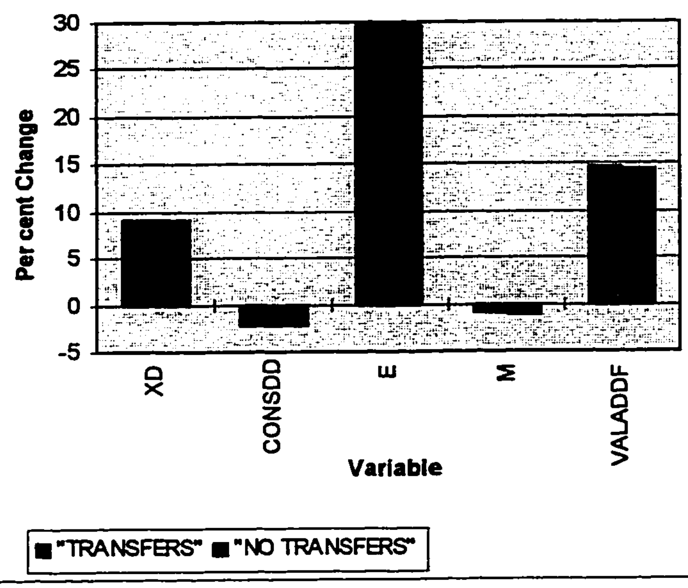
Changing the assumption about the extent of the rise in world prices does not seem to alter the effect of compensatory transfers on private consumption and imports of agricultural products relative to situations under the "no transfer" scenario. The same is

[4] This does not mean, however, that compensatory transfers are equally important under the two world price change scenarios. The comparisons are essentially between results under the "transfer" and "no transfer" scenarios. Apparently, these transfers will be more needed by households under "minimum" world price changes.

true of both agricultural production and value added at factor cost which increase by less than one tenth of one per cent with compensatory transfers (see Figure 5.2.2).

From the above discussions, it can be concluded that compensatory transfers are likely to be useful to agricultural households as income-safety net mechanisms that can guard them from the negative impact of multilateral trade agreements that arise with minimum world price changes. These benefits to households are not, however, without cost to society. Since these transfers have virtually no effect on production, government revenue does not increase via indirect taxes on production. The modest improvement in government revenue comes from sales taxes on final goods whose demand increases with increased household incomes. On balance, government savings (GOVSAV), which is the equilibrating variable in the equation that defines the government budget constraint, drops with compensatory transfers.

Figure 5.2.2 The Effect of Compensatory Transfers on Selected Variables With Maximum Increases in World Prices



5.3 Sensitivity Analysis

The choice of reasonable values for the various elasticity parameters that make up some of the functions in our CGE model is of importance since the simulation results depend to some degree on these values. One way of checking for the suitability of the chosen elasticity values is to conduct a sensitivity analysis. This analysis is conducted through the comparison of comparative static results, under different assumptions about the values of the various elasticities. If the model is sensitive, the comparative static results vary greatly as the elasticity values are changed. One use of a sensitivity analysis is in qualifying conclusions derived from simulation results of a sensitive model, by pointing the direction of the change that the endogenous variables would take, if the elasticity values were to be adjusted in some direction.

Three elasticity measures can be identified in the CGE model applied in this study. These are the elasticity of substitution between imports and home produced goods, the elasticity of transformation between goods produced for exports and those produced for home market delivery, and the price elasticity of demand for wheat in the world market.

In conducting the sensitivity analysis, first, the policy, and world price changes were simulated at the original elasticity values, and percentage changes (from base year levels) of the various endogenous variables were calculated. Then the elasticity values were doubled, the same simulation experiment was performed, and percentage changes (from base values) of the endogenous variables were calculated.[5] Finally, the two sets of percentage changes are compared.[6]

Doubling the CES parameter from which the elasticity of substitution between imports and home produced goods is derived does not seem to affect the model results, except for the level of imports which have varied greatly for almost all products. Other variables, in general, vary by less than one per cent. Only in very few cases do variations exceed one per cent (see Table 5.3).

Simulation results pertaining to exports appear to be sensitive to the doubling of the CET parameter. However, export results are, in general, less sensitive to changes in the CET parameter than are imports to changes in the CES parameter. Furthermore, doubling the CET parameter has virtually no effect on wheat exports. The third experiment involves the doubling of the value of the export demand elasticity for Canadian wheat. The sensitivity appears to be restricted to the wheat sector, leaving the other sectors generally unaffected or minimally affected. With the doubling of the export demand elasticity value, exports of wheat change by about 6.5 per cent from their levels at the original export demand elasticity value. Wheat production and wheat imports each change by 4.2 per cent, while value added at factor cost and each of the primary factor demands change in the order of 3.5 to 4.5 per cent with the doubling of the value of the wheat export demand elasticity relative to the situation when the original elasticity value obtains. In a similar exercise, the wheat export demand elasticity was

[5] Since the elasticity values for the CES and CET functions are generally set at conservative levels, compared to those used in other studies (e.g., Guzel, 1990; Burniaux, 1990), changing them upward (such as doubling them) is thought to be sufficient for the purpose of the sensitivity analysis. On the other hand the price elasticity of Canadian wheat exports has been changed in both direction to evaluate the sensitivity of the model to changes in this parameter.

Table 5.3 Changes in Selected Variables due to Doubling the Elasticity Parameters

		Wheat	Other Grains	Fruits & Veg.	Live - stock	Milk & poultry	Other Agric.	Food Process.	Rest of Econ.
		Per cent							
CES	XD	1.093	1.305	0.671	0.897	1.602	-0.686	0.69	0.036
	CONSDD	-0.541	-0.161	0.019	-0.134	-0.152	-0.125	-0.049	-0.004
	INVEST	-0.530	-0.123	0.078	-0.084	-0.104	-0.066	0.010	0.063
	E	0.103	0.546	0.110	0.581	1.246	1.007	0.279	0.217
	M	23.106	6.903	0.454	7.637	36.991	13.32	3.317	0.043
	VALADDF	1.321	1.460	0.733	1.002	1.667	-0.524	0.688	0.040
	LABR	1.328	1.467	0.743	1.010	1.674	-0.512	0.698	0.028
	CAPTL	1.312	1.453	0.724	0.993	1.658	-0.533	0.679	0.049
	AGLND	0.163	0.372	0.617	0.291	0.430	2.040	0	0
CET	XD	0.295	6.329	0.643	1.303	0.345	0.011	0.043	0.047
	CONSDD	-0.796	-0.470	-0.126	-0.228	-0.165	-0.230	-0.079	0.009
	INVEST	-0.766	-0.437	-0.029	-0.145	-0.076	-0.133	0.019	0.090
	E	0.396	16.278	6.707	6.364	7.030	4.741	0.188	0.407
	M	-3.919	-0.877	0.077	-0.483	-0.207	0.844	0.124	0.245
	VALADDF	0.851	6.604	0.790	1.538	0.509	0.357	0.041	0.056
	LABR	0.878	6.616	0.820	1.565	0.538	0.387	0.072	0.022
	CAPTL	0.823	6.579	0.760	1.509	0.479	0.326	0.010	0.087
	AGLND	-1.969	4.679	2.315	1.408	2.623	2.851	0	0
PEED	XD	4.169	-0.170	-0.128	0.001	-0.006	-0.049	-0.006	0.016
	CONSDD	0.815	-0.100	-0.016	-0.003	-0.007	-0.093	0.011	-0.004
	INVEST	0.932	-0.087	0.010	0.024	0.019	-0.067	0.038	0.031
	E	6.470	-0.432	-0.379	-0.026	-0.047	0.222	-0.035	0.048
	M	4.207	-0.214	-0.059	-0.045	-0.049	0.384	-0.034	-0.029
	VALADDF	4.341	0.020	-0.057	-0.120	0.073	0.115	-0.007	0.020
	LABR	4.343	0.031	-0.044	0.131	0.085	0.128	0.006	0.006
	CAPTL	4.330	0.010	-0.069	0.108	0.061	0.104	-0.019	0.031
	AGLND	3.465	-1.306	1.780	1.355	1.430	1.408	0	0

PEED stands for price elasticity of export demand for wheat. All other representations are as defined before.

halved, (essentially indicating increased export market power for this sector) and the comparative static results compared with those obtained with the original elasticity value. The sensitivity of the model is still restricted to the wheat sector. This is moderate relative to the case when the elasticity value was doubled. However, it does not follow

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[6]To conduct the sensitivity analysis, Scenario 1 was used. In addition, nine endogenous variables were selected for the purpose of comparing results obtained under differing elasticity values.

that smaller than originally used wheat export demand elasticity value is more "appropriate" since at the smaller export demand elasticity value, the wheat sector becomes more sensitive to changes in the other elasticity parameters.

Overall, the model is not sufficiently sensitive to cause concern about the simulation results and the conclusions made. However, it may be added that, if the "true" values of the various elasticities were found to be smaller than those used in the model, the comparative static results of exports and imports results reported would be overstatements of the true outcomes, and vice versa.

6. RECURSIVE DYNAMICS

In the previous chapters the CGE model was programmed to simulate the effects of the specified UR-related changes in domestic policy and world prices as if these changes were to take place to their full extent at once. In other words, the simulations were static and time was not an issue. Consequently, the results analyzed so far give the answer to the question: "what would happen to Canadian agriculture if the required changes in domestic policies (as stipulated in the UR agreement) and anticipated changes in world prices took place in the base year?" However, the URA only requires signatories to phase-in changes in trade distorting policies over the period of six years. The present chapter addresses the effect of the phasing-in (or piecemeal adoption) of changes in policies and world prices, in a recursive dynamic framework.

Solving a CGE model sequentially over discrete time periods, where the periods are related through updating of some exogenous time dependent variables is termed recursive dynamics in the literature (Robinson et al, 1990; Gunning and Keyzer, 1995). The time dependent variables such as the capital stock, labour force, and factor productivity are treated as exogenous (fixed) within periods, but vary from one period to the next. Different rules can be followed to update these dated variables, particularly, the capital stock. In this study, installation or adjustment costs are assumed away as are gestation lags. The capital stock is simply treated as a scalar on which fixed rates of depreciation apply over the period considered. Denoting labour force by LABR, and capital stock by CAPTL, the two variables are updated over time as follows:

$$LABR(t+1) = (1 + g(t)) * LABR(t) \qquad (60)$$

$$CAPTL(t+1) = (1-\delta) * CAPTL(t) + INVEST(t) \quad (61)$$

where g(t) is the annual growth rate of the labour force, and δ is the annual depreciation rate on capital. In addition to the two factors of production, total factor productivity (TFP) is updated by sector-specific growth rates.

The discomforting feature of recursive dynamic models is the built-in assumption that optimization (such as utility and profit maximization) take place within periods, but not between periods. However, while they are not intertemporal optimization models, recursive dynamic models have the advantage that they can be used to make policy-based forward projections, starting with some base year. Furthermore, not only the time dependent variables mentioned earlier, but also some other macro-economic scenarios, can be incorporated in the base-line solution, upon which simulation experiments of particular interest can be conducted.

The economy-wide capital stock is expected to depreciate uniformly, at the average rate of 5 per cent per year. This rate was calculated from historical data obtained from the 1995 publication of "Fixed Capital Flows and Stocks, Historical". The labour force is assumed to increase by one per cent per annum; this value was computed from data contained in the 1995 publication of "Canadian Economic Observer, Historical Supplement". Statistics Canada publishes both sources. Agricultural land is assumed to remain the same as in the base year. The growth rates in total factor productivity were determined after consulting reports from other studies. Veeman and Fantino (1994) report a 1.34 per cent annual growth rate in TFP for Canadian agriculture. Their finding was based on data covering the period from 1971 to 1990. More recently, Veeman, Fantino, and Peng (1995) updated their finding to 2.5 per cent by considering the 1984 to 1991 period. Narayanan and Kizito (1992) reported a similar finding (2.42 per cent growth rate in TFP). In this study, it is assumed that TFP grows at the rate of 2.4 per cent per annum in the agriculture sector.

TFP growth rates are lower in the non-agriculture sectors than in the agriculture sector. In the food processing sector TFP is assumed to grow by 0.3 per cent per annum, while this grows by 0.8 per cent in the rest of the economy sector. These values were either taken directly or derived from TFP growth rates for the various sectors of the Canadian economy as reported in Narayanan and Kizito (1992).

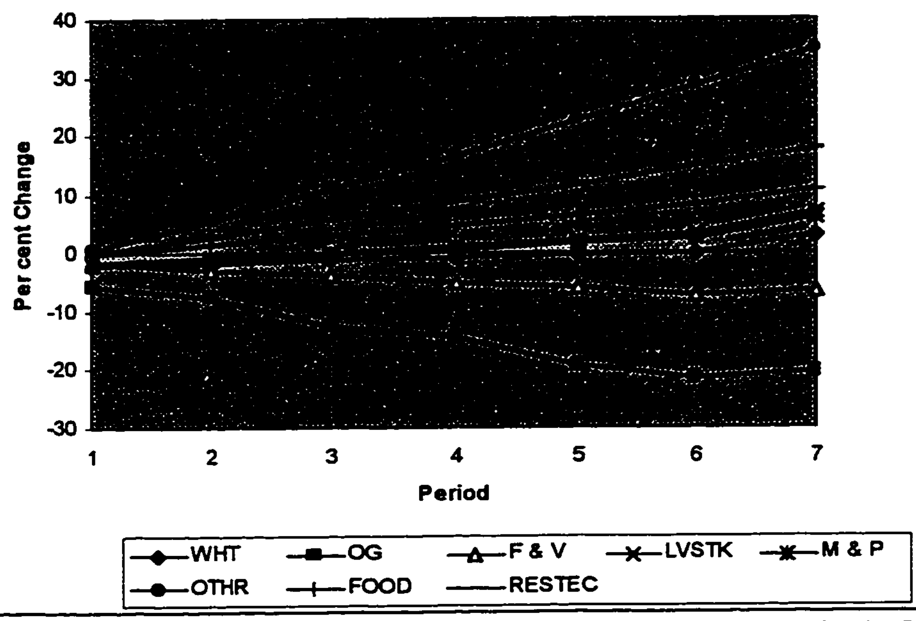
The recursive dynamic simulation experiments are handled in the following way: The policy changes (i.e., the reductions in tariffs, export subsidies and domestic support) are made over a six year period, with a sixth of each of the policy commitments being effected each year. In other words, the Canadian government is assumed to reduce tariffs, export subsidies, and domestic support each year by equal amounts over the six year implementation period. World prices, likewise, are assumed to rise by a uniform percentage every year over the implementation period. It is further assumed that each of the six portions of the policy commitments are put in place at the beginning of each year. Except for the first year, in subsequent years the base scenario incorporates growth in aggregate factor supplies and TFP. That is, for the sequence of CGE solutions over the six years, there are a sequence of simulations (referred to here as "base runs") that incorporate the growth in the supplies of primary factors and TFP serving as base scenarios. However, in order to trace the trend in the simulation results, percentage changes are calculated from common base year values of 1991. In the recursive dynamic model, phasing-in changes in policies and world prices interact with underlying economic changes such as growth in factor productivities and aggregate factor supplies to determine the growth patterns of the endogenous variables of the model.

6.1 Scenario 8: Recursive Dynamic Results Under the Assumption of "Minimum" Increases in World Prices

The first set of diagrams given below (i.e., Figures 6.1a to 6.1g) trace projections of selected variables over the six-year period as phasing-in of UR-related domestic policy changes (i.e., reductions in tariffs, export subsidies, and domestic support) and anticipated minimum increases in world prices take place. From Figure 6.1a we observe that projections of exports follow different trends across sectors. The exports of other grains, and fruits and vegetables remain below base year level, with a declining trend throughout the projection period.

Exports of other agriculture, on the other hand, are projected to rise the most at the average rate of 4.4 per cent per year. Exports from the food processing sector grow at 1.5 per cent per year (see Table 6.1.1). Under the assumption of minimum increases in world prices, wheat exports barely exceed the base year levels until the sixth year. By the end of the projection period (i.e., the end of the implementation period of the URA), exports of other grains have declined by about 20 per cent, while exports of other agriculture have increased by 35 per cent relative to the base year levels. Exports from the livestock , and the milk and poultry sectors grow at modest rates (of 0.9 and 0.8 per cent per year, respectively). By the end of the projection period these exports are eight and seven per cent above the base year levels, respectively (see Table 6.1.2). Aggregate

Figure 6.1a. Projections of Exports With Minimum Increases in World Prices



WHT = Wheat, OG = other grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and Poultry, OTHR = other agriculture, FOOD = Food Processing, RESTEC = "Rest of Economy".

agricultural exports remain below the 1991 base year level until all the policy and the minimum world price changes have exhausted their effects; only after then do aggregate agricultural exports exceed the base level by a small margin. In contrast, exports of non-agriculture products follow a rising trend from the very beginning of the projection period.

It is interesting to discern which of the two effects (those due to UR-related domestic policy and world price changes or the underlying economic changes, i.e., the growth in aggregate factor supply and TFP) determine the trend of sectoral export over the projection period. Noting that the policy and world price changes are introduced into the model at the beginning of each year and, therefore, the last "dose" of these changes are put in place at the beginning of the sixth year, the last segment of the trend (Figure

Table 6.1.1 Growth Rates of Selected Variables Over the Projection Period[a]

	XD	E	M	LABR	CAPTL	AGLND	VAL-ADDF
Wheat	0.74	0.43	1.60	-2.65	-1.11	-0.86	-1.38
Other Grains	-0.53	-3.22	2.61	-1.57	-0.02	0.24	-0.29
Fruits & Vegetables	0.77	-0.96	1.67	-0.34	1.23	1.49	0.96
Livestock	1.28	0.94	1.95	-1.48	0.07	0.33	-0.20
Milk & Poultry	1.28	0.84	5.32	-1.69	-0.14	0.12	-0.41
Other Agriculture	2.38	4.35	-4.33	-0.81	0.76	1.01	0.48
Food Processing	1.40	1.47	2.29	0.39	1.97	0.00	1.70
Rest of Economy	2.18	2.35	2.19	0.90	2.49	0.00	2.21
Agriculture	*1.21*	*0.29*	*1.29*	*-1.37*	*-0.06*	*0.00*	*-0.17*
Non-agriculture	*2.14*	*2.32*	*2.19*	*0.88*	*2.48*	*0.00*	*2.19*

[a] The rates are given in percentages.

6.1a) is determined solely by the changes in the updated variables. (On the other hand, the level of exports that obtain at the beginning of the first year incorporate the effects of domestic policy and world price changes alone). Based on the last segment of the trend of exports from the various sectors, it may be deduced about the entire trend that i) the two effects (of policy and world price changes, as versus the underlying economic changes) work in opposite directions, and ii) the trends are predominantly conditioned by the base runs which simulate the growth in the updated variables. In other words, given the minimum increases in world prices, exports are affected more by non-policy factors, such as growth in productivity and factor supplies, than by UR-related changes in policy parameters.

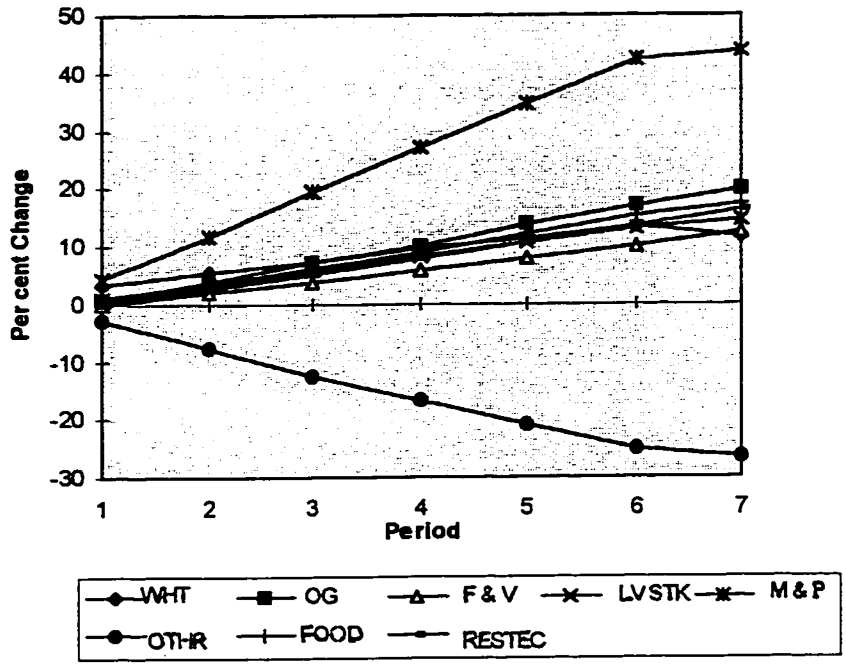
Table 6.1.2. Results of Simulation 12: End-Period Projections of Selected Variables, and Percentage Changes from Base Values [a]

	XD	% Δ	E	% Δ	M	% Δ	LABR	% Δ	CAPTL	% Δ	AGLND	% Δ	VALADDF	% Δ
Wheat	3.197	5.304	1.977	3.083	0.114	11.72	0.531	-17.13	9.622	-7.532	24.31	-5.874	1.578	-9.276
Other Grains	2.181	-3.621	0.700	-20.48	0.247	19.78	0.849	-10.49	13.57	-0.115	26.64	1.676	1.052	-1.999
Fruit & Vegetables	1.380	5.493	0.136	-6.520	1.553	12.29	0.712	-2.371	2.452	8.941	0.693	10.89	1.028	6.886
Livestock	7.560	9.283	1.282	6.802	0.288	14.48	1.424	-9.939	17.29	0.497	28.81	2.298	1.130	-1.399
Milk & Poultry	5.910	9.300	0.224	6.037	0.212	43.77	1.628	-11.24	8.822	-0.955	7.243	0.820	1.735	-2.824
Other Agriculture	4.709	17.88	0.515	34.70	0.261	-26.64	1.562	-5.518	6.868	5.430	4.452	7.320	2.273	3.441
Food Processing	43.86	10.23	6.066	10.79	7.187	17.14	12.70	2.754	19.69	14.66	0.000	0.000	14.04	12.48
Rest of Economy	1086.6	16.26	182.5	17.63	195.4	16.34	577.7	6.439	1807	18.77	0.000	0.000	529.6	16.53
Agriculture	24.938	8.767	4.834	2.030	2.675	9.352	6.705	-9.219	58.62	-0.414	92.14	0.000	8.794	-1.214
Non-agriculture	1130.4	16.01	188.6	17.40	202.6	16.37	590.4	6.357	1826	18.73	0.000	0.000	543.5	16.39

[a] Minimum world price changes are assumed. The symbol " % Δ" stands for percentage change from base value. The base values are presented in Appendix 4.1.1. Values are in constant Canadian dollars.

Projections of imports under the assumption of minimum increases in world prices, and given the base runs, are in most cases dissimilar to those of exports. Imports of other agriculture decline throughout the projection period (at the average rate of 16.7 per cent per year). By the end of the sixth year, imports of these products have declined by more than 26 per cent from the base year level. On the other hand, imports of milk and poultry rise at the highest rate of about 5.3 per cent per year; by the end of the sixth year, these have risen by 44 per cent above the base year level. Imports of the remaining products increase over the projection period in comparison to the base year levels, but not as much as for milk and poultry. By the end of the sixth year, imports of these have risen in the order of 12 per cent (wheat) to 20 per cent (other grains). Aggregate imports of

Figure 6.1b Projections of Imports With Minimum Increases in World Prices



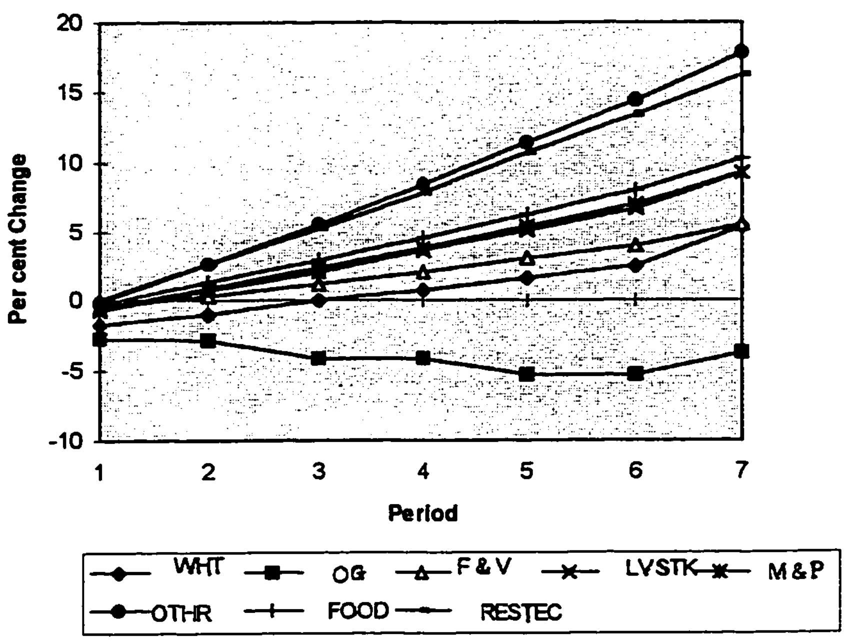
WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = "Rest of Economy".

