

1990

# Canadian agriculture factor retention under different policy regimes

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**Canadian agriculture factor retention under different policy  
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**Krakar, Janice Eileen, Ph.D.**

**Iowa State University, 1990**

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**Canadian agriculture factor retention  
under different policy regimes**

**by**

**Janice Eileen Krakar**

**A Dissertation Submitted to the  
Graduate Faculty in Partial Fulfillment of the  
Requirements for the Degree of  
DOCTOR OF PHILOSOPHY**

**Department: Economics  
Major: Agricultural Economics**

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I wish to dedicate this dissertation to my mother, who died September 2, 1988, and to my father.

## 1. INTRODUCTION

### 1.1 Background

For the last half century Canadian agriculture has been undergoing structural reform. Small labor intensive mixed semi-subsistence farms have evolved into large capital intensive specialized market-oriented businesses. Simultaneous to this farm size expansion, farm numbers have dwindled. Tables 1.1 through 1.4 highlight these trends. By altering the input configuration of agriculture, technological advancements have not only increased the quantity and quality of output produced, but have changed the very organization of the sector.

Agriculture reorganization has not been peculiar to Canada. Rather it has been the norm in most developed countries.<sup>1</sup> In each case, as in Canada, technological innovations have been the catalyst. Mechanization, building design modifications, irrigation devices,

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<sup>1</sup>The USDA (1981) describes similar structural changes for the United States, Wormell (1978) for Great Britain, Weinschenck (1973) for the European Community and Ogura (1982) for Japan.

**Table 1.1: Selected statistics reflecting technology adoption in Canadian agriculture<sup>a</sup>**

Characteristics	YEAR			
	1971	1976	1981	1986
Number of Farms (000)	366.1	338.6	318.4	293.1
Ave. Farm Size (acres)	463.4	499.4	511.4	571.8
Hired Help (weeks of paid labour)	10.5	10.9	14.2	19.5
Tractors Per Farm	1.63	1.88	2.07	2.48
Combines Per Farm	0.44	0.48	0.51	0.54
Swathers Per Farm	0.38	0.45	0.52	0.55
Area Fertilized Per Farm (acres)	46.8	N/A	143.6	195.2
Area Sprayed for Insects and Disease Per Farm (acres)	6.2	N/A	12.8	38.7
Area Sprayed for Weeds and Bush Per Farm (acres)	57.9	N/A	118.2	193.5

<sup>a</sup>Source: Statistics Canada, 1986.

Table 1.2: Farm classification by size, Canada<sup>a</sup>

Number and Percentage of Farms	YEAR			
	1971	1976	1981	1986
under 10 acres	14,214 ( 3.9%)	14,095 ( 4.2%)	16,413 ( 5.2%)	14,679 ( 5.0%)
10 - 69 acres	38,608 (10.5%)	40,573 (12.0%)	40,301 (12.7%)	35,561 (12.1%)
70 - 239 acres	127,544 (34.8%)	108,965 (32.2%)	99,000 (31.1%)	86,955 (29.7%)
240 - 399 acres	59,864 (16.4%)	52,859 (15.6%)	47,081 (14.8%)	42,799 (14.6%)
400 - 559 acres	35,821 ( 9.8%)	31,571 ( 9.3%)	27,759 ( 8.7%)	25,193 ( 8.6%)
560 - 759 acres	28,970 ( 7.9%)	26,616 ( 7.9%)	23,758 ( 7.5%)	21,897 ( 7.5%)
760 - 1119 acres	29,995 ( 8.2%)	29,513 ( 8.7%)	27,788 ( 8.7%)	26,294 ( 9.0%)
1120 - 1599 acres	16,753 ( 4.6%)	17,909 ( 5.3%)	18,283 ( 5.7%)	18,637 ( 6.3%)
over 1600 acres	14,341 ( 3.9%)	16,451 ( 4.8%)	17,978 ( 5.6%)	21,074 ( 7.2%)
Total	366,110 (100.0%)	338,552 (100.0%)	318,361 (100.0%)	293,089 (100.0%)

<sup>a</sup>Source: Statistics Canada, 1986.

**Table 1.3: Agriculture capital stock value, Canada  
(Millions Current Dollars)<sup>a</sup>**

Capital Stock	YEAR			
	1971	1976	1981	1986
Total Capital	\$ 24,067	\$ 57,054	\$130,304	\$109,676
Land and Buildings	\$ 16,936	\$ 43,555	\$103,275	\$ 80,088
Machinery & Equipment	\$ 3,909	\$ 9,034	\$ 17,444	\$ 20,766

<sup>a</sup>Source: Statistics Canada, 1986.

**Table 1.4: Farm classification by structural organization, Canada<sup>a</sup>**

Farm Number	YEAR			
	1971	1976	1981	1986
Individual or Family Farm <sup>b</sup>	336,159 (91.8%)	311,609 (92.0%)	293,827 (92.3%)	263,244 (89.8%)
Partnership with a Written Agreement	21,018 (5.7%)	11,832 (3.5%)	11,486 (3.6%)	12,147 (4.1%)
Legally Constituted Company				
- Family	7,080 (1.9%)	11,947 (3.5%)	10,742 (3.4%)	15,091 (5.1%)
- Other	911 (0.2%)	1,991 (0.6%)	1,247 (0.4%)	1,286 (0.4%)
Other Type	942 (0.3%)	1,173 (0.3%)	1,059 (0.3%)	1,321 (0.5%)
Total	366,110 (100.0%)	338,552 (100.0%)	318,361 (100.0%)	293,089 (100.0%)

<sup>a</sup>Source: Statistics Canada, 1986.

<sup>b</sup>Includes partnerships without written agreements.

fertilizers, pesticides, plant and animal genetic improvements, feed additives, and veterinary supplies have all served to enhance biological yields and/or land productivity. As these new and more capital intensive technologies were introduced into agriculture production processes, producers responded by enlarging their land holdings and by specializing their operations.

Consistent with behavioral rules derived under profit maximization, producers increased their land input as the marginal physical product of land, and hence the marginal value product of land increased relative to its cost, and specialized their operations to achieve scale economies associated with indivisible crop specific and livestock specific technologies. This expansion and specialization, on top of capital induced higher biological yields, caused output per worker to mushroom. Since the agriculture labor force did not proportionately adjust itself downward to compensate for increased labor productivity, total agriculture production outstripped demand, causing commodity prices to plummet. As the commodity prices spiraled downward, so did the value of human resources employed in agriculture.

This confluence of events gave rise to what was referred to in the 60s as "The Farm Problem" (Heady et al.,

1967). It created a disparity between the value of labor and land in agriculture and their value in nonagriculture. The disparity was evidence of an excess supply of resources in agriculture. Although the capital induced increases in the marginal physical products of labor and land had initially raised the marginal values of labor and land, the subsequent fall in commodity prices more than offset these marginal physical product increases, causing an overall net decline in marginal values. Labor resources began to migrate from agriculture and irreplaceable cultivatable land was sold into urban use.

The remnant agriculture producers were the most economically efficient. These were the producers with the superior managerial skills and technical know-how. These were the producers who were the most receptive to technological change. These producers tried to counterbalance the drop in commodity prices by cutting their per unit costs and by expanding their output. To achieve further scale economies associated with mechanization, these producers enlarged their land holdings by amalgamating with the abandoned holdings of the less efficient producers, and by using new land reclamation practices to bring previously unarable land into cultivation. To expand their output, they increased their



productivity by adopting more and more technological innovations in the form of new and improved variable capital inputs.

The surviving producers were so successful in their endeavors to increase output, total agriculture production continued to outstrip demand despite the lower labor base. As a result prices remained low and producers were encouraged to adopt even more technological innovations to realize even more cost savings and to achieve even higher productivity levels (Cochrane, 1958). The outcome was ever burgeoning supplies. Commodity markets could still not support all the producers, even though their number had been greatly reduced. As a result labor resources continued to be drawn from agriculture.

## 1.2 Statement of Problem

Purely from an economic efficiency view point, the exit of resources from agriculture does not constitute a public concern. Instead it can be argued that because of psychological perceptions concerning the intrinsic worth of farming as a way of life and labor market imperfections, labor resources have not left agriculture fast enough. The

migration of resources from agriculture is simply the way the economy is self-adjusting to restore efficiency after having been perturbed out of equilibrium by technological change. Resources are flowing to the sectors where they are most productive as measured by their value in that use. Left alone this self-adjustment process would continue until sufficient resources have left agriculture to restore parity between their marginal value in agriculture and in nonagriculture. However, this technology driven adjustment process has not been left alone.

Governments of developed countries, for various reasons, have tried to halt or at least temper the migration of labor from agriculture. Western European governments and the Japanese government wanted to alleviate growing social unrest by halting the flow of rural people to already overcrowded urban areas and to prevent the severe food shortages experienced during WWII from ever reoccurring by achieving self-sufficiency (Weinschenck, 1973; Wormell, 1978; and Ogura, 1982). North American governments wanted to maintain their historical comparative advantage in international markets and were urged by a nostalgic urban populace, fresh from the farm, to preserve the lifestyle of traditional family farms. In each developed country the government felt the private market

was not fully reflecting environmental, political, social and psychological positive externalities associated with retaining resources in agriculture. In short, the government felt that the private values of resources in agriculture underestimated their perceived social values.

This deviation between the private and perceived social values of agriculture resources provided the motivation for government intervention. Governments intervened by redistributing income from consumers and taxpayers to agriculture producers. This income redistribution was accomplished by a wide array of policy instruments, with the policy instrument mix varying across commodities, time and countries (OECD, 1987a-e).

The present global concerns are that: 1) government intervention in agriculture has gone beyond the point of mere income redistribution in many countries and is escalating into rampant agriculture protectionism; 2) government intervention is crippling many state treasuries; and 3) government intervention is providing uneven support across commodities and across countries creating huge inefficiencies in world production and trading patterns. In fact the concern about these matters has been so great agriculture has assumed a priority status in the ongoing negotiations for the General Agreement on Tariffs and Trade

(GATT).

There is a consensus of opinion among member countries subscribing to the GATT that if added economic order is to be achieved in international agriculture markets, domestic agricultural policies and border measures can no longer be exempted by waivers from the GATT code. The question is not whether, but how to get back to trade based on comparative advantage rather than on the size of each country's treasury. Because the noneconomic pressures that motivated governments to intervene in their agriculture sectors in the first place still exist to a large extent, it is unrealistic to expect that countries will adopt a completely nonintervening attitude toward their agriculture sectors. With this in mind, as a second best solution, the call is for global decoupling of farm income subsidies and farm production decisions.

It is being suggested that one way that governments can accomplish decoupling is to replace their production distortionary commodity specific policies with less distortionary lump sum income transfers. Although lump sum income transfers may still encourage higher production levels in a country than would occur without any government intervention, they should not encourage, unlike current commodity specific support policies, production of

commodities for which the country does not enjoy comparative advantage.

As part of the GATT negotiations, Canada will be committed to a particular policy reform. In the past 50 years, experience has shown that agriculture retention and use of resources over time can be and is influenced by the policies in play. Traditional trade theory states a country has comparative advantage in production of those goods which use the factors it has in greatest abundance most intensively. This means that the policy course Canada decides to pursue in the future can affect Canada's comparative advantage in agriculture trade by affecting long run primary resource availability to agriculture.

### 1.3 Statement of Intent

The purpose of this study is to compare the impacts two markedly different policy regimes have on Canada's long run resource use patterns. The policy regimes considered are the current commodity specific program, and a decoupled program that involves lump sum transfers to factors of production. In effect these two general policy regimes bound the likely outcome from the ongoing GATT

negotiations.

The study will be conducted in the framework of the Canadian Agriculture Model (CAM) and the Basic Linked System (BLS). The CAM is just one of many models that make up the BLS, a comprehensive system developed by the Food and Agriculture Program of the International Institute for Applied Systems Analysis (IIASA). The BLS is a recursive dynamic nonspatial general equilibrium world trade model (Fischer et al., 1988). It contains 18 national models, one of which is the CAM, 2 regional models and 14 more simplistic country grouping models. Together the 20 national and regional models account for over 80 percent of world population, over 80 percent of world land base, over 80 percent of world trade and over 80 percent of world agriculture production.

The CAM provides an ideal empirical testing ground for studying the longer run impacts of agriculture policies on factor markets. Because it is a general equilibrium model, the CAM encompasses both the factor and commodity markets, simultaneously tying agriculture input demand to agriculture output. This link allows the factor market to interact with, and react to agriculture policies through the commodity markets. Hence, the CAM is capable of handling both commodity specific policies and lump sum

transfers in a consistent fashion. This dual capability of the CAM facilitates the making of a meaningful comparison between the effects of commodity specific policies and lump sum transfers on agriculture resource retention and value. Because the CAM can be simulated interactively with the other country models in the BLS, the effects of fluctuating domestic agriculture resource levels on Canada's comparative advantage can also be analyzed. Of course, as with all models, the CAM is only an approximation of reality, and hence there is always room for improvement. To adapt the CAM for the proposed study, revisions are made to both the input and policy block specifications.

#### 1.4 Objectives

The overall purpose of this study is to analyze the long run implications of different agricultural policy regimes for resource markets. In particular the primary objectives are:

- 1) to determine longer run agriculture factor retention under continued current commodity specific policies;
- 2) to measure aggregate producer benefits generated by current commodity specific policies;

- 3) to determine longer run agriculture factor use under a decoupled policy regime which gives producers in aggregate, in the form of a lump sum transfer, equivalent benefits to what they would receive under a continuance of current commodity specific policies; and
- 4) to compare and contrast the implications current commodity specific policies have for resource markets with the implications lump sum transfer payments would have.

Incidental to these primary objectives, another set of objectives can be identified. These secondary objectives deserve mention as necessary prerequisites for the fulfillment of the primary objectives. They concern the refinement and extension of the CAM and are:

- 5) to strengthen the theoretical underpinnings for intersectoral resource assignment in the CAM;
- 6) to introduce the possibility for resource unemployment in the CAM; and
- 7) to develop structural representations for select agricultural policies in the CAM.

### 1.5 Procedures

The first step in the present study will be to prepare the CAM for the policy exercise. This involves partial respecification of the CAM's input and policy blocks. The



changes to be made to the input block will provide a more realistic and a more theoretically consistent factor market representation. Currently, the CAM assigns resources to the agriculture and nonagriculture sectors in a somewhat ad hoc manner. Resources are assigned to the different sectors according to the profitability of agriculture relative to nonagriculture as indicated through sector prices and output. This method for resource assignment will be replaced with one that adheres more closely to micro formulations of the production decision. Explicit specifications for resource demands of the nonagriculture and agriculture sectors will be derived. These resource demands will be reconciled to total supply through the adjustment of factor rents. Reconciliation in the land and capital markets will require the equating of resource demand to resource supply. Labor demand, however, will not be forced to equal labor supply. Labor unemployment will be permitted, setting the CAM apart from most computable general equilibrium models.

The changes to be made to the policy block are designed to provide more detail about the effects of selected measures, specifically supply management and stabilization programs, on agriculture resource use patterns. Currently, the CAM does not provide a formal

structural representation of these policies<sup>2</sup>, or for that matter any other agricultural policy instrument. Instead of stressing the mechanics of individual policies, the CAM concentrates on their combined effect on commodity prices. It determines the combined effect, as an aggregate tariff equivalent, using world to domestic price linkage equations incorporating a reduced form of the government's decision making process. Because this approach to policy representation does not let the effects of one instrument to be discerned from the effects of another, it will be dropped for the more important domestic policies. For these key policies, structural specification of their mechanics will be introduced into the CAM.

Once the necessary revisions to the CAM have been completed, the next step will be to simulate the CAM in conjunction with the other national and regional models in the BLS. Three policy simulations will be conducted. In the first simulation all the models in the BLS will be simulated as is to gain estimates for agriculture resource use patterns in Canada under status quo policy. In the

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<sup>2</sup>There is structural representation of the dairy supply management program to the extent production quotas are imposed. Other aspects of the program, however, such as the dairy target price and producer direct payments, lack formal structural representations.

second simulation, all the models, except those for the Centrally Planned Economies, will be simulated with their policies dismantled to gain estimates for agriculture resource use patterns under multilateral trade liberalization. Producer benefits of the status quo policy course will be determined as the difference between producers net income between these two scenarios. In the third simulation all the models, except the CAM, will have the same policy framework as in the status quo scenario. The CAM will have commodity policies dismantled as for free trade, but will accommodate the transfer of lump sum payments to producers in amounts equal to the aggregate producer subsidy equivalent of status quo policy.

## 1.6 Organization

Chapter 2 summarizes the significant behavioral features of each primary factor. Chapter 3 addresses the question "to what extent" and "how" these features are incorporated in the revised input block for the CAM. Chapter 4 briefly surveys present Canadian agricultural policy, then describes its structural representation in the

CAM. Chapter 5 evaluates longer run agriculture factor use patterns under the status quo policy course and compares these results to those that would evolve under multilateral trade liberalization. Chapter 6 then explores the question what would happen to agriculture resource usage if all the producer benefits of current commodity specific policies were instead made to producers as lump sum transfers. Finally, Chapter 7 reviews the findings of this study, draws conclusions, and identifies areas in need of further research.

## 2. RESOURCE MARKETS

### 2.1 Introduction

This chapter provides a review of land, labor and capital behavioral features. Emphasis is placed on identifying behaviors peculiar to agriculture employment and presenting dominant theories on how these anomalies arise.

### 2.2 Land Behavioral Features

#### 2.2.1 Farmland disappearance in the rural-urban fringe

Land can easily be converted from agricultural use to nonagricultural use, but the reverse is seldom true. Once the concrete has been poured for commerce and industry, for highway and airport construction, and for residential housing and recreational use, the land is virtually beyond recall to agriculture. Land is perfectly mobile between the agriculture sector and the nonagriculture sector in one direction alone. In the other direction land is completely

immobile. This one way mobility is a policy concern since the majority of land that is moving from agriculture into nonagriculture use is from Classes I and II. The best land for cultivation also happens to be the best land for commercial development.

Land mobility, which in this case is the same as farmland disappearance, depends on sector differences in land rewards. However, since the farmland owner is usually also the farm operator, farmland disappearance depends as well on sector differences in labor rewards, and on the demographic characteristics and psychological preferences of farm operators (Keene 1979). Further, farmland disappearance is not the same for all regions. It is greatest in the rural urban fringes of metropolitan areas. Because the rate of farmland disappearance varies by geographical location, farmland loss poses more of a threat to some agriculture industries than others. For example, in Canada, farm land loss poses more of a threat to fruit and vegetable production clustered around major cities than to grain production in the Prairie grasslands.

#### 2.2.2 Land supply as a growth factor

Despite agriculture land absorption by nonagriculture, the agriculture land base has been increasing over time.

Irrigation, drainage controls, and development of improved chemical inputs have decreased the need for summerfallowing, and have allowed marginal lands to be more fully integrated into agriculture use (see Table 2.1). In addition breeding of hardier plant varieties with shorter growing seasons has permitted cultivation to creep northwards and has expanded double cropping. But the reclaimed land serves only as an imperfect substitute for the farm land loss in rural-urban fringes. More inputs, implying a higher cost of production, are needed to get the same yield on this reclaimed land than on the original land base.

### 2.2.3 Agricultural productive versus market value

The market value of farmland is often greater than can be justified by its agriculture productive value, where agriculture productive value is the present value of the expected stream of earnings from the land in agriculture employment. The agricultural economics literature offers several explanations for this value discrepancy. While no one explanation can account for all the difference between the market value of farmland and its agriculture productive value, each explanation provides a partial account with its importance varying by geographic location and by general

Table 2.1: Agriculture land use in Canada<sup>a</sup>

000's Acres	YEAR			
	1971	1976	1981	1986
Total Farm Area <sup>b</sup>	169,664	169,082	162,815	167,607
Improved Area	108,147	109,285	113,969	113,693
Crops	68,765	70,038	76,518	81,993
Summerfallow	26,741	26,984	23,974	21,002
Pasture	10,224	10,041	10,884	8,795
Other	2,417	2,222	2,592	1,904

<sup>a</sup>Source: Statistics Canada, 1986.

<sup>b</sup>In 1981 unimproved farm land in Western Canada was under reported.



economic conditions.

One explanation is that land is a consumptive good as well as a factor of production. Studies which have taken this approach (Martin and Jeffries, 1966; Pope, 1985) assume the market value of a parcel of land is equal to its agriculture productive value plus its consumptive value. Other explanations are concerned with the investment value of land. Most hypothesize that speculators bid-up the price of agriculture land in the anticipation land values will appreciate as the nonagriculture sector increases its demand for land (Melichar, 1979; Castle and Hoch, 1982; Burt, 1986). Feldstein (1980) offers a variation on this theme. He hypothesizes that inflation spurs the demand for land as an asset holding. Inflation, by depressing the return of other assets such as gold and bonds, motivates investors to enlarge their land holdings at the expense of the other assets in their portfolio.

The explanations of greatest importance for this study are those that attribute the value difference to capitalized benefits of government programs. One of the explanations focuses just on government programs that combine mandatory production controls with price supports. In Canada this has relevance for the supply managed dairy and poultry industries, particularly in the provinces where

production quotas are attached to farms. The theory is that the value of the production quota, as a license to produce a commodity that has a price supported above average total cost, is capitalized into farmland value. This implies that only initial quota recipients receive benefits from government programs combining mandatory production controls with price support. Capitalization of quota values into land prices, by raising the average total cost of production to the commodity price support level, eliminates all program benefits for future quota holders by eliminating economic rents.

Technological advances aggravate the problem of quota rents (Chryst, 1965). Technological advances, by increasing output, cause more restrictive quotas to be set which in turn raise quota values. This increase in quota values becomes capitalized into land prices, increasing the wedge between the price of land that has quota tied to it and the price of land that doesn't. Further this capitalization process is to some extent irreversible. Bullock et al. (1977) show that if quotas are removed, land values will rarely decline to their pre-capitalized levels. The amount by which they decline depends upon the productivity of the land, and the number of viable alternative uses for it.

Herd and Cochrane (1966) argue that all government price support programs are responsible for inflated farmland prices when technological advances are being made, not just the programs that combine production controls with price supports. Their theory is as follows: Technological advances decrease unit costs of production. Government price support programs prevent commodity prices from dropping correspondingly. Consequently, marginal revenues of individual commodity producers exceed their marginal cost. Individual producers react rationally and try to increase output. As they increase output, they increase land demand. The resulting competition for additional land input drives-up the price of land, increasing average unit costs, until all economic rents are dissipated.

## 2.3 Labor Behavioral Features

### 2.3.1 Labor supply as a growth factor

Total labor supply in an economy is a function of the economy's demographic make-up, institutional framework, and economic health. Ignoring immigration inflows and outflows, labor supply can be altered in the short run by altering the participation rate and/or the average hours

worked per labor force participant. The standard utility maximizing labor-leisure choice model hypothesizes that the short run labor supply curve is backward bending above some real wage rate level. This model implies that once the real wage rate passes beyond this crucial level, the income effect of a further increase in the real wage rate will dominate the substitution effect.

Long run labor supply ultimately depends on the population growth rate. The population growth rate, in turn, is influenced by prevailing institutional and social norms such as government retirement pensions, educational requirements, and health service cost and availability.

### 2.3.2 Labor quality

Over time the quality of labor has been increasing. The income earning potential of an individual today is greater than it was 50 years ago. This improvement in quality, due to human capital formation, can be attributed to several factors. One of the two most readily identified factors is that the general populace has improved access to formal education and greater leisure to pursue studies. The second factor is that laborers have increased experience in working with modern technology. Skill acquisition comes along with this experience, and is passed

on from employee to employee through on the job training. Complementing the above two factors has been a general improvement in individuals' physical health due to medical advances. People's receptiveness to new knowledge and their ability to retain this knowledge is correlated with their physical well-being.

### 2.3.3 Voluntary labor unemployment

The most conspicuous labor market imperfection is unemployment. Labor unemployment can be either voluntary or involuntary. Voluntary unemployment is exactly what the name implies: workers are unemployed because they choose to be. Search theory (Phelps, 1970; Diamond, 1981) explains this choice as the natural outcome of job and worker heterogeneity. Jobs differ in the wages they pay, the training and skills required to perform them and by geographic location. Workers also differ. They have different reservation wages, different abilities and different location affinities. Since prospective workers do not have complete information about employment opportunities, they must job search. On receiving a job offer, the individual worker evaluates it according to wages paid, and the moving and training costs involved in accepting the job. Because it is difficult or even

impossible to hunt for jobs while employed, it is to the individual worker's advantage to refuse job offers until an attractive one is received.

An advantage of this frictional view of unemployment is it can be reconciled to a Walrasian labor market equilibrium. So long as the number of job seekers equals the number of job vacancies, i.e., excess demand equals excess supply, the wage rate has no tendency to change, and equilibrium is achieved in the presence of an uncleared labor market (Phelps, 1970).

#### 2.3.4 Involuntary labor unemployment

Involuntary unemployment occurs when unemployed workers, who are willing to work for less than the going wage rate, can't find jobs. Its existence is more troublesome for standard economic theory than voluntary unemployment. It is contrary to the standard conceptualization of a Walrasian equilibrium. As a result of this inconsistency alternative theories have been advanced to justify this observed behavior of labor markets.

One theory is that the labor market is simply in disequilibrium (Briguglio, 1984; Rosen and Quandt, 1978; Barro and Grossman, 1971). Involuntary unemployment is

just a temporary aberration that occurs while the labor market moves between states of rest.

The other theories account for involuntary unemployment at labor market equilibrium. These theories can be subdivided into those which operate in a Walrasian equilibrium framework and those such as Negishi (1977) and Hahn (1978) that dismiss the Walrasian equilibrium framework as inappropriate, and propose nontatonnement equilibrating processes.

The theories that operate in a Walrasian equilibrium framework can be further subdivided into those that make use of implicit contractual arrangements between firms and employees and those that make use of the efficiency wage hypothesis. Contract theory postulates that because firms are less risk averse than employees, informal understandings arise between them on acceptable wage responses to changing economic circumstances (Baily, 1974; Azariadis, 1975). Since these 'understandings' guarantee employees real wage security, the firm's only viable response to uncertain demand is labor input adjustment. The drawback to contract theory is that although it accounts for involuntary unemployment at equilibrium, the portrayed equilibrium is one with higher employment than would be generated in an auction market (Oswald, 1986).

Efficiency wage theory assumes a positive relationship between the wage a worker receives and the effort exerted on the job. Yellan (1984) states that four mutually compatible rationalizations of this relationship have been advanced in the literature: the shirking model, the labor turnover model, the adverse selection model, and the partial gift exchange model.

The shirking model, tendered by Shapiro and Stiglitz (1984), assumes that workers dislike exerting effort because it reduces their utility. Because firms find it impossible to perfectly monitor their employees' performances, individual firms begin to offer wages higher than the market clearing rate as an incentive to their employees not to shirk. Unfortunately, as all firms adopt this practice, the wage padding, in and of itself, loses its effectiveness in discouraging shirking. But all is not lost, since the padded wages have shrunk labor demand, thereby creating unemployment. This induced unemployment serves to replace the padded wages as a work incentive. With unemployment, a worker knows that if he is caught shirking and fired, he cannot immediately gain other employment. While padded wages start out as a 'carrot' for encouraging work effort, they end up as a 'stick'. Equilibrium is reached when all firms find it optimal to



offer the same wage rate. This wage rate is necessarily above the market clearing rate since at full employment there is no incentive whatsoever for workers not to shirk. At full employment a worker knows that if he is fired, he can immediately find another job. The equilibrium unemployment level is that which provides a sufficient deterrent to workers that they are unwilling to chance being caught shirking.

The major objection to this model is that seniority wage schemes, performance bonds and other such employment contracts can substitute for involuntary unemployment as work incentives (Carmichael, 1985). The defense given to this objection is the moral hazard problem (Shapiro and Stiglitz, 1984; 1985). Firms, under these latter schemes, have the incentive to declare workers shirking so they can either replace them with cheaper new employees or appropriate their bonds. Shapiro and Stiglitz argue that the firm's concern for its reputation can at best mitigate this problem, it can not solve it.

The only real difference between the labor turnover model and the shirking model is the reason why firms are initially motivated to raise their wage offerings above market clearing levels. Salop (1979) hypothesizes that firms offer padded wages to gain their employees loyalty,

and thus reduce costly labor turnover. The resulting equilibrium of this labor turnover model is the same as that for the shirking model. Unemployment caused by the padded wages, serves to replace the padded wages as an incentive for long term firm-employee affiliation.

The adverse selection model, proffered by Weiss (1980), posits that a worker's reservation wage is positively correlated with his ability. This means that if a firm requires workers of a certain skill standard, it has to pay wages that are attractive to workers of this standard. It is not in the firm's interest to hire workers who are willing to work for less than this minimum wage since their willingness to work indicates to the firm that they do not have the required skill.

The partial gift exchange model incorporates sociological interplay into the economic setting. Akerlof (1982) states that "workers acquire sentiment for each other and also for the firm. As a consequence of sentiment for the firm, the workers acquire utility for an exchange of "gifts" with the firm.... On the worker's side, the "gift" given is work in excess of the minimum work standard; and on the firm's side the "gift" given is wages in excess of what the workers could receive if they left their current jobs. As a consequence of worker sentiment

for one another, the firm cannot deal with each worker individually, but must ... treat ... workers ... collectively."

#### 2.3.5 Agriculture labor categories

Agriculture labor falls into four different categories: farm operator, farm family, hired, and migrant. Migrant labor distinguishes itself from the other categories on basis of length of employment and required skills. Since little skill is required by migrant laborers, and they are employed for such brief periods, migrant labor is usually not considered a limiting factor in agriculture labor market studies, and as a result is typically ignored. Rather the concern focuses on how distinct the other three categories are from one another. Because hired labor wages are all that can be directly observed, the standard practice is to assume operator and family labor receive the same wage rate as the hired help, and to lump them together as a single input (e.g., Weaver, 1983; Lopez, 1980; Binswanger, 1974). The implication is they are perfect substitutes for each other.

