PRICING EFFICIENCY IN SMALL REGIONAL MARKETS: THE CASE OF FEED GRAINS IN THE MARITIMES

Presented by

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ABSTRACT

This thesis examines the efficiency of the price discovery mechanism in small regional markets utilizing the feed grain markets in the Maritime Provinces of Canada as a case study. Through the application of the Law of One Price (LOP), price transmission symmetry and Vector Error Correction Models (VEC), the author determined the price relationships that exist between the feed grain market in the Maritime Provinces and those in Western and Central Canada as external sources of supply.

The results suggest that there exists a relatively high degree of arbitrage between Maritime feed grain prices and those of Thunder Bay or Chatham for equivalent quality, price transmission being strictly from West to East. Although the LOP hypothesis must be rejected in the short run, in most cases, it was found to hold in the long run. Local markets appear to be highly integrated and price adjustment occurs within a period of four to six weeks, generally corresponding to the lead time of feed grain orders and transportation from Western Canada. A price transmission analysis found no evidence of the exercise of market power in the pricing of local grain.

In general, the pricing of local grains in the Maritimes may be judged as efficient considering that the lag in price response corresponds to the replacement period for Western grains.

RÉSUMÉ

Ce mémoire étudie le mécanisme et l'efficacité de la détermination des prix dans les petits marchés. Le cas des grains de provendes des Provinces Maritimes Canadiennes y est analysé. En se servant de modèles tels ceux de la "Loi du Prix Unique" (LPU), l'asymétrie de la transmission des prix, à vecteurs autorégressifs (VAR) et à correction d'erreur (VEC), l'auteur a tenté de déterminer la nature des relations de prix entre les céréales fourragères des Provinces Maritimes et celles des Prairies et de l'Ontario.

Les résultats suggèrent l'existence d'arbitrage entre le prix des céréales dans les Maritimes et le prix d'un produit équivalent à Thunder Bay ou à Chatham, bien que la transmission de prix se fait en sens unique d'ouest en est. Néanmoins, l'hypothèse de LPU a du être rejetée pour l'ajustement à court terme mais était justifiée pour la dynamique de long terme dans la majorité des cas. De plus, les marchés locaux semblent fortement intégrés. Dans la plupart des cas, l'ajustement au prix des Prairies s'effectue avec un délai variant de quatre à six semaines correspondant à la période requise pour le remplacement du grain. Une analyse de la symétrie de la transmission des prix n'a révélé aucune évidence d'un pouvoir de marché exercé de la part des acheteurs de grains locaux.

De façon générale, le mécanisme de détermination des prix des grains de provendes des Provinces Maritimes peut être considéré comme efficace, avec un délai d'ajustement au prix correspondant au remplacement par des grains de l'Ouest Canadien.

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CHAPTER ONE: INTRODUCTION

1.1 Pricing Efficiency

The question of market performance is of increasing importance with the current trend toward reduced government intervention and freer trade. In such an economy, in the absence of market failure, the price is determined according to the supply and demand conditions prevailing in the market.

The main focus of this thesis will be pricing efficiency for feed grains in the Maritimes. The following definition will be used for the purpose of the present analysis in order to avoid ambiguity:

Pricing efficiency: "...prices are considered efficient if they accurately and effectively track changes in the supply and demand functions of a dynamic market." (Rhodus et al., 1989, p. 876)

Pricing efficiency will refer to the speed and the dynamics of price adjustments. In other words, how quickly the local market returns to equilibrium after a given shock on external markets. In short, pricing efficiency will focus on whether or not prices are correlated between the regions. However, as indicated in the above definition, the price has to reflect the local market conditions so that competition in small regional markets may contribute to pricing efficiency in these markets.

In a country as vast as Canada, with regional concentrations of population and economic activity, interregional trade is essential to the economic prosperity and viability of small regional markets. Through engaging in trade, regional disparities and price differentials between the different areas should be reduced. This thesis will examine the local pricing and the trade of feed grain between a large market, the Canadian Prairies, and a small regional market, the Maritime provinces.

One of the most interesting features of interregional trade consists of establishing the price of a locally produced commodity. Where the region relies on imports in addition to local production, what is the price relationship between the large external market and the small regional market? Are prices of local commodities based solely upon the importation of competing products? How does the price of an imported commodity influence the pricing of a competing product in the regional market? Traditional economic analysis has relied upon theories such as the comparative and absolute advantage, commodity arbitrage, the "Law of One Price" and market integration as an explanation for pricing and trade activity.

"Under pure competition, efficient marketing results in a uniform pattern of prices reflecting supply and demand over space and time" (Cummings, 1967, p. 82). According to Tomek and Robinson (1991), the efficient market hypothesis assumes that the resulting prices are the competitive equilibrium prices if the price establishment process includes all relevant information. In other words, the price of a homogeneous commodity in a large region should be reflected in the price of that commodity in a small regional market such as the Maritime provinces, ceteris paribus. As a result, while the Maritime feed grain prices can be expected to move toward a "uniform pattern" that is achievable under perfect competition, in the short run grain prices may be above or below expected levels.

In general, there are three criteria relevant to the determination of pricing efficiency: (1) that prices reflect local supply and demand conditions compared to imported competing products; (2) that seasonal price differences do not consistently exceed storage costs; and (3) that price differences among markets do not exceed transfer costs. In other words, commodity arbitrage should ensure that the price of local feed grains equals that in Thunder Bay or Chatham plus transfer costs.

1.2 Maritime Feed Grain Pricing Issues

The competitive pricing of feed grain in the Maritime Provinces has been a long standing issue. Producers within the region have felt that local grains were not being priced competitively with grains shipped outside the region. Provincial governments have responded to that concern in the 1970's by creating infrastructure such as grain handling facilities and marketing organizations to facilitate the development of commercial grain marketing within the region. A Federal Government initiative to place local grains on an equal footing with non-local grains was the extension of eligibility of Feed Freight Assistance (FFA)[1] to local grain in 1984.

More recently, the accuracy of Maritime grain prices for purposes of the Gross Revenue Insurance Plan (GRIP) was subject to review with regard to the adequacy of the Statistics Canada survey that was employed for that purpose. The Livestock Feed Bureau (LFB) of Agriculture and Agri-Food Canada was asked by the Maritime GRIP Committee[2] to determine whether data collected through FFA claims could be processed to provide a more complete capture of Maritime grain price information. The results of this determination confirmed the qualities of this FFA database as a virtual census of commercial transactions of local feed grains. As such, it also represents an ideal database on which to perform a pricing efficiency analysis to address the above mentioned concerns.

[1] According to the Federal budget of February 27, 1995, the FFA program is schedule to be terminated during the federal fiscal year 1995-96.

[2] The Maritime GRIP Committee is formed of 6-7 members from major grain pooling organizations and provincial and federal governments.

1.3 Hypothesis, Purpose and Objectives

1.3.1 Hypothesis

The hypothesis of this study is that there exists a statistically significant and consistent relationship between feed grain prices paid to producers in the Maritime Provinces and prices prevailing in other Canadian markets such as Thunder Bay and Chatham in Ontario and that Maritime region prices are efficient in adjusting to external shocks within four to six weeks which is the period required for replacement. Due to the relatively limited size of grain production in the Maritimes, the hypothesis suggests that, at least in the long run, systematic price adjustments will occur in response to external markets. The question of efficiency is also concerned with the *speed* of price adjustments.

1.3.2 Purpose and objectives

The primary purpose of this thesis is to test the pricing efficiency of Maritime feed grain markets by comparing these prices to those of more established markets such as Thunder Bay or Chatham. As a secondary objective, validation of the suitability of price data from FFA claims as a basis for testing the efficiency of Maritime grain prices will be discussed and analyzed. Suitability of the data includes characteristics such as representativeness and consistency. These aspects of data quality will be discussed in more detail under methodology.

The main objectives of this thesis are:

(1) to investigate the pricing efficiency in small regional markets using the Maritime feed grain markets as a case study;

(2) to validate the representativeness and consistency of FFA claim price data in the Maritimes as a basis for this analysis;

(3) to develop a descriptive analysis of feed grain production, utilization and movement within the Maritime Provinces.

1.4 Structure of the Thesis

This introductory chapter has presented the research problem, definition of terms, the hypothesis and main objectives to be met. Chapter two gives a descriptive analysis of the Maritime feed grain markets including a survey of the major studies related to the Canadian feed grain industry, government policies affecting local prices, an overview of production and utilization of feed grains in the Atlantic provinces. Chapter two also describes the structural characteristics of the feed grain market in the region as well as the pattern of inter-regional grain movement. Price levels and relationships to transfer costs, government policies and local market conditions are presented along with a graphical analysis and discussion of the supply and demand of feed grains in the Maritimes illustrating two different market situations: barley surplus in Prince Edward Island and barley deficit in Nova Scotia.

Chapter three presents the review of literature and the methodology. The Law of One Price (LOP) models, asymmetric price transmission, unrestricted vector autoregression (VAR) and vector error correction (VEC) models are described in detail.

Chapter four is the core of the thesis; data, empirical results and interpretation. The first main section presents data collection and preparation which includes several tests that are applied to the data set. Representativeness, consistency analysis, optimal lag length, stationarity, unit root tests, cointegration and error correction mechanisms are conducted on the database. Then, this chapter presents the results and interpretation of the different tests, which is followed by an analysis of impulse functions on Thunder Bay, Chatham and local grain prices. As an application of the VEC analysis, some short run forecasting models for selected grain crops are described and investigated.

Chapter five concludes the thesis by giving a summary, explaining the limitations of the analyses and providing suggestions for further research.

The final section includes a bibliography and appendices to provide further detail on materials discussed in the thesis.

CHAPTER TWO: DESCRIPTIVE ANALYSIS OF THE MARITIME FEED GRAIN MARKET

2.1 Introduction

The following descriptive analysis is necessary to gain a precise understanding of the Maritime feed grain market and its relation to other markets, in both quantitative and qualitative terms. While it may be viewed as a single regional market in some context, in studies of this nature, it is essential to recognize the distinctive features of each province in the region.

This chapter is divided into five main sections, each of which is devoted to an element of the descriptive analysis of the feed grain market. The first part reviews the main studies on the Maritime feed grain markets and their relation to external markets. Second, the production of feed grain is compared to its total utilization. The third part discusses the structural characteristics of the regional market for feed grains. The fourth section addresses the inter-regional grain movement and the different factors affecting price levels and relationships such as transfer costs, government policies and local market conditions. Finally, a graphical analysis of the relative supply and demand conditions for given Maritime grain crops is presented.

2.2 Review of Major Studies on Feed Grain Markets and Related Policies

Sorflaten (1977) conducted a survey of the formula feed industry of the Atlantic Provinces as well as an analysis of the long term trends and potential for grain and livestock in the Maritimes. The goal of the study was to assemble and analyze information used for predictive purposes in Maritime feed grain production. Sorflaten predicted a growth in livestock and feed grain production. Among the factors affecting feed grain production and marketing, he observed that the most influential were weather and climate, intra-regional transportation costs, opportunity cost considerations and the structure of the marketing system, as it existed at that time. However, from an empirical viewpoint, Sorflaten (1977) found that "potato acreage and numbers of grain consuming animal units were, statistically, the most significant empirical factors affecting regional feed grains acreage" (p.2).

The question of variations in price differentials of feed grains between Western Canada and the Atlantic Provinces was addressed by Broadwith et al. (1978). In their study, they suggested that, in a perfect market, differentials between feed grain prices are explained by transportation costs, differences in nutritive content, "modified by the behavior of feed grain purchasers, consumer preference for meat and other technical and behavioral aspects, and the given 'mix' of livestock class" (p.23).

Over the years, a number of studies of feed grains in the Maritimes have focused on the Feed Freight Assistance program which has certainly played an important role in the development of Maritime agriculture but has also been the focus of some critics in the literature (Campbell et al., 1969, Robinson, 1988, Klein et al., 1991). The majority of these studies did not address the issue of pricing efficiency.

In 1969, the Federal Task Force on Agriculture released a report entitled "Canadian Agriculture in the Seventies" (Campbell et al., 1969). The report recommended the termination of the Feed Freight Assistance program as of August 1970. They suggested that the FFA be replaced by equivalent lump-sum payments to the provincial governments of Quebec, Prince Edward Island, New Brunswick, Nova Scotia and Newfoundland, that would help to strengthen the agricultural sector in these provinces. The fixed sum would be gradually reduced until its eventual elimination. The strongest recommendations of this reports were not heeded, but some of the report's criticisms were acknowledged as valid.[3]

Robinson (1988) examined the feed cost problems and FFA policy options in Nova Scotia. First, he reviewed policy history from its creation in 1941, through passage of the Livestock Feed Assistance Act in 1966 to the conditions of 1988. Next, he presented a static analysis of going from an input subsidy to an output basis for payment of FFA. According to Robinson, past analyses on the effects of FFA (such as the Federal Task Force, Campbell et al., 1969), omitted the implications of technical change.

In their study for Agriculture Canada, Klein et al. (1991) analyzed seven different policy options for Feed Freight Assistance. The main concern of the authors in viewing FFA as a program aimed at increasing livestock production in feed deficit regions, was that approximately two thirds of the total FFA subsidy was devoted to sectors under supply management (poultry and dairy production), which cannot increase production simply as a result of cheaper input prices. The options analyzed went from the complete removal of FFA to the enhancement of the subsidy for Atlantic provinces. The main conclusions were that: no region is thoroughly dependent on the FFA subsidy, payment to end users would engender fewer distortions, and raising FFA would increase benefits to livestock producers in feed grain deficit regions but could lead to further distortions in Canadian agriculture.

In April 1993, The George Morris Center and Moncrieff Agri Business Ltd released a study prepared for Agriculture and Agri-Food Canada on the *Competitiveness of the Maritime Grain Industry*. The principal conclusion was that the Maritime Provinces can competitively produce grain as part of a diversified farm operation, i.e. if conducted in a symbiotic relationship with livestock, potatoes and horticultural crops. Their main recommendations were (a) to increase emphasis on economic productivity enhancement, not

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[3] In fact, as discussed earlier, with the Federal budget of Feb. 27, 1995, the FFA program will phase out during the fiscal year 1995-96 and a ten-year decreasing amount will be given to the deficit regions in a similar fashion to that proposed by the Federal Task Force on Agriculture 25 years ago.

just on volume, (b) that P.E.I. Grain Elevators go with a price-pooling system, (c) that on-farm storage be increased, (d) that grain handling facilities go to private ownership, and (e) that farmers cooperate with each other and with input suppliers on input purchases.

2.3 Production and Utilization of Feed Grain

The Maritime provinces[4] are a grain deficit region. The region has traditionally produced between 30 to 40 percent of its total grain requirements consisting primarily of feed grains (George Morris Centre and Moncrieff Agri Business Ltd, 1993). The production of wheat, oats, barley, mixed grain, rye, corn, and soybeans in the Maritimes represents around half of one percent (0.5%) of Canadian total feed grain production. Prince Edward Island is almost self-sufficient, producing grain crops in rotation with potatoes. The balance of the region's grain requirements are met by freight assisted shipments from Ontario and the Prairies on which transportation costs are subsidized under the Feed Freight Assistance (FFA) program.

The annual average production and utilization of grains and oilseeds in the Maritime Provinces for the years 1991 to 1993 are summarized in Table 1. Additional details may be found in Appendix Tables A through I.

Barley is, by far, the most commonly grown type of grain although it has been surpassed by corn in Nova Scotia. Oats still rank second in importance in New Brunswick, while rapidly declining in popularity elsewhere. Despite a steep decline in production since 1981, mixed grains (barley and oats combination) remain second in importance in Prince Edward Island, followed by wheat. Soybeans are gradually becoming established as a cash

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[4] Only three of the four Atlantic provinces will be taken into account for the purpose of this study. Newfoundland is excluded because there is no significant production or commercial transaction of local feed grain in that province.

TABLE 1: Production and utilization of grains and oilseeds in the Maritime Provinces
(Averages in tonnes, 1991-1993)

Production[5]	Prince Edward Island	Nova Scotia	New Brunswick	TOTAL
Barley	109,967	12,647	43,238	165,852
Wheat	21,167	5,038	6,422	32,627
Oats	16,233	8,812	22,343	47,388
Mixed grains	35,435	1,636	1,893	38,964
Corn	28,626			28,626
Rye	1,067	36		1,103
Soybeans	10,300			10,300
Total production	194,169	56,759	73,932	324,864
Total consumption[6]	148,048	241,885	186,968	576,901
Consumption excl. oilseeds	130,019	206,715	160,305	497,039
Self-sufficiency (averages of 1991-92 to 1993-94 according to Statistics Canada data)				
(a) Including oilseeds	131%	23%	40%	56%
(b) Excluding oilseeds	**141%**	**27%**	**46%**	**63%**
Self-sufficiency (averages of 1991-92 to 1993-94 according to FFA shipments)				
Total inbound	20,743	177,139	96,059	293,941
Total outbound	11,034	2,919	2,318	16,271
Net Inbound FFA shipments	14,306	174,220	93,741	277,670
Degree of self-sufficiency[7]	**95.0%**	**24.6%**	**44.1%**	**53.1%**

[5] Statistics Canada, "*Field Crop Reporting Series*", Catalogue 22-002, Sept. 1992 and Nov. 1993.

[6] Averages estimated for 1991-92 and 1992-93 from Statistics Canada, Agriculture Division, "*Consumption of Feed Grains and Oilseeds by Livestock and Poultry, Canada and Provinces*", 1991 and 1992, and, "*Livestock Statistics*", Catalogue 23-603F, 1993. (See Appendix Tables E and F)

[7] Calculated by taking local production (excluding soybeans in Prince Edward Island) as a percentage of production plus net inbound shipments under Feed Freight Assistance.

crop in P.E.I., with 110 farms reporting some acreage in the 1991 Census (Statistics Canada).

According to Statistics Canada production data (Catalogue 22-002, 1992, and 1993), P.E.I. accounted for about 60 percent of the grain production in the region while New Brunswick and Nova Scotia represented 23% and 17%, respectively. When compared with estimated consumption requirements for livestock populations based on Statistics Canada surveys, these same production data suggest that P.E.I. production exceeds local needs by 30 to 40 percent. On the other hand, comparisons of the total inbound and outbound shipments of grain reported under the FFA program suggest that P.E.I. is only now approaching self-sufficiency in total grain production as indicated in Table 1. For New Brunswick and Nova Scotia, the self-sufficiency levels appear to be comparable under both approaches even though they are slightly lower under the FFA shipments approach than by using Statistics Canada production and consumption estimates. Appendix Tables E and F detail the estimated utilization of feed grain in 1991 and 1992. It appears that the degree of self-sufficiency calculated from FFA shipments is comparable to previous studies (George Morris Centre and Moncrieff Agri Business Ltd, 1993).

Consumption estimates are very different from those of production. The estimates suggest that P.E.I., N.B. and N.S. livestock and poultry consume respectively 23%, 29% and 40% of total Maritime grain requirements (Statistics Canada, Cat. 23-603F, 1992 and 1993). Of the three Maritime provinces producing feed grain, Nova Scotia relies most heavily on imported grains.

Because of its important effect on pricing and price levels, it is essential to clarify the situation with respect to supply - demand balances in P.E.I.. The tendency of P.E.I. prices to approach those of Thunder Bay during the past three crop years suggests that the balance derived from net FFA shipments may be the most accurate (See Appendix Tables G, H, and I). In that case, either the production data reported by Statistics Canada is overstated, or the estimated feed grain requirements are underestimated, or both. Thus, an inaccurate picture of the supply - demand balance in P.E.I. has been created.

Grain industry and government officials in the Maritimes believe the net shipments approach to be the most accurate. The reliability of production data should be confirmed, however.

In terms of land use for grain production, Figures 1, 2 and 3 illustrate the acreage devoted to various grains in P.E.I., Nova Scotia and New Brunswick, respectively, for census years 1971 to 1991. The total area of grain production in P.E.I., including, since 1981, that devoted to soybeans, has varied between 157,554 and 178,625 acres. Soybean acreage is reported to have grown very rapidly, from less than 6,000 acres in 1991 to some 19,000 in 1993 (P.E.I. Agricultural Statistics, 1992-93). This development is apparently in response to the previous terms of the GRIP program, since soybean acreage fell back in 1994 after adjustment in the yield eligibility[8].

Total land area committed to grain in Nova Scotia and New Brunswick together has been much lower than that in P.E.I. and has generally declined since 1971. As of 1991, total acreage in Nova Scotia was approximately 32,000 acres while New Brunswick reported 62,000 acres. Additional details on acreage may be found in Appendix Table A.

The commercial importance of grain production in the Maritimes is expressed in Figures 4, 5 and 6 in terms of farm cash receipts for barley, oats and wheat in N.B., N.S. and P.E.I. respectively, for the years 1976 to 1993 (Statistics Canada, Agriculture Economic Statistics, May 1994). According to these data, sales of these three grains in 1992 reached a farm-gate value of $8.1 million in P.E.I., $3.2 million in N.B. and $800 thousand in N.S., for a total of some $12 million. On the other hand, the estimated farm value of total

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[8] Consultation with officials of the Prince Edward Island Department of Agriculture, Fisheries and Forestry, August 1994.

Figure 1

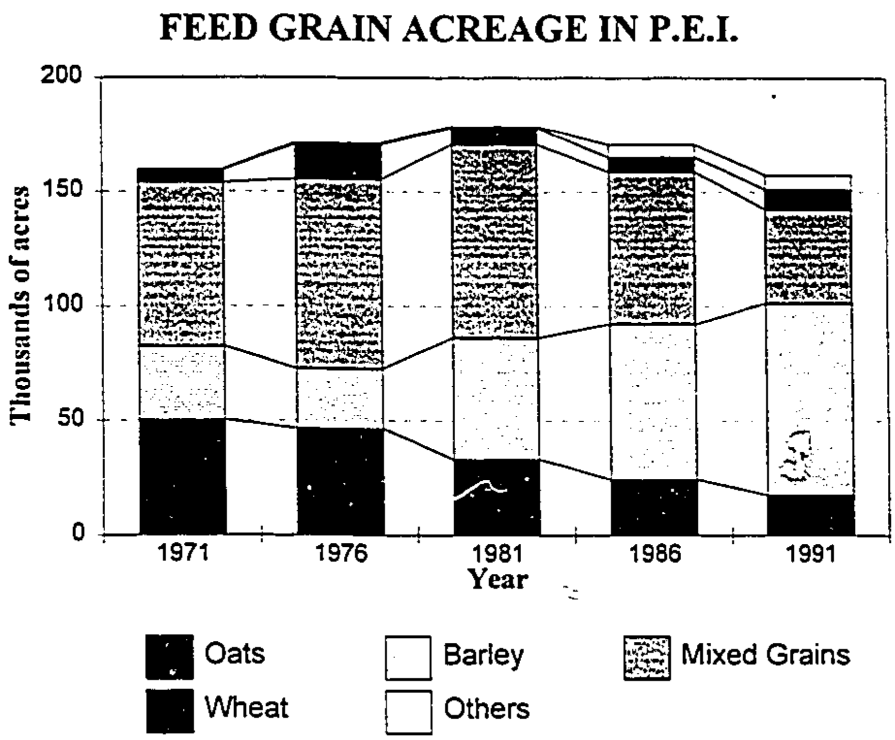
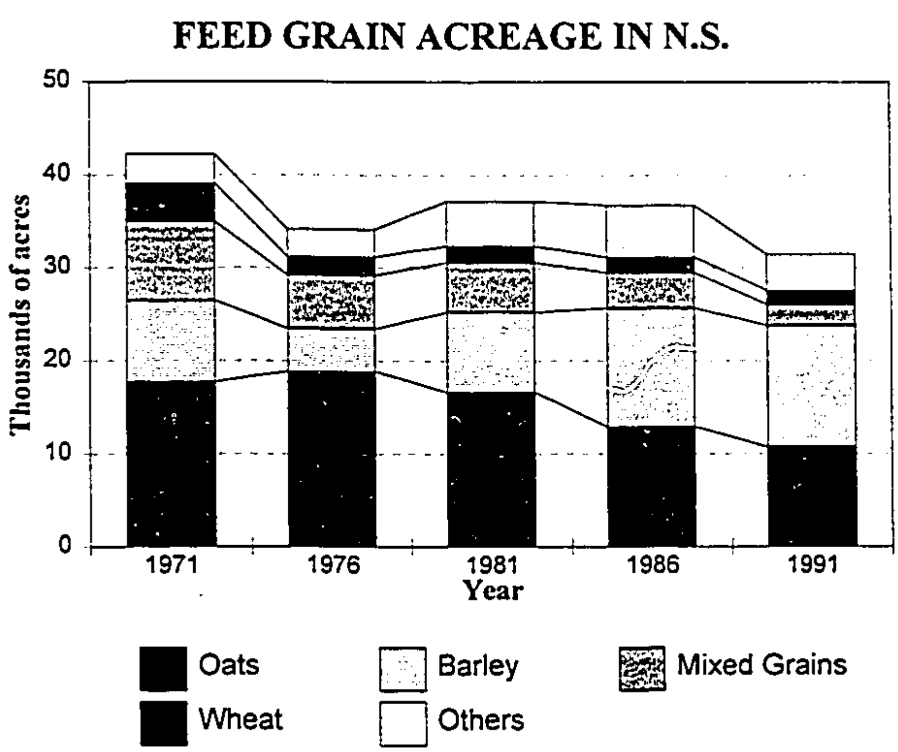


Figure 2



Source: Statistics Canada, Agriculture Economic Statistics, May 1994.

Figure 3

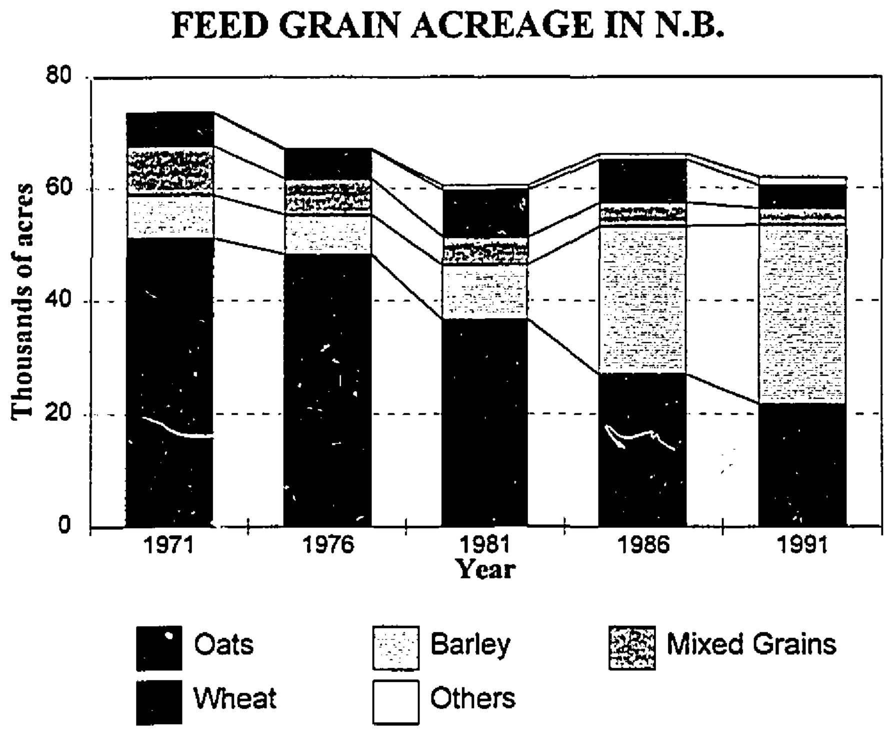
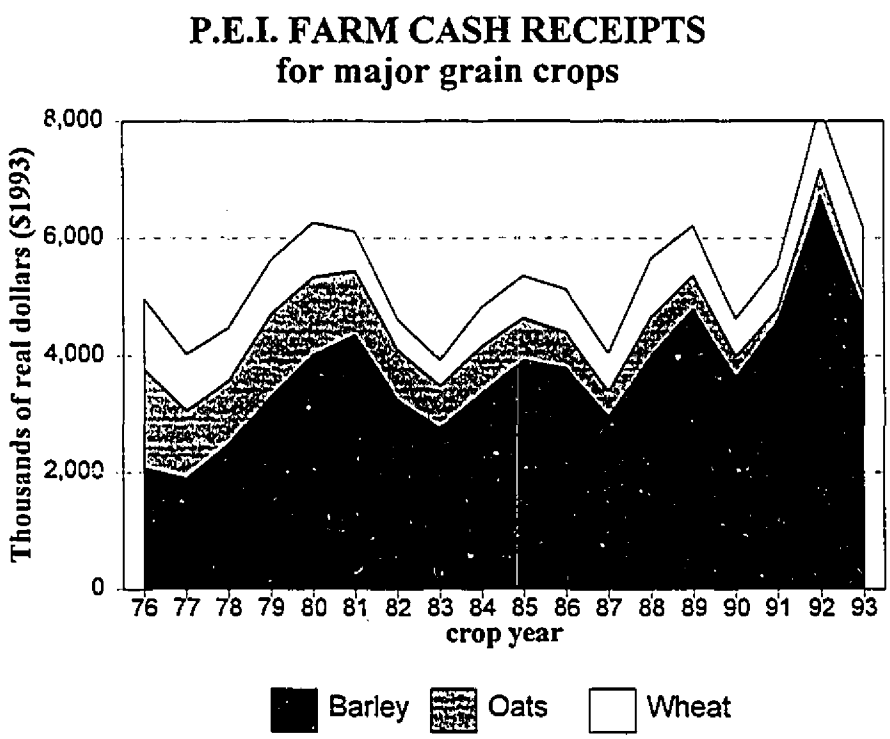


Figure 4



Source: Statistics Canada, Agriculture Economic Statistics, May 1994.