Agricultural products grow at 1.3 per cent per year over the projection period, while imports of non-agricultural products rise at the average rate of 9.4 per cent per year.

Looking at the last segment of each of the trends, it may be deduced that the changes in the updated variables have a moderating effect in both declining and rising trends, while the exhibited trends in imports are predominantly conditioned by the UR-related changes in policy and world prices.

Production rises above base year levels sooner or later during the projection period in all but the other grains sector. Production of other grains remains below the base year level throughout the URA-implementation period, although beginning the fifth year this shows a rising trend (see Figure 6.1c). The highest rate of growth in production occurs

Figure 6.1c Projections of Domestic Production With Minimum Increases in World Prices

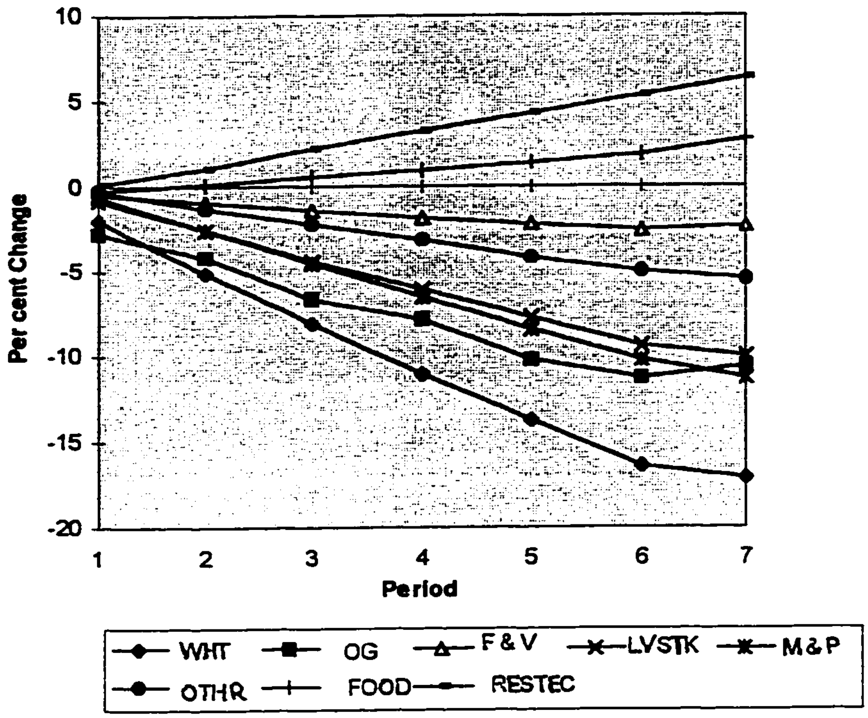


WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = "Rest of Economy" in other agriculture at the rate of 2.4 per cent per year. Wheat production exceeds the base year level beginning the third year; by the end of the sixth year this has risen by 5.3 per cent above the base year level. The production of fruits and vegetables also exhibits a rising trend throughout and crosses the base year level at year two. Production of livestock, and milk and poultry products each increase at 1.3 per cent per year. By the end of the projection period, production of agricultural products is about 8.9 per cent higher than the base year level (see Table 6.1.2).

Given the annual growth rates in aggregate factor supplies and sector-specific TFPs, and the assumption of minimum increases in world prices, the demand for labour exhibits a declining trend over the projection period in all agricultural sectors (see Figure 6.1d). The highest decline in demand for labour occurs in the wheat sector where it declines at the rate of –2.7 per cent per year; by the end of the sixth period, labour demand has declined by 17 per cent compared to the base year level (see Table 6.1.2). Labour demand declines by 1.6 per cent per year in the other grains sector. In the livestock, and milk and poultry sectors, labour demand declines, respectively, by 1.5 and 1.7 per cent per year. By the end of the projection period aggregate labour demand in agriculture drops by 9.2 per cent below the base year level. The non-agriculture sector increases its demand for labour over the projection period by 0.9 per cent per year.

The relative positions of the traces of sectoral capital demand projections are similar to the labour demand projections. Only in the wheat sector does the demand for capital remain below the base year level throughout the projection period (see Figure 6.1e). In the other grains sector, the demand for capital exceeds the base year level only in

Figure 6.1d Projections of Labour Demand With Minimum Increases in World Prices

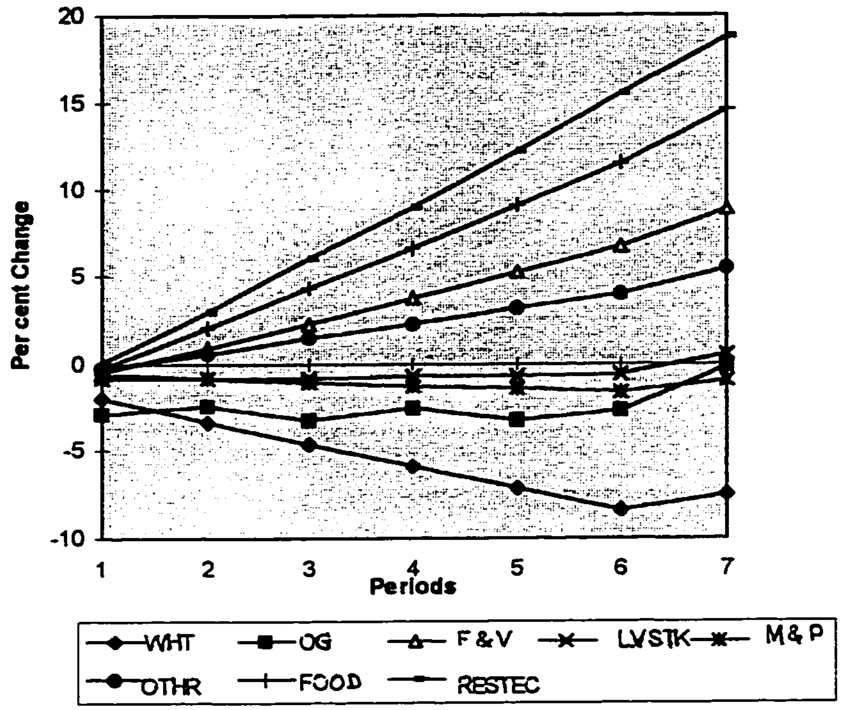


WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = Rest of Economy

the sixth year. Capital demand in the livestock and the milk and poultry sectors exceeds base year levels, respectively, by the fourth and sixth years. The remaining two agricultural sectors increase their demand for capital from the beginning of the projection period. By the end of the projection period, the demand for capital has declined by 0.4 per cent in the agriculture sector and by 18.7 per cent in the non-agriculture sector.

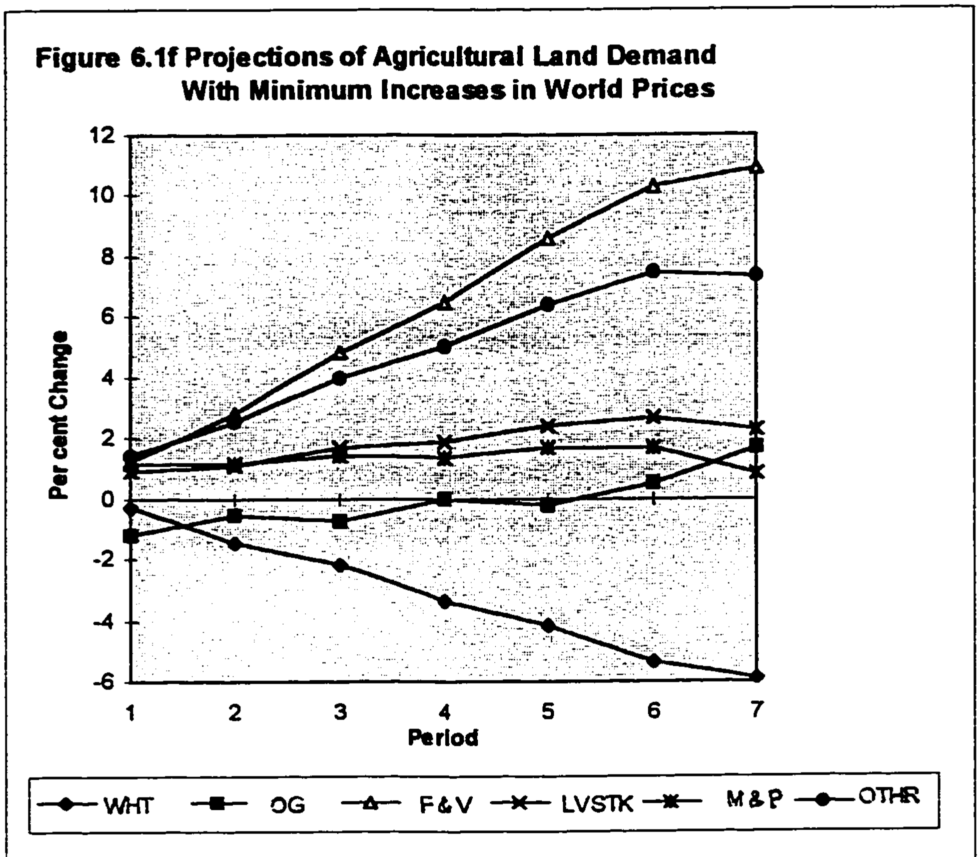
The demand for agricultural land eventually exceeds base year levels in all agricultural sectors except in the wheat sector (see Figure 6.1f). In the wheat sector,

Figure 6.1e Projection of Capital Demand With Minimum Increases in World Prices



WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = Rest of Economy

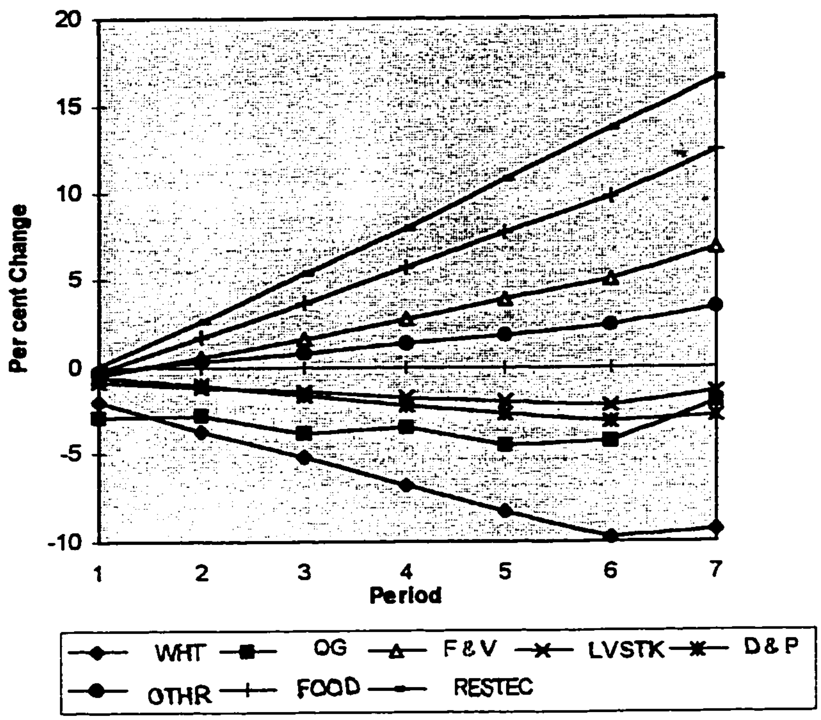
agricultural land demand declines at the rate of 0.9 per cent per year, falling to 5.9 per cent below the base year level in the last year of the projection period. The highest growth in agricultural land demand (1.5 per cent per year) occurs in the fruits and vegetables sector, followed by the other agriculture sector (at 1.0 per cent per year). Looking at the last segment of the traces (or trends), we observe that once the last "dose" of the UR-related domestic policy and world price changes have taken place, the demand for agricultural land appears to decline in all agricultural sectors except in the wheat and other grains sector. By the end of the sixth year, agricultural land demand stands at 10.9, 7.3, and 2.3 per cent higher than base levels in the fruits and vegetables, other agriculture, and livestock sectors, respectively. In the remaining sectors, the demand for agricultural land is higher than base year levels by less than two per cent.



WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture

Trends in factor remuneration and value added at factor cost over the projection period are reflections of the "average" pattern of factor demands (see Figure 6.1g). Projections of factor returns are more favourable in the non-agricultural sectors than in the agricultural sectors. For instance, compared to the situation in the base period, by the end of the projection period, labour and capital income have increased by an average of 16.4 per cent in the non-agricultural sectors. In the agricultural sectors, they have declined by an average of 1.2 per cent (see Table 6.1.2). Value added at factor cost grows at 1.7 and

Figure 6.1g Projections of Value Added With Minimum Increases in World Prices



WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = Rest of Economy

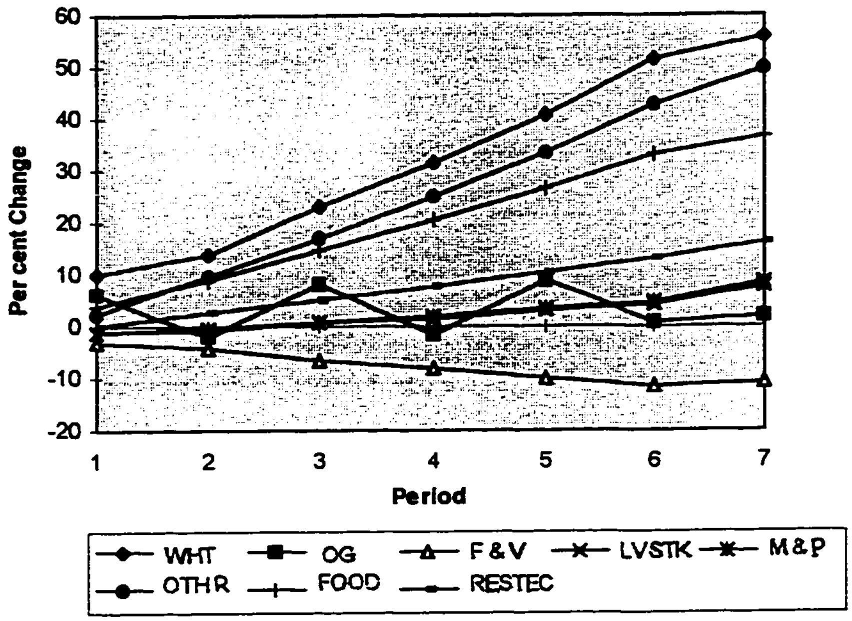
2.2 per cent per year in the food processing and the rest of the economy sectors, respectively. Within the agricultural sectors, factor returns are more favourable in the fruits and vegetables, and other agriculture sectors where they stay above base year levels, rising at modest rates of 1.0 and 0.5 per cent per year, respectively. Given the base runs and the assumption of minimum increases in world prices, the lowest factor remunerations are projected in the wheat sector; at the beginning of the sixth period these have dropped by 10 per cent below base levels.

6.2 Scenario 9: Recursive Dynamic Results Under the Assumption of "Maximum" Increases in World Prices

The following projections are based on the same policy and economic environment as in Scenario 8 but different anticipated changes in world prices of agricultural products, which in this case are assumed to increase by the maximum amounts, as indicated in Chapter 4 in Table 4.1.

Given the UR-related policy commitments of reductions in tariffs, export subsidies, and domestic support, trends of sectoral exports greatly depend on the assumption about world price changes. For instance, in contrast to projections in Scenario 8, under the current scenario in which maximum increases in world prices are assumed, the highest growth in exports occur in the wheat, other agriculture, and food processing sectors, in that order (see Figure 6.2a). Exports from these sectors grow at an average rate of 6.6, 5.9, and 4.5 per cent per year, respectively, over the projection period (see Table 6.2.1). Only the exports of fruits and vegetables remain below their base year level throughout the projection period. Exports of other grains, in contrast to the rest, exhibit a zigzag pattern. From Figure 6.2a, we observe that the first "dose" of policy commitments and world price changes result in positive changes in the exports of other grains. Consequently, upturns in the trend of exports of other grains are determined by the maximum increase in world prices; the growth in aggregate factor supplies and productivities do not appear to contribute positively to the exports of other grains. Exports of livestock, and milk and poultry products rise above base year levels beginning the third year and increase at modest rates afterwards. On average, exports of these two products each grow at the rate

Figure 6.2a Projection of Sectoral Exports With Maximum Increases in World Prices



WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = Rest of Economy

Table 6.2.1 Growth Rates of Selected Variables Over the Projection Period[a]

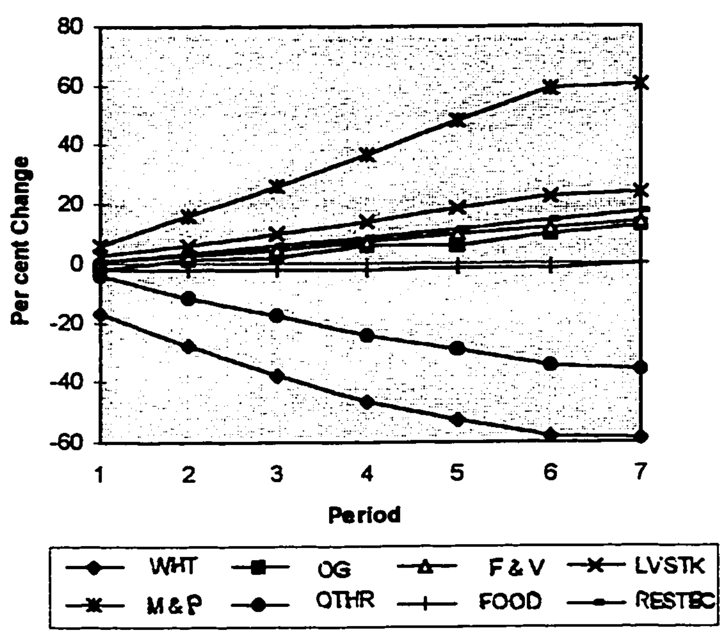
	XD	E	M	LABR	CAPTL	AGLND	VAL-ADDF
Wheat	5.24	6.55	-11.87	2.22	3.80	1.69	3.51
Small Grains	1.13	0.29	1.71	0.45	2.00	-0.07	1.72
Fruits & Vegetables	0.63	-1.64	1.94	-0.34	1.20	-0.86	0.92
Livestock	1.85	1.07	3.17	-0.71	0.82	-1.22	0.55
Milk & Poultry	2.08	1.16	7.00	-0.76	0.77	-1.28	0.49
Other Agriculture	3.10	5.92	-6.14	0.19	1.73	-0.33	1.46
Food Processing	2.34	4.54	0.02	1.33	2.90	0.00	2.62
Rest of Economy	2.12	2.16	2.32	0.86	2.41	0.00	2.13
Agriculture	*2.48*	*3.71*	*1.06*	*-0.06*	*1.76*	*0.00*	*1.56*
Non-agriculture	*2.13*	*2.25*	*2.25*	*0.87*	*2.42*	*0.00*	*2.15*

[a]The rates are given in percentages.

of 2.5 and 3 per cent per year over the projection period. By the end of the projection period, agricultural exports have on average increased by 29 per cent above the base year level (see Table 6.2.2). Over the six-year period, agricultural and non-agricultural exports grew at the rates of 3.7 and 2.3 per cent per year, respectively.

Imports of wheat and other agriculture decline the most throughout the projection period falling at the annual rate of 11.9 and 6.1 per cent, respectively. Imports of processed foods remain at slightly below the base year level to the end of the projection period. Imports of remaining products exhibit rising trends with the highest

Figure 6.2b Projections of Imports With Maximum Increases in World Prices



WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = Rest of Economy

growth for the imports of milk and poultry, and livestock products, at rates of 7 and 3.2 per cent per year, respectively. By the end of the sixth year, imports of these two

Table 6.2.2. Results of Simulation 13: End-Period Projections of Selected Variables, and Percentage Changes from Base Values[a]

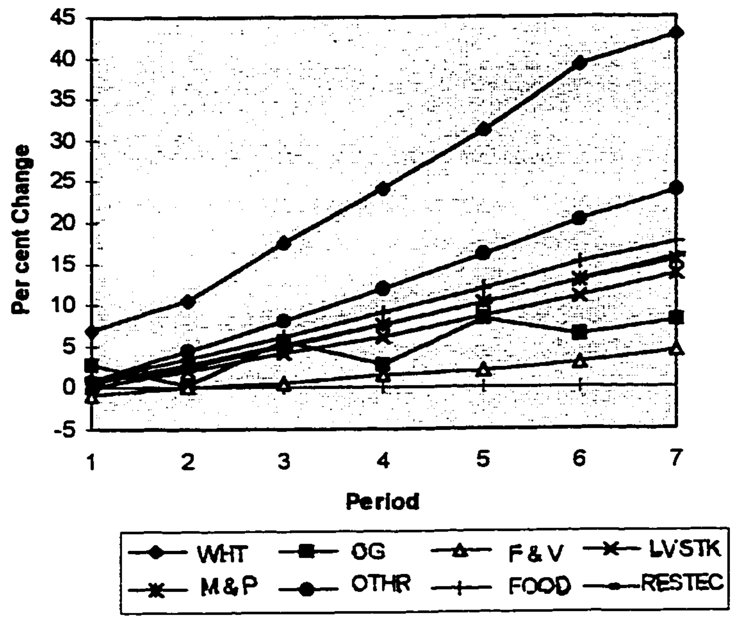
	XD	%Δ	E	%Δ	M	%Δ	LABR	%Δ	CAPTL	%Δ	AGLND	%Δ	VALADDF	%Δ
Wheat	4.339	42.93	2.990	55.95	0.042	-58.7	0.747	16.60	13.51	29.79	29.03	12.43	2.214	27.34
Small Grains	2.448	8.172	0.899	2.081	0.232	12.62	0.978	3.188	15.61	14.86	26.07	-0.506	1.209	12.69
Fruit & Vegetables	1.367	4.516	0.129	-10.94	1.582	14.36	0.713	-2.340	2.446	8.707	0.588	-5.836	1.026	6.654
Livestock	7.863	13.66	1.293	7.756	0.313	24.41	1.504	-4.852	18.22	5.911	25.84	-8.258	1.191	3.910
Milk & Poultry	6.244	15.48	0.229	8.373	0.236	60.55	1.738	-5.224	9.396	5.497	6.565	-8.616	1.848	3.504
Other Agriculture	4.948	23.86	0.571	49.54	0.228	-35.83	1.675	1.330	7.348	12.79	4.053	-2.297	2.431	10.66
Food Processing	46.77	17.55	7.473	36.48	6.143	0.124	13.55	9.706	20.97	22.12	0.000	0.000	14.95	19.81
Rest of Economy	1083	15.85	180.2	16.14	197.3	17.45	576.1	6.161	1798	18.17	0.000	0.000	526.9	15.94
Agriculture	27.21	18.68	6.113	29.03	2.634	7.686	7.355	-0.421	66.52	13.00	92.14	0.000	9.919	11.43
Non-agriculture	1130	15.92	187.7	16.83	203.4	16.84	589.7	6.240	1819	18.21	0.000	0.000	541.8	16.04

[a] Maximum world price changes assumed. The symbol " % Δ" stands for percentage changes from base value. The base values are presented in Appendix 4.1.1. Values are in constant Canadian dollars.

products have risen above base year levels by 60.6 and 24.4 per cent, respectively. Aggregate agricultural imports grow at the rate of 1.1 per cent per year, while imports of non-agricultural products grow at 2.3 per cent per year.