Lopez (1984) argues against this approach. He states that operator labor and hired labor should be treated as different inputs since they engage in different activities

on the farm. Operators perform administrative and entrepreneurial labor services while hired laborers perform more manual services. Given that this is the case, the question is what is the appropriate measure of return to operator labor. Lopez states that the appropriate measure is operator labor's opportunity cost, the nonagriculture wage rate. Tyrchniewicz and Schuh (1969) propose net farm income to family labor per family worker as a candidate. Clark and Brinkman (1984) assume farm operators receive hired labor wages plus a premium for their managerial services. They estimate the premium as  $1/2$  the hired wage rate times  $1/3$  the number of hours worked by both the operator and the hired help on the average farm.

#### 2.3.6 Agriculture - nonagriculture wage discrepancy

The fact that labor returns in agriculture are below returns in nonagriculture is well documented. At dispute is the reason for the discrepancy. One explanation is that agriculture laborers receive sufficient satisfaction from the 'farming' lifestyle (i.e., from living in a rural community, being their own boss, working close to nature, etc.) to compensate them for their lower returns. In other words, agriculture laborers are earning psychological income on top of their monetary income, and if this

psychological income is properly commensurated, the measured difference between agriculture and nonagriculture returns would disappear. The discrepancy between the returns in the two sectors, however, is too large to accept this theory as a total explanation.

Tweeten's (1969) labor adaptation of the Fixed Asset Theory (Johnson, 1956; Edwards, 1959) tries to explain the remaining difference between sector returns after the psychic income has been accounted for. This theory states that there is a difference between the acquisition cost of agriculture labor and its 'salvage value'. The 'salvage value' is the critical value for labor movement. Labor will only move from agriculture when its marginal value product in agriculture falls below its salvage value. Since demographic characteristics of the agriculture labor force, such as a high age mean and lack of formal education, depress agriculture workers' employment value in the nonagriculture sector and their 'salvage value' lies below this nonagriculture employment value by the amount of psychic income they earn from farming, labor becomes trapped in agriculture in times of falling commodity prices, and overproduction results. Johnson and Pasour (1981) argue that this fixed asset theory is erroneous in its use of acquisition prices as the bench mark for optimal

resource determination. The appropriate measure is the resource's opportunity cost. When assets are valued in terms of their opportunity cost, the excess resource usage implied by the fixed asset theory becomes incompatible with rational producer behavior. Further the growing number of farmers who supplement their farm income by engaging in off-farm work casts doubt as to whether the employment value of agriculture workers in nonagriculture production is actually that low. The experience they gain in off-farm work should increase their nonagriculture employment value.

Tweeten's preferred explanation is that a combination of imperfect competition, government intervention and imperfect information flows trap agriculture workers in the agriculture sector. Labor unions, as artificial monopsonies, preclude agriculture workers from gaining entry to certain industries in the nonagriculture sector. Government intervention in the form of minimum wage rates, anti-discriminatory regulations, and other regulations designed to protect employees, put barriers in the way of nonagriculture firms seeking to hire former agriculture workers. Finally, imperfect information dissemination on job availability in the nonagriculture sector retards agriculture workers out migration.

### 2.3.7 Labor and farm programs

Labor's share of agriculture program benefits is the flip side of the capitalization of agriculture program benefits into land values. Various studies (Teigen, 1988; Gertel, 1985; Clark and Brinkman, 1984; Reinsel and Krenz, 1972) have estimated that a high proportion of farm program benefits are capitalized into land values. This implies that the true long run beneficiaries are land owners, not farm operators. Viewed in another way, farm programs only service a very selective clientele, just a subset of all producers. The clientele must meet two requirements. First, they must be the farm owners as well as the farm operators. Second, they must be the first generation farm owners since the programs were initiated. Of this selected clientele, producers with large land holdings are favored over those with small land holdings.

## 2.4 Capital Behavioral Features

### 2.4.1 Capital heterogeneity

Static capital heterogeneity is illustrated by noting that capital is a catchall for buildings, machinery and

equipment. Dynamic capital heterogeneity is illustrated by noting the changing composition of capital stock as conventional capital items are replaced by new innovations and by noting the quality improvement that distinguishes individual capital units of the same type across time.

#### 2.4.2 Asset fixity

A long standing theory is asset fixity traps durable resources in agriculture, causing supply irreversibility and overproduction. This theory in the last decade has been severely attacked. Johnson and Pasour (1981), as reviewed in Section 2.3.6, attack the most popular explanation for this asset fixity, the fixed asset theory. Chambers and Vasavada (1983) suggest an alternative explanation for asset fixity. They posit the cause to be the uncertain decision making environment. But when they proceeded to test for asset fixity arising from this cause, they found little empirical evidence to confirm its existence. They conclude there is no excess capital usage in agriculture, except possibly on a stochastic basis. On average capital usage equals optimal requirements.



## 2.5 Summary

Based on the factor market features identified in the previous sections, the following are plausible assumptions to make concerning land, labor, and capital behavior in a computable general equilibrium model of the agriculture and nonagriculture sectors:

- 1) Factor supplies are not perfectly inelastic, but upward sloping functions of factor rents.
- 2) Capital is heterogenous in composition. Individual units of capital differ in potential efficiency from one sector to the other. As a result, in aggregate, capital is an imperfect substitute for itself in different sectors. The same holds true for labor.
- 3) Neither capital nor labor is perfectly mobile across sectors.
- 4) While the absolute mobility of capital and labor is the same in either direction of movement among sectors, the absolute mobility of land is not. Land is unidirectional mobile towards nonagriculture.
- 5) Psychological preferences and demographic characteristics of land owners and laborers influence land and labor mobility, respectively.
- 6) Land is a consumption and an investment good, as well as a factor of production. Its market value reflects all these end uses.
- 7) Because land supply is more inelastic than the other two primary factors, farm program benefits become capitalized into land rental rates.

- 8) New additions to labor and capital stock, irrespective of sector, are more efficient than those already employed. In contrast, new additions to land stock in the agriculture sector are less efficient than land already employed in agriculture.
- 9) Voluntary and involuntary labor unemployment coexist.
- 10) Labor's efficiency as a factor of production in the nonagriculture sector varies with the wage rate.

Conceptually, the idea of incorporating all the above assumptions as maintained assumptions in the CAM is appealing. Practically, the ideal loses its appeal. It is doubtful whether the additional information this exercise would provide would be worth its cost in terms of manhours and computer expenditures needed to fully respecify and estimate the model, and in terms of loss of model interpretability. Consequently, as will be seen in the next chapter, only the more pertinent and more easily incorporated behavioral features are reflected in the revised input block of the CAM.

### 3. RESOURCE MARKET SPECIFICATION OF THE CAM

#### 3.1 Introduction

This chapter describes the factor market specification of the CAM. The specification has been revised from that contained in earlier versions of the CAM. The revisions were made with the dual intent of obtaining a more realistic and a more theoretically consistent specification. Section 3.2 starts the discussion with an explanation of how the CAM operates and how it interacts with the other national and regional models within the BLS. An overview of the CAM's revised input block is given in Section 3.3. After providing this general background information, the chapter proceeds with a more detailed specification and estimation procedures description of the CAM's revised input block. Data sources are listed in Section 3.4. They are followed by equation analyses in Sections 3.5 through 3.7. Model validation statistics are presented in Section 3.8.

### 3.2 Overview of the CAM and the BLS

The BLS is a recursive dynamic nonspatial computable general equilibrium world trade model system that links together a set of national and regional models, one of which is the CAM. The CAM, as is standard with all the other models within the BLS, consists of three blocks: an exchange block, a production block and a policy block. Commodity supply for period  $t$  is predetermined in period  $t-1$ . In period  $t$ , the CAM's exchange block, taking commodity supply as given, interacts simultaneously with the exchange blocks of all the other national and regional models of the BLS to determine world prices. World prices are calculated to be those for which the sum of trade deficits over all countries is zero. As world prices are determined, the CAM's exchange block is also interacting simultaneously with portions of the CAM's policy block to determine domestic prices and demand. The domestic prices outputted at this stage are fed into the production block. The production block, interacting simultaneously with the remaining portions of the policy block, uses the inputted domestic prices to determine commodity supply for period  $t+1$ . The solution of the production block is completely recursive to that of the national exchange block. Figure

3.1 illustrates the structure of the solution process of the BLS for a hypothetical two country world. Figure 3.2 illustrates the structure of the CAM. The latter diagram can be viewed as an elaboration of Figure 3.1.

### 3.3 Overview of the CAM's Factor Market Structure

Three primary factors are accounted for in the CAM: land, labor and capital. Each factor grows at a prescribed rate over time, but is in fixed supply in any given year. All three factors constrain agriculture production, but only labor and capital constrain nonagriculture production. The technology in each sector exhibits constant returns to scale, allows for factor substitution in the production process, and accommodates technical change.

All three factors are internationally immobile. Land and capital are intersectorally immobile as well. Labor is permitted limited movement across sectors. Workers are free to leave their sector of current employment, but have no guarantee of obtaining work in the competing sector. With positive probability, workers moving between sectors will end up in the unemployment pool. Within the agriculture sector itself, all three factors have

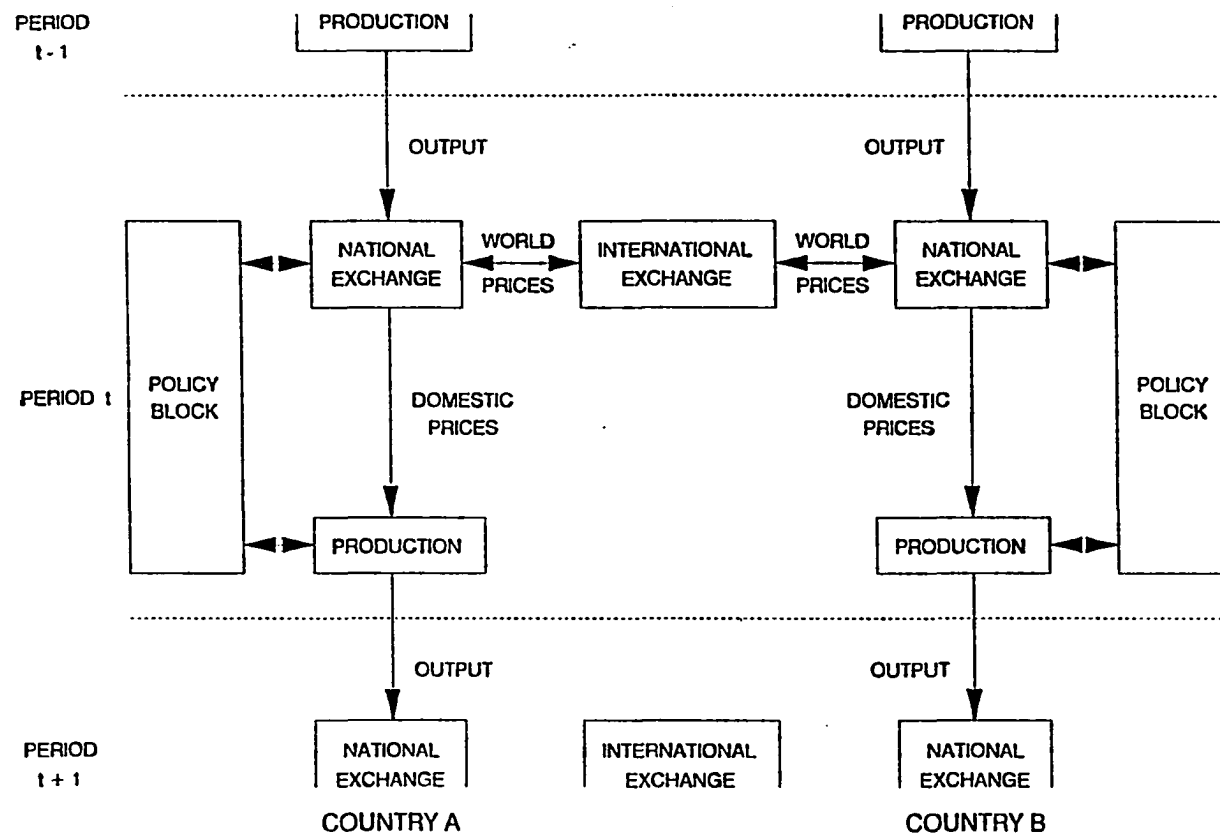


Figure 3.1: Structure of the Basic Linked System for a two country world

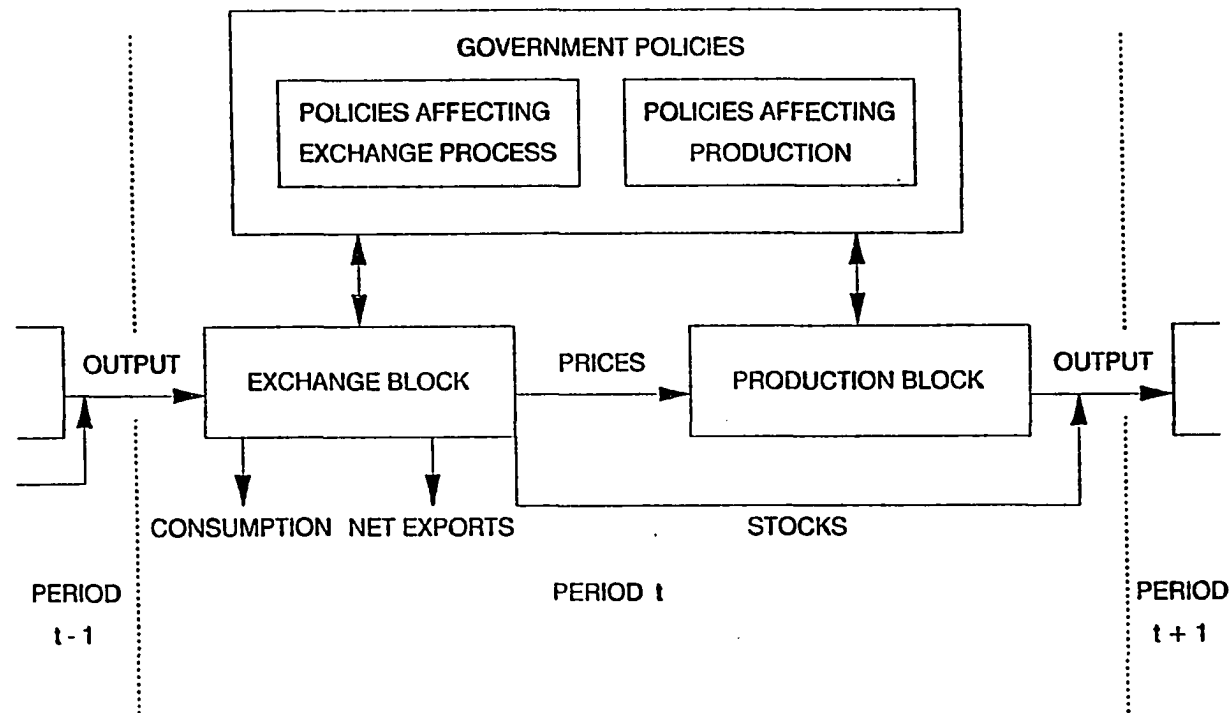


Figure 3.2: Structure of the Canadian Agriculture Model

restricted mobility.

Labor and capital investment are not sector specific in their efficiency potential. As a consequence they can be assigned to either sector. They are allocated to each sector according to input demand functions estimated for that sector. The labor and investment capital markets are assumed to achieve Walrasian equilibrium in each period in the sense factor rewards are the equilibrating adjustment mechanisms.

The capital services available to each sector are assumed directly proportional to the operative capital stock owned by that sector. Each sector's operative capital stock in any given period includes investments made in that period plus undepreciated capital stock remaining from investments made in previous periods. Capital stock is assumed to depreciate according to a geometric decay pattern. Because capital investment takes on 'clay' qualities after its initial sector assignment, capital rewards are allowed to vary across sectors (Jones, 1971). In any given year the capital rewards in the two sectors adjust in unison with one another until equilibrium is attained in the investment capital market. Equilibrium is attained when investment demand equals investment supply.

Equilibrium in the labor market does not require full



employment. Two types of unemployment exist: voluntary and involuntary. Voluntary unemployment is the type depicted in job search theory (Phelps, 1970) and is captured by exploiting Okun's Law. Involuntary unemployment is the type depicted in efficiency wage theory (Stiglitz, 1976). As in the capital investment market, wages in the two sectors adjust with one another in any given year until labor market equilibrium is attained. Equilibrium is attained when labor demand plus unemployment equals labor supply.

Labor and capital assigned to the agriculture sector in any given year are distributed between enterprises, within labor and capital mobility constraints, according to expected net profitability of each enterprise. The labor and capital allocation is not forced to equate the marginal value products of labor and capital, respectively, between the different enterprises. Although land, labor and capital rewards are not explicitly included when calculating the expected net profitability of each enterprise, they are implicitly included in the allocation decision. Grossman (1983) shows that when one or more factors are imperfectly mobile, factor returns are functions of final commodity prices and total endowments of each factor. Since the allocation decision within the

agriculture sector is a function of the same variables that theoretically determine labor and capital rewards, that is a function of all agriculture commodity prices and total availability of land, labor and capital, it is argued labor and capital in the agriculture sector move in response to a reduced form representation of their rewards.

### 3.4 Presentation Organization

Figure 3.3 presents a diagrammatic view of the CAM's revised production block. In this block commodity factor usage is calculated in three stages. Stage 1 fixes the total supply of each factor that is available for allocation. Stage 2 solves for factor rewards, allocates factors between sectors, determines factor unemployment and calculates nonagriculture production. Stage 3 takes the factors allocated to the agriculture sector, distributes them between the various agriculture commodities, and determines agriculture production, both total and individual commodity output. Specification and estimation results for each stage are presented in the next three sections. Short shrift, however, is given to stage 3 because it is the same as in earlier model versions. More

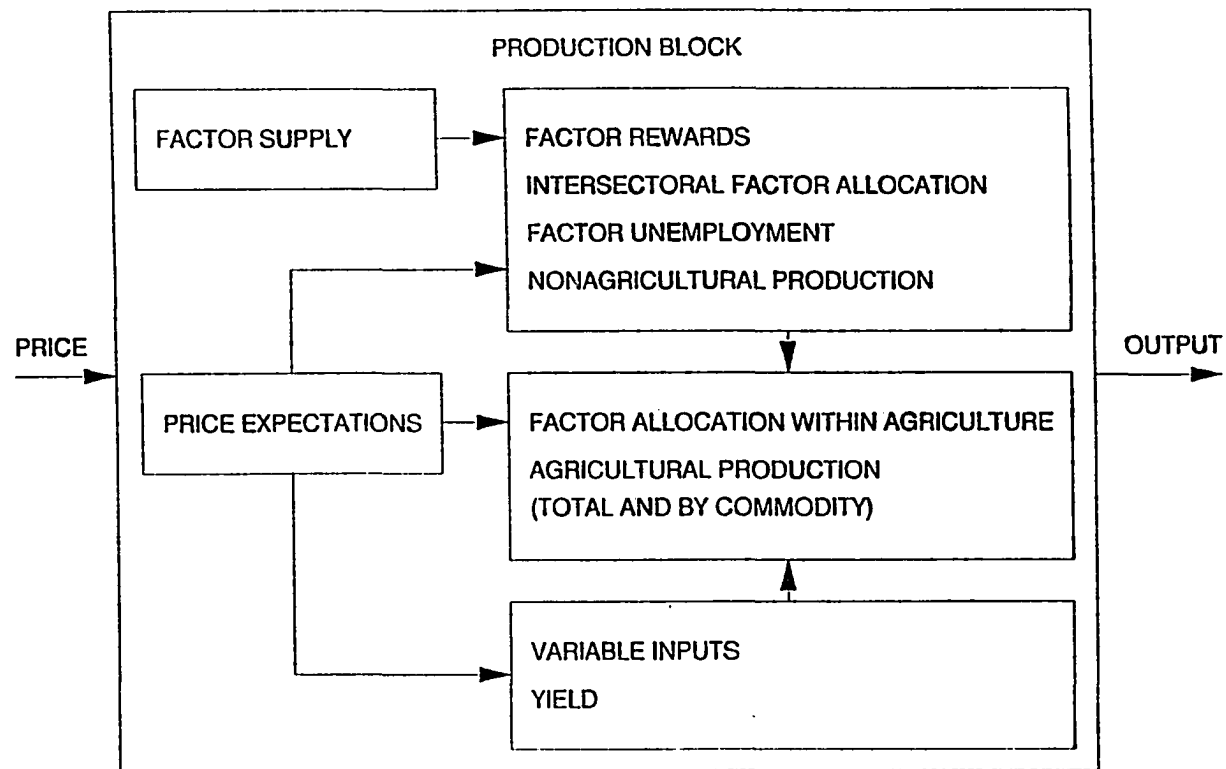


Figure 3.3: Structure of the Canadian Agriculture Model's revised production block

detailed accounts of stage 3 can be found in Fischer et al. (1988); Frohberg and Fischer (1985); and Graham, Huff and Lattimore (1985).

In the specification description of each stage, parameters are denoted by lower case letters with equation identifying subscripts. The lower case letter,  $v$ , is reserved to represent the disturbance term of the equation referenced in the attached superscript. A complete list of the mnemonics used in specifying the CAM is given in Appendix A.

#### 3.4.1 Data construction and source

The national account series used to form the parameter estimates are from the World Tables published by the World Bank. The demographic series, input usage series, and most of the price series are from Statistics Canada and include both published and unpublished data.

Sector prices are the GDP price deflators. Sector nominal wage rates are the annual labor compensations per employee in that sector. Sector nominal capital rental rates are derived using Hall and Jorgenson's (1967) formula which assumes static price expectations and the absence of direct taxation. That is, sector capital rental rates are

calculated by multiplying the implicit investment deflator by the sum of the capital depreciation rate and the long term interest rate:

$$(3.1) \quad R_t = [ I_t^C / I_t ] * [ d_t + i_t ]$$

$$\text{for } d_t = 1 - K_t / [ K_{t-1} + I_t ]$$

where  $d$  is economic depreciation rate;  
 $i$  is average yield on Government 5 to 10 year bonds;  
 $I$  is investment in constant 1970 dollars;  
 $I^C$  is investment in current dollars;  
 $K$  is capital stock in constant 1970 dollars; and  
 $R$  is the nominal capital rental rate.

To get a land rental rate purged of all speculative and consumptive price components, and that just reflects agricultural worth, the land rental rate is taken to be the estimated shadow price of land generated from the base run of an earlier version of the CAM. Since this base run only began in 1970 and the simulated land shadow prices were zero for the first three years of simulation, the simulated shadow prices had to be extrapolated backwards from 1973 to 1961 to get a series sufficiently long for use in estimation. The extrapolation was done in correspondence to the movement of the land rental rate series, published by Statistics Canada. More specifically, the same

percentage changes were assigned to the simulated shadow price series as were observed in the Statistics Canada land rental rate series.

### 3.5 Stage One: Factor Supply Determination

#### 3.5.1 Specification

3.5.1.1 Land supply The agriculture land base is the total area in crop and forage production, summerfallow and improved pasture. Since the growth in the land base in the past has been technology related, it is assumed this growth can continue, but at a decreasing rate as the limits of physical land availability are approached. To represent this long run concave growth trend, agriculture land supply (A) is specified as a linear function of the logarithm of time (T), as shown below in equation (3.2):

$$(3.2) \quad A_t = b_{A0} + b_{A1} \ln(T_t) + b_{A2} (PIGDPA_{t-1} / PIGDPN_{t-1}) + b_{A3} [(QA_{t-1} / NA_{t-1}) / (QN_{t-1} / NN_{t-1})] + v_t^{(A)}$$

Equation (3.2) also has embodied in its structure the additional assumption that actual land supply will deviate

from the long term growth trend in any given year according to the profitability of the agriculture sector relative to the nonagriculture sector. Two ratios are proposed as profitability indicators: the agriculture (PIGDPA) to nonagriculture (PIGDPN) price ratio and the agriculture to nonagriculture income parity ratio as defined by Graham, Huff and Lattimore (1985). The latter compares agriculture value added (QA) per agriculture worker (NA) to nonagriculture value added (QN) per nonagriculture worker (NN).

3.5.1.2 Labor supply Labor force (L) is a multiple of population (POP) and the participation rate (PART):

$$(3.3) \quad L_t = \text{PART}_t * \text{POP}_t.$$

Population is a multiple of the population growth rate (GRPOP) and population in the previous period:

$$(3.4) \quad \text{POP}_t = \text{GRPOP}_t * \text{POP}_{t-1}.$$

On the premise population growth depends primarily on noneconomic factors, the prediction of population growth is left exogenous to the model.

A Spillman function is used to capture the populace's decision to participate in the labor force:

$$(3.5) \quad PART_t = 1 - b_{L0} * b_{L1}^{AGE_t} * b_{L2}^{\ln(WN_{t-1}/PN_{t-1})} + v_t^{(PART)}$$

Increases in either the proportion of the population aged 16 to 45 (AGE), or the lagged real nonagriculture wage rate (WN/PN) are hypothesized to increase the participation rate. The logarithm of the real wage rate is used instead of its level value since increases in real wages increase incomes, and thereby produce a counterbalancing negative effect on labor force participation. Because the proportion of the population aged 16 to 45 is a demographic characteristic like the population growth rate, the determination of this series is also left exogenous to the model.

**3.5.1.3 Investment supply** Investment supply (I) is specified as a multiplicative function of the previous year's gross domestic product (GDPCO) adjusted by the trade



balance (BAL) in constant dollars, the previous year's real rental rate for capital services in the nonagriculture sector (RN/PN) and the previous year's unemployment rate (u):

$$(3.6) \quad I_t = b_{I0} * (GDPCO_{t-1} + BAL_{t-1})^{b_{I1}} * (RN_{t-1}/PN_{t-1})^{b_{I2}} * u_{t-1}^{b_{I3}} + v_t^{(I)}.$$

The amount saved from national income for investment is assumed proportionately related to national income. The real capital rental rate serves as a proxy for the real interest rate. It is hypothesized that as the real interest rate increases, consumers are motivated to favor future consumption over current consumption. As consumers savings increase, investment necessarily increases also. The unemployment rate is used as a rough indicator of the economy's position in the business cycle.

### 3.5.2 Estimation results

Each factor supply equation was estimated using maximum likelihood estimation (MLE) under the assumption its additive disturbance vector is distributed multivariate

normal. This estimator choice was prompted by the inherent nonlinearity of the participation rate and investment equations. Except for land supply, all the equations were regressed using annual data for 1961 to 1981. Because there appeared to be a change in the land supply growth rate between the '60s and the '70s, '60s observations were not used in estimating the land supply equation. To partially compensate for this shortening of the regression period, the regression period for the land supply equation was extended forward to 1985. Coefficient estimates for the three factor supply equations are given in Table 3.1.

The profitability indicators in the land supply equation did not prove to have significant explanatory power. As a result they were dropped from the equation, and the equation was reestimated. The final estimates portray the average annual land supply growth rate of having declined from 0.6% in 1971 to 0.4% in 1985.

The estimated coefficients of the labor force participation rate equation imply a constant wage elasticity of 0.17. The estimated coefficients of the investment supply equation imply, calculating at the mean, a marginal propensity to save of 15 percent. The interest rate elasticity of investment is estimated to be 0.5.

**Table 3.1: Maximum likelihood parameter estimates for the factor supply equations**

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**Land Supply<sup>a</sup>**

<u>Parameter</u>	<u>Estimate</u>	<u>T-Statistic</u>
$b_{A0}$	-28809	-23.80
$b_{A1}$	16956	59.71

**Labour Force Participation<sup>b</sup>**

<u>Parameter</u>	<u>Estimate</u>	<u>T-Statistic</u>
$b_{L0}$	2.4265	20.63
$b_{L1}$	0.0839	3.96
$b_{L2}$	0.8447	19.33

**Investment Supply<sup>b</sup>**

<u>Parameter</u>	<u>Estimate</u>	<u>T-Statistic</u>
$b_{I0}$	3.3725	0.96
$b_{I1}$	0.8331	10.39
$b_{I2}$	0.4762	4.22
$b_{I3}$	-0.1146	-2.27

---

<sup>a</sup>Regression period: 1971-1985.

<sup>b</sup>Regression period: 1961-1976.

### 3.6 Stage Two: Factor Allocation Between Sectors

#### 3.6.1 Specification

3.6.1.1 Sequential optimization It is assumed there exists an aggregate technology for Canadian agriculture and an aggregate technology for Canadian nonagriculture that are independent of each other. It is further assumed the production process in each sector is characterized by partial materials separability (Capalbo and Denny, 1986), that is the primary factors are assumed weakly separable from intermediate inputs, but not from technical change. This assumption, by permitting sequential optimization, permits determination of value added and primary input demands for each sector without requiring determination of total output.

3.6.1.2 Conceptual model of the efficiency wage hypothesis Suppose the efficiency wage hypothesis holds true in the nonagriculture sector. Particularly, assume the following: Nonagriculture value added is a function of the capital services and effective labor used in the production process. The sector's use of capital services is directly proportional to the amount of undepreciated

capital stock it owns. The sector's use of effective labor is related not only to the number of workers it employs, but also to the wages it pays. The latter follows from the underlying efficiency wage hypothesis which says the effort a worker exerts on the job is a positive function of the wage rate received.

Now assume the nonagriculture production function is well behaved, that is it is continuous and continuously differentiable up to the second order, has positive first order partial derivatives, is concave, and is linearly homogenous. Under these assumptions, the decision process of the nonagriculture sector can be expressed as:

$$(3.7) \quad \begin{array}{l} \text{Max} \quad Z = F [ h \cdot N, K ] - W \cdot N - R \cdot K \\ W, N, K \end{array}$$

with  $h = h [W]$  such that  $h_W > 0$

where  $h$  is effort per worker;  
 $K$  is undepreciated capital stock;  
 $N$  is number of employed workers;  
 $R$  is the real capital rental rate;  
 $W$  is the real wage rate; and  
 $Z$  is profit.