Figure 5

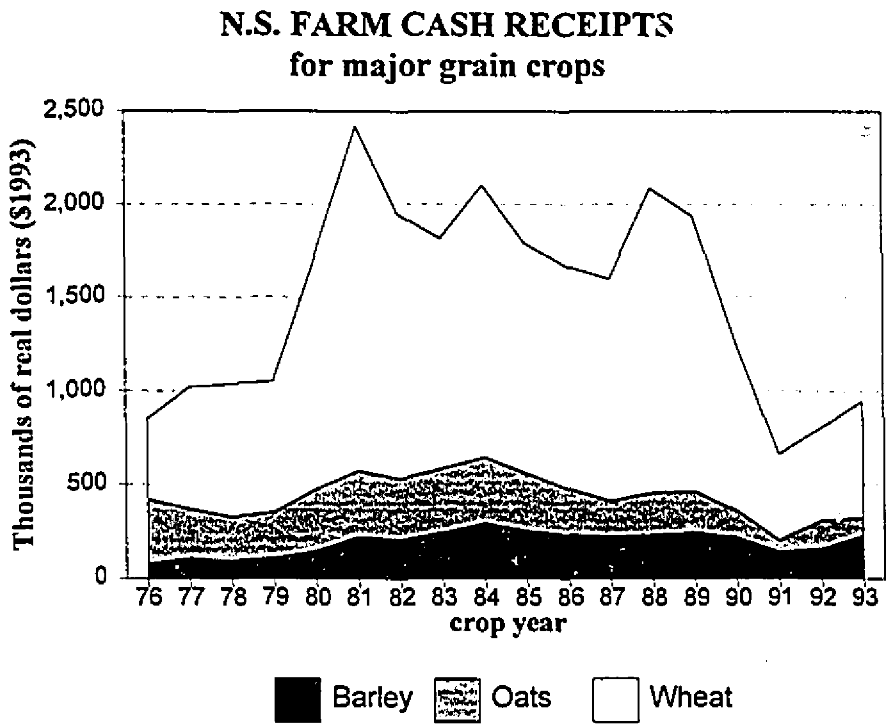
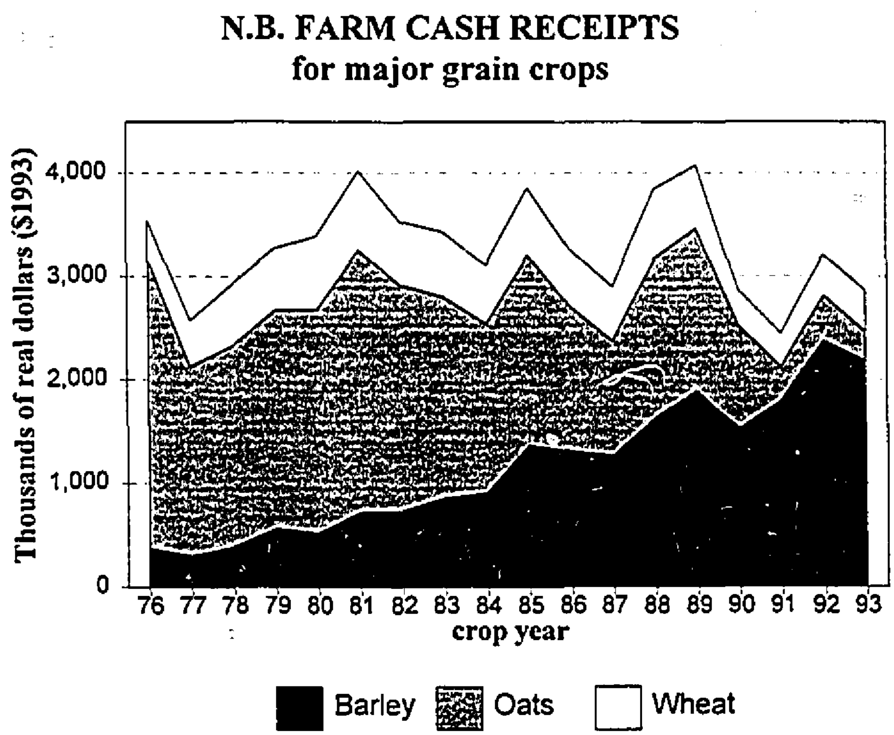


Figure 6



Source: Statistics Canada, Agriculture Economic Statistics, May 1994.

production of these three grains in P.E.I., alone, was reported to be $21.4 million in 1992 (P.E.I. Department of Agriculture, Fisheries and Forestry, Agricultural Statistics and Review of Agriculture, 1992-93, Tables 31 and 32). Although not shown in Figure 5, corn has recently become more important in N.S. surpassing oats and approaching barley in terms of farm cash receipts.

The discrepancy between farm cash receipts and estimated farm value is one indicator of the proportion of grain production sold commercially. In the case of P.E.I., this indicator suggests that off-farm sales of grain in 1992 amounted to 42 percent of barley production, 39 percent of wheat production and 16 percent of oats production. In comparison, the FFA data suggests that, on average between 1991-92 and 1993-94, off-farm sales were evaluated to be 49 percent of barley production, 40 percent of wheat production and 22 percent of oats production (see Table 5). Additional details on farm cash receipts may be found in Appendix Table D.

2.4 Structural Characteristics of the Regional Feed Grain Market

Most grain production in the Maritimes is grown as hog, poultry or dairy feed, and as a rotation crop on potato farms. Consequently, the number of farms reporting some acreage of grain is much larger than those specializing in grain as a cash crop. For example, in 1991, 836 farms in Prince Edward Island were identified as producing some barley, 681 farms in Nova Scotia and 829 farms in New Brunswick produced some oats (Statistics Canada, Census of Agriculture, 1991) (see Appendix Table B). At the same time, the number of farms reporting $2,500 or more of farm income of which at least 51 percent was from sales of grain totalled only 60 in P.E.I., 13 in Nova Scotia, and 23 in New Brunswick (Statistics Canada, Cat. 93-350, 1992) (Appendix Table C).

Many of the farms specializing in grain production are producing for the certified seed or flour milling markets. These markets generally attract a certain price premium over the feed market but are limited in size within the region. Sales of locally grown wheat to Dover Mills in Halifax, the only mill in the region, have ranged between 4,000 and 10,000 tonnes in recent years, although the 1989 total exceeded 13,000 tonnes (MacRae, Nova Scotia Grain Marketing Board, 1994).

According to the Canadian Seed Growers Association, seed grain production in the Maritimes is estimated at 7,651 acres, which represents some 8,377 tonnes of grain (CSGA, 1993). In 1994, seed grain producers who are members of Secan[9] number 7 in N.B., 2 in N.S. and 16 in P.E.I..

Off-farm sales of feed grain may be made to other farms, to feed milling operations and/or to grain marketing and handling operations such as the Prince Edward Island Grain Elevator Corporation, the Nova Scotia Grain Commission or the Valley Grain Pool in New Brunswick. In fact, it is estimated that roughly one-third of all grain sold off farms in P.E.I. is first sold to or through one of the three elevators[10] of the government-owned[11] P.E.I. Grain Elevator Corporation. The Provincial Grain Commis-sion of Nova Scotia, in conjunction with the Nova Scotia Grain Producer Marketing Board, handles the majority of off-farm sales of grain at one of three elevator facilities[12] in that province. In New Brunswick, the formerly government-owned facility at Florenceville (now operated by a producer group

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[9] Secan stands for Seed Canada and is an organization that includes virtually all seed grain growers in Canada.

[10] Elevator #1 in Kensington, Elevator #2 in Roseneath and Elevator #3 in Elmsdale in P.E.I.

[11] Until last year, the Corporation bought and sold local grain on its own account. Since 1992-93, however, the Corporation has been acting as a marketing agent, paying an initial price of 80% of estimated market value and a final payment of any balance after deducting marketing costs.

[12] Located at Bayhead, Middleton and Steam Mill.

under the name of Valley Grain Pool Inc.) handles more than one-quarter of the New Brunswick farm sales of grain.

Much of the grain initially handled by these organizations is eventually sold to the feed manufacturing industry, which is also a major outlet for first transaction sales beyond the farm-gate. The largest outlets in this respect include Co-op Atlantic (Moncton, N.B.) and its member co-ops (Charlottetown, P.E.I., Hartland, N.B. and Kentville, N.S.), the Shur-Gain Division of Maple Leaf Foods which operates facilities in all three provinces (Summerside, P.E.I., Sussex, N.B., Truro and Port Williams, N.S.), as well as locally-owned independent feed mills such as Phillips Feed Services (Charlottetown), Cardigan Feed Services (Cardigan, P.E.I.), Clarence Farm Services (Truro), William A. Flemming (Truro), G&D Ward and Sons (Centreville, N.S.), Grand Falls Milling (Grand Falls, N.B.), Taylors Feeds and Tires (Centreville, N.B.), Distribution Rémi Corriveau (Clair, N.B.) and many smaller mills throughout the region.

2.5 Intra-Regional Grain Movement

The majority of grain sold off-farm travels a relatively short distance to the point of final consumption. However, because grain and livestock production are not uniformly distributed, some grain does move significant distances.

In New Brunswick, for example, most of the grain production occurs in the potato growing area of the upper St. John River Valley, between Florenceville and Grand Falls. Much of the grain grown in this region is trucked to the feed milling centers of Sussex and Moncton in southeastern New Brunswick at costs ranging from 11 to 20 dollars per tonne. Similarly, in Prince Edward Island, some of the grain produced in the potato-growing regions in the eastern (Souris) and western parts (Emsdale and Tignish) of the province is eventually transported to the central part where livestock production is more heavily concentrated. In the case of P.E.I., however, some of the barley production also moves to the feed milling centers in Nova Scotia and New Brunswick.

To illustrate the nature of the intra-regional shipments of grain, movements in excess of 500 tonnes for given origins and destinations were analyzed for crop year 1992-93. In the case of New Brunswick, just under eight thousand tonnes produced in the upper St. John River Valley were found to have moved directly to Southern New Brunswick as a first transaction. Most of an additional 4,252 tonnes showing Florenceville and Hartland as primary destinations would eventually have moved to Southern New Brunswick as well.

The origin and destination of some 25,611 tonnes were analyzed as a sample of major movements within P.E.I. in the crop year 1992-93. Just over half of that total was recorded as first transaction receipts at the three sites of the P.E.I. Elevator Corporation. This grain would eventually have moved to milling centres such as Summerside, Charlottetown and Cardigan, in addition to the grain delivered directly to those locations. These data account for 43% of total FFA transactions of local grain in P.E.I. for the crop year in question.

The volume of grain and the distances moved are generally lower in Nova Scotia than in the two other provinces, because most of the production activity is concentrated in the Annapolis Valley. Nevertheless, some transactions involving grain produced in Northern Nova Scotia, as well as that from Prince Edward Island and New Brunswick, occur in centres such as Truro, Scotsburn and Antigonish. A complete breakdown of Feed Freight Assisted shipments of feed grains by province of origin and destination may be found in Appendix Tables G, H and I for each of the crop years reviewed.

2.6 Factors Affecting Price Levels and Relationships

As a grain-deficit region, it may be expected that grain prices within the Maritimes are related to one another through the common denominator of an external price representing a major source of supply. In the case of the Maritime Provinces, Western Canada is the principal alternate source of supply. Therefore, the common denominator is the price for wheat, oats and barley generated through trading on the Winnipeg Commodity Exchange (WCE) basis in-store Thunder Bay. More specifically, the use of the WCE prices plus transfer costs net of FFA, to generate the landed cost of these grains in the Maritime Provinces, should provide a fairly uniform reference price for all locations in the region. Unfortunately during the period under review, it was impossible to determine an accurate estimate of the landed cost of western grains and Ontario corn due to the existence of confidential rail rates. According to the comparison presented in Appendix Table L, it is likely that any estimate based on published freight rates during this period would overestimate equivalent landed cost by 10 to 20 dollars per tonne in most cases.

The annual weighted averages of grain prices in each of the three Maritime Provinces are summarized in Table 2 by type of grain for crop years 1991-92 to 1993-94. These data reveal substantial differences in price levels among the three provinces, with Nova Scotia generally the highest, except in the case of corn. There is relatively little consistency in the magnitude of these differences through time; prices in P.E.I., for example, are sometimes higher and sometimes lower than those in New Brunswick. To trace the dynamics of these patterns, quarterly prices for local wheat, oats and barley in each of the three provinces along with those at Thunder Bay and Chatham are shown in Figures 7 through 10 for crop years

TABLE 2: **Annual Weighted Average of Feed Grain Prices,** Crop Years 1991-92 to 1993-94

Grain[13]	Crop year	Prince Edward Island	Nova Scotia [14]	New Brunswick
Barley	**1991-92**	$110.76	$126.89	$104.52
	1992-93	$111.02	$115.01	$100.30
	1993-94	$101.96	$114.20	$105.07
Oats	**1991-92**	$110.00	$142.91	$119.27
	1992-93	$114.89	$ 93.38	$102.21
	1993-94	$100.22	$102.34	$104.82
Feed wheat	**1991-92**	$120.68	$131.80	$110.43
	1992-93	$115.77	$112.14	$110.45
	1993-94	$109.25	$121.37	$119.21
Mixed grain	**1991-92**	$114.44		$106.14
	1992-93	$105.18	$82.50	$98.84
	1993-94	$99.66	$91.12	$87.11
Corn	**1991-92**	$150.00	$148.70	
	1992-93	$143.31	$127.54	
	1993-94	$151.28	$140.02	$117.01

Source: Agriculture and Agri-Food Canada, Livestock Feed Bureau, FFA claims data.

[13] No price adjustments for farm gate basis and transportation costs have been made.

[14] Nova Scotia Grain Marketing Board is not included for crop year 1991-92 because it was unavailable.

FIGURE 7:

QUARTERLY AVERAGES OF BARLEY PRICES IN THE MARITIMES AND THUNDER BAY

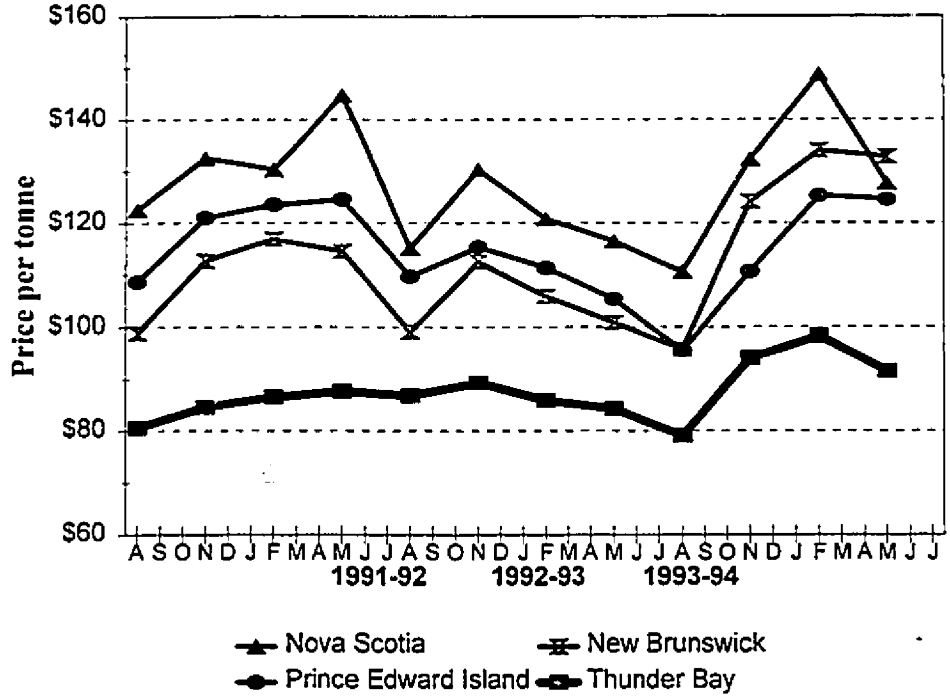


FIGURE 8:

QUARTERLY AVERAGES OF WHEAT PRICES IN THE MARITIMES AND THUNDER BAY

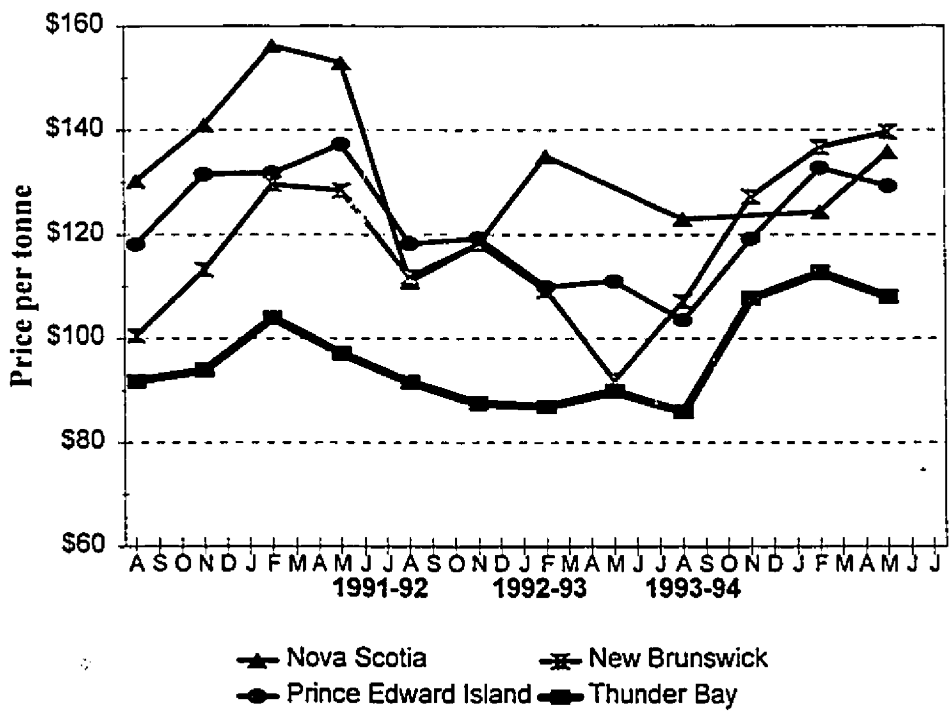


FIGURE 9:

QUARTERLY AVERAGES OF OATS PRICES IN THE MARITIMES AND THUNDER BAY

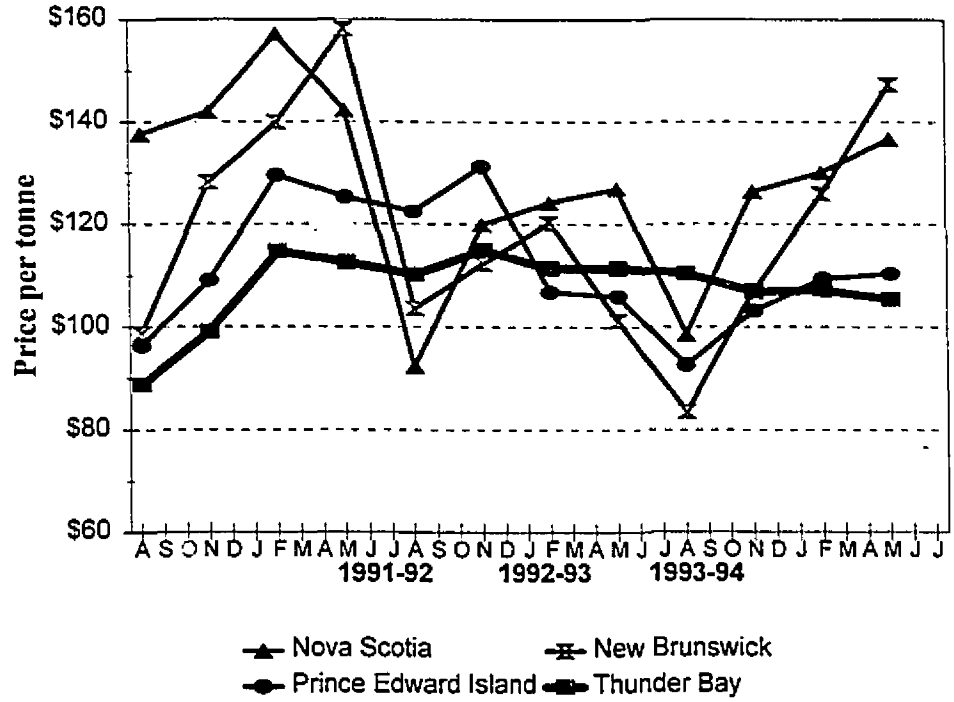
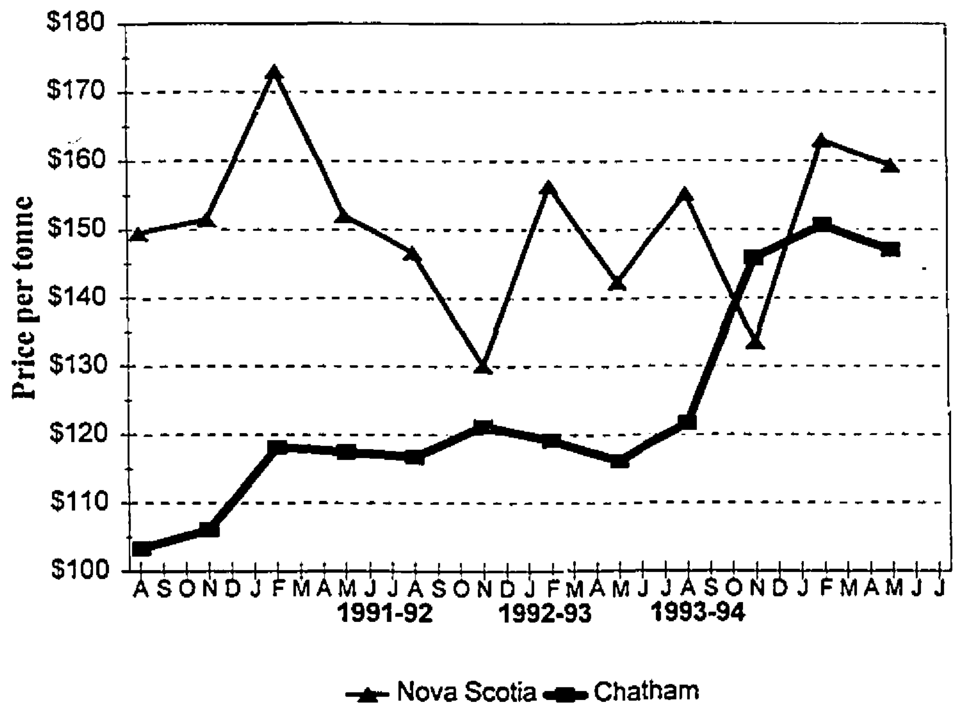


FIGURE 10:

QUARTERLY AVERAGES OF CORN PRICES IN NOVA SCOTIA AND CHATHAM



through 1993-94.[15] 1991-92

From these observations, it is obvious that other factors are at work to modify expected grain price patterns within the region. As may be noted in the above-mentioned figures, local grain prices were much less stable than those in Thunder Bay and Chatham during this period. Some of the factors affecting these relationships are discussed below.

2.6.1 Transportation and handling costs

One of the factors which affects feed grain prices within the region is local transportation and handling costs. As suggested earlier, some of the local grain moves substantial distances (300 to 400 kilometres, respectively, from Northern New Brunswick and Prince Edward Island), at trucking-costs of up to $20 per tonne. This contributes to the lower prices often found in N.B. and P.E.I.. In addition, even where costs are less, the "raw" price reported depends upon the basis on which the grain is bought or sold.

A distinction must be made, therefore, between farm gate and delivered prices. Most transactions occur on a delivered price basis, rather than at a farm-gate price. Over the past three crop years, almost 19,000 out of 25,000 transactions involved the producers bringing the feed grain directly to the feed mill or the elevator with their own truck. Prices on these transactions may be adjusted in order to accurately reflect the farm gate price. Of the remaining 6,000 transactions, approximately 4,500 consisted of grain picked up by the buyer (feed mill) and 1,500 were transferred by a third party with the transfer costs (trucking and handling costs) billed to the buyer of the grain. As will be seen in the next chapter, a

[15] Figures 7, 8, 9 and 10 present a price comparison between the in-store cash price at Thunder Bay or Chatham and the provincial weighted average price in the Maritimes as recorded in the FFA database.

procedure has been developed within the data collection and preparation section to insure that all transactions were on a comparable farm gate basis.

2.6.2 Government policies

There is no doubt that federal and provincial policies have considerable influence on prices of feed grains in the region. First, with regard to federal policies, Feed Freight Assistance (FFA)[16] has two general effects. One of these is to reduce the differential in Western grain prices between Thunder Bay and the Maritimes, subsidizing part of the transfer costs. The other effect is a tendency to equalize the delivered cost of Western grain among locations within the region by virtue of a differential subsidy rate structure related to transfer costs. In New Brunswick, for example, the FFA subsidy ranges from $10.80 per tonne near rail delivery points in Northern N.B., increasing to $19.80 per tonne in the main consumption areas to the south, east and west, and ultimately to $28.80 for Grand Manan Island. In Nova Scotia, the FFA rate structure is lowest in the Halifax area at $7.20 per tonne (based on water transport), increasing in all directions from that point to a range of $12.60 to $19.80 per tonne in the Annapolis Valley and central Nova Scotia and a maximum of $27.00 per tonne at certain points in Cape Breton. All Prince Edward Island locations have the same rate of $23.22 per tonne (Livestock Feed Bureau, 1994).

One manner in which the impact of the FFA program on the Maritime region can be

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[16] A major modification occurred in August 1984 when all domestic feed grains were rendered eligible for FFA, provided they had been commercially marketed within the eligible deficit feed grain regions (Livestock Feed Board of Canada, Annual Report 1984-85). The purpose of the policy change was to develop a competitive grain and livestock industry in the Atlantic provinces and British Columbia. Prince Edward Island benefited the most from this modification because it was, and still is, the most important grain producer in the Maritime region. As a result, total FFA subsidy paid out in P.E.I. increased by more than 60%, from $470,432 for crop year 1983-84 to $754,777 in crop year 1984-85. Since that time, local production has been increasing constantly and FFA payments rose to $1,824,786 for crop year 1993-94 (LFBC, Annual Report 1984-85 and LFB, 1994).

visualized is to think in terms of "price surfaces". The first effect is that the FFA program reduces the price spread between the origins, the Prairies or Ontario, and the final destinations within the FFA eligible regions. This reduces the premium in prices in the FFA eligible regions vis-a-vis the origin, which would normally reflect full transfer costs, by the amount of the subsidy. As the subsidy levels are set on a graduated basis to equalize net freight costs within the FFA eligible regions to the net freight cost in the immediately adjacent non-eligible zones, this results in a flat price surface for eligible grains shipped into the region. The landed cost of these grains is equalized throughout the region.

As the FFA rate structure is based on the transfer costs into the region, this flat price surface for non-local eligible grains does not reflect the actual transfer costs within the region. The price surface for local grains moving within the region must reflect intra-regional transfer costs from various origins to the point of final consumption. As local grains are in direct competition with non-local grain, the local grain price surface tends to be equal to the landed cost of non-local grain minus the intra-regional transfer costs, plus the applicable FFA at the final destination. For example, local grain moving from P.E.I to Nova Scotia would need to be discounted from the landed cost of non-local grain by the amount of the P.E.I. - Nova Scotia transfer costs minus the FFA applicable at the Nova Scotia final destination.

As noted above, the FFA rate differentials between points in the Maritimes do not reflect the cost of moving grain within the region. This is not an issue for grain consumed in the area where it is produced, as commercial sales of local grain qualify for the FFA subsidy rate at that location. If the grain is moved to a higher rate zone, such as from Grand Falls ($12.60) to Moncton ($14.40) or Sussex ($16.20), it qualifies for an additional subsidy (furtherance) to adjust to the higher rate in the destination zone. The furtherance payments, however, do not cover the additional costs of trucking the local grain to the higher rate zones.

For grain moving from a higher rate zone such as P.E.I. ($23.22), to a lower rate zone such as Moncton ($14.40), not only is the transportation cost not covered, but the FFA rate differential ($8.22 per tonne in this case) must be rebated in the event that the subsidy had already been paid at the P.E.I. rate. As the volume of grain shipped off P.E.I. increases, this would be expected to have a depressing effect on grain prices in P.E.I. relative to Nova Scotia and New Brunswick. This could be one of the factors contributing to relatively lower prices for barley in P.E.I., compared to N.S. (Livestock Feed Bureau, 1994).

The second category of government policies affecting local grain prices is the marketing policies and the institutions of the respective provincial governments. Beginning with P.E.I., the government-owned P.E.I. Elevator Corporation, which operates three elevator facilities and handles an estimated one-third of all commercial sales of local grain, undoubtedly has an important effect on grain prices in that province. On the one hand, as a grain treatment and handling facility, the Corporation offers an alternative outlet to other commercial buyers such as feed mills. On the other hand, as a marketing agent that must recover its costs through sales to other commercial buyers, it adds an element of marketing cost that could have a depressing effect on local grain prices, depending on pricing policies followed.

The pricing policy of the P.E.I. Elevator Corporation has varied over the years. For the two first years of the period considered in this analysis, the Corporation paid a cash price to producers and claimed FFA as a buyer. Beginning in 1993-94, the Corporation became a price pooling agent, paying producers an initial price equivalent to 80 percent of the estimated final value of the grain and a final payment, if any, after deducting marketing costs from final sales revenues. The Corporation no longer claims FFA, leaving that role to other buyers. As seen earlier in Figures 7 to 9, P.E.I. grain prices to producers exceed the Thunder

Bay in-store price by less the estimated net transfer cost for Western grains, and sometimes fall below the Thunder Bay price for oats.

A similar pattern may be observed in New Brunswick, where the producer association known as Valley Grain Pool Inc. has operated as a price-pooling marketing agent for the period under review. Using facilities owned by the former N.B. Grain Commission, Valley Grain Pool is believed to account for approximately 20 percent of commercial sales of local grain in New Brunswick.

In Nova Scotia, on the other hand, where the Provincial Grain Commission handles an estimated 12 to 15 percent of commercial sales, grain prices are closer to, and occasionally higher than, the probable landed cost of Western grains. This reflects the policy of the Commission to pay producers a final price approximately equivalent to the landed cost of Western grain. The Commission then attempts to recover their marketing costs from local buyers. Their ability to follow this practice may be related to operating in a distinctly grain-deficit province, with no surplus sub-regions to bring down the provincial average prices. In addition, being a small throughput facility, the Commission is able to target a clientele of specialized users apparently willing to pay a premium for the service they provide.[17] This practice is also supported by a similar policy of the Nova Scotia Grain Marketing Board which is a producer organization.

Other policies that may have some impact on overall grain price levels within the region could include the GRIP and NISA programs and any others that may affect the level of production and sales of local grains. Since any such effects are likely to be more uniform across the region, they are not examined in detail in this thesis.

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[17] Personal communication with Roy Quartermain, Nova Scotia Grain and Forage Commission, August 1994.

2.6.3 New policy directions

Near the point of completion of this thesis, new agricultural policy directions were indicated by the federal Minister of Finance in his 1995 budget. As a result of that budget, the Western Grain Transportation Act (WGTA) will be cancelled as of August 1995. Moreover, the FFA subsidies will be discontinued during the federal fiscal year 1995-96 and, over a period of ten years, a declining balance of the current subsidy will be transferred to feed deficit regions such as the Atlantic Provinces. These and other changes in government policy directions will certainly have an impact on price of local grains in the Maritimes.

