THE UNIVERSITY OF MANITOBA

AN ECONOMETRIC ANALYSIS OF RAPESEED BASIS BEHAVIOR

by

WILLIAM D. MOONEY

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF AGRICULTURAL ECONOMICS

WINNIPEG, MANITOBA

February, 1985

AN ECONOMETRIC ANALYSIS OF RAPESEED BASIS BEHAVIOR

BY

WILLIAM D. MOONEY

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

ABSTRACT

Rapeseed is extremely important to the cash flows, diversification possibilities, and crop rotation plans of prairie farmers. The value added contribution of the edible oil processing industry to the western Canadian economy is also considerable. Hence, the analysis of major factors that may affect rapeseed production is warranted. Basis behavior has been identified as such a factor. It is a major problem contributing to producer marketing risks and to a reluctance to grow rapeseed. In addition, basis variability has added to crusher/processor financial problems and exporter marketing risks.

Theoretically the basis should represent full marketing costs. The basis is the price difference between a futures price and a local cash quote (street price or instore price). In practice the large basis levels which have occured in the rapeseed market have not accurately represented the costs associated with marketing and therefore have discouraged both marketing and production. Another problem concerning basis behavior is its variability which contributes additional marketing risks to hedging strategies for both producers and crushers.

The objectives of this study were:

1. to identify the factors that influence futures and cash prices and thus determine the basis.

2. to estimate the degree to which each of these factors affect basis behavior.
3. to discuss the potential impact of basis risk on hedging effectiveness.
4. to provide insight into future basis changes.

Established basis theory and information specific to the rapeseed industry was used to construct a simultaneous equation econometric model of the rapeseed market. The model was estimated using the 'two stage least-squares' regression technique.

From the regression analysis, predicted values of street and cash bases were generated. Statistical and graphical evidence suggested that the predicted values fit the observed basis levels well, allowing further conclusions to be drawn about basis behavior.

The major findings of the study were as follows:

1. both the street and cash bases are subject to a general widening trend caused by increases in elevation and storage tariffs.
2. the street basis is influenced by delivery quota restrictions. In particular, highly restrictive quotas cause a widening of the basis.
3. the cash basis is generally more varible than the street basis and this is due to the effects of variable producer car stocks in Vancouver.
4. compounding the problem of variability of the cash price basis and contributing to abnormal basis levels is the inadequate degree of arbitrage opportunities in the export market.

5. both street and cash bases are widened (narrowed) by an increase (decrease) in interest rates.

The study concludes with possible solutions and recommendations to alleviate the problem of high and variable rapeseed basis behavior. These recommendations included:

1. the relaxation of delivery quotas to allow optimal delivery/storage decisions by producers.
2. the reduction of institutional constraints upon the delivery of stocks to the futures market, in order to allow arbitrage activities in the cash grain market.
3. hedgers should be cognizant of potential basis movements during periods when elevation tariffs and interest rates are changing.

ACKNOWLEDGEMENTS

I would like to extend my appreciation first, and foremost, to Dr. Colin A. Carter, my major advisor. His support, advice and confidence has contributed to this thesis as well as my overall program of studies. I would also like to express my thanks to the other members of my committee: Dr. R.M.A. Loyns, Dr. D.F. Kraft, and Mr. D. Ford for their advice, comments, and time spent reading the thesis.

I would like to acknowledge and thank the Government of Alberta's Farming for the Future program which funded this research. My appreciation is further extended to the numerous contributors of the data and information required by this study. My gratitude must also be conveyed to Audrey Bonneau for the hours of typing she endured.

The acknowledgements would not be complete without noting the invaluable academic and non-academic interaction provided by my colleagues in the "Annex" and the staff of the Department of Agricultural Economics. Special thanks is bestowed to Dr. E.W. Tyrchniewicz for arousing my curiosity and interest in this field of study.

Finally, I dedicate this thesis to my family and friends for their support, understanding, and encouragement during the periods of doubt.

TABLE OF CONTENTS

<u>Appendix</u> <u>page</u>

LIST OF TABLES

LIST OF FIGURES

Chapter I

INTRODUCTION

Rapeseed,[1] often referred to as Canada's "Cinderella" crop has become a remarkable success over the relatively short time period since its introduction to western Canada in 1943. In 1979-80, a record production area of 8.42 million acres was achieved, to supply not only domestic but significant export markets.[2] Rapeseed's contribution to the crop income of prairie farmers is second only to wheat. The 1979-83 five-year average of farm cash receipts showed rapeseed accounted for $658.7 million or 11.7 percent of prairie crop production value.[3]

To reach these achievements numerous production problems had to be addressed. Canadian plant breeders succeeded in reducing the erucic acid level in oils derived from new rapeseed varieties below an industry imposed and later legislated level of 5%. The reduction of glucosinolates present in rapeseed meals derived from rapeseed to a level acceptable by the feed industry was also accomplished through varietal breeding. Current production research involves advancement of higher

---

[1] Most of the rapeseed now grown in Canada is of a technically improved type known as canola. To be graded canola type the rapeseed must contain less than 5 percent erucic acid in its derived oil and less than 3 mg/g glucosinolate in the meal. Since Canada is the only country to adopt the canola grade, the crop will be referred to as rapeseed throughout this thesis.

[2] Statistics Canada, Field Crop Reporting Series, publication #22-002 #8, 1980.

[3] Statistics Canada, Grain Marketing Unit, unpublished data, Ottawa.

yielding hybrids, the development and pending registration of triazene resistant varieties to allow for better weed control, and the potential introduction of a more drought/heat tolerant and disease resistant species *Brassica juneca*, which would allow expansion into the dark brown soil zones.

Concommitant to the increase of rapeseed production by producers in western Canada was an evolution of the system of marketing rapeseed. The major institutional change was the initiation of rapeseed futures contract trading by the Winnipeg Commodity Exchange in 1963. This aspect of the marketing system performs two major functions:

1. allows the market participants to offset their cash market transactions via futures market transactions (i.e. hedging),
2. provides market information in the form of price signals to the market participants.

A point has now been reached where production problems are no longer the sole major concern of the industry. Marketing problems have recently become significant in preventing rapeseed from achieving its potential importance in Canadian agriculture. These marketing problems include:

1. the presence of Japanese and European Economic Communities' protectionist tariff policies which restrict the imports of Canadian rapeseed value added byproducts, oil and meal.
2. regulatory controls on delivery of rapeseed to Vancouver against futures market price.

3. the attainment of rail transportation rates that favour the movement of the value added products, oil and meal from western to eastern Canada, instead of raw seed.
4. restrictive post-harvest delivery quotas place marketing constraints upon rapeseed growers, processors and exporters.
5. concentration and vertical integration of elevator and exporting companies which may allow some measure of market power to be exerted at opportune moments.
6. restricted railcar and terminal storage availability causes the movement of rapeseed to export position to be governed by a regulatory body and not totally by market situations.

This study will address another marketing concern, that of basis behavior, which drew great attention from industry and regulatory participants in 1980 and will undoubtedly be the focus of concerns in the future. The problem of basis behavior also incorporates some aspects of the other rapeseed marketing problems outlined above.

1.1 THE PROBLEM SETTING

One of the most important of the above marketing concerns is the size and variability of the basis. While there are many definitions of basis, it is generally accepted as the price difference between a dominant (or nearby) futures price and a local cash quote.[4] The street price basis is the difference between the futures price and the elevator or

---

[4] The literature contains many definitions of basis however, the one provided above is consistent with all. For further examples see Peck (1975, p.412), Nosker (1981, p. 75), and Carter and Loyns (1983, p. 81).

crusher price. The F.O.B. Vancouver price is substituted for the street price to determine the cash price basis. At times in the recent past, crushing plants and grain companies have discounted futures prices heavily when buying from producers at local delivery points, resulting in a large basis. Theoretically in a competitive market, the basis should represent full marketing costs. In practice the large basis levels which have occured in the rapeseed market have not accurately represented the costs associated with marketing and therefore may have discouraged marketing and production. While basis variability is necessary to provide signals to market participants, excesive basis variability contributes additional marketing risks to hedging strategies for both producers and crushers.

1.2 HEDGING MOTIVATION FOR PRODUCERS AND PROCESSORS

Hedging is the execution "of an equal and opposite transaction between the cash and futures market to protect or lock in a specified price for some future date."[5] Thus the hedger is attempting to protect himself from an adverse price change. Typically the hedger is a trader of futures contracts who is directly involved with the commodity's production, marketing, and processing and is therefore confronted with cash price variability. In the case of the rapeseed producers, they face the risk associated with street price variability. Oilseed processors are confronted with price variability when making purchase commitments and in holding rapeseed stocks. Hedging, however, transforms the risk associated with cash price changes for a basis risk, which is associated

---

[5] D. Nosker, Futures Handbook for Farmers, Doane Agricultural Services, Inc., second edition, 1981. p. 76.

with changes in the futures/cash price differential. Therefore, hedging practices are risk reducing only if basis variability is less than cash price variability. If there is no possibility of basis change a "perfect hedge" results and the losses (gains) caused by changes in cash prices are offset by gains (losses) in the futures market.[6] Basis, however, is not perfectly predictable, but in most functioning markets has approximately 10 percent of the variability of the cash price.[7] Since the factors that influence futures market prices similarily affect cash prices and vice versa, the resulting price differential is anticipated to be stable. However, recent observations of rapeseed basis behavior indicate an increased price variability which will be addressed in Chapter III of this report. This variability diminishes the attractiveness of hedging as a means of reducing the risk of adverse price changes.