Setting the partial derivatives of this direct profit function equal to zero gives the following behavioral rules:

$$(3.8) \quad Z_W = F_H * N * h_W - N = 0,$$

$$(3.9) \quad Z_N = F_H * h - W = 0, \text{ and}$$

$$(3.10) \quad Z_K = F_K - R = 0,$$

where  $F_H$  denotes the partial derivative of the production function with respect to effective labor. Equation (3.9) can be interpreted in two ways. Noting that  $F_N = F_H * h$ , equation (3.9) is just the standard requirement that workers be hired until the marginal benefit of employing another worker equals the wage rate. The alternative interpretation is gained by dividing through by  $h$  to get equation (3.11):

$$(3.11) \quad F_H = W/h.$$

Equation (3.11) expresses the requirement that the marginal benefit of 1 unit of effort by a worker be equal to the cost of obtaining that effort. Rearranging terms in equation (3.8) and substituting in equation (3.11)

$$(3.12) \quad h_W * W/h = 1$$

gives the additional requirement that the sector choose a wage which will make the elasticity of effort with respect

to the wage rate equal to unity (Stiglitz, 1976).

**3.6.1.3 Nonagriculture value added and primary input demands** For analytical convenience, the nonagriculture value added process is represented using a Cobb-Douglas function exhibiting constant returns to scale and Hicks neutral technical change:

$$(3.13) \quad QN_t = b_{Q0} \exp(b_{Q1} \cdot T) \cdot [a_{Q0} \cdot (WN_{t-1}/PN_{t-1})^{a_{Q1}} \cdot NN_t]^{b_{Q2}} \\ \cdot KN_t^{(1-b_{Q2})} + v_t^{(QN)}.$$

Consistent with the conceptual model in the previous section, equation (3.13) expresses nonagriculture value added (QN) as a function of the capital services and effective labor used in the production process where the sector's use of capital services is assumed directly proportional to the amount of undepreciated capital stock (KN) owned, and the sector's use of effective labor is assumed to be the multiple of the number of workers (NN) it employs and the effort it induces from each worker at its offering wage rate (WN/PN). For analytical convenience, a Cobb-Douglas function is chosen to represent the effort

function of workers. Again for analytical convenience it is assumed that the exertion level of workers is a function of the lagged rather than the current real wage rate. This choice of explanatory variable can be justified to the extent the lagged real wage rate serves as a better indicator of permanent income than the current wage rate. It is further assumed, to permit parameter estimation, that the above technological relationship only holds stochastically and that deviations between observed and planned output are best described by an additive error term.

The input demands for nonagriculture are derived from the primal set-up as the first order conditions for profit maximization. When these input demands are combined with the production function in equation (3.13) and the unemployment rate equation, the following simultaneous system results:

$$(3.14) \quad QN_t = c_{Q0} \exp(b_{Q1} * T) * [(WN_{t-1}/PN_{t-1}) * NN_t]^{b_{Q2}} \\ * KN_t^{(1-b_{Q2})} + v_t^{(QN)}$$

$$\text{where } c_{Q0} = b_{Q0} * a_{Q0}^{b_{Q2}}$$

$$(3.15) \quad (WN_t/PN_t) = b_{Q2} * QN_t / NN_t + v_t^{(WN)}$$



$$(3.16) \quad (RN_t/PN_t) = (1-b_{Q2}) * QN_t / KN_t + v_t^{(RN)}$$

$$(3.17) \quad u_t = b_{u0} * [\log(QN_t)]^{b_{u1}} * L_t^{b_{u2}} * u_{t-1}^{b_{u3}} + v_t^{(u)}$$

Several features should be noted about the above system of equations. First, the exponent,  $a_{Q1}$ , is constrained to the value 1 in equation (3.14) in accordance with the first order condition requiring the elasticity of effort with respect to the wage rate to be unity at the optimum. Second, equations (3.15) and (3.16) are just the standard requirements the marginal productivity of each input be equal to its marginal cost. For estimation purposes an additive error term is identified for each equation under the assumption the sector makes random errors in choosing profit maximizing input levels. The rationale for the unemployment rate equation specification is discussed below.

**3.6.1.4 Unemployment rate** The unemployment rate specification in equation (3.17) is an approximate reduced form showing that unemployment reflects both sides of the labor market. Disturbances in either labor supply or labor demand will reverberate on unemployment. The influence of

labor supply determinants on unemployment is captured by using the labor force, itself, as an explanatory variable. The influence of labor demand determinants is captured by using the gross domestic product of nonagriculture as an explanatory variable. Assuming labor is not an inferior input, there should be a direct correspondence between output changes and labor demand changes. On the assumption there is a natural rate of unemployment which can not be completely eradicated, a logarithmic transformation of nonagriculture value added is used so the effect of this variable on unemployment will diminish as it increases in absolute size. The lagged dependent variable is included in equation (3.17) to account for unemployment persistence due to the business cycle.

#### **3.6.1.5 Intersectoral factor price linkages**

Because land, labor and capital are mobile, in at least one direction, between sectors, it is hypothesized that their reward in agriculture adjusts with their reward in nonagriculture. But, because this mobility is imperfect due to preferential and aptitudinal specificity (Bhagwati and Srinivasan, 1983), it is further hypothesized their reward in agriculture displays a certain amount of

stickiness. Accordingly, the agriculture wage (WA) and capital rental (RA) rates are expressed as multiplicative functions of their counterparts in nonagriculture, and their respective lagged values:

$$(3.18) \quad (WA_t/PN_t) = b_{W0} * (WN_t/PN_t)^{b_{W1}} \\ * (WA_{t-1}/PN_{t-1})^{b_{W2}} + v_t^{(WA)}$$

$$(3.19) \quad (RA_t/PN_t) = b_{R0} * (RN_t/PN_t)^{b_{R1}} \\ * (RA_{t-1}/PN_{t-1})^{b_{R2}} + v_t^{(RA)}$$

The agriculture land rental rate (TA) specification has two twists that distinguish it from the other agriculture return specifications. First, because the CAM does not recognize land as an input in nonagriculture production, the nonagriculture capital rental rate is used in place of the nonagriculture land rental rate under the assumption these two nonagriculture returns are highly correlated with one another. Second under the assumption upward pressure on the land rental rate will increase as land is used more intensively, the land rental rate is adjusted by the ratio of crop and forage area (AA) to total agriculture area (A):

$$(3.20) \quad (TA_t/PN_t) = b_{T0} * (AA_t/A_t) * (RN_t/PN_t)^{b_{T1}} \\ * (TA_{t-1}/PN_{t-1})^{b_{T2}} + v_t^{(TA)}$$

On the presumption all three agriculture factor rewards reflect agriculture's profitability relative to nonagriculture, it is assumed the disturbance terms of the three equations are contemporaneously correlated.

**3.6.1.6 Planned agriculture primary input demands and production cost** Agriculture producers must decide on aggregate primary input usage before they are certain of commodity and input prices. Their planned demands for operator labor (DNAO), hired labor (DNAH), capital services (DKA) and land (DAA) are derived using a dual approach. Under the assumption the value added function is linearly homogeneous, expected production cost ( $C^e$ ) can be expressed as a multiple of expected output ( $QA^e$ ) times expected unit cost ( $G^e$ ) where unit cost is a function of expected input prices and a technology index:

$$(3.21) \quad C_t^e = QA_t^e * G_t^e [WN_t^e/PN_t^e, WA_t^e/PN_t^e, RA_t^e/PN_t^e, TA_t^e/PN_t^e, T_t]$$

The unit cost function, as expressed in equation (3.21), incorporates the postulate that prior to the beginning of a production period, when total labor requirements are being decided upon, operator labor and hired labor are not considered perfect substitutes for each other in a farm operation. Adopting Lopez's (1984) use, the price of operator labor is taken to be the nonagriculture wage rate, and the price of hired labor to be the agriculture wage rate. Note the distinction between operator and hired labor made here in Stage 2 is discontinued in Stage 3. It is assumed that once the production period has begun, and the total number of workers committed to agriculture production is fixed, operator labor and hired labor can substitute perfectly for each other in this finite time horizon if the need arises.

To give the data as much voice as possible in the determination of an exact structure for the unit cost function, the unit cost function is expressed in translog functional form:

$$(3.22) \quad \ln(G_t^e) = \ln(b_{G0}) + \sum_{i=1}^4 b_{Gi} \ln(P_{it}) + b_{G5} \ln(T_t)$$

$$\begin{aligned}
& + 0.5 * \left[ \sum_{i=1}^4 \sum_{j=1}^4 b_{Gij} * \ln(P_{it}) * \ln(P_{jt}) \right] \\
& + \sum_{i=1}^4 b_{G5i} * \ln(P_{it}) * \ln(T_t) \\
& + 0.5 * b_{G55} * [\ln(T_t)]^2
\end{aligned}$$

$$\text{where } P_{1t} = W N_t^e / P N_t^e, \quad P_{2t} = W A_t^e / P N_t^e,$$

$$P_{3t} = R A_t^e / P N_t^e, \text{ and } P_{4t} = T A_t^e / P N_t^e.$$

The advantage of the translog functional form is its flexibility. It can act as a second order Taylor series approximation to any twice-differentiable cost function, and thus by implication to the true cost function (Christensen et al., 1973). Of course how good the approximation is depends on how many a priori restrictions are imposed and how consistent these restrictions are with reality. In consideration of this codicil, restrictions are used parsimoniously. Besides constant returns to scale restrictions, two other sets of restrictions are imposed. One set ensures symmetry, that is it ensures  $b_{Gij} = b_{Gji}$  for all  $i$  and  $j$ . The other set ensures linear homogeneity in prices by forcing:

$$(3.23) \quad \sum_{i=1}^4 b_{Gi} = 1$$

and

$$(3.24) \quad \sum_{i=1}^4 b_{Gij} = 0 \text{ for } i=1, \dots, 5.$$

By Shephard's lemma, the first logarithmic derivatives of the translog cost function with respect to input prices are the input cost shares ( $M_i$ ):

$$(3.25) \quad M_{it} = b_{Gi} + \sum_{j=1}^4 b_{Gij} * \ln(P_{jt}) + b_{G5i} * \ln(T_t)$$

for  $i = 1, \dots, 4$ .

Given estimates of expected production cost and input cost shares, the planned input demands can then be obtained by multiplying each cost share by production cost and dividing by the respective input price:

$$(3.26) \quad X_{it} = (C_t^e / P_{it}^e) * M_{it} \quad \text{for } i=1, \dots, 4$$

where  $X_{1t} = \text{DNAO}_t$ ;  $X_{2t} = \text{DNAH}_t$ ;  $X_{3t} = \text{DKA}_t$ ;  
and  $X_{4t} = \text{DAA}_t$ .

To derive estimates for total cost and the individual

cost shares, additive disturbance terms are introduced into the cost function of equation (3.22) and the cost shares of equation (3.25) on the assumption producers make random errors in choosing cost minimizing input levels. The disturbances are assumed to be distributed multivariate normal and to be contemporaneously correlated across equations. Because the share equations are forced to sum to unity at each observation, the covariance structure of the combined five equation system is singular. As a result one of the share equations can be deleted without loss of information. With the additional assumption the disturbances are serially independent, it does not matter which equation is deleted, provided the remaining equations are estimated with a Maximum likelihood procedure (Berndt and Savin, 1975). The cost shares chosen for estimation with the cost function are desired operator labor, desired capital services and desired land.

**3.6.1.7 Market clearing identities**      Agriculture  
land input (AA), operator labor input (NAO) and hired labor input (NAH) are each assumed to equal the respective planned demand:



$$(3.27) \quad AA_t = DAA_t$$

$$(3.28) \quad NAO_t = DNAO_t$$

$$(3.29) \quad NAH_t = DNAH_t.$$

As discussed below, this equivalence assumption is not carried over to capital services.

Summerfallow and improved pasture area (SF) is calculated residually from the agriculture land market closing identity. It is the difference between agriculture land supply and the area in crop and forage production:

$$(3.30) \quad SF_t = A_t - AA_t.$$

The nonagriculture work force (NN) is calculated residually from the labor market closing identity. It is equated to total labor supply (L) adjusted by the national employment rate ( $1 - 0.01 \cdot u$ ) less the agriculture work force:

$$(3.31) \quad NN_t = [1 - 0.01 \cdot u_t] \cdot L_t - NAO_t - NAH_t.$$

It is assumed that realized capital input does not always equal planned input because of time lags encountered in appropriating funds for major capital purchases, and in

making buildings and/or equipment operational after their purchase. In particular, an arbitrary assumption is made that only 30 percent of the difference between the desired capital stock and the stock (KA) which was bought into the current period can be realized within a single year.

Agriculture investment (IA) is set equal to this amount plus the amount necessary to replace the depreciated capital of the previous year:

$$(3.32) \quad IA_t = DA_t * KA_{t-1} + 0.3 * [ DKA_t - (1-DA_t) * KA_{t-1} ] \\ + v_t^{(IA)}.$$

Nonagriculture investment (IN) is calculated residually from the investment capital market closing identity. It is the difference between total investment supply (I) and agriculture investment:

$$(3.33) \quad IN_t = I_t - IA_t.$$

Both nonagriculture (KN) and agriculture capital stock (KA) are equated to capital stock brought into the current period plus the current period's investment, all adjusted by the capital depreciation rate:

$$(3.34) \quad KN_t = (1-DN_t) * [ KN_{t-1} + IN_t ]$$

$$(3.35) \quad KA_t = (1-DA_t) * [ KA_{t-1} + IA_t ].$$

### 3.6.2 Estimation results

With the exception of the agriculture cost function, all behavioral equations of this Stage were estimated with annual data for 1961 to 1981 using Maximum Likelihood procedures. Parameter estimates for the simultaneous system consisting of the nonagriculture value added equation, the nonagriculture input demand equations and the unemployment equation are given in Table 3.2. To reduce multicollinearity problems, the nonagriculture production function was written in capital intensive form during system estimation. In comparison to earlier versions of the model, the nonagriculture sector is portrayed as more capital intensive. The output elasticity of capital is 0.33 compared to a value of 0.24 in the earlier versions. In addition less emphasis is placed on Hicks neutral technical change. The contribution of this type of technical change to output is estimated at 0.7 percent per year compared to 4.5 percent in the earlier versions. One reason for the lower technical change coefficient is that the current structure, unlike the earlier versions,

**Table 3.2: Maximum likelihood parameter estimates for the simultaneous system consisting of the nonagriculture value added equation, the nonagriculture primary input demand equations and the unemployment rate equation<sup>a</sup>**

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<u>Parameter</u>	<u>Estimate</u>	<u>T-Statistic</u>
$c_{Q0}$	0.6889	20.98
$b_{Q1}$	0.0067	10.53
$b_{Q2}$	0.6693	250.04
$b_{u0}$	2.3839	1.49
$b_{u1}$	-1.1208	-1.08
$b_{u2}$	0.3070	1.22
$b_{u3}$	0.4949	4.90

---

<sup>a</sup>Regression period: 1961-1981.

implicitly accounts for embodied technical change in labor through the wage rate variable in the production function. This argument is based on the postulate the increase in the real wage rate over time has partly reflected an increase in labor quality.

The elasticity of unemployment,  $e_u$ , with respect to the wage rate can be calculated from the estimated parameters for the nonagriculture value added, the unemployment rate and labor force participation rate equations using the following formula:

$$(3.36) \quad e_u = b_{u1} * b_{Q2} / \ln(QN) - b_{u2} * \ln(b_{L2}).$$

When the parameter estimates from Table 3.2 are plugged into equation (3.36), the resulting estimate for  $e_u$  turns out to be very small; only 0.01.

On the assumption the disturbances for the intersectoral factor price linkages are contemporaneously correlated, the three linkage equations were estimated simultaneously as a set of equations. The parameter estimates are contained in Table 3.3. The intersectoral price transmission elasticity of wages is estimated at 0.80 and the intersectoral price transmission elasticity of capital rental rates at 0.47. These estimates suggest

Table 3.3: Maximum likelihood parameter estimates for the intersectoral factor price linkages<sup>a</sup>

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Agriculture Wage Rate

<u>Parameter</u>	<u>Estimate</u>	<u>T-Statistic</u>
$b_{W0}$	0.4066	4.68
$b_{W1}$	0.7992	5.22
$b_{W3}$	0.4274	3.15

Agriculture Capital Rental Rate

<u>Parameter</u>	<u>Estimate</u>	<u>T-Statistic</u>
$b_{R0}$	2.8191	5.35
$b_{R1}$	0.4679	6.74
$b_{R3}$	0.5246	3.78

Agriculture Land Rental Rate

<u>Parameter</u>	<u>Estimate</u>	<u>T-Statistic</u>
$b_{T0}$	0.5604	3.45
$b_{T1}$	0.3267	1.22
$b_{T2}$	0.4808	2.72

---

<sup>a</sup>Regression period: 1961-1981.

capital is more sector specific than labor. The price transmission elasticity for land is low at 0.33, but this is probably more a reflection of the quality of the nonagriculture capital rental rate as a proxy for the land rental rate than it is of lack of correlation in land rental rates across sectors.

Great difficulty was encountered in estimating the planned agriculture cost shares and cost function. Although it would have been theoretically more efficient to estimate them together, preliminary trials indicated both the SHAZAM software package, which was used for all the other estimation, and the data were inadequate for this task. Although use of alternative software packages were able to solve the computational problem, they could not address the data inadequacy. As a consequence a decision was made to estimate the cost function recursively of the cost shares. Having made this decision, it was once more possible to employ the SHAZAM software.

Originally a Statistics Canada published series was used for the land rental rate. However, use of this series consistently produced estimates implying a positive own-price elasticity for land. The consumptive and speculative components of this series were diagnosed as the problem. As explained earlier, to get a series purged of

these land price components, the shadow price of land estimated in an earlier version of the CAM was adopted for the land rental rate between 1973 and 1981. To get values prior to 1973 the shadow price estimates were extrapolated backwards in correspondence to percentage changes in the Statistic Canada series. It was thought that this would be appropriate since the land prices were not as inflationary in the '60s as in the '70s. Estimation attempts, however, were still unsuccessful. Even restricting coefficients to imply the same own price elasticities that Lopez (1980) found did not prove fruitful. Finally, recognizing the land rental rate might still be the problem, a dummy variable, which takes the value of one prior to 1973 and zero thereafter when the land rental rate reflects only the shadow price estimates, was introduced into each share equation to shift the land rental rate slope parameters. The results of this joint estimation of the cost shares are reported.

Parameter estimates are given in Table 3.4. They were checked for structural soundness by examining not only their inferences for the input demands, but also their inferences for the underlying cost function and production technology. Specifically checks were made on whether the implied input demands are positive and have 'reasonable'



**Table 3.4: Maximum likelihood parameter estimates for the agriculture input cost shares<sup>a,b</sup>**

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	<u>Operator Labor</u>	<u>Hired Labor</u>	<u>Capital Services</u>	<u>Land</u>
<u>Variables</u>				
Intercept	0.22075 (38.11)	0.03850	0.32894 (15.19)	0.41181 (6.39)
Nonagriculture Wage	0.00575 (0.57)	0.01243	-0.01402 (-0.89)	-0.00417 (-0.56)
Agriculture Wage	0.01243	0.00625	-0.01815	-0.00053
Agriculture Capital Rent	-0.01402 (-0.89)	-0.01815	0.05560 (2.45)	-0.02343 (-2.67)
Agriculture Land Rent	-0.00417 (-0.56)	-0.00053	-0.02343 (-2.67)	0.02813 (9.75)
Shift Variable	-0.01205 (-3.07)	-0.00016	0.01374 (3.14)	-0.00153 (-1.01)
Technology Index	-0.03215 (-4.38)	-0.00518	0.09684 (12.63)	-0.05951 (-10.27)

---

<sup>a</sup>T-statistics are reported in parentheses below the parameter estimates.

<sup>b</sup>Regression period: 1961-1981.

price elasticities, whether the implied cost function is concave in input prices and has 'reasonable' Allen partial elasticities of substitution, and whether the implied production technology reflects 'reasonable' factor augmenting technical change.

Since factor prices and the total production cost are always positive, the implied input demands can be tested for positivity by examining whether the fitted cost shares are positive at each observation. The two fitted labor cost shares and the fitted capital cost share are positive at each observation. The fitted land cost share is positive only for observations after 1972. Since failure of this positivity test corresponds with the structural shift embedded in the land rental rate coefficients, it is not necessary to reject all the estimated parameters, just the estimated parameters for the shift variable,  $D6172 \cdot \ln(TA)$ . Because the estimated structure for the time period prior to 1973 has to be rejected along with the estimated parameters for the shift variable, the rest of the checks are just conducted over 1973 to 1981 observations.

The implied cost function can be checked for concavity in input prices by examining if the Hessian matrix is negative semi-definite at each observation. Concavity is

satisfied.

The parameter estimates for the trend variables are statistically significant and their signs suggest technical change has been labor saving, capital using and land saving. This technology portrayal is consistent with conventional belief.

The Allen partial elasticities of substitution for the translog cost function are:

$$(3.37) \quad AES_{ii} = [ b_{Gii} + M_i^2 - M_i ] / M_i^2$$

and

$$(3.38) \quad AES_{ij} = [ b_{Gij} + M_i * M_j ] / [ M_i * M_j ] \text{ for } i \neq j.$$

Allen (1938) showed input demand price elasticities to be related to the Allen partial elasticities of substitution in the following manner:

$$(3.39) \quad E_{ij} = M_j * AES_{ij}.$$

Mean values of the Allen partial elasticities of substitution and the input demand price elasticities estimates are given in Tables 3.5 and 3.6, respectively. According to these values, operator labor is more own price

**Table 3.5: Estimates of the Allen partial elasticities of substitution for the primary input demands of agriculture<sup>a</sup>**

	<u>Operator Labor</u>	<u>Hired Labor</u>	<u>Capital Services</u>	<u>Land</u>
Operator Labour	-8.12			
Hired Labour	7.34	-33.19		
Capital Services	0.83	-0.15	-0.16	
Land	0.37	0.59	0.82	-7.3

<sup>a</sup>Reported values are the means of the estimates between 1973 and 1981.

**Table 3.6: Estimates of the price elasticities for the primary input demands of agriculture<sup>a</sup>**

	Elasticity of			
	<u>Operator Labor</u>	<u>Hired Labor</u>	<u>Capital Services</u>	<u>Land</u>
<u>With Respect To</u>				
Nonagriculture Wage	-0.8354	0.1407	-0.6649	-0.0298
Agriculture Wage	0.7395	-0.6627	-0.1200	0.0432
Agriculture Capital Rent	0.0913	-0.0025	-0.1297	0.0580
Agriculture Land Rent	0.0458	0.0122	0.6542	-0.5042

<sup>a</sup>Reported values are the means of the estimates between 1973 and 1981.

elastic than is hired labor, and both categories of labor are more own price elastic than capital services and land. The estimated value of -0.84 for operator own price elasticity is similar to Lopez's (1980) estimate of -0.90. The estimated values for capital services and land, however, deviate from Lopez's estimates. The own price elasticity of capital is estimated to be -0.13 compared to Lopez's -0.41, and the own price elasticity of land is estimated to be -0.50 compared to Lopez's -0.36. The AES estimates imply all the primary inputs are substitutes for each other except hired labor and capital services. The AES of -0.15 combined with the cross price elasticity of -0.12 for capital services with respect to the agriculture wage rate and the cross price elasticity of 0.00 for hired labor with respect to the capital rental rate suggest that while hired labor is regarded as a complement to capital, the reverse is not true. Note the finding that operator labor and hired labor are substitutes for each other contrasts to the finding of Lopez (1984).

On the strength of the above checks and tests, all the parameter estimates, except those for the shift variable, are deemed reasonable and structurally sound for the time horizon after 1972. As a result they were accepted for use in the CAM's revised input block. However, this acceptance

is with reservation because of the lack of rigor employed in their estimation.

The translog cost function was regressed over 1973 to 1981 observations with all the parameter estimates obtained from the joint estimation of the cost share equations imposed to get estimates for the three remaining unknown coefficients:  $b_{G0}$ ,  $b_{G5}$ , and  $b_{G55}$ . The estimates for  $b_{G5}$  and  $b_{G55}$  were not statistically significant from zero. The estimate for  $b_{G0}$  was 4.95.

### 3.7 Stage Three: Factor Allocation Within Agriculture

Agriculture's share of the primary resources is distributed to the different commodities in Stage 3 via the following nonlinear programming model:

$$(3.40) \quad \text{Max}_{K_{it}, N_{it}} \quad Z_t = \sum_{i=1}^{10} V A_{it} * Y_{it} * A_{it}$$

$$(3.41) \quad \text{with } A_{it} = a_{it} * K_{it}^{b_{1i}} * N_{it}^{(b_{2i}-b_{1i})}$$

$$(3.42) \quad a_{it} = b_{3i} * \exp(b_{4i} * T) * K A_t^{(b_{5i}-b_{1i})} \\ * (N A O_t + N A H_t)^{(1-b_{5i}-(b_{2i}-b_{1i}))}$$

$$(3.43) \quad b_{1i} + (b_{2i} - b_{1i}) < 1$$

$$(3.44) \quad b_{5i} + (1 - b_{5i}) = 1$$

$$(3.45) \quad \text{such that } \sum_{i=1}^7 A_{it} + \sum_{i=8}^{10} g_i A_{it} - AA_t < 0$$

$$(3.46) \quad \sum_{i=1}^{10} N_{it} - (NAO_t + NAH_t) < 0$$

$$(3.47) \quad \sum_{i=1}^{10} K_{it} - KA < 0$$

$$(3.48) \quad K_{it} > 0.7 * K_{it-1} \quad \text{for } i=1, \dots, 7$$

$$(3.49) \quad K_{it} > 0.9 * K_{it-1} \quad \text{for } i=8, \dots, 10$$

$$(3.50) \quad (N_{it}/K_{it}) \geq 0.8 * (N_{it-1}/K_{it-1})$$

for  $i=1, \dots, 10$

where  $i=1$  is wheat,  $i=3$  is coarse grains,  $i=4$  is oilseed meal,  $i=5$  is other food of crop origin;  $i=6$  is nonfood items of crop origin,  $i=7$  is fruit,  $i=8$  is pork, poultry and eggs,  $i=9$  is beef cattle, and  $i=10$  is dairy cattle.

As shown, the factors are distributed, within availability, substitutability and mobility constraints, to maximize expected short run profit ( $Z$ ) of the whole agriculture sector. Expected short run profit of the whole agriculture sector is calculated in equation (3.40) as the simple summation over all agriculture commodities of commodity



output times producers expectations of government assisted unit value added ( $VA_i$ ). Chapter 4 describes in detail how government assisted unit value added is determined for each commodity. Briefly, it equals the market return plus all direct payments made to producers by the government in association with that commodity less variable cost. Output equals yield ( $Y_i$ ) per unit of production times the number ( $A_i$ ) of units produced.

Equation (3.41) posits a Cobb-Douglas relationship between the number of units of each commodity produced and the amount of capital and labor used in the production process. Although the whole agriculture sector exhibits constant returns to scale with respect to capital and labor input, any one particular commodity exhibits decreasing returns to scale with respect to the capital and labor devoted exclusively to that commodity. The parameter  $b_{2i}$  defines the returns to scale of commodity  $i$ . The parameter  $b_{1i}$  is the elasticity of commodity  $i$  with respect to own capital input. The parameter  $b_{4i}$  captures Hicks neutral technical change. Finally the parameter  $b_{5i}$  determines how changes in total capital and labor allowance for agriculture will shift the isoquant of the production function for commodity  $i$ .

Equations (3.45) to (3.47) are availability

constraints and just ensure that the amount of land ( $A_i$ ), labor ( $N_i$ ) and capital ( $K_i$ ) employed in the production of each commodity will not exceed, when totaled, the maximum amount available to the sector. Note, equation (3.45) recognizes a certain quantity of land ( $g_i$ ) must be put aside for forage production to meet roughage requirements for producing each animal unit of type  $i$ . Equations (3.48) and (3.49) are mobility constraints on capital recognizing most capital items employed in agriculture are commodity specific. Capital goods employed in livestock production are assumed to be less flexible than those employed in crop production. No more than 30 percent of the capital used in crop enterprises and no more than 10 percent of the capital used in livestock enterprises can be switched between enterprises in any two consecutive years. Equation (3.50) is a substitutability constraint. In recognition that a large change in the ratio of labor to capital usage across any two consecutive years implies unlikely radical technology changes in the production of a commodity, labor usage is restrained so that the labor-capital ratio in the current year is at least 80 percent of the labor-capital ratio in the previous year.

Table 3.7 gives the parameter estimates contained in the CAM for the individual commodity production functions.

**Table 3.7: Parameter estimates for the agriculture commodity production functions<sup>a</sup>**

	b1i	b2i	Parameters		b5i
			b3i	b4i	
<u>Commodity</u>					
Wheat	0.2497	0.2694	512.7	0.010	0.5568
Coarse Grains	0.1865	0.2081	480.0	0.010	0.5000
Oilseed Meal	0.1919	0.2000	130.0	0.000	0.5000
Other Food of Crop Origin	0.1811	0.2216	46.77	0.002	0.5730
Nonfood Items of Crop Origin	0.0629	0.2000	2.49	0.002	0.7402
Fruit	0.1603	0.2002	14.23	0.000	0.3969
Pork, Poultry & Eggs	0.2274	0.2587	4.74	0.000	0.9076
Bovine & Ovine Meats	0.2202	0.3034	0.41	-0.005	0.7000
Dairy Products	0.3445	0.4420	0.11	0.000	0.4659

<sup>a</sup>Source: Frohberg and Fischer, 1985.

Frohberg and Fischer (1985) describe the iterative procedure used to derive these estimates.