2.6.4 Local market conditions

One of the factors which may influence regional price relationships is variations in local supply and demand conditions. As suggested earlier, for example, changes in production levels would certainly be a factor in Prince Edward Island, as that province approaches self-sufficiency or surplus conditions for certain grains. This is likely a contributing factor to the greater differences between corn and barley prices in P.E.I. relative to mainland locations, for example. The sensitivity of provincial average prices to changes in local production levels will be analyzed in more detail in a later section.

On the demand side, variations in the competitive structure of the formula feed industry could contribute to differences in the intensity of demand. For the region as a whole, the feed manufacturing industry is concentrated among relatively few firms, one of which is Co-op Atlantic or its member co-operatives. However, the degree of concentration and role played by producer-owned co-operatives in the feed industry varies among locations within the region. It would appear, for example, that the competitive structure of the industry may be more intense at Truro and the Annapolis Valley in Nova Scotia where several firms are located at other locations in the Maritimes. This could be a contributing factor to higher prices for local feed grains in Nova Scotia than in the other two provinces, along with the fact that N.S. is less self-sufficient in grain production.

Another element that may affect regional price relationships is the matter of quality differences. This issue is often expressed by buyers as a reason for discounting local grains relative to those from Western Canada. It is argued, for example, that the lower protein content of local grains, associated with fertilization levels and other management practices of producers who grow grain only as a rotation crop require the addition of more expensive supplements in feed formulation. Protein levels may also be affected by climatic conditions.

Variations in quality across numerous small lots of local grain may also require more frequent adjustments in feed formulations, which add to the cost of feed manufacturing operations. This supports the arguments for the involvement of provincially operated grain handling facilities, which aim for a greater standardization of grain quality through grading, drying and blending of the grain they handle. A statistical evaluation of such data as are available in terms of grade and moisture content of individual transactions is summarized in Table 3, by province and type of grain, for average of crop years 1991-92 to 1993-94.

With regard to the contents Table 3, a few brief comments are in order:

(a) In terms of grade, barley appears to be of higher and more consistent quality than oats, wheat or corn, averaging close to a number one grade;

(b) Moisture content of all grains is variable from one transaction to another, and tends to be on the high side for top quality.

(c) It appears that grade and moisture content have some degree of influence on pricing of local feed grains and therefore must be taken into account in the pricing efficiency analysis.

TABLE 3: Statistical Measures of Selected Quality Aspects of Local Grains
Average of Crop years 1991-1992 to 1993-94

Province and type of grain	Number of transactions	GRADE Mean	GRADE St. Dev.	GRADE C.V.	MOISTURE CONTENT Mean	MOISTURE CONTENT St. Dev.	MOISTURE CONTENT C.V.
NEW BRUNSWICK							
Barley	1,118	1.18	0.41	35%	14.02	1.69	12%
Oats	351	2.50	1.12	45%	13.38	1.79	13%
Wheat	160	1.89	0.87	46%	14.21	2.00	14%
NOVA SCOTIA							
Barley	268	1.25	0.46	37%	15.91	2.91	18%
Oats	228	2.41	0.93	39%	14.67	2.61	18%
Wheat	102	1.49	0.66	44%	16.71	2.45	15%
Corn	146	2.62	1.35	52%	26.01	6.64	26%
PRINCE EDWARD ISLAND							
Barley	4,290	1.17	0.40	34%	15.27	2.74	11%
Oats	434	2.33	1.11	48%	14.01	1.18	8%
Wheat	604	1.45	0.67	46%	14.77	1.91	13%
Mixed grain	1,001	3.95	0.30	8%	14.14	1.12	8%

The coefficient of variation (C.V.) is equal to the standard deviation (St. Dev.) divided by the mean.

For example, Thunder Bay grade differentials have 2 CW barley trading at a two dollar per tonne discount to 1 CW, Canada Feed Wheat at five dollars discount to 3 CWRS, and 3 CW oats at two dollars discount to 1 CW and 2 CW (Winnipeg Commodity Exchange, 1994). For example, Thunder Bay grade differentials have 2 CW barley trading at a two dollar per tonne discount to 1 CW, Canada Feed Wheat at five dollars discount to 3 CWRS, and 3 CW oats at two dollars discount to 1 CW and 2 CW (Winnipeg Commodity Exchange, 1994). Therefore, it appears to be important to account for grain quality on a monthly basis in the tests for commodity arbitrage and LOP tests.

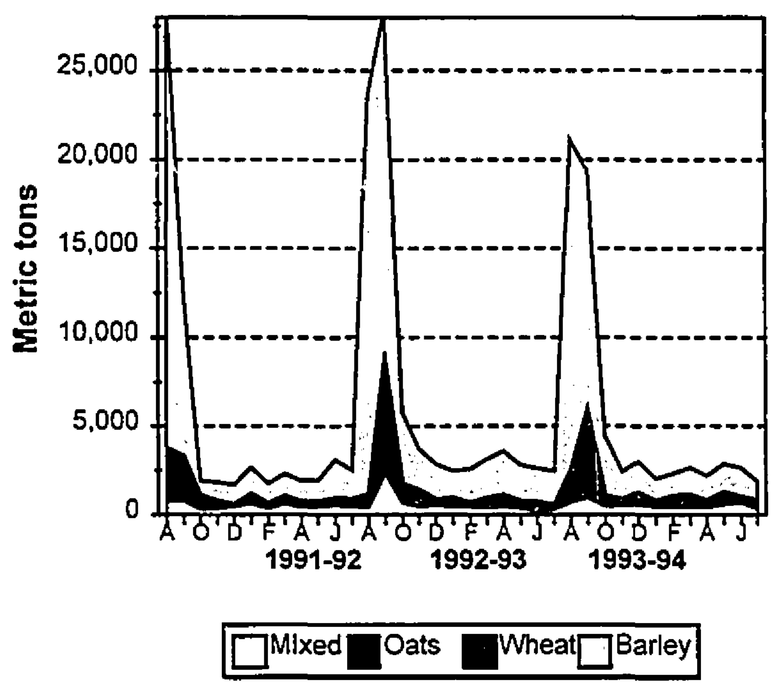
The seasonality of local grain marketing may contribute to variations in price relationships by putting more pressure on the system in certain periods than in others.

An analysis of monthly sales of local grain reveals a distinct pattern of heavy concentration of such sales in the harvest period of August through September in most cases. An example of this pattern is illustrated in Figure 11 for the province of P.E.I..

FIGURE 11

MONTHLY SALES OF GRAIN IN P.E.I.

Crop years 1991-92, 1992-93, 1993-94



Source: FFA claims, Livestock Feed Bureau, 1991-92 through 1993-94.

2.7 Supply and Demand Analysis of the Maritime Grain Market

The following section compares theoretical models for two completely different markets in terms of local self-sufficiency within the Maritime provinces: first, the market for barley in Prince Edward Island as a case of local over-production and the market for barley in Nova Scotia[18] as a representative case for small amount of locally produced feed grain relative to imports.

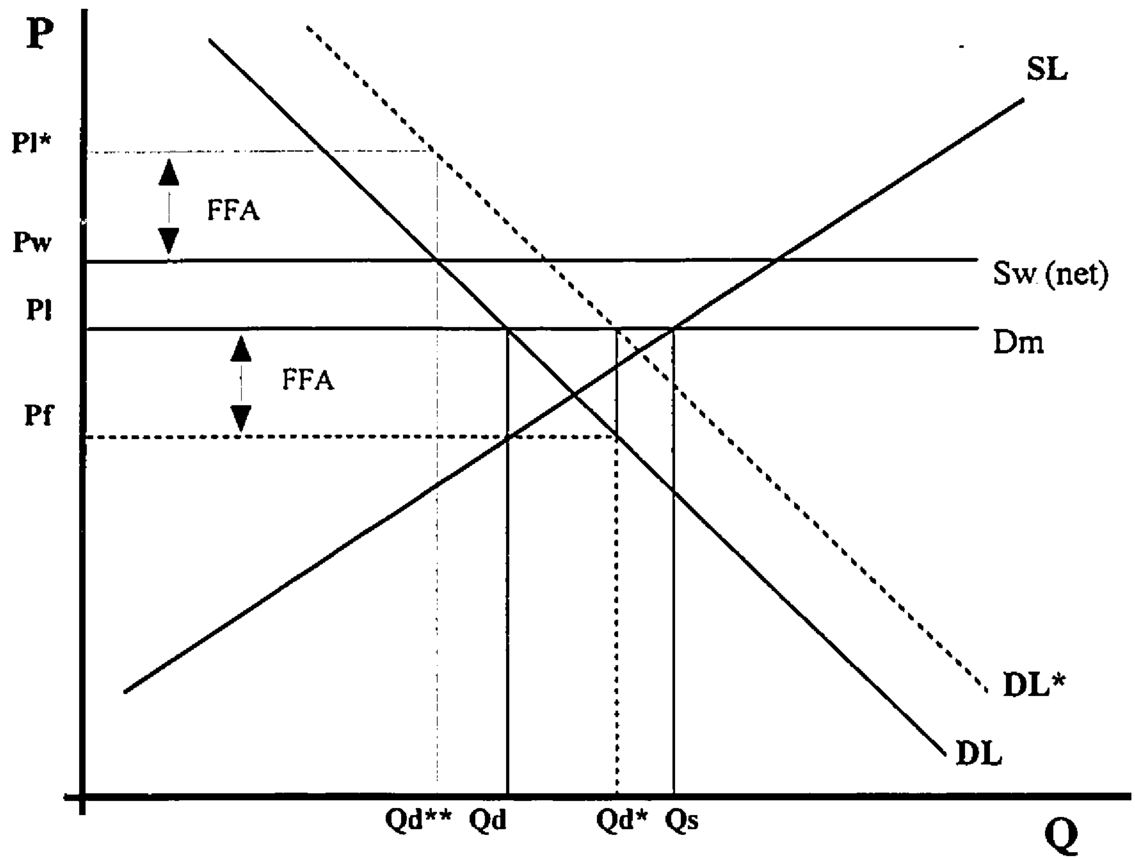
2.7.1 Supply and demand for P.E.I. barley

As discussed earlier, Prince Edward Island is almost self-sufficient in overall feed grain requirements. While the province is deficit in wheat and corn, there is apparently an overproduction of barley and oats. According to FFA shipment data this surplus reached 32 percent for oats and 22 percent for barley in 1993-94, (Coffin and Froment, 1995, Table 8). The total of that surplus was moved to N.B. and N.S..

In order to visualize the impact on local prices, Figure 12 shows a demand and supply analysis for the barley market in P.E.I. and its relation to Western grains. Given that the FFA subsidy applies to local grains, it is assumed that barley users are indifferent between local and Western grains of equivalent quality (grade and protein content). Since P.E.I. is in a grain deficit region, it is assumed that P.E.I. barley producers face a perfectly elastic demand on the mainland. Moreover, with reference to Figure 12, it is assumed that the supply of Western (Sw) grain is perfectly elastic at price (Pw) net of FFA subsidy. Since P.E.I. is more than self-sufficient in barley, the local demand (DL) is assumed to be less than supply at both

[18] It is only a representative crop for limited local production. It could be any feed grain crop in any of the Maritime Provinces, except for barley and oats in P.E.I..

FIGURE 12: Supply and Demand of Barley in Prince Edward Island



the net price of western barley (Pw) and the price of local barley (Pl) to compete on mainland markets, the difference reflecting the cost of transportation to those markets minus the FFA at destination. The presence of the FFA subsidy on local grains moves the demand for local barley from (DL) to (DL*) and reflects the rebate available to the buyer of local grain. As a result, only the quantity supplied (Qs) minus the quantity of local demand (Qd*) is shipped off the Island. In other words, given the surplus position, P.E.I. grain producers receive the price Pl. By construction, the users are able to capture the full amount of the FFA (Pl minus Pf) which induces them to buy the additional quantity (Qd* minus Qd). However, to the extent that (Pl) reflects the FFA at final destination, that part of the FFA benefit is captured by grain producers. To the extent that FFA at origin exceeds FFA at final destination, that part of the FFA is captured by grain users. In contrast, in a short supply situation, with output less than or equal to Qd**, the situation is reversed. In theory, the price of local grain being based on the landed cost of Western grain on the Island, local buyers are willing to pay (Pl*) to local grain producers before claiming the FFA subsidy (Pl* minus Pw).

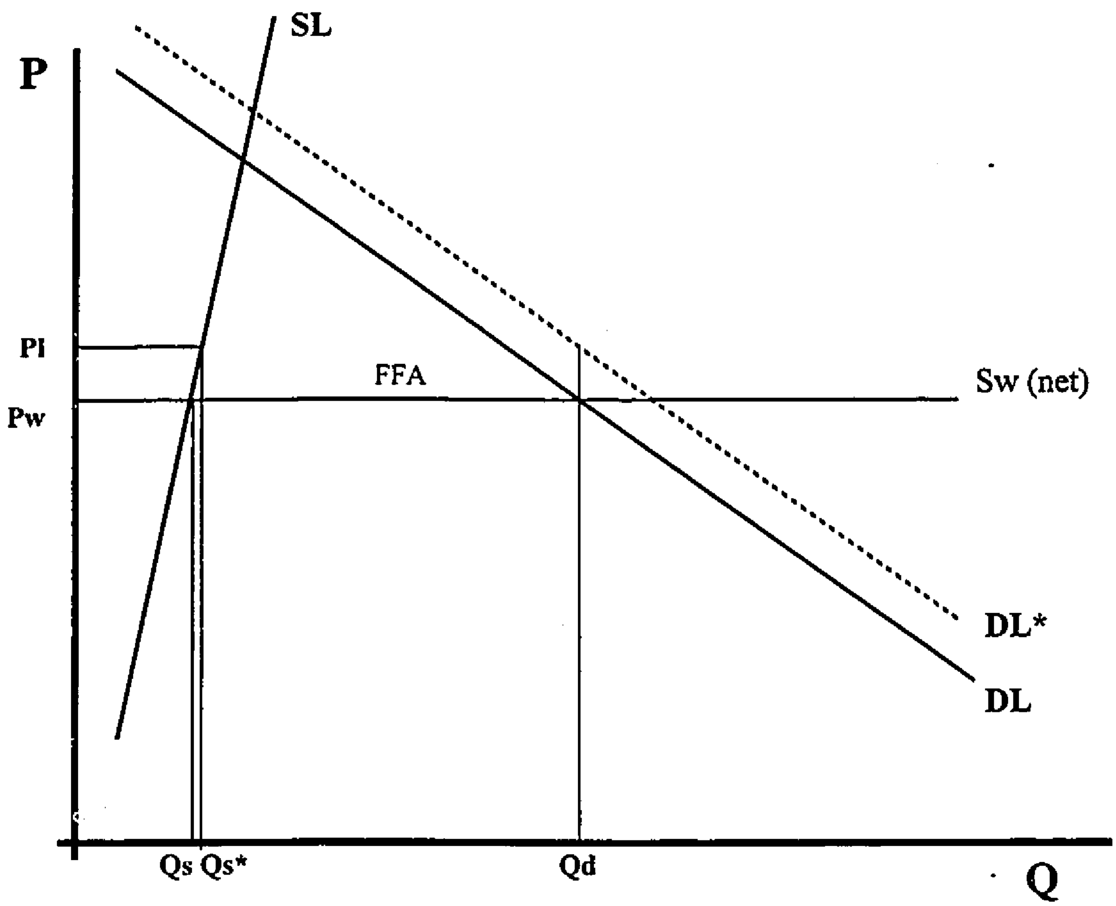
2.7.2 Supply and demand for N.S. barley

In this section, the supply and demand analysis of Nova Scotia wheat is presented as a representative case for those feed grain markets in the Maritimes that reflects pure deficit conditions.[19] The major difference between this and the previous case is the relative position of the supply curve for local grain.

Figure 13 shows that the supply of barley in N.S. (SL) is to the left of the intersection between demand (DL) and the supply of Western grain (Sw). In this context, and assuming as before that buyers are indifferent between local and Western grains (i.e. they are perfect substitutes), local grain producers should be able to capture FFA subsidy on local grains which induces an increase of local production from (Qs) to (Qs*). This implies that local buyers are willing to pay a premium for local grains (Pl) equivalent to the FFA subsidy (i.e. the vertical difference between (DL) and (DL*)) which they would then claim from the Livestock Feed Bureau in order to have local grain at the same net cost as Western grain. Grain producers would therefore produce (Qs) and the quantity (Qd) minus (Qs) would be supplied from external sources to satisfy total demand.

[19] In essence, this reflects all situations except barley and oats in P.E.I. and the region of Grand Falls in N.B..

FIGURE 13: Supply and Demand of Barley in Nova Scotia



Hence, in theory at least, grain producers should be able to capture the FFA subsidy in grain deficit provinces while grain users capture it in the case of grain surplus areas such as barley in P.E.I.. In practice, in both cases, the subsidy is likely to be shared between buyer and seller, reflecting factors such as the competitive structure of the market, the level of market information available, the adequacy of storage space at peak season, etc..

CHAPTER THREE: LITERATURE REVIEW AND METHODOLOGY

3.1 Introduction

This chapter will review the literature on empirical analysis relevant to the present study and will introduce the methodology and the theoretical framework utilized. Chapter three will also present the approaches that are employed to carry out the hypothesis of the thesis.

Following the introduction, the chapter is divided into three major sections. Section 3.2 is devoted to a review of the literature on the law of one price followed by the specification of the models. Section 3.3 includes discussion on the symmetry of price transmission as a test for market power. Finally, section 3.4 deals with pricing efficiency and the dynamics of price adjustments. Vector autoregression (VAR) models are presented as vector error correction (VEC) models. A review of the literature on VAR analysis is also presented.

3.2 The Law of One Price

3.2.1 Review of literature

Over the past few decades, economists have devoted considerable effort towards explaining the principles of international trade. International economics explain how a number of distinct economies interact with one another, while allocating scarce resources to satisfy human wants. The origins of these theories can be found in the beginning of the nineteenth century in the basic foundations of the laws of absolute and comparative advantage formulated from the work of Adam Smith and David Ricardo (Smith, 1937). From their seminal essays followed many other related concepts from which the law of one price emerged.

The principle of the "law of one price" (LOP) is typically used as a reference measure to verify the price relationships of internationally traded commodities. From that perspective, it can be seen as an essential constituent of international trade theory and exchange rate determination. According to Chachioliades (1990), the LOP holds for a commodity when that "commodity commands the same price everywhere" (p.88). An important extension is that the LOP also holds for goods that are traded between provinces or different regions in a given country, with adjustments for transfer costs.

As suggested by Rhodus et al. (1989), "prices in a competitive market equate marginal and average revenues with marginal and average costs, thus directing production and allocating resources" (p. 875). Departures from these market conditions result in a noncompetitive situation and may lead to inaccurate prices. When monopolistic and oligopolistic market structures are ruled out, perfect competition is assumed to hold. Consequently, a close parallel can be seen between economic agents and trading areas. In a perfectly competitive domestic market, all buyers and sellers of a commodity or a factor are price takers: that is, each one of them is too small to individually exert any appreciable influence on the price. Similar results can be observed with nations or regions that are exchanging products with each other. Perfect competitors are also completely informed about the prices that prevail in all parts of the market with the result that the same price holds everywhere (Baffes, 1991). In addition, as Chacholiades (1990) noted, "the prices are determined by supply and demand; in the long run, commodity prices are equal to their respective costs of production" (p.88).

Assuming that transportation costs are non-existent, the elementary theory of Isard

(1977) asserts that "perfect commodity arbitrage insures that each good is uniformly priced (in common currency units) throughout the world" (p.942). In other words, the world price that is based on the major suppliers of an agricultural commodity should be reflected in all small producing areas. For example, if the exchange rate is R, P_a and P_b are the prices of goods a and b in a small regional market and P_a^* and P_b^* are the respective prices in a large producing area. With the unrealistic supposition that there is no transportation costs, tariffs, or other barriers to trade, commodity arbitrage establishes that $P_a=RP^*_a$ and $P_b=RP^*_b$. Furthermore, in the pure theory of international trade, the law of one price will hold solely for the products that are tradable, perfectly homogeneous and where there is absence of market failure. Therefore, as suggested by Carter et al. (1990), in the presence of perfect commodity arbitrage, the price of the same good in two locations will differ only by the transfer costs in moving the commodity between the two markets.

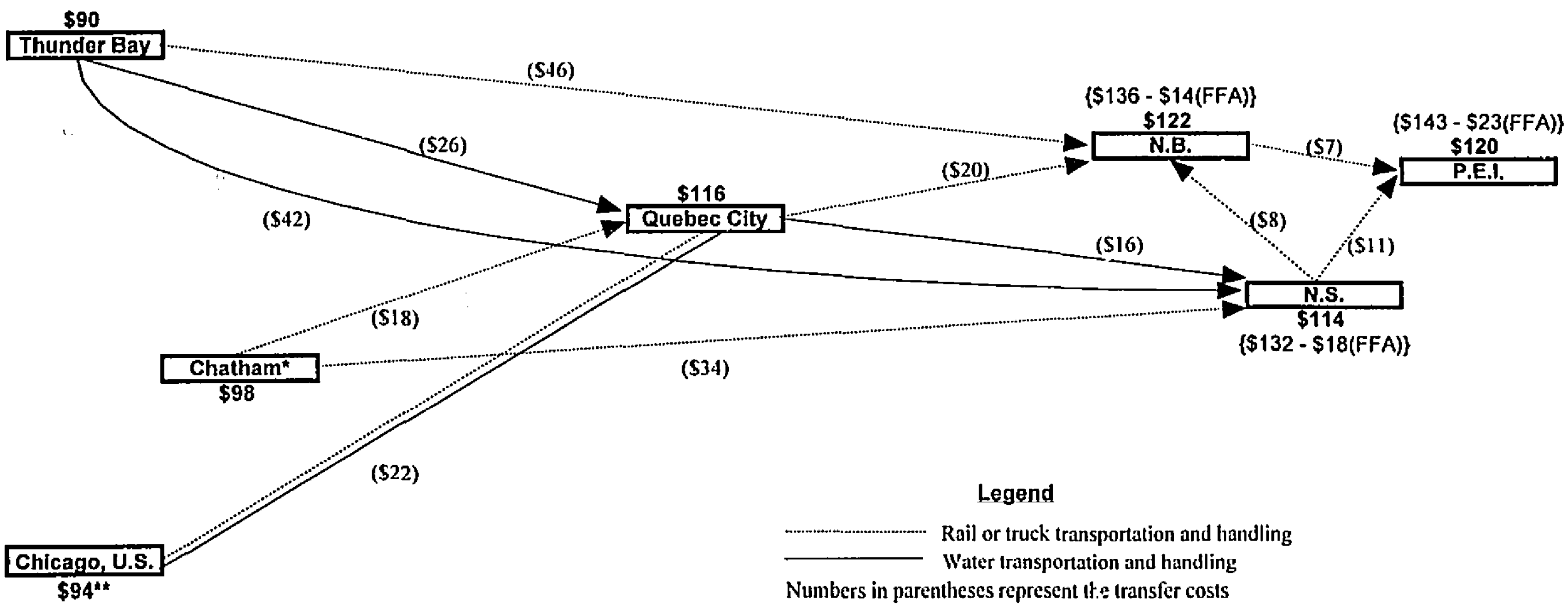
Figure 14 shows a hypothetical example of what perfect commodity arbitrage might represent in the context of feed grain price discovery in the Maritimes in relation to the major Canadian markets for feed grains. An important feature of this diagram is that feed grains are strictly moving in the direction indicated by the arrows (from west to east). In Figure 14, Thunder Bay, Chatham and Chicago represent feed grain surplus regions and reflect world market conditions while the three Maritime Provinces are depicted as deficit regions. The most important characteristic of this flow chart is that the lowest cost source (Thunder Bay, for example) determines the price prevailing in each deficit market. Given the price of feed grain in Thunder Bay plus the transfer costs, Maritime grain prices should be relatively easy to predict if the law of one price holds. Under the hypotheses, the prices of two integrated markets can differ only temporarily by more than transfer cost. Jain (1980) argues that ephemeral price differences arise from a lead or a lag in receiving information.

Other related concepts such as basing point systems and purchasing power parity

FIGURE 14

Hypothetical Example of Feed Grain Flows, Transfer Costs and Prices: Movement from External Sources to the Maritimes

(Price per metric ton)



* For the present purpose, Ontario is considered to be in a grain surplus position. If Ontario were in a deficit position, there would be grain movement from Chicago to Chatham.

** In Canadian currency, due to inegibility for FFA, U.S. grain would not move past Quebec City.

Source: Adapted from Tomek and Robinson, 1990.

(PPP)[20] are not examined in this thesis since they relate more to exchange rates and international trade.[21] Obviously, due to the scope of the present study, there is no need to include purchasing power parity and exchange rate considerations since we are dealing with internal markets only.[22] There are other important differences between international and interregional trade as well. When regions such as the Canadian Prairies and the Atlantic provinces engage in trade, they are not restricted by tariffs and problems such as dumping are almost non-existent. On the other hand, the case of non-tariff barriers such as quotas is very different. Haack et al. (1981) argue that impediments to interprovincial trade in food and agricultural products are extensive in Canada.[23] On the one hand, they pointed out examples of barriers to interprovincial trade such as Feed Freight Assistance rate distribution, Crow Rate Benefits, truck regulation, etc... within the Maritimes, for example. On the other hand, these subsidies can be viewed as trade facilitators between the Prairies and the Maritimes by reducing the transport cost barrier.

In a less than perfect world, most of the authors reviewed have shown that the law

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[20] In a simple one commodity world, purchasing power parity and the law of one price are equivalent. However in the real world of multiple commodity markets, there exists a difference between the two theories. As Aizenman (1984) demonstrated, even in the extreme case where LOP holds for every good, differences in consumption baskets across regions may cause a change in relative prices which can lead to deviations in PPP.

[21] Purchasing power parity is said to exist when the exchange rate (R) is proportional to the ratio of prices levels in the two regions. Ardeni (1989) affirmed that the PPP is a generalization of the LOP, whereas Officer (1986) suggested instead that it is a weighted average of all commodity prices in a country. According to the PPP theory, changes in relative price levels cause exchange rates to move, whereas according to the LOP, changes in exchange rates induce prices to shift. (Jain, 1980) For example, if LOP holds, a depreciation of the Canadian dollar compared to the U.S. currency would cause Canadian commodity prices to increase by the full extent of the exchange rate change (Carter and Hamilton, 1989) while in presence of PPP the inverse situation should occur.

[22] Although Chicago (U.S. corn) appears in Figure 14 as an external market and has a dominant influence on the Canadian corn market at Chatham, as well as on Western grains at Thunder Bay, it is not a direct source of supply to the Maritimes because U.S. corn is not eligible for FFA.

[23] Haack et al. (1981) assert that a lack of uniformity in government policies are likely to have a negative impact on resource allocation by creating artificial advantages or disadvantages in one region over others.

of one price is rejected more often than accepted. Many explanations have been advanced to justify that assertion. Crouhy-Veyrac et al. (1982) found the LOP to be true 11 times out of 46 in testing markets for different products. Generally, it seems that the LOP holds more often for primary products than for more sophisticated or processed commodities. This justifies the assumption that the LOP holds in particular for agricultural products and is less valid for other sectors of the economy. This may be due to the fact that primary goods are typically more homogeneous than manufactured or processed products.

Most of the empirical literature associates the failure of the law of one price with the omission of transfer costs in the long run, while short run deviations could be attributed to poor information about prices or sharp variations in transfer costs (Ardeni, 1989), (Crouhy-Veyrac et al., 1982), (Baffes, 1991) and (Richardson, 1978). Moreover, Baffes (1991) adds that the failure of the LOP as a long run relationship is "price-specific" and "time-period-specific" rather than a general failure. In the opinion of Goodwin (1990), these results indicate that the inclusion of the expectations of arbitragers may be of some value when considering the LOP test. Similarity of compared markets seems to be a powerful force in favor of the law of one price.

3.2.2 Specification of LOP models to be utilized

According to the law of one price, Maritime grain prices should differ from those at Thunder Bay or Chatham by a margin consistent with net transportation and handling costs but be highly correlated through time. However, an accurate price estimator will also reflect local market conditions through market-clearing adjustments. In this section, models are developed for feed wheat, oats and barley prices in the Maritimes in relation to those at Thunder Bay and to corn at Chatham.

As observed in the earlier section, the law of one price does not always appear to hold with respect to the relationship between local grains and Western grains. Nevertheless, there is an obvious influence of Western and Central Canadian grain prices on those in the Maritime region. The LOP test will analyze the strength of that influence and the role of other factors in order to determine the strength of Thunder Bay or Chatham prices as predictors of the Maritime market.

Although there is not complete agreement, most empirical tests of the law of one price (LOP) use a model similar to that of Richardson (1978) which is adapted for use in this study. The general form of the models to be tested in this case is as follows:

$$\begin{aligned} LOG\ (MARITIME\_PRICE_t) = \beta_0 &+ \beta_1 LOG\ (CASHPRICE\_TB_t) + \\ &\beta_2 LOG\ (CASHPRICE\_TB_{t-1}) + \\ &\beta_3 LOG\ (CASHPRICE\_TB_{t-2}) + \\ &\beta_4 LOG\ (VOLUME) + \beta_5 LOG\ (TRF\_COST) + \\ &\beta_6 LOG\ (GRADE) + \beta_7 LOG\ (MOISTURE) + \epsilon \end{aligned} \tag{1}$$

where TB stands for the price prevailing in Thunder Bay, TRF_COST is the transfer cost of feed grains from Thunder Bay to each of the Maritime Provinces, VOLUME is the volume of local grain marketed during the period, GRADE and MOISTURE are the average grade and moisture content of the local grain observed during the month and β_0, β_1, β_2, β_3, β_4, β_5, β_6, β_7 are the parameters to be estimated which in this case become elasticities except for β_0.

When the law of one price holds, perfect commodity arbitrage could be verified by the following tests:

(1) LOP in the short run: β_1, $\beta_5 = 1$

(2) LOP in the long run: $\beta_1 + \beta_2 + \beta_3 = 1$ and $\beta_5 = 1$

In theory, a weaker test can be used to verify the complete absence of commodity arbitrage then implying that LOP is far from holding. This test would suggest, by contrast that:

(1) LOP in the short run: $\beta_1, \beta_5 = 0$

(2) LOP in the long run: $\beta_1 + \beta_2 + \beta_3 = 0$ and $\beta_5 = 0$

For commodities that are highly substitutable, commodity arbitrage is evident. In this particular case, each value by estimation of the first three parameters together and the fifth $\{\beta_1 + \beta_2 + \beta_3, \beta_5\}$ should lie close to one. In other words, perfect substitutability of commodities (between Thunder Bay and Maritime feed grain crops) in the long run would be reflected by $\beta_1 + \beta_2 + \beta_3 = 1$, and $\beta_5 = 1$.