1.3 NEED FOR THE STUDY

Rapeseed is extremely important to the absolute incomes, cash flows, diversification possibilities, and crop rotation plans of prairie farmers. It is also the primary raw product for a large edible oil processing industry in Western Canada. Hence it is valuable to analyze of any factor that may affect rapeseed production and/or marketing. Basis behavior has been identified as such a factor.

---

[6] Many examples of a perfect hedge exist throughout the literature. (See for example, Loyns (1981 pp. 20-22.)

[7] C. Carter and R.M.A. Loyns, Hedging Canadian Grain, Winnipeg Commodity Exchange, 1983, p. 40.

While the store of economic analysis of Canadian rapeseed marketing is large, most studies have centered on either domestic supply/demand analysis (Lowe and Perkins, 1979; Kulshereshtha et al, 1979; Perkins, 1979; Craddock, 1973) or international trade analysis (Griffith and Meilke, 1980 and 1982; Furtan, Nagy and Storey, 1978; and Swallow, 1982). Only two previous studies have included futures market or futures prices influence upon rapeseed pricing and production practices (Martin and Storey, 1975 and Campbell, 1976 respectfully). In an extensive literature search, no previous study has been found to have analyzed rapeseed basis behavior; in fact no prior studies could be found on identification of factors contributing to basis movements of its major substitute product, soybeans.

Most studies of the basis behaviour of other commodities have incorporated relatively simple analytical techniques such as single equation econometric analysis (Ward and Dasse, 1977; and Kahl, 1979). This study, however, will utilize an alternative methodology. A simultaneous equation technique in which the basis is endogenously determined will be employed to analyze its behavior. Therefore, in addition to identifying the factors influencing basis behavior, this thesis will augment the existing body of literature concerning models future and cash price determination.

1.4 OBJECTIVES AND OUTLINE OF THE STUDY

Traditionally, basis changes (especially the cash basis) in most commodities have been small, enabling producers and other hedgers to accurately predict subsequent basis movements.[8] However, rapeseed basis behaviour has been highly variable.[9] Since the effectiveness of hedging is directly dependent upon a predictable future basis, the investigation of factors influencing basis behavior would be expected to generate useful market information.

Specific objectives of this thesis are:

1. to identify the factors that influence future and cash prices and thus determine the basis.
2. to evaluate the degree to which each of these factors affect basis behavior.
3. to discuss the potential impact of basis risk on hedging effectiveness.
4. to provide means by which prospective basis changes may be predicted and corrected for.

Chapter II provides a review of the literature relevant to this study, including rapeseed market analysis, future and cash price relationships, and previous basis behavior investigation. Chapter III presents graphical and statistical analysis of theoretical and empirical ba-

---

[8] For example, Kahl (1979) found that the average Chicago corn basis in January computed using the nearby March futures contract ranged from -$.05 to +$.05 per bushel from 1960 to 1969.

[9] For the time period August, 1977 to July 1983 the cash basis was $11.49 +/- $45.65. The street prices for the same study period were $51.33 +/- $38.22.

sis movements. In addition, this section addresses objective (3), the impact of basis risk on the effectiveness of hedging rapeseed .

Chapter IV is a theoretical discusion of the relevant market relationships that are utilized to derive the system of equations presented in Chapter V, the empirical section of the study.

Chapter VI presents and interprets the empirical results and addresses objectives (1), (2), and (4). The results are summarized and conclusions drawn in the final chapter. Chapter VII also denotes the particular contribution of this study to the understanding of basis behavior in the theoretical and applied senses.

Chapter II

REVIEW OF RELEVANT LITERATURE

A critical preliminary step to the analysis in this thesis is a review of the relevant literature. The subjects examined include: (1) the production, marketing and processing sectors of the rapeseed industry, (2) basis theory, and (3) empirical studies of basis behavior. This chapter however will not review basis theory as its importance to this thesis warrants special consideration and is therefore examined in detail in Chapter III.

Previous basis studies provided excellent resources from which the empirical sections of this thesis were derived. In particular, they describe the econometric modelling techniques used to analyze basis behavior, and the distinct factors that influence basis behavior in specific commodities.

A detailed examination of rapeseed studies was undertaken to identify industry participants, their structural relationships and the incorporated institutional constraints. This was necessary to yield certain hypotheses regarding factors influencing basis behavior, and to provide the appropriate information concerning the theoretical substructure of the empirical model. The following sections summarize the area reviewed.

2.1 PREVIOUS STUDIES OF THE CANADIAN RAPESEED INDUSTRY

2.1.1 Rapeseed Production Studies

The review of rapeseed supply response studies was valuable in determining the factors which affect production decisions. Two studies provided much of the required information concerning this topic. Petrie and Lowe (1979), and Kwon and Uhm (1980), used econometric modelling and analysis to determine that the previous crop year's average rapeseed price, wheat stocks, wheat prices and the previous year's summerfallow acreage are the principal factors which determined the number of acres planted in rapeseed. Kwon and Uhm also included a dummy variable for insect infestation. While both studies predict acreage response well, the use of last year's average price of rapeseed as the sole price expectation variable is questionable. Perhaps the good fit of both models is due to upward trends in acreage planted to rapeseed (displayed in Figure 2.1) over the study years of 1957 - 1976 and 1957 - 1978 for Petrie and Lowe and Kwon and Uhm, respectively. The analysis of 1978 to 1981 might indicate the need for inclusion of a better expectant price variable such as rapeseed futures market prices as they should represent (given a competitive market) an unbiased estimate of future spot prices.[10]

---

[10] R.W. Gray, "The Characteristic Bias in Some Thin Futures Markets." Food Research Institute Studies, Vol. 1, No. 3, 1960.

2.1.2 Studies of the Rapeseed Processing Sector

Numerous articles have been written of the Canadian oilseed crushing industry. The state-of-the-industry-Report by the Canola Crushers of Western Canada (1982) provided the majority of information relating to the economic importance of the crushing industry to Canada and in particular to the agricultural community in the three prairie provinces.[11] The report centered on the economic benefits of the industry:

1. seed purchases from producers of $300 million
2. value added from processing of $100 million
3. multiplier effects estimates of $200 million
4. rural labour employment of 1100 - 1200 person years
5. foreign exchange earnings of $110 million

In addition to the above economic contributions the domestic rapeseed crushing industry provides import substitution for edible oilseeds and their byproducts. The crushing industry provides producers with a marketing alternative to export sales through line elevator companies. This may increase the competition for rapeseed, and perhaps, raise the street price. This report also outlines the structure of the western Canadian crushing industry participants, locations, processing methods and capacities. Because the structural aspects of the industry will be incorporated into the theoretical and empirical sections of this thesis. As well the report summarizes concerns of the industry such as crush margins, and transportation issues such as compensatory freight rates

---

[11] For more specific topics concerning the oilseed crushing industry see studies by: Canola Crushers of Western Canada (1976 and 1979), Erling-Tyrell (1983), Hughes (1983), Lowen (1983) and Perkins (1976).

and lack of rolling stock for processed byproducts. These are also factors hypothesized to influence futures and cash pricing and therefore basis behavior.

2.2 STUDIES OF RAPESEED MARKETING

The literature reviewed from the large store of rapeseed market analysis provided much of the theoretical information from which the empirical analysis of this study was based.[12] The studies by Kulshreshtha et al (1979), Swallow (1983) and Martin and Storey (1975) figured prominently in contributing to this study.

Kulshreshtha et al (1979) forecasted quarterly rapeseed prices at both the street and export levels, as well as the quarterly prices of rapeseed oil and meal, quantities demanded, and inventories of seed, oil and meal. The model, composed of eleven endogenous equations and two identities, was estimated using two-stage least squares analysis. Of these, two equations were of particular interest to this thesis:

1. The equation which estimated farm inventories of rapeseed incorporated independent variables representing: lagged farm inventories, cash prices of rapeseed and the futures prices of soybeans as a proxy for rapeseed price expectations. The adequate results from their estimation of this equation suggests similar variables be incorporated into the equation estimating monthly equilibrium

---

[12] For further information regarding rapeseed marketing in Canada see: Agriculture Canada (1977), Canadian International Grains Institute (1977), Craddock (1973), Furtan, Nagy and Storey (1978 and 1979), Griffith and Meilke (1980, 1982a, 1982b), Nagy and Furtan (1977), Natural Products Marketing Council (1981), Rigaux (1976), Uhm (1975).

farm inventory levels in this thesis.

2. The equation which estimated commercial inventories of rapeseed included variables depicting: rapeseed export demands, soybean future prices representing price expectations and the cash price of rapeseeed. Proxies of these variables were embodied in its counterpart equation in this empirical analysis.