### 3.8 Model Validation

Table 3.8 presents the simulation model determining resource supply and intersectoral allocation in the CAM. The form of some equations in this simulation model differs slightly from what was estimated. Changes were made in select equations for three reasons. The first reason was to calibrate model output. In some equations it was necessary to realign the intercept or scaling parameter because simulated values of explanatory variables, exogenous to the input block, but endogenous to the rest of the model, were of slightly different magnitude than the actual values used for estimation.

The second reason was to reduce computation time and cost. Solution of the BLS is very computer intensive. So computation time would not be unduly escalated with the incorporation of this new input block segment for the CAM, the system of equations was made completely recursive by using lagged rather than current values for endogenous variables appearing on the right hand side of some

Table 3.8: Simulation set-up for intersectoral factor allocation in the CAM<sup>a,b</sup>

---

Land Supply

$$A_t = -28809 + 16956 \cdot \ln(T_t)$$

Population

$$POP_t = GRPOP_t * POP_{t-1}$$

Labor Participation

$$PART_t = 1 - 2.43 * 0.0839^{AGE_t} * 0.845^{\log(WN_{t-1}/PN_{t-1})}$$

Labor Supply

$$L_t = PART_t * POP_t$$

Investment Supply

$$I_t = 3.12 * (GDPCO_{t-1} + BAL_{t-1})^{-0.115} * (RN_{t-1}/PN_{t-1})^{0.833} * (RN_{t-1}/PN_{t-1})^{0.476} * u_{t-1}$$

Expected Agriculture Output

$$Q_t^e = 1.03 * [(QA_{t-1} + QA_{t-2} + QA_{t-3})/3] * (PIGDPA_{t-1}/PIGDPN_{t-1})^{0.1}$$

---

<sup>a</sup>Equations are written with 3 significant digit accuracy.

<sup>b</sup>Equations are written so that the normalization variable appears on the RHS of the expression.

Table 3.8 (Continued)

Planned Agriculture Production Cost

$$\begin{aligned}
C_t = \exp \{ & 1.56 + \ln(QA_t^e) + 0.221 \ln(WN_{t-1}/PN_{t-1}) + 0.0385 \\
& * \ln(WA_{t-1}/PN_{t-1}) + 0.4237 \ln(RA_{t-1}/PN_{t-1}) + 0.412 \\
& * \ln(TA_{t-1}/PN_{t-1}) + 0.00288 [\ln(WN_{t-1}/PN_{t-1})]^2 + 0.00313 \\
& * [\ln(WA_{t-1}/PN_{t-1})]^2 + 0.0278 [\ln(RA_{t-1}/PN_{t-1})]^2 + 0.0141 \\
& * [\ln(TA_{t-1}/PN_{t-1})]^2 + 0.0124 \ln(WN_{t-1}/PN_{t-1}) * \ln(WA_{t-1} \\
& /PN_{t-1}) - 0.0140 \ln(WN_{t-1}/PN_{t-1}) * \ln(RA_{t-1}/PN_{t-1}) \\
& - 0.00417 \ln(WN_{t-1}/PN_{t-1}) * \ln(TA_{t-1}/PN_{t-1}) - 0.0322 \\
& * \ln(WN_{t-1}/PN_{t-1}) * \ln(T_t) - 0.0182 \ln(WA_{t-1}/PN_{t-1}) \\
& * \ln(RA_{t-1}/PN_{t-1}) - 0.000532 \ln(WA_{t-1}/PN_{t-1}) * \ln(TA_{t-1} \\
& /PN_{t-1}) - 0.00518 \ln(WA_{t-1}/PN_{t-1}) * \ln(T_t) - 0.0234 \\
& * \ln(RA_{t-1}/PN_{t-1}) * \ln(TA_{t-1}/PN_{t-1}) + 0.0968 \ln(RA_{t-1} \\
& /PN_{t-1}) * \ln(T_t) - 0.0595 \ln(TA_{t-1}/PN_{t-1}) * \ln(T_t) \}
\end{aligned}$$

Planned Crop & Forage Area

$$\begin{aligned}
DAA_t = [C_t / (TA_{t-1}/PN_{t-1})] * [ & 0.412 - 0.00417 \ln(WN_{t-1} \\
& /PN_{t-1}) - 0.000532 \ln(WA_{t-1}/PN_{t-1}) - 0.0234 \\
& * \ln(RA_{t-1}/PN_{t-1}) + 0.0281 \ln(TA_{t-1}/PN_{t-1}) \\
& - 0.0595 \ln(T_t) ]
\end{aligned}$$

Crop & Forage Area

$$AA_t = \text{Min} \{ DAA_t, A_t \}$$

Table 3.8 (Continued)

Summerfallow & Pasture

$$SF_t = A_t - AA_t$$

Planned Agriculture Operator Labor

$$DNAO_t = [C_t / (WN_{t-1} / PN_{t-1})] * [0.221 + 0.00575 * \ln(WN_{t-1} / PN_{t-1}) + 0.0124 * \ln(WA_{t-1} / PN_{t-1}) - 0.0140 * \ln(RA_{t-1} / PN_{t-1}) - 0.00417 * \ln(TA_{t-1} / PN_{t-1}) - 0.0322 * \ln(T_t)]$$

Agriculture Operator Labor

$$NAO_t = DNAO_t$$

Planned Agriculture Hired Labor

$$DNAH_t = [C_t / (WA_{t-1} / PN_{t-1})] * [0.0585 + 0.0124 * \ln(WN_{t-1} / PN_{t-1}) + 0.00625 * \ln(WA_{t-1} / PN_{t-1}) - 0.0182 * \ln(RA_{t-1} / PN_{t-1}) - 0.000532 * \ln(TA_{t-1} / PN_{t-1}) - 0.00518 * \ln(T_t)]$$

Agriculture Hired Labor

$$NAH_t = DNAH_t$$

Agriculture Labor

$$NA_t = NAO_t + NAH_t$$

Table 3.8 (Continued)

Planned Agriculture Capital

$$DKA_t = [C_t / (RA_{t-1} / PN_{t-1})] * [0.427 - 0.0140 * \ln(WN_{t-1} / PN_{t-1}) \\ - 0.0182 * \ln(WA_{t-1} / PN_{t-1}) + 0.0556 * \ln(RA_{t-1} / PN_{t-1}) \\ - 0.0234 * \ln(TA_{t-1} / PN_{t-1}) + 0.0968 * \ln(T_t)]$$

Agriculture Investment

$$IA_t = DA * KA_{t-1} + 0.3 * [DKA_t - (1 - DA) * KA_{t-1}]$$

Agriculture Capital

$$KA_t = (1 - DA_t) * [KA_{t-1} + IA_t]$$

Unemployment Rate

$$u_t = 2.38 * (\ln(QN_{t-1}))^{-1.12} * L_t^{0.307} * u_{t-1}^{0.495}$$

Nonagriculture Labor

$$NN_t = L_t * (1 - 0.01 * u_t) - NA_t$$

Nonagriculture Investment

$$IN_t = I_t - IA_t$$

Nonagriculture Capital

$$KN_t = (1 - DN_t) * [KN_{t-1} + IN_t]$$



Table 3.8 (Continued)

Nonagriculture Value Added

$$QN_t = 0.689 * \exp(0.00666 * T_t) * [(WN_{t-1}/PN_{t-1}) * NN_t]^{0.669} * KN_t^{0.331}$$

Nonagriculture Wage Rate

$$WN_t = PN_t * [0.669 * QN_t / NN_t]$$

Nonagriculture Capital Rental Rate

$$RN_t = PN_t * [0.331 * QN_t / KN_t]$$

Agriculture Wage Rate

$$WA_t = PN_t * [0.407 * (WN_t / PN_t)^{0.799} * (WA_{t-1}^S / PN_{t-1})^{0.427}]$$

Agriculture Capital Rental Rate

$$RA_t = PN_t * [2.82 * (RN_t / PN_t)^{0.468} * (RA_{t-1}^S / PN_t)^{0.525}]$$

Agriculture Land Rental Rate

$$TA_t = PN_t * [0.560 * (AA_t / A_t) * (RN_t / PN_t)^{0.317} * (TA_{t-1} / PN_{t-1})^{0.481}]$$

equations. The equations affected were the unemployment equation and the agriculture production cost and input demand equations. Table 3.9 shows the resulting recursive structure of the system of equations.

Note the replacement of current endogenous variables with lagged endogenous in the planned agriculture production cost and input demand equations is tantamount to making the assumption agriculture producers in the simulation model have extrapolative expectations. Because factor rents do not fluctuate widely from one year to the next, agriculture producers were given naive expectations about factor rents. It was assumed producers take the current period values for factor rents as their expectations for the succeeding period. In contrast producers were given more sophisticated extrapolative expectations about agriculture output. The reason for doing so was because output does vary widely from one year to the next as a result of weather shocks. It was assumed producers use for their output expectation ( $QA^e$ ) a three year moving average of past output levels multiplied by the long term average growth rate all adjusted by the current price ratio between agriculture and nonagriculture:

Table 3.9: Recursive structure for intersectoral factor allocation in the CAM

		EQUATION NUMBER <sup>a</sup>																											
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
		1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	
ENDOGENOUS																													
A	X										X	X																	
POP		X		X																									
PART			X	X																									
L				X													X	X											
I					X																	X							
C						X																							
DAA							X	X																					
AA								X	X																				
SF									X																				
DNAO										X	X																		
NAO											X				X														
DNAH												X	X																
NAH													X	X															
NA														X		X													
U															X	X													
NN																X									X	X			
DKA																	X	X											
IA																		X	X	X									
KA																			X										
IN																					X	X							

<sup>a</sup>Equations: 1) Land supply; 2) Population; 3) Labor participation; 4) Labor force; 5) Investment supply; 6) Agriculture Production Cost; 7) Planned crop & forage area; 8) Crop & forage area; 9) Summerfallow; 10) Planned operator labor; 11) Operator labor; 12) Planned hired labor; 13) Hired labor; 14) Agriculture Employed; 15) Unemployed; 16) Nonagriculture employed; 17) Planned agriculture capital; 18) Agriculture investment; 19) Agriculture capital; 20) Nonagriculture investment; 21) Nonagriculture capital; 22) Nonagriculture production; 23) Nonagriculture wage; 24) Nonagriculture capital rent; 25) Agriculture wage; 26) Agriculture capital rent; 27) Agriculture land rent.

Table 3.9 (Continued)

[illegible]

$$(3.46) \quad QA_t = 1.03 * [(QA_{t-1} + QA_{t-1} + QA_{t-3}) / 3] \\ * (PIGDPA_{t-1}/PIGDPN_{t-1})^{0.1} + v_t^{(QA^e)}$$

The price ratio serves as an indicator of the profitability of agriculture production relative to nonagriculture production.

The third reason for making equation changes in the simulation model was to enforce structural integrity. Theoretically the shadow prices of land, labor and capital outputed from the resource allocation optimizing model of Stage 3 should equal their market value. To ensure that simulated market price movements do not diverge from the estimated shadow price movements, the estimated shadow prices are used in place of the lagged market prices in the agriculture factor rent equations.

The model in Table 3.8 was simulated both in a stand alone run and in conjunction with the entire BLS in a linked run to determine strengths and weaknesses in its structure. Intra- and post-sample simulation summary statistics are presented in Table 3.10. Surprisingly, the investment and capital specifications perform better as part of the whole CAM and BLS than on their own. The revised input structure appears to have some difficulty in dealing with hired agriculture labor. Part of the reason

**Table 3.10: RMS percent errors of selected variables from the stand alone and linked simulations of the CAM's revised input block**

	<u>Intra-Sample<sup>a</sup></u>		<u>Post-Sample<sup>b</sup></u>	
	<u>Stand Alone</u>	<u>Linked</u>	<u>Stand Alone</u>	<u>Linked</u>
A	0.6	0.5	0.6	0.3
AA	4.9	10.6	5.6	17.6
COST	11.2	16.0	14.8	16.1
I	5.6	4.1	11.5	7.0
IA	21.7	5.2	30.6	38.5
IN	5.7	4.3	12.4	6.8
KA	8.3	1.3	2.9	3.8
KN	1.1	1.1	3.2	1.6
L	1.8	1.6	2.4	3.0
NA	8.7	8.7	22.2	12.9
NAH	27.5	35.5	18.4	34.0
NAO	10.0	9.7	24.2	2.9
NN	1.7	1.5	1.5	1.6
PART	1.8	1.6	2.4	2.9
QN	2.9	3.2	2.2	1.8
RA/PN	14.8	18.2	14.3	21.3
RN/PN	13.1	11.9	11.9	11.6
SF	8.7	19.0	14.7	40.6
TA/PN	34.0	40.5	13.4	22.6
u	12.8	12.7	35.5	36.6
WA/PN	8.7	25.0	12.0	7.6
WN/PN	3.5	3.7	7.3	4.1

<sup>a</sup>Simulation Period: 1973-1981.

<sup>b</sup>Simulation Period: 1982-1985.

is that this is the smallest cost share. Other trouble spots for the revised structure are factor rents, particularly the capital rental rate. The difference in RMS percent errors of agriculture rents between the two runs reflect the substitution in the linked run of lagged shadow prices estimates for lagged market values.

It should be remembered, however, when examining the simulation statistics that the CAM and BLS do not purport to be a short range forecasting medium, but a long term policy analysis tool. In this guise it is more important that the input structure captures long term market trends than it is that it reproduces history exactly. In fact, under these circumstances too close a fit could be interpreted as a black mark against the revised specification because it would indicate the parameter estimates were reflecting transitory market movements rather than persistent trends. A more revealing performance criterion would be one that compares simulated with actual growth rates. Table 3.11 makes this comparison for selected variables for the period 1974 through 1985. As a general rule, the growth rates estimated during the linked run are more modest than actual growth rates. With respect to this growth rate comparison criterion, the revised resource structure does quite well for hired labor,

**Table 3.11: Actual and simulated average annual growth rates of selected variables: 1974-1985**

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Percent Growth Rates		
	<u>Actual</u> <sup>a</sup>	<u>Simulated</u> <sup>b</sup>
A	0.4	0.4
AA	1.3	1.1
COST	3.8	2.9
I	3.3	2.5
IA	-1.4	2.4
IN	2.9	2.6
KA	2.9	3.3
KN	1.1	1.1
L	2.8	2.3
NA	0.4	2.1
NAH	2.9	2.7
NAO	-0.6	1.7
NN	2.4	2.2
PART	1.6	1.2
QN	2.9	3.0
RA/PN	2.0	0.4
RN/PN	2.5	1.9
SF	-1.5	0.0
TA/PN	-5.3	2.2
u	6.4	0.9
WA/PN	-0.8	0.2
WN/PN	-0.1	0.8

---

<sup>a</sup>Simulation Period: 1973-1981.

<sup>b</sup>Simulation Period: 1982-1985.



but still does an inadequate job on factor rents.

### 3.9 Summary

This chapter reviewed the revised resource market structure of the CAM. Distinguishing features of the specification include:

- the use of the efficiency wage hypothesis to help explain unemployment;
- the treatment of hired labor as a separate input from operator labor; and
- the derivation of the agriculture input demands using a cost function approach.

Great difficulties were encountered in estimating the agriculture cost and input demand equations, and as a result some license was taken in their estimation. However, despite the lack of rigor exercised during the estimation of these equations, the resulting estimates appear to exhibit reasonable theoretical properties for the period after 1973.

On the whole, the revised resource structure does a reasonable job in reproducing history, although its

performance in the area of factor rents and hired labor demand is less than satisfactory.

#### 4. AGRICULTURE POLICY SPECIFICATION OF THE CAM

##### 4.1 Introduction

This chapter describes the agriculture policy specification of the CAM. Like the factor market specification, the agriculture policy specification has been revised from that in earlier versions of the model. Based on the postulate price manipulation is the principal tool governments use to achieve their various objectives, earlier versions of the CAM calculated domestic prices using a set of equations representing the reduced form of the government's decision making process. The approach is similar to that adopted by Skold and Meyers (1987); Meilke and Griffith (1983); and Lattimore and Schuh (1979). Less than perfect price transmission from the world market to the domestic is explained in price linkages by economic performance monitoring variables policy makers are assumed to observe and react to when determining target protection levels for domestic prices. Although this approach lends itself to an analysis of say an unilateral 50 percent producer subsidy reduction, it does not give information on what is the best way to cut the subsidies. Because all

policies are expressed as tariff equivalents, the effects of removing one particular policy instrument can not be delineated from the effects of removing another. However, it is precisely this information that is required. Because of competitive, complementary and input-output relationships between commodities, starting with their production and continuing through to their final consumption, a policy directed towards a single commodity often exerts both positive and negative externalities on a host of other commodities. To distinguish between the effects different instruments have on both targeted and nontargeted commodities, requires structural representation of each policy instrument considered. The CAM's policy block has been revised with the intent of providing such structural representation for selected domestic farm programs.

The organization of the chapter is as follows. To begin with a brief review of Canadian commodity specific agriculture policy is given in Section 4.2. The review serves to identify which policy instruments merit structural representation. The CAM's revised policy block is then presented. Section 4.3 describes the operational design and basic specification of the block. It describes in the context of the CAM what instruments are available to

the government, how the government determines target levels and permissible bounds for realized values of these instruments, and to what extent producers consider the government's policy setting actions when forming market price expectations for the coming year. For all intensive purposes this part of the policy block is the same as that contained in earlier versions of the CAM. The remaining four sections of the chapter describe the specification of the domestic farm programs selected for structural representation, and relate how the government in the context of the CAM raises funds to finance these programs.

## 4.2 Canadian Agriculture Commodity Policy

### 4.2.1 Grain and oilseeds

Apart from transportation subsidies and the recent Special Canada Grains Program, federal policies affecting grain and oilseed production focus on promoting marketing efficiency and providing producers with an income safety net rather than price and income support, per se. For the most part grain and oilseed grown in the Canadian Wheat Board (CWB) designated area is legislatively treated separately from that grown in the rest of Canada. The CWB

designated area includes the three Prairie provinces and a small region in British Columbia. For brevity grain and oilseed producers in the CWB designated area will be hereafter loosely referred to as Prairie producers. Wheat, barley and oats grown in the CWB designated area will be referred to as the Board grains and rye, canola and flaxseed grown in this same area as the Non-Board grains.

Board grain producers have three marketing options. The first and generally preferred option is to deliver their grain to the CWB, a federal agency, which markets the grain for them. Board grain producers must exercise this first option for all their grain destined for domestic human consumption or export. The other two marketing options are only open to grain destined for domestic feed use. Producers delivering to the CWB receive a pooled price paid in installments. The first installment is paid on delivery of the grain and is based on the government guaranteed initial payments. Even though the initial payments serve as price floors, they theoretically do not have distorting market effects since the government tries to set them conservatively below projected market equilibrium. In general the Government succeeds in this objective. The last few years being an exception, realized market prices have rarely been below the set initial

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payments. The last installment or final payment is usually made in the first quarter of the calendar year succeeding the close of the crop year on July 31. This final payment is the per unit combined earnings from all grain sales made during the year less initial payments and CWB operating costs. Intermediary installments or adjustment payments may be made throughout the crop year to producers who have already delivered their grain to the CWB if an increase in initial payments is warranted by buoyant export prices. The second marketing option producers have is to deliver their grain to the off-board market and receive full settlement for the grain at the time of the sale. The off-board market refers to both private grain companies acquisitions and local farm to farm, farm to feedlot, and farm to feedmill sales. The third and final option producers have is to market their grain through their own livestock operations.

The CWB acquires stocks, as needed to meet sales commitments, through two sets of marketing quotas. These marketing quotas are issued to prevent congestion of the grain delivery system and to equalize delivery opportunities among producers. They are based on producers cultivated acreage. The first set of quotas limit the amount of the three Board grains that can be delivered to

elevators for the CWB. They are necessary since the pooled price producers receive from the CWB provides no incentive to producers to spread their deliveries throughout the crop year when producers have to finance on farm storage costs from their own pockets. The second set of quotas limit the amount of Board grains that can be delivered in total to elevators for both the CWB and the off-board market. They are used to prevent off-board grain from clogging the elevator system and thus hindering CWB deliveries. Because Non-Board grains compete for the same storage and transportation facilities as the Board grains, the CWB also issues delivery quotas for them even though it is not responsible for their export.

To help Prairie producers protect themselves against losses caused by international market fluctuations, the government offers an asymmetric stabilization program. The Western Grain Stabilization Program (WGSP) guarantees Prairie producers that if the aggregate or per ton net cash flow generated from the combined commercial sales of certain commodities in the current year falls below the previous 5 year average, they will be reimbursed the shortfall through deficiency payments. The stabilized commodities include all the Board and Non-Board grains and most specialty crops. Participation in the program is



voluntary and costs producers a certain percentage of their gross sales receipts. The producer levy fluctuates in accordance with the stabilization fund balance. The federal government's contribution to the stabilization fund on a percent basis of commercial sales is 2 percentage points higher than the producer levy. In addition the federal government pays all administration costs. The maximum coverage a producer can insure against is \$60,000 worth of grain sales. The attractive feature of the program is all grain and oilseed crops must be experiencing depressed market conditions before any payments are triggered, and all participating producers receive the same compensation no matter what crop they are growing. As a result producers participating in this program should have no incentive on the basis of this program to switch between the stabilized crops. However, because farm fed grain is ineligible for payment under the program, producers may have an incentive to commercially market their grain rather than feed it or sell it to local livestock producers.

Grain and oilseed transportation within Canada is subsidized through several federal programs. Prairie producers are subsidized the cost of moving their grain to export positions. Prior to 1984 Prairie producers only paid fixed statutory rates called the Crows Nest Pass

Rates. The Crows Nest Past Rates were frozen in 1922 at the competitive levels of 1897. Because of the lack of incentive on the railways' part, at these low freight rates, to upgrade grain handling and transportation facilities, this infrastructure deteriorated causing lost export sales. To rectify the growing problem, the federal government financed branchline rehabilitation projects, box car repairs, hopper car purchases, and other investment programs designed to increase rail grain shipping capacity. Despite these subsidies, however, the physical grain carrying and handling capacity of Canadian railways continued to deteriorate. As a result the Government terminated the Crow rates in 1984 and introduced the Western Grain Transportation Act (WGTA). Under this new legislation, grain freight rates charged are competitive with those of other commodities. The freight costs are paid jointly by the Government and Prairie producers, with Prairie producers assuming a larger share through time of the total cost over and above \$659 million. The government will pay the first \$659 million of the freight costs in perpetuity. This subsidy is called the Crow Benefit.

Under the authority of the Feed Freight Assistance Act, the federal government offers a rebate on the movement of Canadian grown feedgrains to eligible feed deficit

regions within Canada. Over time regions classified as eligible recipients of this subsidy have decreased in number while regions classified as eligible shippers have increased.

Other rail subsidies exist besides those discussed above, but they are of relatively minor importance in terms of both total government expenditure and realized producer benefits when compared to those under the WGTA.

Grain and oilseed producers outside the CWB designated area are offered protection from world price troughs under the Agricultural Stabilization Act (ASA). The ASA guarantees producers a price floor for their commodity that is 90 percent of the 5 year market price average adjusted for changes in cash costs. When the market price falls below this support price, producers receive a deficiency payment equal to the discrepancy. The federal government shoulders the full cost of this program and sets no limits on the amount of commercial grain sales that are eligible for deficiency payment receipt.

To tide Board grain producers over until marketing quotas are issued for their grain, the federal government, under the Prairie Grain Advance Payment Act, provides interest-free cash advances of up to \$30,000 per producer on the security of their farm stored grain. Interest-free

cash advances are also made available to other grain and oilseed producers, but under different legislative authority. The authority in this latter case is the Advance Payments for Crops Act.

Protection against natural hazards is offered to all crop producers through voluntary crop insurance programs. These insurance programs are jointly funded by the Federal and Provincial Governments and participating producers.

As commented earlier, the CWB controls all Prairie Board grains destined for export. This centralization of export authority gives Canada a bargaining advantage in the international arena. To further assist Board grain export the CWB is able to arrange credit financing for the purchasing country with Canadian Government loan guarantees.

In addition to export control of the three Board grains, the CWB has import control over them and all their substitutes except corn. This exclusive import control may change in the future. Under the terms of the bilateral trade agreement between Canada and the U.S, U.S. wheat and feedgrains will be able to enter Canada without importers first having to gain permission from the CWB. This change will be triggered once it is determined that the subsidies U.S. producers receive for each commodity, in total value,

are equal to or less than the amount received by Canadian producers.

There are no quantity restrictions on U.S. corn imports, but these imports are subject to a specific tariff and a countervail duty. Because there are no quantity restrictions, the U.S. corn import price acts as a ceiling on Eastern Canadian feedgrain prices.

The price domestic millers must pay for wheat has been administratively set through a series of two price schemes for the last two decades. These schemes have insulated the domestic mill rate from the world price and have alternately benefited consumers at the expense of producers, and producers at the expense of consumers. In recent years significant benefits have been passed on to producers through this program. The program was terminated July 31, 1988, however, after it was discerned most of the benefits were shifting to Eastern producers away from targeted Western producers. For the crop year 1988 the government will issue producers a one time subsidy to compensate them for the loss of benefits they were receiving under the program.

To help crop producers through currently depressed market conditions, the federal government in the past few years has issued several special subsidies. These ad hoc

subsidies ostensibly are just stop gap measures until long term policy solutions can be reached through international negotiations. In 1986 and 1987, for example, the government issued deficiency payments to crop producers under the Special Canada Grain Program (SCGP). Working within an absolute expenditure ceiling for the whole SCGP, the size of the deficiency payment or 'assistance rate' for each eligible crop was set in proportion to the impact international subsidies were calculated to have on that crop's domestic price. Producers were paid according to their seeded area in each crop and the historical average yield recorded for that crop in their region of production.

#### 4.2.2 Red meats

Canadian red meat industries are relatively government unfettered. The key federal policies governing these industries provide income safety nets rather than price support. The safety nets are achieved through asymmetric stabilization programs that cut off the troughs of market price fluctuations and leave the peaks undisturbed. Stabilization is conducted under the authority of the ASA. In the past provisions of the ASA for livestock producers were similar to those for grain producers. The ASA

guaranteed cattle, hogs and sheep producers a price floor for their commodity that was 90 percent of the 5 year market price average adjusted for changes in cash costs. The program was completely government funded and covered all commercial livestock sales. There were no limits on how much an individual producer could receive or how much could be paid out in aggregate.

More recently voluntary National Tripartite Stabilization (NTS) schemes have been initiated under the ASA to replace the old completely government funded method of stabilization. These schemes are jointly funded by the federal government, participating provincial governments, and participating producers within the participating provinces. The federal and provincial governments each match producers levy contributions up to a combined maximum. The government expenditure ceiling cap for hogs and cattle is 8 percent of total market returns and for lambs 13 percent.

There are two types of stabilization schemes. One type guarantees producers a price floor for their commodity that equals the estimated national current cash costs of production for their commodity plus a percentage of the historical 5 year moving average margin between cash costs and national selling prices. The other type guarantees

producers a price floor for their commodity that equals a percentage of the 10 year moving average national market price of their commodity adjusted for inflation and changes in feed costs. The schemes for feeder cattle producers, slaughter cattle producers and hog producers fall in the first category while the schemes for cow-calf producers and lamb producers fall in the second category.

Health restrictions prevent many exporting countries from gaining access to the Canadian domestic market. Both meat and live animal imports are prohibited from countries not free of foot and mouth disease. Live animals from acceptable exporting regions are allowed into Canada tariff-free after a set quarantine period. Meat imports are all tariffed. During the mid 1970s, Oceanic countries adhered to voluntary agreements limiting meat imports. In 1981 the voluntary agreements were replaced by formal quantitative restrictions under the Meat Import Act. These formal quantitative restrictions, however, were not activated until 1985 when they were applied to subsidized EEC beef imports.



#### 4.2.3 Dairy

Dairy, one of the more protected agriculture industries in Canada, is a government regulated supply managed industry. Milk destined for use in manufacturing is treated distinctly from that destined for fluid consumption. The federal government is responsible for setting policies affecting the production and pricing of industrial milk and cream, and trade of manufactured dairy products. The Canadian Dairy Commission, a federal agency, oversees the administration of these policies with the combined cooperation of provincial governments and provincial producer marketing boards. Industrial milk production is constrained by quota to a level that just gives national self-sufficiency on a butter-fat basis. This national quota is allocated to the different provincial governments who in turn further allocate it to all the dairy producers operating in their particular province. Producers receive a flat rate unit subsidy of \$6.03/hl on their within-quota production over and above the market return. The market return is supported by federal government surplus purchases of butter and skim milk powder. The government purchase price of these commodities is set to induce a market price for industrial milk and cream, which when added to the direct unit payment

paid to producers, will provide producers with the government established Target Return. Prior to calendar year 1988 this target return was based on a cost of production formula which had as its components various farm input price indices and the consumer price index along with judgmental factors. Currently, the target return is based on a cost of production survey, and takes into consideration the costs of only 70 percent of the producers surveyed. The selected producers are those reporting the lowest cost operations. This change in the Target Return calculation is designed to eliminate the most inefficient dairy operations.

The government tightly restricts imports of both manufactured dairy products and dairy substitutes to prevent international competition from eroding the domestic market return. The importation of butter and skim milk powder is completely prohibited. Other dairy products are subject to tariffs, in addition to the import quantity restrictions.

Canadian dairy exports have the competitive advantage a central selling agency, the CDC, offers in trade negotiations and foreign market procurement. Dairy products acquired through the CDC's surplus purchasing activities are exported at world prices. The financial

losses incurred on these exports, as well as on traditional exports are exacted from producers through levies.

Fluid milk regulation is decentralized with provincial governments assuming policy control for pricing and production within their borders. To prevent the policies of one province from disrupting the fluid milk industry in another province, interprovincial trade in fluid milk is prohibited along with international trade in fluid milk. Each province sets daily quotas to maintain self-sufficiency in its own fluid needs. The provinces vary, though, in how they price this fluid milk. Some provinces allow the retail market to determine price given the controlled production, while other provinces set price according to full cost of production formulas. In all cases fluid milk prices command a premium over industrial milk prices. Provinces also differ in methods of quota transfer. In some provinces, such as Ontario, quota is bought and sold as a commodity in and of itself. In other provinces quota is attached to specific capital items; for instance, in Saskatchewan quota is attached to dairy cows.