Two assumptions were made in the use of data to test the LOP. First, the Maritime provinces were assumed to be price takers for grains. Second, the demand for local feed grains was assumed to be relatively stable throughout the crop year. The supply was captured by total monthly transactions. Nine models were used to test the law of one price: barley in the three provinces; oats and feed wheat in N.B. and P.E.I.; corn in N.S.; and, mixed grain in P.E.I.. The results of the tests on LOP are presented in chapter four.

3.3 Symmetry of Price Transmission

Given the somewhat irregular relationship of response of local feed grain prices to variations at Thunder Bay or Chatham (as presented previously in Figures 7 to 10 of section 2.6), the question arises as to whether or not the response pattern is the same to price <u>decreases</u> as to price <u>increases</u>. In other words, is there a symmetrical pattern of price transmission, such as it may be, from Thunder Bay to local grain prices? One reason for posing this question is the hypothesis that the market power of local grain buyers could explain the weak response to external markets. If those buyers have market power, and exercise it in their own interest, one might expect to see local prices respond more strongly to price decreases at Thunder Bay than to price increases.

This hypothesis is tested in this case by separating week-to-week price changes at Thunder Bay or Chatham into two variables, one representing increases and the other decreases, and performing a regression analysis of the relationships of local price changes to those variables. The model specification presented in Equation 2 is similar to the one of Pick et al. (1990):

$$MARITIME\_PRICE_t = \alpha_0 T + \alpha_1 TB\_UP_t + \alpha_2 TB\_DOWN_t + \epsilon_t \qquad (2)$$

where $MARITIME\_PRICE_t$ is the first difference of local grain prices, T is a time trend, TB_UP_t is the sum of all week-to-week increases in the cash price of in-store grain at Thunder Bay, and TB_DOWN_t is the sum of all week-to-week decreases in the cash price at Thunder Bay. If the Maritime grain price response is symmetric for both price increases and decreases in Thunder Bay prices, one would expect to observe $\alpha_1 = \alpha_2$ which becomes the null hypothesis of the F-test versus the alternatives which suggest that $\alpha_1 > \alpha_2$ or $\alpha_1 < \alpha_2$ providing that the t-test is not rejected.

The method used in this study for testing the symmetry of Maritime grain price movement was first motivated by Houck's (1977) estimation of nonreversible functions. This analysis has been utilized in many other studies in order to test the symmetry of price transmission between the farm and retail level in marketing agricultural products. Ward (1982) examined the linkage among retail, wholesale and shipping points for a group of fresh vegetables. When testing asymmetry in farm-retail price transmission for U.S. dairy products, Kinnucan and Forker (1987) found that retail dairy product prices adjust more rapidly and more fully to increases in the farm price of milk than to decreases. On the contrary, Boyd and Brorsen (1988) showed that wholesale pork prices in the U.S. respond similarly to farm price decreases and increases. The same conclusions were found for retailers' response to wholesale price movement. Hahn (1989) used endogenous switching regressions to examine farm, wholesale and retail price interactions between beef and pork markets in the U.S.. He found that price movements in both pork and beef tend to be asymmetrical; they increase faster than they decrease. Finally, Pick et al. (1990) analyzed the price asymmetry and marketing margin behavior for California - Arizona citrus. They also found, as expected, that retail prices adjust more fully to increases in main market prices than to decreases.

3.4 Pricing Efficiency and Vector Autoregression Model Specifications

Vector autoregression analysis (VAR) is applied as an analytical technique to determine the nature of the relationship among prices and the dynamics of price adjustment when one or more of the variables or factors is suddenly changed or "shocked". This technique also permits an analysis of the relationships among the prices of different grains (feed wheat, oats, barley, corn and soybeans) within the Maritimes in order to determine how well any one of them might represent the others.

3.4.1 Review of previous studies

One of the main functions of an efficient market is to facilitate and accelerate the flow of information between the buyers and the sellers of a particular commodity. As discussed by Rhodus et al. (1989), "pricing efficiency is analogous to informational efficiency because prices are considered efficient if they accurately and effectively track changes in the supply and demand functions of a dynamic market." (p. 877) In other words, in an efficient market, the price of a given good resulting from the flow of information should be the equilibrium price reflecting supply and demand conditions.

In the case of the present study, pricing efficiency will be assessed by examining the relationships between feed grain prices observed in the Prairies and the grain price paid in a small regional market, the Maritime provinces. Adamowicz et al. (1984) affirmed that an efficient market will quickly reflect price shifts in other associated markets. Not only the issue of whether or not an adjustment occurs but also the speed[24] of price transmission is of great interest in the empirical literature. Goodwin and Schroeder (CJAE, 1991) evaluated the dynamic relationships among international wheat prices for seven trading countries using a VAR model. Babula and Romain (1991) examined Canadian broiler chicken price responses when the U.S. prices shift following the implementation of the national supply management program (Canadian Chicken Marketing Agency) in 1979. For their part, Larue and Babula (1994) tested the dynamic relationships between money supply and food-based prices in Canada and the U.S. with the help of a restricted VAR, a vector error correction (VEC) model.

An important line of inquiry concerns how rapidly traders react to changes in market conditions. "The more rapid the response, the more efficient is the information flow and the pricing mechanism" (Adamowicz et al., 1984, p. 463). According to Rhodus et al. (1989), the frequency of price change is an important aspect of pricing efficiency. The magnitude of price shifts appears to be closely related to the frequency. More frequent price

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[24] For more information on speed of price adjustment, see Arrow (1959) pp.41-48. He suggested that the speed of price adjustment depends upon three factors: (a) the shape of the marginal cost curve, (b) the possibility of accumulating and decumulating inventories, and (c) the degree of information available in the market.

adjustments imply relatively small price changes in response to varying market conditions while slow or very infrequent responses to the same market imply large shifts in prices.

Many authors have studied the concept of pricing efficiency. Leavitt et al. (1983) evaluated the market performance of the Alberta Pork Producers' Marketing Board in making some comparisons with different Canadian and American markets. Adamowicz et al. (1984) suggested a follow-up study on dynamic price relationships of hog markets. On their side, Veeman, and Taylor (1987) assessed the question of pricing efficiency in the rapeseed futures market. Finally, Faminow and Benson (1990) looked at spatial market integration in the case of hogs analyzing the relations between pricing efficiency, FOB pricing and basing-point pricing systems.

3.4.2 Specification of the VAR and VEC models

Vector autoregression analysis is an appropriate technique to examine the dynamics of price adjustments not captured by "regular" regression analysis. In fact, vector autoregressive models are often employed to explore dynamic relationships among a set of interrelated economic variables. With such a multivariate system, every variable is allowed to influence every other variable in the system with lags (Bessler, 1984). The vector autoregression (VAR) model can be expressed as follows (Greene, 1993):

$$x_t = \mu + \Gamma_1 x_{t-1} + \ldots\ldots + \Gamma_p x_{t-p} + \epsilon_t \quad (3)$$

where x_t is the dependent variable, x_{t-1} ..... x_{t-p} are lagged values of x_t, μ is the vector of intercept terms, and Γ_1 ..... Γ_p are the parameter matrices. In the absence of autocorrelation of errors, as shown in (3), VARs are equivalent to seemingly unrelated regression models

(SUR) with identical regressors. In that case, the equations are estimated separately using ordinary least squares (OLS) and are relatively simple to estimate. For non-trending series, no data transformations should be applied.

When the data series are non-stationary, the VAR model may be re-specified as a vector error correction model (VEC) imposing the matrix of cointegrating relation coefficients π, à priori. The VEC model (restricted VAR) can be developed from equation 3 stated previously and can be specified as follows:

$$\Delta x_t = \mu + \Gamma_{11} \Delta x_{1t-1} + ... + \Gamma_{1p} \Delta x_{1t-p} + ... + \Gamma_{i1} \Delta x_{it-1} + ... + \Gamma_{ip} \Delta x_{it-p}$$
$$+ \Pi_{11} \Delta x_{1t-p-1} + ... + \Pi_{ip} \Delta x_{it-p-1} + \sum \Gamma_k \Delta x_k + \epsilon_t \qquad (4)$$

where the Π is the matrix of restrictions found from the cointegration analysis such that $\Pi = \alpha\ \beta'$ and the individual series x_{1t-p-1} ..... x_{it-p-1} are cointegrated. The k stationary variables I(0) that are required to be included in the model are specified in levels as x_k.

It is also important to choose the right lag length. Goodwin and Schroeder (CJAE, 1991) suggest that the likelihood ratio test statistic is the best technique for choosing the appropriate lag order to implement the VAR system. The likelihood ratio test statistic is given by:

$$L = (T - p)\ (\ln|\Sigma_j| - \ln|\Sigma_k|) \sim \chi^2_{n(k-j)} \qquad (5)$$

where T is the number of observations, p is the number of parameters in each of the unrestricted regressions, Σ_j is the residual covariance matrix for the model with j lags where $j < k$, and n is the number of endogenous variables in the VAR model.

Some consideration must be given to the ordering of the variables in the VAR for the purpose of impulse response functions. Typically, variables that are not expected to have any predictive value for other variables should be put last. In other words, there should be a stronger causality relationship from the first to the second variable, from the second to the third and so on for other variables. Moreover, in order to interpret the results of VAR analysis adequately, a stationary system resulting from cointegrated price series must be used.

The case of feed grain movements in Canada appears to be an appropriate situation for the application of vector autoregression analysis (Goodwin and Schroeder, CJAE, 1991). In this case, the VAR analysis will be used to evaluate the dynamic relationships of grain pricing in the Maritime Provinces.

In the present study, restricted VAR models[25], often called vector error correction (VEC), should be able to demonstrate the pricing efficiency of regional markets for barley, wheat, oats, mixed grain and corn in Canada. In other words, it will measure the rate of adjustment of grain prices in one region to those in another region, which will permit the prediction of price level adjustment from one region to another. Another interesting feature of restricted VAR models is their ability to accurately forecast in the short run.[26]

The database used, which is based on FFA claims, contains over 25,000 commercial feed grain transactions that have occurred within the Maritimes over the past three crop years. The data were grouped on a weekly, monthly and quarterly basis for flexibility of analysis. Monthly and quarterly price series have already been used for LOP analysis. For the purpose of a vector autoregression (VAR) analysis, it is best to start from weekly observations. This corresponds to the general practice of weekly or bi-weekly price

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[25] The identification of the model is done by imposing restrictions on the residuals as will be seen in chapter four.

[26] According to some authors (for example Litterman, 1979), the restricted VAR analysis would be more accurate in forecasting than would be a simultaneous equation model containing multiple structural equations.

adjustments in the Maritimes. The transformed database includes local price data from the first week of August 1991 to the last week of July 1994 (156 observations). VEC models are used for New Brunswick, Prince Edward Island and all the Maritime provinces taken together. In the case of Nova Scotia, price series for local barley and corn are specified as stationary variables I(0) in the Maritime model. For oats, mixed grain and feed wheat, VAR analysis is not utilized since more than half of the commercial transactions captured in the FFA database were under the Nova Scotia Grain Marketing Board and therefore pooled at the same price throughout the crop year. Under such conditions, there appears to be no justification for vector autoregression analysis.

CHAPTER FOUR: DATA, EMPIRICAL RESULTS AND INTERPRETATION

4.1 Introduction

This chapter presents the data set components and the transformation and tests performed on the that data for use in the various statistical analyses presented in chapter three. The results of these tests and analyses will be presented as well as a discussion of these results.

The chapter is divided into seven main sections. Section 4.2 discusses the data collection, preparation and evaluation for testing purposes. It also deals with the various tests applied to the data set to confirm its relevance and suitability for the regression models. The numerous tests utilized in this section reflects a process of gradation from the raw data to a data set that is accurate and suitable for the analyses presented in latter sections of the chapter. In other words, there is a logical link and an evolution in the order in which the tests are presented. Representativeness and consistency tests are the first applied to the FFA database. Also in this section, data properties such as stationarity, optimal lag length for VAR modelling, cointegration and error correction mechanisms often found to be critical before any regression is performed, are analyzed in detail.

Section 4.3 explores the results of the law of one price (LOP) analysis while the fourth section is devoted to the symmetry of price transmission results and their implications in terms of market power of grain purchasers. Section 4.5 clarifies the notion of long run price relationships and shows the outcome of the cointegration analysis. This becomes the basis for the vector autoregression (VAR) and vector error correction (VEC) analyses presented in section 4.6. The seventh section deals with the analysis and results of various price shocks (impulse functions) applied on Thunder Bay, Chatham and local markets.

Finally, section 4.8 presents the results and graphic and representation of short run forecasting models for the farm gate price of local feed grains in the Maritimes.

4.2 Data Collection, Preparation and Evaluation

4.2.1 Data collection and preparation

The data set used for the purpose of the present thesis was obtained from the FFA price database (Livestock Feed Bureau, 1991-92 to 1993-94) and adapted for the required analysis. The FFA database has been gathered from invoices of commercial transactions included in FFA claims and primary stock certificates related to claim submissions. In cases where claimants are grain merchants or brokers, the information contained in the claim is usually not the first transaction but rather the second, third or even fourth transaction. In that situation, the primary stock certificates provide the information necessary to obtain a first transaction price. For each grain transaction, seventeen (17) pieces of information are collected. There are as follows:

Field	Description
1. Document type:	FFA claim, primary stock certificate or digital information (diskette) from the large organizations.
2. Number:	The number of the claim or the primary stock certificate associated with the transaction.
3. Province:	The province of origin of the feed grain.
4. Seller:	The name of the producer (seller) or the company.
5. Origin:	The city or the nearest town of origin.
6. Buyer:	The buyer of the grain in the first transaction in the case of primary stock certificates, or the claimant's name in the case of a claim from

a feed mill or a livestock producer.

7. Destination: The destination of the grain as the result of the first transaction. (not necessarily where the grain is used)

8. Grain: The types of grain (barley, corn, mixed grain, oats, rye and feed wheat, all eligible FFA crops).

9. Grade: The grade of the grain taken from the grade certificate annexed to the claim. The range is grade 1 to grade 5.

10. Moisture: The moisture content of the grain. The maximum moisture allowed in straight grades for FFA vary by type of grain[27].

- Barley: 17.0% >---> 14.8%
- Oats and mixed grain: 17.0% >---> 14.0%
- Wheat: 17.0% >---> 14.5%
- Corn: 17.0% >---> 15.5%

11. Volume: The volume of the transaction in tonnes. Due to trucking sizes it is, most of the time, approximately a 12 tonne or a 30 tonne load.

12. Price: Price paid to the grain producer, subject to comment in the transportation field.

13. Transportation: Nature of the grain carrier. The possible types are seller, buyer and third party. Whenever the transportation cost is available, it is supplied in this category.

14. Invoice date: The date appearing on the invoice.

15. Delivery date: The date that the feed grain is moved. It usually appears on scale certificates.

16. Delivery cost: Field built from the transportation grid applying a cost of transportation according to the distance between the origin and the destination.

17. Comments: Any additional commentary that explains large price inconsistencies or other aberrations.

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[27] For example, barley over 17.1% moisture content is unacceptable for the Feed Freight Assistance program, weights of barley shipments between 14.9% and 17.0% are reduced by excess moisture and barley containing 14.8% or less moisture is accepted as is.

The transactions are compiled by province and by type of grain. The transactions are sorted by delivery date and clustered by month on a crop year basis. Monthly summaries include the number of transactions, the total tonnage, the weighted average price, the simple average price, the standard deviation of prices, the maximum and the minimum price paid per tonne, and lower and upper bounds for confidence intervals at levels of 99%, 95% and 90%[28], (See Appendix Tables J and K). At the end of each report, there is a yearly summary including the total tonnage of the crop year in question and the weighted price based on individual transactions for the whole year. From the statistical summary lines, summary sheets[29] are produced for each crop year, grouped by province. Appendix J presents an example of one of those summary sheet for the feed barley recorded for P.E.I. in crop years 1991-92 to 1993-94.

4.2.2 Data transformation and evaluation

Because the data set comes directly from feed grain transaction invoices, it is hard to dispute its reliability. Therefore, this data set appears to be unique and ideal for the application of various tests on indicators of market performance. Nevertheless, the data are

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[28] Since for most months the number of transactions is greater than or equal to 30 (application of the "Central Limit Theorem"), the observations are assumed to follow a Normal distribution. The confidence intervals are found using the following formula:

$$X \pm Z_{\alpha/2} \frac{S}{\sqrt{n}}$$

where X is the weighted average price
$Z_{\alpha/2}$ corresponds to the level of confidence
S is the standard deviation
and n is the number of observations.

[29] These are the summary sheets provided to the GRIP committee on a periodical basis, (see Appendix Tables J and K).

subject to certain transformations and tests to ensure their suitability for these analyses. These are discussed below.

(a) Transport cost adjustment

From the FFA database described in the previous section, two distinct price series were built from the 25,000 individual transactions, the first with monthly prices for the LOP tests and the second with weekly prices for purpose of the VAR analysis.

In order to have all grain prices on a comparable basis, an adjustment for transfer costs was made when the sellers assume these costs or use their own truck. For the three crop years included in this study, a systematic adjustment was made using the rates presented in Table 4. This method of adjustment was developed to ensure that all the grain recorded was on the same basis (farm-gate price). Prices were adjusted according to the transportation grid taking into account the origin and the destination of the grain and applying a rate according to the distance between the two points.

The inference of this kind of adjustment is the creation of a "farm-gate" price surface in each province to compare the "wholesale" price surface generated by the in-store Thunder Bay prices plus transfer costs.

(b) Representativeness analysis

The question of representativeness addresses how appropriately the relevant data characterize the local market and reflect the overall production of grain in the region. The fact that these data represent actual transactions in a more or less market clearing context, and can be weighted by volume of transaction, should permit the estimation of what part of

TABLE 4: Estimated Trucking Rates for Price Adjustment to Farm-gate Basis
(Truck mileage rate)

Distance in Kilometres	$ per metric ton[30]
0 --- 10	$ 5.50
11 --- 20	$ 6.00
21 --- 30	$ 6.50
31 --- 40	$ 7.00
41 --- 60	$ 8.00
61 --- 80	$ 9.00
81 --- 100	$ 10.00
101 --- 120	$ 11.00
121 --- 140	$ 12.00
141 --- 160	$ 13.00
161 --- 180	$ 14.00
181 --- 200	$ 15.00
201 --- 250	$ 16.00
251 --- 300	$ 17.00
301 --- 400	$ 18.50
401 --- 500	$ 20.00
501 --- 600	$ 21.00
601 --- 800	$ 22.00
801 --- 1000	$ 23.00

[30] These transportation costs are based on average trucking rates within the Maritime provinces at an average truck load of approximately 11 metric tons. The overall average tonnage by transaction is 10.95 metric tonnes in the FFA database. (These figures were obtained with the help of Mr. John McAnulty, Director of Transportation, Livestock Feed Bureau and through consultation with officials in the Maritime feed grain industry.)

the total market the transactions in question represent. This has been estimated for barley, feed wheat, oats, and rye in each province, using production data and estimated requirements by livestock as indicators of market size. The proportion of grain production which is utilized on the farm where it is produced is estimated as a residual.

Given that the level of FFA provides a significant incentive for buyers of feed grain to claim the subsidy, it is reasonable to assume that these claims identify virtually all of the transactions of local feed grains eligible for FFA.[31] Moreover, since the claims procedure requires the reporting of comprehensive data on price, quantity and other specifications of the grain involved in the transaction, it is possible to calculate weighted average prices that should reflect a market-clearing context in each case. Under these circumstances, it is difficult to imagine a set of data that could be more representative of a local market.

It is important, however, to establish just what part of the market the FFA data do represent. This is done first by expressing FFA transactions for each grain in each province as a percentage of production. These measures are presented in Table 5 where production data are adjusted for estimated seed production.

As may be observed in the second last column of Table 5, FFA transactions for the period under review represent anywhere from 3-4 percent of production in the case of mixed grains in Nova Scotia and New Brunswick and rye in Prince Edward Island to more than half of all wheat and barley in N.B.. In general, FFA transactions represent from 28 to 44 percent of total grain production in each province. If, indeed, Statistics Canada data do in fact overestimate production, (as suggested in Section 2.3) these proportions could be even larger. As a second measure of representativeness, local grain transactions are expressed as a share of total FFA shipments for each province. These are shown in the last column of

[31] Exceptions might be found in small farm-to-farm transactions where it would be costly to obtain the required documentation.

TABLE 5: Local Feed Grain Transactions as Percentage of Maritime Grain Production (in tonnes), averages for 1991-92 to 1993-94

	Production[32]	FFA transactions (local grain) FFA tonnage	% of prod.	% of total FFA[33]
NEW BRUNSWICK				
All wheat	5,890	3,081	52%	8%
Oats	20,689	3,839	19%	47%
Barley	39,622	22,665	57%	60%
Mixed grains	1,891	60	3%	
Corn		21		
Rye		46		
	=====	=====	=====	=====
Total:	68,092	29,712	44%	35%
NOVA SCOTIA[34]				
All wheat	4,642	1,379	30%	2%
Oats	8,786	2,125	24%	30%
Barley	12,534	4,215	34%	9%
Mixed grains	1,630	59	4%	
Corn	9,528	2,144	23%	5%
Rye		649		
	=====	=====	=====	=====
Total:	37,120	10,571	28%	8%
PRINCE EDWARD ISLAND				
All wheat	20,508	8,130	40%	57%
Oats	16,048	3,592	22%	108%
Barley	108,144	53,040	49%	109%
Mixed grains	35,433	6,968	20%	104%
Corn		57		
Rye	1,066	27	3%	
	=====	=====	=====	=====
Total:	181,199	71,814	40%	98%

---

[32] Statistics Canada (Cat. 22-002) production data adjusted for estimated seed production based on inspected acreage reported by the "Canadian Seed Growers' Association".

[33] Estimates reflect all FFA shipments of local grain, including that destined for other provinces, as a percentage of total FFA shipments designated for that Province. Estimates larger than 100 (oats, mixed grain and barley in P.E.I.) means that outbound shipments of that grain to other provinces exceed the inbound movement. Moreover, in the case of wheat, FFA data are based only on feed production.

[34] Averages for crop years 1992-93 and 1993-94 only.

Table 5. On this basis, the data are most representative of the market in P.E.I. and less in N.B. and N.S..

To summarize, there is little doubt about the representativeness of the FFA data for wheat, oats and barley in all provinces, mixed grains in Prince Edward Island and corn in Nova Scotia. Beyond that, the commercial market for other grains is so limited or FFA transactions so few as to render it difficult to determine representativeness.

(c) Consistency tests

In the present context, the term consistency refers to the degree of dispersion of observations over time and space within the Maritimes. Statistical measures such as standard deviation and coefficient of variation are employed to determine the ability of the data set to yield unbiased samples. This involves comparisons of these characteristics for different samples taken within the same time period (one to six months) and the comparison of these sample characteristics from one period to another. In other words, are there particular periods when these data are less reliable? Is there a threshold number of observations where consistency begins to break down? In addition to providing information about sampling requirements, this analysis should indicate the quality and consistency of the weighted average price as a single value indicator of the overall market at any point in time.

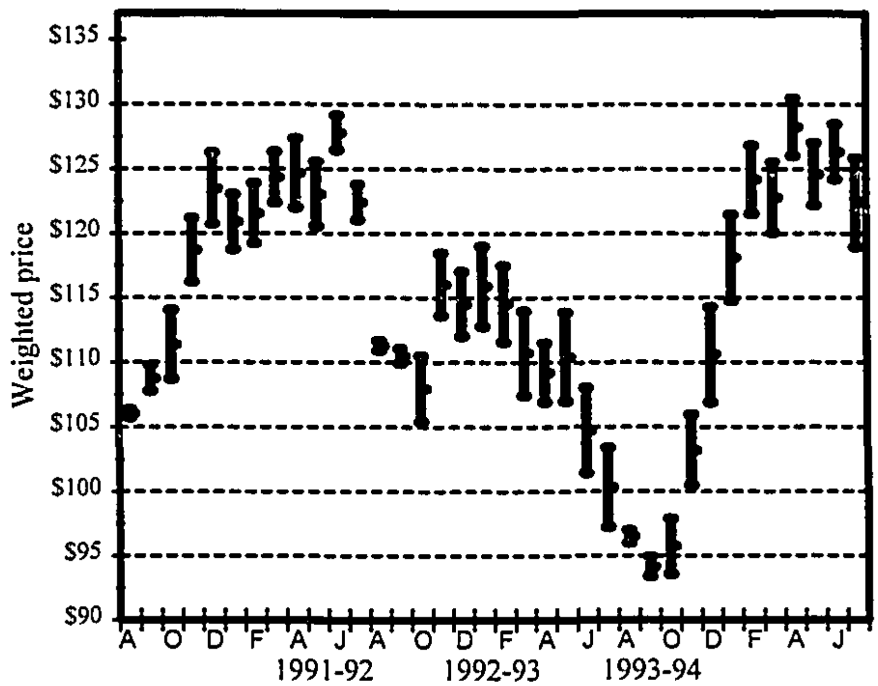
On the assumption that the observations are distributed as a Normal distribution, the standard deviation and coefficient of variation are employed as measures of central tendency around the mean. Similarly, the estimation of confidence intervals that serve to identify the range of prices required to include 99 percent of the observations provides an indicator of the quality of average price as a measure of the market.

As a visible example, confidence intervals for barley in Prince Edward Island and wheat in New Brunswick are illustrated in Figures 15 and 16. These measures of quality are sensitive to the number of transactions included in the sample and have little or no meaning when sample size falls below 30 transactions. As a general rule, the larger the number of transactions involved, the greater the reliability of the mean as an indicator of the market. Of course, the size of standard deviation may also be influenced by the level (magnitude) of prices. In this sense, the coefficient of variation (CV) which is normalized by removing the units of measurement, is a better indicator of consistency through time when price levels are changing.

As may be seen from the confidence intervals for barley in P.E.I. (Figure 15), the

FIGURE 15

CONFIDENCE INTERVALS FOR PRICE OF BARLEY IN P.E.I. (99%)

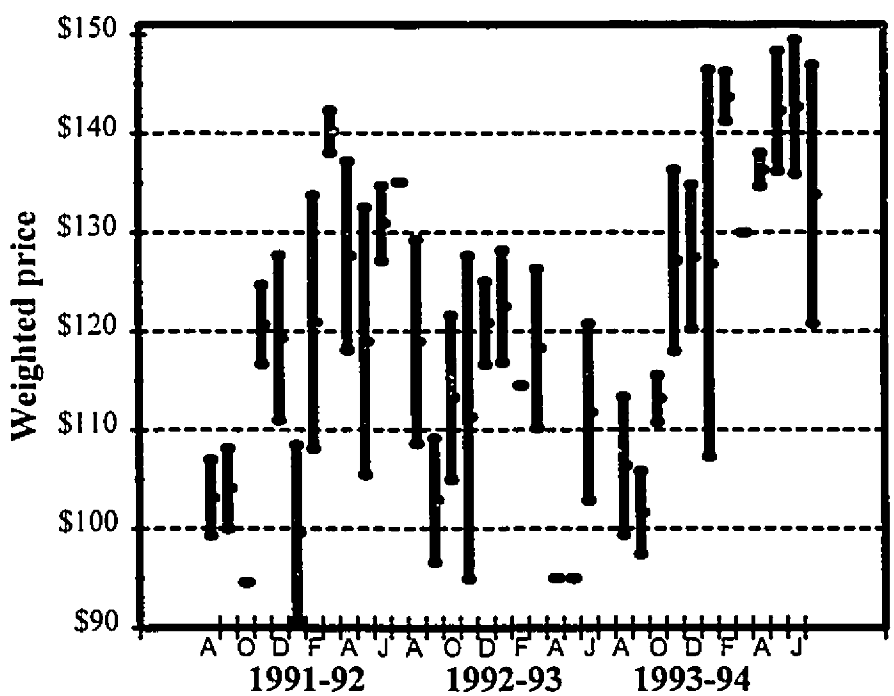


consistency of this series is generally very good. In most months, 99 percent of the transactions fall within a relatively narrow price band. This is especially apparent in the months of August and September of each year, when the greatest concentration of sales occurs.

In contrast, the confidence intervals for wheat in New Brunswick (Figure 16) are so wide and variable in most cases, they present a very inconsistent pattern for this commodity. In fact, because of the numbers rule, the only months in which these measures have relevance (i.e. when transactions exceed thirty) are August and September of 1991 and September of 1992 and 1993, (see Appendix Table K). In cases such as this, one cannot take monthly

FIGURE 16

CONFIDENCE INTERVALS FOR PRICE OF WHEAT IN N.B. (99%)



weighted average prices as reliable indicators of local market on a seasonal basis.

Tests of normality performed on monthly prices revealed that normality did not hold for any grain in any of the three provinces. However, the same tests applied to weekly data for the full period under review yield finer results and offer a better explanation of the real situation. Some descriptive statistics related to weekly weighted prices for crop years 1991-92 to 1993-94 (156 observations) are presented in Table 6.

Skewness and Kurtosis statistics are presented as well as the Jarque-Bera statistics of normality. The calculated Jarque-Bera statistic is compared to a tabulated chi-square with two degrees of freedom (i.e. accept normality of price data when $W < 5.99$ with 95% confidence). In summary, on the basis of weekly weighted prices over a three-year period, normality is found to hold for all price series except for New Brunswick wheat and Nova Scotia corn. These normality tests appear to be consistent with the previous graphical analysis. For barley in P.E.I. (Figure 15), the normality test suggests a value of 0.64 compared to 6.64 for N.B. wheat (Figure 16). As expected, normality cannot be rejected for barley in P.E.I. and rejected for wheat in N.B..

In the case of N.B. wheat, the implications are not critical since the calculated value is relatively close to the tabulated value and the Skewness is low. The situation of N.S. corn, for which normality is strongly rejected, appears to be more of a problem. As mentioned earlier, the most probable reason for rejection of normality is the limited volume of corn production and transactions. As a result, the regressions, the tests and price forecasting using Nova Scotia corn price series will not be very reliable. However, the normality test of Thunder Bay barley price shows the lower Jarque-Bera value (0.00186) of all price series, which is a positive point since it is expected to be the most reliable grain price basis for external markets.