Under the assumption of maximum increases in world prices, trends of sectoral production are, largely, similar to those of exports. Domestic production of wheat grows at the rate of 5.2 per cent per year; by the end of the sixth year, wheat production has increased by 42.9 per cent above the base year level. Domestic production in other agriculture and food processing sectors grows, respectively, at the rate of 3.1 and 2.3

Figure 6.1c Projections of Domestic Production With Maximum Increases in World Prices

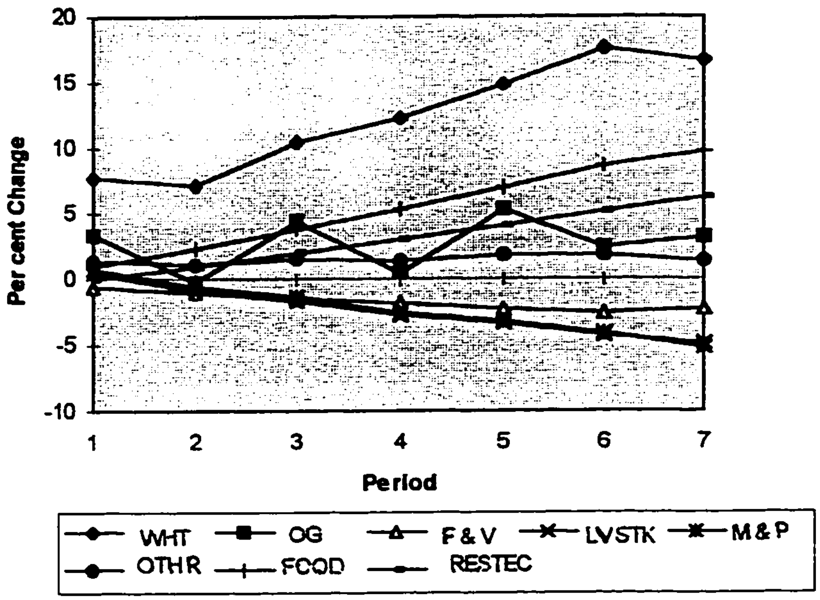


WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = Rest of Economy per cent per year over the projection period. Domestic production in the remaining sectors also rises above the base year levels for most part of the projection period. Aggregate agricultural production grows at the rate of 2.5 per cent per year reaching by the end of the sixth year a level 18.7 per cent higher than the base year level.

The assumption about the magnitude of the increases in world prices greatly determines the trends of primary factor demands. In Scenario 9, for instance, labour demand increases the highest in the wheat sector, growing at the rate of 2.2 per cent per year over the projection period. In contrast, labour demand declines in the livestock, and milk and poultry sectors, respectively, at the rate of 0.7 and 0.8 per cent per year. Labour demand in the fruits and vegetables sector remains below the base year level throughout the projection period, while in the other grains sector labour demand remains above the base year level for most part (see figure 6.2d). The rise in labour demand in the crops sectors, in contrast to its decline in the non-crop sectors, particularly in the livestock, and milk and poultry sectors, can be explained in terms of the simulated favourable world price changes for crop products, which are primarily reflected in relatively higher levels of domestic production of these products.

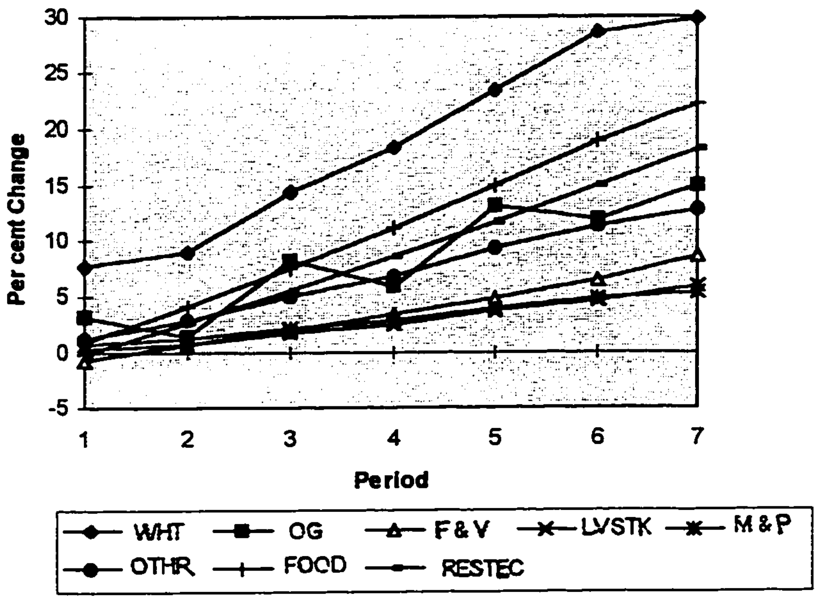
Capital demand increases throughout the projection period in all the sectors, the highest growth taking place in wheat, where this grows at the rate of 3.8 per cent per year (see Figure 6.2e). In the livestock, and milk and poultry sectors, the demand for capital increases at the rate of 0.8 per cent per year. The demand for capital in agriculture as a whole grows at 1.8 per cent per year, which is a little less than the 2.4 per cent growth rate in the non-agriculture sector. Looking at the end period, capital demand has increased

Figure 6.2d Projections of Labour Demand With Maximum Increases in World Prices



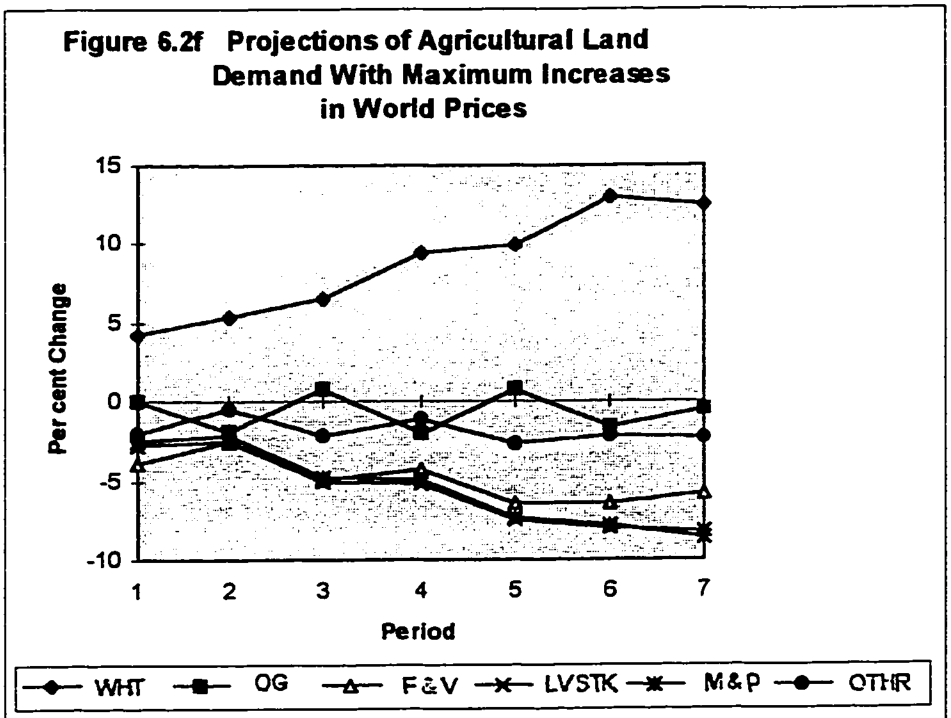
WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = Rest of Economy

Figure 6.2e Projection of Capital Demand With Maximum Increases in World Prices



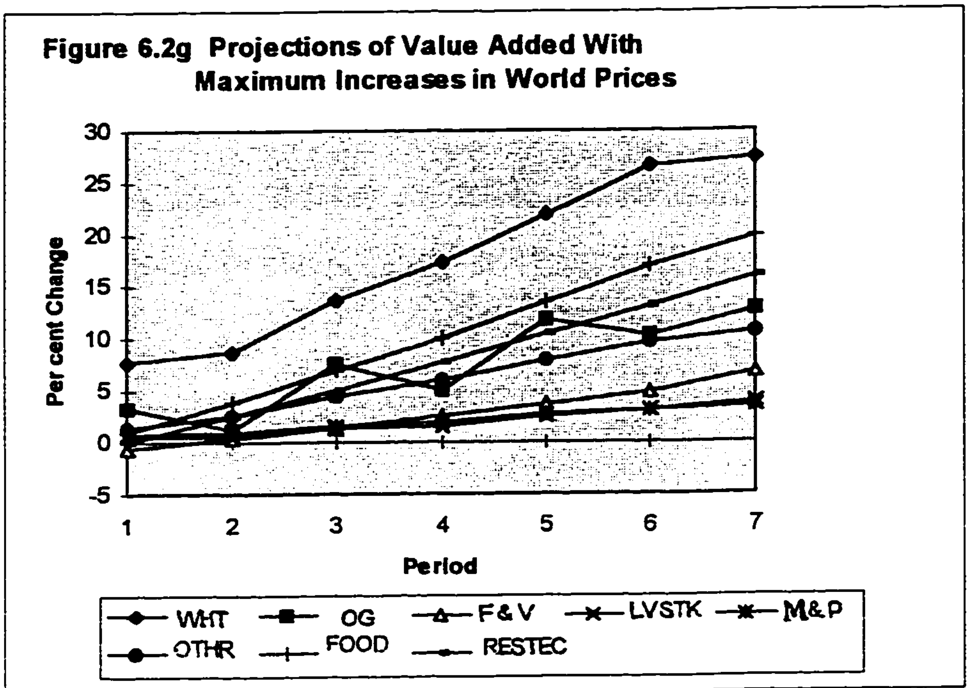
WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = Rest of Economy by 29.8, 22.1, and 14.9 per cent over base year levels, respectively, in the wheat, food processing, and other grains sectors. In the remaining agricultural sectors, capital demand grows between 5 and 13 per cent (see Table 6.2.2).

In Scenario 9, the demand for agricultural land increases throughout the projection period singularly in the wheat sector, where it rises 1.7 per cent per year. In the remaining sectors, agricultural land demand remains at or declines below base year levels (See Figure 6.2f). The largest decline in agricultural land demand occurs in the livestock, and milk and poultry sectors, where by the end of the projection period, this has fallen 8.3 and 8.6 per cent below the base year levels, respectively.



WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture

Changes in value added and in factor remuneration are most favourable in the wheat sector, growing at the rate of 3.5 per cent per year reaching 27.3 per cent above the base year levels (see Figure 6.2g). The second highest factor returns occur in the food



WHT = Wheat, OG = Other Grains, F & V = Fruits and Vegetables, LVSTK = Livestock, M & P = Milk and poultry, OTHR = Other Agriculture, FOOD = Food Processing, RESTEC = Rest of Economy

processing sector. In this sector, factor incomes grow during the projection period at the rate of 2.6 per cent per year; by the end of the projection period, these are 20 per cent above the base year levels. By the end of the projection period average factor incomes in agriculture have increased by more than 11.4 per cent above base year levels.

7. SUMMARY AND CONCLUSION

This thesis attempted to evaluate the impacts on the Canadian agriculture of multilateral trade liberalization in a general equilibrium framework. Specifically, attempt was made to evaluate the implications of the Uruguay Round Agreement (URA) on Canadian agriculture. In contrast to multi-country general equilibrium models used in global studies of trade liberalization, in this study, a single-country CGE model is used. The advantage of using a single-country general equilibrium model is in the detail that can be incorporated into the analysis. Furthermore, since the focus is on a particular country, Canada, this approach is efficient and cost saving in assembling the required data.

In applying the general equilibrium model, the Canadian economy is divided into eight sectors, consisting of six agricultural sectors (wheat, other grains, fruits and vegetables, livestock, milk and poultry, and other agriculture), and two non-agricultural sectors (food processing and the rest of the economy). The impacts of the URA on the Canadian economy, and more specifically, on the specified sectors, were assessed by simulations involving changes in both external prices and domestic policy.

The policy changes stipulated by the URA in relation to agricultural trade liberalization are expected to have different implications for different countries. Canadian agricultural producers are generally believed to benefit from the Agreement in so far as export subsidy reductions by major subsidizing countries will raise the export prices of certain agricultural products. From a sectoral view point, these benefits can, however, be weighed against the effects on agricultural producers of reduced protection, reduced export subsidies, and reduced domestic support.

Since a single country CGE model is used in this study, world prices were introduced into the model exogenously except in the case of wheat prices. The anticipated changes in world prices were taken from global studies that projected these changes. However, the literature does not provide a consistent and uniform set of anticipated changes in world prices. Rather, projections of changes in world prices of agricultural products, following multilateral trade liberalization, are marked by wide differences. Consequently, based on literature and studies that have projected global price changes from the URA, two sets of price changes --the "minimum" and the "maximum" anticipated changes -- were considered in this study. The "minimum" world (export/import) price change scenario is one in which the world prices of crop products including wheat, other grains, and other agriculture increase by four per cent each and the average price of processed foods rises by one per cent following the URA. Under the "maximum" world (export/import) price change scenario, the world price of wheat, other grains, other agriculture, and processed food are anticipated to change by 36.7, 16.3, 10.0, and 7.5 per cent, respectively. World prices for the remaining products are assumed to remain unchanged. The first set of analyses to assess the impact of the URA on Canadian agriculture involved the simulation of the policy changes required of the Canadian government according to the URA with, alternatively, both the "minimum" and "maximum" increases in world prices of the selected products.

The results from the two simulations show that the URA will have a negative effect on Canadian agriculture if world prices increase only by the minimum amount. That is, the minimum increases in projected world prices are too small to offset the negative effects of the reductions in tariffs, export subsidies and domestic support on farm production and income for Canadian agricultural producers. For example, with the minimum response in the world prices of exports, total agricultural production declines by close to five per cent while total agricultural exports decline by 13 per cent. Import competition increases as total agricultural imports increase by 2.5 per cent. The hardest hit sectors within agriculture are the other grains and wheat sectors, in that order. Production in these two sectors declines by 13.7 and 9.6 per cent, respectively, while their exports also dropped by 28.7 and 12.2 per cent, respectively. Although imports of most agricultural products increased, imports of milk and poultry increased the highest by 28.3 per cent. The food processing sector is affected the same way by the simulated world price and domestic policy changes as is the agriculture sector. Production and exports of processed foods both decline while imports increase. The opposite is true of the rest of economy sector.

With the minimum increases in world prices of the selected products and the URA policy commitments, the value added terms of trade deteriorates for agriculture, and consequently both labour and capital uses decline in all agricultural sub-sectors. Thus, factor incomes and value added at factor cost also decline in these sectors. The greatest drop in factor returns is for agricultural land which fell by 7.7 per cent. Primary factor employment and factor incomes also declined in the food processing sector, while these increase in the rest of economy sector.

If world prices were to increase by the maximum amount, however, Canadian agricultural producers would on average gain from the Uruguay Round Agreement.

Under this scenario, total agricultural production increases by 9 per cent and total agricultural exports by 29.6 per cent. In particular, domestic production and exports of wheat increase by 41 and 59.4 per cent, respectively, while domestic output and exports of other grains increase by 16.5 and 36.6 per cent, respectively. Domestic production and exports of processed foods increase by 5.9 and 25 per cent, respectively. Imports of crop products and processed foods fall by as much as 60.5 per cent in the case of wheat, for example. A rise in the world prices of crop and processed food products, other things remaining constant, means a rise in the prices of imports of the same products; hence the fall in imports of these products. Imports of non-crop agricultural products, whose world prices are assumed to remain the same under the simulation scenario, increase by as much as 40 per cent in the case of milk and poultry, for example.

With the maximum increases in world prices, mobile factors move from the non-agriculture sector into agriculture. Labour and capital demand increase, respectively, by 10.2 and 15.1 per cent in agriculture, while they decline by 0.1 and 0.6 per cent, respectively, in the non-agricultural sector. Within agriculture, labour and capital demand increased the highest in the wheat sector where demand for labour rose by 47 per cent and demand for capital increased by 46.6 per cent. Value added at factor cost and factor incomes also increase the most in the wheat sector where these increased by 47 per cent each above base year levels. Higher levels of world prices meant higher increase in the return for agricultural land relative to returns to other factors. Compared to base year levels, return to agricultural land increases by 22.3 per cent.

In summary, the effect of the 1994 URA on Canadian agriculture could be either negative or positive depending on which set of world price changes were simulated, together with the domestic policy changes. A further inquiry was therefore of interest to determine the "break-even" world price changes, defined as the magnitude of price changes which, together with the domestic policy changes under consideration, would generate unchanged levels of production from the base period. A Walrasian tatonnement-type procedure was applied to the CGE model of the Canadian economy to determine these "break-even" world price changes.

If the world prices of crops and processed foods alone were to adjust, a 10.8 per cent rise in the world price of Canadian wheat would be required to offset the negative effect of the domestic policy changes on Canadian wheat producers. Likewise, the world price of other grains would have to increase by 10.6 per cent, while those of other agriculture and processed foods would have to increase by 3.9 and 2.5 per cent, respectively, to counterbalance the effects of the policy changes on producers in the respective sectors according to the chosen criterion.

The computed "break-even" price changes are in general closer to the minimum than the maximum world price changes. The implication of this is that if equal probability is given to the occurrence of the minimum and " maximum" world price changes, the farm sector in aggregate has gained from the URA. Recent OECD (1996) estimates of the actual world price changes conform with the maximum increases thus validating the above conclusion.

An additional experiment involved the determination of "break-even" world price changes for all crop and non-crop agricultural products and processed food products. It was found that the highest "break-even" price change -- 13 per cent -- would be required for milk and poultry. The world price of Canadian wheat would have to increase by 10.9 per cent, while those of other grains, fruits and vegetables, livestock, other agriculture, and processed food would have to rise by 10.3, 2.6, 5.9, 1.9, 2.3 per cent, respectively, to offset the impacts of the domestic policy changes arising from the URA for agriculture.

Another area of interest in this thesis was the determination of the relative importance of the effects of the three policy changes on Canadian agriculture. Consequently, the three domestic policy changes -- tariff reduction, export subsidy reduction, and domestic support reduction -- were simulated separately. As far as domestic production was concerned, the results of the separate simulation experiments show that agricultural and processed food producers are "better off" (either less "worse off" or directly "better off") with tariff reduction than with the other two policy changes. Domestic support programs are considerably more important to agricultural producers than are export subsidies. Agricultural exports are also more discouraged by reductions in domestic support than reductions in export subsidy.

In agriculture, the demand for labour and capital are most affected by the reductions in domestic support and least affected by the reductions in tariffs. In terms of both domestic production, and the demand for mobile factors, the effects of domestic support reduction are the strongest in the other grains and wheat sectors, in that order. Each of the policy changes result in a fall in the demand for agricultural land in the wheat sector. Tariff reductions also lead to a fall in the demand for agricultural land in the milk and poultry sector. Export subsidy reduction result in lower demand for agricultural land in the other grains sector, as does the reduction in domestic support. More intersectoral reallocation of agricultural land takes place due to reduction in domestic support than in response to any other UR-related policy change. Regarding value added at factor cost and factor incomes, the least negative or the most positive impact comes from tariff reductions. The opposite is true of domestic support reductions.

A number of considerations might qualify the results cited above. For example, it could be argued that export subsidy reductions such as the "Crow benefit" subsidy on rail rates for grains moved to export points would have been made by the government for budgetary reasons, regardless of the Uruguay Round Agreement. The implication of this is that the "pure" effect of the URA should not include the effects of export subsidy reductions. These effects were excluded (or netted out) by first simulating the export subsidy reductions alone and using the results obtained as base levels for the simulation of the reductions in tariffs and domestic support and increases in world prices. The exclusion of the effects of export subsidy reductions under the assumption of minimum changes in world prices is noticeably important only for the wheat and other grains sectors. In these two sectors, the pure effect of the URA is such that production declines by 4.42 and 2.34 per cent less, respectively, than when export subsidy reductions are attributed to the URA. Similarly, exports of wheat and other grains decline by 3 and 9.8 per cent less, respectively. The exclusion of the effects of export subsidy reductions has some effect on the imports of wheat and other grains but not on the imports of other products. Imports of wheat and other grains increased by 6.5 and 3.2 per cent less, respectively. Total agricultural output and total agricultural exports decline by about one and 3.3 per cent less, respectively.

The pure effect of the URA under the assumption of maximum increases in world prices is such that the production and export of wheat increase by 3.5 and five per cent more while the imports of wheat decline by two per cent more than the case where the reductions in export subsidies were attributed to the URA. Similarly, the output and exports of other grains increase by 10.6 and 23.7 per cent more, respectively, while the decline in imports of other grains is 3.6 per cent greater than if the reductions in export subsidies were netted out from the overall effect of the URA. Agricultural production increases by 1.73 per cent more when the effects of the reductions in export subsidies were excluded than when they are not.

With the assumption of maximum increases in world prices, labour and capital demand increase in the wheat sector, respectively, by 12 and 5 per cent more under the "pure" effect of the URA than is the case when the reductions in export subsidies are attributed to the URA. In the other grains sector, labour and capital demand each increase by 5 per cent more when the effects of export subsidies are netted out than otherwise. The demand for agricultural land increases in the other grains sector with the exclusion of the effects of export subsidy reductions and the assumption of "maximum" increases in world prices and decline in the remaining agricultural sectors relative to the case when the effects of export subsidy reductions are not netted out.

Factor incomes, and hence sectoral value added at factor cost improve somewhat in all agricultural sectors with the exclusion of the effects of export subsidy reduction relative to when these effects are incorporated, but noticeably so only in the wheat and other grains sectors. In these two sectors, value added improves by 5.1 and 11.8 per cent, respectively. Total agricultural value added at factor cost improves by 2.8 per cent if the reductions in export subsidies were not attributed to the URA than otherwise. These improvements tend to increase as world prices increase.

A second consideration that could potentially qualify the basic simulation results is the redesigning of domestic support programs as "green" programs. The Canadian government has already taken measures in this direction mainly due to budgetary reasons and to avoid countervailing actions from the U.S.. In this study, this issue was handled by introducing a lump sum compensatory transfer from government to households of the dollar amount of the commitment reduction in domestic support.

Under the assumption of minimum increases in world prices, such compensation improves agricultural household incomes by close to 13 per cent relative to the "no-compensation" scenario. The other noticeable effect occurs in private consumption and imports of agricultural products where compensatory transfers improve the first by 0.14 per cent and the second by 0.12 per cent relative to the case when no compensatory transfers are simulated. Since the compensatory transfers are introduced into the model as non-production inducing, the effects on domestic output, input allocation, and value added are virtually zero. The above outcomes are not affected by our assumption regarding the magnitude of the increases in world prices. Agricultural household incomes alone improve by half a per cent more with the assumption of maximum world price changes than the levels under the minimum world price change assumption.

A third consideration involved a test for sensitivity of the model with respect to the model elasticity parameters. This test was conducted by altering the values of these parameters and observing the changes in the comparative static results. Import and export levels are moderately sensitive to the choice of the values of the elasticity parameters. The conclusion from the test is that if the "true" values of the various elasticities were found to be smaller than those used in the model, the comparative static results of imports and exports reported would be overstatements of the true outcomes, and vice versa.

The last chapter of the thesis dealt with a recursive dynamic analysis of the effects of the UR agreement on Canadian agriculture. This analysis is in accord with the gradual rather than instantaneous aspects of the URA, which requires signatories only to phase-in, the commitments of changes in trade distorting policies over a period of six years, between 1995 and 2001. In solving the CGE model sequentially (or recursive-dynamically) over the six-year period, total labour supply, the capital stock, and sectoral total factor productivity were updated each year. The simulations of the annually updated factor supplies and total factor productivities over the six years then constituted the base case run whose results served as base scenarios for subsequent experiments in which the phased-in changes in policies and world prices over the six-year period were assessed.

This set of results shows that the assumptions regarding the magnitude of the increases in world prices determine the traces of the recursive dynamic results over the six-year period. For example, under the assumption of minimum increases in world prices, the highest growth of exports occurs in the other agriculture sector, while under maximum increases in world prices the greatest export growth takes place in the wheat sector. With minimum world price changes, aggregate agricultural exports remain below the base year level until the beginning of the sixth year; only then do aggregate agricultural exports exceed the base level by a small margin. With maximum increases in world prices, however, aggregate agricultural export rises at the rate of 3.7 per cent per annum and, by the end of the projection period, these are 29 per cent above the base year level. The traces (trends) of exports under the two assumptions of world price changes are, largely, reflected back on the traces of domestic production. Under the assumption of maximum increases in world prices, agricultural production increases at the rate of 2.5 per cent per annum reaching a level 18.7 per cent higher by the end of the projection period than in the base year period.

Like most other variables, sectoral factor demands too behave differently over the projection period depending on the assumption about the magnitude of the changes in world prices. For example, labour demand declines below base level in all but the non-agricultural sectors under the assumption of minimum world price increases. With maximum increases in world prices, however, the demand for labour remains above base period levels in the crops sectors as well. With maximum increases in world prices, the demand for each of the primary factors -- labour, capital, and agricultural land -- increases the most in the wheat sector. By the end of the projection period, the demand for these factors reaches 16.6, 29.8, and 12.4 per cent above the base year levels, respectively. Similarly, if minimum increases in world prices were assumed, the demand for labour, capital, and agricultural land declines the most in the wheat sector. Under this scenario, the demand for labour, capital and agricultural land in the wheat sector decline by 17.3, 7.5, and 5.9 per cent, respectively, by the end of the projection period compared to the base year levels. Under the assumption of minimum increases in world prices, sectoral value added declines in most of the agricultural sectors while under the assumption of maximum increases in world prices, value added is above base year level in all sectors throughout the projection period.