#### 4.2.4 Poultry

Poultry policy is similar to dairy. Chicken and turkey production are each supply managed by a federal

agency (The Canadian Chicken Marketing Agency (CCMA) and The Canadian Turkey Marketing Agency (CTMA), respectively). Each federal agency sets production quota for national self-sufficiency at a producer price that will recoup full cost of production, and allocates this quota among the provinces. Provinces are responsible for setting the poultry price within their own borders. They do so according to a formula that expresses producer price as cost of production adjusted for current market conditions. Although there is no surplus purchasing by the federal agencies to support price, there is some by provincial marketing boards. As with dairy, quota transfer among producers is a provincial responsibility and varies by province from free market, to auction, to asset fixation.

Imports are restricted in quantity to a maximum of their historical share of domestic production. For broilers this share is 6.3 percent and for turkeys 2.0 percent. Supplemental imports are allowed if domestic shortages arise. All imports are subject to flat rate tariffs. Under the terms of the free trade agreement with the U.S., in the future these tariffs will be eliminated, and the import quantity restrictions relaxed.

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#### 4.2.5 Eggs

The egg industry is also supply managed and has a federal agency, the Canadian Egg Marketing Agency (CEMA), serving both as its coordinator and its watch dog. The CEMA sets the producer price of shell eggs using a full cost of production formula. It then issues production quota in an amount equal to the calculated national egg demand at that price floor. At times, because of fluctuating demand, the Agency has to purchase surplus table eggs. On acquisition, the CEMA resells these surplus purchases, at a financial loss, to the processing industry as breakers. Both consumers and producers are levied to offset the financial loss. Production quota transfer is again a provincial policy decision, and as such varies from province to province.

Imports are restricted in quantity to a maximum of 0.625 percent of the previous year's domestic production. Imports made within this quota are subject to a flat rate tariff. Again, the Canadian-U.S. bilateral trade agreement calls for elimination of the tariff and a marginal increase in import quantity restrictions.

#### 4.2.6 Fruits and vegetables

Domestic fruit and vegetable production has primarily been protected by seasonal tariffs. The Canadian-U.S. bilateral trade agreement, however, spells the end of this source of protection. The ASA provides completely government funded stabilization coverage for certain horticultural crops on a discretionary basis at a discretionary support level. Recently a national tripartite stabilization scheme, along the lines of those for red meats, was established for apples. Producer marketing boards with price negotiating powers are a popular form of provincial government support. Fruit and vegetable producers, like grain producers, have the option of participating in crop insurance programs.

#### 4.3 Specification of the CAM's Policy Block

Given the dynamic, regional and commodity specific nature of Canadian agriculture policy, it is apparent how futile an effort it would be to structurally represent each and every policy in the CAM. Such an effort would result in a black box which for all practical purposes would not give any more useful information than could be obtained

from a simpler model that did not attempt such thorough policy coverage. For this reason only select domestic farm programs are structurally represented and license is taken in specifying their regional and temporal applicability. Particular attention is given to spelling out the mechanics of income stabilization and supply management programs. Meilke and Warley (1988) identify these program types as "two of the most distinctive and prominent features of Canadian agricultural policy". No attempt is made to spell out border protection measures. The price linkages estimated for earlier versions of the CAM are retained to account for all border barriers, from import quotas and tariffs, to health restrictions and bilingual labelling requirements. It is argued that these price linkages do not double count the direct payments to farmers issued under the income stabilization programs since they were estimated using market prices as the dependent variable rather than producers actual in-pocket gross unit returns for each commodity.

#### 4.3.1 Solution priority

Three underlying assumptions about government behavior regulate the operation of the CAM's policy block. The

assumptions are as follows: 1) the government intervenes in commodity markets by manipulating domestic market prices and by issuing direct payments to producers; 2) the government places lower priority on internal commodity price support and producer income stabilization than it does on correcting external payment imbalances and carrying out social programs financed through income taxes; and 3) government intervention in the commodity markets will stop short of causing socially undesirable and economic destabilizing changes in domestic human consumption, commodity trade and stocking activities.

In accordance to these assumptions, the CAM's policy block sets target values and maximum and minimum bounds for Canada's trade deficit and income tax rate and for the domestic price, domestic human consumption, net trade volume and stock of each tradeable commodity bundle. The solution algorithm gives priority in terms of target value realization first to the trade deficit, second to the income tax rate, third to domestic prices, fourth to commodity trade, fifth to stocks and last to human consumption. What this priority ranking means is that if it is not mathematically possible to achieve all target values, the solution algorithm will hold the economic variable with the higher priority at its target value and

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will adjust the economic variable of lower priority within the permissible limits until an equilibrium solution is found. The economic variable with the higher priority will only be moved away from its target value if an equilibrium solution cannot be found that allows the economic variable of lower priority to stay within its permissible limits. Because generous bounds are placed on trade volumes, realized commodity prices almost always equal their set target values. Price target values are set responsive to the changing economic conditions depicted by the model's solution. This is in contrast to the other policy parameters, which are set either externally, or internally according to rules that are invariant to the model's portrayed solution.

#### 4.3.2 Target price formation

The BLS requires the CAM to offer the same commodity bundles for international exchange as every other national model does. There are ten commodity bundles eligible for exchange. These are (1) wheat; (2) rice; (3) coarse grains; (4) bovine and ovine meats; (5) dairy products; (6) other livestock products which includes pork, poultry, eggs and fish; (7) protein feed which includes oilseed meal,

meat meal and fish meal; (8) all other food which includes oils and fats, sugar, fruit, vegetables and beverages; (9) nonfood agriculture which includes fibers, wool and industrial products; and (N) nonagriculture.

Target domestic consumer prices are set for each bundle, except dairy products, using world to domestic price linkages. The linkages represent the reduced form of policy makers' decision making process. They include as explanatory variables the market performance indicators policy makers are believed to observe and react to when determining border protection for domestic market prices. In particular the linkage equations express the target domestic market price ( $CTP_i$ ) for each agriculture bundle  $i$  as a multiplicative function of the world market price ( $WPI$ ) in the current year, the world market price in the previous year, the realized domestic price ( $CPI$ ) in the previous year and the self-sufficiency ratio ( $SSR_i$ ) average over the previous two years. Because only relative prices matter, prices are deflated by either the world ( $WPN$ ) or domestic ( $CPN$ ) nonagriculture price as is appropriate. Algebraically,

$$\begin{aligned}
 (4.1) \quad [CTPi_t/CTPN_t] &= b_{i0} * [WPI_t/WPN_t]^{b_{i1}} \\
 &\quad * [WPI_{t-1}/WPN_{t-1}]^{b_{i2}} \\
 &\quad * [CPI_{t-1}/CPN_{t-1}]^{b_{i3}} \\
 &\quad * [0.5*(SSRi_{t-1}+SSRi_{t-2})]^{b_{i4}} \\
 &\quad + v_t^{(CTPi)} \quad \text{for } i=1, \dots, 4, 6, \dots, 9.
 \end{aligned}$$

Table 4.1 gives parameter estimates for these policy synthesizing price linkages. The parameter  $b_{i1}$  reflects the extent to which relative world price changes are passed onto domestic market prices. The value of 1 for this parameter in the wheat and coarse grain linkages implies perfect price transmission whereas the value of 0.283 in the other livestock products linkage implies isolation of the domestic market from world prices. This latter result is more indicative of the poultry component of this bundle than it is the pork and fish components. The parameter  $b_{i2}$  comes into play for bundles, such as the bovine and ovine bundle, whose component parts have biological production processes spanning several periods causing adjustment lags, and bundles, such as the other food items bundle, whose component parts are reported over different crop years across countries. The parameter  $b_{i4}$  reflects the extent to

**Table 4.1: Parameter values for the target price equations<sup>a</sup>**

	Parameters				
	bi0	bi1	bi2	bi3	bi4
Wheat	1.0181	1.0000	0.0000	0.0000	0.0000
Rice	0.8598	0.2657	0.0000	0.5084	0.0000
Coarse grains	0.8549	1.0000	0.0000	0.0000	0.0000
Bovine and Ovine Meats	1.9659	0.5867	0.0991	0.0000	-0.5000
Other Livestock Products	4.5380	0.2830	0.0000	0.5448	-1.1160
Protein Feeds	0.9965	0.5650	0.0000	0.4350	0.0000
Other Food	3.7180	0.6760	0.3240	0.0000	-1.3990
Nonfood Agriculture	2.4090	0.3236	0.2528	0.0000	-0.8971

<sup>a</sup>Source: Frohberg and Fischer, 1985.

which the government intervenes in the market with self-sufficiency as its goal. This parameter does not have significance for bundles which are net exported, such as wheat and coarse grains, and bundles whose physiology prevent their viable production in Canada, such as rice.

Dairy target prices are set according to cost of production. Details of the formulation are given in Section 4.4 where the Dairy Supply Management Program specification is laid out.

The nonagriculture target price is set as a time varying fraction of the current nonagriculture world price where the time varying fraction is a multiplicative function of the previous year's ratio between the domestic and world nonagriculture prices:

$$(4.2) \quad CTPN_t = 0.99 * [ CTPN_{t-1} / WPN_{t-1} ]^{0.776} * WPN_t.$$

#### 4.3.3 Consumer prices

As discussed in connection with the priority ranking of the solution algorithm, realized consumer prices (CPI) can lie anywhere in a set range around their target values, their exact value being that which achieves a domestic market equilibrium without causing other policy variables

to go outside their permissible bounds:

$$(4.3) \quad C P i_t = C T P i_t + P D E V i_t$$

with  $P D E V i_t < (P M A X i - 1) * C T P i_t$  if  $P D E V i_t > 0$

and  $P D E V i_t > (P M I N i - 1) * C T P i_t$  if  $P D E V i_t < 0$

for  $i = 1, \dots, 9$

where

$P D E V i$  is the difference between the target and realized consumer price of bundle  $i$ ;

$P M A X i$  is the maximum value, expressed as a percentage of the target price, which the realized consumer price can adopt; and

$P M I N i$  is the minimum value, expressed as a percentage of the target price, which the realized consumer price can adopt.

#### 4.3.4 Producer prices

The commodity bundles eligible for exchange in the BLS group commodities that are homogeneous from a consumer demand perspective. The commodities need not be homogeneous from a production perspective, and in fact often are quite heterogeneous when considered from this viewpoint. Consider, for example, the protein feed exchange bundle. Commodities comprising this bundle can be broadly subdivided into: oilseed meals, meat meals, and fish meals. While the production process of a commodity in each subdivision is somewhat similar to the production

processes of other commodities in that same subdivision, it is completely different from the production processes of commodities in the other two subdivisions. Because of this irreconcilable dissimilarity in production processes across commodities within exchange bundles, national and regional models within the BLS are not forced to produce the same bundles as they exchange internationally. The CAM allows for the production of 10 agriculture commodity bundles: (WH) wheat; (CG) coarse grains; (OM) oilseed meal; (FR) fruit; (OC) all other food of crop origin; (NC) nonfood agriculture of crop origin; (BO) bovine and ovine meats; (DY) dairy products; (PO) pork, poultry and eggs; and (FI) fish.

Producer market returns for the production bundles are derived from the consumer prices for the exchange bundles using a multistage mapping process. The first stage corrects for the fact different weights are appropriate when aggregating commodities within a bundle for consumption than are appropriate when aggregating for production. As shown the difference in appropriate aggregation weights is captured by a constant multiplicative factor, PPTCi:

$$(4.4) \quad PPI_t = PPTCi_t * CPI_t + v_t^{\frac{PPI}{CPI}}.$$

PPTCi is the average historical ratio of exchange bundle i's commodity component prices weighted by consumption quantities to the commodity component prices weighted by production quantities. Table 4.2 reports the value of PPTCi for each exchange bundle.

The second stage interpolates from the producer price of the more diverse exchange bundles producer prices for subaggregates of their commodity components. Each subaggregate consists entirely of commodities with similar production processes. The left side of Table 4.3 shows the various subaggregates of each bundle.

To do the interpolation additional information has to be introduced to make the problem solvable. The type of information introduced depends upon the postulated relationship between the subaggregates. If the K subaggregates of bundle i are assumed consumption independent, then the information added is each subaggregate's contribution to total revenue. Given this information the formula for the producer price of the jth subaggregate is:

$$(4.5) \quad PP_{ij_t} = S_{ij_t} * PP_{i_t} * Q_{i_t} / Q_{ij_t} + v_t^{PP_{ij}}$$



**Table 4.2: Price corrections for aggregation weight differences between economic activities<sup>a</sup>**

Exchange Bundle	PPTCi	FPTPi	
		ai0	ai1
1: Wheat	1.0000	0.9000	0.0000
3: Coarse grains	0.9711	0.9988	-0.0011
4: Bovine and Ovine Meats	0.9871	n/a	n/a
5: Dairy Products	1.0000	0.2500	0.0000
6: Other Livestock Products	0.9131	n/a	n/a
7: Protein Feeds	0.3455	0.9491	-0.0438
8: Other Food Items	0.6541	1.4914 <sup>b</sup> 1.0134 <sup>c</sup>	0.0854 <sup>b</sup> -0.0021 <sup>c</sup>
9: Nonfood Agriculture	0.9724	n/a	n/a

<sup>a</sup>Source: Frohberg and Fischer, 1985.

<sup>b</sup>Used as feed for ruminants.

<sup>c</sup>Used as feed for hogs and poultry.

**Table 4.3: Exchange bundle price disaggregation and production bundle market return aggregation<sup>a</sup>**

Exchange Bundles	Production Bundles <sup>b</sup>									
	WH	CG	OM	FR	OC	NC	BO	DY	PO	FI
1: Wheat	X									
2: Rice										
3: Coarse Grains		X								
4: Bovine & Ovine							X	X		
5: Dairy Products								X		
6: Other Livestock Products										
61: Pork, Poultry & Eggs									X	
62: Fish										X
7: Protein Feeds										
71: Oilseed Meal			X							
72: Meat Meal							X	X	X	
73: Fish Meal										X
8: Other Food Items										
81: Oilseed Oil			X							
82: Ruminant Fat							X	X		
83: Lard									X	
84: Fish Oil										X
81: Fruit				X						
82: Rest of Other Food					X					

<sup>a</sup>Source: Fischer et al., 1988.

<sup>b</sup>Production bundle mnemonics are as follows:  
 WH=wheat; CG=coarse grains; OM=oilseed meal; FR=fruit;  
 OC=other food of crop origin; NC=nonfood agric. of crop  
 origin; BO=bovine & ovinemeats; DY=dairy products;  
 PO=pork, poultry & eggs; and FI=fish.

Table 4.3 (Continued)

[illegible]

where  $PP_{ij}$  is the producer price of subaggregate  $j$  of bundle  $i$ ;  
 $S_{ij}$  is the share of bundle  $i$ 's revenue contributed by subaggregate  $j$ ;  
 $PP_i$  is the producer price of bundle  $i$ ;  
 $Q_i$  is production of bundle  $i$ ; and  
 $Q_{ij}$  is production of subaggregate  $j$  of bundle  $i$ .

If the  $K$  subaggregates of bundle  $i$  are assumed consumption substitutes, then the information added is the proportion each subaggregate's price is of the sum of all the subaggregate prices. Adding this information about  $K-1$  of the subaggregates to the production quantity weighted average of all  $K$  subaggregate prices yields a system of  $K$  equations in the  $K$  unknown subaggregate prices:

$$\begin{aligned}
 PP_i &= [ PP_{i1} \cdot Q_{i1} + \dots + PP_{iK} \cdot Q_{iK} ] / Q_i \\
 (4.6) \quad S_{i1} &= PP_{i1} / [ PP_{i1} + \dots + PP_{iK} ] \\
 &\cdot \\
 &\cdot \\
 S_{iK-1} &= PP_{iK-1} / [ PP_{i1} + \dots + PP_{iK} ]
 \end{aligned}$$

Solution of system (4.6) gives the following formula for the price of the  $j$ th subaggregate of bundle  $i$ :

$$(4.7) \quad PP_{ijt} = S_{ijt} \cdot PP_{it} \cdot Q_{it} / \left[ \sum_{k=1}^K S_{ikt} \cdot Q_{ikt} \right] + v_t^{PP_{ij}}$$

$$\text{where } S_{ij_t} = P_{ij_t} / \sum_{k=1}^K P_{ik_t}.$$

Both the total revenue shares for the consumption independent interpolation and the price shares for the consumption substitute interpolation are estimated using a logit expression:

$$(4.8) \quad S_{ij_t} = W_{ij_t} / \sum_{k=1}^K W_{ik_t} + v_t^{S_{ij}}$$

with

$$W_{ij_t} = \exp(a_{0ij} + a_{1ij} * T_t) / [1 + \exp(a_{0ij} + a_{1ij} * T_t)].$$

Table 4.4 reports the parameter estimates for these logit specifications.

The third and final stage of the mapping procedure recombines the producer prices of the exchange bundles and their subaggregates to arrive at the market return for each production bundle. The market return earned on production bundle  $k$  equals the producer price of the equivalent exchange bundle  $i$  being produced plus all revenue earned on the  $L$  various byproducts resulting from bundle  $k$ 's production:

**Table 4.4: Parameter estimates used in determining total revenue and price sum shares of the exchange bundle subaggregates<sup>a</sup>**

Exchange Bundles and Preliminary Subaggregates	Subaggregates	Parameters	
		a0ijj	ali j
6: Other Livestock Products <sup>b</sup>	61: Pork, Poultry and Eggs	1.0339	-0.0109
	62: Fish	0.9385	0.0198
7: Protein Feeds <sup>b</sup>	71: Oilseed Meal	0.9369	0.0255
	72: Meat Meal	1.2854	-0.1656
	73: Fish Meal	1.4657	-0.1300
8: Other Food Items <sup>c</sup>	Fats and Oils	-0.6177	-0.0252
	Nonfats and Oils	0.6177	0.0252
Fats and Oils <sup>b</sup>	81: Oilseed Oil	1.0481	0.0250
	82: Ruminant Fat	0.4398	-0.0489
	83: Lard	0.9888	-0.0658
	84: Fish Oil	1.9079	-0.1453
Nonfats and Oils <sup>b</sup>	85: Fruit	1.2539	-0.0386
	86: Rest of Other Food	0.9344	0.0103
9: Nonfood Agriculture <sup>b</sup>	91: Of Crop Origin	0.9294	0.0158
	92: Ruminant Hides	1.2790	-0.0564
	93: Other Livestock Hides	0.0000	0.0000

<sup>a</sup>Source: Frohberg and Fischer, 1985.

<sup>b</sup>Parameters used to determine price sum shares.

<sup>c</sup>Parameters used to determine total revenue shares.

$$(4.9) \quad Pk_t = PPI_t + \sum_{l=1}^L BYkl_t * PPl_t.$$

where

$Pk$  is the market return for production bundle  $k$ ;  
 $PPI$  is the producer price of exchange bundle  $i$ ;  
 and  
 $BYkl$  is the amount of byproduct  $l$  resulting from  
 the production of 1 unit of bundle  $k$ .

The right side of Table 4.3 shows the various prices that go into the formation of the market return for each production bundle.

#### 4.3.5 Feed prices

The feed price for exchange bundle  $j$  is a multiplicative function of the producer price:

$$(4.10) \quad FPI_t = FPTPI_t * PPI_t + v_t^{FPI}$$

with  $FPTPI_t = a_{0i} + a_{1i} * Tt.$

The multiplicative factor  $FPTPI$  corrects for the fact commodities comprising an exchange bundle may be fed in different combination than they are produced.  $FPTPI$  is the average historical ratio of exchange bundle  $i$ 's commodity component prices weighted by production quantities to the

commodity component prices weighted by feed quantities. To account for the fact the commodity components of some bundles have been fed in varying combinations over time as one commodity has gained popularity at the expense of the other commodities, the average historical ratio is expressed as a linear trend function. However, as shown in Table 4.2, the coefficient on time is zero for most bundles.

#### 4.3.6 Producer market price expectations

At the time producers make their production decisions in period  $t$  for period  $t+1$ , they are unaware of the market prices that will prevail in period  $t+1$ . Hence, they must form expectations about these prices. Producers are assumed to have extrapolative expectations. Under the postulate their uncertainty is attributed more to incomplete knowledge about world supply and demand conditions than about government border protection response, producers price expectation in period  $t$  for the landed import price ( $CP_i^e$ ) of exchange bundle  $i$  in period  $t+1$  is a three year weighted average of current and past target prices:



$$(4.11) \quad \text{CPI}_t^e = 0.5 \cdot \text{CTPi}_t + 0.4 \cdot \text{CTPi}_{t-1} \\ + 0.1 \cdot \text{CTPi}_{t-2} + v_t^{(\text{CPI})}$$

for  $i=1, \dots, 4, 6, \dots, 9$ .

An exception to this rule is their expectation concerning dairy price. Producers form their dairy price expectation using the same cost of production formula the government uses to set target prices (see Section 4.4).

It is assumed producers have complete knowledge about the relationship between the landed import prices of the exchange commodities and the market returns they receive for the different production bundles, and that they adjust their landed import price expectations accordingly to form expectations about their own market returns.

#### 4.3.7 Market unit value added

Market unit value added (VAK) of production bundle  $k$  is defined to be that portion of net market revenue which is attributable to the services of the primary factors used in bundle  $k$ 's production. It is calculated as market return ( $P_k$ ) less unit variable cost ( $VCK$ ):

$$(4.12) \quad VAK_t = PK_t - VCK_t.$$

This value added concept has greater relevance for factor allocation and use than does market return, per se. Producers will devote their fixed factors of production, i.e., land, labor, and capital, to the activities that will earn them the greatest reward in that employ. This is the maintained hypothesis of the nonlinear optimizing model used to determine agriculture commodity factor usage in the CAM's input block (see Section 3.7).

#### 4.3.8 Variable production cost

As shown in equations (4.13) and (4.14), the CAM distinguishes between two types of variable inputs: yield increasing and nonyield increasing:

$$(4.13) \quad VCK_t * Yk_t = [1 + Z1k] * PFZ_t * FZk_t + Z2k * PPN_t * Yk_t \\ + v_t^{(VCK)} \quad \text{for } k \in \text{crops};$$

and

$$(4.14) \quad VCK_t = \sum_{j=1}^J FPj_t * FDkj_t + Z2k * PPN_t * Yk_t + v_t^{VCK} \\ \text{for } k \in \text{livestock}.$$

It is assumed all nonyield increasing inputs, such as machinery repairs and veterinarian expenses, are applied in absolute constant amount,  $Z2k$ , per unit of commodity  $k$  produced. This holds true whether commodity  $k$  is of crop or livestock origin. If commodity  $k$  is of crop origin, then it is assumed all yield increasing inputs other than nitrogen fertilizer (this would include pesticides and herbicides as well as phosphate and potash) are applied in fixed proportion,  $Z1k$ , to optimal nitrogen input ( $FZk$ ) per hectare. Optimal nitrogen input is determined according to the first order condition of a revenue optimization model that maximizes per hectare profit margin over fertilizer costs (see Fischer et al. 1988). If commodity  $k$  is of livestock origin, then the yield increasing inputs are the feed concentrates. Total feed cost is determined by summing over all exchange bundles, the optimal amount fed per head owned ( $FDkj$ ) times the bundle's price as feed ( $FPj$ ). Optimal feed rations are determined using a cost minimizing model (see Fischer et al. 1988).

#### 4.4 Dairy Supply Management

Because domestic dairy prices are completely insulated from world prices and are administratively set according to changes in cost of production, the world to producer price linkage of Section 4.3.2 is not used to determine target prices for the dairy exchange bundle. Instead the dairy target price (CTP5) is calculated by adjusting the previous annual value in line with changes in cost of production. The change in cost of production is calculated by taking a weighted average of the percentage changes in the price of each variable and fixed input. The percentage price change of each input is weighted according to that input's contribution to total cost on an 'average' dairy farm. Feed ingredients other than milk and roughage are assigned a weight of 0.40, other variable inputs a weight of 0.24, labor a weight of 0.20, and interest and depreciation a weight of 0.16. The dairy target price formula is presented in Table 4.5. As shown the cost of production formula assumes 0.8 units of hired labor are used in association with every unit of operator labor. The nonagriculture capital rental rate is used for the interest and depreciation price.

Although the realized consumer price (CP5) for dairy

**Table 4.5: Policy block specification for dairy supply management**

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**Consumer Target Price**

$$\begin{aligned} \text{CTP5}_t = & \text{CTP5}_{t-1} * [1 + 0.40\% \Delta((\text{FP1}_t * \text{FD51}_t + \text{FP3}_t * \text{FD53}_t + \text{FP7}_t \\ & * \text{FD57}_t + \text{FP8}_t * \text{FD58}_t) / \text{YDY}_t) + 0.24\% \Delta(0.007 * \text{PPN}_t) \\ & + 0.20\% \Delta(0.56 * \text{WN}_t + 0.44 * \text{WA}_t) + 0.16\% \Delta \text{RN}_t] \end{aligned}$$

**Realized Consumer Price**

$$\text{CP5}_t = \text{CTP5}_t$$

**Expected Consumer Price**

$$\begin{aligned} \text{CTP5}_t^* = & \text{CTP5}_{t-1} * [1 + 0.40\% \Delta((\text{FP1}_t^* * \text{FD51}_{t-1} + \text{FP3}_t^* * \text{FD53}_{t-1} \\ & + \text{FP7}_t^* * \text{FD57}_{t-1} + \text{FP8}_t^* * \text{FD58}_{t-1}) / \text{YDY}_{t-1}) + 0.24 \\ & \% \Delta(0.007 * \text{PPN}_t) + 0.20\% \Delta(0.56 * \text{WN}_{t-1} + 0.44 * \text{WA}_{t-1}) \\ & + 0.16\% \Delta \text{RN}_{t-1}] \end{aligned}$$

**Producer Price**

$$\text{PP5}_t = 1.0 * \text{CP5}_t$$

**Feed Price**

$$\text{FP5}_t = 0.25 * \text{PP5}_t$$

**Production Quota**

$$\text{QDY}_t = 1.0055 * (\text{D5}_{t-1} - \text{I5}_{t-1})$$


---

Table 4.5 (Continued)

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Market Return

$$PDY_t = PP5_t + PP4_t * BY54_t + PP72_t * BY57_t + PP82_t * BY58_t \\ + PP92_t * BY59_t$$

Unit Value Added

$$VADY_t = [PDY_t * YDY_t - FP1_t * FD51_t - FP3_t * FD53_t - FP5_t * FD55_t \\ - FP7_t * FD57_t - FP8_t * FD58_t - 0.08 * YDY_t * PPN_t] / YDY_t$$


---

products is not forced to equal the target price, it is constrained to lie in close proximity to it by the same relationship as that used for the other exchange bundles (see equation 4.3).

The market return (PDY) dairy producers receive per unit of production includes not only the price of dairy products (PP5), but also the returns earned on the beef (BY54), meat meal (BY57), ruminant fat (BY58) and hide (BY59) byproducts resulting from milk production. Value added per unit of milk production (VADY) equals the market return less feed and other variable costs.

Producers dairy price expectations correspond to how they think cost of production is going to change, which in turn is based on their extrapolative market price expectations. As explained in Section 4.3.6 their expectations concerning feed prices for year  $t+1$  are 3 year weighted moving averages of current and past consumer target prices times the appropriate weight aggregation correction factors to get to feed price basis. Because factor returns are more stable than commodity prices, producers expectations about factor costs are naive. They take the current value as their expected value for next year. This is consistent with the specification of the agriculture cost function and input demands of Chapter 3.

Producers expectations about feed concentrate consumption and milk yield per cow are also naive.

Producers are not able to freely respond to their price and value added expectations since dairy production is constrained by quota. The quota restricts national dairy production to a constant multiplicative factor of domestic demand in the previous year (D5) less beginning stocks (I5).

#### 4.5 Western Grain Stabilization Program (WGSP)

For representational ease, several assumptions are made in contradiction to actual features of the WGSP. They are as follows: 1) the WGSP is applicable to all grain and oilseeds grown in Canada, not just those grown in the Prairies; 2) there is full producer participation, i.e., all producers sign up for the program and never exercise their withdrawal option; 3) the WGSP covers all commercial grain sales, not just an individual's first \$60,000 worth; and 4) specialty crops are not included in the program. As a consequence of the first three assumptions, the representation over estimates program benefits. However, it is felt the gain in model interpretability wrought by



making these assumptions is worth the bias in results.

Also for representation ease, producers are assumed to be risk neutral. To the extent producers are risk averse, as they are generally believed to be, this assumption will cause production to be under estimated since output increases associated purely with the risk reduction aspect of this program are ignored. It is unknown how much this production under estimation will offset the program benefit over estimation resulting from the first three assumptions.