TABLE 6: Descriptive Statistics for Weekly Weighted Prices by Origin Type of Grain, 1991-92 to 1993-94

NEW BRUNSWICK	Variance	Skewness	Kurtosis	Normality
Barley	18.42	-0.14985	-0.10106	0.62518*
Oats	24.63	0.05083	-0.31804	0.69677*
Feed wheat	207.32	0.50758	0.17771	6.63823
NOVA SCOTIA	**Variance**	**Skewness**	**Kurtosis**	**Normality**
Barley	26.17	0.15721	0.48061	2.06150*
Corn	34.95	0.00482	2.02719	25.68507
PRINCE EDWARD ISL.	**Variance**	**Skewness**	**Kurtosis**	**Normality**
Barley	7.16	0.04333	0.30675	0.63502*
Mixed grain	6.43	0.05679	-0.69106	3.06453*
Oats	35.72	-0.09398	-0.05099	0.23706*
Feed wheat	32.01	0.07280	-0.31045	0.73488*
THUNDER BAY	**Variance**	**Skewness**	**Kurtosis**	**Normality**
Barley	3.48	-0.00717	0.00963	0.00186*
Oats	7.12	0.21011	0.61057	3.43359*
Feed wheat	5.39	-0.31410	0.55789	4.41171*
Corn (Chatham)	5.28	-0.01001	0.19903	0.25008*

* Impossibility of rejecting the Normal distribution of weekly weighted prices is tested the help of the statistic: Jarque-Bera $\chi^2_{(2)}$ critical value = 5.99 ($P < 0.05$)

(d) Optimal lag length for VAR models

An important element of vector autoregression modelling resides in the choice of the length of lagged dependent variables. According to Doan (1994), a number of criteria have been proposed for allowing the data to determine the length of a distributed lag. This involves the use of a function of the residual sum of squares combined with a penalty for large numbers of parameters. For the present study, two methods are explored. The first is the Akaike Information Criterion (AIC) and the second is the Schwarz Bayesian Criterion (SBC). For both of them, the optimal lag length corresponds to the minimum value of the function. The empirical forms of both criteria are as follows:

Akaike Information Criterion: $T \log (RSS) + 2K$

Schwarz Bayesian Criterion: $T \log (RSS) + K (\log T)$

where K is the number of regressors and T is the number of observations, which is 156 in the present case. The number of lags in the system of equations is then chosen so as to minimize autocorrelation, heteroskedasticity, and non-normality while maximizing the fit of the model (Larue, 1993).

The optimal lag length according to both criteria are presented in Table 7 for each of the individual data series. This table suggests that the AIC criterion is a better measure than the Schwarz criterion when applied to these price series because it appears to be closer to the expected lag structure corresponding to timing of shipments with the exception of mixed grains in P.E.I. and feed wheat in Thunder Bay. According to AIC, around 5 or 6 lags should be considered for data analysis and for a long enough period for the residuals to be uncorrelated. However, for the purpose of the VAR models, a breakdown by province will be used following the VAR specifications mentioned in the Section 3.4.2 above.

TABLE 7: **Optimal Lag Length of Individual Price Series: Akaike (AIC) and Schwarz (SBC) Criteria**

Origin and Grain type		AIC	SBC
		(weeks)	
New Brunswick	Barley	3	1
	Oats	8	2
	Feed wheat	5	0
Nova Scotia	Barley	2	1
	Corn	4	1
Prince Edward Island	Barley	3	1
	Mixed grains	11	7
	Oats	3	1
	Feed wheat	3	2
Thunder Bay	Barley	6	4
	Oats	8	0
	Feed wheat	12	3
Chatham	Corn	3	0

(e) Stationarity and unit root tests

There are several diagnostic tests that may be applied to a database in order to learn the characteristics of the series before any regression is performed. There exists two classes of tests and data transformations. First, there are univariate tests that are applied to only one data series at a time; and second, there exists multivariate tests which analyze two or more series at a time and their interrelations. The three unit root tests presented below fall into the category of univariate tests, while the tests seeking cointegration relations are multivariate tests. Ooms (1994) asserts that multivariate tests for unit roots may be a poor guide for model selection since it is hard to visualize the degree of nonstationarity in a system.

The unit root test for stationarity of the series is invariably one of the most important diagnostic tests that can be applied on a series for the purpose of empirical vector autoregressive modelling. Typically, there are two types of stationarity: stationarity in mean and stationarity in variance. A nonstationary series that indicates the presence of unit root in the autoregressive part, would be one in which the mean and/or the variance are not stable through time. Moreover, the unit root can take two distinct forms: the stochastic unit root non-stationarity and the deterministic nonstationarity.[35]

Plotting the data series over time may yield a visual sense for whether or not a series is stationary. Figure 17 shows the weekly cash price of feed wheat in Thunder Bay. With regards to that series, it appears that the price is not stationary in mean but most probably stationary in variance since the magnitude of price fluctuations appears to be similar throughout the three crop years.

For the purpose of the present analysis, three different test are performed to investigate for the presence of a unit root indicating a nonstationary series. First, the Augmented Dickey-Fuller test unit root "t-test" is computed using the @ADF RATS procedure. The specification of the Augmented Dickey-Fuller test with no trend is :

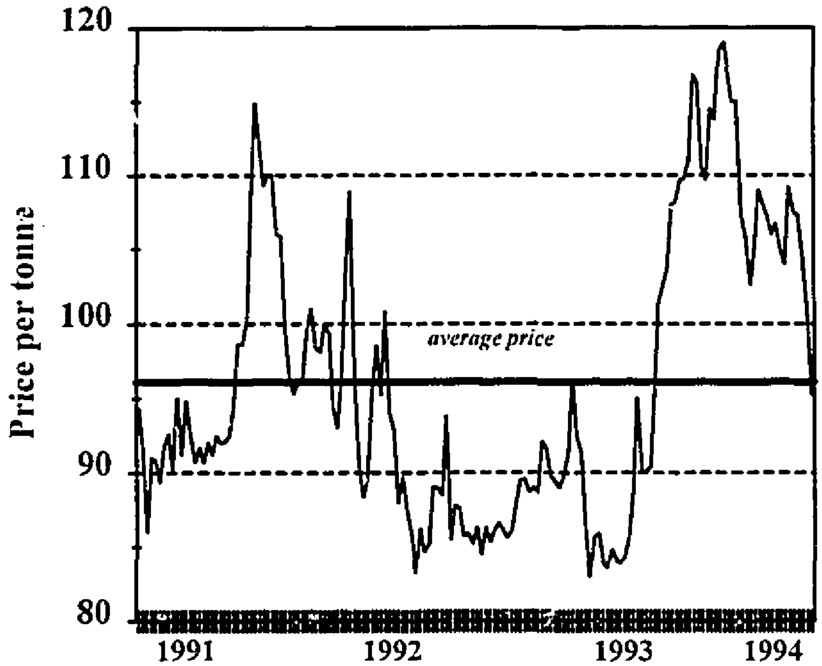
$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \epsilon_t \qquad (6)$$

[35] See Ooms (1994) for a complete discussion on univariate testing for unit root non-stationarity with deterministic or stochastic terms (Appendix 2).

FIGURE 17

Feed Wheat Cash Price in Thunder Bay

Weekly prices, 1991-92 to 1993-94



where ϵ_t is white noise and P is the number of lagged terms chosen to ensure that the errors are uncorrelated. This test determines the appropriate number of lagged differences by three methods: Akaike (AIC) criterion, Bayesian (BIC) criterion or, by adding lags until the Ljung-Box[36] test fails to reject no serial correlation (Doan, 1994). Under the null hypothesis, the presence of a unit root can be tested by $\alpha_1 = 0$.

A second test is presented as an alternative to the inclusion of lagged terms to allow for serial correlation. This test was developed by Phillips and Perron (1991) and uses non-

[36] Under the hypothesis of this test, there is no autocorrelation in ϵ_t and no correlation between x_t and ϵ_t.

parametric correction for serial correlation. The approach is first to calculate the above unit root test from the regression equations with p = 0. The statistics are then transformed to remove the effects of serial correlation on the asymptotic distribution of the test statistic. The critical values are the same as those used for the Dickey-Fuller tests. As asserted by Ooms (1994), the Phillips-Perron tests offer a wider choice of spectral estimators. It is utilized to examine the so-called "long memory" properties of the data. In summary, the only difference between the Augmented Dickey-Fuller and the Phillips-Perron tests is their treatment of any "nuisance" serial correlation aside from that generated by the hypothesized unit root. (Doan, 1994)

The third test used to detect evidence of a unit root in the series is the KPSS test of stationarity proposed by Kwiatowski et al. (1992). This test is very different from ADF and Phillips-Perron since the null hypothesis (Ho) X(t) is stationary. According to Kwiatowski et al. (1992), this test is said to give a better indication of stationary than the two others. In theory, the KPSS test should not reject stationarity more often than ADF and Phillips-Perron tests since it requires strong evidence against stationarity in order to be able to reject Ho.

The results of the three tests on unit root and stationarity properties are presented in Table 8. With regards to Table 8, the main observation is that most of the series are non-stationary I(1) (marked by an asterisk). The results for the three tests are very similar showing that only the Nova Scotia price series are stationary I(0). The most plausible explanation for this situation is that, compared to New Brunswick and Prince Edward Island feed grains, a larger share of grains (between 35 and 50%) is commercialized through the Nova Scotia Grain Marketing Board pooling organization. Except for Nova Scotia barley and corn, all other price series will taken as non-stationary for the following analysis.

TABLE 8: Unit Root and Stationarity Test Results on Individual Price Series: ADF, Phillips-Perron and KPSS (Without trend and 4 lags)

Price series	Aug. Dickey-Fuller	Phillips-Perron	KPSS
NB_BLY	-1.91*	-2.24*	0.70*
NB_OATS	-1.86*	-6.67	0.29 (L ≥ 2)
NB_WHEAT	-2.70*	-2.56*	0.53*
NS_BLY	-2.97	-3.93	0.29 (L ≥ 2)
NS_CORN	-3.52	-3.87	0.19 (L ≥ 1)
PEI_BLY	-1.84*	-2.42*	0.61*
PEI_MIX	-1.86*	-2.47*	1.06*
PEI_OATS	-2.61*	-3.44	0.55*
PEI_WHEAT	-2.27*	-5.62	0.54*
TB_BLY	-2.80*	-2.82*	0.72*
TB_OATS	-3.35	-3.03	0.62*
TB_WHEAT	-2.12*	-2.15*	0.67*
CHTM_CORN	-1.70*	-1.67*	2.27*

Note: At the significance level of 5% the critical value for the ADF and Phillips-Perron test is -2.88 while it is 0.463 for the KPSS stationarity test. In the table, the variables that exhibit non-stationarity (impossibility to reject the unit root hypothesis for ADF and Phillips-Perron and rejection of the null hypothesis of stationarity (Ho) for KPSS test) are indicated by an **asterisk** *. The minimum lag parameters required to accept stationarity are indicated in the brackets besides the KPSS calculated values.

Although not reported here, similar tests (ADF, Phillips-Perron and KPSS) were also performed on the first differences of the working series in order to demonstrate that stationarity can be induced by taking a first difference implying that all price series under observation are all either I(0) or I(1).

(f) Cointegration analysis and error correction mechanisms

Once unit root tests have been performed so that the stationarity properties of the different data series are determined and most of the series are observed to be non-stationary, the next step is the test for cointegration. The presence of cointegration between series indicates evidence of a long run relationship between non-stationary variables. As noted by Engle and Granger (1987), it might be possible that individual non-stationary series exhibit a long run relationship behavior when they are taken as a whole system. When two or more individual series move together in the same direction, they are said to be cointegrated. Cointegration implies that deviations from equilibrium are stationary, with finite variance, even though the series themselves are non-stationary and have infinite variance. As explained by Dolado et al. (1990):

> "...integrated variables are a specific class of non-stationary variables with important economic and statistical properties. These are derived from the presence of unit roots that give rise to stochastic trends, as opposed too pure deterministic trends, with innovations to an integrated process being permanent instead of transient." (p. 249)

For the purpose of the present thesis, the maximum likelihood approach of Johansen and Juselius (1990) is utilized as a multivariate diagnostic test. Equation 7 presents their primary cointegration method when cointegration is applied to a vector of p economic variables:

$$X_t = \Pi_1 X_{t-1} + \ldots + \Pi_k X_{t-k} + \mu + \phi D_t + \varepsilon_t \qquad (7)$$

where D_t is a vector of seasonal dummies, μ an intercept term and $\epsilon_t = \pi N(0,\sigma)$. As indicated by Larue and Babula (1994), the above can be re-expressed as:

$$Z_{0t} = \Gamma Z_{t1} + \pi Z_{kt} + \epsilon_t \qquad (8)$$

where

$Z_{0t} = \Delta X_t$

$Z_{1t} = (\Delta X_{t-1}, ..., \Delta X_{t-k}, D_t, 1)$

$Z_{kt} = X_{t-k}$

$\Gamma = (\Gamma_1, ..., \Gamma_{k-1}, \phi, \mu)$ and

$\Gamma_i = -(1 - \pi_1 - ... - \pi_i)$ where L is a lag operator and Δ is 1 - L.

In equation 8, the coefficient matrix π encloses the information about the long run relationships between the series and X_t and contributes itself to hypothesis testing. "A π of full rank implies that X_t is a stationary system while a rank of zero means that equation 9 is simply a differentiated vector time-series model. In the intermediate case, the rank of π is such that $0 < r < p$, the element series in X_t are cointegrated and π can be expressed as the product $\alpha \beta'$ where α and β are matrices with dimensions p x r" (Larue and Babula, 1994, p. 162). In this model, p represents the individual coefficients, r the number of cointegrating relationships, while α and β illustrate, respectively, the speed of adjustment and the adjustment amount coefficients needed when the system comes back to equilibrium ("error-corrects") after a given shock. Thus, the relations βX_t can be interpreted as the stationary relations among nonstationary variables, i.e., as cointegrating relations (Johansen and Juselius, 1992). This procedure is known as the trace test.

Johansen (1988) and Johansen and Juselius (1990) generate two sets of residuals R_{0t} and R_{1t} to determine the rank of π. Another test is suggested to find the number of cointegrating relations (r): the maximal eigenvalue test. The likelihood ratio test statistic for the hypothesis that there are at most r cointegration vectors is: (Johansen, 1988)

$$-2\ln(Q) = -T\sum_{i=r+1}^{p}\ln(1-\lambda_i) \qquad (9)$$

where $\lambda_{r+1},.....\lambda_p$ are the p - r smallest squared canonical correlations. The above statistic is distributed as a χ^2 with r (p-s) degrees of freedom, where p and s are the number of cointegrating vectors and the number of restrictions per cointegrating vector respectively[37].

The results and interpretation of cointegration relation tests are given with VAR and VEC results later in this chapter.

4.3 Analysis of LOP Results

This section presents the LOP results and the relative degree of commodity arbitrage for various Maritime feed grain crops for both short run and long run price deviations from Thunder Bay prices. The regressions were performed on monthly weighted average prices with two lagged dependent variables for the price prevailing in Thunder Bay. For the use of the present analysis, the current price plus the two lagged prices together represent quarterly weighted prices which are utilized as a proxy for long run price adjustments.

Because of the logarithmic form of the equation specified in the LOP model (equation 1 of chapter three), the regression coefficient can be interpreted as elasticities[38]. Although not shown here, the plots of the autocorrelation (ACF's) and partial auto-correlation (PACF's) functions suggested that all price series except Nova Scotia barley are distributed as an autoregressive process of first order AR(1), thus implying stationarity. The

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[37] See Johansen (1988), Johansen and Juselius (1990) and Larue (1994) for a more complete explanation and proof of the above tests.

[38] The log transformation also permits the elimination of most of non-stationarity problems.

analysis indicated that N.S. barley is a stationary series but distributed as a moving average of first order MA(1) process. On the contrary, the N.S. corn monthly price series was found to be non-stationary.

Therefore, each model in N.B. and P.E.I. was corrected for autocorrelation of the first order AR(1) using the method of Cochrane-Orcutt. Nova Scotia barley was adjusted for the MA(1) process while the nonstationarity of Nova Scotia corn price data was removed by applying a Box-Cox's power transformation in order to stabilize the mean and the variance.[39]

Table 9 presents the results of the LOP tests. For New Brunswick and Prince Edward Island the estimated coefficient of correlation RHO is, most of the time, significant at the level of 1 percent. Also, in all cases $0 < | \rho | < 1$ meaning that, with the help of monthly data corrected for autocorrelation of first degree and taken in logarithm, all models in N.B. and P.E.I. exhibit stationarity, which means that the various distributions and the mean and variance of the samples are relatively stable from one month to another. With respect to the estimates of price transmission elasticities, in most cases, with the exception of wheat and oats in N.B. and wheat in P.E.I., the coefficients are close to 0.50 for the current period t. Therefore, it would appear that the LOP does not hold (indicated by ~~LOP~~ in Table 9) for any of these grains in the short run since a price shock in Thunder Bay during the current month is only half reflected in Maritime grain prices. A coefficient close to unity for the variable LOG_PRICE_TB_t would have confirmed the LOP in the short run. The F-test for complete absence of commodity arbitrage was computed as an alternate, but weaker, method of testing the LOP. The results shown in Table 9 indicate that some degree of commodity arbitrage prevails for barley in N.S. and P.E.I. in the short run. The analysis suggests opposite results for wheat, oats, corn and mixed grains where arbitrage seems to be absent in the short run.

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[39] The Box-Cox transformation applied is the following: $T(Z_t) = (Z^{\lambda}_t - 1) / \lambda$ where $\lambda = 0$ for a logarithmic transformation.

TABLE 9: Regression Coefficients for the Law of One Price (LOP) Tests[41] on Monthly Weighted Average Prices by Province and Type of Grain, 1991-92 to 1993-94

NOVA SCOTIA	BARLEY		CORN
$INTERCEPT_t$	-3.0146*[40]	$INTERCEPT_t$	2.3564
$LOG\_PRICE\_TB_t$	0.5713**	$LOG\_PRICE\_CHT_t$	0.5835**
$LOG\_PRICE\_TB_{t-1}$	0.5541*	$LOG\_PRICE\_CHT_{t-1}$	-0.4838
$LOG\_PRICE\_TB_{t-2}$	-0.0392	$LOG\_PRICE\_CHT_{t-2}$	0.1559
LOG_VOLUME_t	-0.0321**	LOG_VOLUME_t	-0.0347***
$LOG\_TRF\_COST_t$	0.7561***	$LOG\_TRF\_COST_t$	0.5317**
LOG_GRADE_t	0.1428***	LOG_GRADE_t	-0.0503
$LOG\_MOISTURE_t$	-0.0081	$LOG\_MOISTURE_t$	-0.2119***
Adjusted R^2	72.0%	Adjusted R^2	66.5%
D.-W. Statistics	1.67	D.-W. Statistics	2.22
LOP in Short run[41]	~~LOP~~, arbitrage		~~LOP~~, no arbitrage
LOP in Long run	LOP, arbitrage		~~LOP~~, no arbitrage

NEW BRUNSWICK	BARLEY	OATS	FEED WHEAT
$INTERCEPT_t$	-0.0380	9.9742	-2.0691
$LOG\_PRICE\_TB_t$	0.4686	-1.1712*	0.0544
$LOG\_PRICE\_TB_{t-1}$	0.4372	-0.0545	0.5442*
$LOG\_PRICE\_TB_{t-2}$	0.2443	-0.3376	0.6857**
LOG_VOLUME_t	-0.0618***	-0.0123	0.0191
$LOG\_TRF\_COST_t$	0.2578	1.5861	0.5666**
LOG_GRADE_t	0.0540	0.1334	-0.1499**
$LOG\_MOISTURE_t$	-0.4153	-1.6936	-0.5290**
RHO	0.5329**	0.7725***	0.4287***
Adjusted R^2	75.0%	61.2%	67.4%
D.-W. Statistics	2.05	1.81	1.84
LOP in Short run	~~LOP~~, no arbitrage	~~LOP~~, no arbitrage	~~LOP,~~ no arbitrage
LOP in Long run	LOP, arbitrage	~~LOP~~, no arbitrage	LOP, arbitrage

[40] The signs ***, ** and * represent significant at the level of 1%, 5% and 10% respectively.

[41] Two separate tests: (1) test of the law of one price (LOP), and (2) test of absence of commodity arbitrage where the critical value for both tests is PROB ($F_{3,28} \le 4.57$) = 99%

PRINCE EDWARD ISLAND	BARLEY	OATS	WHEAT	MIXED
INTERCEPT $_t$	-5.8382***	-4.5666	0.0259	-3.9119
LOG_PRICE_TB $_t$	0.4592***	0.3639	0.1089	0.4956**
LOG_PRICE_TB $_{t-1}$	0.3159**	0.3839	0.1251	0.2608
LOG_PRICE_TB $_{t-2}$	0.3462**	0.0913	0.4556**	0.3453*
LOG_VOLUME $_t$	-0.0319**	-0.0643***	-0.0383***	-0.0295
LOG_TRF_COST $_t$	1.0329***	0.6357	0.5664**	0.4404
LOG_GRADE $_t$	-0.0933	0.0170	-0.0234	0.3215
LOG_MOISTURE $_t$	0.5825*	1.1578*	-0.1803	0.6046
RHO	0.3604*	0.5478***	0.2084	0.7865***
Adjusted R^2	91.9%	61.7%	76.1%	79.8%
D.-W. Statistics	1.90	2.01	1.92	2.68
LOP in Short run	~~LOP~~ arbitrage	~~LOP~~ no arbitrage	~~LOP~~ no arbitrage	~~LOP~~ no arbitrage
LOP in Long run	LOP arbitrage	LOP arbitrage	~~LOP~~ arbitrage	~~LOP~~ no arbitrage (Barley only)

The LOP was tested for long run adjustment to Thunder Bay and Chatham using a three-month distributed lag. As most of the empirical literature argues, the LOP can hold in the long run. The empirical results of this analysis show that, on a quarterly basis, commodity arbitrage occurs for most of the grains in the three provinces, while the law of one price holds for barley in all three provinces, wheat in N.B. and oats in P.E.I..[42] It does not hold for N.B. oats, exhibiting an inverse relationship (negative coefficient) between the price of local grain and the Thunder Bay price in both the short and the long run. Nor does it hold for N.S. corn. Furthermore, the model demonstrates that the price of mixed grains depends principally upon the price of barley in Thunder Bay.

[42] In the case of N.B. barley and P.E.I. oats, the F-test results appear to be irrelevant because none of the coefficients for Thunder Bay price, (current and lagged periods) are found to be significant.

Many factors may contribute to the failure of the LOP, especially in the short run. First, there is the question of the effect of the volume of local grain marketed. As might be expected, given the concentration of marketing which occurs in the fall months (as shown in Figure 11), the volume of local grain sales has a negative and statistically significant effect on local grain prices in all cases except wheat and oats in N.B. and mixed grains in P.E.I.. That is, local prices fall as the monthly volume of sales increases and vice-versa. In all cases, however, the magnitude of that impact is very small with a 20 percent change in volume contributing to a change of less than one dollar per tonne in the price of grain in most cases. Second, according to some feed mills and main buyers of local grain, the difference in grade and grade variability between Western and local grain could contribute to variance in price differentials. The results reported in Table 9 suggest that grade differential had a significant effect in only two cases - N.S. barley where the direction of influence was opposite to that expected, and N.B. wheat.[43] Moisture content proved to be a highly significant and negative factor in the case of N.S. corn and N.B. wheat but not for the other grains. Finally, the only other variable tested was transfer cost (Thunder Bay or Chatham to a central destination in each province)[44] which proved to be highly significant and of considerable magnitude for N.S. barley and corn as well as for N.B. wheat and P.E.I. barley and wheat. It should be noted, however, that the transfer cost variable is based on published rates which changed only once during the period under review. In this sense, its role is similar to that of a dummy variable representing structural change.

Among the factors not included in the model, is the presence of pooling organizations and Provincial Agencies in the three provinces which set a producer price at the beginning

[43] However, these measures of grades do not reflect variations in protein content which was cited by grain buyers as a problem with local grains.

[44] Moncton for N.B., Truro, N.S. and Charlottetown for P.E.I..

of the crop year with very few, if any, adjustments during the year. There is also the problem of a limited number of transactions and the missing values[45] for some crops in the latter part of the crop year which may also interfere with the test. Other possible factors such as the timing of shipments and local market conditions not captured in the model could also account for the LOP failure. One of those conditions could be the exercise of market power by concentrated market structures. This hypothesis is tested through a price transmission analysis in the section which follows.

4.4 Results of Price Transmission Symmetry Analysis

The results of the price transmission analysis applied on weekly price change are presented in Table 10 for barley in each province. Linear regression models corrected for autocorrelation of the first degree were built for each of the feed grains in the Maritime provinces. The impact of rising and falling prices in Thunder Bay or Chatham on local grain price is analyzed. The upward arrows (↑) represent the Maritime grain price response to rising prices at Thunder Bay or Chatham while the downward arrows (↓) show the response to decreasing grain price at the same locations. As can be seen in Table 10, few regressions present significative coefficients: three in N.B.; two in N.S.; and, none in P.E.I.. Moreover, none of the Thunder Bay barley price fluctuations in either direction, have a significant impact on Maritime barley prices. Although not reported here, similar results were found for this price transmission analysis on all other grains.

In general, these models reveal no asymmetry in the adjustment of local prices to price increases versus decreases at Thunder Bay or Chatham. In other words, the results of

[45] Since there was not a significant amount of missing values and prices were not missing for more than one month, the missing values were replaced by an interpolation of the weighted price observed before and after the absent value.

TABLE 10: Symmetry of Price Transmission between Thunder Bay or Chatham and Maritime Destinations for Barley

Dependent Variable	Exogenous Var.	Coefficient	R^2
NB_BARLEY	SUM_TB_BLY ↓	-0.5308	
	SUM_TB_BLY ↑	0.2908	72.5%
	SUM_TB_WHT ↓	0.3727*	
	SUM_TB_WHT ↑	0.4851*	70.5%
	SUM_TB_OATS ↓	0.6483***	
	SUM_TB_OATS ↑	-0.0256	72.5%
	SUM_CHTM_CORN ↓	-0.0388	
	SUM_CHTM_CORN ↑	0.0557	69.9%
NS_BARLEY	SUM_TB_BLY ↓	0.3626	
	SUM_TB_BLY ↑	0.6621	65.2%
	SUM_TB_WHT ↓	0.5841**	
	SUM_TB_WHT ↑	0.4931	65.9%
	SUM_TB_OATS ↓	0.2790	
	SUM_TB_OATS ↑	-0.2526	65.8%
	SUM_CHTM_CORN ↓	-0.0787	
	SUM_CHTM_CORN ↑	0.7596***	65.8%
PEI_BARLEY	SUM_TB_BLY ↓	-0.1053	
	SUM_TB_BLY ↑	0.2616	81.3%
	SUM_TB_WHT ↓	0.0550	
	SUM_TB_WHT ↑	0.0480	81.2%
	SUM_TB_OATS ↓	0.2258	
	SUM_TB_OATS ↑	-0.0371	81.4%
	SUM_CHTM_CORN ↓	0.1887	
	SUM_CHTM_CORN ↑	0.0592	80.1%

this test do not support the hypothesis of the exercise of market power by feed grain buyers in the Maritimes.

4.5 Results of Cointegration Relation Tests

In the previous chapter, the unit root and stationarity tests were conducted on individual series (see Table 8). It has been found that all price series were non-stationary except for Nova Scotia barley and corn. Therefore, in the present section, some cointegration relation tests will be conducted on those price series that are not stationary in order to examine the possible existence of long run relationships between non-stationary series. As discussed by Ericsson (1992), cointegration formalizes, in statistical terms, the property of a long run relation between integrated economic variables.

Since most of the previous chapter's diagnostic tests were consistent with appropriately specified models, Johansen and Juselius (1990) trace and maximum eigenvalue tests are applied to two separate models. Results on the number of long run equilibrium relationships in New Brunswick and Prince Edward Island are given in Table 11. As explained previously, Nova Scotia price series were excluded since they were found to be stationary. Table 11 suggests that there are two cointegrating relationships for the New Brunswick model and three for the Prince Edward Island model.[46] In most cases, it is difficult to tell which variables are definitely cointegrated, especially as the number of I(1) variables included in the model increases. However, in the present case, some cointegration relations can be identified quite easily. Typically, the two highest values of inverse sign in

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[46] The calculated maximal eigenvalues and trace statistics were compared against the critical values of Table 1* (Osterwald-Lenum, 1992, p. 467) at a confidence level of 95%.

the cointegration vector are integrated variables (indicated in bold characters in Table 11).[47] For the N.B. model, there appears to be a long run price relationship between N.B. oats and wheat and also between N.B. and Thunder Bay barley. Also, typically, the adjustment vector suggests a high adjustment parameter (α) for these variables. The situation is not so clear for the P.E.I. cointegration model. Cointegrating relationships between P.E.I. barley and mixed grains and P.E.I. and Thunder Bay oats are self-explanatory. Although, the third long run relationship is less certain, there seems to be one between Thunder Bay barley and Chatham corn which is not relevant for this analysis.

The Johansen maximum likelihood and trace test was also applied on a model including all N.B., P.E.I. and Western grain crops as well as prices for barley and corn in Nova Scotia incorporated as additional I(0) variables. The goal of the exercise was to explore the relationships between the three Maritime provinces and learn about the integratedness of Maritime markets. For example, it might be the case that the N.B. wheat price is cointegrated with P.E.I. wheat price. The model suggests at least seven cointegrating relationships and possibly even an eighth. The main problem faced by a model like this, is the number of series (13 in the present case) which makes the identification of integrated variables almost impossible.

In order to clarify the situation, some cointegration tests were conducted using combinations of two or three I(1) variables at a time. These tests suggested that there are strong possibilities the following combinations of prices are cointegrated:

(i) N.B. barley and Thunder Bay barley

(ii) N.B. wheat, P.E.I. wheat and Thunder Bay wheat

(iii) Wheat and oats in P.E.I.

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[47] In practice, the larger the number of I(1) variables in a VEC model is, the harder it is to interpret the cointegration relations. In theory, the exclusion tests $\beta_i = 0$ and the proportionality tests ($\beta_i = -\beta_j$) can be performed to better characterize the long run relationships.