Overall, the various simulation results indicate that the Uruguay Round Agreement has differential effects on the different sectors. The non-crop agricultural sectors are unlikely to gain from the agreement. The crop sectors in general and the wheat sector in particular are likely to gain from the agreement if the signatories of the agreement implement the policy changes. However, the recursive dynamic results indicate that any potential gain is likely to occur only after half way into the six-year implementation period.

Future Research Directions: In accordance with the scope of the study, changes in domestic farm programs which are not directly connected to the UR agreement were not simulated even if these changes were undertaken after the UR agreement and have important implications to the Canadian agriculture. The inclusion of such, if any, changes is one area of future research. Since the focus in this study is the agriculture sector, the non-agriculture sector has been represented only by two sectors -- the food processing sector and a highly aggregated rest of economy sector. One disadvantage of this representation was that the macro variable results might have been dominated by the magnitude of the changes in the rest of the economy sector. A further disaggregation of the rest of the economy sector is one area of improvement in future research. Data refinement, particularly in relation to the input-output table is likely to remain a preoccupation in future research. In future research, the application of a dynamic general equilibrium model of the Canadian economy can overcome some of the criticisms of the recursive dynamic model which is used in the last chapter of this study.

REFERENCES

Adelman, I. and S. Robinson (1978). *Income Distribution Policy in Developing Countries: A Case Study of Korea*. Stanford, CA: Stanford University Press.

Adelman, I. and S. Robinson (1986). "U.S. Agriculture in a General Equilibrium Framework: Analysis With a Social Accounting Matrix." *American Journal of Agricultural Economics*. 68: 1196-1207.

Adelman, I. and S. Robinson (1988). "Macroeconomic Shocks, Foreign Trade, and Structural Adjustment: A General Equilibrium Analysis of the U.S. Economy, 1982-1986." In: C. Carter and W. Gardiner (eds.), *Elasticities in International Agricultural Trade*. Boulder, CO: Westview Press.

Agriculture and Agri-Food Canada (1993). "GATT and Agriculture". Fact sheet.

Ahmadi-Esfahani, F.Z. (1989). "Estimation of Price Elasticities of Export Demand for Canadian and U.S. Wheat: A non-traditional Approach." *Canadian Journal of Agricultural Economics* 37: 173-190.

Alston, J. M., R. Gray, and D.A. Summer (1994). "The Wheat War of the 1994." *Canadian Journal of Agricultural Economics* 42: 231-251.

Alberta Agriculture (1995). "GATT/WTO Implications for the Agri-Food Sector in Alberta." Unpublished.

Anderson, K. and R. Tyers (1988). "Liberalizing OECD Agricultural Policies in the Uruguay Round: Effects on Trade and Welfare." Reprinted Series No. 379, Institute for International Economic Studies, (Reprinted from *Journal of Agricultural Economics* vol. 39, may, 1988).

Armington, P. S. (1969). "A Theory of Demand for Products Distinguished by Place of Production." *IMF Staff Papers* 16: 159-176.

Arrow, K and Hahn, F (1971) *General Competitive Analysis*. San Francisco: Holden-Day, Inc.

Bailey, K. (1987). "A Structural Econometric Model of the Canadian Wheat Sector." Technical Bulletin, No. 1733, ERS, USDA.

Baker, D., M. Hallberg, and D. Blandford (1989). "U.S. Agriculture Under Multilateral and Unilateral Trade Liberalization -What the Models Say." Paper A.E & R.S 200, Department of Agricultural Economics and Rural Sociology, The Pennsylvania State Univ. Park, PA.

Boadway, R. and J. Treddenick (1978). "A General Equilibrium Computation of the Effects of the Canadian Tariff Structure." *Canadian Journal of Economics* 11 (3): 424-446.

Brooke, A., D. Kendrick, A. Meeraus (1988). *GAMS: A Users guide*. New York: The Scientific Press.

Brooks, H. and D. Kraft (1994). "The 1994 Uruguay round GATT Agreement and the Canadian Grains and Oilseeds Industry." Unpublished.

Burniaux, J.M., and J. Waelbrock (1985). "The Impact of the CAP on Developing Countries: A General Equilibrium Analysis." In: C. Stevens and J. Verloren Van Themaat, Pressure *Groups, Policies and Development*. London: Hodder and Stoughton.

Burniaux, J.M., F. Delorme, I. Lienert, J.P. Martin, and D. Van der Mensbrugghe (1989). "A Economy-Wide Effects of Agricultural Policies in OECD Countries: Final Results." Economics and Statistics Department, OECD, Paris.

Burniaux, J.M., F. Delorme, I. Lienert, and J.P. Martin (1990). "Walras: A Multi-sector, Multi-country Applied General Equilibrium Models for Quantifying the Economy-wide Effects of Agricultural policies." *OECD Economic Studies*. 13: 205-236.

The Canadian Wheat Board (1992). "Examining the Competitiveness of the Canadian Grain Industry." Unpublished

The Canadian Wheat Board (1993). "The Winds of Change: Challenge and Opportunity." Annual Report, 1992-93.

Cahill, S. (1991). "Implications for Canada of One Possible Uruguay Round Outcome: Results From a Multi commodity Analysis With Trade Analysis Simulation System (TASS)." Working Paper 10/91, Policy Branch, Agriculture Canada.

CARD-FAPRI (1994). *Implications of the Uruguay Round for Agriculture, World Agriculture in a Post-GATT Environment*.

Carter, C. A., D. Blandford, and R. Piggott (eds.) (1993). *North-South Grain Markets and Trade Policies*. San Francisco: Westview Press.

de Janvry, A. and E. Sadoulet (1987). "Agricultural Price Policy in General Equilibrium Models: Results and Comparisons." *American Journal of Agricultural Economics*. 69: 230-245.

Dervis, K., J. de Melo, and S. Robinson (1982). *General Equilibrium Models for Development Policy*. New York: Cambridge University Press.

Dixon, P.B., B.R. Parmenter, J. Sutton, and D.P. Vincent (1982). *ORANI: A Multisectoral Model of the Australian Economy*. Amsterdam: North-Holland.

FAO (1993). *Cartel Policies Review 1992-93*. Commodities and Trade Division, FAO, U.N.

Fischer, G, K. Frohberg, M. Keyzer, and K. Parikh (1988). *Linked National Models: A Tool For International Food Policy Analysis.* Boston: Kluwer Academic Publishers, for the international Institute of Applied Systems Analysis.

Francois, J., and K. Reinert (eds.) (1994). *Applied Methods for Trade Policy Modelling*. Cambridge: Cambridge University Press.

Frohberg, K. (1989) "Economy wide Effects of a Multilateral Trade Liberalization in Agriculture by Industrialized Market Economies on Canada, Japan, and the European Communities." Working Paper 88-WP 40, Centre for Agricultural and Rural Development (CARD), Iowa State University, Ames, Iowa.

Fulton, M., K. Rosaasen, A. Schmitz (1989). *Canadian Agricultural Policy and Prairie Agriculture*. Economic Council of Canada, Ottawa.

Gardner, B. (1988). "Some Recent Studies of Agricultural Trade Liberalization." Invited Paper, XX International Conference of the IAAE, Buenos Aires, Argentina, Aug. 24- 31.

Gleckler, J. and L. Tweeten (1994). "The Economics of Grain Producer Cartels." Working Paper No. 94-1, IATRC.

Government of Canada (1994). "The Uruguay Round of the General Agreement on Tariffs and Trade, An Assessment of the Economic Impact on Canada." The Federal Finance Department, August.

Gunning, J.W., and M.A. Keyzer (1995). "Applied General Equilibrium Models for Policy Analysis." *Handbook of Development Economics*, Vol. 3A: 2025-2107.

Guzel, H.A. (1990). "Effects of Exchange Rate Changes on Canadian Agriculture: A General Equilibrium Analysis." A Ph.D Thesis, Department of Agricultural Economics, University of Saskatchewan.

Haley, S.L. (1989). *Using Producer and Consumer Subsidy Equivalents in the SWOPSIM Modelling Framework.* USDA, ERS Staff Report No. AGES 89-11, Washington, D.C..

Hansen. B (1970). *A Survey of General Equilibrium Systems*. Economic Handbook Series, McGraw-Hill Book Company, New York

Hathaway, D. (1994). "The Treatment of Agriculture in the Uruguay Round: Matching Expectations With Reality." Unpublished Paper.

Hertel, T. (1993). "A Partial Vs General Equilibrium Analysis of Trade Policy Reform." *Journal of Agricultural Economics Research* 44 (3): 3-15.

Horner, G.L., J. Corman, R.E. Howitt, C.A. Carter, and R.J. MacGregor (1992). "The Canadian Regional Agriculture Model Structure." Technical Report 1/92, Policy Branch, Agriculture Canada.

Ingco, M.D. (1994). "How Much Agricultural Liberalization was Achieved in the Uruguay Round?" Paper Prepared for Presentation to the Annual Conference of the IATRC, Washington D.C., Dec. 15-16, Unpublished.

The International Agricultural Trade Research Consortium (IATRC) (1994). "The Uruguay Round Agreement on Agriculture: An Evaluation." Commissioned Paper No. 9.

The International Wheat Council (1995). "Grain Market Report." London, England. March

Johansen, L. (1960). *A Multi-sectoral Study of Economic Growth.* Amsterdam: North-Holland Publishing Company.

Krugman, P. (1992). "Does the New Trade Theory Require a New Trade Policy?" *The World Economy.* 15(4): 423-24.

Leontief, W. W (1941). *The Structure of the American Economy, 1919-1939.* First Edition. New York: Oxford University Press.

Lysy, F.J. and L. Taylor (1980). "The General Equilibrium Income Distribution Model." In: L.taylor, E. Bacha, E. Cardoso, and F.J. Lysy (eds.), *Models of Growth and Distribution for Brazil.* London: Oxford University Press.

Meilke, K.D., and B. Larue (1989). "A Quantitative Assessment of the Impacts of trade Liberalization on Canadian Agriculture." In: *Agriculture in the Uruguay Round of GATT Negotiations: Implications For Canada's and Ontario's Agri-food System.* AEB 89/6, Department of Agricultural economics and Business, Univ. of Guelph, July, 46-74.

Miller, R.E., and P. D. Blair (1985). *Input-output Analysis: Foundations and Extensions,* New Jersey: Prentice-Hall, Inc.

Miller, M.H and J.E. Spencer (1977). "The Static Economic Effects of the U.K. Joining the EEC: A General Equilibrium Approach." *Review of Economic Studies.* February, 44(1): 71-93.

Miner, W.W. (1994). "Agriculture After the Uruguay Round: The New Agenda, The Implications For National Agricultural and Trade Policy: A Canadian Perspective." Paper Presented at IATRC Annual Meeting, Washington, D.C. December 15.

Morishima, M. (1981). *Walras' Economics: A Pure theory of capital and money*; Cambridge: CambridgeUniversity Press.

Narayanan, S., and E. Kizito (1992). "Multifactor Productivity for Canadian Agriculture Update to 1990 With Analysis." Working Paper 1/93, Agriculture Canada Policy Branch.

Organization For Economic Co-operation and Development (1987). *National Policies and Agricultural Trade.* OECD, Paris.

Organization For Economic Co-operation and Development (1993). *Monitoring and Outlook of Agricultural Policies, Markets and Trade.* OECD, Paris.

Organization For Economic Co-operation and Development (1996)*Agricultural Policies, Markets and Trade in OECD Countries, Monitoring and Evaluation 1996, Main Report*, OECD, Paris.

Parikh, K., G. Fischer, K. Frohberg, and O. Gubrandsen (1988). *Towards Free Trade in Agriculture*. International Institute of Applied Systems Analysis, Laxenburg, Austria: Martinus Nijhoff Publishers.

Parmenter, B.R. (1982). "Inter-Industry Analysis: The ORANI Model of Australia's Industrial Structure." In: L.R. Webb and R.H. Allen, *Industrial Economics. Australian Studies.*

Powell, A., and R.H. Snape (1993). "The Contribution of Applied General Equilibrium Analysis to Policy Reform in Australia." *Journal of Policy Modelling* 15 (4) 393-414.

Premakumar, V., K. Oerter, D. Darnell, B. Smith, and W. Meyers (1994). "Uruguay Round Agreement on Agriculture: Summary of Commitments from Selected Country Schedules." GATT Research Paper 94-GATT 22.

The Provincial and Federal Officials (1994). "Impact of the GATT Agreement on Canadian Agriculture and Agri-Food." June.

Pyatt, G., and A. Roe (1977). *Social Accounting for Development Planning with Special reference to Sri Lanka*. Cambridge Univ. Press: Cambridge.

Robinson, S. (1989). "Multisectoral Models." *Handbook of Development Economics*, Vol.2: 885 - 947.

Robinson, S. (1990). "Analysing Agricultural Trade Liberalization With Single Country CGE Models." Working Paper Series, Univ. of Berkeley, Department of Agriculture and Resource Economics, No. 824, Berkeley, CA: California.

Robinson, S., M. Kilkenny, and I. Adelman (1989). "The Effect of Agricultural Trade Liberalization on the U.S. Economy: Projections to 1991." In A. Stoeckel, D. Vincent, and S. Cuthbertson (eds). *Macroeconomic Consequences of Farm Support Policies*. Durham, NC: Duke University Press.

Robinson, S., M. Kilkenny, and K. Hanson (1990). "The USDA/ERS Computable General Equilibrium (CGE)) Model of the United States." Agriculture and Rural Economy Division, ERS, USDA.

Roningen, V.O (1988). "Trade Liberalization Results From ST86." Memorandum to IATRC Symposium Participants, Group II, May 17. ERS, USDA, Washington, D.C..

Roningen, V.O (1991). *Measuring Agricultural Trade Distortions: A Simple Approach*. USDA, ERS Staff Report No. AGES 9145, Washington, D.C..

Roningen, V.O., and P.M. Dixit (1989). *Economic Implications of Agricultural Policy Reform in Industrial Market Economies*. USDA, ERS Staff Report No. AGES 89-36.

Rossmiller, G.E. (1994). "The Impact of GATT on Economists and Vice Versa." Paper Presented at the Annual Meeting of the IATRC, Agriculture After the Uruguay Round: The New Agenda For Trade and Policy Research. December.

Scarf, H (1967). "On the Computation of Equilibrium Prices." In: W. Fellner et al (eds), *Ten Economic Studies in the tradition of Irving Fisher*. New York: Wiley.

Scarf, H. and J.B. Shoven (1984). *Applied General Equilibrium Analysis*. Cambridge: Cambridge University Press.

Shanahan, P. (1994). "What Was Accomplished in the Uruguay Round Agricultural Negotiations?" Paper Prepared for the Annual Meeting of the International Agricultural Trade Research Consortium: Washington, D.C..

Shoven, J.B. and J. Whalley (1992). *Applying General Equilibrium*. Cambridge Surveys of Economic Literature, Cambridge: Cambridge University Press.

Stoeckel, A., D. Vincent, and S. Cuthbertson (eds) (1989). *Macroeconomic Consequences of Farm Support Policies*. Durham, NC: Duke University Press.

Thomassin, P. and A. Andison (1987). "Agriculture Canada's Input-Output Model, Part I:

Disaggregation of the Agriculture Sector of Canada." Agriculture Canada, Policy Branch, Working Paper 6/87. Ottawa: Agriculture Canada.

Toma and Bouma Management Consultants (1995). "Take Action: Agri-Food, GATT/NAFTA Opportunities Guide for AAFRD."

Tweeten, L. (1992). *Agricultural Trade: Principles and Policies*. Westview Press: Boulder San Francisco.

Tyers, R. and K. Anderson (1992). *Disarray in World Food Markets: A Quantitative Assessment*. Cambridge: Cambridge University Press.

Tyers, R. (1994). "Economic Reform in Europe and the Former Soviet Union: Implications for International Food Markets." A Research Report No. 99, IFPRI, Washington, D.C.

Taylor, L. (1975). Theoretical Foundations and Technical Implications." In: C.R. Blitzer, P.B. Clark, and L.Taylor (eds.,) *Economy-wide Models and Development Planning*. London: Oxford University Press.

USDA (1987). *Government Intervention in Agriculture: Measurement, Evaluation, and Implications for Trade negotiations.* ERS Staff Report No. AGES 861216, Washington, D.C., January.

Valdes, A., and J. Zietz (1980). *Agricultural Protection in OECD Countries: Its Costs to Less Developed Countries.* Research Report No. 21, International Food Policy Research Institute, Washington, D.C., December.

Veeman, M.M., and T.S. Veeman (1987). "Export Markets for Western Canadian Wheat: Trends and Market Mix." ARCA Project No. 84-0364, Farming for the Future Research Program.

Veeman, M.M. (1989). "Market Share Competition in World Wheat Markets." Project No. 87- 0119, Farming for the Future Research program.

Veeman, M.M. (1998). "Who Will Sell Western Canada's Grain?" *Canadian Journal of Agricultural Economics.*

Veeman, T.S., A. Fantino (1994). "Empirical Measurement of Multifactor Productivity in Canadian Agriculture." In: S. Narayanan and J. King (eds.), *Measuring Agricultural Productivity and Related Data for Regional, National, and International Comparisons Proceedings*. Ottawa.

Veeman, T.S., A. Fantino, and Y. Peng (1995). "Capital Formation, Technical Change, and Profitability in Prairie Agriculture." Project Report 95-09 AARI Project # 920199.

Walras, L. (1874, 1987) *Elements of d'economie politique pure*. Lausanne: L. Corbaz. English translation of the definitive edition by William Jaffe (1954). *Elements of Pure Economics*. London: Allen and Unwin.

Wang, Z. (1997). "The Impact of China and Taiwan Joining the World Trade Organization on US and World Agricultural Trade: A Computable General Equilibrium Analysis." Technical Bulletin No. 1858, ERS, USDA.

Weintraub, E.R. (1979). *Microfoundations: The compatibility of microeconomics and macroeconomics*, Cambridge Survey of Economic Literature, Cambridge: Cambridge University Press.

Whalley, J. (1982). "An Evaluation of the Recent Tokyo Round Trade Agreement Using General Equilibrium Computational Methods." *Journal of Policy Modeling*. November, 4(3): 341-61.

Young, L., M. Merchant, and A. McCalla (1991). "The Political Economy of Agricultural Trade." ERS, Agriculture and Trade Analysis Division, USDA.

Appendix 2.1 Model Equations, Definition and Specification.

The following are definitions and specifications of all the equations that make up the CGE model. In the equations, lower case letters are used for parameters and indices, while upper case letters are used for endogenous variables. The GAMS program follows certain conventions in writing equations, indicating indices, and naming or identifying variables. These conventions were followed in writing the following program. "SUM" "PROD" stand for the summation and product operators, respectively. Indices are given in parenthesis; The "SUM" and "PROD" operators apply over the index that appears after the left parenthesis following either of these operators. Various types of suffixes are used to identify variables. ".FX" identifies the variable it is suffixed to as fixed; ".L", as a suffix appearing before the solution of the model, denotes an initial guess while after the solution, it denotes the solution value of the variable it is suffixed to.

Notations

Indices:

i, j	sectors
ied	sectors with export demand functions
iedn	sectors with fixed world export prices
f	factors of production
fld	final demand category
incg	income group (LABOR for wage/salary earners, ENTERP for capital owners, and PROP for agricultural land owners).

(Note: where there are sectors that are not exporting or that are not importing, additional indices would be necessary to identify such sectors from the rest. The additional indices are not required here as there are no such sectors in our case)

Parameters:

Production, and supply/demand functions parameters:

ap(i)	Shift parameter for production function
alpha(i, f)	Share parameter in production function
am(i)	Shift parameter in composite good (import-domestic) CES function
delta(i)	CES function share parameter
rhom(i)	CES function exponent
ae(i)	Shift parameter in composite good (export - domestically sold) CET function
elastm(i)	Elasticity of substitution between imports and domestic goods
gamma(i)	CET function share parameter
rhot(i)	CET function exponent
rhoe(i)	Export demand function exponent
elastt(i)	Elasticity of substitution betwn exports and domestic ss in production
econst(ied)	Shift parameter for export demand function
elaste(i)	Price elasticity of domestic demand
wfdist(i,f)	Factor price distortion
io(i,j)	Input output coefficient

imat(i,j)	capital composition matrix
pwm(i)	World price of imports
pwse(ied)	World price of export substitutes
tereal(i)	Real export subsidy rate
tmreal(i)	Real import tariff rate
t_m	Import tariff rate
t_e	Export subsidy rate

Tax/Subsidy rates:

hhtr	Household income tax rate
enttr	enterprise tax rate
itaxin(i)	Indirect tax rate on activities
subsdr(i)	Production subsidy rate
netitaxin(i)	Indirect tax rate minus subsidy rate

Other rates and shares:

depr(i)	Depreciation rate
entsr	Enterprise saving rate
gles(i)	Government expenditure shares
conshr(i)	Household expenditure shares
kio(i)	Share of investment by sector of origin
kish(i)	Shares of investment by sector of destination
dstr(i)	Ratio of inventory investment to domestic output
mps	Household saving rate
fs(f)	Aggregate factor supply

Variables:

Price Variables

EXR	Exchange rate
PINDEX	GNP deflator
PX(i)	Domestic output price
PD(i)	Domestic sales price
P(i)	Price of composite good
PVA(i)	Value added price
PK(i)	Unit price of capital
PE(i)	Export price
PM(i)	Import price
PWE(i)	World price of exports

Production, and Supply/Demand Variables:

E(i)	Exports
FCRDD(i,f)	Factor demand
LABR	Labour input
CAPTL	Capital input
AGLND	Agricultural land input
INT(i)	Intermediate input demand
M(i)	Imports
WF(f)	Average factor price

X(i)	Composite good supply (i.e., the composite of domestic products and imports)
XD(i)	Domestic output
XXD(i)	Domestic sales

Income Variables:

DEPRECIA	Depreciation charges
ENTSAV	Enterprise saving
TEXPSUB	Total export subsidy
ENTTAX	Enterprise tax revenue
NETGOVROW	Net foreign borrowing
FSAV	Foreign savings
NETGOVENT	Government transfer to enterprise
GOVREV	Total government revenue
GOVSAV	Government savings
NETGOVHH	Government transfer to households
HHSAV	Household savings
HHINCTAX	Total household tax revenue
INDTAXIN	Total indirect tax revenue
SUBSD	Total production subsidy
INDTAXOUT	Total tax on finished goods
NETHHROW	Net remittance from abroad
SAVINGS	Total savings
TARIFF	Tariff revenue
YFACTOR(f)	Factor income
YINCG(incg)	Income by income group
YHH	Total household income

Expenditure Variables:

CONSDD(i)	Private consumption demand
ID(i)	Investment goods demand by sector of origin
DK(i)	Investment by sector of destination
DST(i)	Inventory investment by sector
GOVDD(i)	Government consumption demand
GOVTOT	Aggregate government consumption
FXDINV	Fixed capital investment
INVEST	Total investment
GNPVA	Nominal GNP
RGNP	Real GNP

Equations:

Price Equations

P1) $PM(i) = pwm(i) * (1 + t_m(i)) * EXR$

P2) $PE(i) = PWE(i) * (1 + t_e(i)) * EXR$

P3) $P(i) = (PD(i) * XXD(i) + PM(i) * M(i)) / X(i)$

P4) $PX(i) = (PD(i) * XXD(i) + PE(i) * E(i)) / XD(i)$

P5) PVA(i) = PX(i) * (1 - itaxin(i) + subsdr(i)) - sum(j, io (j,i) * P(j))

P6) PINDEX = GNPV / RGNP

where, X(i) = XD(i) - E(i) + M(i) = XXD(i) + M(i)

XXD(i) = XD(i) - E(i)

Production, and Supply/Demand Equations

Q1) XD(i) = ap(i) * PROD(f, FCRDD(i, f) **alpha(i,f))

Q2) XD(i) = ae(i)*[gamma(i) *E(i)**rhot(i) + (1 gamma(i))*
XXD(ie)**rhot(i)]**(1/rhot(i)

Q3) E(i) = XXD(i) * [((1-gamma(i)) /gamma(i)) * (PD(i) / PE(i))] **(1/(rhot(i)-1))

Q4) E(ied) = econst(ied) * (PWE(ied) / pwse(ied))**(-rhoe(ied))

Q5) X(im) = am(i) * [delta(i) *M(im)**(- rhom(i))
+ (1 - delta(i))*XXD(im)**(- rhom(i))] **(-1/rhom(i))

Q6) M(im) = XXD(im) * [(delta(i) / (1 - delta(i)) * (PD(im) / PM(im))]**(1/(1+rhom(i))

Q7) WF(f) * wfdist(i, f) = PVA(i) * alpha(i, f) * XD(i) / FCRDD(i, f)

Q8) INT(i) = SUM(j , io(i , j) * XD (j))

Income Equations

Y1) YFACTOR(f) = SUM(i, WF(f) * wfdist(i,f) * FCRDD(i, f))

Y2) YINCG("LABOR") = YFACTOR("LABR"), where LABR stands for labour.