Tables 4.6 to 4.9 lay out the CAM's WGSP specification. Table 4.6 contains the specifications for the general program variables, while Tables 4.7 to 4.9 contain government assisted value added calculations for the wheat, coarse grains, and oilseed meal production bundles, respectively. In Table 4.6 aggregate net eligible commercial grain and oilseed returns (NRWGS) for the current year are calculated by summing net eligible commercial wheat, coarse grains and oilseed returns. Net returns for crop  $i$  are calculated as the historical ratio of commercial marketings to production times market value added ( $VA_i$ ) times production ( $Q_i$ ). Aggregate net eligible commercial returns for the current year are compared with their historical 5 year moving average both on a gross and a per tonne basis. If the current value is below the 5

**Table 4.6: Policy block specification of WGSP deficiency payments**

**Total WGSP Payout**

$$\begin{aligned}
 \text{PYTWGS}_t &= \text{Max} \left\{ 0, \left( \frac{1}{5} \right) * \sum_{k=1}^5 \text{NRWGS}_{t-k} - \text{NRWGS}_t, \right. \\
 &\quad \left. \text{QWGS}_t * \left[ \left( \frac{1}{5} \right) * \sum_{k=1}^5 \left( \frac{\text{NRWGS}_{t-k}}{\text{QWGS}_{t-k}} \right) - \left( \frac{\text{NRWGS}_t}{\text{QWGS}_t} \right) \right] \right\}
 \end{aligned}$$

**Net Returns on WGSP Eligible Commercial Sales**

$$\begin{aligned}
 \text{NRWGS}_t &= 0.887 * \text{VAWH}_t * \text{QWH}_t + 0.625 * \text{VACG}_t * \text{QCG}_t \\
 &\quad + 0.918 * \text{VAOM}_t * \text{QOM}_t
 \end{aligned}$$

**WGSP Eligible Commercial Sales**

$$\text{QWGS}_t = 0.887 * \text{QWH}_t + 0.625 * \text{QCG}_t + 0.918 * 1.56 * \text{QOM}_t$$

**WGSP Producer Levy**

$$\text{LVYWGS}_t = \begin{cases} 0.04 & \text{if } \text{BALWGS}_{t-1} < 0 \\ 0.03 & \text{if } \text{BALWGS}_{t-1} > 0 \\ & \text{ \& } \text{BALWGS}_{t-1} < 0.5 * \left( \frac{1}{5} \right) * \sum_{k=1}^5 \text{NRWGS}_{t-k} \\ 0.02 & \text{if } \text{BALWGS}_{t-1} > 0 \\ & \text{ \& } \text{BALWGS}_{t-1} > 0.5 * \left( \frac{1}{5} \right) * \sum_{k=1}^5 \text{NRWGS}_{t-k} \end{cases}$$

$$\text{where } \text{BALWGS}_t = \text{BALWGS}_{t-1} + \text{WGSFDG}_t - \text{PYTWGS}_t$$

Table 4.6 (Continued)

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WGSP Funding: Government and Producer Contributions

$$\begin{aligned} \text{WGSFDG}_t = & (2 * \text{LVYWGS}_t + 0.02) * [0.887 * \text{PP1}_t * \text{QWH}_t \\ & + 0.625 * \text{PP3}_t * \text{QCG}_t + 0.918 * (\text{PP71}_t * \text{QOM}_t \\ & + \text{PP82}_t * \text{QOO}_t)] \end{aligned}$$

---

year average on one or both of these bases, a deficiency payment is triggered. The size of the deficiency payment (PYTWGS) is set equal to whatever is the maximum of the following: zero; the discrepancy on a gross basis; and total grain and oilseed sales eligible for deficiency payment receipt (QWGS) times the discrepancy on a per tonne basis. Commercial grain and oilseed sales are calculated as the sum of each crop's production times its historical marketing to production ratio. In calculating QWGS account is taken that the WGSP figures oilseed tonnage in its bulk rather than crushed form. This is done by multiplying meal production by 1.56 to inflate it back up to uncrushed product.

The percent levy on commercial sales exacted from producers (LVYWGS) varies depending upon the balance of the stabilization fund account (BALWGS). If the account is in deficit, producers are required to contribute 4% of their commercial sales. If the account is in surplus but less than half of the historical 5 year moving average of net crop proceeds, producers are required to contribute 3% of their sales. Finally, if the account is in surplus and is greater than half of the historical 5 year moving average of net crop proceeds, producers are required to contribute 2%. Total funding of the stabilization account (WGSFDG)

comes from both the federal government and producers. The federal government's contribution on a percent basis of commercial sales is 2 percentage points higher than the producer levy. No account is taken of any interest accruing on fund surpluses.

Tables 4.7 to 4.9 show that crop  $i$ 's share of the deficiency payment,  $PYTWGS$ , equals the proportion of total producer levy contributions over the last three years that was contributed by producers of crop  $i$ . The levy contribution of crop  $i$ 's producers ( $LVY_i$ ) in any year is the multiple of the producer levy and the proportion of crop  $i$ 's production that is commercially sold. The total deficiency payment made to crop  $i$  divided by crop  $i$ 's eligible commercial sales gives the deficiency payment for crop  $i$  on a per tonne basis ( $DPI$ ). The return on crop  $i$ 's commercial sales is the market return ( $P_i$ ) plus the per tonne deficiency payment less the per tonne producer levy. The government assisted return ( $P_i^a$ ) equals the return on commercial sales, weighted by commercial sales over total production, plus the market price, weighted by the production remainder over total production.

Because WGSP calculations are based on oilseed sales rather than their product sales, the government assisted returns for oilseed meal and oil are determined recursively

**Table 4.7: Policy block specification for wheat return calculations**

---

**Market Return**

$$PWH_t = PP1_t$$

**Government Assisted Return**

$$PWH_t^a = 0.113 * PWH_t + 0.887 * [PWH_t + DPWH_t - LVYWGS_t * PWH_t]$$

**WGSP Deficiency Payment Per Tonne**

$$DPWH_t = PYTWGS_t * \left[ \frac{\sum_{k=0}^2 (LVYWH_{t-k})}{\sum_{k=0}^2 (LVYWH_{t-k} + LVYCG_{t-k} + LVYOM_{t-k})} \right] / [0.887 * QWH_t]$$

**WGSP Levy Payment**

$$LVYWH_t = LVYWGS_t * 0.887 * PWH_t * QWH_t$$

**Market Unit Value Added**

$$VAWH_t = [PWH_t * YWH_t - (1. + 0.5) * PFZ_t * FZWH_t - 0.15 * PPN_t * YWH_t] / YWH_t$$

**Government Assisted Unit Value Added**

$$VAWH_t^a = [PWH_t^a * YWH_t - (1. + 0.5) * PFZ_t * FZWH_t - 0.15 * PPN_t * YWH_t] / YWH_t$$


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**Table 4.8: Policy block specification for coarse grain return calculations**

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**Market Return**

$$PCG_t = PP3_t$$

**Government Assisted Return**

$$PCG_t^a = 0.375*PCG_t + 0.625*[PCG_t + DPCG_t - LVYWGS_t*PCG_t]$$

**WGSP Deficiency Payment Per Tonne**

$$DPCG_t = PYTWGS_t * \left[ \frac{\sum_{k=0}^2 (LVYCG_{t-k})}{\sum_{k=0}^2 (LVYWH_{t-k} + LVYCG_{t-k} + LVYOM_{t-k})} \right] / [0.625*QCG_t]$$

**WGSP Levy Payment**

$$LVYCG_t = FT*LVYWGS_t*0.625*PCG_t*QCG_t$$

**Market Unit Value Added**

$$VACG_t = [PCG_t*YCG_t - (1.+0.5)*PFZ_t*FZCG_t - 0.15*PPN_t*YCG_t]/YCG_t$$

**Government Assisted Unit Value Added**

$$VACG_t^a = [PCG_t^a*YCG_t - (1.+0.5)*PFZ_t*FZCG_t - 0.15*PPN_t*YCG_t]/YCG_t$$


---

**Table 4.9: Policy block specification for oilseed return calculations**

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**Market Return on Oilseeds**

$$POS_t = [PP71_t * YOM_t + PP81_t * YOO_t] / [1.56 * YOM_t]$$

**Government Assisted Return on Oilseeds**

$$POS_t^a = 0.082 * POS_t + 0.918 * [POS_t + DPOS_t - LVYWGS_t * POS_t]$$

**Government Assisted Return on Oilseed Meal**

$$PP71_t^a = (PP71_t / POS_t) * POS_t^a$$

**Government Assisted Return on Oilseed Oil**

$$PP81_t^a = (PP81_t / POS_t) * POS_t^a$$

**WGSP Deficiency Payment Per Tonne**

$$DPOS_t = PYTWGS_t * \left[ \frac{\sum_{k=0}^2 (LVYOS_{t-k})}{\sum_{k=0}^2 (LVYWH_{t-k} + LVYCG_{t-k} + LVYOM_{t-k})} \right] / [0.918 * 1.56 * QOM_t]$$

**WGSP Levy Payment**

$$LVYCG_t = FT * LVYWGS_t * 0.918 * [PP71_t * QOM_t + PP81_t * QOO_t]$$

**Market Unit Value Added**

$$VAOM_t = [PP71_t * YOM_t + PP81_t * YOO_t - (1 + 0.8) * PFZ_t * FZOM_t - 0.60 * PPN_t * YOM_t] / YOM_t$$



Table 4.9 (Continued)

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Government Assisted Unit Value Added

$$\begin{aligned} \text{VAOM}_t^a = & [\text{PP71}_t * \text{YOM}_t + \text{PP81}_t * \text{YOO}_t - (1.+0.8) * \text{PFZ}_t * \text{FZOM}_t \\ & - 0.60 * \text{PPN}_t * \text{YOM}_t] / \text{YOM}_t \end{aligned}$$

---

from the government assisted return for oilseed.

It is assumed producers make their cropping decisions based on their expectations concerning government assisted unit value added ( $VAi^a$ ) rather than just market unit value added ( $VAi$ ). The two value added concepts differ in that the former takes into account deficiency payment receipt from the WGSP while the latter doesn't. To form their expectations about deficiency payment receipt, producers must first form preliminary production estimates. At the point of time they are making these estimates, producers have already decided the total amount of land they are going to commit to crop and forage production in the coming year. They use this knowledge to estimate individual crop areas for year  $t+1$ . In particular producers in year  $t$  initially expect crop  $i$ 's area ( $Ai^e$ ) in year  $t+1$  to equal current area ( $Ai$ ) adjusted by the percent change in total crop and forage area ( $AA$ ):

$$(4.15) \quad Ai_t^e = Ai_t * [ 1 + (AA_{t+1} - AA_t)/AA_t ].$$

Producers initial yield expectations incorporate trend yield growth rates. In particular producers expect crop  $i$ 's yield ( $Yi^e$ ) in year  $t+1$  to equal current yield ( $Yi$ )

adjusted by the simple average of the trend yield growth rate (YTRDi) and last year's growth rate:

$$(4.16) \quad Y_{it} = Y_{it} * [1 + 0.5 * (YTRDi + (Y_{it} - Y_{it-1}) / Y_{it-1})].$$

Ideally, these initial production expectations should be used only as the starting values of an iterative procedure which would simultaneously solve producers deficiency payment expectations with yield and area. However, since the allocation model is very computer intensive, such an iterative procedure would greatly escalate computation time. For the sake of minimizing computation time, this simultaneous solution was not attempted. The recursive passage of information from deficiency payment expectation formation to yield calculation to area calculation is only gone through once in each time period.

#### 4.6 Red Meat Tripartite Stabilization

A hybrid of the different stabilization schemes covering the various stages of production and the various commodity components of the bovine and ovine production bundle in the different provinces is structurally

represented. The hybrid comes closest to resembling the slaughter cattle and feeder cattle National Tripartite Price Stabilization (NTPS) schemes. Specifically, producer floor prices (SPBO) are calculated on an annual basis as current cash costs plus 90 percent of the preceding 5 year average margin between cash costs and market realized prices. As for the WGSP, several sweeping assumptions are made for representation ease that are in contradiction to actual features of the NTPS schemes. They are as follows: 1) there is neither individual or national limits to the stabilization coverage, all production is eligible; 2) there is full province and producer participation; and finally 3) the scheme is indefinite with no set termination date. Again producers are assumed to be risk neutral.

Table 4.10 shows that the government assisted return (PBO<sup>a</sup>) on bovine and ovine production equals the market return (PBO) or the support price, depending on which is the higher, less the producer levy. The market return includes the revenues earned on the meat meal, fat, and hide byproducts.

If the support price is greater than the market price, the total stabilization payout (PYTBO) equals the price difference times production (QBO). Otherwise the payout is zero. The producer levy on commercial sales is assumed to

**Table 4.10: Policy block specification for bovine and ovine return calculations**

---

**Market Return**

$$PBO_t = PP4_t + PP72_t * BY47_t + PP82_t * BY48_t + PP92_t * BY49_t$$

**Government Assisted Return**

$$PBO_t^a = \text{Max} \{ PBO_t, SPBO_t \} - LvyBO_t * PBO_t$$

**Stabilization Support Price**

$$SPBO_t = [VCBO_t + 0.90 * \sum_{k=1}^5 VABO_{t-k} * YBO_t] / YBO_t$$

**Total NTS Payout**

$$PYTBO_t = \text{Max} \{ 0, SPBO_t - PBO_t \} * QBO_t$$

**Producer Levy**

$$LvyBO_t = 0.015 - 0.0001 * BALBO_{t-1}$$

**Stabilization Fund Balance**

$$BALBO_t = BALBO_{t-1} + FDGBO_t - PYTBO_t$$

**NTS FUNDING: Government and Producer Contributions**

$$FDGBO_t = 3 * LvyBO_t * PBO_t * QBO_t$$

**Variable Cost Per Head**

$$VCBO_t = FP1_t * FD41_t + FP3_t * FD43_t + FP5_t * FD45_t + FP7_t * FD47_t \\ + FP8_t * FD48_t + PPN_t * 0.06 * YBO_t$$

Table 4.10 (Continued)

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Market Unit Value Added

$$VABO_t = [PBO_t * YBO_t - VCBO_t] / YBO_t$$

Government Assisted Unit Value Added

$$VABO_t^a = [PBO_t^a * YBO_t - VCBO_t] / YBO_t$$

---

be 1.5 percent plus an adjustment according to the size of the stabilization deficit (BALBO). The federal government, provincial governments and producers all contribute to the total funding (FDGBO) of the stabilization account. Both the federal and the provincial governments contribute in equal proportions to producers.

As for the WGSP, it is assumed beef producers take into consideration expected deficiency payment receipt when forming production decisions for the coming year. To form these deficiency payment payout expectations they need initial yield estimates. It is assumed beef producers form their initial yield estimates the same way as grain producers form their initial yield estimates (see Equation (3.16)).

Ideally, pork policy should be specified similar to bovine and ovine policy, and poultry and egg policy similar to dairy policy. However, because pork, poultry and eggs are combined into a single production bundle in the CAM, such differential policy treatment is difficult to quantify. As a result, since pork is the dominant component of the other livestock products production bundle, a decision was made to just represent pork stabilization policy for this bundle. As can be seen in Table 4.11 the specification is exactly the same as that

**Table 4.11: Policy block specification for pork, poultry and egg return calculations**

---

**Market Return**

$$PPO_t = PP61_t + PP72_t * BY67_t + PP83_t * BY68_t + PP93_t * BY49_t$$

**Government Assisted Return**

$$PPO_t^a = \text{Max} \{ PPO_t, SPPO_t \} - LVYPO_t * PPO_t$$

**Stabilization Support Price**

$$SPPO_t = [VCPO_t + 0.95 * \sum_{k=1}^5 VAPo_{t-k} * YPO_t] / YPO_t$$

**Total NTS Payout**

$$PYTPO_t = \text{Max} \{ 0, SPPO_t - PPO_t \} * QPO_t$$

**Producer Levy**

$$LVYPO_t = 0.02 - 0.0001 * BALPO_{t-1}$$

**Stablization Fund Balance**

$$BALPO_t = BALPO_{t-1} + FDGPO_t - PYTPO_t$$

**NTS Funding: Government and Producer Contributions**

$$FDGPO_t = 3 * LVYPO_t * PPO_t * QPO_t$$

**Variable Cost Per Head**

$$VCPO_t = FP1_t * FD61_t + FP3_t * FD63_t + FP5_t * FD65_t + FP7_t * FD67_t \\ + FP8_t * FD68_t + 0.04 * YPO_t * PPN_t$$



Table 4.11 (Continued)

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Market Value Added

$$VAPO_t = [PPO_t * YPO_t - VCPO_t] / YPO_t$$

Government Assisted Value Added

$$VAPO_t^a = [PPO_t^a * YPO_t - VCPO_t] / YPO_t$$

---

for bovine and ovine, with two exceptions. First, producer floor prices (SPBO) are calculated as current cash costs plus 95 percent of the preceding 5 year average margin between cash costs and market realized prices rather than 90 percent. Second, the producer levy on commercial sales is assumed to be 2 percent with adjustment rather than 1.5 percent.

#### 4.7 Government Program Financing

It is assumed the government finances its share of stabilization funding through an income tax,  $\alpha$ . The size of  $\alpha$  varies from year to year in direct correspondence to the amount of monies needed. The government just collects funds sufficient for its current needs, no more, no less, and levies the income tax after (or multiplicatively to) the income tax,  $\phi$ , used to service the trade deficit. It is assumed that agriculture producers must pay both types of income tax on any deficiency payments they receive as well as on their market income.

#### 4.8 Summary

This chapter concentrated on the process by which Canadian policies filter world prices before they are transmitted to the various levels of the domestic market. It was decided after a brief review of Canadian commodity specific agriculture policy, that out of the myriad of policies affecting domestic agriculture production and trade, supply management and income stabilization programs were the most deserving of particular attention. Structural specifications were formed of the mechanics of these programs, and incorporated into the CAM. The effects of all other farm programs and border measures on domestic prices were netted together and expressed as a tariff equivalent.

## 5. AGRICULTURE FACTOR RETENTION UNDER THE CURRENT COMMODITY SPECIFIC POLICY REGIME

### 5.1 Introduction

This chapter reports the long run implications, as portrayed by the CAM, of the current commodity specific policy setting for agriculture factor retention. To get these results two policy simulations involving the entire BLS were carried out. Section 5.2 outlines how the CAM was calibrated for these policy runs. The first scenario, described in Section 5.3, assumes a continuance of current commodity specific policies. The second scenario, described in Section 5.4, assumes global free trade in agricultural commodities. The results of this free trade run are used as base reference for the results of the status quo run. In Section 5.5 estimates are given on how much protection current policies provide agriculture commodities. Several different government intervention measures are employed. The impacts current policies have on agriculture factor usage and value are then assessed in Section 5.6.

## 5.2 Model Calibration

The policy runs were conducted using the entire BLS so that world prices feeding into the CAM would reflect the interaction of the CAM with the other national and regional models. In other words, so world commodity prices would reflect any large country impacts Canada may have on them during the course of simulation.

Originally 2015 was chosen for the projection horizon. This was shortened to 2000 when the simulation results past this date were found to be dynamically unstable. Continued extrapolation of the growth trends estimated for the earlier years, gave rise in the latter years to unreasonable projections, both in terms of their magnitude and inter-year stability.

The breakdown of the simulation results after year 2000 is not surprising. During initial construction of the BLS, solution alignment devices were introduced into the structure of each of its component models to guide simulation solutions of selected variables towards pre-set target values for the year 2000. The purpose was to prevent simulation solutions from straying off on tangents. Since the BLS was not originally intended for use beyond 2000, similar guidance measures are not available in its

structure to provide corrective influence beyond this date.

To create a realistic starting point for the scenarios, equations in the input block of the CAM were calibrated to project close to actual values and growth rates for the mid '80s. In line with the recessionary character of this period, scaling parameters were lowered in the investment supply and agriculture cost equations, and time trends were dampened in the nonagriculture value added and land supply equations.

### 5.3 Scenario 1: The Status Quo

#### 5.3.1 Structural representation

Agriculture policy representation in the CAM for the status quo scenario is as described in Chapter 4. All border instruments are expressed in terms of tariff equivalents in world to domestic price linkages mimicking the reduced form of the government's decision making process. Overlaid on this specification are the mechanics of selected domestic farm programs, namely the Dairy Supply Management Program, the Western Grain Stabilization Program, and the Red Meat Stabilization Program.

The methodology employed to represent agriculture

policy in each of the other national and regional models within the BLS falls into one of three categories. The first category is policy representation by structural specification. The USA, India, China and CMEA models adopt this methodology which differentiates between various forms of government intervention. The USA model, for example, explicitly recognizes trade quotas, land set aside programs, and stock policies apart from other domestic price support instruments. The second category is policy representation through the exclusive use of world to domestic price linkages. The linkages employed are like those in the CAM. They use the lagged world price, domestic price and self-sufficiency ratio as explanatory variables for synthesizing different price support measures into an aggregate tariff equivalent. Instruments that provide support via other means than price are ignored. The majority of models within the BLS adopt this reduced form specification. The third category is policy representation as a fixed percentage difference between domestic prices and corresponding world prices. This methodology is used in the 14 simple regional models accounting for the rest of the world in the BLS. Table 5.1 shows which models in the BLS contain which type of policy specification.

**Table 5.1: National and regional model classification of the BLS according to agricultural policy specification<sup>a</sup>**

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**Type 1: Structural**

U.S.A.	India
China	Canada (Revised
CMEA	Version)

**Type 2: Reduced Form**

Argentina	Japan
Australia	Mexico
Austria	New Zealand
Brazil	Nigeria
EC	Pakistan
Egypt	Thailand
Indonesia	Turkey
Kenya	

**Type 3: World Price Percentages**

African Oil Exporters  
 African Medium Income Calorie Exporters  
 African Medium Income Calorie Importers  
 African Low Income Calorie Exporters  
 African Low Income Calorie Importers  
 Latin American High Income Calorie Exporters  
 Latin American High Income Calorie Importers  
 Latin American Medium-Low Income  
 Southeast Asia High-Medium Income Calorie Exporters  
 Southeast Asia High-Medium Income Calorie Importers  
 Asia Low Income  
 Southwest Asia High Income Oil Exporters  
 Southwest Asia Medium-Low Income  
 Rest of the World

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<sup>a</sup>Source: Fischer et al., 1988.



### 5.3.2 Simulation output

Simulation output for the status quo scenario is presented in Tables 5.2 through 5.7. While examining these tabular results it should be kept in mind that the BLS does not purport to be a forecasting medium capable of picking up every market inflection. Rather, the BLS should be interpreted as a policy analysis tool that sifts through short term market fluctuations, as well as spurious deviations, to extract underlying secular trends.

The BLS's portrayal of a continuance of status quo policies is as follows. As shown in Table 5.2 the general economy's recovery from the effects of the '80s recession will be protracted, but sure and stable. The economy's annual growth rate during the forecast horizon slowly, but steadily increases from 1.7 percent in 1989 to 2.1 percent in 2000. Labor force expansion does not keep up with this output expansion. The growth rate of the labor force gradually falls over time from 1.1 percent in 1989 to 0.8 percent in 2000 in correspondence to a downward trend in population growth rates. Population growth rates are exogenous to the simulation and were provided by the Environmental Protection Agency. In reaction to the tight labor supply, wages rise at an increasing rate relative to both the nonagriculture price and capital rent (see Table

---

**Table 5.2: Estimated growth rates for economic indicators in the status quo scenario<sup>a</sup>**

	YEAR	
	1989/1995	1996/2000
<b><u>Macro Statistics</u></b>		
GDP in 70\$	1.7	1.9
Per Capita GDP in 70\$	0.9	1.3
Nonagriculture GDP in 70\$	1.7	2.0
Agriculture GDP in 70\$	0.4	0.1
Market Income Parity	-1.8	-0.9
<b><u>Labor Statistics</u></b>		
Population <sup>b</sup>	0.7	0.6
Labor Force	0.9	0.8
Unemployment Rate	0.2	0.2
Total Employed	0.8	0.8
Nonagriculture Employed	0.9	0.8
Agriculture Employed	0.9	0.5
<b><u>Capital Statistics</u></b>		
Total Capital	1.2	1.4
Nonagriculture Capital	1.2	1.5
Agriculture Capital	1.3	1.4
Total Investment	1.6	1.8
Nonagriculture Investment	1.6	1.8
Agriculture Investment	1.4	1.4

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent change in each economic variable.

<sup>b</sup>Population growth rates are exogenous to the simulation. The source for these growth rates is the Environmental Protection Agency.

5.3). The rise in real wages hinders a drop in the unemployment rate in two ways. First, it promotes increased effort on the part of all employed workers, so the physical number of workers required to perform any task is less than it was previously. Consequently, not as many workers have to be hired to service the output growth as would have had to have been hired if the real wage had remained constant. Second, and more importantly, it encourages the substitution of capital for labor in the nonagriculture production process.

Market income parity of agriculture workers is measured by dividing the per worker contribution to agriculture GDP by the per worker contribution to nonagriculture GDP. Agriculture workers steadily lose parity to nonagriculture workers throughout the forecast horizon. In response to this parity loss, the influx of new farm entrants declines (see Table 5.4). The crop and forage area growth rate increases simultaneous to the decline in the growth rate of farm operators implying a gradual expansion in the average size farm. As land holdings increase per farm enterprise, so does the requirement for complementary capital and labor services. Capital stock grows at a constant annual rate of 1.3 percent throughout the forecast horizon. Supplemental

**Table 5.3: Estimated growth rates for real factor rents in the status quo scenario<sup>a</sup>**

	YEAR	
	1989/1995	1996/2000
<b><u>Factor Rents</u><sup>b</sup></b>		
Nonagriculture Wage	0.8	1.1
Nonagriculture Capital Rent	0.5	0.5
Agriculture Wage	0.8	1.6
Agriculture Capital Rent	0.6	0.5
Agriculture Land Rent	0.9	1.3

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent change in each economic variable.

<sup>b</sup>All factor rents are expressed relative to the price of nonagriculture.

**Table 5.4: Estimated growth rates for agriculture factor usage in the status quo scenario<sup>a</sup>**

	<u>YEAR</u>	
	<u>1989/1995</u>	<u>1996/2000</u>
<u>Factor of Production</u>		
Agriculture Labor	0.9	0.5
Operator Labor	0.7	0.5
Hired Labor	1.2	0.5
Capital Services	1.3	1.3
Crop and Forage Area	0.5	0.7
Summerfallow and Pasture	-0.3	-0.7

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent change in each economic variable.

labor input is obtained through the hireling market. Since agriculture is the less preferred sector of employment, agriculture wages are performed to grow at a faster rate than nonagriculture wages to attract additional farm hired help. The ensuing rapid rise in agriculture wages, however, serves to choke back the momentum in hired labor demand from 1.2 percent in the early '90s to 0.5 percent at the end of the decade.

Table 5.5 shows that crop producers essentially receive all the benefits from the stabilization programs. No deficiency payments are triggered for cattle or hogs throughout the forecast horizon. This is in direct contradiction to the current state of affairs which has seen frequent and large payouts issued under the red meat stabilization plans. The CAM appears to be incapable of handling the red meat stabilization plans in a credible manner. The trouble lies in its annual framework. The quarterly income dips, which the red meat stabilization programs are designed to guard against, are masked in the average annual income figure which the CAM calculates. As a result the model has a built in bias to under estimate both the occurrence and size of livestock deficiency payments.

For the next decade grain deficiency payments are

**Table 5.5: Estimated stabilization policy parameters for the status quo scenario<sup>a</sup>**

	YEAR	
	1989/1995	1996/2000
<b><u>All Programs</u></b>		
Total Transfer <sup>b</sup>	-0.2	0.3
Required Income Tax	0.2	0.2
<b><u>Western Grain Stabilization Program<sup>c</sup></u></b>		
Expected Payout	8.4	10.4
Actual Payout	16.5	17.5
Wheat's Share (%)	48.5	47.3
Coarse Grains' Share (%)	25.3	28.4
Oilseed's Share (%)	26.2	24.2
Fund Surplus	11.1	4.8
<b><u>Beef Stabilization<sup>c</sup></u></b>		
Expected Payout	0.0	0.0
Actual Payout	0.0	0.0
Fund Surplus	32.9	46.8
Levy	1.4	1.0
<b><u>Pork Stabilization<sup>c</sup></u></b>		
Expected Payout	0.0	0.0
Actual Payout	0.0	0.0
Fund Surplus	32.4	50.2
Levy	1.8	1.1

<sup>a</sup>Reported statistics are calculated as simple averages of each economic variable.

<sup>b</sup>The total transfer to agriculture producers is expressed as a percent of GDP of agriculture.

<sup>c</sup>Stabilization payouts and fund balances are expressed as a percent of total commercial sales for the commodities in question.

forecast to be, in value, roughly equal to 17 percent of commercial sales. Of this total amount payable to the grain sector, wheat, in absolute terms, gets the lion's share of the benefits, but in relative terms, loses ground to coarse grain. The shifting of benefits towards coarse grains mirrors a relative shift in production patterns towards coarse grains because of depressed world wheat prices (see Table 5.6). Note that under the assumption of full producer participation in the Western Grain Stabilization Program and the assumption that the current levy system was in effect since the start of the program, the fund does not go into deficit despite the high payout rate. Under these qualifying assumptions the WGSP seems to be self-sustainable.

A quick comparison of the rate at which agriculture producers lose parity throughout the projection period with the amount of income they receive from the stabilization programs reveals the anomaly that the rate at which producers lose market parity is countercyclical to the payout of the stabilization payments. Intuitively, one would expect market parity loss to be the greatest when the most stabilization payments are being made since these payments are triggered by falling agriculture producer incomes. The key to this anomaly lies in the value added



**Table 5.6: Estimated growth rates for agriculture commodity production in the status quo scenario<sup>a</sup>**

<u>Agriculture Commodity</u>	<u>YEAR</u>	
	<u>1989/1995</u>	<u>1996/2000</u>
Wheat	2.8	1.0
Coarse Grains	3.4	4.9
Oilseed Meal	2.2	-0.1
Other Food of Crop Origin	1.0	0.9
Nonfood of Crop Origin	0.9	0.9
Fruit	0.7	0.3
Other Livestock Products	1.0	1.1
Bovine and Ovine Meats	1.7	1.5
Dairy Products	0.7	0.3

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent change in each economic variable.

nature of the GDP calculations. Depressed feed grain prices are a double edged sword with regard to aggregate agriculture income. On the one hand they lower grain producers incomes, but on the other hand they increase livestock producers profitability. The results imply that livestock producers net income gain from falling feed grain prices compensates for grain producers net income loss during the '90s.

Table 5.5 shows that an income tax of around 0.2 percent is required throughout the projection period to finance the stabilization programs. Because of the CAM's bias against livestock stabilization payment payouts, this estimate is better interpreted as a lower bound for the required tax rate, rather than the mean value. If there were livestock payouts, the producer levy, and hence the government contribution share would not drop.