The second important study of rapeseed marketing analyzed Japanese influences on the Canadian rapeseed industry. Swallow (1983) addressed the possible welfare outcomes resulting from alternative trade and tariff policies by both Canada and Japan. In his study, Swallow outlines and discusses structural aspects of the Japanese market for Canadian rapeseed. He also provides an indepth description of the Japanese participants and instutitions, including an analysis of their market conduct. The importance of the Japanese/Canadian rapeseed trade to both nations is revealed by the sixteen year average (1965-1980) of product movement between them. Canada's share of Japanese rapeseed imports exceeded 95 percent, which accounted for over 75 percent of total Canadian exports.[13] This high degree of bilateral market interdependence suggests that it is crucial that this study consider Japanese demand factors in analysis of rapeseed pricing.

Martin and Storey's (1975) paper is the only one published which specifically deals with rapeseed futures and street price relationships. They evaluated the pricing peformance of the Canadian rapeseed market using Working's (1949) model of temporal price relationships (see Chap-

[13] Brent M. Swallow, "Policy Analysis of Canadian/Japanese Trade of Rapeseed and Rapeseed Products", unpublished M.Sc. Thesis, University of Saskatchewan, Saskatoon, 1983, pp. 7-8.

ter III) and Gray's hypothesis that futures prices are unbiased estimates of future spot or cash prices. They also demonstrated the effects of this pricing performance upon street prices received by producers. Using data from the 1973-74 crop year, they found that consecutive futures contracts (e.g. January and March) are inclined to be inverted and downward biased.[14] The contracts do not reflect storage charges incurred and therefore may forecast lower spot prices than those observed.

Martin and Storey hypothesized two causes of the market bias. Futures market illiquidity (i.e. is relatively few trades) forced a risk premium to be paid to speculators to entice purchases of futures contracts, as the number of hedgers greatly exceeded the number of speculators in the market. This downward price bias was estimated by Martin and Storey to be $.09/bushel or approximately $4.00/tonne. The other source of bias arose from physical constraints on the rapeseed market such as transportation, storage facility availability and quota restrictions. If these constraints occur, exporters unable to fulfill sales commitments are sometimes forced to acquire rapeseed by accepting delivery on futures contracts. This practice can have two effects. First, the nearby futures contract prices can be bid up relative to distant contracts. Second, these logistical problems are additional sources of uncertainty about future supply availability, resulting in discounted price expectations and therefore downward biased prices of distant contracts. These constraints also add to the uncertainty in the rapeseed

[14] Two definitions can be applied to the term inverted market. It can describe a situation where the cash price exceeds the dominant futures price, or it can describe a market in which the price of a nearby futures contract exceeds a more distant futures month price. The later applies in this discussion.

cash and futures markets and could discourage market speculation, thus adding to the liquidity problem.

The liquidity problem of the Winnipeg rapeseed futures market probably figured prominently in the selection of Chicago soybean futures by Kulshreshtha et al (1979) as the price expectation variable in their model Table 2.1 indicates that since the mid-1970's the volume of rapeseed contracts traded on the Winnipeg Commodity Exchange has increased nearly two-fold. Another indicator, the open interest represents the number of unliquidated purchases or sales. The increase in open interest shown in Table 2.1 indicates that market liquidity is now higher than during Martin and Storey's study period. While the degree to which the liquidity has increased is unknown, the increase in volume and open interest has surely had some positive effects.

Downward bias in futures prices are expected to be reflected in prices received by producers; since street prices are usually based on the price of a rapeseed futures contract 60 to 120 days away from maturity.[15] The analysis performed by Martin and Storey indicated a downward biased futures contract may cause the street price to be discounted by more than the actual marketing charges.[16] A reconstruction of the Martin and Storey method of determining bias using the data from subsequent years incorporated into this analysis shows the bias is now negligible

[15] S.N. Kulshreshtha, A.K. Banerjee, W.H. Furtan, and G.G. Storey. "Quarterly Rapeseed, Rapeseed Oil and Rapeseed Meal Forecasting Model", in FARM, Agriculture Canada, Ottawa, March 1983, p.20.

[16] During the period of the Martin and Storey study (1975) the basis was set by a street price committee consisting of representatives of each of the major elevator companies. In 1976/77 crop year the use of the street price committee was suspended allowing each company to establish its own basis.

TABLE 2.1

Yearly Volumes of Rapeseed Futures Contracts Traded on the Winnipeg Commodity Exchange, Crop Years 1979/71 - 1982/83

Crop Year	Average Daily Open Interest 000's contracts	Number of Contracts (000's)
1970/71	-	507
1971/72	-	538
1972/73	-	675
1973/74	8.9*	408
1974/75	7.4*	322
1975/76	7.2*	331
1976/77	9.1*	423
1977/78	10.2	482
1978/79	15.8	581
1979/80	16.3	633
1980/81	18.1	684
1981/82	14.1	568
1982/83	16.4	690
1983/84	16.0	790 (estimated)

Source: Winnipeg Commodity Exchange, Annual Report, 1982/83.
* Winnipeg Commodity Exchange, Daily Trading Cards, 1973-1977.

(ie. $.03/bu or $1.20/tonne), and not statistically different from zero.[17]

This thesis will attempt to determine the significance of the impact of transportation constraints and storage facility restrictions on basis behavior in the rapeseed market.[18]

---

[17] Colin A. Carter, unpublished work, 1983.

[18] Open interest can be defined as the cumulative number of unliquidated purchases or sales, which represents the number of long or short positions that are still held or are 'open'. (See Carter and Loyns, 1983, pp. 82).

2.3 REVIEW OF EMPIRICAL STUDIES OF BASIS BEHAVIOR

Ward and Dasse (1977) investigated the factors contributing to basis behavior in the frozen concentrated orange juice (FCOJ) market. They determined that the market was upward biased, which resulted in the basis exceeding the full cost of storage. This bias was referred to as the basis residual (BR), which reflected variables such as: convenience yeild (CV); risk premium for stockholding (RP); market liquidity (ML); freeze bias time (FB) and freeze bias adjustment (FBA) which reflect the period during the life of a futures contract when freezing may damage a new crop. Also included was a variable representing periods when freezing did occur (FZ). The equation to explain basis residual behavior was:

$$BR = -0.027^{*} + 0.302E\text{-}5RP - 0.003CY^{*} + 0.454E\text{-}4ML + 0.367FB^{*}$$

$$-0.252FBA^{*} + 0.016FZ^{*} \qquad (2.1)$$

* indicating statistical significance at 95 percent confidence level.

From the above findings Ward and Dasse concluded that the positive market bias (i.e. the basis exceeding the costs of storage) was due to variables associated with anticipating and actual freeze effects. Ward and Dasse also stipulated that omission of variables unique to any commodity, in the case of orange juice, the freeze bias, leads to clear mispecification of an explanatory basis model.

Kahl (1979) provided empirical analysis of monthly intertemporal basis behavior in the U.S. corn market, using ordinary least squares analysis of a reduced form equation (2.2).

BASt = LBASt + PBSt - CGCt (2.2)

where: LBASt = the basis for the same contract month during the previous month.

PBSt = (stocks in storage t-1) + (government stocks t-1 - government stocks t) - (price associated demand at t).

CGCt = percentage of current bin space available for corn at time equal to t.

For each contract month, this equation was estimated and the basis predicted. To test the equation's performance the predicted month to month basis changes were compared to the actual changes. The predictions appeared to estimate well as displayed in the prediction/realization diagram (Figure 2.1). The model was also compared to the following four alternative models. Alternative Model I, was a descriptive model similar to the original empirical model but it incorporated a dummy variable to distinguish between basis behavior in the 1960's and 70's. Alternative Model II inserted an alternate dummy variable to the original reduced form equation. The dummy variable represented basis behavior in summer versus non-summer months. The other two comparison models, III and IV, added interest rates and corn stocks respectively to the reduced form model. Interest rates were incorporated to explain changes in costs of storage and corn stocks were entered to capture some of the effects of convenience yield. Kahl found that in almost every case that the original reduced form equation explained more of the total variation in the basis, i.e. a higher R-square (coefficient of determination) than any of the alternative models.

The model successfully predicted corn basis behavior. However, the author stated "that much of the explanation is dependent on the lagged basis term."[19] This variable contained many expectation factors prompting the author to suggest alternate variables as proxies, such as production, demand, and price forecasts. Moreover, the use of reduced form equations can lead to coefficient interpretation problems. If the structural equations, that are used to derive the reduced form equations are underidentified (i.e. fewer equations than unknown parameters) estimates of the structural parameters cannot be obtained.[20] If the structural equations are overidentified, (more equations than unknown structural parameters) the reduced form equation will not yield unique estimates of the structural coefficients.[21] As a result, it is proposed for the present study not to use a reduced form of analysis of rapeseed basis behavior. This study will estimate structural equations directly to determine the factors influencing basis behavior.

While the study by Ward and Dasse was more specific in identifying factors contributing to basis behavior than Kahl's, both studies stated that identification of factors is an essential step in comprehending and predicting basis movement.