Y3) YINCG("ENTERP") = YFACTOR("CAPTL") + GET - ESAV - ETAX - DEPR

Y4) YINCG("PROP") = YFACTOR("AGLAND")

Y5) YHH = SUM(incg, YINCG(incg)) + NETGOVHH + NETHHROW* EXR

Y6) TARIFF = SUM(i, t_m(i) * pwm*M(i))*EXR

Y7) INDTAXIN = SUM (i, itaxin(i) * PX(i) * XD(i))

Y8) TEXPSUB = SUM(i, t_e (i) * PWE(i)* E(i)) * EXR

Y9) DEPRECIA = SUM(i, DEPRI(i) * PK(i)* FCRDD(i, "CAPTL"))

Y10) ENTTAX = enttr * (YFACTOR("CAPTL") - DEPRECIA + NETGOVENT +
NETENTROW * EXR)

Y11) HHINCTAX = hhtax * YHH

Y12) ENTSAV = entsr * (YFACTOR("CAPTL") + NETGOVENT - ENTTAX - DEPRECIA
+ NETENTROW * EXR

Y13) HHSAV = mps * YHH * (1 - hhtax)

Y14) GOVREV = TARIFF + INDTAXIN + INDTAXOUT + HHINCTAX + ENTTAX +
NETGOVROW * EXR

Y15) SAVINGS = HHSAV + ENTSAV + GOVSAV + DEPRECIA + (FSAV*EXR)

Expenditure Equations

E1) P(i) * CONSDD(i) = (conshr(i)* (1 - mps)* (1 - hhtr) *YHH) /(1 + itaxout("CONS"))

E2) P(i)*GOVDD(i) = gles(i) * GOVTOT

E3) DST(i) = dstr(i) * XD(i)

E4) FXDINV = INVEST - SUM (i, DST(i) * P(i))

E5) PK(i) DK(i) = kish(i) * FXDINV

E6) ID(i) = kio(i) * FXDINV

E7) GNPVA = SUM (i, PVA(i) * XD(i)) + INDTAXIN - SUBSD + TARIFF - TEXPSUB

E8) RGNP = SUM(i, CONSDD(i) + DST(i) + ID(i) + GOVDD(i))
+ SUM(1 - tereal(i) * E(i)) - SUM(i, (1 - tmreal(i) * M(i))

Euilibrium Equations (or System Constraints)

S1) X(i) = INT(i) + CONSDD(i) + GOVDD(i) + ID(i) + DST(i)

S2) SUM(i, FCRDD(i, f)) = fs(f)

S3) GR = GOVTOT + GOVSAV + TEXPSUB + NETGOVENT + NETGOVHH

S4) SUM (i, pwm(i) * M(i)) = SUM (i, PWE(i) * E(i) + FSAV + NETHHROW +
NETENTROW + NETGOVROW

S5) SAVINGS = INVEST

Macroeconomic Closure

M1) FSAV = fsav
M2) NETHHROW = nethhrow
M3) NETGOVROW = netgovrow
M4) NETENTROW = netentrow
M5) NETGOVENT = netgovent
M6) NETGOVHH = netgovhh
M7) GOVTOT = govtot
M8) PINDEX = pindex
M9) PWE(iedn) = pwe(iedn)

Appendix 2.2. GAMS Program for the Canada-Specific CGE Model

```
$TITLE: CGE MODEL FOR CANADA WITH EMPHASIS ON AGRICULTURE
$OFFSYMLIST OFFSYMXREF OFFUPPER

* In developing the following program Robinson et al (1990) has been used extensively.

* BASE YEAR 1991


*SET DECLARATION

SETS
 I SECTORS / wheat            wheat sector
             othergrains      small grains and oilseeds
             fruitveg         fruits and vegetables
             lvstk            cattle hogs livestock combination
             milkpoult        milk and poultry
             otherag          other agriculture
             food             food industry
             restec           rest of economy /

 F  FACTORS OF PRODUCTION        / labr     labour
                                   captl    capital
                                   aglnd    agricultural land /


 FLD  FINAL DEMAND CATEGORY      / cons     private consumption demand
                                   inv      total investment demand
                                   gov      government cons demand
                                   exp      total exports demand/

 INCG  INCOME GROUPS        / labor    labour
                              enterp   enterprise owners
                              prop     land owners/

HH    HOUSEHOLD TYPES       /aghh    agricultural households
                             naghh   non agric'l households /

* SUBSET DEFINITION
 AG(I)        AG SECTORS          /wheat, othergrains, fruitveg, lvstk, milkpoult,
                                   otherag/
 NAG(I)       NON AG SECTORS


 IED(I)          SECTORS WITH EXPORT DEMAND EQUATION
 IEDN(I)         SECTORS WITH NO EXPORT DEMAND EQUATION
```



```
* SUBSET DEFINITION
IED(I)          SECTORS WITH EXPORT DEMAND EQUATION
IEDN(I)         SECTORS WITH NO EXPORT DEMAND EQUATION
```

```
ALIAS(I,J) ;
*## for SAM
SETS  ISAM CATEGORIES  /COMMODITY, ACTIVITY, LABOUR, CAPITAL,
                LAND, ENTERPRISE, HOUSEHOLDS, GOVT,
                CAPACCOUNT, WORLD, TOTAL/
   ISAM1(isam)     /TOTAL/
   ISAM2(isam) ;
   ALIAS(isam2,isam3) ;
   PARAMETER SAM(isam,isam)  SOCIAL ACCOUNTING MATRIX ;
   isam2(isam) = NOT isam1(isam) ;

PARAMETERS
*### READ IN PARAMETERS AS RATES, SHARES, ELASTICITIES
*#### PARAMETER ASSIGNMENT

 CONSHR(i)      HOUSEHOLD CONSUMPTION SHARES
 DEPR(i)        DEPRECIATION RATES
 TR(i)          RATIO OF INVENTORY INVESTMENT TO GROSS OUTPUT
 ENTSR          ENTERPRISE SAVING RATE
 ENTTR          ENTERPRISE TAX RATE
 GLES(i)        GOVT CONSUMPTION SHARES
 HHTR           HOUSEHOLD TAX RATE
 ITAXIN(i)      INDIRECT TAX RATE ON ACTIVITIES
 ITAXOUT(fld)   INDIRECT TAX RATE ON FINAL DEMAND GOODS
 KIO(i)         SHARE OF INVESTMENT BY SECTOR OF ORIGIN
 KISH(i)        SHARE OF INVESTMENT BY SECTOR OF DESTINATION
 ELASTM(i)      ELASTICITY OF SUBSTITUTION BETW IMPORTS AND DOM GOODS
 ELASTT(i)      ELASTICITY OF SUBSTITUTION BETW EXP AND DOM SS IN PRODUCTION
 ELASTE(i)      EXPORT DEMAND ELASTICITY
 RHOM(i)        ARMINGTON FUNCTION EXPONENT
 RHOT(i)        CET FUNCTION EXPONENT
 RHOE(i)        EXPORT DEMAND PRICE ELASTICITY
 SUBSDR(i)      PRODUCTION SUBSIDY RATE
 NETITAXIN(i)   NET INDIRECT TAX RATE ON ACTIVITIES (IND. TAX RATE LESS SUBSD.)
 TE(i)          EXPORT SUBSIDY RATE
 TM(i)          IMPORT TARIFF RATE
 SUMGLES        SUM OF GOVT CONSUMPTION SHARES
 SUMKIO         SUM OF CAP INVESTMENT BY SECTOR OF ORIGIN
 SUMKISH        SUM OF CAP INVESTMENT BY SECTOR OF DESTINATION
 SUMCONSHR      SUM OF PRIVATE CONSUMPTION SHARE

*## READ IN FOR INITIALIZATION OF VARIABLES

 CONSDD0(i)     PRIVATE CONSUMPTION DEMAND BY SECTOR
 GOVDD0(i)      GOVERNMENT CONSUMPTION DEMAND BY SECTOR
 DK0(i)         INVESTMENT BY SECTOR OF DESTINATION
 ID0(i)         INVESTMENT BY SECTOR OF ORIGIN
 ENTTAX0        TAX REVENUE FROM ENTERPRISE
 ENTSAV0        ENTERPRISE SAVINGS
 EXR0           EXCHANGE RATE
 E0(i)          EXPORTS
 FSAV0          NET FOREIGN SAVINGS
```

GOVTOT0	TOTAL VOLUME OF GOVERNMENT CONSUMPTION
GOVSAV0	GOVERNMENT SAVINGS
HHSAV0	HOUSEHOLD SAVINGS
INVEST0	TOTAL INVESTMENT
M0(i)	IMPORTS
MPS0	HOUSEHOLD MARGINAL PROPENSITY TO SAVE
PD0(i)	DOMESTIC GOODS PRICE
PE0(i)	DOMESTIC PRICE OF EXPORTS
PINDEX0	GNP DEFLATOR
PM0(i)	DOMESTIC PRICE OF IMPORTS
HHINCTAX0	TOTAL HOUSEHOLD INCOME TAX
NETENTROW0	TRANSFER FROM ENTERPRISE TO NON-RESIDENTS
NETGOVROW0	NET FOREIGN TRANSFER FROM GOVERNMENT
NETGOVHH0	TRANSFER FROM GOVT TO HOUSEHOLDS
NETGOVENT0	TRANSFER FROM GOVT TO ENTERPRISES
NETHHROW0	TRANSFER FROM HOUSEHOLDS TO NON-RESIDENTS
XD0(i)	VOLUME OF DOMESTIC OUTPUT

*##COMPUTED PARAMETERS FOR INITIALIZATION OF VARIABLES

DEPRECIA0	TOTAL DEPRECIATION EXPENDITURE
FD0(f)	AGGTEGATE FACTOR DEMAND
FS0(f)	AGGREGATE FACTOR SUPPLY
INT0(i)	INTERMEDIATE INPUT DEMAND
P0(i)	PRICE OF COMPOSITE GOOD
PK0(i)	CAPITAL GOOD PRICE BY SECTOR OF DESTINATION
PVA0(i)	VALUE ADDED PRICE BY SECTOR
PWM(i)	WORLD MARKET PRICE OF IMPORTS
PWE0(i)	WORLD PRICE OF EXPORTS
PWSE(i)	WORLD PRICE OF EXPORT SUBSTITUTE
PX0(i)	AVERAGE OUTPUT PRICE
SUBSIDY0(i)	PRODUCTION SUBSIDY BY SECTOR
SUBSD0	TOTAL PRODUCTION SUBSIDY
INTAXIN0(i)	INDIRECT TAX ON PRODUCTION BY SECTOR
INDTAX0	TOTAL INDIRECT TAX REVENUE
EXPSUB0(i)	EXPORT SUBSIDY BY SECTOR
TAR0(i)	TARIFF REVENUE BY SECTOR
TARIFF0	TOTAL TARIFF REVENUE
TEXPSUB0	TOTAL EXPORT SUBSIDY
WFDIST(i,f)	FACTOR PRICE DISTORTION MEASURES
WF0(f)	AGGREGATE AVERAGE FACTOR PRICE
XXD0(i)	VOLUME OF DOMESTIC SALES
X0(i)	VOLUME OF COMPOSITE GOOD SUPPLY
YFACTOR0(f)	TOTAL FACTOR INCOME
YFSECT0(i)	FACTOR INCOME BY SECTOR
YINCG0(INCG)	TOTAL INCOME BY INCOME GROUP
YHH0	TOTAL HOUSEHOLD INCOME

*## COMPUTED PARAMETERS AS RATES, SHARES

TEREAL(i)	REAL EXPORT SUBSIDY RATE
TMREAL(i)	REAL TARIFF RATE
AM(i)	ARMINGTON FUNCTION SHIFT PARAM

AP(i)	PRODUCTION FUNCTION SHIFT PARAM
ALPHA(i,f)	PRODUCTION FUNCTION FACTOR SHARE PARAM
AE(i)	CET FUNCTION SHIFT PARAM
DELTA(i)	ARMINGTON FUNCTION SHARE PARAM
ECONST(i)	EXPORT DEMAND CONSTANT
GAMMA(i)	CET FUNCTION SHARE PARAM
PWTS(i)	PRICE INDEX WEIGHTS
QD(i)	DUMMY VARIABLE FOR COMPUTING AP(i)
RMD(i)	RATIO OF IMPORTS TO DOMESTIC SALES

*####### PARAMETER ASSIGNMENT

TABLE IO(i,j) INPUT-OUTPUT COEFFICIENTS

	WHEAT	OTHERGRAINS	FRUITVEG	LVSTK
WHEAT	0.003212	0.010192	0.000712	0.046195
OTHERGRAINS	0.004333	0.013748	0.000951	0.062985
FRUITVEG	0.000184	0.000584	0.000041	0.002642
LVSTK	0.006634	0.021052	0.001111	0.123071
MILKPOULT	0.001324	0.004197	0.000278	0.021228
OTHERAG	0.012289	0.038993	0.002746	0.174958
FOOD	0.006235	0.019331	0.002241	0.143471
RESTEC	0.573076	0.597114	0.266638	0.289802

+	MILKPOULT	OTHERAG	FOOD	RESTEC
WHEAT	0.037900	0.003449	0.011444	0.000043
OTHERGRAINS	0.050239	0.004702	0.011195	0.000105
FRUITVEG	0.002185	0.000197	0.006990	0.000326
LVSTK	0.041382	0.009174	0.088750	0.000105
MILKPOULT	0.017656	0.001604	0.116640	0.000161
OTHERAG	0.147383	0.013064	0.006418	0.000497
FOOD	0.180077	0.014070	0.160169	0.007127
RESTEC	0.322409	0.382961	0.282946	0.470190

;

TABLE IMAT(i, j) CAPITAL COMPOSITION MATRIX

	WHEAT	OTHERGRAINS	FRUITVEG	LVSTK
WHEAT	0.009377	0.000000	0.000000	0.000000
OTHERGRAINS	0.000000	0.010032	0.000000	0.000000
FRUITVEG	0.000000	0.000000	0.011395	0.000000
LVSTK	0.000000	0.000000	0.000000	0.074311
MILKPOULT	0.000000	0.000000	0.000000	0.000000
OTHERAG	0.000000	0.000000	0.000000	0.000000
FOOD	0.000000	0.000000	0.000000	0.000000
RESTEC	0.990623	0.989968	0.988605	0.925689

+	MILKPOULT	OTHERAG	FOOD	RESTEC
WHEAT	0.000000	0.000000	0.000000	0.000000
OTHERGRAINS	0.000000	0.000000	0.000000	0.000000
FRUITVEG	0.000000	0.000000	0.000000	0.000000
LVSTK	0.000000	0.000000	0.000000	0.000000
MILKPOULT	0.027050	0.000000	0.000000	0.000000
OTHERAG	0.000000	0.042771	0.000000	0.000000
FOOD	0.000000	0.000000	0.255774	0.000000
RESTEC	0.972950	0.957229	0.744226	1.000000

*FACTORS OF PRODUCTION
*LABOUR IN MILLIONS OF LABOUR WEEKS
*CAPITAL IN BILLIONS OF 1991 4
*LAND IN MILLIONS OF ACRES

TABLE FACTORDD(i,f) FACTOR DEMAND BY SECTORS

	LABR	CAPTL	AGLND
WHEAT	0.640493	10.405460	25.823400
OTHERGRAINS	0.947913	13.587590	26.198810
FRUITVEG	0.729671	2.250419	0.624840
LVSTK	1.581050	17.202060	28.163230
MILKPOULT	1.834155	8.906584	7.184091
OTHERAG	1.652776	6.514496	4.148696
FOOD	12.355080	17.173000	0.000000
RESTEC	542.708700	1521.126000	0.000000

;

*FACTOR INCOME IN BILLIONS OF 1991 $
TABLE FACTORY(i,f) FACTOR INCOME BY SECTOR

	LABR	CAPTL	AGLND
WHEAT	0.254564	1.119193	0.365328
OTHERGRAINS	0.376748	0.528968	0.167042
FRUITVEG	0.290008	0.625481	0.047079
LVSTK	0.628388	0.414536	0.103634
MILKPOULT	0.728985	0.954522	0.101398
OTHERAG	0.656896	1.284895	0.255015
FOOD	6.530896	5.949855	0.000000
RESTEC	286.875800	167.581200	0.000000

;

*## PRODUCTION SECTOR PARAMETERS
*QUANTITIES ARE IN BILLIONS
TABLE PRODSECPAR(*,I) SECTORAL QUANTITIES AND PRICES

	WHEAT	OTHERGRAINS	FRUITVEG	LVSTK
E	1.917582	0.880930	0.145337	1.200305
M	0.101910	0.205892	1.383173	0.251928

```
P          1.000000   1.000000   1.000000    1.000000
PD         1.000000   1.000000   1.000000    1.000000
PE         1.000000   1.000000   1.000000    1.000000
PK         1.000000   1.000000   1.000000    1.000000
PM         1.000000   1.000000   1.000000    1.000000
PX         1.000000   1.000000   1.000000    1.000000
XD         3.036075   2.263220   1.307690    6.918177
DK         0.429888   0.561395   0.092976    0.710710
TAR        0.008194   0.008985   0.000280    0.010329
EXPSUB     0.255892   0.080003   0.004184    0.037252
SUBSIDY    0.872293   0.773544   0.094642    0.737151
INTAXIN    0.325508   0.3679581  0.080520    0.529015

  +        MILKPOULT  OTHERAG    FOOD        RESTEC

E          0.211540   0.382053   5.475757    155.151070
M          0.147232   0.355775   6.135167    167.965950
P          1.000000   1.000000   1.000000    1.000000
PD         1.000000   1.000000   1.000000    1.000000
PE         1.000000   1.000000   1.000000    1.000000
PK         1.000000   1.000000   1.000000    1.000000
PM         1.000000   1.000000   1.000000    1.000000
PX         1.000000   1.000000   1.000000    1.000000
XD         5.407422   3.994906   39.790950   934.637900
DK         0.367981   0.269150   1.253400    123.724800
TAR        0.043111   0.001540   0.484407    3.185150
EXPSUB     0.008187   0.010691   0.116961    0.003070
SUBSIDY    1.054720   0.203350   0.293300    9.503300
INTAXIN    0.355444   0.286755   0.364500    42.409000
   ;

*##MISCELLANEOUS PARAMETERS
TABLE PARAM(*,I) TAX RATES AND OTHERS

           WHEAT      OTHERGRAINS  FRUITVEG   LVSTK

DEPR       0.016516   0.016208   0.016932   0.012263
DSTR      -0.017555  -0.022722  -0.022944   0.021782
GLES       0.002719   0.001684   0.000680   0.002496
KIO        0.000032   0.000044   0.000008   0.000415
KISH       0.003374   0.004406   0.000731   0.005578
CONSHR     0.000254   0.000702   0.005424   0.002394

  +        MILKPOULT  OTHERAG    FOOD       RESTEC

DEPR       0.012975   0.015803   0.033634   0.053181
DSTR       0.002629   0.015911   0.009416  -0.007020
GLES       0.000952   0.001862   0.002598   0.987008
KIO        0.000078   0.000092   0.002516   0.996817
KISH       0.002888   0.002112   0.009838   0.971074
CONSHR     0.000634   0.002554   0.068902   0.919136
  ;
```

```
*##INDIRECT TAX RATES ON FINAL DEMAND

TABLE ITAX(*, FLD) INDIRECT TAX RATES ON FINAL DD CATEGORIES

             CONS       INV        GOV        EXP
 ITAXOUT     0.109514   0.041425   0.035159   0.000000
    ;

*### MACRO TOTALS (ABSOLUTE VALUES ARE IN BILL C$)

SCALARS      GOVEMP      /0.512596/ ;
             EXR0         =  1.000000 ;
             PINDEX0      =  1.000000 ;
             MPS0         =  0.077451;
             GOVTOT0      = 40.928000 ;
             INVEST0      = 121.319900 ;

*###TAX
             ENTTAX0      = 15.015000 ;
             HHINCTAX0    = 101.485000 ;

*###TRANSFERS
        NETHHROW0         =  3.5730 ;
        NETENTROW0        = -14.567 ;
        NETGOVHH0         = 152.741 ;
        NETGOVENT0        =  27.301 ;
        NETGOVROW0        = -11.894 ;

*###SAVINGS
        ENTSAV0       = 17.955749 ;
        HHSAV0        = 33.157 ;
        GOVSAV0       = -37.691 ;
        FSAV0         = 30.844 ;

TABLE ELASTICITY(*,I) SECTORAL ELASTICITIES

             WHEAT      OTHERGRAINS  FRUITVEG  LVSTK

ELASTM       4.0        1.5          2.0       1.5
ELASTT       4.0        4.0          4.0       1.5
ELASTE       3.0

  +          MILKPOULT  OTHERAG   FOOD     RESTEC

ELASTM       1.5        4.0       3.0      2.0
ELASTT       1.5        1.5       3.0      2.0
ELASTE
   ;

*######### END PARAMETER ASSIGNMENT
```

```
*######### SPECIFY PARAMETERS FROM TABLE VALUES

*##OTHER TABLE VALUES OF PARAMETERS

 E0(i)          = PRODSECPAR("E",i) ;
 ECONST(i)      = PRODSECPAR("E",i) ;
 M0(i)          = PRODSECPAR("M",i) ;
 PX0(i)         = PRODSECPAR("PX",i) ;
 PE0(i)         = PRODSECPAR("PE",i) ;
 PM0(i)         = PRODSECPAR("PM",i) ;
 P0(i)          = PRODSECPAR("P",i) ;
 PD0(i)         = PRODSECPAR("PD",i) ;
 PK0(i)         = PRODSECPAR("PK",i) ;
 XD0(i)         = PRODSECPAR("XD",i) ;
 DK0(i)         = PRODSECPAR("DK",i) ;
 EXPSUB0(i)     = PRODSECPAR("EXPSUB",i) ;
 SUBSIDY0(i)    = PRODSECPAR("SUBSIDY",i) ;
 INTAXIN0(i)    = PRODSECPAR("INTAXIN", i) ;
 TAR0(i)        = PRODSECPAR("TAR",i) ;

 DEPR(i)        = PARAM("DEPR",i) ;
 DSTR(i)        = PARAM("DSTR",i) ;
 GLES(i)        = PARAM("GLES",i) ;
 KIO(i)         = PARAM("KIO",i) ;
 KISH(i)        = PARAM("KISH",i) ;
 ITAXIN(i)      = INTAXIN0(i)/(PX0(i)*XD0(i)) ;
 SUBSDR(i)      = SUBSIDY0(i)/(PX0(i)*XD0(i)) ;
 NETITAXIN(i)   = ITAXIN(i) - SUBSDR(i) ;
 TM(i)          = TAR0(i)/(PM0(i)*M0(i)-TAR0(i)) ;
 TE(i)          = EXPSUB0(i)/(PE0(i)*E0(i)- EXPSUB0(i)) ;
 ITAXOUT(fld)   = ITAX("ITAXOUT", fld) ;
 CONSHR(i)      = PARAM("CONSHR",i) ;

 RHOM(i)  = (1/ELASTICITY("ELASTM",i))-1 ;
 RHOT(i)  = (1/ELASTICITY("ELASTT",i))+1 ;
 RHOE(i)  = ELASTICITY("ELASTE",i) ;

*NORMALIZING SHARE PARAMETERS

 SUMGLES        = SUM(i, GLES(i)) ;
 GLES(i)        = GLES(i)/SUMGLES ;
 SUMKIO         = SUM(i, KIO(i)) ;
 KIO(i)         = KIO(i)/SUMKIO ;
 SUMKISH        = SUM(i, KISH(i)) ;
 KISH(i)        = KISH(i)/SUMKISH ;
 SUMCONSHR      = SUM(i, CONSHR(i)) ;
 CONSHR(i)      = CONSHR(i)/SUMCONSHR ;

*## DEFINE INDEXES BASED ON READ IN DATA
 NAG(i)     = not AG(i) ;
 IED(i)     = yes$RHOE(i) ;
 IEDN(i)    = not IED(i) ;
```

```
*## COMPUTE FROM INITIAL DATA

INT0(i)        = SUM(j, IO(i,j)*XD0(j)) ;
PVA0(i)        = PX0(i) - SUM(j, IO(j,i)*P0(j)) - ITAXIN(i) + SUBSDR(i) ;
PWE0(i)        = PE0(i)/((1+TE(i))*EXR0) ;
PWM(i)         = PM0(i)/((1+TM(i))*EXR0) ;
XXD0(i)        = XD0(i) - E0(i) ;
SUBSD0         = SUM(i, SUBSDR(i)*PX0(i)*XD0(i)) ;
INDTAX0        = SUM(i, ITAXIN(i)*PX0(i)*XD0(i)) ;
TARIFF0        = SUM(i, TM(i)*PWM(i)*M0(i))*EXR0 ;
TEXPSUB0       = SUM(i, TE(i)*E0(i)*PWE0(i))*EXR0 ;

*## FOR 1991 TMREAL AND TEREAL ARE DERIVED FROM TM AND TE
*## FOR OTHER YEARS READ IN TMREAL AND TEREAL

TMREAL(i)      = TM(i)*PWM(i)*EXR0 ;
TEREAL(i)      = TE(i)*PWE0(i)*EXR0 ;

*####### CALIBRATION OF PARAMETERS FROM DATA #########
*## FACTOR MARKET PARAMETERS

FS0(f)         = SUM(i, FACTORDD(i,f)) ;
YFACTOR0(f)    = SUM(i, FACTORY(i,f)) ;
YFSECT0(i)     = SUM(f, FACTORY(i,f)) ;
WF0(f)         = YFACTOR0(f)/FS0(f) ;
WFDIST(i,f)$FACTORDD(i,f)             = (FACTORY(i,f)/FACTORDD(i,f))/WF0(f) ;
WFDIST(i,f)$(FACTORDD(i,f)EQ 0)       = 0.0 ;

*##INSTITUTIONAL AND HOUSEHOLD INCOME, TAX RATE, AND SAVING RATE

DEPRECIA0      = SUM(i,DEPR(i)*PK0(i)*FACTORDD(i, "CAPTL")) ;
ENTTR          = ENTTAX0/(YFACTOR0("CAPTL") + NETGOVENT0 + NETENTROW0*EXR0
                                                              - DEPRECIA0) ;
ENTSR          = ENTSAV0/(YFACTOR0("CAPTL") - ENTTAX0 + NETGOVENT0
                         + NETENTROW0*EXR0 - DEPRECIA0) ;
YINCG0("LABOR")       = YFACTOR0("LABR") ;
YINCG0("ENTERP")      = YFACTOR0("CAPTL") + NETGOVENT0 + NETENTROW0*EXR0
                                        - ENTSAV0 - DEPRECIA0 - ENTTAX0 ;
YINCG0("PROP")        = YFACTOR0("AGLND") ;
YHH0                  = SUM(INCG, YINCG0(INCG)) + NETGOVHH0 + NETHHROW0*EXR0 ;
HHTR                  = HHINCTAX0/YHH0 ;

DISPLAY WFDIST, WF0, YFSECT0, YFACTOR0 ;
DISPLAY YINCG0, YHH0, ENTTR, ENTSR, HHTR ;

*####CALIBRATION OF SHIFT AND SHARE PARAMETERS
* FOR IMPORT-DOMESTIC COMPOSITE - DELTA FROM COSTMIN, XO FROM ABSORPTION
* AM FROM ARMINGTON

DELTA(i)       = (PM0(i)/PD0(i))*(M0(i)/XXD0(i))**(1+RHOM(i)) ;
DELTA(i)       = DELTA(i)/(1.0+DELTA(i)) ;
X0(i)          = (PD0(i)*XXD0(i) + PM0(i)*M0(i))/P0(i) ;
```

```
 RMD(i)          = M0(i)/XXD0(i) ;
 AM(i)           = X0(i)/(DELTA(i)*M0(i)**(-RHOM(i))
                        + (1-DELTA(i))* XXD0(i)**(-RHOM(i)))**(-1/RHOM(i)) ;
 DISPLAY DELTA,AM,RMD ;

*FOR EXPORTS- GAMMA FROM SUPPLY, AE FROM CET

 GAMMA(i)        = 1/(1 + PD0(i)/PE0(i)*(E0(I)/XXD0(i))**(RHOT(i)-1)) ;
 AE(i)           = XD0(i)/(GAMMA(i)*E0(i)**RHOT(i) + (1-GAMMA(i))
                               *XXD0(i)**RHOT(i))**(1/RHOT(i)) ;
 DISPLAY GAMMA, AE ;

* FOR FACTOR DEMAND -  ALPHA FROM PROFIT MAX, AP FROM OUTPUT AND
* FD0 FROM PROFIT MAX

 ALPHA(i,f)      = (WFDIST(i,f)*WF0(f)*FACTORDD(i,f))/YFSECT0(i) ;
 QD(i)           = PROD(f,FACTORDD(i,f)**ALPHA(i,f)) ;
 AP(i)           = XD0(i)/QD(i) ;
 FD0(f)          = SUM(i,(XD0(i)*PVA0(i)*ALPHA(i,f)/(WFDIST(i,f)
                                    *WF0(f)))$WFDIST(i,f)) ;
 DISPLAY ALPHA,AP,QD,FD0 ;

* SPECIFY WEIGHTS FOR PRODUCER PRICE INDEX
 PWTS(i)     = XD0(i)/SUM(j, XD0(j)) ;

DISPLAY PWTS ;

*#### END OF CALIBRATION ####

 DISPLAY XD0, X0, XXD0 ;
 DISPLAY PVA0, PD0, PE0, PWE0, PM0, TM, TE ;

*##########################################################

 VARIABLES

*################## VARIABLE DECLARATION

*#### PRICE BLOCK

EXR        EXCHANGE RATE   (C$ PER US $)
 P(i)      PRICE OF COMPOSITE GOODS
 PD(i)     DOMESTIC PRICES
 PE(i)     DOMESTIC PRICE OF EXPORTS
 PINDEX    GNP DEFLATOR
 PK(i)     PRICE OF CAPITAL GOODS BY SECTOR OF DESTINATION
 PM(i)     DOMESTIC PRICE OF IMPORTS
 PVA(i)    VALUE ADDED PRICE
 PWE(i)    WORLD PRICE OF EXPORTS
 PX(i)     AVERAGE OUTPUT PRICE
*PWSE(i)   WORLD PRICE OF EXPORT SUBSTITUTES
*PWM(i)    WORLD PRICE OF IMPORTS
```