Table 5.7 shows how agriculture's share of the primary resources is distributed across commodities. Wheat and coarse grains use the most land, bovine and ovine meat production the most labor, and other livestock products the most capital.

**Table 5.7: Estimated factor allocation by agriculture commodity in the status quo scenario<sup>a</sup>**

		YEAR	
		1989/1995	1996/2000
Wheat	Land Share <sup>b</sup>	43.2	41.8
	Labor Share	3.2	3.1
	Capital Share	12.9	9.1
Coarse Grains	Land Share <sup>b</sup>	38.2	40.3
	Labor Share	2.4	3.6
	Capital Share	4.6	7.3
Oilseed Meal	Land Share <sup>b</sup>	14.2	13.5
	Labor Share	0.7	0.6
	Capital Share	3.5	3.4
Other food Crops	Land Share <sup>b</sup>	4.3	4.1
	Labor Share	9.2	8.4
	Capital Share	9.4	8.8
Nonfood Crop	Land Share <sup>b</sup>	0.2	0.2
	Labor Share	13.3	12.2
	Capital Share	1.4	1.3
Fruit	Labor Share	1.7	1.5
	Capital Share	1.6	1.3
Other Livestock	Labor Share	19.8	19.4
	Capital Share	32.8	33.2
Bovine and Ovine	Labor Share	30.3	32.9
	Capital Share	18.2	20.4
Dairy Products	Labor Share	19.5	18.3
	Capital Share	15.7	15.2

<sup>a</sup>Reported statistics express average annual commodity use as a percent share of total agriculture use.

<sup>b</sup>Area devoted to each crop is expressed as a percent share of total crop area only. Land put aside for forage use is not included in the calculation

## 5.4 Scenario 2: Multilateral Trade Liberalization

### 5.4.1 Hypothesis

In this scenario it is assumed all countries, except the centrally planned economies, agree to completely phase out over a five year period, starting in 1990, all intervention in agriculture markets.

### 5.4.2 Domestic price determination

Parikh et al. (1988) point out that under multilateral trade liberalization the domestic market price of an exchange bundle for any particular country need not equal the world market price. There are three possible sources of deviation between the two prices. The first source of deviation is peculiar to the BLS and concerns the way world prices were constructed for the exchange bundles. The world market price for each exchange bundle was constructed by weighing the world prices of its commodity components by internationally traded quantities. But, when considering the world price of an exchange bundle in the context of a particular country, the weights need to be changed to domestically consumed quantities. The second source of deviation concerns product quality differences between what the particular country produces and what is internationally

traded. The third source of deviation concerns the particular country's net trade position. Due to transportation costs the domestic price of importers is higher than the world market price, and the domestic price of exporters lower.

The procedure used to account for these three sources of price deviation in the BLS for the multilateral trade liberalization scenario is the same as that employed by Parikh et al. (1988). For convenience, this two-step procedure is briefly reviewed. In the first step the world market price ( $P_i^*$ ) of each exchange bundle  $i$  is adjusted to reflect the domestic consumption pattern and product quality of country  $j$  by successively multiplying the world price by constant multiplicative factors:  $WTOC_{ij}$  and  $QAD_{ij}$ .  $WTOC_{ij}$ , which corrects for the domestic consumption pattern, is the historical average ratio of the world prices of bundle  $i$ 's commodity components weighted by world trade to the prices weighted by country  $j$ 's domestic consumption.  $QAD_{ij}$ , the correction factor for quality differentials, in contrast to  $WTOC_{ij}$  which is data based, reflects for the most part subjective judgments.

Parikh et al. call the world price, after the above adjustments have been made, the country specific world market price ( $CSWP_{ij}$ ):

$$(5.1) \quad CSWP_{ij_t} = WTO_{Cij} * QAD_{ij} * P_{i_t}^*$$

In the second step the influence of the country's net trade position on domestic prices is determined from the  $CSWP_{ij}$ 's according to country  $j$ 's self-sufficiency in commodity  $i$ . Given a self-sufficiency ratio ( $SSR_{ij}$ ) of unity, the domestic price of a bundle ( $CPI_{ij}$ ) equals the country specific world market price. For all other values of the self-sufficiency ratio, the domestic price varies, within absolute bounds, from the country specific world market price inversely as the self-sufficiency ratio varies from unity:

$$(5.2) \quad CPI_{ij_t} = [ 1 + (1-SSR_{ij_{t-1}})*WPDEV_{ij_t} ] * CSWP_{ij_t}$$

with  $WPDEV_{ij_t} = WPMAX_i$  if  $SSR_{ij_t} < 1$

and  $WPDEV_{ij_t} = WPMIN_i$  if  $SSR_{ij_t} > 1$

where

$WPMAX_i$  is the maximum percent difference allowed between the domestic price of exchange bundle  $i$  and the commodity specific world market price; and

$WPMIN_i$  is the minimum percent difference allowed between the domestic price of exchange bundle  $i$  and the commodity specific world market price.

#### 5.4.3 Transition period

To promote solution stability in the BLS a five year transition period is allowed between the time the move to multilateral trade liberalization is initiated and the time it takes full effect. As a result the model's portrayed solutions do not fully reflect free trade until the year 1995. This transition period is consistent with reality to the extent countries will want to gradually rather than instantaneously remove their protection measures in order to give their producers time to adjust to the new global trading conditions.

During the transition period domestic market prices are weighted averages of what the price would be assuming a continuation of current commodity specific policies and what the price would be under free trade. The weights assigned to each price varies over time with the free trade price being assigned the smallest weight during the first year of the transition period and the largest weight during the last year.

Stabilization deficiency payments are phased out during the transition period by gradually lowering program support prices. This is done by introducing an adjustment variable, FT, into the support price calculations so that in general:

$$(5.3) \quad SPi_t = [ VCi_t + FT*SLi*\sum_{k=1}^5 VAi_{t-k}*Yi_{t-k} ] / Yi_t$$

where SLi is the stabilization program support level:  
           0.90 for beef, 0.95 for pork, & 1.00 for  
           grain and oilseeds;  
 SPi is the support price of commodity i;  
 VAi is value added or market return over cash costs  
       of commodity i;  
 VCi is the cash costs associated with producing  
       commodity i; and  
 Yi is yield of commodity i.

The adjustment variable FT takes the value of 1 under the current policy regime and 0 under multilateral free trade. During the transition period it progressively adopts lower values between the range of 0.95 and 0.75. This means, for example, that for the beef stabilization program, producers support price for the first year of the transition period equals current unit cash costs plus 95\*90 percent of the preceding 5 year average margin between unit cash costs and market realized prices. Producer levies are decreased simultaneously with and in equal proportion to value added support.

At the end of the transition period, it is assumed that if there is a deficit in the stabilization fund account, the government will completely absorb the deficit. If there is a surplus individual producers will be paid back their contributions in proportion to the total amount



they paid into the fund. Because these refunds will be based on producers historical production rather than their current production, it is assumed effects of the refunds on production will be null. That is, it is assumed that producers will regard the fund as windfall gains that have no association with their production decisions.

## 5.5 Commodity Protection Rates

### 5.5.1 Measures

Reviews cataloguing the strengths and weaknesses of different government intervention measures are readily available in the literature (for e.g., Corden, 1971; Balassa, 1971; Strak, 1982; Hazler and Parsons, 1987; and Schwartz and Parker, 1988). The five measures employed in this study correspond to the Hazler and Parsons definitions. Four of the measures determine the amount of income transferred to producers by just focusing on the policies implications for price and producers in-pocket unit return. The fifth measure provides a more balanced assessment of income transfer. It allows production quantity to respond, as well as price, to policy implementation and change.

The first measure considered provides the least policy coverage, but is the most often used because it is the easiest to calculate. The nominal rate of protection (NRP) of commodity  $i$  is defined to be the percentage excess, attributable to government intervention, of the domestic market price ( $P_i$ ) over the world market price ( $P_i^*$ ):

$$(5.4) \quad NRP_i = (P_i - P_i^*) / P_i^*$$

As defined, the NRP only recognizes policies that drive a wedge between domestic and world market prices. Thus, while the NRP recognizes all border barriers, both tariff and nontariff, directly applicable to commodity  $i$ , it does not recognize the tariff structure on intermediate inputs used in commodity  $i$ 's production. Likewise, while the NRP recognizes farm programs, such as government surplus purchases, production quotas and administrative pricing, that support producers incomes via market price, it does not recognize programs, such as deficiency payments, marketing subsidies, research and extension funding, and input subsidies, that support producers incomes via other means than market price.

The nominal rate of assistance (NRA) and the effective

rate of protection (ERP) pick up some, but not all of this policy fallout. Each captures all the policy instruments captured by the NRP, plus a few more. They differ with respect to what types of additional instruments they incorporate.

The NRA of commodity  $i$  is defined to be the percentage excess, attributable to government intervention, of producers gross unit return adjusted by direct government assistance ( $Pi^a$ ), over the world market price:

$$(5.5) \quad NRA_i = (Pi^a - Pi^*) / Pi^*.$$

As defined, the NRA accounts for deficiency payments and marketing subsidies in addition to all the policies that drive a wedge between domestic and world market prices of commodity  $i$ . It ignores, however, all input directed instruments.

The ERP of commodity  $i$  is defined to be the percentage excess, attributable to government intervention, of unit value added ( $VA_i$ ) calculated with domestic market prices over unit value added ( $VA_i^*$ ) calculated with world market prices:

$$(5.6) \quad ERP_i = (VA_i - VA_i^*) / VA_i^*.$$

While this measure recognizes all price supporting instruments directly applicable to commodity  $i$  and each of its intermediate inputs, and recognizes to a certain extent research and extension funding through the input-output coefficients used to calculate unit value added, it does not recognize producer income support via other means than price.

The fourth measure considered is the effective rate of assistance (ERA). The ERA of commodity  $i$  is defined to be the percentage excess, attributable to government intervention, of unit value added calculated using producers gross unit return adjusted by direct government assistance ( $VA_i^a$ ) over unit value added calculated with world market prices:

$$(5.7) \quad ERA_i = (VA_i^a - VA_i^*) / VA_i^*.$$

Although the ERA is more comprehensive in terms of policy coverage than the other three government intervention measures discussed so far, it is just as lacking as they are when it comes to quantifying production

effects of policy implementation and change. It is unrealistic to assume that producers will not adjust their production levels in response to changes in their in-pocket unit returns. Completely different pictures can be obtained about the impacts of a policy change on producers welfare when production is allowed to react as well as price. For example, because supply management programs restrict output, the income transfer associated with them is less than that implied by just looking at the programs' effect on price. The producer subsidy equivalent (PSE) takes into account both price and quantity affect of government intervention.

The PSE of a particular commodity is defined to be the amount of money that would have to be given its producers to fully compensate them for eliminating all forms of government intervention that influence the income they receive for producing the commodity. The PSE for commodity  $i$  is calculated as government assisted unit value added times production ( $Q_i$ ) less unit value added calculated with world market prices times the production that would ensue if this was all the return producers received:

$$(5.8) \quad PSE_i = VAI^a * Q_i - VAI^* * Q_i^*.$$

### 5.5.2 World market price

The crucial question when calculating the above 5 measures is 'What values should be used as the world market prices?'. For lack of better information, many studies (Josling, 1981; Barichello, 1982; Harling and Thompson, 1983; OECD, 1987b; and Goodloe, 1988) have just used current world prices. There are two problems with this practice. First, it subsumes Canada is a small country with respect to every commodity. While this assumption is legitimate for the majority of agriculture goods, it is not for grains, particularly wheat. Second, it is completely misleading when the protectionist action is pursued simply to offset world price distortions induced by other countries interventions. The appropriate reference world prices are the world prices that would prevail if all countries stopped intervening in agriculture markets. The advantage of working in the BLS is that it is possible, by running a multilateral trade liberalization scenario like the one described in Section 5.4, to estimate these hypothetical prices.

### 5.5.3 Protection estimates

Table 5.8 contains estimates of commodity protection rates for each of the production bundles. The estimates were calculated using mean price and quantity values for the 5 year period starting in 1996. Unfortunately the ERA estimates only reflect those farm programs, which support producers incomes via other means than price, explicitly incorporated in the structure of the CAM. For example, the effective rate of assistance estimates for wheat, coarse grains and oilseed meals do not reflect transportation subsidies since these subsidies are not structurally represented in the CAM. Because no attempt was made to represent farm programs, which support producers incomes via other means than price, for commodities other than grain and livestock products, estimates of nominal and effective rates of assistance for these commodities are the same as the respective estimates of nominal and effective rates of protection.

One of the most striking things about Table 5.8 is the preponderance of negative numbers listed there. The implication is that most of current Canadian government intervention just goes to offset the harmful price distorting effects of other countries policy actions. In other words, status quo policies do not transfer excess

**Table 5.8: Estimates of commodity protection rates associated with status quo policies<sup>a</sup>**

	NRP	ERP	NRA	ERA	PSE <sup>b</sup>
Wheat	-4.7	-14.2	-1.6	-6.1	-16.5
Coarse Grains	-3.4	-28.4	-1.2	-24.3	-22.8
Oilseed Meal	-2.4	-9.9	0.9	-3.9	-8.5
Other Food of Crop Origin	-7.8	-15.2	-7.8	-15.2	-17.5
Nonfood Crops	15.9	17.9	15.9	17.9	25.7
Other Livestock Products	-1.6	-1.3	-2.7	-3.2	4.1
Bovine and Ovine Meats	-13.5	-15.6	-14.4	-16.6	-31.8
Dairy Products	2.9	3.3	2.9	3.3	-12.1
Fruit	-6.6	-23.7	-6.6	-23.7	-27.8

<sup>a</sup>Reported statistics are calculated using the mean value of price and quantity estimates over the period 1996 through 2000.

<sup>b</sup>Producer Subsidy Equivalents are expressed as percentages of net income in the status quo scenario.



income to Canadian agriculture producers, but only restore their incomes to levels that they would otherwise be at if other countries didn't intervene in the marketplace. The inference is that Canada could be quite competitive with agriculture products in a multilateral free trade environment.

The above results are in direct contradiction to those obtained in other studies (see Table 5.9). Both the USDA (1988) and the OECD (1987b) depict Canada as a significant subsidizer in its own right rather than a guilt free party trying to mend damage caused by the policy setting actions of other governments. Several factors contribute to this divergent portrayal. First, PSE's are time dependent. Their value is a function of the period for which they are calculated. Both the USDA and OECD estimates reflect historical data. The present study's estimates reflect forecast data, and are calculated for a period when commodity prices are even more bleak than they have been to date. The implication is that Canada, because of its relatively small treasury, and hence lack of wherewithal to compete, has to give ground in this future period in the on going subsidy war between major exporters. It is a realization of a fear that is currently pushing Canada to the GATT bargaining table.

**Table 5.9: Comparison of producer subsidy equivalent estimates across studies**

	Present Study	OECD Study <sup>a</sup>	USDA Study <sup>b</sup>
Time Frame	1996/00	1979/81	1982/86
<u>PSEs</u> <sup>c</sup>			
Wheat	-16.5	16.6	30.4
Coarse Grains	-22.8	11.2	23.6
Oilseed Meal	-8.5	17.4	26.6
Other Livestock Products	4.1	21.7	12.8
Bovine & Ovine Meats	-31.8	13.1	9.9
Dairy	-12.1	80.2	73.7

<sup>a</sup>Source: OECD (1987b).

<sup>b</sup>Source: USDA (1988).

<sup>c</sup>PSEs are expressed as percentages of net income.

A second factor contributing to the divergence of results is the incomplete policy recognition of the present study. Among key policies omitted from the protection estimates are transportation subsidies for grains and oilseed, and direct producer payments for manufacturing milk.

The third factor concerns what world reference prices the different studies use. Both the USDA and the OECD use current world prices mirroring the policy actions of all countries, rather than world prices "uncontaminated" from government intervention. As a result, it is impossible to decipher from the OECD and USDA estimates whether current Canadian policies are adding to or correcting world price distortions.

Finally, the fourth factor concerns quantity response. The USDA and OECD studies implicitly assume production levels will be impervious to removal of status quo policies. The present study allows production quantities to adjust. The importance of this feature can be demonstrated by examining the ERA and PSE estimates for other livestock products. The ERA estimate, which does not consider production response, implies a negative protection rate while the PSE estimate implies a positive protection rate.

## 5.6 Factor Usage and Reward Comparison Across Sectors

Tables 5.10 through 5.13 show the estimated percent differences between the two scenarios in level values of selected economic indicators. Free trade values are expressed relative to the status quo values. In general, in terms of variable coverage, these Tables follow the format of Tables 5.2 through 5.7 with the omission of variables describing nonagriculture output and factor usage. Because there is less than a 0.2 percent difference in nonagriculture output and factor usage between the two scenarios, data for the nonagriculture sector are not reported. The tentative conclusion is made that a move to free trade in agriculture commodities will have minimal impact on the nonagriculture sector.

Although agriculture output, as a whole, only increases a marginal 1.6 percent under multilateral trade liberalization, much more buoyant prices in this scenario than in the status quo scenario increase agriculture producers market income parity by 32.3 percent (see Table 5.10). As a result of greater parity, significant differences in agriculture labor force size and composition can be noted between the two scenarios (see Table 5.12). Total labor employment in agriculture is less in the

**Table 5.10: Estimated percent differences in agriculture profitability indicators between the multilateral trade liberalization and status quo scenarios<sup>a</sup>**

	YEAR	
	1990/1995	1996/2000
<b>Profitability Indicators</b>		
GDP of Agriculture	0.3	1.6
Market Income Parity	25.3	32.3

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent difference in each economic variable between the two scenarios, using the status quo figure as the base.

**Table 5.11: Estimated percent differences in real factor rents between the multilateral trade liberalization and status quo scenarios<sup>a</sup>**

	<u>YEAR</u>	
	1990/1995	1996/2000
<b>Factor Rents<sup>b</sup></b>		
Nonagriculture Wage	0.0	-0.2
Nonagriculture Capital Rent	0.0	0.1
Agriculture Wage	9.4	27.3
Agriculture Capital Rent	0.0	0.0
Agriculture Land Rent	2.0	3.6

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent difference in each economic variable between the two scenarios, using the status quo figure as the base.

<sup>b</sup>All factor rents are expressed relative to the price of nonagriculture.

**Table 5.12: Estimated percent differences in agriculture factor usage between the multilateral trade liberalization and status quo scenarios<sup>a</sup>**

	YEAR	
	1990/1995	1996/2000
<b><u>Factors of Production</u></b>		
Agriculture Labor	0.7	-1.4
Operator Labor	2.5	7.7
Hired Labor	-1.9	-13.7
Capital Services	0.8	2.5
Crop and Forage Area	1.4	1.8
Summerfallow and Pasture	-2.0	-2.7

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent difference in each economic variable between the two scenarios, using the status quo figure as the base.

**Table 5.13: Estimated percent difference in agriculture commodity production and factor usage between the multilateral trade liberalization and status quo scenarios<sup>a</sup>**

		YEAR	
		1990/1995	1996/2000
Wheat	Production	-0.3	10.5
	Land Use	3.7	5.6
	Labor Use	9.5	11.9
	Capital Use	12.8	21.4
Coarse Grains	Production	-3.8	-7.1
	Land Use	-2.9	-4.3
	Labor Use	-16.8	-25.7
	Capital Use	-14.1	-19.3
Oilseed Meal	Production	3.1	4.1
	Land Use	1.5	0.1
	Labor Use	1.4	-8.1
	Capital Use	4.4	-0.2
Other Food Crop	Production	1.6	-0.3
	Land Use	-1.1	-3.4
	Labor Use	-9.0	-21.8
	Capital Use	-6.4	-15.2
Nonfood Crops	Production	-5.9	-12.5
	Land Use	-7.9	-12.4
	Labor Use	-35.8	-52.5
	Capital Use	-34.1	-48.3
Fruit	Production	0.0	-2.7
	Labor Use	-6.8	-19.2
	Capital Use	-4.0	-12.3

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent difference in each economic variable between the two scenarios, using the status quo figure as the base.



Table 5.13 (Continued)

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Other Livestock	Production	-5.1	-7.3
	Labor Use	-26.6	-34.6
	Capital Use	-24.5	-29.1
Bovine and Ovine	Production	3.6	10.0
	Labor Use	13.7	24.4
	Capital Use	17.8	34.9
Dairy Products	Production	13.1	16.0
	Labor Use	40.0	33.0
	Capital Use	42.0	44.3

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multilateral trade liberalization scenario. However, while total labor employment is down by 1.5 percent the number of farm operators is up by 7.7 percent. The absolute decline in employment opportunities in agriculture is strictly with respect to hired labor. The implication is clear. Current commodity specific policies are not preserving the traditional family farm, as is often their stated intent. Instead, they are aiding and abetting the demise of the family farm by encouraging a move to huge industrial agrarian operations that are run using a hired work force rather than unpaid family labor.

Capital use and land use increase under multilateral trade liberalization in correspondence to the increase in number of farm operators, but does not keep pace implying smaller farm sizes and a switch to more labor intensive agriculture activities. Table 5.13 shows dairy and beef production, which don't require as large a scale operations, as say grains do, to achieve economies of scale, are favored. Beef production is up 10 percent and dairy 16 percent. Higher world wheat prices increases the production of this commodity at the expense of coarse grains. Both the production of other livestock products and the production of nonfood items of crop origin is down in comparison to production levels in the status quo

scenario. Note, these are the two commodities that were estimated to have positive PSEs.

### 5.7 Summary

This chapter explored the factor market implications associated with a continuation of the status quo policy course. Under this policy regime, it was projected there will be a trend to larger farm sizes. Farmers will become more and more dependent on capital and hired labor to augment their own labor services in the running of these larger farm operations. Because agriculture producers will find it increasingly difficult to scrape a living from the depressed commodity market conditions characteristic of this period, there will be a decline in the growth rate of number of farm operators. Grain markets will be particularly hard hit. WGSP deficiency payments annually paid out during this period amount to 17 percent of commercial sales. There are no deficiency payments made under the red meat stabilization plans, but this is more a reflection of structural weaknesses in the CAM than healthy livestock markets. Financing of stabilization programs costs Canadian taxpayers a little less than 0.2 percent of

their income.

Estimated commodity protection rates indicate Canada is not a major subsidier in its own right, and that most of Canadian government intervention just goes to offset harmful price distortions induced by other countries policies. If all countries were to stop their protectionist activities, it is estimated there would be an increase in number of Canadian farm operators, and decreases in the average farm size with respect to the situation under a continuation of current agriculture policies.

## 6. AGRICULTURE FACTOR RETENTION IN A DECOUPLED POLICY SETTING

### 6.1 Introduction

Decoupling is the current catchword being bandied around in agriculture policy discussions. Many people feel that the only viable way to bring order to the chaotic state world agriculture markets are now in is to multilaterally separate farm income subsidies from farm production decisions. This chapter explores the resource implications if Canada should take the initiative and unilaterally implement such a policy regime. Specifically, this chapter examines what would happen to agriculture factor usage if the aggregate producer subsidy equivalent of the present policy setting were passed on to producers in lump sum transfers.

The chapter is organized as follows: To begin with Section 6.2 explains, using welfare concepts and diagnostic tools, the theoretical economic advantage associated with Canada making such a policy change. In theory economic efficiency gains can be made because producers receipt of the lump sum transfer would be independent from their

production decisions. Unfortunately, lump sum transfer payments lose their theoretical production neutrality when actually put into practice. Stated in other words, it is impossible to design a workable payment scheme that will not to some extent distort relative factor usage. Section 6.3 discusses this and other issues involved in devising a workable decoupled policy program and describes the program chosen for analysis in this study. Section 6.4 explains how this program was structurally incorporated in the CAM. Simulation results are presented in Section 6.5 as percent comparisons with the results obtained for the status quo scenario of the previous chapter. Finally in Section 6.6 conclusions are drawn about the long run implications this policy program has for agriculture resource retention.

## 6.2 Theoretical Rationale

The income disparity between individuals in the agriculture sector and individuals in the nonagriculture sector in the Canadian economy can be depicted as in Figure 6.1. The curve UU represents the grand utility possibility frontier for the two sectors. For each level of utility,  $u^0$ , that individuals in the agriculture sector receive, it

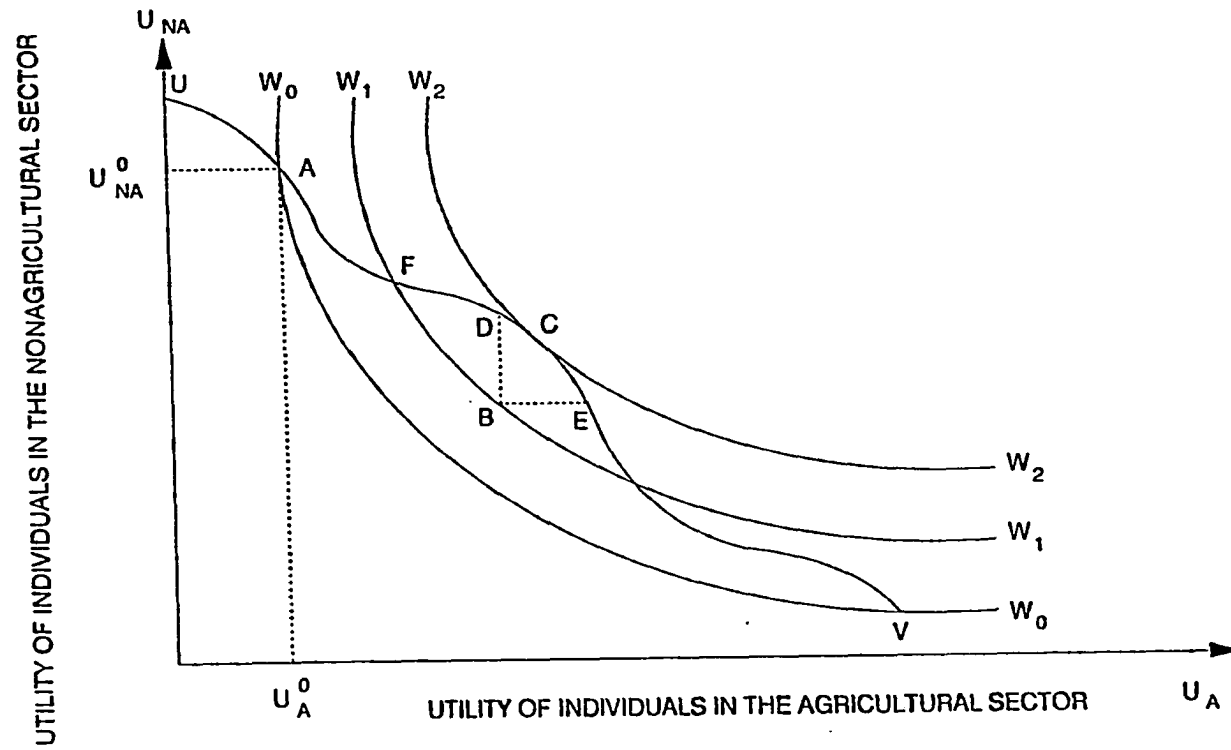


Figure 6.1: Illustration of income disparity between individuals in agriculture and nonagriculture in terms of a grand utility possibility frontier for the two sectors

shows the maximum utility obtainable by individuals in the nonagriculture sector. Without government intervention, the economy would be on the frontier at a point, such as A, with individuals in the nonagriculture sector receiving a disproportionate amount of utility compared to individuals in the agriculture sector. Although point A is pareto efficient, it is not the social optimum. It can be inferred from past government behavior that the social optimum lies somewhere to the right of point A, at a more egalitarian income distribution. Bergman's (1938) social welfare function, mapped as isocurves in utility space, is invoked for pictorial convenience. Society can maximize its welfare at point C where isocurve W2W2 is tangent to the utility possibility frontier. To bring the economy closer to this social optimum, the Canadian government is currently using border instruments and farm programs to redistribute income in favor of the agriculture sector. However, because this type of government intervention distorts price signals, the economy is not winding up at point C, but at some point B inside the utility possibility frontier. Although point B is not pareto efficient, it is on a higher isocurve than point A indicating that society, as a whole, feels better off at point B than it does at point A despite the inefficiencies associated with being at



point B. Society is willing to sacrifice economic efficiency in order to ensure a minimum standard of living for all segments of its populace. But the sacrifice is unnecessary. By changing its method of income redistribution to a lump sum transfer, theoretically the government should be able to move the economy down along the utility possibility frontier from point A, if not all the way to point C, at least to some point between D and C on the frontier. All these points are pareto superior to point B. At all these points both sectors of the economy would receive greater utility than they are currently receiving at point B. Note, according to the social welfare function drawn, even if the government only moved the economy to a point between F and D, society as a whole would still be better off than it is at point B, although individuals in the agriculture sector would be slightly worse off.

### 6.3 Designing a Decoupled Policy Program

As a prerequisite to implementing a decoupled agriculture policy program, the government must ask itself several questions. The first question is 'How much income

in total should be transferred from consumers and taxpayers<sup>1</sup> to agriculture producers?'. The normative answer to this question is that the government should transfer that amount of income sufficient to move the economy from point A (the competitive solution) in Figure 6.1 to point C where the isocurve of the social welfare function is tangent to the utility possibility frontier. The problem with this answer is the difficulty in analytically identifying the social welfare function. Although the social welfare function is a conceptually pleasing construct, it does not survive the transition from theory to practical application. Arrow (1951), by his impossibility theorem, showed that there is no way to derive this function democratically. Moreover, as Mishan (1973) comments "Even if there were no fundamental obstacles to its construction, or even if one could think up reasonable conditions under which a social welfare function could exist, there would remain the virtually impossible task of arranging for society to rank unambiguously all conceivable combinations of the

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<sup>1</sup>Although agriculture producers are consumers and taxpayers as well as nonagriculture producers, they make up such a small segment of the total population, that almost all the monies collected for redistribution to the agriculture sector, do come from the nonagriculture sector.

individual welfares".