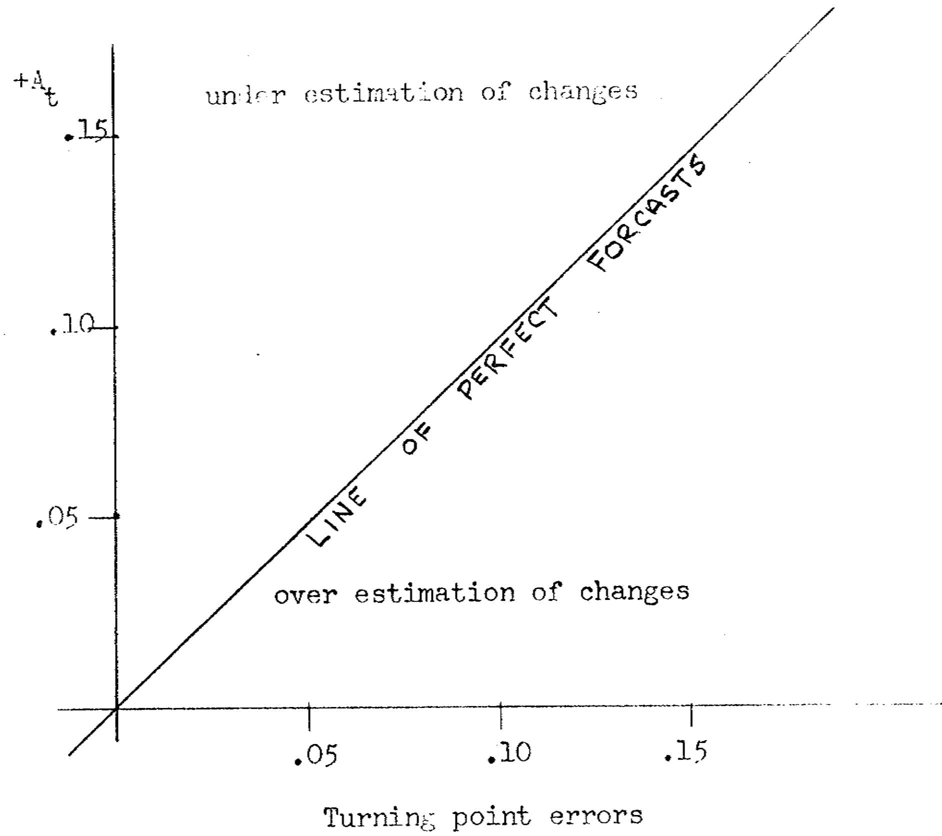
---

[19] Kahl, p. 220.

[20] A. Koutsoyiannis, Theory of Econometrics, second edition, MacMillan Press Ltd., London, 1981. pp. 372-373.

[21] Ibid.

Figure 2.1: Prediction/Realization for Basis Changes in 1976 and 1977 for the June Contract Month



Source: Kahl (1979), p.207.

This chapter has presented an overview of the Canadian rapeseed industry and reviewed some empirical investigations of basis behavior. It in conjunction with the subsequent chapter summarizing the current theory of basis behavior provides most of the resources required for the empirical analysis of rapeseed basis behavior.

Chapter III

BASIS THEORY AND THE RAPESEED MARKET

Basis theory has been well explored and discussed throughout the literature of cash and futures markets. In contrast, the empirical studies however, are somewhat less developed. It is however, extremely important to review and understand the basic theoretical explanation of basis behavior because it is the foundation from which all empirical studies evolve.

This chapter will first identify and discuss the generally recognized views of basis movement for a seasonally produced, storable commodity.[22] It then proceeds and compares the theoretical basis expectations with the observed basis behavior for Vancouver rapeseed for the periods August 1977 to July 1983. Finally, this section provides producer and crusher hedging examples to demonstrate the impact of basis variability upon hedging effectiveness in reducing price change risk.

---

[22] Initially basis theory was applied to only storable commodities, but with the advent of futures markets for nonstorable or nonseasonal commodities (i.e. live hogs or silver), basis theory has been expanded, Hieronymus (1977).

3.1 BASIS THEORY

Much of the present day basis theory has arisen from the foundation provided by Working's theory of the carrying charge (1942, 1949), which explains basis movement over the life of a contract. It defines basis as the charge established through supply and demand in the market for commodity storage services.[23] That is, in a perfectly competitive market[24] the basis reflects the price or cost of storage incurred until the futures contract matures.[25] However this price of storage reflects more than the physical costs. It also incorporates: (1) opportunity cost of storage (interest rates); (2) costs of handling, processing and transformation services; (3) costs of commodity and storage facility insurance; (4) costs of risk aversion which is a premium paid to attract participants in the oppostie side of the futures market; (5) transportation costs; (6) convenience yield; and (7) normal profits of performing these marketing functions.

The physical cost of storage plus the first four constituents in the above list are a function of the length of time to contract maturity; as the date of maturity approaches, the time of storage decreases, which lessens the associated costs and therefore charges in a competitive market. Thus, for a seasonaly produced, storable commodity such as

[23] Further discussions of the carrying charge theory may be found in Brennan (1958), and Weymar (1966).

[24] It is assumed that the market is perfectly competitive. That is, the market has a large number of participants, the product is homogenous, market information is equally available to all participants and the product is fully mobile within the market.

[25] K.Kahl, "An Analysis of Intertemporal Basis Movements", unpublished Ph.D. Thesis, North Carolina State University at Raleigh, 1979, p. 15.

rapeseed these conditions dictate that the cash basis should narrow as time to contract maturity decreases.

Theoretically the fifth factor, transportation costs, should be included in basis measurements when the specified delivery locations differ from the production site.[26] The omission of transportation costs in empirical investigation of basis behavior is however a reasonable simplification, due to unchanging transportation costs over the life of the contract and providing one considers only one production and one delivery site. While the nominal cost of transportation may be omitted, the other effects of transportation such as the availability of sufficient railcars must be included and will be discussed later in this section.

The sixth factor, convenience yield was initially conceived and discussed by Kaldor (1939), and has since been examined by Working (1949), Brennan (1958), and Weymar (1966) in the development of the theory of storage. It is generally regarded as the returns received from the holding of a working inventory and thus tends to offset some of the actual costs of physical storage.[27]

Theoretically the positive magnitude of the basis is restricted to the physical cost of storage plus the first six factors listed previously. A basis larger than these total costs allows abnormal economic profits. These profits accrue to those who purchase cash stocks and sell futures contracts. In the case of rapeseed, the profits accrue to

---

[26] To fulfill rapeseed futures contract specifications the commodity may be delivered to Vancouver, Saskatoon, Moose Jaw, Edmonton, Calgary or Lethbridge. Deliveries to the inland terminals are discounted by $10.00/tonne.

[27] Kahl, p. 16.

elevator and crushing companies. As stated above, these profits will be bid away in a competitive market as they entice the concomitant selling of futures contracts and purchasing of cash stocks to fulfill delivery requirements (arbitrage). These actions force down the futures price and bid up the cash price respectively, and thus narrow the basis to the appropriate level covering the total costs of storage. In other words the theoretical upper limit to the size of the basis is given by full carrying charges. The empirical chapters of this thesis will address this deviation from the theoretical expectations.

Conversely the theoretical lower boundary of a basis is nonexistent. A negative basis (inverted market) can be expected under certain market conditions. This however does not characterize the normal intertemporal relationship of cash and dominant futures month prices. A negative basis occurs when the convenience yield (the returns from storage) exceeds the total costs of storage.[28] The volume held in storage is inversely related to the size of the basis, i.e. the greater the amount by which futures price exceeds the cash price the greater the amount held in storage.[29]

Carrying charge theory further stipulates that as the futures contract matures, that is, as the date of maturity approaches, the basis will converge to zero.[30] If the futures price exceeds the cash price,

---

[28] Further discussions of the convenience yields net effects upon basis levels may be found in Brennan (1958) and Telser (1958).

[29] H. Working, The Theory of the Price of Storage, A.E.R., 39(6): pp. 1254-1262, 1949.

[30] Thomas A. Hieronymus, Economics of Futures Trading for Commerical and Personal Profit, 2nd edition, Commodity Research Bureau Inc., New York, N.Y., (1977) pp. 152-153.

profits could be earned through the purchase of cash stocks and delivering on a previously sold futures contract. The converse also holds true; if the cash price exceeds the future price a contract is purchased and delivery accepted for sale in the cash market. The potential for profits allows arbitrage between the markets to force theoretically the basis in the delivery month to zero.[31]

Basis behavior however is subject to certain specific technical considerations that may cause the cash/futures price inequality near contract maturity. It has been observed and in particular in the grain and oilseed industry that the cash price usually exceeds the futures price in the designated delivery month.[32] This cash premium is due to several risk factors associated with futures deliveries including:[33]

1. unknown actual date of delivery. In the case of rapeseed, it can be delivered any time until the last business day of the specified delivery month, to the primary delivery points, or before the eighth last business day of the delivery month to the alternate delivery points.[34]
2. uncertain quality of product delivered. To alleviate this deficiency most futures contracts allow two or more specified grades to be accepted subject to certain penalties and premiums. Rapeseed contracts specify #1 Canada or #2 Canada at a $13.00 per

---

[31] Ibid.

[32] Ibid.

[33] Ibid., for example see Martin and Storey (1975).

[34] Carter and Loyns, p. 62.

tonne discount to those delivering on futures contracts.[35]

3. uncertain delivery sites, as indicated in #1 above.