TABLE 11: **Maximum Likelihood Cointegration Results for N.B. and P.E.I. Models and their respective relation to Thunder Bay and Chatham feed grain markets**

NEW BRUNSWICK (r=2)	NB_BLY	NB_OATS	NB_WHT	TB_BLY	TB_OATS	TB_WHT	CHTM_CORN
Eigenvalues (λ's)	0.27193	0.22958	0.12263	0.11438	0.07595	0.05005	0.01590
Max. eigenvalue statistics	47.60	39.12	19.62	18.22	11.85	7.70	2.40
Trace Statistics	146.52	98.92	59.80	40.17	21.95	10.11	2.40
Cointegrated vector 1 (β_1)	1.000	**-0.830**	**0.876**	0.989	0.794	-0.247	-1.123
Adjustment vector 1 (α_1)	-0.087	0.490	-0.116	-0.047	-0.017	-0.016	0.058
Cointegrated vector 2 (β_2)	**1.000**	0.049	-0.697	**-1.367**	0.611	-0.066	0.163
Adjustment vector 2 (α_2)	-0.345	0.527	0.349	0.054	-0.107	-0.005	0.010

P.E.I. (r=3)	PEI_BLY	PEI_MIX	PEI_OATS	PEI_WHT	TB_BLY	TB_OATS	TB_WHT	CH_CRN
Eigenvalues (λ's)	0.30205	0.23837	0.17961	0.15287	0.12048	0.07402	0.03949	0.02160
Max. eigenvalue stat.	53.94	40.84	34.62	24.89	19.26	11.54	6.04	3.28
Trace Statistics	189.48	135.54	84.70	53.02	40.11	20.85	9.32	3.28
Coint. vector 1 (β_1)	**1.000**	**-1.009**	0.097	-0.190	0.046	-0.034	0.101	-0.264
Adjust. vector 1 (α_1)	-0.537	0.525	0.819	0.329	0.083	0.072	0.129	0.064
Coint. vector 2 (β_2)	1.000	-0.381	**3.606**	-3.243	-1.691	**-4.539**	1.740	0.744
Adjust. vector 2 (α_2)	-0.009	0.009	-0.090	0.047	0.002	0.052	0.002	-0.006
Coint. vector 3 (β_3)	1.000	-0.560	0.840	-0.723	**-3.965**	-0.270	0.075	**1.168**
Adjust. vector 3 (α_3)	-0.011	0.037	-0.152	0.090	0.052	-0.057	0.015	-0.001

(iv) Barley and corn in N.S.

(v) N.S. barley and P.E.I. barley

The Phillips and Ouilaris (1990) multivariate trace statistic was conducted as an additional test in order to "double-check" the results found by the Johansen and Juselius method. The results of this cointegration procedure indicate that the following groups of variables are cointegrated:

	Endogenous variable	Significant exogenous variables[48]
(1)	NB_BLY	NB_OATS, NB_WHEAT, TB_BLY, TB_OATS and TB_WHT
(2)	NB_OATS	NB_BLY
(3)	NB_WHEAT	NB_OATS
(4)	PEI_BLY	PEI_MIX, PEI_WHT and TB_OATS
(5)	PEI_MIX	PEI_BLY, PEI_OATS and CHTM_CORN
(6)	PEI_OATS	CHTM_CORN
(7)	PEI_WHEAT	PEI_BLY and TB_WHT
(8)	TB_BARLEY	CHTM_CORN

The results of the two-variable Johansen tests combined with the Table 11 and Phillips and Ouilaris cointegration tests definitely show that the Maritime feed grain markets are fully integrated. As explained in the previous chapter, the cointegration (β 's) and adjustment (α 's) vectors are utilized to build the estimated long run matrix π as $\alpha \beta ' = \pi$. This squared matrix π of size (p x p), often called matrix of Bayesian prior, is then specified as a matrix of restrictions in the vector autoregression.

In the autoregressive representation $A(L) X_t = \epsilon_t$, the cointegration of the variable

[48] Exogenous (or independent) variables that are significant at the level of 5%.

X_t generates a restriction which makes A(1) singular where L is a lag operator (Engle and Granger, 1987). From this expression, the error correction representation can be specified as $\Delta X_t = \Pi X_{t-1} + \epsilon_t$ which is run like a regular VAR. As Engle and Granger (1987) pointed out, a pure unrestricted VAR in differences would be mispecified if two or more variables of the system are cointegrated. The next section presents the outcome of the VAR and VEC analyses.

4.6 Results and Interpretation of Vector Autoregression and Vector Error Correction Analysis

Even with a VAR system, whose primary goal should be to examine all dynamic relationships among the variables, it appears obvious that there will be no causality of influence of Maritime grain prices on Thunder Bay or Chatham grain prices. Therefore, only those results which reflect Maritime prices as the endogenous variable are reported in Table 12. The VAR and VEC analyses will confirm or contradict the previous findings of the law of one price tests.

4.6.1 The unrestricted vector autoregression analysis

The significant regression coefficients of the exogenous variables from the unrestricted vector autoregression (VAR) model are presented as first results in Table 12. Keeping in mind that the magnitude of the coefficient is not very reliable in a VAR model based on first difference of series, these results give an approximate lag delay for the price adjustments of feed grain in the Maritimes to local and external markets. The models appear to be well explained with all adjusted R^2 near 70%. The Durbin-Watson statistics are also

TABLE 12: **Significant Regression Coefficients of Unrestricted VAR Models using the first difference of price series**

Endogenous Variables	R^2	D-W	Significant Independent Variables	
NB_BLY	0.78	1.91	NB_BLY{1}	-0.8183***
			{2}	-0.4132**
			NB_OATS{1}	-0.0660*
			{2}	-0.1247***
			{3}	-0.1364***
			{4}	-0.1267**
			NS_BLY{6}	0.1833*
			PEI_BLY{4}	0.6024**
			PEI_OATS{2}	0.2036**
			PEI_WHEAT{1}	0.1981**
			TB_WHEAT{2}	0.8179**
NB_OATS	0.71	1.90	NB_OATS{1}	-0.6196***
			{2}	-0.7547***
			{3}	-0.3901**
			{4}	-0.4094**
			PEI_BLY{1}	1.2783*
			{3}	1.9887**
			TB_BLY{3}	-3.3924**
			TB_OATS{5}	1.9374**
NB_WHEAT	0.74	1.92	NB_WHEAT{5}	-0.2239*
			NS_BLY{3}	0.2321*
			PEI_MIX{3}	0.7184**
			PEI_OATS{1}	0.2130*
			TB_BLY{2}	-0.9599**
			{3}	-1.0597**
			CHTM_CORN{6}	0.6537*
NS_BLY	0.73	2.02	NS_BLY{1}	-0.2659**
			NS_CORN{1}	-0.2103*
			TB_OATS{3}	0.6410**

NS_CORN	0.66	2.02	NS_CORN{1}	-0.3221**
			PEI_WHEAT{2}	0.4364**
			TB_WHEAT{5}	1.2905***
PEI_BLY	0.73	1.98	PEI_BLY{1}	-0.6106***
			{2}	-0.3212**
			PEI_MIX{1}	0.3507**
			TB_BLY{4}	0.5691**
PEI_MIX	0.70	2.24	PEI_MIX{1}	0.4986***
			{2}	-0.4053**
			PEI_OATS{2}	0.1203**
PEI_OATS	0.68	1.89	PEI_OATS{1}	-0.5598***
			{2}	-0.4070***
			{4}	-0.3379**
			{5}	-0.3750**
			{6}	-0.2432*
			TB_OATS{6}	0.6648*
PEI_WHEAT	0.78	1.84	PEI_WHEAT{1}	-0.8642***
			{2}	-0.5311***
			PEI_BLY{2}	0.5589*
			{3}	0.8242**
			{4}	0.6472*
			PEI_MIX{4}	-0.6102*
			{5}	-0.6153*
			CHTM_CORN{5}	0.6968*

representative of a good fit of the models because they all fall between 1.84 and 2.24, which indicates that the residuals are uncorrelated for the model using a six-period lag.

As expected when first differences are utilized, in all cases except for P.E.I. mixed grain with one lag, the lagged dependent variables have a negative coefficient. The magnitude and the lag length of these coefficients indicates the duration required for prices to come back to equilibrium after a given shock. For example, the N.B. barley price re-adjusts almost entirely in the week following a shock whereas the N.B. wheat price does not return to equilibrium at all in the period encompassed in this analysis.[49]

Some interesting observations must be noted regarding Table 12. First, the price of P.E.I. barley appears to have a stronger effect on the N.B. barley than prices at Thunder Bay. Second, N.B. barley and oats are inversely related. Third, the price adjustments to Thunder Bay and Chatham markets are typically longer[50] (4 to 6 weeks) than the adjustments to local markets (1 to 3 weeks). Somewhat surprisingly, the results suggest that the price of oats and wheat in Thunder Bay are more important than the Thunder Bay barley price for adjustment in the Maritimes. Finally, P.E.I. prices are less influenced than N.B. and N.S. by prices prevailing on external markets. This is consistent with expectations given the relative surplus position emerging in P.E.I..

4.6.2 Vector error correction (VEC) models

As observed in the section on the law of one price, Maritime feed grain prices do not usually adjust immediately to a change in price at Thunder Bay or Chatham. Local market conditions, the time required to ship grain between regions, and the pricing policies of local buyers (eg. pooling) may all affect the rate of adjustment of regional prices to external markets. In other words, while the law of one price may *eventually* hold, it may take some

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[49] The most likely reason is that the VAR model with six week lag is not a long enough period for N.B. wheat price to be captured.

[50] The lag period of four to six weeks for price adjustments to Prairie and Central Canada markets corresponds to a three week lead period for feed grain orders plus approximately 10 days for grain transportation by water or rail to Maritime centers. (personal communication with John McAnaulty, Livestock Feed Bureau)

time for this to occur.

Some light can be shed on the rate of adjustment of prices in the Maritimes by considering how they respond to a one-time "shock" of prices at Thunder Bay or Chatham. That pattern of response may include, for example, how much they respond, how long they take to respond and how long they take to return to their previous "equilibrium" position. As already established through the LOP and cointegration analyses, of course, that response pattern will reflect the fact that these prices are also influenced by local market conditions and by each other.

The results of the unrestricted VAR analysis gives only a general overview of the dynamics of price adjustments. Table 12 is consistent with previous findings on cointegration analysis. Since most of the variables appear to be cointegrated, the next step is the error correction models, the restricted VAR. In fact, as seen earlier, the cointegrated non-stationary variables can be used to formulate and estimate a model with an error correction mechanism. As mentioned by Charemza and Deadman (1992), "the fact that variables are cointegrated implies that there is some adjustment process which prevents the errors in the long run relationship from becoming larger and larger" (p. 154). In the present analysis, starting from $\pi = \alpha \beta'$, the matrix βX_{t-k} constitutes a set of r error correction mechanisms (cointegrating relations) that separate the long and short run responses in the model.

The usual way of presenting results of a VEC model is the in-sample forecast error variance decomposition attributed to innovations[51] in respective series. As mentioned by Bessler (1984), decompositions of forecast error variance give a measure useful in applied analysis. Two models are examined separately: New Brunswick (Table 13) and Prince Edward Island (Table 14). The ordering of the variables may affect the results in this

[51] The term innovation was adopted from Bessler (1984) and Goodwin and Schroeder (CJAE, 1991).

analysis in terms of the size of the influence attributed to each one. In this case, the ordering is based on (a) the magnitude of local sales of the grain, (b) the theory of regional price relationships and (c) the results of the cointegration analysis.

Tables 13 and 14 report forecast error variance decompositions and standard errors for 1, 3, 6, 12, 23 and 24 weeks ahead. In both systems and for each of the price series, the standard errors increase through time but level off, thus implying stationary systems (Bessler, 1984).

In theory, the crops with the smallest amount of weekly sales should be the most exogenous.[52] As suggested by Babula and Romain (1991), a variable is said to be strongly exogenous if more than half of the forecast error variance is self-explained.[53] In this sense, for the 24 week-periods, wheat prices in the two provinces and oats in New Brunswick are strongly exogenous.

In New Brunswick (Table 13), local barley, oats and wheat prices are the most strongly influenced by the cash prices of barley and wheat in Thunder Bay. Innovations in the N.B. barley price have a noticeable effect on oats and wheat, especially in the short run. Innovations in Thunder Bay oats and Chatham corn prices do not have any significant effect on prices of local grains in New Brunswick.

With regard to the Prince Edward Island model (Table 14), barley is the most endogenous crop and none of the other price series seem to have any conspicuous impact on its pricing. The price of oats is largely influenced by innovations in Thunder Bay barley and Chatham corn prices and, to a lesser extent, by the price of local barley. Wheat price fluctuations can be mainly attributed to shocks on the P.E.I. barley price. The results found

[52] A variable is considered largely exogenous when large portions of its forecast error variance are attributed to own-variation (Bessler, 1984)

[53] A more formal definition of strong exogeneity is given by Ericsson (1992).

TABLE 13: **Proportion of Forecast Error Variance of New Brunswick Feed Grain Crops Allocated to Price Innovations on Local and External Markets**

Variable	Weeks ahead	Standard error	Percentage of forecast error explained by:						
			NB_BLY	NB_OATS	NB_WHEAT	TB_BLY	TB_WHEAT	TB_OATS	CHTM_CORN
NB_BLY	1	6.85	100.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	8.92	96.72	0.00	0.08	2.71	0.49	0.00	0.00
	6	10.03	86.18	0.01	0.28	10.68	2.83	0.01	0.01
	12	11.60	65.59	0.05	0.45	25.09	8.76	0.03	0.04
	23	13.25	50.24	0.07	0.41	33.57	15.55	0.06	0.10
	24	13.34	49.55	0.08	0.39	33.82	15.99	0.07	0.10
NB_OATS	1	22.81	0.71	99.29	0.00	0.00	0.00	0.00	0.00
	3	29.13	1.45	98.48	0.00	0.02	0.03	0.00	0.01
	6	30.98	3.52	95.57	0.00	0.53	0.26	0.02	0.10
	12	32.37	5.75	88.77	0.02	3.32	1.70	0.04	0.40
	23	34.05	5.49	80.33	0.03	8.08	5.15	0.08	0.83
	24	34.16	5.46	79.82	0.03	8.33	5.42	0.09	0.86
NB_WHEAT	1	8.14	1.39	0.24	98.37	0.00	0.00	0.00	0.00
	3	11.75	1.54	0.30	98.08	0.01	0.05	0.00	0.02
	6	13.27	1.77	0.33	97.21	0.12	0.41	0.01	0.15
	12	14.01	1.86	0.32	93.26	1.66	2.14	0.05	0.71
	23	14.64	1.73	0.30	85.85	4.52	5.64	0.11	1.85
	24	14.68	1.72	0.30	85.34	4.68	5.90	0.12	1.94

TABLE 14: **Proportion of Forecast Error Variance of Prince Edward Island Feed Grain Crops Allocated to Price Innovations on Local and External Markets**

Variable	Weeks ahead	Standard error	Percentage of forecast error explained by:						
			PEI_BLY	PEI_OATS	PEI_WHEAT	TB_BLY	TB_WHEAT	TB_OATS	CHTM_CORN
PEI_BLY	1	3.89	100.00	0.00	0.00	0.00	0.00	0.00	0.00
	3	5.82	79.45	0.03	0.05	0.04	0.03	0.00	0.08
	6	7.98	55.10	0.06	0.12	0.14	0.11	0.00	0.27
	12	10.23	40.92	0.07	0.18	0.37	0.28	0.01	0.67
	23	11.54	35.93	0.07	0.20	0.71	0.56	0.10	1.56
	24	11.59	35.76	0.07	0.20	0.73	0.58	0.12	1.65
PEI_OATS	1	3.59	1.46	98.54	0.00	0.00	0.00	0.00	0.00
	3	5.50	4.21	86.06	0.28	6.40	0.09	0.03	0.22
	6	7.40	7.40	62.60	0.55	23.40	0.07	0.13	1.55
	12	9.45	8.77	42.76	0.82	34.44	0.11	0.17	9.64
	23	11.33	7.65	30.35	0.96	31.42	0.23	0.14	23.06
	24	11.44	7.54	29.74	0.96	30.92	0.24	0.14	24.02
PEI_WHEAT	1	8.61	0.06	0.27	99.86	0.00	0.00	0.00	0.00
	3	11.89	0.76	0.13	97.46	0.00	0.04	0.00	0.00
	6	13.35	2.41	0.18	91.19	0.10	0.32	0.01	0.00
	12	14.57	4.42	0.26	79.27	0.25	1.07	0.11	0.03
	23	15.40	5.50	0.28	71.11	0.30	1.73	0.68	0.22
	24	15.43	5.53	0.28	70.79	0.30	1.75	0.76	0.24

in both models are consistent with previous findings: when fluctuations in Thunder Bay or Chatham prices have an effect on prices of local crops, the most noticeable impact occurs with a delay of at least six weeks.

The following two sections deal, respectively, with impulse functions of price shocks and with a dynamic forecast analysis based on the VEC models. These will give more information on the relative effects of a single series on others.

4.7 Analysis of Price Shocks on Thunder Bay, Chatham and Local Markets

The calculation of responses of a system to particular initial shocks are generally called impulse functions. As mentioned by Goodwin and Schroeder (CJAE, 1991) these impulse functions permit the evaluation of the dynamic paths of adjustment of prices to shocks in the data series.

Figure 18 and 19 present the New Brunswick feed grain price responses following a shocks of $10.00 per tonne on Thunder Bay barley and wheat prices, respectively. Of the two Thunder Bay cash prices, barley has a relatively stronger impact. This may simply reflect the fact that the prices of barley and wheat in Thunder Bay tend to move together. In both cases, N.B. barley is the most immediately affected by the shocks, but in terms of magnitude, it is eventually surpassed by oats in the first case and wheat in the second case.

Figures 20 and 21 present the effect of the same Thunder Bay price shocks on Prince Edward Island feed grains. As might be expected in an almost self-sufficient province, the impact of the shocks is generally much smaller, barely reaching 20 percent response by the lead grains (barley and wheat) in each case. From Figure 21, it even appears that a shock on the Thunder Bay wheat price has a small, negative impact on P.E.I. oats.

Figure 18:

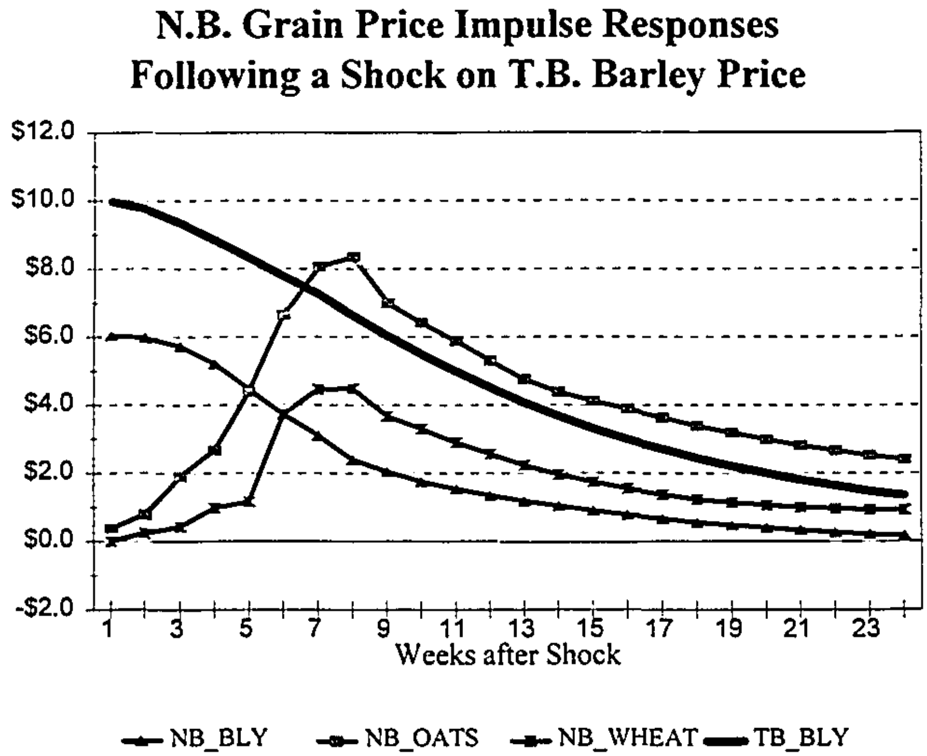


Figure 19:

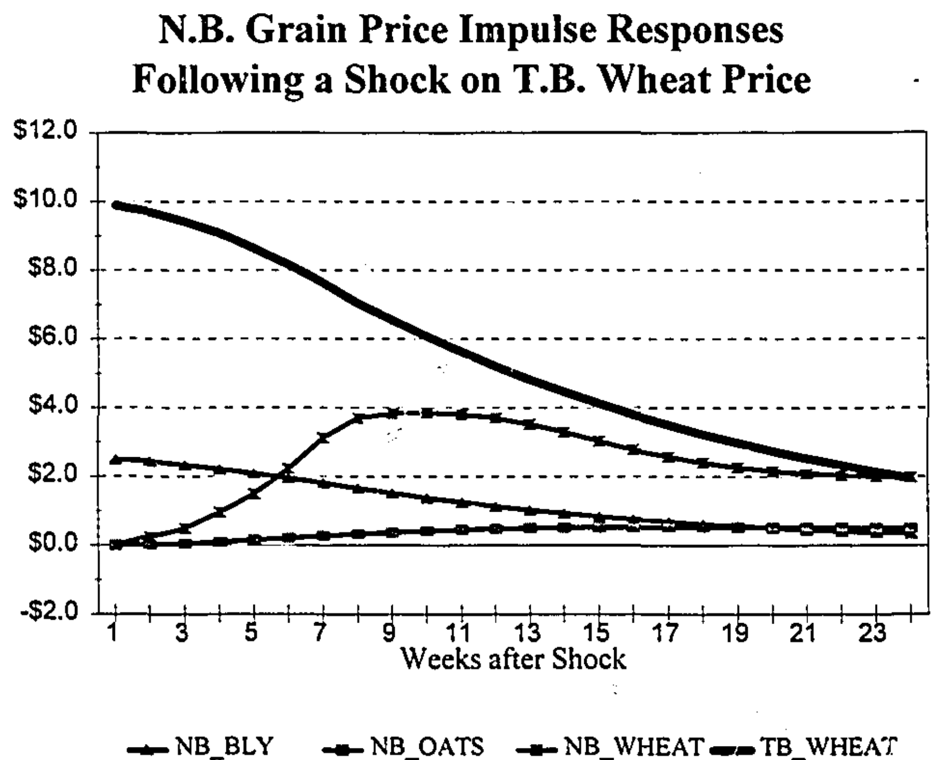


Figure 20:

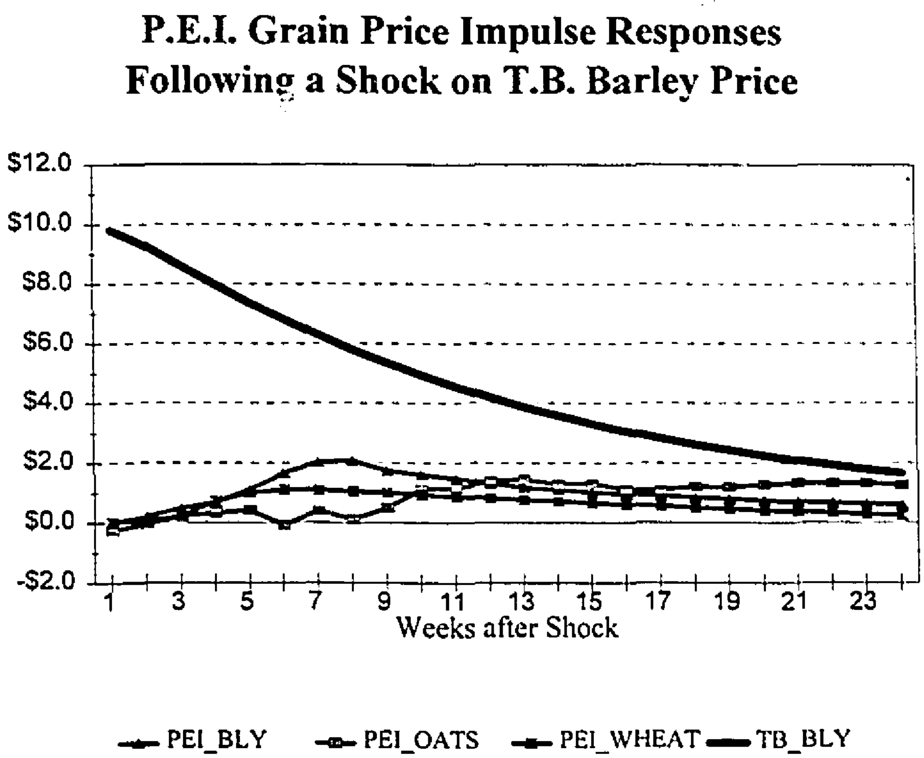
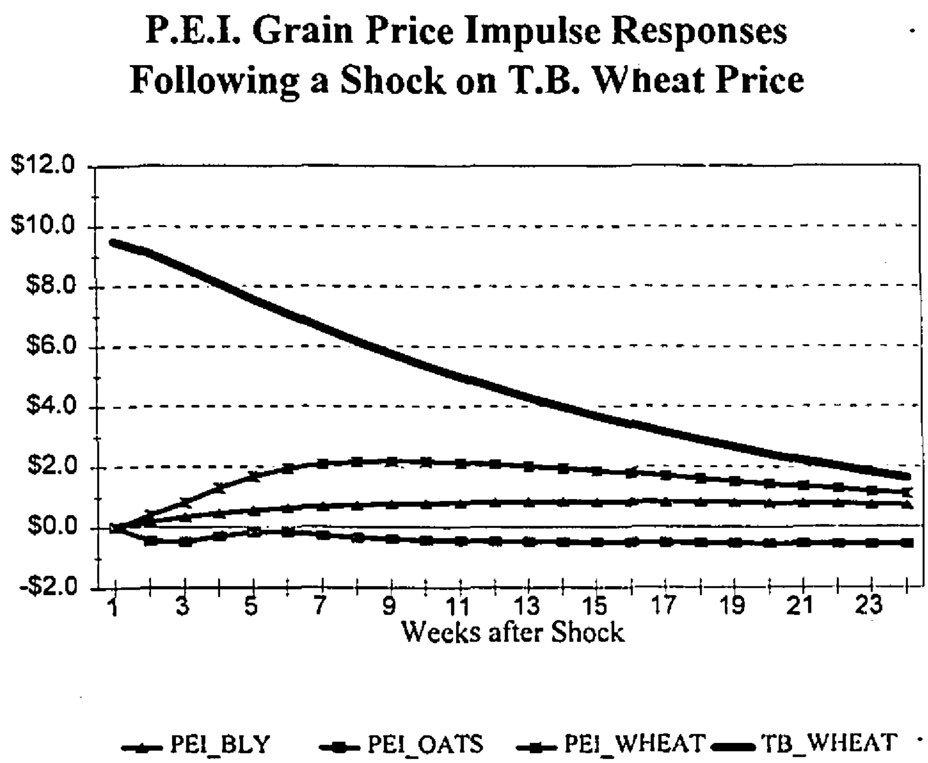


Figure 21:

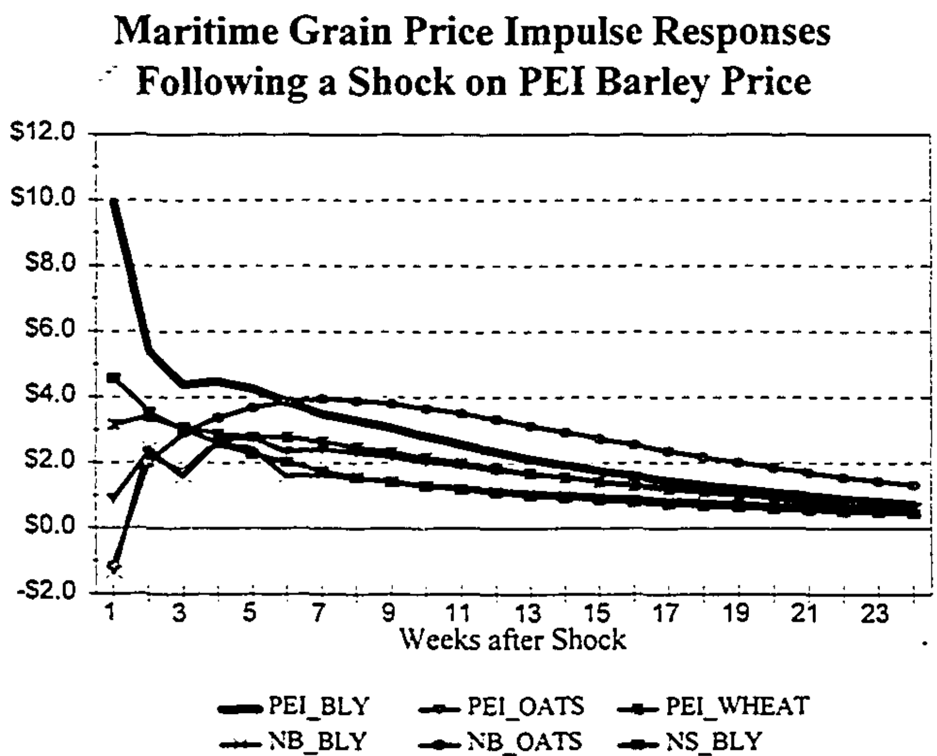


One of the surprising aspects of these results is the length of time required for local prices to respond to a shock at Thunder Bay in the first place, (at least six weeks for maximum response) and then the length of time for *all* prices to recover. This feature becomes more evident when compared to the response functions for a shock in a local price.

Figure 22 illustrates some selected Maritime grain price impulse responses following a shock on the P.E.I. barley price, which is dominant in the Atlantic provinces. In the first 6 to 8 weeks most of the local crops are influenced. Nova Scotia barley and P.E.I. wheat are more sensitive in the first three weeks while N.B. oats is influenced with a delay of 4 to 6 weeks. The magnitude of most of the responses does not exceed 40 percent of the initial shock.

In summary, this analysis suggests, as expected, N.B. prices are more influenced by

Figure 22:



external markets than are those of P.E.I.. In general, these results illuminate the failure of the law of one price in the short run (one month) and in some cases even in the longer run as revealed earlier.

4.8 An Application of the VEC Model: Forecasting

In order to benefit from the vector error correction analysis and, also, to gain a better understanding of price behavior in the local feed grain markets in the Maritimes, dynamic forecasting represents a useful application of the restricted VAR models. The procedures and results of this approach are discussed below.

The univariate autoregressive moving-average (ARMA) model is generally successful in time-series forecasting. However, as mentioned by Kaylen (1988), ARMA models fail to account for information about other potentially important variables. On the other hand, vector autoregression models do in fact incorporate this information. Previous research has shown that unrestricted VAR do not forecast well (Nerlove et al. (1979), Litterman (1986)). As a result, restricted VAR models with Bayesian priors accounting for error correction will be used.