Because of the positive slant of this study, it is possible to beggar the above issue of what is the optimal size income transfer for the government to make, and to take a more pragmatic approach. It is assumed, without allusion to how this amount measures up to the optimal size transfer, that the government will give agriculture producers the compensating variation associated with discontinuing current commodity specific policies. This arbitrary assumption is all that is required to assess which policy regime gives the biggest bang per dollar received by agriculture producers<sup>2</sup>. An estimate for the compensating variation of the policy change is derived by taking the difference between what producers would receive as income assuming a continuance of current commodity specific policies and what they would receive assuming multilateral trade liberalization. Because the reference is multilateral trade liberalization rather than unilateral, monies, presently given to producers just to offset the price distorting effects of other countries

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<sup>2</sup>A drawback with focusing on dollar received by agriculture producers rather than dollar collected from consumers and taxpayers is that it does not permit measurement of how much income is lost in making the transfer between sectors. Okun (1975) calls this income loss the leakage associated with the income transfer.

policy actions, are excluded from the lump sum transfer calculation.

The second question the government has to answer is 'How should this lump sum transfer be allocated among the various agriculture producers?'. Ideally, it should be allocated in such a manner to be production neutral with respect to both output and input mixes, and to be targeted towards the most needy producers without encouraging inefficiency. Unfortunately, taken together, these combined requirements are too tall an order to fill in the real world. There is a wide gulf between what can be done in theory and what can be done in practice.

So the individual producer payments do not favor the production of one commodity over another, they need to be distributed per farm enterprise (or equivalently per man-year of operator labor). Distribution according to ownership or current usage of any other resource will not be output neutral, but will favor some agricultural activities over others. This is not to say that distribution according to operator labor is without shortcomings. For one thing, it is not resource neutral. Because operator labor is not in fixed supply, but an upward sloping function of its own rewards, distribution according to operator labor will have the same price

distorting impacts that an unit subsidy on operator labor would have in these circumstances.

As shown in panel A of Figure 6.2, in the first instance the transfer payments would shift the operator labor supply curve to the right until the vertical distance  $ab$  equals the size of the individual producer payment, increasing operator labor employment in agriculture from  $NAO_0$  to  $NAO_1$ . The increase in operator labor supply, in turn, would put downward pressure on its own reward, decreasing the market return for operator labor from  $W_0$  to  $W_1$ . As the market return for operator labor falls, so would demand for its substitutes<sup>3</sup>, i.e., demand for hired labor, capital services and land. Panel B shows that in the second instance, the price of these substitutes falls in reaction to the shift backwards in their demand curves, causing a similar shift backwards in the operator labor demand curve. As all the primary input prices drop, so would the cost of agriculture production, causing a rightward shift in the commodity supply curve. More output

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<sup>3</sup>Hired labor, capital and land are all input substitutes for operator labor in agriculture production according to the parameters estimated for the cost function in Chapter 2. Findings of other empirical studies may disagree with this classification. For e.g., Lopez (1984) found operator labor and hired labor to be complements rather than substitutes.

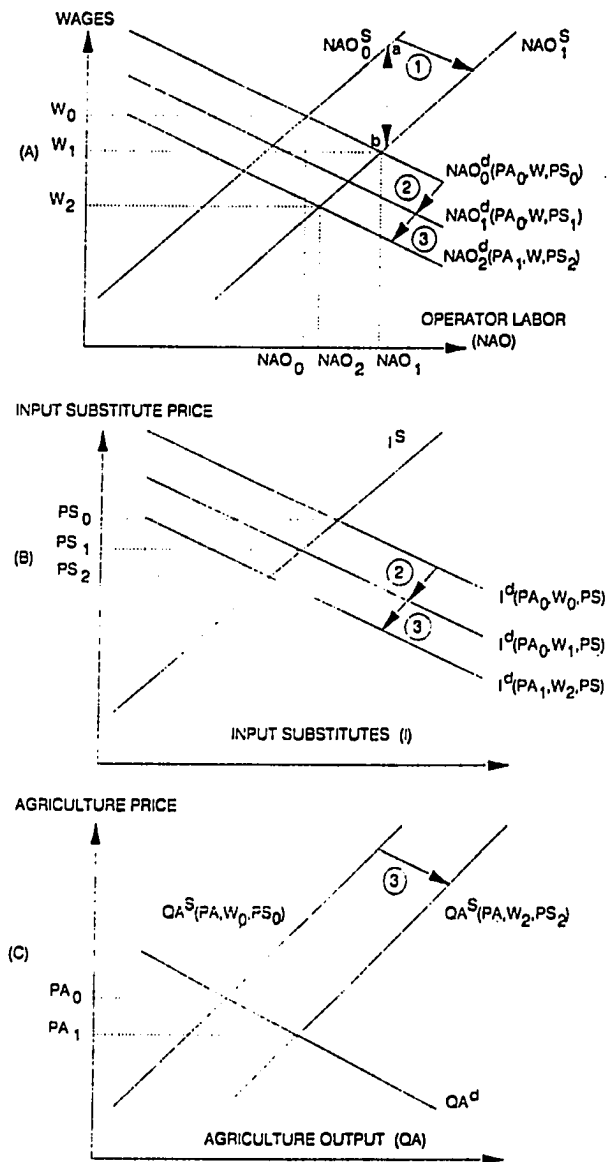


Figure 6.2 The impacts of a lump sum transfer distributed according to operator labor

would be offered to the market at each price, than was offered previously. The additional commodity output, in its turn, would depress commodity prices. As shown in Panel C, commodity prices drop from  $PA_0$  to  $PA_1$ , shifting all the input demand curves further backwards. As a result the relationship between final and beginning operator labor employment is indeterminate. It depends on how far backwards the operator labor demand curve shifts in response to decreases in the price of its input substitutes and the price of output. As drawn operator labor employment is greater in the long run than in a free market situation, but whether this would be true in actuality depends on own and cross price elasticities.

#### 6.4 Structural Framework

In the scenario under analysis in this chapter, it is assumed that only Canada decouples its farm income subsidies from farm production decisions. All the other countries continue with their current policy regimens. Accordingly, the policy specification in all the models in the BLS, except the CAM, is the same as in the status quo scenario. The policy specification in the CAM for this

scenario, has as its basis, the format it had in the multilateral trade liberalization scenario. Overlaid on these bare bones, the following structural alterations were made to emulate the effects the lump sum transfer would have on agriculture production.

First, on the assumption the lump sum transfer to the agriculture sector will be equally distributed among operator labor, no matter what type of agriculture activity they are engaged in or the size of their farm operations, a variable, called SUB, is introduced to represent the unit subsidy to each producer. It is calculated internally by dividing the total income transfer (TSUB) by the number of farm operators (NAO):

$$(6.1) \quad SUB_t = TSUB_t / NAO_t.$$

The total income transfer is an exogenous variable to the model simulation. It is calculated for year  $t$  as a 5 year moving average of the sum over all agriculture bundles, of the positive subsidy equivalents (PSE) that producers would have received under a continuation of the current policy setting relative to what they would have received under multilateral trade liberalization:



$$(6.2) \quad \text{TSUB}_t = \sum_{t=0}^4 \sum_{i=1}^9 \text{Max} \{ 0, \text{PSE}_{it} \}.$$

On the assumption negative producer subsidy equivalents for any commodity are indicative of a lack of government intervention, rather than deliberate producer exploitation on the part of the government, only positive subsidy equivalents are totaled in equation (6.2). A five year average is used rather than a single year's value to smooth out sharp inter-year fluctuations, and thus to provide solution stability.

To account for the unit subsidy's effect on resource allocation, the cost function and input demand equations are respecified taking the nonagriculture wage less the unit subsidy to be the market price of operator labor ( $\text{WN}^a$ ):

$$(6.3) \quad \text{WN}_t^a = (\text{WN}_t - \text{SUB}_t).$$

Somewhat similar assumptions are made regarding the financing of the lump sum transfer payments to agriculture producers as were made regarding the government financing of the stabilization payments in the status quo scenario. First, it is assumed that the full amount of monies

transferred to agriculture producers in any given year is collected in that year through an income tax,  $\alpha$ . Second it is assumed that the transferred monies are prey to the same income taxes, as producers market income is. Third, it is assumed that the income tax,  $\alpha$ , is collected after (or multiplicatively to) the income tax,  $\phi$ , used to service the trade deficit. Together, these three assumptions ensure the aggregate disposable income of the populace is the same in total as it was before the income redistribution. They are not sufficient, however, to guarantee that the income redistribution will be consumption neutral. Because the CAM does not recognize agriculture producers as different consumers from nonagriculture producers, the consumption effects of the income redistribution can not be analyzed within the confines of this study.

## 6.5 Simulation Results

Tables 6.1 through 6.6 contain the results for the decoupled policy scenario. The simulation output depicts the Canadian nonagriculture sector as being quite insensitive to the adoption of a decoupled policy regimen.

Nonagriculture production and input usage vary by less than half of one percent between the decoupled policy scenario and the status quo scenario. For this reason, attention will be confined to ramifications of the decoupled policy regime for the agriculture sector.

Estimated policy parameters for the lump sum transfer payment program are summarized in Table 6.1. The first thing to note about the estimates is that they imply a smaller income tax is needed to finance the decoupled policy program than would be needed to finance a continuation of current stabilization policies. The status quo scenario projected that a tax rate of 0.15 percent was required, on average, to fund the government's contributions to the Western Grain and Red Meat Stabilization programs, alone. The decoupled scenario projects that a tax rate of only 0.06 percent is sufficient, on average, to fund the lump sum transfer payments to agriculture producers. This tax rate differential, however, does not constitute evidence that a lump sum transfer payment program would be less costly to taxpayers than status quo policies since taxpayers monies going to just offset the price distorting effects of other countries policy actions in the status quo scenario are not being collected in the decoupled scenario for lump sum

**Table 6.1: Estimated program parameters for the decoupled policy scenario<sup>a</sup>**

	YEAR	
	1990/1995	1996/2000
Lump Sum Transfer <sup>b</sup>	2.4	2.3
Individual Producer Payment <sup>c</sup>	3.5	3.2
Income Tax Required to Service Program (Percent)	0.1	0.1

<sup>a</sup>Reported statistics are calculated as simple averages of each economic variable.

<sup>b</sup>The total transfer to agriculture producers is expressed as a percent of GDP of agriculture.

<sup>c</sup>Producer payments are expressed as a percent of the nonagriculture wage.

**Table 6.2: Estimated percent differences in agriculture profitability indicators between the decoupled policy and status quo scenarios<sup>a</sup>**

Profitability Indicators	YEAR	
	1990/1995	1996/2000
GDP of Agriculture	2.4	2.3
Market Income Parity	3.5	3.2

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent difference in each economic variable between the two scenarios, using the status quo figure as the base.

**Table 6.3: Estimated percent differences in real factor rents between the decoupled policy and status quo scenarios<sup>a</sup>**

	YEAR	
	1990/1995	1996/2000
<b>Factor Rents<sup>b</sup></b>		
Nonagriculture Wage	0.0	0.0
Nonagriculture Capital Rent	0.0	0.0
Farm Operators Opportunity Cost	-3.5	-3.1
Agriculture Wage	5.1	18.4
Agriculture Capital Rent	0.0	0.0
Agriculture Land Rent	-0.1	-3.9

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent difference in each economic variable between the two scenarios, using the status quo figure as the base.

<sup>b</sup>All prices are expressed relative to the price of nonagriculture.

**Table 6.4: Estimated percent differences in agriculture factor usage between the decoupled policy and status quo scenarios<sup>a</sup>**

	YEAR	
	1990/1995	1996/2000
<b>Factors of Production</b>		
Agriculture Labor	0.4	-2.2
Operator Labor	3.2	5.4
Hired Labor	-3.7	-13.2
Capital Services	-0.3	-0.3
Crop and Forage Area	0.0	1.6
Summerfallow and Pasture	0.1	-2.4

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent difference in each economic variable between the two scenarios, using the status quo figure as the base.

transfer.

The aggregate amount of income transferred to agriculture producers makes up in value a little less than two and a half percent of total GDP of agriculture. This payment on an individual producer basis works out to be roughly three and a half percent of the nonagriculture wage rate.

It is estimated an unilateral move on the part of Canada to a decoupled policy regime would have similar directional effects on Canada's agriculture labor force size and composition as a multilateral move to trade liberalization would have. Table 6.4 shows that the agriculture labor force declines relative to the status quo scenario in absolute number by 2.2 percent, but all of the decrease is in the hired work force. The hired work force decreases by over 13 percent. The number of farm operators, and implicitly the number of farm enterprises increase, but not to the same extent as in the free trade scenario. Operator labor increases by 5.4 percent compared to 7.7 percent in the free trade scenario.

Likewise as in the free trade scenario, total area put into crops and forage increases relative to the status quo scenario. However, in contrast to the free trade scenario, capital usage declines relative to the status quo scenario.



Capital usage in the decoupled scenario is 0.3 percent less than in the status quo scenario, while capital usage in the free trade scenario is 2.5 percent higher. Because countries other than Canada continue with their current trade distorting commodity specific policies in the decoupled scenario, there is not expanded international market growth as there is under multilateral trade liberalization. Without this market growth there is no room for combined labor and capital increases. Operator labor in the decoupled scenario increases relative to the status quo scenario at the expense of capital input.

Table 6.5 shows percentage differences in commodity production between the decoupled and status quo scenarios. The results show a greater diversification of output in the decoupled scenario. Beef, dairy and specialty crop production gain prominence while grain production decreases.

Chapter 2 reviewed the agricultural literature's contention that most of the benefits associated with current programs are capitalized into land values, and go to land owners rather than farm operators. Table 6.6, which compares shadow prices in the decoupled policy scenario with those in the status quo scenario imply farm labor would retain more government sponsored benefits if

**Table 6.5: Estimated percent differences in agriculture commodity production and factor usage between the decoupled policy and status quo scenarios<sup>a</sup>**

		YEAR	
		1990/1995	1996/2000
Wheat	Production	-9.7	-11.8
	Land Use	-2.9	0.8
	Labor Use	-11.0	2.9
	Capital Use	-10.4	7.0
Coarse Grains	Production	-6.3	-15.1
	Land Use	-0.7	-1.6
	Labor Use	-3.7	-6.0
	Capital Use	-3.1	-2.2
Oilseed Meal	Production	6.4	9.2
	Land Use	5.6	7.7
	Labor Use	32.3	47.5
	Capital Use	33.1	53.2
Other Food Crops	Production	4.7	3.9
	Land Use	2.7	0.8
	Labor Use	12.3	4.5
	Capital Use	13.0	8.7
Nonfood Crops	Production	-2.8	-6.6
	Land Use	-2.9	-6.9
	Labor Use	-13.1	-28.7
	Capital Use	-12.7	-25.9
Fruit	Production	1.7	-0.4
	Labor Use	7.8	0.9
	Capital Use	8.5	4.9
Other Livestock	Production	-3.9	-8.1
	Labor Use	-18.1	-35.7
	Capital Use	-17.2	-33.1

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent difference in each economic variable between the two scenarios using the status quo figure as the base.

Table 6.5 (Continued)

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Bovine and Ovine	Production	-0.3	2.0
	Labor Use	-4.3	2.2
	Capital Use	-3.5	6.3
Dairy Products	Production	14.8	15.8
	Labor Use	30.9	38.4
	Capital Use	31.9	35.6

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**Table 6.6: Estimated percent differences in shadow prices between the decoupled policy and status quo scenarios<sup>a</sup>**

	YEAR	
	1990/1995	1996/2000
Land Shadow Price	-8.5	-30.6
Labor Shadow Price	12.9	48.4

<sup>a</sup>Reported statistics for each time period are calculated as simple averages of the annual percent difference in each economic variable between the two scenarios, using the status quo figure as the base.

they were issued as lump sum transfer payments rather than through current commodity specific policies. The shadow price of labor in the decoupled scenario is up 48 percent and the shadow price of land down 31 percent relative to the status quo scenario.

de Gorter and McClatchy (1984) argue that the agriculture policies of a country should be evaluated with respect to how much they distort world prices than with respect to how much income they transfer to producers of that country. Table 6.7 shows estimated percent differences in relative world prices between the two policy scenarios and the multilateral trade liberalization scenario. The numbers in the Table indicate that current Canadian policies do affect world prices. That is, Canada is not a small country in international grain and livestock trade. World prices of these commodities are, in general, higher in the decoupled scenario than they are in the status quo scenario. The exception is the world price of dairy products. Although rents are being transferred to dairy producers through current dairy policy, Canadian dairy output is restricted minimizing the impact of the rent transfers on world trade.

**Table 6.7: Estimated percent differences in relative world prices between the two policy scenarios and the multilateral trade liberalization scenario<sup>a</sup>**

	YEAR	
	1990/1995	1996/2000
Wheat	-20.0 (-21.9)	-16.7 (-18.2)
Coarse Grains	-16.0 (-17.6)	-16.2 (-18.0)
Bovine and Ovine Meats	-28.4 (-29.0)	-27.0 (-27.5)
Dairy Products	-8.0 (-7.4)	-11.3 (-10.9)
Other Livestock Products	-15.4 (-16.0)	-14.5 (-14.5)
Protein Feed	-13.0 (-14.0)	-13.1 (-14.0)
Other Food Items	0.4 (0.4)	3.9 (3.9)
Nonfood Agriculture	5.2 (4.5)	13.0 (12.2)

<sup>a</sup>The simulation results for the decoupled policy scenario appear first. Underneath these in parentheses are the results for the status quo scenario.

## 6.6 Conclusions

This chapter looked at the implications Canada's unilateral adoption of a decoupled policy regime would have for agriculture resource retention in Canada. Although many policy programs could have been designed that would qualify to varying degrees as being decoupled, only one was considered for this analysis. The particular program under consideration consisted of lump sum transfer payments payable in equal amounts to farm operators, regardless of their farm size or commercial sales value. The total amount of monies transferred to farm operators was equal to the estimated compensating variation associated with the status quo policy regime.

It was estimated such an unilateral move on Canada's part would have similar effects on Canada's labor force size and composition as a multilateral move to trade liberalization would have. The number of farm operators increase relative to what they would have under a continuation of current policies while the average size farm decreases. In contrast, however, to multilateral trade liberalization the increase in operator labor reflects a switch towards more labor intensive technology rather than market growth. Capital usage declines.

The results also suggest that farm operators would retain a greater portion of government assistance if it was passed to them through lump sum transfers rather than through current commodity specific policies, and that lump sum transfers would have less negative impact on world prices than the current policies do.



## 7. SUMMARY AND CONCLUSIONS

### 7.1 Summary

This study explored the implications different policy regimes have for agriculture resource markets. Particular attention was focused on agriculture labor retention. Two markedly different policy regimes were analyzed. The first regime was just a continuation of the current commodity specific policy setting. The second regime, composed purely of lump sum transfer payments to operator labor, decoupled agriculture producers receipt of government aid from their production decisions. These two regimes represent extreme cases bounding the most likely outcomes of the ongoing GATT negotiations.

The analysis was performed in the empirical setting of the CAM and the BLS. The procedure was to run two simulations, each one representing one of the policy regimes, and to compare and contrast across these simulations Canadian factor usage and reward levels. The assumption was made throughout these simulations that the governments in other countries maintain their status quo policy courses. The amount of income transferred to

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agriculture producers in the decoupled policy run was set equal to the amount of benefits producers would receive in aggregate without any policy change, i.e., the compensating variation associated with current policies. The compensating variation was determined by taking the difference between Canadian producers net income when all countries, inclusive of Canada, continue with their status quo policy courses and when they stop all government intervention. This method of calculation for the compensating variation excludes government program benefits that just go to offset the harmful world price distortions induced by other countries policy actions.

Before the policy simulations were run, the input block of the CAM was revised with the intention of making the CAM a more responsive tool for the study. The efficiency wage hypothesis was used along with Okun's law to explain the existence of unemployment at equilibrium. Input demands for nonagriculture were derived from the combined estimation of a Cobb-Douglas production function and the first order conditions for profit maximization. Input demands for agriculture were derived from the estimation of a translog cost function and the associated input cost shares.

Alterations were also made to the policy block of the

CAM. These alterations centered on adding stabilization program representation and linking changes in dairy target prices to changes in dairy cost of production.

## 7.2 Conclusions

The main findings of this study are:

- 1) The Canadian nonagriculture sector is quite insensitive to agriculture policy regimes in reign both domestically and abroad. Nonagriculture production and factor usage took on the same values over the forecast horizon under multilateral agriculture trade liberalization and unilateral agriculture policy decoupling as they did under the status quo policy course.
- 2) According to the Producer Subsidy Equivalents estimated, that allowed production as well as price to respond to the removal of all government intervention in agriculture markets, most of current Canadian government assistance to agriculture producers just goes to compensate them for the market distorting impacts of government intervention in other countries. Further, the compensation is incomplete so Canadian producers as a whole, are worse off than they would be in a global free trade situation. The implication is that Canadian agriculture producers can compete in a free trade environment.
- 3) Government assistance administered through lump sum transfer payments to farm operators is more conducive to preserving the traditional family farm than government assistance administered through current commodity specific policies. It was projected farm number would be greater, but the average farm size smaller in the former situation than in the latter. Use of hired farm labor would also fall in the former situation relative to the latter.

- 4) Unilateral adoption of a decoupled policy regime of the type considered would have similar directional effects on agriculture labor force size and composition in Canada as a multilateral move to agriculture trade liberalization would have, but opposite directional effects on capital usage. Under multilateral trade liberalization there would be sufficient growth in commodity markets to accommodate both increased capital usage and operator labor usage. The same growth possibilities are not available when other countries continue with their present trade distorting policies. As a result, operator labor input increases at the expense of capital and hired labor input.
- 5) Unilateral adoption of a decoupled policy regime of the type considered would lead to a greater diversification in agriculture output in Canada. Beef, dairy and specialty crop production would gain greater prominence. Current commodity specific policy instruments encourage large scale farm operations since benefits are tied to level of production. Without this encouragement to expand, grain production would take a back seat as producers diversify their operations.
- 6) A smaller proportion of government income transfers to the agriculture sector would be lost to producers through capitalization if the income transfer was administered in lump sum form rather than through present commodity specific policies. The estimated shadow prices imply that in a decoupled setting farm operators would retain the benefits rather than pass them on to farm land owners.
- 7) In general, government assistance administered through lump sum transfer payments to farm operators rather than through current commodity specific policies would have a smaller negative influence on commodity world prices. The exception to this rule occurs when government price and income assistance is accompanied by mandatory output restrictions, as with the case of dairy.

### 7.3 Areas of Further Research

Further research can branch off in two different directions. First, additional work needs to be done in improving the structural integrity of the CAM. Structural modifications are needed in several areas. For example, more research is needed in the area of identifying the agriculture cost and input demand equations. The policy block should be further refined to accommodate explicit representation of access barriers. Effort should be made to determine why the current specification of the red meat stabilization program consistently under estimates the size and frequency of payments, and to correct this known bias. Finally, in light of the different policy frameworks in which pork and poultry operate in Canada, the nonlinear optimizing model needs to be reconfigured to treat pork and poultry as two separate production entities rather than as a single entity so that this different policy framework will be reflected in the forecasted production responses.

The second direction further research can take is to extend the results of the study to consider multilateral adoption of the decoupled policy regime assumed for Canada, to consider Canada's unilateral implementation of other types of decoupled policy regimes, and to consider the

effects on resource allocation of different transfer  
payment amounts.

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## 9. APPENDIX A: VARIABLE MNEMONICS

A	Land Base in Agriculture, Canada
AA	Crop and Forage Area, Canada
AGE	Proportion of Population Aged 16 to 45, Canada
Ai	Production Unit of Agriculture Production Bundle i, Canada
BAL	Trade Balance, Canada
BALBO	Balance of the Fund Account for Beef Under NTPS
BALPO	Balance of the Fund Account for Pork Under NTPS
BALWGS	Balance of the Fund Account for WGSP
BYk1	Byproduct 1 Resulting From the Production of 1 Unit of Agriculture Exchange Bundle k, Canada
CPi	Consumer Price of Agriculture Exchange Bundle i, Canada
CPN	Consumer Price of Nonagriculture, Canada
CTPi	Consumer Target Price of Commodity i, Canada
DA	Capital Depreciation Rate in Agriculture, Canada
DAA	Planned Crop and Forage Area, Canada
DKA	Planned Capital Stock for Agriculture, Canada
Di	Domestic Demand of Agriculture Exchange Bundle i, Canada
DN	Capital Depreciation Rate in Nonagriculture, Canada
DNAH	Planned Hired Labor Employment for Agriculture, Canada

DNAO	Planned Operator & Family Labor Employment for Agriculture, Canada
FDij	Amount of Feed Concentrate j Fed to Produce 1 Unit of Livestock Commodity i, Canada
FPi	Price of Feed Concentrate i, Canada
FZi	Nitrogen Fertilizer Applied Per Hectare of Crop i, Canada
GDPCO	Gross Domestic Product, Canada
gi	Area of Forage Production Required to Feed 1 Production Unit of Livestock Commodity i, Canada
GRPOP	Population Growth Rate, Canada
I	Gross Fixed Capital Formation, Canada
IA	Gross Fixed Capital Formation in Agriculture, Canada
ii	Ending Stocks of Agriculture Exchange Bundle i, Canada
IN	Gross Fixed Capital Formation in Nonagriculture, Canada
KA	Capital Stock in Agriculture, Canada
Ki	Capital Stock Allocated to Agriculture Production Bundle i, Canada
KN	Capital Stock in Nonagriculture, Canada
L	Labor Force, Canada
LVYWGS	Producer Levy on Commercial Sales Under the WGSP
NA	Employment in Agriculture, Canada
NAH	Hired Labor Employment in Agriculture, Canada
NAO	Operator Labor Employment in Agriculture, Canada

Ni	Labor Allocated to Agriculture Production Bundle i, Canada
NN	Employment in Nonagriculture, Canada
NRWGS	Aggregate Net Commercial Grain & Oilseed Market Returns Eligible for the WGSP
PART	Labor Force Participation Rate, Canada
PFZ	Nitrogen Price, Canada
Pi	Market Return of Agriculture Production Bundle i, Canada
PIGDPA	Price Deflator for the Gross Domestic Product of Agriculture, Canada
PIGDPN	Price Deflator for the Gross Domestic Product of Nonagriculture, Canada
PN	Price Index for Nonagriculture, Canada
POP	Population, Canada
PPI	Producer Price of Agriculture Exchange Bundle i, Canada
PPN	Producer Price of Nonagriculture, Canada
PSBO	Producer Support Price for Beef Production Under the Red Meat NTPS
PSPO	Producer Support Price for Pork Production Under the Red Meat NTPS
PYTBO	Total Stabilization Deficiency Payment for Beef Issued Under the Red Meat NTPS
PYTPO	Total Stabilization Deficiency Payment for Pork Issued Under the Red Meat NTPS
PYTWGS	Total Stabilization Deficiency Payment Issued Under the WGSP
QA	Gross Domestic Product of Agriculture, Canada

Qi	Production of Agriculture Commodity i, Canada
QN	Gross Domestic Product of Nonagriculture, Canada
QWGS	Grain & Oilseed Production Eligible for Deficiency Payment Receipt Under the WGSP
RA	Nominal Capital Rental Rate in Agriculture, Canada
RN	Nominal Capital Rental Rate in Nonagriculture, Canada
SF	Summerfallow and Pasture Area, Canada
SSRi	Self-Sufficiency Ratio for Agriculture Commodity i, Canada
T	Linear Trend (Calendar Year less 1900)
TA	Nominal Land Rental Rate in Agriculture, Canada
u	Unemployment Rate, Canada
VAi	Unit Market Value Added of Agriculture Commodity i, Canada
VCi	Unit Variable Cost of Agriculture Production Bundle i, Canada
WA	Nominal Wage Rate in Agriculture, Canada
WN	Nominal Wage Rate in Nonagriculture, Canada
WPi	World Price of Agriculture Exchange Bundle i, Canada
WPN	World Price of Nonagriculture, Canada
Yi	Yield of Agriculture Production Bundle i, Canada

## 10. APPENDIX B: UNITS OF MEASUREMENT

Agriculture Exchange Bundles

	Quantity	Price
Wheat	1000 Tonnes	1000 \$/Tonnes
Rice	1000 Tonnes Milled Rice	1000 \$/Tonne Milled Rice
Coarse Grains	1000 Tonnes	1000 \$/Tonne
Bovine & Ovine Meats	1000 Tonnes Carcass Weight	1000 \$/Tonne Carcass Weight
Dairy Products	1000 Tonnes Milk Equivalent	1000 \$/Tonne Milk Equivalent
Other Livestock Products	1000 Tonnes Protein Equivalent	1000 \$/Tonne Protein Equivalent
Protein Feed	1000 Tonnes Protein Equivalent	1000 \$/Tonne Equivalent
Other Food Items	Millions 1970 US \$	\$/1970 US \$
Nonfood Agriculture Items	Millions 1970 US \$	\$/1970 US \$

Agriculture Production Bundles

	Production Unit	Yield
Wheat	1000 Hectares	Tonnes/Hectare
Coarse Grains	1000 Hectares	Tonnes/Hectare
Oilseed Meal	1000 Hectares	Tonnes of Protein Equivalent/Hectare

Other Crops	1000 Hectares	1000 1970 US \$ /Hectare
Nonfood Crops	1000 Hectares	1000 1970 US \$ /Hectare
Other Livestock Products	1000 Tonnes Protein Equivalents	1
Bovine & Ovine Meats	Million Head	Tonnes of Carcass Weight/1000 Head
Dairy Products	Million Head	Tonnes of Milk Equivalent/1000 Head
Fruit	Millions 1970 US \$	1

Factors of Production

	Quantity	Price
Land	1000 Hectares	Index
Labor	1000s	1000 \$/Year
Capital	Million 1970 US \$	Index

National Account Series

	Quantity	Price
Gross Domestic Product	Million 1970 US \$	Index (1970=1)
Trade Balance	Million 1970 US \$	