*#### PRODUCTION BLOCK

E(i)	EXPORTS	('91 BILL C$)
M(i)	IMPORTS	('91 BILL C$)
X(i)	COMPOSITE GOOD SUPPLY	('91 BILL C$)
XD(i)	DOMESTIC OUTPUT	('91 BILL C$)
XXD(i)	DOMESTIC SALES	('91 BILL C$)

*#### FACTOR OF PRODUCTION BLOCK

FS(f)	FACTOR SUPPLY	
FCRDD(i,f)	SECTORAL FACTOR DEMAND	
WF(f)	AVERAGE FACTOR PRICE	
YFACTOR(f)	FACTOR INCOME	(BILL C$)
LAMBDA(i)	SHADOW PRICE	

*#### INCOME AND EXPENDITURE BLOCK
*GOVEMPDD GOVT EMPLOYMENT EXPENDITURE (BILL C$)

CONSDD(i)	FINAL DEMAND FOR PRIVATE CONSUMPTION	('91 BILL C$)
DEPRECIA	TOTAL DEPRECIATION EXPENDITURE	(BILL C$)
DK(i)	INVESTMENT BY SECTOR OF DESTINATION	('91 BILL C$)
DST(i)	INVENTORY INVESTMENT BY SECTOR	('91 BILL C$)
ENTSAV	ENTERPRISE SAVINGS	(BILL C$)
ENTTAX	ENTERPRISE TAX	(BILL C$)
NETENTROW	NET TRANSFERS FROM ENTERPRISE TO WORLD	(BILL C$)
NETGOVROW	NET FOREIGN BORROWING BY GOVERNMENT	(BILL US$)
FSAV	NET FOREIGN SAVINGS	(BILL US$)
FXDINV	FIXED CAPITAL INVESTMENT	(BILL C$)
GOVDD(i)	FINAL DEMAND FOR GOVERNMENT CONSUMPTION	('91 BILL C$)
GOVTOT	TOTAL VOLUME OF GOVERNMENT CONSUMPTION	('91 BILL C$)
NETGOVENT	NET TRANSFER FROM GOVT TO ENTERPRISE	(BILL C$)
GOVSAV	GOVERNMENT SAVINGS	(BILL C$)
GOVREV	GOVERNMENT REVENUE	(BILL C$)
HHSAV	TOTAL HOUSEHOLD SAVINGS	(BILL C$)
NETGOVHH	NET TRANSFERS FROM GOVT TO HOUSEHOLDS	(BILL C$)
ID(i)	FINAL DEMAND FOR PRODUCTIVE INVESTMENT	('91 BILL C$)
INDTAXIN	INDIRECT TAX ON INTERMEDIATE INPUTS	(BILL C$)
SUBSIDY(i)	PRODUCTION SUBSIDY BY SECTOR	(BILL C$)
SUBSD	SUBSIDY FOR ACTIVITIES	(BILL C$)
*NETTAXIN	NET INDIRECT TAX ON INTERMEDIATE INPUTS	(BILL C$)
INDTAXOUT	INDIRECT TAX ON FINAL DD GOODS	(BILL C$)
INT(i)	INTERMEDIATE USES	('91 BILL C$)
INVEST	TOTAL INVESTMENT	(BILL C$)
MPS	MARGINAL PROPENSITY TO SAVE BY HH	
EXPSUB(i)	EXPORT SUBSIDY BY SECTOR	('91 BILL C$)
TEXPSUB	TOTAL EXPORT SUBSIDY	('91 BILL C$)
NETHHROW	NET REMITTANCE FROM ABROAD	(BILL US$)
SAVINGS	TOTAL SAVINGS	(BILL C$)
TAR(i)	TARIFF REVENUE BY SECTOR	('91 BILL C$)
TARIFF	TOTAL TARIFF REVENUE	('91 BILL C$)
HHINCTAX	TOTAL HOUSEHOLD INCOME TAX	(BILL C$)
YINCG(INCG)	TOTAL INCOME BY INCOME GROUP	(BILL C$)

```
YHH            TOTAL HOUSEHOLD INCOME          (BILL C$)

*#### GNP CALCULATIONS

RGNP           REAL GNP                   ('91 BILL C$)
GNPVA          MARKET PRICE GNP              (BILL $)
   ;

*################## VARIABLE INITIALIZATION ################

EXR.L                  = EXR0 ;
NETGOVROW.L            = NETGOVROW0 ;
FSAV.L                 = FSAV0 ;
GOVTOT.L               = GOVTOT0 ;
NETGOVENT.L            = NETGOVENT0 ;
GOVSAV.L               = GOVSAV0 ;
NETGOVHH.L             = NETGOVHH0 ;
INVEST.L               = INVEST0 ;
NETHHROW.L             = NETHHROW0 ;
NETENTROW.L            = NETENTROW0 ;
MPS.L           = MPS0 ;
PD.L(i)         = PD0(i)  ;
P.L(i)          = P0(i) ;
PX.L(i)         = PX0(i) ;
PM.L(i)         = PM0(i) ;
PE.L(i)         = PE0(i) ;
XD.L(i)         = XD0(i) ;
E.L(i)          = E0(i) ;
M.L(i)          = M0(i) ;
TAR.L(i)        = TAR0(i) ;
EXPSUB.L(i)     = EXPSUB0(i) ;
SUBSIDY.L(i)    = SUBSIDY0(i) ;
FCRDD.L(i,f)    = FACTORDD(i,f) ;
YFACTOR.L(f)    = SUM(i, FACTORY(i,f)) ;

*#### COMPUTING INITIAL VALUES FOR OTHER VARIABLES
*#### OUTPUT AND PRICE

XXD.L(i)        = XD.L(i) - E.L(i) ;
X.L(i)          = (PD.L(i)*XXD.L(i) + PM.L(i)*M.L(i))/P.L(i) ;
PK.L(i)         = SUM(j, P.L(j)*IMAT(j,i)) ;
PWE.L(i)        = PE.L(i)/((1 + TE(i))*EXR.L) ;
PWSE(i)         = PWE.L(i) ;
PVA.L(i)        = PX.L(i) - SUM(j, IO(j,i)*P.L(j)) - ITAXIN(i) + SUBSDR(i) ;

*#### VALUE ADDED AND THE FLOW OF INCOME

FS.L(f)         = SUM(i, FCRDD.L(i,f)) ;
WF.L(f)         = YFACTOR.L(f)/FS.L(f) ;
SUBSD.L         = SUM(i, SUBSDR(i)*PX.L(i)*XD.L(i)) ;
TARIFF.L        = SUM(i, PWM(i)*M.L(i)*TM(i))*EXR.L ;
TEXPSUB.L       = SUM(i, TE(i)*E.L(i)*PWE.L(i))*EXR.L ;
INDTAXIN.L      = SUM(i, (ITAXIN(i)*PX.L(i)*XD.L(i))) ;
```

```
DEPRECIA.L   = SUM(i, DEPR(i)*PK.L(i)*FCRDD.L(i, "CAPTL")) ;
ENTTAX.L     = ENTTR*(YFACTOR.L("CAPTL") + NETGOVENT.L + NETENTROW.L*EXR.L
                              - DEPRECIA.L) ;
ENTSAV.L     = ENTSR*(YFACTOR.L("CAPTL") + NETGOVENT.L + NETENTROW.L*EXR.L
                                                   - (ENTTAX.L + DEPRECIA.L)) ;
YINCG.L("LABOR")     = YFACTOR.L("LABR") ;
YINCG.L("ENTERP")    = YFACTOR.L("CAPTL") + NETGOVENT.L + NETENTROW.L*EXR.L
                                        - (ENTSAV.L + ENTTAX.L + DEPRECIA.L) ;
YINCG.L("PROP")      = YFACTOR.L("AGLND") ;
YHH.L        = SUM(INCG, YINCG.L(INCG)) + NETHHROW.L*EXR.L + NETGOVHH.L ;

HHINCTAX.L   = HHTR*YHH.L ;
HHSAV.L      = MPS.L*YHH.L*(1.0 - HHTR) ;


*FINAL DEMAND

INT.L(i)     = SUM(j, IO(i,j)*XD.L(j)) ;
CONSDD.L(i)  = CONSHR(i)*(1.0 - MPS.L)*YHH.L
                    *(1.0 - HHTR)/(1.109514*P.L(i)) ;
GOVDD.L(i)   = (GLES(i)* GOVTOT.L)/P.L(i) ;
DST.L(i)     = DSTR(i)*XD.L(i) ;
FXDINV.L     = INVEST.L - (SUM(i, DST.L(i)*P.L(i))) ;
DK.L(i)      = (KISH(i)*FXDINV.L)/PK.L(i) ;
ID.L(i)      = KIO(i)*FXDINV.L ;
*ID.L(i)     = SUM(j, IMAT(i,j)*DK.L(j)) ;
INDTAXOUT.L  = ITAXOUT("CONS")*(SUM(i, P.L(i)*CONSDD.L(i)))
                  + ITAXOUT("INV")*(SUM(i, P.L(i)*ID.L(i))) ;

GOVREV.L     = TARIFF.L + INDTAXIN.L - SUBSD.L + INDTAXOUT.L - TEXPSUB.L
                          + HHINCTAX.L + ENTTAX.L + NETGOVROW.L*EXR0 ;

SAVINGS.L    = HHSAV.L + GOVSAV.L + DEPRECIA.L + FSAV.L*EXR0 + ENTSAV.L ;

*####GNP

RGNP.L       = SUM(i, CONSDD.L(i) + DST.L(i) + ID.L(i) + GOVDD.L(i))
                          + SUM(i, (1.0 - TEREAL(i))*E.L(i))
                          - SUM(i, (1.0 - TMREAL(i))*M.L(i)) ;

GNPVA.L    = SUM(i, PVA.L(i)*XD.L(i)) + INDTAXIN.L - SUBSD.L + TARIFF.L
                   - TEXPSUB.L ;
PINDEX.L   = GNPVA.L/RGNP.L ;

* PINDEX.L     = SUM(i, pwts(i)*PX.L(i)) ;
  LAMBDA.L(i)   = 1 ;

DISPLAY YFACTOR.L, YINCG.L, YHH.L, GNPVA.L, PINDEX.L,
                  INDTAXOUT.L, INDTAXIN.L, SUBSD.L ;
DISPLAY INT.L, CONSDD.L, GOVDD.L,ID.L, DK.L, DST.L ;

*######### END VARIABLE SPECIFICATION ##########
```

```
*#### TO CHECK FOR DATA CONSISTENCY, DISPLAY INITIAL SAM

*################### SOCIAL ACCOUNTING MATRIX ############

SAM("COMMODITY", "ACTIVITY")              = SUM(i, (P.L(i)*INT.L(i))) ;
SAM("COMMODITY", "HOUSEHOLDS")            = SUM(i, (P.L(i)*CONSDD.L(i))) ;
SAM("COMMODITY", "GOVT")                  = SUM(i, (P.L(i)*GOVDD.L(i))) ;
SAM("COMMODITY", "CAPACCOUNT")            = SUM(i, (P.L(i)*(DST.L(i) +ID.L(i)))) ;
SAM("ACTIVITY", "COMMODITY")              = SUM(i, (PX.L(i)*XD.L(i))
                                               - (PE.L(i)*E.L(i))) ;
SAM("ACTIVITY", "GOVT")            = TEXPSUB.L ;
SAM("ACTIVITY", "WORLD")           = SUM(i, ((PWE.L(i)*EXR.L)*E.L(i))) ;
SAM("LABOUR", "ACTIVITY")          = YFACTOR.L("LABR") ;
SAM("CAPITAL", "ACTIVITY")         = YFACTOR.L("CAPTL") ;
SAM("LAND", "ACTIVITY")            = YFACTOR.L("AGLND") ;
SAM("ENTERPRISE", "CAPITAL")       = YFACTOR.L("CAPTL") ;
SAM("ENTERPRISE", "GOVT")          = NETGOVENT.L ;
SAM("ENTERPRISE", "WORLD")         = NETENTROW.L*EXR.L ;
SAM("HOUSEHOLDS", "LABOUR")        = YINCG.L("LABOR") ;
SAM("HOUSEHOLDS", "LAND")          = YINCG.L("PROP") ;
SAM("HOUSEHOLDS", "ENTERPRISE")    = YINCG.L("ENTERP") ;
SAM("HOUSEHOLDS", "GOVT")          = NETGOVHH.L ;
SAM("HOUSEHOLDS", "WORLD")         = NETHHROW.L*EXR.L ;
SAM("GOVT", "COMMODITY")           = TARIFF.L ;
SAM("GOVT", "ACTIVITY")            = INDTAXIN.L - SUBSD.L ;
SAM("GOVT", "ENTERPRISE")          = ENTTAX.L ;
SAM("GOVT", "HOUSEHOLDS")          = HHINCTAX.L + ITAXOUT("CONS")*(SUM(i,
                                                    P.L(i)*CONSDD.L(i))) ;
SAM("GOVT", "CAPACCOUNT")          = ITAXOUT("INV")*(SUM(i, P.L(i)*ID.L(i))) ;
SAM("GOVT", "WORLD")               = NETGOVROW.L*EXR0 ;

SAM("CAPACCOUNT", "ENTERPRISE")           = ENTSAV.L + DEPRECIA.L ;
SAM("CAPACCOUNT", "HOUSEHOLDS")           = HHSAV.L ;
SAM("CAPACCOUNT", "GOVT")                 = GOVSAV.L ;
SAM("CAPACCOUNT", "WORLD")         = FSAV.L*EXR.L ;
SAM("WORLD", "COMMODITY")          = SUM(i, ((PWM(i)*EXR.L)*M.L(i))) ;
SAM(ISAM2, "TOTAL")                = SUM(ISAM3, SAM(ISAM2, ISAM3)) ;
SAM("TOTAL", ISAM3)                = SUM(ISAM2, SAM(ISAM2, ISAM3)) ;

OPTION DECIMALS=3 ;
DISPLAY SAM ;

*###########################################################################*

EQUATIONS

*################### EQUATION DECLARATION ##############################*

*## PRICE BLOCK

 PMDEF(i)           DEFINITION OF DOMESTIC IMPORT PRICES
 PEDEF(i)           DEFINITION OF DOMESTIC EXPORT PRICES
 ABSORPTION(i)      VALUE OF DOMESTIC SALES
```

SALES(i)	VALUE OF DOMESTIC OUTPUT
ACTP(i)	DEFINITION OF ACTIVITY PRICES
PKDEF(i)	DEFINITION OF CAPITAL GOODS PRICE
PINDEXDEF	DEFINITION OF GENERAL PRICE LEVEL

*## PRODUCTION BLOCK

ACTIVITY(i)	PRODUCTION FUNCTION
PROFITMAX(i,f)	FIRST ORDER CONDITION FOR PROFIT MAXIMUM
INTEQ(i)	TOTAL INTERMEDIATE USES
CET(i)	CET FUNCTION
ESUPPLY(i)	EXPORT SUPPLY
EDEMAND(i)	EXPORT DEMAND FUNCTIONS
ARMINGTON(i)	COMPOSITE GOOD AGGREGATION FUNCTION
COSTMIN(i)	FOC FOR COST MINIMIZATION OF COMPOSITE GOOD

*## INCOME BLOCK

YFACTOREQ(f)	FACTOR INCOME
YLABOR	LABOUR INCOME
YENTERP	CAPITAL INCOME
YPROP	PROPERTY INCOME
HHY	HOUSEHOLD INCOME
TARIFFDEF	TARIFF REVENUE
ITAXINDEF	INDIRECT TAX ON DOMESTIC PRODUCTION
ITAXOUTDEF	INDIRECT TAX ON DOMESTIC SALES
SUBSDDEF	SUBSIDY FOR DOMESTIC PRODUTION
EXPSUBDEF	EXPORT SUBSIDIES
TAXENT	ENTERPRISE TAX
HHYTAXDEF	TOTAL HOUSEHOLD INCOME TAXES
DEPREQ	DEPRECIATION EXPENDITURE
SAVENT	ENTERPRISE SAVINGS
HHSAVEQ	HOUSEHOLD SAVINGS
GOVREVEQ	GOVERNMENT REVENUE
TOTSAV	TOTAL SAVINGS

*## EXPENDITURE BLOCK

CONSDDEQ(i)	PRIVATE CONSUMPTION
GOVDDEQ(i)	GOVERNMENT CONSUMPTION
GOVREVUSE	GOVERNMENT REVENUE USE
DSTEQ(i)	INVENTORY INVESTMENT
FIXEDINV	FIXED INVESTMENT NET OF INVENTORY
PRODINV(i)	INVESTMENT BY SECTOR OF DESTINATION
IEQ(i)	INVESTMENT BY SECTOR OF ORIGION