It is also feasible that the futures price may exceed the cash price during the delivery month. This usually occurs when delivery constraints are encountered. Constraints which have been common within the Canadian grain industry include; lack of available storage facilities, transportation equipment constraints, and labour problems (e.g. strikes and lockouts). The cash discount is equal to the costs of holding the product until delivery is made.[36] The discount arises from short hedgers buying back contracts to offset their positions when delivery is impossible, which raises the futures price.[37]

Another cause of futures/cash price inequality at contract maturity is restrictions placed upon grain companies which prohibit railcar delivery to the futures market. In effect, this leaves only producer carloads to arbitrage between the two markets. The effects of producer cars and lack of arbitrage will be addressed in Chapter V, the empirical section of this thesis.

Therefore, at maturity, basis is only theoretically equal to zero. Risk premiums, delivery constraints and transaction costs generate a non-zero basis, but the available arbitrage dictates that this differential is as small as possible.

---

[35] Ibid.

[36] Hieronymus, p. 153.

[37] Kahl, p. 19.

In addition to intertemporal basis behavior the carrying charge theory provides explanations for the relationship of the prices of various futures months contracts at a specific point in time. It states that the longer the contract maturity is from a specified time, the longer the storage period therefore the greater the associated costs.[38] To offset these larger costs, a premium must be paid to those who store and maintain the commodity's quality. This premium is reflected in the form of higher futures prices for contracts maturing later after harvest.

However, the seasonality of production breaks the relationship between various futures contracts at a specified point in time. In a year when the supply of a commodity is very short in relation to the demand, the old crop futures price (in the case of rapeseed, June) is greater than the new crop futures price (November), as shown in Figure[39]3.1 In years where a adequate carryover is expected, old crop futures sell at a discount to new crop futures and thereby provide an incentive for the holding of stocks into the new crop year. Old crop contracts may also be discounted in relation to new crop contracts to encourage old crop consumption. Figure 3.2 exhibits this futures price relationship. From these above examples it has been shown that it is only the supply of the commodity in existence relative to demands that accounts for the presence of between crop year futures price discounts or premiums.[40] There-

---

[38] Working. p. 1258.

[39] The September rapeseed contract should not be expected to fit the expected patterns as it is a transition month - a month in which the new crop is being harvested. For further discussion of the old crop/new crop transition year see Working (1977) pp. 155-156.

[40] Ibid., pp. 1254-1262.

Figure 3.1: Futures Contract Price Relationships in Periods of Tight Intercrop Year Carryover

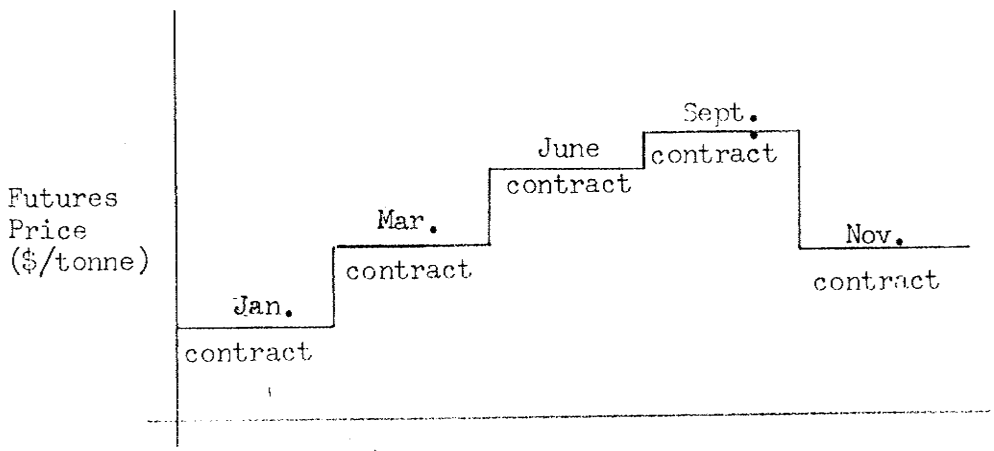
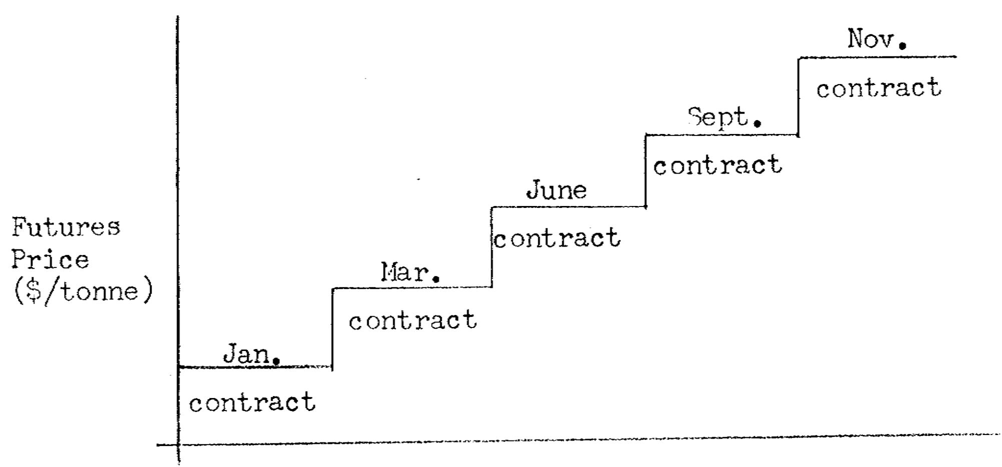


Figure 3.2: Futures Contract Price Relationships in Periods of Adequate Inter-crop Year Carryover.



fore in a year with normal stocks the expectation of a large harvest should not result in an inverted old crop - new crop relationship.

Consequently, the carrying charge theory has provided the infrastructure from which the current basis theory regarding both storable and nonstorable commodities has evolved. It implies that immediately after harvest, basis should reflect the total cost of storage until a specified contract matures. As stocks are depleted and the contract approaches maturity, the convenience yield and the shorter storage periods narrow the basis; thus a negative basis (inverted market) is possible if stocks are sufficiently low. At contract maturity arbitrage between the cash and futures markets should force the respective prices to equalize, i.e. basis equals zero. However the basis may be be subject to transaction costs, risk premiums or discounts and delivery constraint effects, and therefore may not achieve the theoretical position.

When analyzing basis behavior for the realm of contracts at a specific point in time, the theory predicts that basis increases as the length of time to contract maturity increases. The market may invert if tight supply situations develop before new crop harvest.

In subsequent studies Working suggested the existence of a seasonality trend in the behavior of the basis of many commodities.[41] He proposed that post-harvest supply abundance (large demand for storage) coupled with static storage facility volumes caused the price of storage space (i.e. cost of storage) to be higher than in pre-harvest periods when stocks are low and competition for storage facilities amongst and between different crops is lessened. Accordingly for a crop that is seasonally produced the post-harvest basis is wide and generally narrows into the crop year as stocks are depleted.

---

[41] Working, 1949. p. 1260.

3.2 DESCRIPTION OF BASIS DATA

The period 1977-83 produced numerous policy adjustments, transportation constraints, widely varying production levels and differing world market situations. What have been the effects of these factors upon the level or behavior of the basis? In the remaining sections of this chapter actual basis data are compared to theoretical patterns discussed above to determine whether deviation from the expected has occured. Before any comparative analysis can be undertaken, it is necessary to develop a data set for the rapeseed basis.

Basis was defined previously as the difference between a specified futures contract and a cash price at a particular point in time, which may be expressed as:

$$B(t) = Fm(t) - Cl(t) \qquad (3.1)$$

where: B(t) = the basis for a specified futures contract at time t.

Fm(t) = the futures price at time t* for contract month m.

Cl(t) = the cash price at time t* for location l.

Since there are many futures contracts being traded at a point in time it is necessary to specify which contract, its exchange and its associated restrictions and characteristics. Similarily there are numerous cash prices which may be employed, the particular grade and location must be specified.

Selected for the empirical analysis in this thesis are monthly average price per tonne of Canada #1 rapeseed for the period August 1977 to July 1983. Two cash quotations were examined. The street price data consists of the monthly average of the daily street prices of Alberta Wheat Pool and United Grain Growers for Manitoba and Saskatchewan. The monthly average cash price based in storage Vancouver was collected from closing daily prices on the Winnipeg Commodity Exchange. The futures price represents the monthly average of daily prices at market closing for the nearest contract maturing more than ninety days from the end of the specified contract month. Substituting the futures and appropriate cash price data into equation (3.1) provides an estimate of the monthly basis values for purposes of identifying factors contributing to its behavior.