Before running a forecast analysis from a vector error correction model, it is important to clarify certain key points. Because of the VEC model specifications, the forecasting procedure is dynamic, (i.e. the prediction depends upon multiple lagged variables). In order to obtain a reliable prediction, it must be assumed that the relationship between the past and the present will remain constant in the future. Also, the model must be free of autocorrelation.

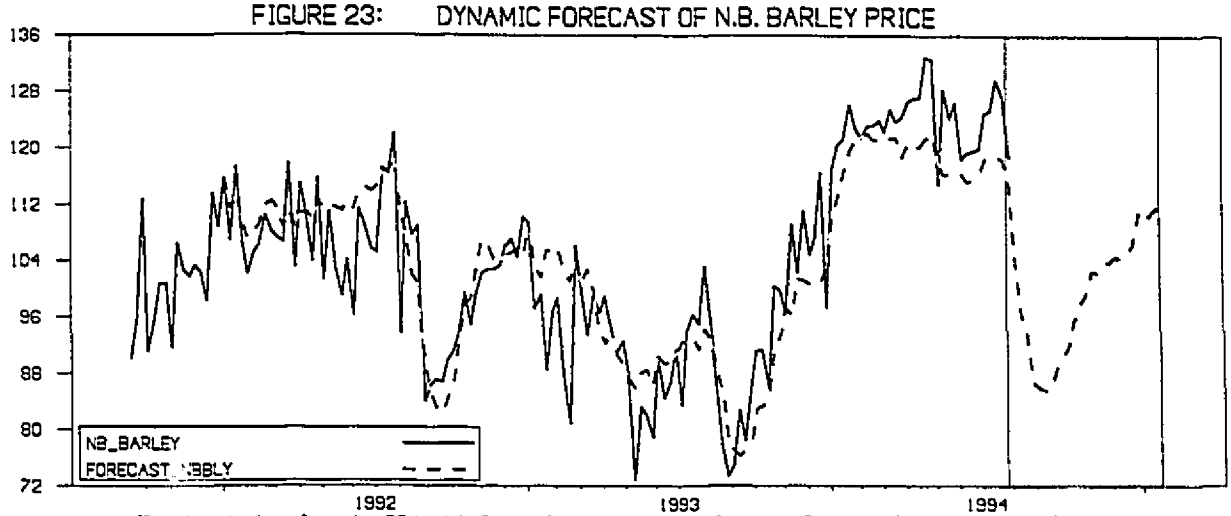
In the present analysis, the seasonality of feed grain marketing is key to the forecasting problem since the sales of feed grain occur mostly during the fall and diminish significantly as the crop year progresses. Therefore, seasona'ity is included as a deterministic dummy variable in the model in order to reflect sales of locally produced grain. Also, in a dynamic or multi-step forecast model, cointegrated series must be incorporated as exogenous variables.

In this thesis, the Bayesian approach with restrictions (VEC models used in the previous section) on the coefficients is utilized as a basis for forecasting. Figures 23, 24 and 25 show the dynamic forecast results for the three New Brunswick crops. The predicted grain prices are indicated by the broken lines from January 1992 to December 1994. In the shaded area of the graphs, the forecasted prices (broken line) are displayed from the first week of August 1994 to the last week of December 1994. The three N.B. figures exhibit very similar forecasting patterns: prices fall dramatically during the harvest period and then gradually increase from the beginning of September through to the end of the crop year. There is only a slight deviation in the case of oats where the harvest-low period is less extreme.

Similar forecast patterns may be observed in Figures 26 to 29, illustrating prices of barley, oats, feed wheat and mixed grain in Prince Edward Island. The case of Nova Scotia barley and corn (Figures 30 and 31) is different. The prediction appears less certain because the volume of local grain is much smaller and price is seemingly more variable than for New Brunswick and Prince Edward Island.

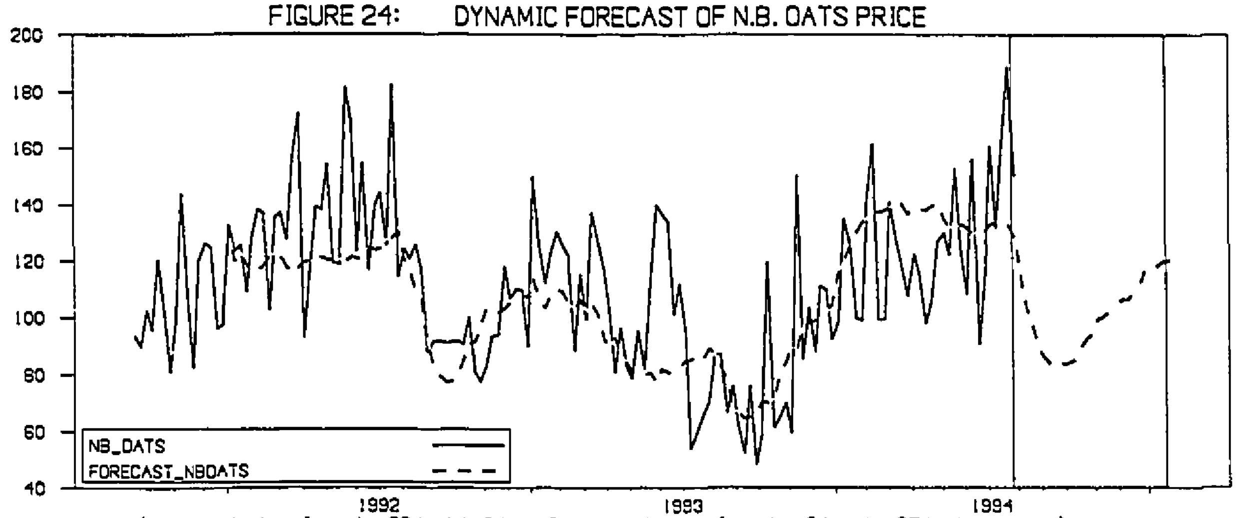
Although the data were collected on a weekly basis over three years (156 observations) and were found to be highly reliable in most cases, there are possible questions as to the ability of the model to forecast, particularly in the case of Nova Scotia. For example, the results of the Jarque-Bera test showed that N.S. corn had a non-normal distribution (Table 6), but a certain proportion of these results were obtained from low

FIGURE 23: DYNAMIC FORECAST OF N.B. BARLEY PRICE



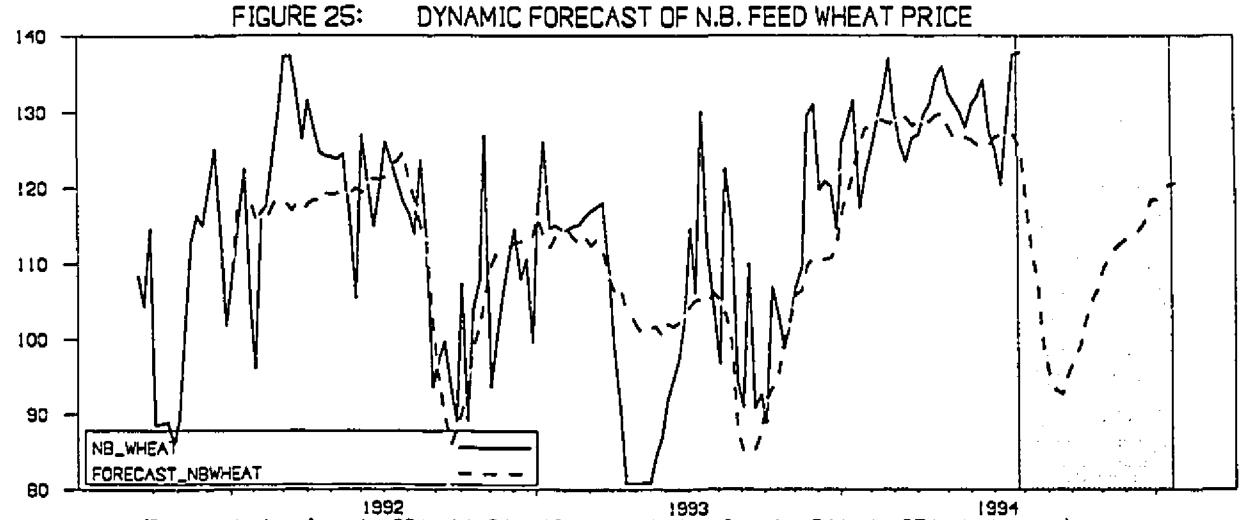
(Predicted prices from Jan.92 to July 94 and forecasted prices from Aug.94 to Jan.95 in shaded area)

FIGURE 24: DYNAMIC FORECAST OF N.B. OATS PRICE



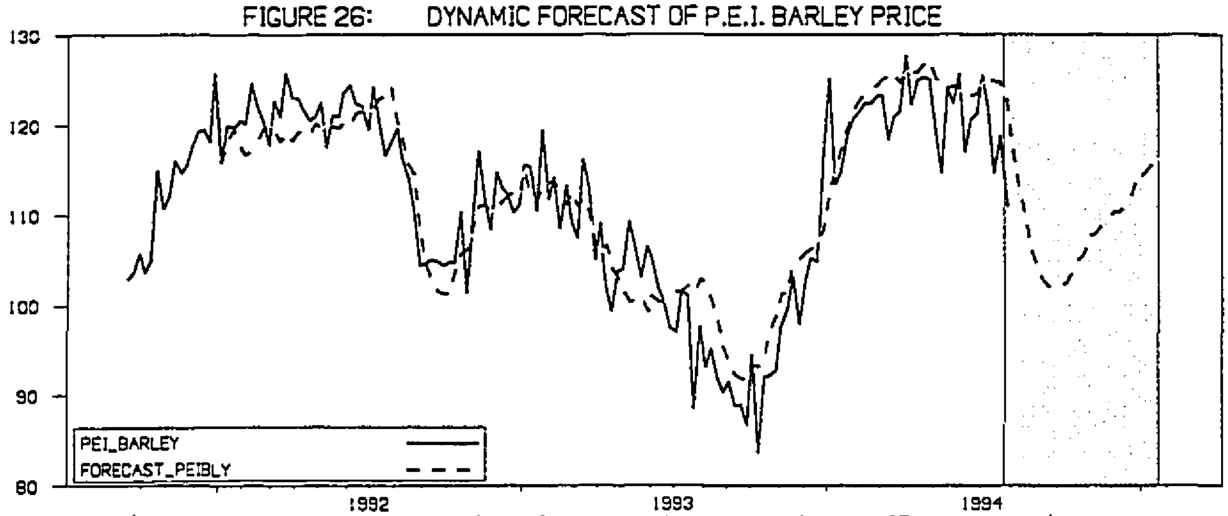
(Predicted prices from Jan.92 to July 94 and forecasted prices from Aug.94 to Jan.95 in shaded area)

FIGURE 25: DYNAMIC FORECAST OF N.B. FEED WHEAT PRICE



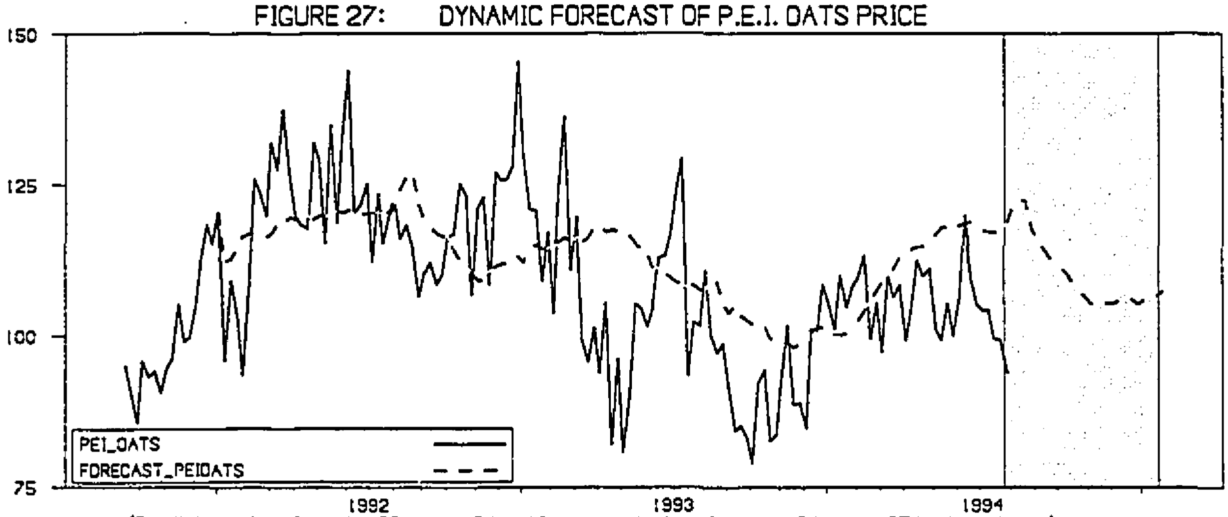
(Predicted prices from Jan.92 to July 94 and forecasted prices from Aug.94 to Jan.95 in shaded area)

FIGURE 26: DYNAMIC FORECAST OF P.E.I. BARLEY PRICE



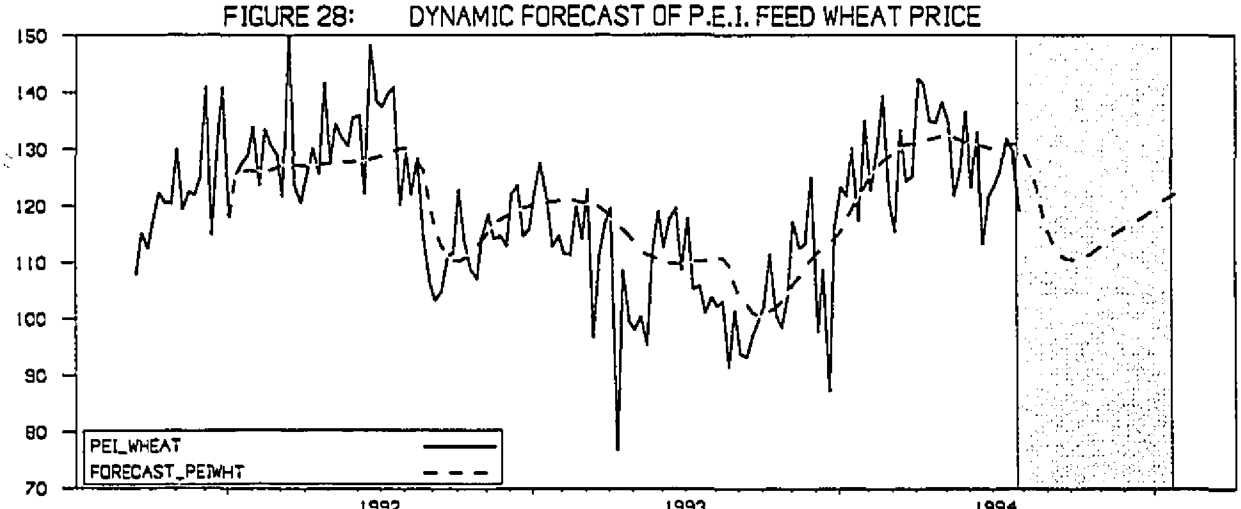
(Predicted prices from Jan.92 to July 94 and forecasted prices from Aug.94 to Jan.95 in shaded area)

FIGURE 27: DYNAMIC FORECAST OF P.E.I. OATS PRICE



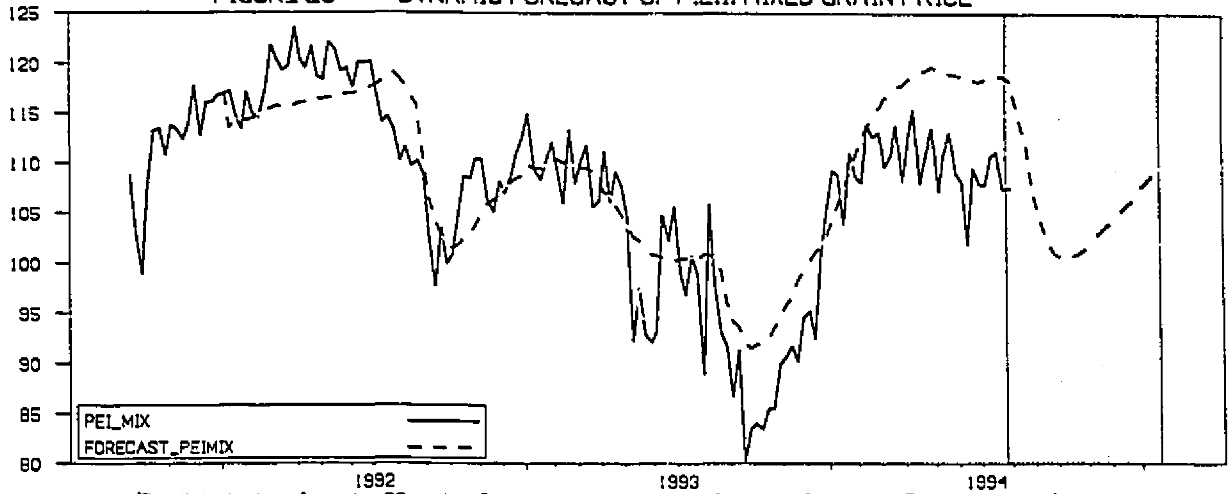
(Predicted prices from Jan.92 to July 94 and forecasted prices from Aug.94 to Jan.95 in shaded area)

FIGURE 28: DYNAMIC FORECAST OF P.E.I. FEED WHEAT PRICE



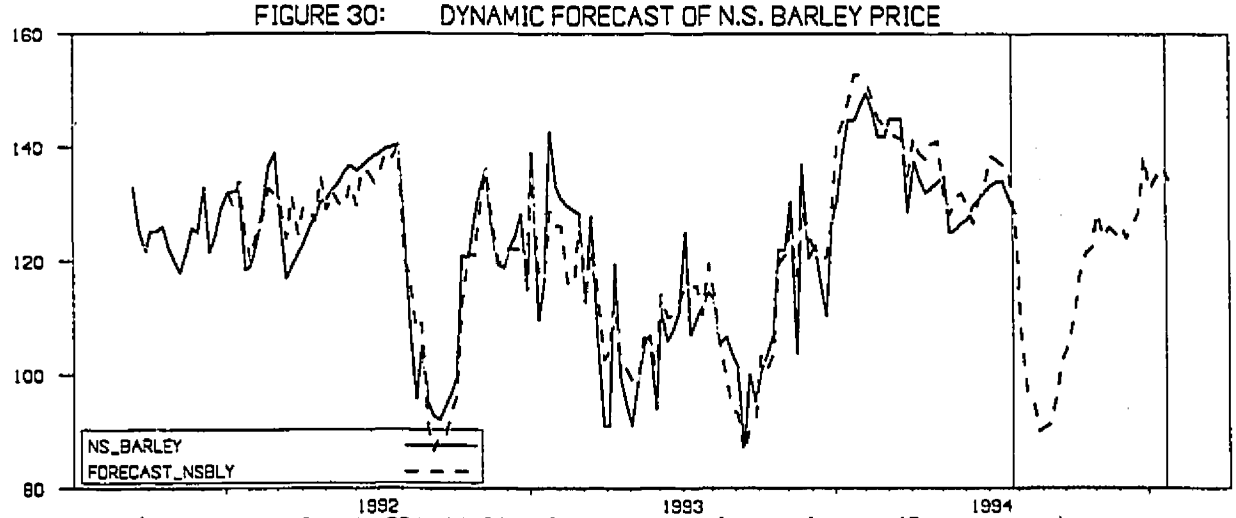
(Predicted prices from Jan.92 to July 94 and forecasted prices from Aug.94 to Jan.95 in shaded area)

FIGURE 29: DYNAMIC FORECAST OF P.E.I. MIXED GRAIN PRICE



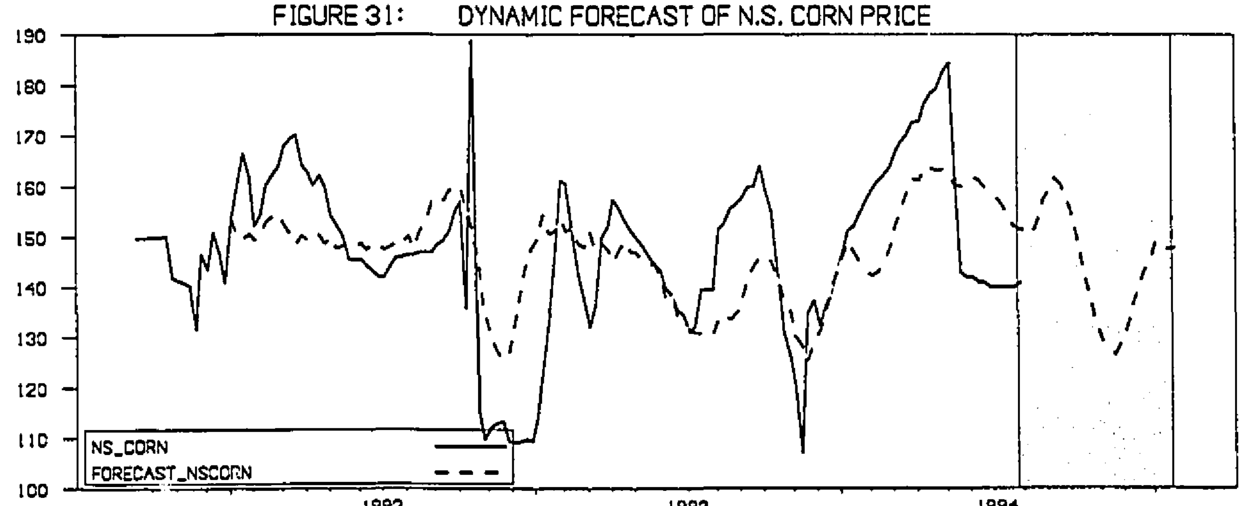
(Predicted prices from Jan.92 to July 94 and forecasted prices from Aug.94 to Jan.95 in shaded area)

FIGURE 30: DYNAMIC FORECAST OF N.S. BARLEY PRICE



(Predicted prices from Jan.92 to July 94 and forecasted prices from Aug.94 to Jan.95 in shaded area)

FIGURE 31: DYNAMIC FORECAST OF N.S. CORN PRICE



(Predicted prices from Jan.92 to July 94 and forecasted prices from Aug.94 to Jan.95 in shaded area)

tonnage numbers. Because of this small sample size, prices were extremely volatile and correspondingly difficult to validate.

In summary, these models are more accurate for a short run than a long run forecast. In the present analysis, with a historical database of only three years, forecasts of more than three months out-of-sample risk displaying certain inaccuracies. A larger database, such as one that draws upon more than just the three past years, would certainly be more reliable for forecasting purposes and would depict seasonal trends more precisely.

CHAPTER FIVE: CONCLUSIONS

The main focus of this thesis was to examine the pricing efficiency in small regional markets utilizing the Maritime feed grain markets as a case study. The objectives were to verify the existence of a consistent relationship between feed grain prices in the Maritimes and prices prevailing at Thunder Bay and Chatham, and to investigate the efficiency of prices in adjusting to external price shocks. This was done by applying multiple analytical techniques and performing various regression analysis on a unique database of weighted average prices of feed grains, initially captured for the GRIP programs and Statistics Canada requirements and including over 25,000 individual transactions. The results and the implications of the analysis of each of the characteristics and techniques are summarized below in the order in which they appear in the thesis.

5.1 Main Findings

The first stage of the thesis was to investigate the overall structure of grain production and pricing in the Maritime region (New Brunswick, Nova Scotia and Prince Edward Island). This revealed that P.E.I. is the largest grain producer of the region with approximately 60 percent of the volume while N.S., which accounts for more than 40 percent of feed grain usage, is the major consumer. As a by-product of production and utilization, the respective degrees of self-sufficiency were computed using two approaches: (a) Statistics Canada production and requirement estimates and (b) net inbound FFA shipments. The FFA approach was found to be more realistic, indicating that P.E.I., N.S. and N.B. were self-sufficient at 95, 25 and 44 percent, respectively, in total grain production, with P.E.I.

emerging as a surplus producer of barley and oats. These numbers also suggested that, on average for the crop years 1991-92 to 1993-94, the Maritimes imported approximately 47 percent of their total requirements. Based on this analysis, it appears that Statistics Canada production data overestimates grain production in Prince Edward Island.

An analysis of the structural characteristics of the regional feed grain market also revealed that a large number of farms produce grains in the Maritimes (2,346) but very few (96) are specialized in grain production (Statistics Canada, 1991, cat. 93-348). Many of the farms specialized in grain production are producing for the certified seed or flour milling markets. Off-farm sales of feed grain may be made to other farms producing livestock and poultry, to feed mills and/or to grain marketing and handling operations such as the Prince Edward Island Grain Elevator Corporation, the Nova Scotia Grain and Forage Commission or the Valley Grain Pool in New Brunswick.

The examination of grade and moisture content of Maritime feed grains showed that barley, which averaged very close to a number one grade, was generally of better and more consistent quality than oats, wheat, mixed grain or corn. The seasonality of local grain marketing was scrutinized as another factor accounting for variation in price relationships with external markets. In most cases, there was a heavy concentration of sales in the harvest period of August and September.

A variety of tests and transformations were applied to the database in order for the data to be rendered as reliable as possible. A representativeness analysis comparing commercial feed grain transactions (FFA database) against Statistics Canada production data indicated that FFA data represent between 30 and 40 percent of the overall Maritime feed grain production. The normality test of Jarque-Bera was constructed as a measure of consistency of price data over time and space. According to the results obtained, all price series were found to be normally distributed except for New Brunswick feed wheat and Nova

Scotia corn. Certain statistical measures suggest that there could be some question as to the consistency of the mean (weighted average) price as a measure of central tendency over time. This is especially true for periods when there are too few transactions to have a strong measure of confidence in the estimates. In effect, due to the seasonal concentration of marketing of feed grains in August to October, the degree of confidence associated with data from subsequent months tends to diminish.

Several other diagnostic tests were then applied to the database in order to learn the various characteristics of the series before any empirical work was attempted. First, the analysis of optimal lag length by the Akaike and Schwarz criteria revealed that a five or six-week lag for the purpose of vector autoregression was appropriate. Second, tests of unit roots and stationarity indicated that most of the individual series were non-stationary in mean. The only exceptions are N.S. barley and corn where the three tests performed on individual series rejected the hypothesis of the presence of a unit root. In such circumstances, cointegration analysis was the next logical step since individual non-stationary series can be found to be stationary as a system when there is evidence of long run relationships among non-stationary variables. The cointegration test results showed that there exists two relations of cointegration in N.B., three in P.E.I. and possibly seven or eight relations between the 13 variables studied. These results emphasized that the feed grain markets in the Maritime provinces are highly integrated.

With regard to the Law of One Price, one may say that it does not hold strictly for any locally produced feed grain compared to Western grains, at least in the short run. However, the test of absence of commodity arbitrage has shown that there exists some degree of arbitrage and, in some cases, such as barley in Nova Scotia and mixed grain in Prince Edward Island, the LOP is very close to holding, even in the short run. The LOP test results confirm previous empirical findings and suggest that long run price adjustments are usually systematic, and more likely to be observed. In the present analysis, with the use of lagged prices (quarterly price data), the LOP was found to hold for most of the Maritime grain crops in the long run.

The analysis of the symmetry of price transmission did not reveal any evidence of the exercise of market power by feed grain buyers in the Maritimes. This is due to the fact that very few regression coefficients appear to be statistically significant, for upward price adjustments as well as for falling prices at Thunder Bay or Chatham. In those few cases where coefficients were found to be significant with a level of at least 10 percent, Maritime prices appear to react more strongly to falling grain prices at Thunder Bay. However, the non-significance of most of the coefficients does not permit strong conclusions to be drawn.

Unrestricted vector autoregression on first differences of price series shed some light upon the dynamics of price adjustments of Maritime feed grain crops to Thunder Bay and Chatham prices. The results revealed that the pricing of a particular crop depends primarily upon its own price of the past two or three weeks and secondarily upon other local and external prices. The speed of adjustments to Thunder Bay or Chatham prices is relatively slow (four to six weeks) compared to adjustments to local dominant crops such as P.E.I. barley (one to three weeks). This lag period for price adjustments to Western grains could be due to a three week lead period for grain orders plus approximately ten days for grain delivery to the Maritimes.

Since the unrestricted VAR does not take into account the long run price relationships found in the cointegration analysis, the vector error correction (VEC) models were necessary in order to increase the reliability and efficiency, principally in terms of their forecasting ability. To achieve this, the author applied decompositions of forecast error variance and standard errors of N.B. and P.E.I. feed grain crops allocated to price innovations on local and external markets. The results of the analysis suggested that N.B. prices are much more influenced by Thunder Bay cash prices than are those of P.E.I.. It has also been shown that fluctuations in the N.B. barley price had important effects on wheat and oats pricing, especially in the short run. Moreover, as expected, P.E.I. barley prices were found to be the most endogenous of all Maritime grains. Being a dominant crop, P.E.I. barley was found to have a noticeable impact on the pricing of most of the local feed grain crops.

The calculation of price impulse responses also revealed that N.B. grain prices are more sensitive to Thunder Bay barley and wheat prices than are P.E.I. crops. Therefore, N.B. was the most responsive to external shocks. With regard to Thunder Bay price shocks on P.E.I., it was discovered that only P.E.I. oats appeared to be significantly influenced. The response of major Maritime crops to a shock on the P.E.I. barley price was also studied. The results indicated that N.S. barley and P.E.I. wheat are more sensitive in the three weeks following the shock while N.B. oats and P.E.I. mixed grain are influenced after a delay of four to six weeks.

Finally, the dynamic forecast models built as an application of the VEC models suggested that the Maritime grain prices follow a general seasonal pattern of low prices during the harvest season, then increasing gradually until the next crop. While these models may produce accurate short run forecasts, they may yield misleading results if they are used to make long run predictions (more than three months).

This thesis demonstrates the application of a variety of analytical techniques to a unique set of regional price data to test for pricing efficiency and the dynamics of price adjustments. Although the results were often weak in the short run, those for longer run price adjustment reflected a stronger response of Maritime feed grain prices to external markets.

As explained previously, the efficiency of prices in a regional market is proportional to the rapidity of the response to main markets. In the various analyses performed in this thesis, it has been found that the price adjustment to the external markets was at least one month. If one considers that it corresponds approximately to the lead time of order and transportation, Maritime feed grains prices may be considered efficient. However, efficiency might be improved if a better flow of information about prices was made available to producers and if the pooling organizations, which have a relatively large market share, could periodically release their expected pool return.