*## MARKET CLEARING

EQUIL(i)	GOODS MARKET EQUILIBRIUM
FMEQUIL(f)	FACTOR MARKET EQUILIBRIUM
CAEQ	CURRENT ACCOUNT BALANCE
* WALRAS	SAVING INVESTMENT EQUILIBRIUM

```
*## The WALRAS equation is redundant, given that the model
*## satisfies Walras' Law.

*## GROSS NATIONAL PRODUCT

 GNPY          TOTAL VALUE ADDED INCLUDING INDTAX AND SUBS.
 GNPR          REAL GNP
    ;
*############### EQUATION ASSIGNMENT #####################*

*## PRICE BLOCK

 PMDEF(i)..        PM(i)  =E= PWM(i)*(1 + TM(i))*EXR ;

 PEDEF(i)..        PE(i)  =E= PWE(i)*(1 + TE(i))*EXR ;

 ABSORPTION(i)..      P(i)*X(i)  =E= PD(i)*XXD(i) + PM(i)*M(i) ;

 SALES(i)..        PX(i)*XD(i)  =E= PD(i)*XXD(i) + PE(i)*E(i) ;

 ACTP(i)..         PVA(i)  =E= PX(i)*(1.0 - ITAXIN(i) + SUBSDR(i))
                     - SUM(j, IO(j,i)*P(j)) ;

PKDEF(i)..         PK(i)  =E= SUM(j, P(j)*IMAT(j,i)) ;

 PINDEXDEF..        PINDEX =E= GNPVA/RGNP ;

* PINDEXDEF..       PINDEX  =E= SUM(i, pwts(i)*PX(i)) ;

*## PRODUCTION BLOCK

 ACTIVITY(i)..      XD(i)  =E= AP(i)*PROD(f$ALPHA(i,f),
                                  FCRDD(i,f)**ALPHA(i,f)) ;

 PROFITMAX(i,f)$WFDIST(i,f)..  WF(f)*WFDIST(i,f)*FCRDD(i,f)  =E=
                                  LAMBDA(i)*XD(i)*PVA(i)*ALPHA(i,f) ;

 INTEQ(i)..         INT(i)  =E= SUM(j, IO(i,j)*XD(j)) ;

 CET(i)..           XD(i)  =E= AE(i)*(GAMMA(i)*E(i)**RHOT(i)
                     + (1 - GAMMA(i))*XXD(i)**RHOT(i))**(1/RHOT(i)) ;

 ESUPPLY(i)..       E(i)/XXD(i)  =E= (PE(i)/PD(i)*(1 - GAMMA(i))
                                   /GAMMA(i))**(1/(RHOT(i) - 1)) ;

 EDEMAND(ied)..     E(ied)  =E= ECONST(ied)*(PWE(ied)/PWSE(ied))
                                  **(-RHOE(ied)) ;

ARMINGTON(i)..      X(i)  =E= AM(i)*(DELTA(i)*M(i)**(-RHOM(i)) +
                     (1 - DELTA(i))*XXD(i)**(-RHOM(i)))**(-1/RHOM(i)) ;

 COSTMIN(i)..       M(i)/XXD(i)  =E= (PD(i)/PM(i)*DELTA(i)/
                           (1 - DELTA(i)))**(1/(1 + RHOM(i))) ;
```

```
*## INCOME AND EXPENDITURE BLOCK

YFACTOREQ(f)..      YFACTOR(f)  =E= SUM(i, WF(f)*WFDIST(i,f)*FCRDD(i,f)) ;

YLABOR..            YINCG("LABOR")  =E= YFACTOR("LABR") ;

YENTERP..           YINCG("ENTERP")  =E= YFACTOR("CAPTL") + NETGOVENT
                      + NETENTROW*EXR0 - (ENTSAV + ENTTAX + DEPRECIA) ;

YPROP..             YINCG("PROP")  =E= YFACTOR("AGLND") ;

HHY..               YHH  =E= SUM(INCG, YINCG(INCG))
                            + NETGOVHH + NETHHROW*EXR ;

ITAXINDEF..         INDTAXIN  =E= SUM(i, ITAXIN(i)*PX(i)*XD(i)) ;

SUBSDDEF..          SUBSD  =E= SUM(i, SUBSDR(i)*PX(i)*XD(i)) ;

TARIFFDEF..         TARIFF  =E= SUM(i, TM(i)*M(i)*PWM(i))*EXR ;

EXPSUBDEF..         TEXPSUB  =E= SUM(i, TE(i)*E.L(i)*PWE.L(i))*EXR.L ;

DEPREQ..            DEPRECIA  =E= SUM(i, DEPR(i)*PK(i)*FCRDD(i, "CAPTL")) ;

TAXENT..            ENTTAX  =E= ENTTR*(YFACTOR("CAPTL")
                    - DEPRECIA + NETGOVENT + NETENTROW*EXR0) ;

HHYTAXDEF..         HHINCTAX  =E= HHTR*YHH ;

SAVENT..            ENTSAV  =E= ENTSR*(YFACTOR("CAPTL") + NETGOVENT
                            + NETENTROW*EXR0 - (ENTTAX + DEPRECIA));

HHSAVEQ..           HHSAV  =E= MPS*YHH*(1 - HHTR) ;

CONSDDEQ(i)..       P(i)*CONSDD(i)  =E= CONSHR(i)*(1 - MPS)*YHH*(1-HHTR)
                                        / (1 + ITAXOUT("CONS")) ;

GOVDDEQ(i)..        P(i)*GOVDD(i)  =E= GLES(i)*GOVTOT ;

DSTEQ(i)..          DST(i)  =E= DSTR(i)*XD(i) ;

FIXEDINV..          FXDINV  =E= INVEST - SUM(i, DST(i)*P(i)) ;

PRODINV(i)..        PK(i)*DK(i)  =E= KISH(i)*FXDINV ;

IEQ(i)..                    ID(i)  =E= KIO(i)*FXDINV ;

ITAXOUTDEF..        INDTAXOUT  =E= ITAXOUT("CONS")*(SUM(i, P(i)*CONSDD(i)))
                                  + ITAXOUT("INV")*(SUM(i, P(i)*ID(i))) ;

GOVREVEQ..          GOVREV  =E= TARIFF + INDTAXIN - SUBSD
                            + INDTAXOUT + HHINCTAX + ENTTAX + NETGOVROW*EXR ;
```

```
GOVREVUSE..          GOVREV  =E= GOVTOT + GOVSAV
                             + TEXPSUB + NETGOVENT + NETGOVHH ;

TOTSAV..             SAVINGS  =E= HHSAV + ENTSAV + GOVSAV + DEPRECIA
                                + FSAV*EXR ;

*PRODINV(i)..        PK(i)*DK(i)  =E= KISH(i)*(INVEST - SUM(j, DST(j)
*                                *P(j))) ;

*## MARKET CLEARING

EQUIL(i)..           X(i)  =E= INT(i) + CONSDD(i) + GOVDD(i) + ID(i)
                               + DST(i) ;

FMEQUIL(f)..         SUM(i, FCRDD(i,f))  =E= FS(f) ;

CAEQ..               SUM(i, PWM(i)*M(i))  =E= SUM(i, PWE(i)*E(i))
                     + (FSAV + NETENTROW + NETHHROW + NETGOVROW) ;

*WALRAS..            SAVINGS  =E= INVEST ;

*## GROSS NATIONAL PRODUCT

GNPY..               GNPVA  =E= SUM(i, PVA(i)*XD(i)) + INDTAXIN - SUBSD
                                 + TARIFF - TEXPSUB ;

GNPR..               RGNP  =E= SUM(i, CONSDD(i) + DST(i) + ID(i) + GOVDD(i))
                           + SUM(i, (1.0 - TEREAL(i))*E(i))
                           - SUM(i, (1.0 - TMREAL(i))*M(i)) ;

*#### ADDITIONAL RESTRICTIONS

PWE.FX(iedn)             = PWE.L(iedn) ;

FCRDD.FX(i,f)$(WFDIST(i,f) EQ 0) = 0 ;

* QUOTA CONSTRAINT

* XD.FX("MILKPOULT")            = XD.L("MILKPOULT") ;
 LAMBDA.FX("MILKPOULT")  = 1.0 ;
 LAMBDA.FX("WHEAT")         = 1.0 ;
 LAMBDA.FX("OTHERGRAINS")  = 1.0 ;
 LAMBDA.FX("FRUITVEG")      = 1.0 ;
 LAMBDA.FX("LVSTK")         = 1.0 ;
 LAMBDA.FX("OTHERAG")       = 1.0 ;
 LAMBDA.FX("FOOD")          = 1.0 ;
 LAMBDA.FX("RESTEC")        = 1.0 ;

*####VARIABLE BOUNDS

P.LO(i)        = 0.0 ; PD.LO(i)     = 0.0 ; PM.LO(i)     = 0.0 ;
PK.LO(i)       = 0.0 ; PX.LO(i)     = 0.0 ; PVA.LO(i)   = 0.0 ;
```

```
FCRDD.LO(i,f)$(FCRDD.L(i,f) NE 0)  = 0.0 ;
X.LO(i)          = 0.0 ;
XD.LO(i)         = 0.0 ;
M.LO(i)          = 0.0 ;
XXD.LO(i)        = 0.0 ;
E.LO(i)          = 0.0 ;
INT.LO(i)        = 0.0 ;

*################# MODEL CLOSURE ###################*

*### FOREIGN EXCHANGE MARKET CLOSURE

*  EXR.FX        = EXR.L ;
   FSAV.FX       = FSAV.L ;
   NETENTROW.FX        = NETENTROW.L ;
   NETHHROW.FX         = NETHHROW.L ;
   NETGOVROW.FX        = NETGOVROW.L ;

*###INVESTMENT-SAVING CLOSURE

   MPS.FX        = MPS.L ;
*  INVEST.FX     = INVEST.L ;

*### EXOGENOUS GOVT EXPENDITURE AND GOVT CLOSURE

   GOVTOT.FX           = GOVTOT.L ;
   NETGOVENT.FX        = NETGOVENT.L ;
   NETGOVHH.FX         = NETGOVHH.L ;
*  GOVSAV.FX           = GOVSAV.L ;

*### FACTOR MARKET CLOSURE

    FS.FX(f)           = FS.L(f) ;
*   WF.FX("LABR")      = WF.L("LABR") ;
*   FS.LO("LABR")      = -inf ;
*   FS.UP("LABR")      = +inf ;

*### NUMERAIRE PRICE INDEX

     PINDEX.FX         = PINDEX.L ;

*############################## END OF MODEL ##############################

OPTIONS ITERLIM = 1000,LIMROW = 0,LIMCOL = 0,SOLPRINT = ON ;
MODEL CANADA91 /ALL/ ;
SOLVE CANADA91 MAXIMIZING RGNP USING NLP ;


*######### i) TABLES OF RESULTS FOR VARIABLES IN THE MODEL

*### SECTORAL QUANTITY AND PRICE RESULTS
*** QUANTITY RESULTS
PARAMETER QUANTITY1(*, i) ;
```

```
QUANTITY1("X", i)       = X.L(i) ;
QUANTITY1("XD", i)   = XD.L(i) ;
QUANTITY1("XXD", i)  = XXD.L(i) ;
QUANTITY1("E", i)       = E.L(i) ;
QUANTITY1("M", i)       = M.L(i) ;
QUANTITY1("INT", i)   = INT.L(i) ;
QUANTITY1("CONSDD", i)        = CONSDD.L(i) ;
QUANTITY1("GOVDD", i)         = GOVDD.L(i) ;
QUANTITY1("ID", i)     = ID.L(i) ;
QUANTITY1("DK", i)    = DK.L(i) ;
QUANTITY1("DST", i)               = DST.L(i) ;
QUANTITY1("SUBSIDY", i)       = SUBSIDY.L(i) ;
QUANTITY1("EXPSUB", i)        = EXPSUB.L(i) ;
QUANTITY1("TAR", i)               = TAR.L(i) ;


***PRICE RESULTS
PARAMETER PRICES1(*, i) ;
PRICES1("PX", i)          = PX.L(i) ;
PRICES1("PD", i)          = PD.L(i) ;
PRICES1("P", i)           = P.L(i) ;
PRICES1("PVA", i)         = PVA.L(i) ;
PRICES1("PK", i)          = PK.L(i) ;
PRICES1("PE", i)          = PE.L(i) ;
PRICES1("PM", i)          = PM.L(i) ;
PRICES1("PWE", i)         = PWE.L(i) ;
PRICES1("PWM", i)         = PWM(i) ;
PRICES1("LAMBDA", i)   = LAMBDA.L(i) ;

*### RESULTS FOR FACTORS OF PRODUCTION

PARAMETER FACTORDD(i,f) ;
FACTORDD(i,f)        = FCRDD.L(i,f) ;

*### OTHER FACTOR VARIABLE RESULTS

SET OFVAR /WF, FS, YFACTOR/ ;
PARAMETER FACTVAR(ofvar, f) OTHER FACTOR VARIABLE RESULTS ;
FACTVAR("WF",f)              = WF.L(f) ;
FACTVAR("FS",f)              = FS.L(f) ;
FACTVAR("YFACTOR",f)         = YFACTOR.L(f) ;

*### MISCELLANEOUS RESULTS
SET INGVAR /YINCG/ ;
PARAMETER MSLVAR(ingvar, incg) INCOMES BY INCOME GROUPS ;
 MSLVAR("YINCG", incg)  = YINCG.L(incg) ;

*#### MACRO AGGREGATE RESULTS

 PARAMETER SCALRS1(*) MACRO RESULTS ;
 SCALRS1("EXR")        = EXR.L ;
 SCALRS1("PINDEX")   = PINDEX.L ;
 SCALRS1("MPS")        = MPS.L ;
```

```
SCALRS1("GNPVA")    = GNPVA.L ;
SCALRS1("YHH")      = YHH.L ;

SCALRS1("GOVTOT")   = GOVTOT.L ;
SCALRS1("GOVREV")   = GOVREV.L ;
SCALRS1("INVEST")   = INVEST.L ;
SCALRS1("FXDINV")   = FXDINV.L ;

SCALRS1("INDTAXIN")       = INDTAXIN.L ;
SCALRS1("SUBSD")          = SUBSD.L ;
SCALRS1("TARIFF")         = TARIFF.L ;
SCALRS1("INDTAXOUT")      = INDTAXOUT.L ;
SCALRS1("ENTTAX")         = ENTTAX.L ;
SCALRS1("HHINCTAX")       = HHINCTAX.L ;
SCALRS1("TEXPSUB")        = TEXPSUB.L ;

SCALRS1("NETHHROW")       = NETHHROW.L ;
SCALRS1("NETENTROW")      = NETENTROW.L ;
SCALRS1("NETGOVHH")       = NETGOVHH.L ;
SCALRS1("NETGOVENT")      = NETGOVENT.L ;
SCALRS1("NETGOVROW")      = NETGOVROW.L ;

SCALRS1("ENTSAV")         = ENTSAV.L ;
SCALRS1("HHSAV")          = HHSAV.L ;
SCALRS1("GOVSAV")         = GOVSAV.L ;
SCALRS1("FSAV")           = FSAV.L ;
SCALRS1("DEPRECIA")       = DEPRECIA.L ;

OPTION DECIMALS = 6 ;
DISPLAY PRICES1 ;
DISPLAY QUANTITY1 ;
DISPLAY FACTORDD1 ;
DISPLAY FACTVAR ;
DISPLAY SCALRS1 ;
DISPLAY MSLVAR ;
OPTION DECIMALS = 3 ;

*#### MORE TABLES OF RERIVED RESULTS
* GNP TABULATIONS

SET   gnpi      rows      /consumpt, investment, inventory, govcons, exports,
                            imports, gnp/
      gnp1(gnpi)          /gnp/
      gnp2(gnpi)
      gnpj      columns         /nominal
                                 real
                                 nomshare
                                 realshare
                                 deflator/ ;
      gnp2(gnpi) = NOT gnp1(gnpi) ;

SETS  agr(i)    ag sectors      /wheat, othergrains, fruitveg, lvstk,
                                        milkpoult, otherag/
```

```
        nagr(i)  nonag sectors      /food, restec/

   PARAMETER gnptab(gnpi,gnpj)        GNP ACCOUNTS ;
   PARAMETER gnptab2(i, gnpj)         SECTORAL VALUE ADDED ;
   PARAMETER sumgnp(gnpj)             AGGREGATE GNP ;
   PARAMETER gnpratio                 GNP value added correction factor ;

* ABSORPTION
set     rar     rows          /ag, nonag, total/
        rac     columns       /GNP, XD, INT, C, V, I, G, E, M, LABR, CAPTL, AGLND/


*FACTOR INCOMES AND OTHERS
set     rf      /yfcap, profit, rental, rdist, wdcap, yflabor,
                wdlabor, yfland, wdland, pint, intinp, valaddmp, valaddfc/


*
PARAMETERS
agtotpx        ag terms of trade output price
agtotva        ag terms of trade value added
agtote         ag terms of trade world export prices
agtotm         ag terms of trade world import prices
avgprofit      average profit rate
avgwf          average factor price current weights
nbot           nominal balance of trade
rbot           real balance of trade
reale          real exports
realm          real imports
intinp(i)      intermediate input demand by sector i
nintinp(i)     nominal intermediate input demand by sector i
nexports       nominal exports
nimports       nominal imports
ngnp           nominal GNP
agpindx        ag price index
nagpindx       non ag price index
pint(i)        cost per unit of intermediate inputs
profit(i)      profit rate
rdist(i)       capital rental proportionality factor
rental         rental rate of capital
valaddmp(i)    value added at market price
valaddfc(i)    value added at factor cost
sumvaddmp      total value added at market price
sumvaddfc      total value added at factor cost
shexports      share of exports in nominal gnp
shimports      share of imports in nominal gnp
shnbot         balance of trade share of nominal gnp
yf(i,f)        factor income

          ;

*#### AG TERMS OF TRADE

agpindx        = SUM(agr, px.l(agr)*xd.l(agr))/SUM(agr, xd.l(agr)) ;
```

```
nagpindx         = SUM(nagr, px.l(nagr)*xd.l(nagr))/SUM(nagr, xd.l(nagr)) ;
agtotpx          = 100*agpindx/nagpindx ;
agpindx          = SUM(agr, pva.l(agr)*xd.l(agr))/SUM(agr, xd.l(agr)) ;
nagpindx         = SUM(nagr, pva.l(nagr)*xd.l(nagr))/SUM(nagr, xd.l(nagr)) ;
agtotva          = 100*agpindx/nagpindx ;
agpindx          = SUM(agr, pwe.l(agr)*e.l(agr))/SUM(agr, e.l(agr)) ;
nagpindx         = SUM(nagr, pwe.l(nagr)*e.l(nagr))/SUM(nagr, e.l(nagr)) ;
agtote           = 100*agpindx/nagpindx ;
agpindx          = SUM(agr, pwm(agr)*m.l(agr))/SUM(agr, m.l(agr)) ;
nagpindx         = SUM(nagr, pwm(nagr)*m.l(nagr))/SUM(nagr, m.l(nagr)) ;
agtotm           = 100*agpindx/nagpindx ;

DISPLAY agtotpx, agtotva, agtote, agtotm ;

*** nominal GNP
ngnp             = SUM(i, p.l(i)*(consdd.l(i) + dst.l(i) + id.l(i) + govdd.l(i))
                          + pe.l(i)e.l(i) - pwm(i)*exr.l*m.l(i)) ;


*#### BALANCE OF TRADE
nexports         = SUM(i, e.l(i)*exr.l*pwe.l(I)) ;
nimports                  = SUM(i, m.l(I)*exr.l*pwm(i) ;
nbot             = nexports - nimports ;
rbot             = SUM(i, e.l(i)) - SUM(i, m.l(i)) ;
shexports        = 100*nexports/gnpva.l ;
shimports        = 100*nimports/gnpva.l ;
shnbot           = 100*nbot/gnpva.l ;

DISPLAY ngnp, nexports, nimports, nbot, rbot, shexports, shimports, shnbot ;

*### GNP TABLES

 gnptab("consumpt", "nominal")     = SUM(i, p.l(i)*consdd.l(i)) ;
 gnptab("consumpt", "real")        = SUM(i, consdd.l(i)) ;
 gnptab("investment", "nominal")   = SUM(i, p.l(i)*id.l(i)) ;
 gnptab("investment", "real")      = SUM(i, id.l(i)) ;
 gnptab("inventory", "nominal")    = SUM(i, p.l(i)*dst.l(i)) ;
 gnptab("inventory", "real")       = SUM(i, dst.l(i)) ;
 gnptab("govcons", "nominal")      = SUM(i, p.l(i)*govdd.l(i)) ;
 gnptab("govcons", "real")         = SUM(i, govdd.l(i)) ;
 gnptab("exports", "nominal")      = SUM(i, pwe.l(i)*e.l(i))*exr.l ;
 gnptab("exports", "real")         = SUM(i, (1-tereal(i))*e.l(i)) ;
 gnptab("imports", "nominal")      = -SUM(i, pwm(i)*m.l(i))*exr.l ;
 gnptab("imports", "real")         = -SUM(i, (1-tmreal(i))*m.l(i)) ;
 gnptab("gnp", "nominal")          = SUM(gnp2, gnptab(gnp2, "nominal")) ;
 gnptab("gnp", "real")             = SUM(gnp2, gnptab(gnp2, "real")) ;
 gnptab(gnpi, "nomshare")          = 100*gnptab(gnpi,"nominal")
                                            /gnptab("gnp","nominal") ;
 gnptab(gnpi, "realshare")         = 100*gnptab(gnpi,"real")
                                            /gnptab("gnp","real") ;

 gnptab2(i, "nominal")             = pva.l(i)*xd.l(i) + netitaxin(i)*xd.l(i)
                                            -te(i)*pwe.l(i)*e.l(i)*exr.l ;
```

```
gnptab2("restec", "nominal")      = gnptab2("restec", "nominal") + tariff.l ;
gnptab2("restec", "real")         = gnptab2("restec", "real")
                                        + SUM(i, tmreal(i)*m.l(i)) ;
sumgnp("nominal")                 =  SUM(i, gnptab2(i, "nominal"));
sumgnp("real")                    =  SUM(i, gnptab2(i, "real"));
gnpratio                          = gnptab("gnp", "real")/sumgnp("real") ;
gnptab2(i, "real")                = gnpratio*gnptab2(i, "real") ;
sumgnp("real")                    = SUM(i, gnptab2(i, "real")) ;
gnptab2(i, "nomshare")            = 100*gnptab2(i, "nominal")/sumgnp("nominal") ;
gnptab2(i, "realshare")           = 100*gnptab2(i, "real")/sumgnp("real") ;
sumgnp("nomshare")                = SUM(i, gnptab2(i, "nomshare")) ;
sumgnp("realshare")               = SUM(i, gnptab2(i, "realshare")) ;
*gnptab2(i, "deflator")           = 100*gnptab2(i, "nominal")/gnptab2(i, "real") ;

DISPLAY GNPTAB, GNPTAB2, SUMGNP, GNPRATIO ;

*##### ABSORPTION

PARAMETER ABSORB(rar, rac)   ABSORPTION TABLE ;
absorb("ag","c")               = SUM(agr, CONSDD.L(agr)) ;
absorb("nonag","c")        = SUM(nagr, CONSDD.L(nagr)) ;
absorb("total","c")            = SUM(i, CONSDD.L(i)) ;
absorb("ag","v")               = SUM(agr,DST.L(agr)) ;
absorb("nonag","v")        = SUM(nagr, DST.L(nagr)) ;
absorb("total","v")        = SUM(i, DST.L(i)) ;
absorb("ag","i")           = SUM(agr,ID.L(agr)) ;
absorb("nonag","i")            = SUM(nagr, ID.L(nagr)) ;
absorb("total","i")        = SUM(i, ID.L(i)) ;
absorb("ag","g")               = SUM(agr, GOVDD.L(agr)) ;
absorb("nonag","g")        = SUM(nagr, GOVDD.L(nagr)) ;
absorb("total","g")        = SUM(i, GOVDD.L(i)) ;
absorb("ag","e")               = SUM(agr, E.L(agr)) ;
absorb("nonag","e")        = SUM(nagr, E.L(nagr)) ;
absorb("total","e")            = SUM(i, E.L(i)) ;
absorb("ag","m")           = SUM(agr, M.L(agr)) ;
absorb("nonag","m")        = SUM(nagr, M.L(nagr)) ;
absorb("total","m")        = SUM(i, M.L(i)) ;

absorb("ag","labr")        = SUM(agr, FCRDD.L(agr,"LABR")) ;
absorb("nonag","labr")     = SUM(nagr, FCRDD.L(nagr,"LABR")) ;
absorb("total","labr")     = SUM(i, FCRDD.L(i,"LABR")) ;
absorb("ag","captl")       = SUM(agr, FCRDD.L(agr,"CAPTL")) ;
absorb("nonag","captl")    = SUM(nagr, FCRDD.L(nagr,"CAPTL")) ;
absorb("total","captl")    = SUM(i, FCRDD.L(i,"CAPTL")) ;
absorb("ag","aglnd")       = SUM(agr, FCRDD.L(agr,"AGLND")) ;
absorb("nonag","aglnd")    = SUM(nagr, FCRDD.L(nagr,"AGLND")) ;
absorb("total","aglnd")    = SUM(i, FCRDD.L(i,"AGLND")) ;

absorb("ag","GNP")         = SUM(agr, CONSDD.L(agr) + DST.L(AGR) + ID.L(agr)
                                 + GOVDD.L(agr) + E.L(agr) - M.L(agr)) ;
absorb("nonag","GNP")      = SUM(nagr, CONSDD.L(nagr) + DST.L(nagr)
                                 + ID.L(nagr) + GOVDD.L(nagr) + E.L(nagr)
                                         - M.L(nagr)) ;
```

```
absorb("total","GNP")      = absorb("ag","GNP") + absorb("nonag","GNP") ;

DISPLAY ABSORB ;

*#### OTHER PARAMETERS

INTINP(j)       = SUM(i, IO(i,j)*XD.L(j)) ;
NINTINP(j)      = SUM(i, P.L(i)*IO(i,j)*XD.L(j)) ;
PINT(i)         = SUM(j, IO(j,i)*P.L(j)) ;
YF(i,"CAPTL")           = WFDIST(i,"CAPTL")*WF.L("CAPTL")*FCRDD.L(i,"CAPTL") ;
YF(i,"LABR")            = WFDIST(i,"LABR")*WF.L("LABR")*FCRDD.L(i,"LABR") ;
YF(i,"AGLND")           = WFDIST(i,"AGLND")*WF.L("AGLND")*FCRDD.L(i,"AGLND") ;

PROFIT(i)       = (WFDIST(i, "CAPTL")*WF.L("CAPTL")*FCRDD.L(i, "CAPTL"))
                                          /(FCRDD.L(i, "CAPTL")*PK.L(i)) ;
AVGPROFIT        = SUM(i, WFDIST(i, "CAPTL")*WF.L("CAPTL")*FCRDD.L(i, "CAPTL"))
                                          /SUM(i, FCRDD.L(i, "CAPTL")*PK.L(i)) ;
*AVGWF(f)       = YFACTOR.L(f)/FS.L(f) ;
RENTAL(i)       = (WFDIST(i, "CAPTL")*WF.L("CAPTL")*FCRDD.L(i, "CAPTL"))
                                                  /(FCRDD.L(i, "CAPTL")) ;
RDIST(i)                = RENTAL(i)/WF.L("CAPTL") ;
VALADDMP(i)             = (PVA.L(i) + ((ITAXIN(i) - SUBSDR(i))*PX.L(i)))*XD.L(i) ;
VALADDFC(i)             = (PVA.L(i))*XD.L(i) ;
SUMVADDMP               = SUM(i, VALADDMP(i)) ;
SUMVADDFC               = SUM(i, VALADDFC(i)) ;
RMD(i)                  = M.L(i)/XXD.L(i) ;

DISPLAY AVGPROFIT, VALADDMP, VALADDFC, SUMVADDMP, SUMVADDFC ;

*FACTOR RETURNS

PARAMETER FACTORS1(i, rf)     FACTOR RETURNS DISTRIBUTIVE PARAMETERS ;
FACTORS1(i, "YFCAP")          = YF(i, "CAPTL") ;
FACTORS1(i, "PROFIT")         = PROFIT(i) ;
FACTORS1(i, "RENTAL")         = RENTAL(i) ;
FACTORS1(i, "RDIST")          = RDIST(i) ;
FACTORS1(i, "WDCAP")          = WFDIST(i, "CAPTL") ;
FACTORS1(i, "YFLABOR")        = YF(i, "LABR") ;
FACTORS1(i, "WDLABOR")        = WFDIST(i, "LABR") ;
FACTORS1(i, "YFLAND")         = YF(i, "AGLND") ;
FACTORS1(i, "WDLAND")         = WFDIST(i, "AGLND") ;
FACTORS1(i, "PINT")                   = PINT(i) ;
FACTORS1(i, "INTINP")         = INTINP(i) ;

PARAMETER FCTINC1(rar,rf)     FACTOR INCOME TABLE ;
FCTINC1("ag", "YFCAP")        = SUM(agr, YF(agr, "CAPTL")) ;
FCTINC1("ag", "YFLABOR")       = SUM(agr, YF(agr, "LABR")) ;
FCTINC1("ag", "YFLAND")               = SUM(agr, YF(agr, "AGLND")) ;
FCTINC1("ag", "VALADDMP")      = SUM(agr, VALADDMP(agr)) ;
FCTINC1("ag", "VALADDFC")      = SUM(agr, VALADDFC(agr)) ;

FCTINC1("nonag", "YFCAP")                     = SUM(nagr, YF(nagr, "CAPTL")) ;
FCTINC1("nonag", "YFLABOR")           = SUM(nagr, YF(nagr, "LABR")) ;
```

```
FCTINC1("nonag", "VALADDMP")        = SUM(nagr, VALADDMP(nagr)) ;
FCTINC1("nonag", "VALADDFC")        = SUM(nagr, VALADDFC(nagr)) ;

FCTINC1("total", "YFCAP")                  = SUM(i, YF(i, "CAPTL")) ;
FCTINC1("total", "YFLABOR")         = SUM(i, YF(i, "LABR")) ;
FCTINC1("total", "YFLAND")          = SUM(i, YF(i, "AGLND")) ;
FCTINC1("total", "VALADDMP")        = SUM(i, VALADDMP(i)) ;
FCTINC1("total", "VALADDFC")        = SUM(i, VALADDFC(i)) ;

DISPLAY FACTORS1, FCTINC1  ;



*###### SOCIAL ACCOUNTING MATRIX #######

SAM("COMMODITY", "ACTIVITY")      = SUM(i, (P.L(i)*INT.L(i))) ;
SAM("COMMODITY", "HOUSEHOLDS")    = SUM(i, (P.L(i)*CONSDD.L(i))) ;
SAM("COMMODITY", "GOVT")          = SUM(i, (P.L(i)*GOVDD.L(i))) ;
SAM("COMMODITY", "CAPACCOUNT")    = SUM(i, (P.L(i)*(DST.L(i) +ID.L(i)))) ;
SAM("ACTIVITY", "COMMODITY")      = SUM(i, (PX.L(i)*XD.L(i))
                        - (PE.L(i)*E.L(i))) ;
SAM("ACTIVITY", "GOVT")          = SUM(i, EXPSUB.L(i)) ;
SAM("ACTIVITY", "WORLD")          = SUM(i, ((EXR.L*PWE.L(i))*E.L(i))) ;
SAM("LABOUR", "ACTIVITY")         = YFACTOR.L("LABR") ;
SAM("CAPITAL", "ACTIVITY")        = YFACTOR.L("CAPTL") ;
SAM("LAND", "ACTIVITY")          = YFACTOR.L("AGLND") ;
SAM("ENTERPRISE", "CAPITAL")      = YFACTOR.L("CAPTL") ;
SAM("ENTERPRISE", "GOVT")         = NETGOVENT.L ;
SAM("ENTERPRISE", "WORLD")        = NETENTROW.L*EXR.L ;
SAM("HOUSEHOLDS", "LABOUR")       = YINCG.L("LABOR") ;
SAM("HOUSEHOLDS", "LAND")         = YINCG.L("PROP") ;
SAM("HOUSEHOLDS", "ENTERPRISE")   = YINCG.L("ENTERP") ;
SAM("HOUSEHOLDS", "GOVT")         = NETGOVHH.L ;
SAM("HOUSEHOLDS", "WORLD")        = NETHHROW.L*EXR.L ;
SAM("GOVT", "COMMODITY")          = TARIFF.L ;
SAM("GOVT", "ACTIVITY")          = INDTAXIN.L - SUBSD.L ;
SAM("GOVT", "ENTERPRISE")         = ENTTAX.L ;
SAM("GOVT", "HOUSEHOLDS")         = HHINCTAX.L + ITAXOUT("CONS")*(SUM(i,
                              P.L(i)*CONSDD.L(i))) ;
SAM("GOVT", "CAPACCOUNT")         = ITAXOUT("INV")*(SUM(i, P.L(i)*ID.L(i))) ;
SAM("GOVT", "WORLD")             = NETGOVROW.L*EXR.L ;

SAM("CAPACCOUNT", "ENTERPRISE")   = ENTSAV.L + DEPRECIA.L ;
SAM("CAPACCOUNT", "HOUSEHOLDS")   = HHSAV.L ;
SAM("CAPACCOUNT", "GOVT")         = GOVSAV.L ;
SAM("CAPACCOUNT", "WORLD")        = FSAV.L*EXR.L ;
SAM("WORLD", "COMMODITY")         = SUM(i, ((PWM(i)*EXR.L)*M.L(i))) ;
SAM(ISAM2, "TOTAL")              = SUM(ISAM3, SAM(ISAM2, ISAM3)) ;
SAM("TOTAL", ISAM3)              = SUM(ISAM2, SAM(ISAM2, ISAM3)) ;

OPTION DECIMALS=3 ;
DISPLAY SAM ;
```