3.3 THEORETICAL EXPECTATIONS OF RAPESEED BASIS BEHAVIOR

Basis theory evolved from the theory of storage suggests that as a futures contract approaches maturity, the costs associated with commodity storage would decline causing the price of this maturing contract to fall relative to the cash price or the cash price to rise relative to the futures price. Either case causes a basis to narrow. Since the empirical analysis of this study examines a basis for the nearby futures contract not closer than ninety days from the final delivery day of the specified futures month, the basis is expected to fall until the next futures contract is used to calculate it.[42] The next contract month re-

---

[42] The basis analyzed in this study is in fact an empirical estimate of the basis. The true basis is measured error free, only if the true data (i.e. futures contract, storage costs, etc.) are known.

quires a longer storage period and consequently has a higher basis value. The theoretical effects of the cost of storage in relation to the maturity of and changes the specified futures contract are shown in

Figure 3.3: Expected Basis Behavior Including Only the Effects of Costs of Storage Over a Crop Year

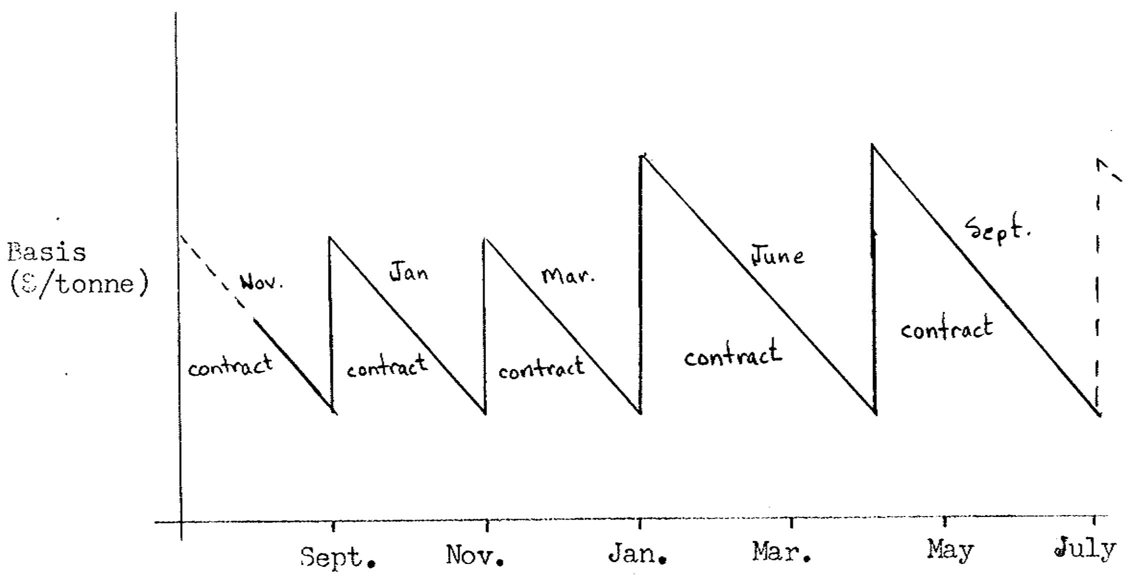


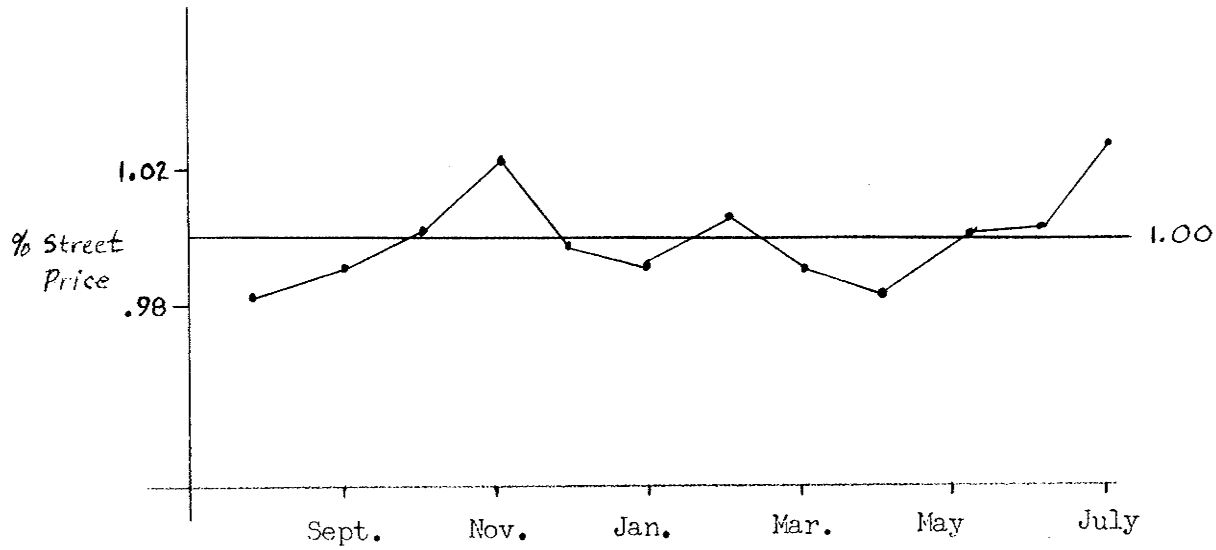
Figure 3.3.

The seasonality factor initially proposed by Working (1949) is significant in the observed behavior of the rapeseed basis. Carter (1984) estimated the seasonality index for rapeseed street prices exhibited in Figure[43] 3.4.

---

[43] Colin A. Carter, Street and Futures Price Relationships in Canadian Open-Market Grains, Extension Bulletin, Department of Agricultural Economics and Farm Management, Univeristy of Manitoba, Winnipeg, 1984. pp. 15-17.

Figure 3.4: Seasonal Pattern of Rapeseed Street Prices: 1977-1983



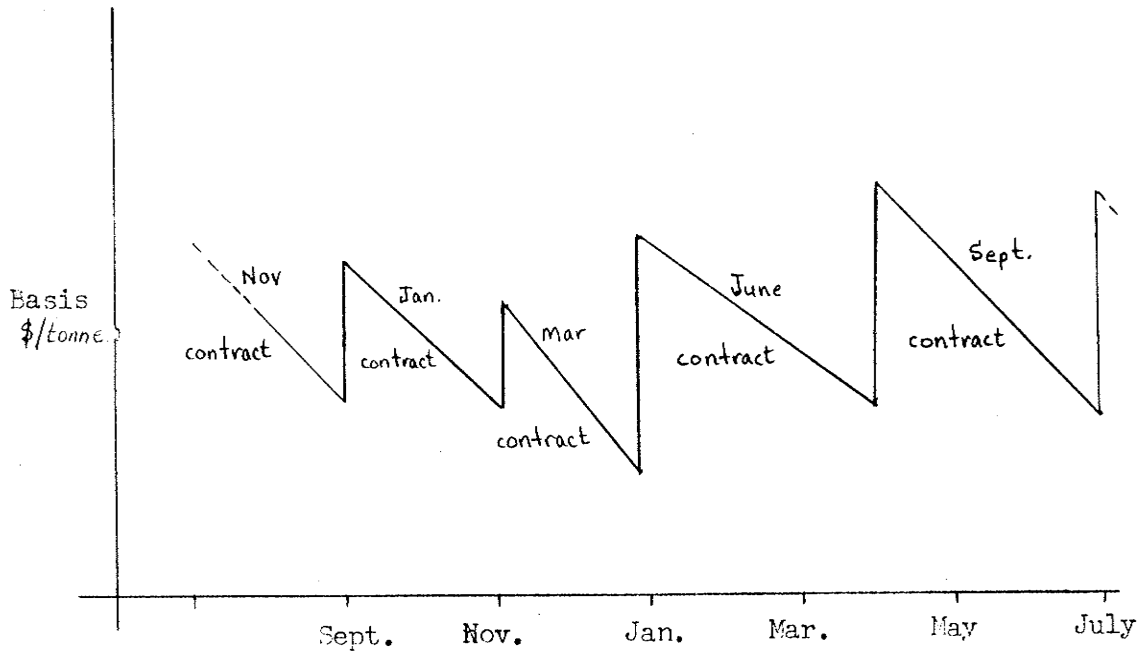
source: Carter (1984), p. 16.

This analysis concurs with Working's observations, and shows that a larger discount is applied to the street price during and immediately after harvest than is affixed immediately preceeding the harvest.

Incorporating both the cost of storage effects upon basis behavior and the rapeseed seasonality trend, basis theory predicts the price relationship as depicted in Figure 3.5.

Intra-year basis behavior should reflect the inter-year behavior expected and in addition should include a general upward trend as the cost of storage increases due to higher insurance, interest and labour costs.