5.2 Recommendations for Further Research

This thesis has examined the pricing efficiency of Maritime feed grain markets and their price relation to Thunder Bay and Chatham. It has been found that the price of local grains in the Maritimes depend principally upon the price of competing products. In the past few decades, the cost of transportation has been subsidized by the Federal Government through programs such as the Western Grain Transportation Act (WGTA) and Feed Freight Assistance (FFA). However, as announced in the federal budget of February 1995, these programs will be terminated by the fall of 1995. Hence, following these new policy directions, it would be useful to analyze the impact of FFA removal on Maritime feed grain production and pricing. Moreover, subsequent work could be devoted to analysis of the resulting impact on livestock and poultry production in feed grain deficit regions.

In addition, further research could focus on an extensive analysis of the role of information in regional markets. For example, a study on the bargaining power of the Maritime grain producers could be conducted. In light of the apparent price increase after the harvest season, on-farm storage could result in significant gain for grain producers. Therefore, a study of factors affecting Maritime grain producer returns, such as pooling organizations, would be beneficial to the industry.

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Appendix A: Feed Grain Acreage in the Maritime Provinces

(area in acres)

Prince Edward Island	1971	1976	1981	1986	1991	1991 as % of 1971
Wheat*	5,788	15,500	7,313	6,545	8,714	151%
Oats	50,313	46,587	33,127	24,460	17,540	35%
Barley	32,134	26,090	53,237	68,002	84,183	262%
Mixed Grains	71,408	82,800	84,547	66,376	40,742	57%
Corn	131	649	289	710	465	355%
Spring Rye	13		7	36	33	254%
Soybeans			103	4,723	5,877	
Total	159,787	171,626	178,623	170,852	157,554	98.60%

Nova Scotia	1971	1976	1981	1986	1991	1991 as % of 1971
Wheat	4,090	2,002	1,784	6,300	1,510	37%
Oats	17,782	18,900	16,634	12,926	10,743	60%
Barley	8,699	4,546	8,612	12,762	13,067	150%
Mixed Grains	8,536	5,771	5,366	2,800	2,289	27%
Corn	2,969	2,887	4,562	4,883	3,808	128%
Spring Rye	48	17	59		108	225%
Soybeans	120	43	193	757	457	
Total	42,244	34,166	37,210	40,428	31,982	75.71%

New Brunswick	1971	1976	1981	1986	1991	1991 as % of 1971
Wheat	5,891	5,118	8,443	7,796	4,070	69%
Oats	51,187	48,182	36,671	26,993	21,755	43%
Barley	7,614	7,067	9,640	26,220	31,648	416%
Mixed Grains	8,897	6,481	4,974	4,133	2,997	34%
Corn	65	292	750	821	662	1018%
Spring Rye	47	2			864	1838%
Soybeans	17	9	53	146	44	
Total	73,718	67,151	60,531	66,109	62,040	84.16%

* Wheat represents the total area in acres of all types of wheat including spring wheat, durum wheat as well as winter wheat

Source: Statistics Canada, Census Overview of Canadian Agriculture: 1971-1991, pp. 65-73 and pp. 105-107.

Appendix B: Number of Farms Declaring Grain Production in the Maritimes

Prince Edward Island	1971	1976	1981	1986	1991
Wheat*	481	587	257	136	156
Oats	2,042	1,467	918	600	507
Barley	972	511	691	765	836
Mixed Grains	2,025	1,683	1,487	1,160	750
Corn	23	55	45	29	21
Spring Rye	2		18	58	31
Soybeans			12	83	110

Nova Scotia	1971	1976	1981	1986	1991
Wheat	229	129	99	74	57
Oats	1,568	1,352	1,060	718	681
Barley	516	291	359	458	454
Mixed Grains	489	331	258	136	113
Corn	87	67	95	94	69
Spring Rye	6	5	10		15
Soybeans	8	4	14	39	21

New Brunswick	1971	1976	1981	1986	1991
Wheat	306	256	309	213	101
Oats	2,385	1,908	1,357	921	829
Barley	450	353	355	487	510
Mixed Grains	315	223	163	110	83
Corn	24	36	45	23	20
Spring Rye	6	1		22	38
Soybeans	4	3	5	10	6

Source: Statistics Canada, Census Overview of Canadian Agriculture: 1971-1991, pp. 20-21, 65-73 and 105-107.

Appendix C: Farms Reporting More Than Half Their Income from Grain Sales

	1971	1976	1981	1986	1991
Prince Edward Island	11	139	90	94	63
Nova Scotia	9	44	58	63	13
New Brunswick	4	76	53	69	23

* Wheat represents the total area in acres of all types of wheat including spring wheat, durum wheat as well as winter wheat

Source: Statistics Canada, Census Overview of Canadian Agriculture: 1971-1991, pp. 20-21, 65-73 and 105-107.

Appendix D:

Farm Cash Receipts from Farming Operations

(in thousands of real dollars ($ 1993))

	Prince Edward Island				Nova Scotia				New Brunswick			
	Barley	Oats	Wheat	Total	Barley	Oats	Wheat	Total	Barley	Oats	Wheat	Total
1976	2,081	1,686	1,211	4,977	80	343	426	848	371	2,797	376	3,544
1977	1,894	1,169	968	4,031	107	264	646	1,017	300	1,825	450	2,575
1978	2,484	1,096	893	4,474	93	236	709	1,038	387	1,941	602	2,930
1979	3,298	1,411	913	5,622	109	244	699	1,052	560	2,112	594	3,266
1980	4,009	1,331	929	6,270	149	328	1,242	1,719	518	2,162	708	3,388
1981	4,347	1,104	663	6,114	225	352	1,838	2,415	720	2,541	762	4,023
1982	3,244	869	514	4,627	206	329	1,416	1,951	729	2,183	620	3,532
1983	2,758	725	444	3,927	245	346	1,226	1,817	853	1,946	631	3,430
1984	3,362	807	660	4,829	298	351	1,455	2,104	906	1,638	569	3,113
1985	3,916	728	716	5,360	255	307	1,231	1,793	1,364	1,846	652	3,862
1986	3,787	609	734	5,130	233	246	1,184	1,664	1,305	1,402	556	3,262
1987	2,963	432	645	4,039	221	192	1,187	1,600	1,263	1,117	521	2,900
1988	3,995	670	986	5,651	235	226	1,627	2,088	1,628	1,549	674	3,851
1989	4,797	568	844	6,210	247	221	1,471	1,939	1,889	1,576	613	4,078
1990	3,623	369	636	4,628	217	146	900	1,264	1,523	998	342	2,863
1991	4,592	200	733	5,525	141	63	458	661	1,789	335	321	2,445
1992	6,721	462	1,076	8,259	160	152	494	805	2,371	446	392	3,209
1993	4,790	236	1,153	6,179	228	98	620	739	2,177	291	393	2,861

Source: Statistics Canada, Agriculture Economic Statistics, December 1993.

Appendix E: Utilization of Feed Grain in the Maritime Provinces in 1991

New Brunswick

	No. heads	Factors (in metric tons per animal)							Consumption (in metric tons)							
		Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Total
Beef cattle	49,500	0.2580		0.1000		0.0180			12,771	0	4,950	0	891	0	0	18,612
Dairy cattle	48,200	0.4300	0.1380	0.1390	0.4150	0.0820	0.0750	0.2970	20,726	6,652	6,700	20,003	3,952	3,615	14,315	75,963
Sheep and lambs	9,300	0.0190	0.0050	0.0090	0.0070	0.0030			177	47	84	65	28	0	0	400
Hogs	120,900	0.0590	0.0330		0.1710	0.0620			7,133	3,990	0	20,674	7,496	0	0	39,293
Layers	502,000		0.0035		0.0158	0.0053		0.0011	0	1,757	0	7,932	2,661	0	552	12,901
Chickens	10,085,000		0.0004		0.0023	0.0007		0.0001	0	4,034	0	23,196	7,060	0	1,009	35,298
Turkeys	550,000		0.0013		0.0058	0.0020		0.0005	0	715	0	3,190	1,100	0	275	5,280
Horses	3,100			0.3460					0	0	1,073	0	0	0	0	1,073
Total									40,807	17,194	12,806	75,059	23,187	3,615	16,151	188,819

Nova Scotia

	No. heads	Factors (in metric tons per animal)							Consumption (in metric tons)							
		Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Total
Beef cattle	63,200	0.2360		0.0960		0.0180			14,915	0	6,067	0	1,138	0	0	22,120
Dairy cattle	62,000	0.3290	0.1050	0.1070	0.3150	0.0670	0.0610	0.2320	20,398	6,510	6,634	19,530	4,154	3,782	14,384	75,392
Sheep and lambs	30,100	0.0170	0.0040	0.0080	0.0060	0.0020			512	120	241	181	60	0	0	1,114
Hogs	229,200	0.1020	0.0930		0.0480	0.0490			23,378	21,316	0	11,002	11,231	0	0	66,926
Layers	881,000		0.0037		0.0167	0.0056		0.0012	0	3,260	0	14,713	4,934	0	1,057	23,963
Chickens	13,761,000		0.0004		0.0020	0.0006		0.0001	0	5,504	0	27,522	8,257	0	1,376	42,659
Turkeys	788,000		0.0012		0.0056	0.0020		0.0005	0	946	0	4,413	1,576	0	394	7,328
Horses	3,000			0.3460					0	0	1,038	0	0	0	0	1,038
Total									59,203	37,656	13,980	77,360	31,349	3,782	17,211	240,541

Prince Edward Island

	No. heads	Factors (in metric tons per animal)							Consumption (in metric tons)							
		Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Total
Beef cattle	47,900	0.3640		0.1720					17,436	0	8,233	0	0	0	0	25,674
Dairy cattle	36,500	1.1250		0.1240	0.0590	0.2260			41,063	0	4,526	2,154	8,249	0	0	55,991
Sheep and lambs	4,700	0.0250		0.0230					118	0	108	0	0	0	0	226
Hogs	175,800	0.1750	0.0360	0.0420	0.0360	0.0220			30,765	6,329	7,384	6,329	3,868	0	0	54,674
Layers	138,000		0.0040		0.0181	0.0060		0.0013	0	552	0	2,498	828	0	179	4,057
Chickens	1,496,000		0.0004		0.0023	0.0006		0.0001	0	598	0	3,441	898	0	150	5,086
Turkeys	4,000		0.0017		0.0079	0.0027		0.0070	0	7	0	32	11	0	28	77
Horses	1,900			0.3460					0	0	657	0	0	0	0	657
Total									89,381	7,486	20,914	14,453	13,853	0	357	146,443

Statistics Canada asked for collaboration at the ten provinces to provide them reliable coefficient of feed consumption in their respective province. The factors represent intake per animal output of 1991.

Source: Statistics Canada, Division de l'Agriculture, "Consommation de Céréales et de Graines Oléagineuses par le Bétail et la Volaille, Canada et Provinces, 1991"
Statistics Canada, Division de l'Agriculture, "Statistiques du Bétail", Cat. 23-603F, 1993.

APPENDIX F: Utilization of Feed Grain in the Maritime Provinces in 1992

New Brunswick

	No. heads	Factors (in metric tons per animal) Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Consumption (in metric tons) Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Total
Beef cattle	55,100	0.2620		0.1010		0.0180			14,436	0	5,565	0	992	0	0	20,993
Dairy cattle	43,400	0.4300	0.1380	0.1390	0.4160	0.0820	0.0760	0.2980	18,662	5,989	6,033	18,054	3,559	3,298	12,933	68,529
Sheep and lambs	8,500	0.0200	0.0050	0.0090	0.0080	0.0030			170	43	77	68	26	0	0	383
Hogs	131,900	0.0540	0.0290		0.1680	0.0600			7,123	3,825	0	22,159	7,914	0	0	41,021
Layers	506,000		0.0036		0.0162	0.0054		0.0011	0	1,822	0	8,197	2,732	0	557	13,308
Chickens	9,932,000		0.0004		0.0023	0.0007		0.0001	0	3,973	0	22,844	6,952	0	993	34,762
Turkeys	526,000		0.0013		0.0058	0.0020		0.0005	0	684	0	3,051	1,052	0	263	5,050
Horses	3,100			0.3460					0	0	1,073	0	0	0	0	1,073
Total									40,391	16,335	12,747	74,373	23,227	3,298	14,746	185,117

Nova Scotia

	No. heads	Factors (in metric tons per animal) Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Consumption (in metric tons) Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Total
Beef cattle	67,600	0.2410		0.0970		0.0180			16,292	0	6,557	0	1,217	0	0	24,066
Dairy cattle	54,500	0.3750	0.1210	0.1230	0.3630	0.0760	0.0710	0.2620	20,438	6,595	6,704	19,784	4,142	3,869	14,279	75,810
Sheep and lambs	26,200	0.0170	0.0040	0.0080	0.0060	0.0020			445	105	210	157	52	0	0	969
Hogs	224,800	0.1020	0.0930		0.0480	0.0490			22,930	20,906	0	10,790	11,015	0	0	65,642
Layers	886,000		0.0039		0.0173	0.0058		0.0012	0	3,455	0	15,328	5,139	0	1,063	24,985
Chickens	13,679,000		0.0004		0.0021	0.0006		0.0001	0	5,472	0	28,726	8,207	0	1,368	43,773
Turkeys	739,000		0.0012		0.0057	0.0020		0.0005	0	887	0	4,212	1,478	0	370	6,947
Horses	3,000			0.3460					0	0	1,038	0	0	0	0	1,038
Total									60,104	37,420	14,508	78,997	31,251	3,869	17,080	243,229

Prince Edward Island

	No. heads	Factors (in metric tons per animal) Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Consumption (in metric tons) Barley	Wheat	Oats	Corn	Soybean	Canola	Screenings	Total
Beef cattle	49,100	0.3590		0.2010		0.0380			17,627	0	9,869	0	1,866	0	0	29,362
Dairy cattle	35,200	1.1230		0.1240	0.0590	0.2270			39,530	0	4,365	2,077	7,990	0	0	53,962
Sheep and lambs	3,000	0.0340		0.0310		0.0030		0.0020	102	0	93	0	9	0	6	210
Hogs	185,400	0.1620	0.0440	0.0010	0.0430	0.0570			30,035	8,158	185	7,972	10,568	0	0	56,918
Layers	112,000		0.0038		0.0170	0.0057		0.0012	0	426	0	1,904	638	0	134	3,102
Chickens	1,518,000		0.0004		0.0023	0.0007		0.0001	0	607	0	3,491	1,063	0	152	5,313
Turkeys	6,000		0.0013		0.0021	0.0005		0.0061	0	8	0	13	3	0	37	60
Horses	1,900			0.3460		0.0360			0	0	657	0	68	0	0	726
Total									87,293	9,198	15,170	15,457	22,205	0	329	149,652

Statistics Canada asked for collaboration at the ten provinces to provide them reliable coefficient of feed consumption in their respective province. The factors represent intake per animal output of 1992.

Source: Statistics Canada, Division de l'Agriculture, "Consommation de Céréales et de Graines Oléagineuses par le Bétail et la Volaille, Canada et Provinces, 1992"
Statistics Canada, Division de l'Agriculture, "Statistiques du Bétail", Cat. 23-603F, 1993.

Appendix G: **Feed Freight Assisted Shipments by Feed Grains and by Province of Origin and Destination**

Crop year 1991-1992 (in tonnes)

Barley

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	39,735	2,828	4,329		46,892
N.S.	16	1,962	44	1,127	3,149
N.B.	7	882	23,806		24,695
Quebec		1	403		404
Ontario	58				58
Prairies	9,200	58,762	18,716	10,804	97,482
Maritimes	39,758	5,672	28,179	1,127	74,736
Total	49,016	64,435	47,298	11,931	172,680

Mixed Grain

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	6,592				6,592
N.S.		73		73	146
N.B.			12		12
Quebec					0
Ontario					0
Prairies					0
Maritimes	6,592	73	12	73	6,750
Total	6,592	73	12	73	6,750

Wheat

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	6,999	1,178	476		8,653
N.S.	11	1,332	31	763	2,137
N.B.		15	3,989		4,004
Quebec			177		177
Ontario	1,417	5,689	512		7,618
Prairies	5,259	38,990	27,239	25,367	96,855
Maritimes	7,010	2,525	4,496	763	14,794
Total	13,686	47,204	32,424	26,130	119,444

Corn

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	89				89
N.S.	16	1,684	44	971	2,715
N.B.		31	82		113
Quebec	381	1,380	5,814		7,575
Ontario	8,786	60,929	53,615	18,920	142,250
Prairies					0
Maritimes	105	1,715	126	971	2,917
Total	9,272	64,024	59,555	19,891	152,742

Oats

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	4,017	430	340		4,787
N.S.	5	716	31	417	1,169
N.B.	4	531	2,902		3,437
Quebec	1	90	48		139
Ontario					0
Prairies	1,677	6,420	5,415	1,517	15,029
Maritimes	4,026	1,677	3,273	417	9,393
Total	5,704	8,187	8,736	1,938	24,565

Rye

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	33		36		69
N.S.		78		44	122
N.B.					0
Quebec					0
Ontario					0
Prairies		917			917
Maritimes	33	78	36	44	191
Total	33	995	36	44	1,108

Source: Agriculture and Agri-Food Canada, Livestock Feed Bureau, 1992.

Appendix II: **Feed Freight Assisted Shipments by Feed Grains and by Province of Origin and Destination**
Crop year 1992-1993 (in tonnes)

Barley

Origin	Destination: P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	59,949	6,404	2,971		69,324
N.S.		5,158			5,158
N.B.		2,315	23,103		25,418
Quebec	507	-505	1,837		1,839
Ontario		30	62		92
Prairies	2,293	40,091	14,131	4,475	60,990
Maritimes	59,949	13,877	26,074		99,900
Total	62,749	53,493	42,104	4,475	162,821

Mixed Grain

Origin	Destination: P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	5,762	116	23		5,901
N.S.		81			81
N.B.			2		2
Quebec					0
Ontario					0
Prairies					0
Maritimes	5,762	197	25		5,984
Total	5,762	197	25		5,984

Wheat

Origin	Destination: P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	8,793	20	320		9,133
N.S.		441			441
N.B.		7	3,380		3,387
Quebec			488		488
Ontario					0
Prairies	10,522	66,765	40,707	25,391	143,385
Maritimes	8,793	468	3,700		12,961
Total	19,315	67,233	44,895	25,391	156,834

Corn

Origin	Destination: P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.		14			14
N.S.	437	-1,682	533	3,234	2,522
N.B.	278	276	509		1,063
Quebec	226	2,188	10,148		12,562
Ontario	6,923	53,388	35,713	8,348	104,372
Prairies					0
Maritimes	715	-1,392	1,042	3,234	3,599
Total	7,864	54,184	46,903	8,348	117,299

Oats

Origin	Destination: P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	5,175	849	575		6,599
N.S.		1,354	28	1	1,383
N.B.		288	3,176		3,464
Quebec		63	78		141
Ontario					0
Prairies	728	4,133	3,971	275	9,107
Maritimes	5,175	2,491	3,779	1	11,446
Total	5,903	6,687	7,828	276	20,694

Rye

Origin	Destination: P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	4				4
N.S.		87	225		312
N.B.			181		181
Quebec					0
Ontario					0
Prairies		28			28
Maritimes	4	87	406		497
Total	4	115	406		525

Source: Agriculture and Agri-Food Canada, Livestock Feed Bureau, 1993.

Appendix I: **Feed Freight Assisted Shipments by Feed Grains and by Province of Origin and Destination**
Crop year 1993-1994 (in tonnes)

Barley

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	39,650	6,511	2,227	545	48,933
N.S.		5,199			5,199
N.B.		1,563	27,033		28,596
Quebec			1,585		1,585
Ontario			9		9
Prairies	435	27,651	11,079	5,208	44,373
Maritimes	39,650	13,273	29,260	545	82,728
Total	40,085	40,924	41,933	5,753	128,695

Mixed Grain

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	6,734	585	53		7,372
N.S.		265			265
N.B.		120	101		221
Quebec					0
Ontario					0
Prairies					0
Maritimes	6,734	970	154	0	7,858
Total	6,734	970	154	0	7,858

Wheat

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	11,617	233	20		11,870
N.S.		1,602			1,602
N.B.		148	2,599		2,747
Quebec			469		469
Ontario	7		4		11
Prairies	7,351	98,310	49,739	24,957	180,357
Maritimes	11,617	1,983	2,619	0	16,219
Total	18,975	100,293	52,831	24,957	197,056

Corn

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	75				75
N.S.		1,947			1,947
N.B.			29		29
Quebec	394	6,972	25,748		33,114
Ontario	4,813	30,936	14,653	15,506	65,908
Prairies					0
Maritimes	75	1,947	29	0	2,051
Total	5,282	39,855	40,430	15,506	101,073

Oats

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	4,308	952	1,043		6,303
N.S.		2,860	641		3,501
N.B.		490	3,780		4,270
Quebec			18		18
Ontario					0
Prairies	473	1,265	1,483	1,708	4,929
Maritimes	4,308	4,302	5,464	0	14,074
Total	4,781	5,567	6,965	1,708	19,021

Rye

	Destination				
Origin	P.E.I.	N.S.	N.B.	NFLD	Total
P.E.I.	4	25			29
N.S.		577	64		641
N.B.			41		41
Quebec					0
Ontario					0
Prairies					0
Maritimes	4	602	105	0	711
Total	4	602	105	0	711

Source: Agriculture and Agri-Food Canada, Livestock Feed Bureau, 1994.

Appendix Table J:

MONTHLY TRANSACTIONS OF BARLEY IN PRINCE EDWARD ISLAND FOR CROP YEARS 1991-92 TO 1993-94

Crop year 1991-92		# Trans.	Total Volume (M.T.)	Average Price	Weighted Price	Standard Deviation	Confidence Level (99%) Lower	Upper
August	1991	2581	29417.24	$105.87	$106.00	6.03	$105.70	$106.31
September	1991	424	5188.58	$107.95	$108.75	7.88	$107.76	$109.74
October	1991	79	799.21	$111.10	$111.39	9.25	$108.70	$114.07
November	1991	86	1033.31	$119.05	$118.71	8.87	$116.24	$121.18
December	1991	78	1094.50	$123.72	$123.48	9.47	$120.72	$126.25
January	1992	106	1481.19	$120.95	$120.90	8.53	$118.77	$123.04
February	1992	93	1063.16	$121.69	$121.57	8.67	$119.25	$123.89
March	1992	113	1237.26	$124.99	$124.35	8.09	$122.39	$126.32
April	1992	98	1130.87	$125.24	$124.68	10.26	$122.01	$127.35
May	1992	107	1138.96	$122.72	$123.05	9.98	$120.56	$125.54
June	1992	179	2120.61	$127.10	$127.81	7.01	$126.46	$129.16
July	1992	154	1590.09	$122.66	$122.44	6.57	$121.08	$123.81
		4098	**47294.98**	**$119.42**	**$110.76**			

Crop year 1992-93		# Trans.	Total Volume (M.T.)	Average Price	Weighted Price	Standard Deviation	Confidence Level (99%) Lower	Upper
August	1992	1813	22365.98	$110.86	$111.27	6.19	$110.90	$111.65
September	1992	1211	19211.46	$110.98	$110.49	7.31	$109.95	$111.04
October	1992	128	4014.80	$112.20	$107.95	11.19	$105.40	$110.50
November	1992	142	2296.84	$118.96	$116.05	11.21	$113.62	$118.47
December	1992	124	1957.63	$116.87	$114.53	10.80	$112.03	$117.04
January	1993	92	1490.08	$117.92	$115.91	11.52	$112.81	$119.01
February	1993	118	1899.29	$114.75	$114.54	12.46	$111.58	$117.50
March	1993	137	2154.27	$111.77	$110.69	14.87	$107.41	$113.97
April	1993	217	2445.71	$109.60	$109.20	12.95	$106.93	$111.47
May	1993	142	2005.10	$110.52	$110.43	15.93	$106.98	$113.88
June	1993	144	1895.94	$104.32	$104.70	15.21	$101.43	$107.97
July	1993	166	1898.88	$99.89	$100.32	15.40	$97.23	$103.40
		4434	**63635.98**	**$111.55**	**$110.66**			

Crop year 1993-94		# Trans.	Total Volume (M.T.)	Average Price	Weighted Price	Standard Deviation	Confidence Level (99%) Lower	Upper
August	1993	1691	18589.90	$96.68	$96.49	7.61	$96.01	$96.97
September	1993	1114	13431.22	$94.08	$94.14	9.63	$93.40	$94.89
October	1993	297	3330.01	$95.49	$95.73	14.52	$93.56	$97.90
November	1993	126	1560.18	$102.49	$103.21	11.91	$100.48	$105.95
December	1993	144	1746.35	$110.92	$110.59	17.24	$106.88	$114.29
January	1994	108	1215.14	$121.18	$118.13	13.53	$114.77	$121.49
February	1994	95	1265.26	$124.69	$124.19	9.99	$121.54	$126.83
March	1994	99	1513.63	$124.64	$122.81	10.57	$120.07	$125.55
April	1994	126	1365.36	$126.87	$128.26	9.61	$126.05	$130.47
May	1994	152	1562.32	$122.52	$124.62	11.39	$122.23	$127.00
June	1994	156	1601.74	$125.19	$126.34	10.32	$124.21	$128.47
July	1994	104	1007.10	$119.99	$122.43	13.57	$118.99	$125.86
		4212	**48188.21**	**$101.95**	**$101.96**			

Source: Agriculture and Agri-Food Canada, Livestock Feed Bureau, FFA claims 1991-92 to 1993-94.

Appendix Table K:

MONTHLY TRANSACTIONS OF FEED WHEAT IN NEW BRUNSWICK FOR CROP YEARS 1991-92 TO 1993-94

Crop year 1991-92		# Trans.	Total Volume (M.T.)	Average Price	Weighted Price	Standard Deviation	Confidence Level (99%) Lower	Upper
August	1991	72	1227.97	$102.48	$103.13	12.51	$99.32	$106.93
September	1991	48	985.48	$101.54	$104.07	10.88	$100.02	$108.12
October	1991	1	20.37	$94.60	$94.60	0.00	$94.60	$94.60
November	1991	18	245.36	$119.21	$120.70	6.57	$116.70	$124.70
December	1991	4	78.53	$121.25	$119.30	6.50	$110.92	$127.68
January	1992	13	317.64	$104.14	$99.60	12.34	$90.77	$108.43
February	1992	6	292.19	$129.32	$120.94	12.16	$108.13	$133.75
March	1992	15	233.14	$139.40	$140.19	3.19	$138.07	$142.32
April	1992	3	70.41	$128.83	$127.65	6.41	$118.11	$137.20
May	1992	10	249.27	$120.34	$119.00	16.59	$105.47	$132.53
June	1992	11	94.82	$128.77	$130.95	4.81	$127.21	$134.70
July	1992	1	18.98	$135.11	$135.11	0.00	$135.11	$135.11
		202	**3834.16**	**$118.75**	**$110.43**			

Crop year 1992-93		# Trans.	Total Volume (M.T.)	Average Price	Weighted Price	Standard Deviation	Confidence Level (99%) Lower	Upper
August	1992	12	202.91	$118.10	$118.98	13.87	$108.64	$129.31
September	1992	48	1041.76	$105.16	$102.91	16.83	$96.64	$109.18
October	1992	27	528.18	$108.17	$113.30	16.77	$104.97	$121.63
November	1992	3	71.03	$109.89	$111.31	10.98	$94.96	$127.67
December	1992	10	376.85	$119.90	$120.88	5.12	$116.70	$125.05
January	1993	15	405.43	$122.63	$122.54	8.53	$116.85	$128.22
February	1993	1	28.36	$114.50	$114.50	0.00	$114.50	$114.50
March	1993	5	133.77	$118.00	$118.29	7.00	$110.21	$126.36
April	1993	1	26.76	$95.00	$95.00	0.00	$95.00	$95.00
May	1993	2	53.43	$95.00	$95.00	0.00	$95.00	$95.00
June	1993	6	104.10	$113.33	$111.79	8.50	$102.84	$120.74
July	1993	5	104.95	$81.60	$69.27	39.12	$24.14	$114.41
		135	**3077.53**	**$108.44**	**$110.45**			

Crop year 1993-94		# Trans.	Total Volume (M.T.)	Average Price	Weighted Price	Standard Deviation	Confidence Level (99%) Lower	Upper
August	1993	36	424.87	$105.26	$106.33	16.20	$99.36	$113.29
September	1993	42	497.44	$98.97	$101.63	10.45	$97.47	$105.80
October	1993	7	144.75	$114.29	$113.14	2.43	$110.77	$115.52
November	1993	9	284.96	$129.21	$127.17	10.63	$118.04	$136.31
December	1993	17	462.85	$127.00	$127.50	11.63	$120.23	$134.78
January	1994	4	76.38	$125.08	$126.83	15.15	$107.28	$146.37
February	1994	2	60.26	$143.65	$143.69	1.35	$141.23	$146.16
March	1994	4	42.48	$130.00	$130.00	0.00	$130.00	$130.00
April	1994	10	98.91	$136.00	$136.34	2.00	$134.70	$137.97
May	1994	5	61.62	$141.60	$142.23	5.27	$136.16	$148.31
June	1994	6	88.81	$140.21	$142.65	6.42	$135.89	$149.41
July	1994	4	87.36	$135.90	$133.84	10.12	$120.80	$146.89
		146	**2330.69**	**$115.23**	**$119.21**			

Source: Agriculture and Agri-Food Canada, Livestock Feed Bureau, FFA claims 1991-92 to 1993-94.

Appendix Table L: PUBLISHED RAIL RATES
Before and After Confidential Rates

BARLEY Ex Thunder Bay or Armstrong

Destination		Prior to October 1, 1994 (per metric tonne)	Effective October 1, 1994 (per metric tonne)	Difference
Edmunston, NB	Cargo Flo	$56.00	$37.79 (1)(2)	$18.21
	Mill		$38.41 (1)(3)	$17.59
Moncton, NB	Cargo Flo	$57.54	$41.45 (1)(2)	$16.09
	Mill		$46.61 (1)(3)	$10.93
Truro, NS		$54.67	$45.98 (1)(3)	$8.69
New Minas, NS		$61.73	$45.98 (1)(3)	$15.75
			Average difference:	**$14.54**

Source: CN 4484 D

CORN Ex Chatham

Destination	Prior to October 1, 1994 (per metric tonne)	Effective October 1, 1994 (per metric tonne)	Difference
Edmunston, NB	$61.51	$32.77	$28.74
Moncton, NB	$56.22	$40.52	$15.70
Truro, NS	$54.01	$39.33	$14.68
New Minas, NS	$58.42	$39.33	$19.09
		Average difference:	**$19.55**

Source: CN 4436 A

(1) Hopper Cars of 4550 cu Capacity
(2) Cargo Flo Rates Truck Loading Charges Included
(3) Rate Delivered To Mill