Appendix 4.1.1. Reproduced Solution Values of the Base Year

Sectoral Prices[a]

	PX	PD	P	PVA	PK	PE	PM	PWE	PWM
Wheat	1.000	1.000	1.000	0.573	1.000	1.000	1.000	0.867	0.920
Small grains	1.000	1.000	1.000	0.474	1.000	1.000	1.000	0.909	0.956
Fruits & Vegetables	1.000	1.000	1.000	0.736	1.000	1.000	1.000	0.971	1.000
Livestock	1.000	1.000	1.000	0.166	1.000	1.000	1.000	0.969	0.959
Dairy & Poultry	1.000	1.000	1.000	0.330	1.000	1.000	1.000	0.961	0.707
Other Agriculture	1.000	1.000	1.000	0.550	1.000	1.000	1.000	0.972	0.994
Food Processing	1.000	1.000	1.000	0.314	1.000	1.000	1.000	0.979	0.921
Rest of Economy	1.000	1.000	1.000	0.486	1.000	1.000	1.000	1.000	0.981

[a] The reproduced unitary prices are in conformity with the base year prices since, following the common practice in calibrating CGE models, these were all set equal to one. (This practice leads demand and supply in the goods market to equilibrate at unitary prices and further implies that the sectoral flows in the base year are both real and nominal magnitudes (Robinson et al, 1990)).

Sectoral Output and Disposition[a]

	XD	INT	CONS-DD	INVEST	INVEN-TORY	GOV-DD	E	M
Wheat	3.036	1.068	0.090	0.004	-0.053	0.111	1.918	0.102
Small grains	2.263	1.315	0.250	0.006	-0.051	0.069	0.881	0.206
Fruits & Vegetables	1.308	0.616	1.931	0.001	-0.030	0.028	0.145	1.383
Livestock	6.917	4.811	0.852	0.053	0.151	0.102	1.200	0.252
Dairy & Poultry	5.407	5.054	0.226	0.010	0.014	0.039	0.212	0.147
Other Agriculture	3.995	2.908	0.909	0.012	0.064	0.076	0.382	0.356
Food Processing	39.791	15.122	24.527	0.321	0.375	0.106	5.476	6.135
Rest of Economy	934.64	459.44	327.18	127.01	-6.561	40.396	155.15	167.97
Agriculture	*22.926*	*15.814*	*4.258*	*0.085*	*0.094*	*0.425*	*4.738*	*2.446*
Non-agriculture	*974.43*	*474.52*	*351.7*	*127.33*	*-6.186*	*40.503*	*160.63*	*174.10*

[a] Values are in billions of constant Canadian Dollars.

Appendix 4.1.1 Cont'd

Value Added, Factor Demand and Factor Incomes[a]

	VAL - ADDM	VAL - ADDF	LABR	YF-- LABR	CAPTL	YF-- CAPTL	AGLND	YF - AGLND
Wheat	1.192	1.739	0.640	0.255	10.404	1.119	25.822	0.365
Small grains	0.667	1.073	0.948	0.377	13.588	0.529	26.202	0.167
Fruits & Vegetables	0.948	0.962	0.730	0.290	2.250	0.625	0.625	0.047
Livestock	0.938	1.146	1.581	0.628	17.198	0.414	28.159	0.104
Dairy & Poultry	1.086	1.785	1.834	0.729	8.907	0.955	7.188	0.101
Other Agriculture	2.280	2.197	1.653	0.657	6.515	1.285	4.149	0.255
Food Processing	12.552	12.481	12.355	6.531	17.173	5.950	0.000	0.000
Rest of Economy	487.36	454.46	542.71	286.88	1521.1	167.58	0.000	0.000
Agriculture	*7.112*	*8.902*	*7.386*	*2.935*	*58.861*	*4.927*	*92.143*	*1.039*
Non-agriculture	*499.92*	*466.94*	*555.06*	*293.41*	*1538.3*	*173.53*	*0.000*	*0.000*

[a] Values are in billions of constant Canadian Dollars.

Aggregate Variables[a]

VARIABLE	VALUE	VARIABLE	VALUE	VARIABLE	VALUE	VARIABLE	VALUE
EXR	1.000	HHINCTAX	101.485	SAVINGS	126.599	SHEXP	32.307
GNPVA	510.254	ENTTAX	15.015	INVEST	121.320	SHIMP	33.866
YHH	529.585	SUBSD	13.532	FXDINV	127.415	*Agriculture's*	*Terms*
GOVREV	183.796	TEXPSUB	0.516	DEPRECIA	82.332	*of Trade*	
INDTAXIN	44.719	ENTSAV	17.956	NETGOVENT	27.301	AGTOTPX	99.999
INDTAXOUT	44.261	GOVSAV	-37.691	NETGOVHH	152.741	AGTOTVA	81.033
GOVTOT	40.928	HHSAV	33.157	NETHHROW	3.573	AGTOTE	91.706
TARIFF	3.742	NETFSAV	30.844	NETGOVROW	-11.894	AGTOTM	99.128

[a] Values are in billions of Canadian Dollars.

Appendix 4.1.2. GAMS Program to Simulate the Effects of Multilateral Trade Liberalization

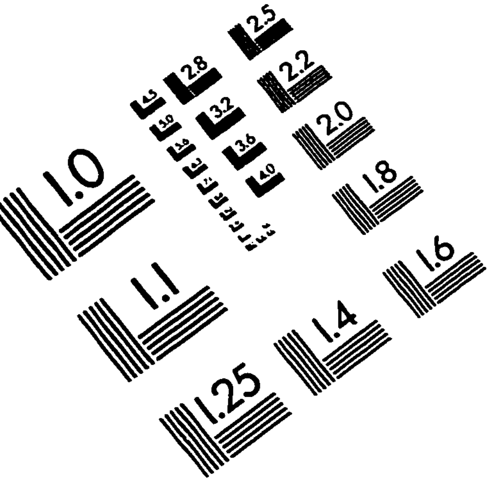
- The following GAMS program is developed to evaluate the effects of the URA on Canadian
- agriculture. The simulations involve URA induced changes in domestic policy parameters, such
- reductions in export subsidy, domestic support, import tariffs, and anticipated changes in the world
- prices of agricultural products

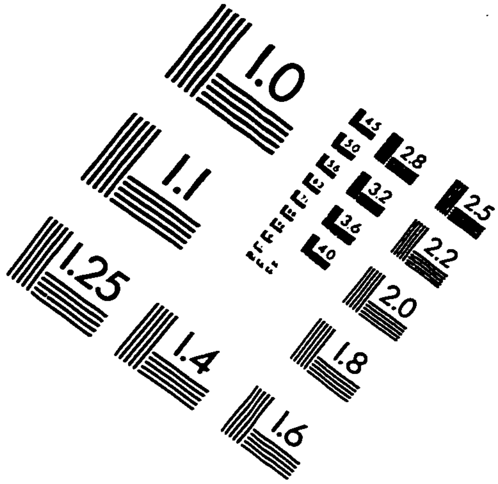
- The world prices below are increased by the "minimum" amount. The case of "maximum"
- increases in World prices is straightforward

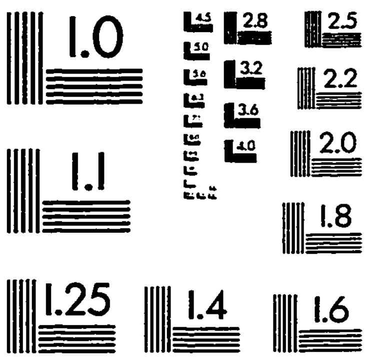
```
#####******########********
PWSE("WHEAT")       = PWSE("WHEAT")*1.04 ;
PWE("OTHERGRAIN")   = PWE("OTHERGRAIN")*1.04 ;
PWE("FRUITVEG")     = PWE("FRUITVEG")*1.0 ;
PWE("LVSTK")        = PWE("LVSTK")*1.0;
PWE("MILKPOULT")    = PWE("MILKPOULT")*1.0 ;
PWE("OTHERAG")      = PWE("OTHERAG")*1.04 ;
PWE("FOOD")         = PWE("FOOD")*1.01 ;

PWM("WHEAT")        = PWM("WHEAT")*1.04 ;
PWM("OTHERGRAIN")   = PWM("OTHERGRAIN")*1.04 ;
PWM("FRUITVEG")     = PWM("FRUITVEG")*1.0 ;
PWM("LVSTK")        = PWM("LVSTK")*1.0 ;
PWM("MILKPOULT")    = PWM("MILKPOULT")*1.0 ;
PWM("OTHERAG")      = PWM("OTHERAG")*1.04 ;
PWM("FOOD")         = PWM("FOOD")*1.01 ;

##########
SUBSIDY.L("WHEAT")       = SUBSIDY.L("WHEAT")*0.80 ;
SUBSIDY.L("OTHERGRAIN")  = SUBSIDY.L("OTHERGRAIN")*0.80 ;
SUBSIDY.L("FRUITVEG")    = SUBSIDY.L("FRUITVEG")*0.80 ;
SUBSIDY.L("LVSTK")       = SUBSIDY.L("LVSTK")*0.80 ;
SUBSIDY.L("MILKPOULT")   = SUBSIDY.L("MILKPOULT")*0.80 ;
SUBSIDY.L("OTHERAG")     = SUBSIDY.L("OTHERAG")*0.80 ;
SUBSIDY.L("FOOD")        = SUBSIDY.L("FOOD")*0.94 ;

SUBSDR("WHEAT")       = SUBSIDY.L("WHEAT")/(PX.L("WHEAT")
                        *XD.L("WHEAT")) ;
SUBSDR("OTHERGRAIN")  = SUBSIDY.L("OTHERGRAIN")/(PX.L("OTHERGRAIN")
                        *XD.L("OTHERGRAIN")) ;
SUBSDR("FRUITVEG")    = SUBSIDY.L("FRUITVEG")/(PX.L("FRUITVEG")
                        *XD.L("FRUITVEG")) ;
SUBSDR("LVSTK")       = SUBSIDY.L("LVSTK")/(PX.L("LVSTK")
                        *XD.L("LVSTK")) ;
SUBSDR("MILKPOULT")   = SUBSIDY.L("MILKPOULT")/(PX.L("MILKPOULT")
                        *XD.L("MILKPOULT")) ;
SUBSDR("OTHERAG")     = SUBSIDY.L("OTHERAG")/(PX.L("OTHERAG")
                        *XD.L("OTHERAG")) ;
SUBSDR("FOOD")        = SUBSIDY.L("FOOD")/(PX.L("FOOD")
                        *XD.L("FOOD")) ;
```

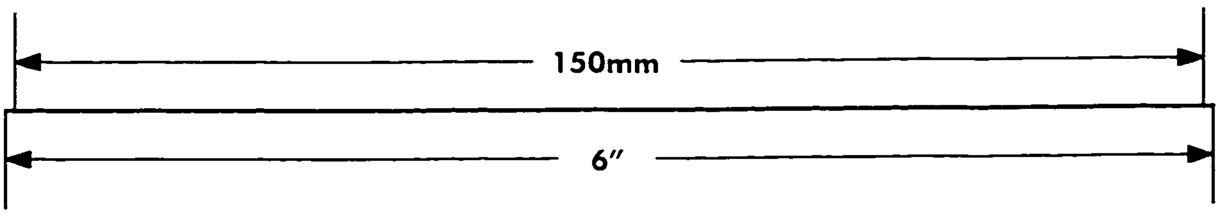
```
###########

EXPSUB.L("WHEAT")     = EXPSUB.L("WHEAT")*0.64 ;
EXPSUB.L(“OTHERGRAIN”) = EXPSUB.L(“OTHERGRAIN”)*0.64 ;
EXPSUB.L("FRUITVEG")  = EXPSUB.L("FRUITVEG")*0.64 ;
EXPSUB.L("LVSTK")     = EXPSUB.L("LVSTK")*0.64 ;
EXPSUB.L(“MILKPOULT”) = EXPSUB.L(“MILKPOULT”)*0.64 ;
EXPSUB.L("OTHERAG")   = EXPSUB.L("OTHERAG")*0.64 ;
EXPSUB.L("FOOD")      = EXPSUB.L("FOOD")*0.90 ;

TE("WHEAT") = EXPSUB.L("WHEAT")/(PE.L("WHEAT")*E.L("WHEAT")
                        - EXPSUB.L("WHEAT")) ;
TE(“OTHERGRAIN”) = EXPSUB.L(“OTHERGRAIN”)/(PE.L(“OTHERGRAIN”)
            *E.L(“OTHERGRAIN”) - EXPSUB.L(“OTHERGRAIN”)) ;
TE("FRUITVEG") = EXPSUB.L("FRUITVEG")/(PE.L("FRUITVEG")*E.L("FRUITVEG")
                        - EXPSUB.L("FRUITVEG")) ;
TE("LVSTK") = EXPSUB.L("LVSTK")/(PE.L("LVSTK")*E.L("LVSTK")
                        - EXPSUB.L("LVSTK")) ;
TE(“MILKPOULT”) = EXPSUB.L(“MILKPOULT”)/(PE.L(“MILKPOULT”)
            *E.L(“MILKPOULT”) - EXPSUB.L(“MILKPOULT”)) ;
TE("OTHERAG") = EXPSUB.L("OTHERAG")/(PE.L("OTHERAG")*E.L("OTHERAG")
                        - EXPSUB.L("OTHERAG")) ;
TE("FOOD") = EXPSUB.L("FOOD")/(PE.L("FOOD")*E.L("FOOD")
                        - EXPSUB.L("FOOD")) ;

####################
TAR.L("WHEAT")     = TAR.L("WHEAT")*0.358447 ;
TAR.L(“OTHERGRAIN”) = TAR.L(“OTHERGRAIN”)*0.500720 ;
TAR.L("FRUITVEG")  = TAR.L("FRUITVEG")*0.85 ;
TAR.L("LVSTK")     = TAR.L("LVSTK")*0.533869 ;
TAR.L(“MILKPOULT”) = TAR.L(“MILKPOULT”)*0.628595 ;
TAR.L("OTHERAG")   = TAR.L("OTHERAG")*0.85 ;
TAR.L("FOOD")      = TAR.L("FOOD")*0.777434 ;
TAR.L("RESTEC")    = TAR.L("RESTEC")*0.627108 ;

TM("WHEAT") = TAR.L("WHEAT")/(PM.L("WHEAT")*M.L("WHEAT")- TAR.L("WHEAT")) ;

TM(“OTHERGRAIN”) = TAR.L(“OTHERGRAIN”)/(PM.L(“OTHERGRAIN”)*M.L(“OTHERGRAIN”)
                              - TAR.L(“OTHERGRAIN”)) ;
TM("FRUITVEG") = TAR.L("FRUITVEG")/(PM.L("FRUITVEG")*M.L("FRUITVEG")
                              - TAR.L("FRUITVEG")) ;
TM("LVSTK") = TAR.L("LVSTK")/(PM.L("LVSTK")*M.L("LVSTK") - TAR.L("LVSTK")) ;

TM(“MILKPOULT”) = TAR.L(“MILKPOULT”)/(PM.L(“MILKPOULT”)*M.L(“MILKPOULT”)
                              - TAR.L(“MILKPOULT”)) ;
TM("OTHERAG") = TAR.L("OTHERAG")/(PM.L("OTHERAG")*M.L("OTHERAG")
                              - TAR.L("OTHERAG")) ;
TM("FOOD") = TAR.L("FOOD")/(PM.L("FOOD")*M.L("FOOD") - TAR.L("FOOD")) ;

TM("RESTEC") = TAR.L("RESTEC")/(PM.L("RESTEC")*M.L("RESTEC")
            - TAR.L("RESTEC")) ;

SOLVE CANADA91 MAXIMIZING GNPVA USING NLP ;
```

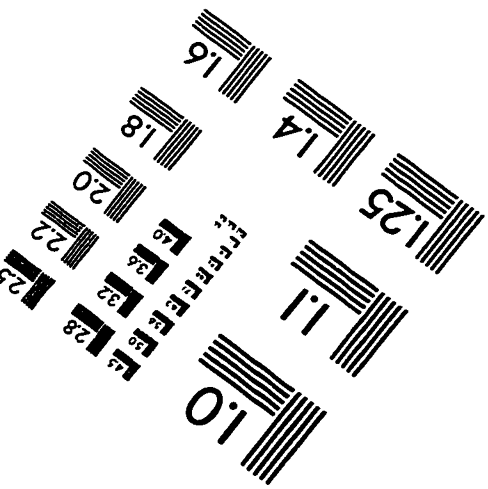
IMAGE EVALUATION TEST TARGET (QA-3)

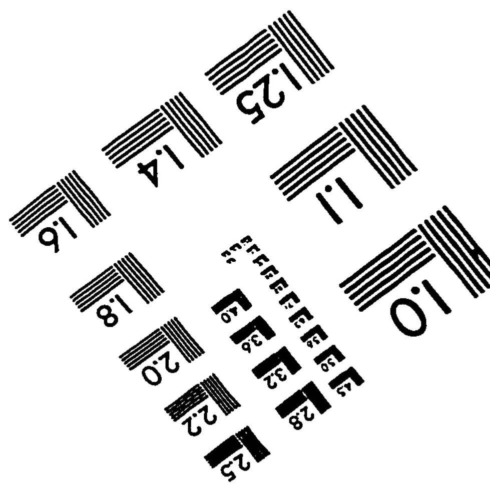












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