Figure 3.5: Theoretical Expectations of Intracrop Year Rapeseed Basis Behavior

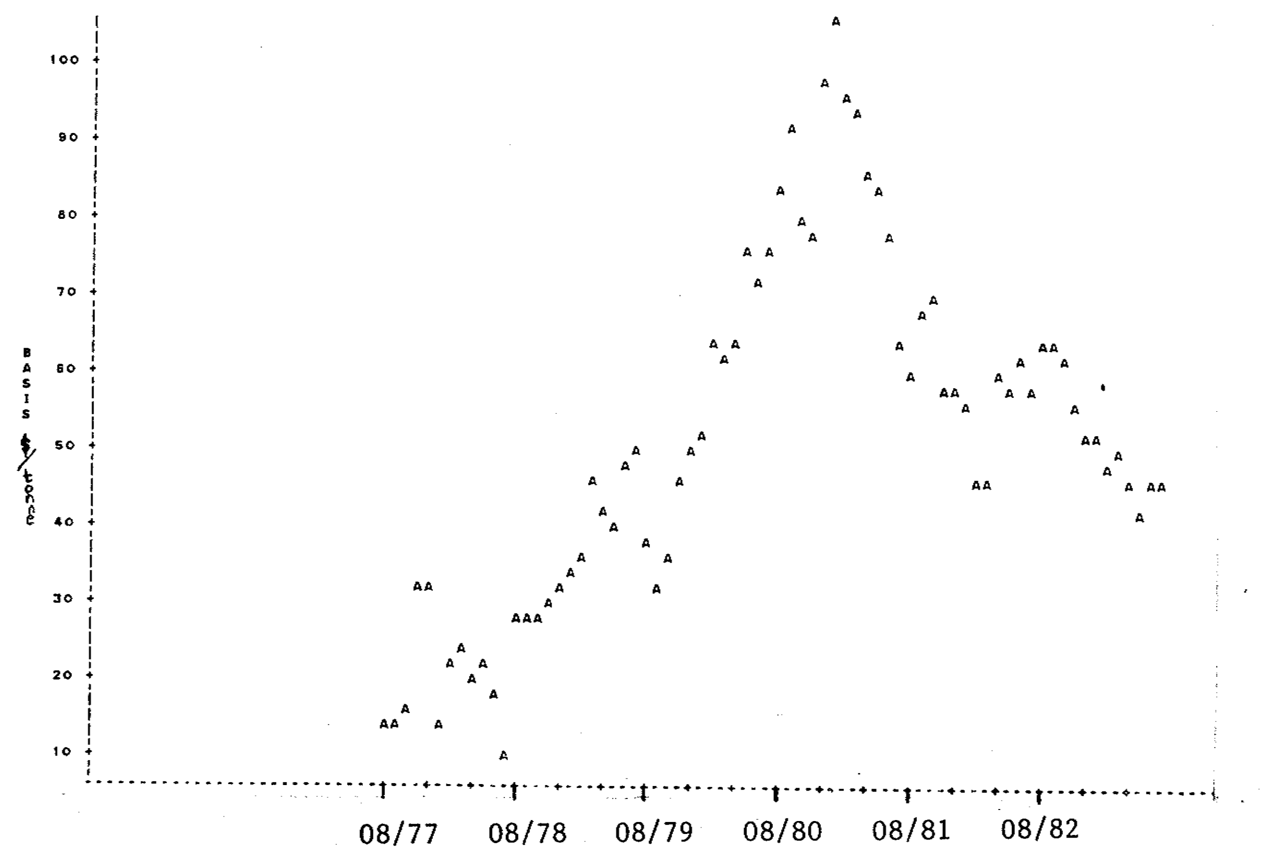


3.4 OBSERVED RAPESEED BASIS BEHAVIOR

The plot of the average monthly rapeseed street and cash price basis for August 1977 to July 1983, indicates that there was behavior counter to the theoretical intra-year basis behavior discussed in the previous section. Figure 3.6 shows that monthly street price basis ascended from September 1978, peaked in January 1980 and declined along a similar, but negative trend until February 1981. Subsequent to the initial zenith was a second distinct, but less pronounced peaking from February 1981 to July 1983. The plot of the cash price basis (Figure 3.7) exhibits similar, summit and trough behavior as the street basis for the corresponding time frame. Much of this abnormal behavior coincided with the changing of railcar allocation responsibilities and policies which is discussed in Section 5.1.

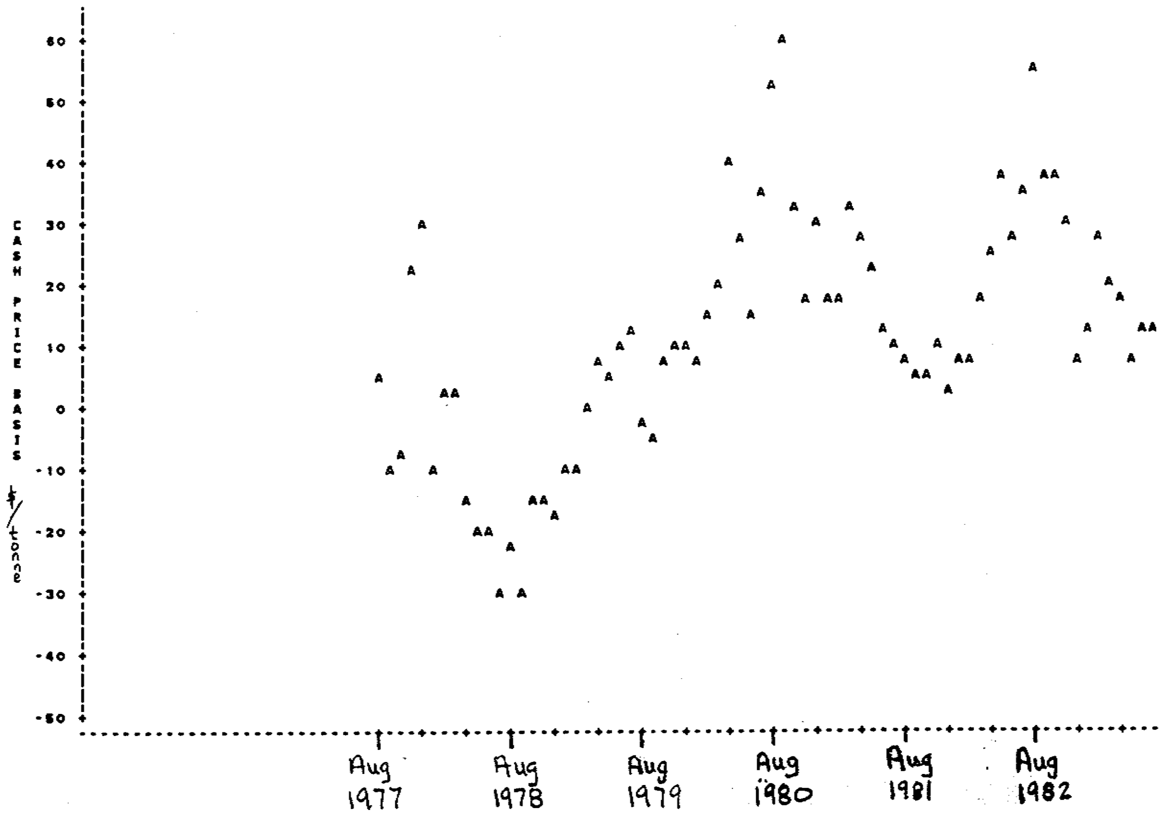
Over the seventy-two monthly observations of basis values for this study the mean of the street and cash price basis were respectively \$51.33/tonne and \$11.49/tonne with 95 percent confidence intervals of +/- \$38.22/tonne (\$0.89/bu) and +/- \$45.65/tonne (\$1.06/bu) respectively. The wide confidence intervals indicate a very large variance associated with rapeseed basis behavior. This large variance has negative implications for the effectiveness of hedging as an instrument of price risk reduction.

Figure 3.6: Plot of Observed Street Price Basis (August 1977 - July 1983)



Source: Canadian Grain Commission, Economics and Statistic Division

Figure 3.7: Plot of Observed Cash Price Basis (August 1977 - July 1983)



Source: Winnipeg Commodity Exchange Annual Reports 1976-1983.

3.5 EFFECTS OF BASIS VARIANCE UPON HEDGING EFFECTIVENESS

When employing hedging as a method to "lock in" an objective price and minimize the risk of price changes it can be assumed that the hedger is risk averse. A change in basis however disrupts the returns from the offsetting cash and futures market transactions. The following examples will exhibit the effect of different magnitudes of basis changes upon hedging effectiveness to attain an anticipated rate of return for producers and processors.

3.5.1 Consequences of Hypothetical Basis Changes Upon Producer Hedging Effectiveness

Example 1: No Basis Change - No Change in Basis from Time of Placing and Lifting Hedge, Resulting in the Attainment of the Objective Street Price

Date	Action Taken	June Futures Price $/tonne	Street Price $/tonne	Basis $/tonne	Outcome
Sept.30	producer sets hedge by selling 20 tonnes of June rapeseed for $450/tonne	$450	$400	$50	
Feb.15	producer sells rapeseed at local delivery point at at $350/tonne. He concommitantly lifts the hedge by buying 20 tonnes of June rapeseed for $400/tonne	$400	$350	$50	producer receives $350/tonne from local cash delivery. Producer receives $50/tonne from futures market transaction
	*net receipt = $400/tonne				

*Net receipts do not include costs of brokerage services or interest lost on margin deposits.

Example 2: Low Basis Variability Hedge - the basis may change, but is expected to vary little from value at time hedge is set.

Date	Action Taken	June Futures Price $/tonne	Street Price $/tonne	Basis $/tonne	Outcome
Sept.30	producer sets hedge by selling 20 tonnes of June rapeseed for $450/tonne	$450	$400	$50	
Feb.15	producer sells rapeseed at local delivery point at $345/tonne. Simultaneously he lifts hedge by buying 20 tonnes of June rapeseed at $400/tonne	$400	$345	$55	producer receives $345/tonne from cash delivery. producer receives $50/tonne profit on futures market transaction.
	net receipt = $395/tonne				

Therefore, if there is no change in the basis short hedging allows producers to attain the objective street price.

The net receipt of $395/tonne in Example 2 is close to the original objective of $400/tonne attained in Example 1. The $5/tonne difference from actual vs. objective arises from the small ($5) widening of the basis. Conversely the small variance allows for an equal, narrowing of the basis which would increase the net receipt above the $400/tonne objective.

Example 3: High Basis Variability Hedge - the basis has the potential to to vary greatly between the time of placement and lifting

Date	Action	June Futures Price $/tonne	Street Price $/tonne	Basis $/tonne	Outcome
Sept.30	producer sets hedge by selling 20 tonnes June futures for $450/tonne	$450	$400	$50	
Feb.15	farmer sells rapeseed to local delivery point at $320/tonne. He simultaneously lifts the hedge by purchasing 20 tonnes ofJune rapeseed at $400/tonne.	$400	$320	$80	producer receives $320/tonne from cash sales. Producer receives $50/tonne from futures market transaction.
	net receipt = $370/tonne				

The net receipt of $370/tonne received in Example 3 is not close to the original objective of $400. The large widening of the basis from $50 to $80 dollars over the four and one half months created this shortfall. As in the case of the low basis variability the basis could also narrow to the same degree creating additional returns to the short hedger. Long hedgers, those buying futures contracts in attempt to lock in a purchasing price also must be concerned about basis changes, which have opposite effects to those of short hedgers (i.e. basis widening/ narrowing increases/decreases returns) as will be displayed in the next chapter.

3.5.2 Observed Consequences of Basis Change Upon Hedging Effectiveness of the Processing Sector

In the latter months of 1980 and early months of 1981, processors and line elevator companies were accepting a significant portion of their rapeseed (60-80 percent) subject to pricing at a future date.[44] As this unpriced seed was exported or crushed and its byproducts sold, elevator and processing companies established long futures positions to hedge against unfavorable street price movements. The consequence of these long positions relative to shifts in the basis in the subsequent months of early 1981 (January through April inclusive) is revealed in

Example 4: Processor Long Hedge - The processor tries to lock in a raw seed purchase price, however, the basis at time of contract sale has been observed to narrow from time of purchase.

Date	Action	June Futures Price $/tonne	Street Price $/tonne	Basis $/tonne	Outcome
Mar 15/81	Processor sets hedge by buying 100 tonnes of June rapeseed	$359.48	$268.39	$ 97.89	
April 15/81	Lifts hedge by selling contract.	$364.20	$277.76	$ 86.44	Processor pays $277.76 street price, an increase of $12.66 gains $4.72 from futures market transaction. Net loss - $7.94 due to basis narrowing.

[44] IBI Group/Theo Joseph Inc., Improvement of Grain Car Allocation Procedures, prepared for GTA, Winnipeg, August, 1981. p. 11.

the following example:

The additional net cost of raw seed to the processor equals the increase in the street price and the loss incurred from the futures transaction. This of course is equal to the amount by which the basis narrowed. Hence, long hedgers are just as susecptible to basis changes as are short hedgers as has been historically revealed.

In this analysis the assumption that hedgers have been risk averse has been utilized. Any potential widening of the basis, specifically in the case of the short hedger reduces the quality of the hedge and thus detracts from hedging as a means of price risk reduction. If the basis variability is high and the magnitude that the basis may widen or narrow is great as determined for Canada #1 Rapeseed the ability of hedging to minimize potential losses from adverse price changes is lessened considerably.

The next chapter will present a theoretical discussion of simultaneous determination of cash and futures prices and therefore basis prediction.

Chapter IV

THEORETICAL DISCUSSION OF THE RAPESEED CASH, FUTURES AND STORAGE MARKETS

This chapter presents a theoretical discussion concerning the determination of the rapeseed basis. The first section will discuss the interaction of supply and demand and therefore the achieved equilibria in the individual cash, futures and storage markets. However, because each of the above markets' equilibria are not determined exogenous to the others, it is theoretically possible to incorporate all of the above markets and simultaneously determines the equilibrium prices in each. This will be discussed in Section 2. The simultaneously determined equilibrium price levels in the cash and futures markets consequently determine a value representing the basis. The theoretical discussion of this chapter provides a basic foundation for the development of a more complex empirical model of basis behavior in the subsequent chapter.

4.1 THEORETICAL ASPECTS OF THE RAPESEED INDUSTRY

4.1.1 Storage Market

The monthly stocks of rapeseed are extremely important to the cash and futures markets because the seasonality of production means the month-ending stocks in all positions (farm, elevator and export terminal) form the only supply sources in the subsequent month.

Brennan (1958) assumed that demand is solely price dependent, thereby allowing the demand function for current utilization to be expressed as:[45]

$$P(t) = f[Y(t)] \qquad (4.1)$$

where: P(t) = cash price of rapeseed in period t

Y(t) = quantity of rapeseed crushed domestically and/or exported in period t.

Since the demand in t is equal to the carryover from the previous period t-1, plus production, less carryover to the next period (i.e. storage in t), equation 4.1 can be rewritten as:

$$P(t) = f[S(t-1) + H(t) - S(t)] \qquad (4.2)$$

where: S(t-1) = stocks held in period t

H(t) = production in period t

S(t) = stocks carried into period t+1

To derive the carryover from t to period t+1, it must be assumed that S(t-1) and H(t) are known.[46] Given the assumption that rapeseed is a normal good (i.e. it has a negative own price elasticity), if the price in t rises (falls), the demand in that period will be less (higher), which causes the carryover S(t) to be larger (smaller). A larger carryover should produce a lower price in t+1. Conversely a smaller carryover should cause P(t+1) to rise (ceteris paribus).[47] This can be

[45] Michael J. Brennan, "The Supply of Storage", An. Econ. Rev. 48:50-51.

[46] Ibid., p. 52.

represented by:

$$P(t+1) - P(t) = f(t+1)[Y(t+1)] - f(t)[Y(t)] =$$

$$f(t+1)[S(t) + H(t+1) - S(t+1)] - f(t)[S(t-1) + H(t) + S(t)]$$

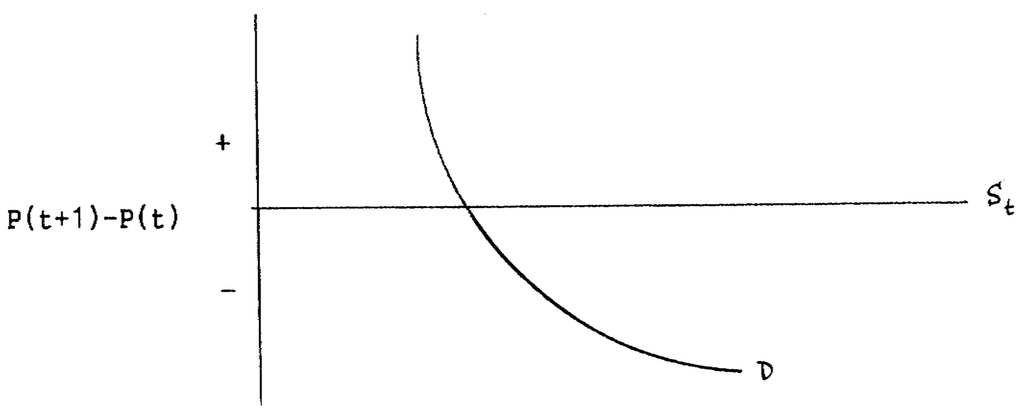
$$H(t) + S(t)] \qquad (4.3)$$

where:

$$\frac{\delta[f(t+1)-f(t)]}{\delta S(t)} < 0.$$

With a negative partial derivative and $S(t-1)$, $S(t+1)$, $H(t)$, $H(t+1)$ determined exogenously, the price spread between t+1 and t is a decreasing function of $S(t)$.[48] This monthly demand curve for storage of rape-

Figure 4.1: Demand For Storage Curve



Source: Brennan (1958) p. 53.

---

[47] Ibid.

[48] Ibid.

seed is shown in Figure 4.1.

To determine the equilibrium in the storage market the supply of storage curve must also be derived. Under the assumption of profit maximization a firm in a competitive industry will hold a level of stocks such that the net marginal cost of stock holding equals the expected returns to storage.[49] The net marginal cost of storage is defined as "the marginal outlay on physical storage plus a marginal risk aversion factor minus the marginal convenience yield on stocks."[50]

Physical storage costs [o(t)S(t)] contain both a constant and an increasing marginal component.[51] Until storage capacity is nearly fully utilized the cost per unit stored is constant. After this point however, the marginal cost increases.

The total risk-aversion factor, [r(t)S(t)] is an increasing function of stocks.[52] As the amount of stocks held increases, the risk of the investment to the capital position of the firm increases.

The convenience yield [c(t)S(t)], discussed in Chapter III of this study is a return to stockholders from the ability to insulate themselves from day to day or seasonal market fluctuations. At high stock levels the convenience yield is zero, however, as stocks are depleted, the convenience yield becomes increasingly positive.

---

[49] Ibid., pp. 52-53.

[50] Ibid.

[51] Ibid., p. 54.

[52] Ibid.

By incorporating the above three factors, physical costs, risk-aversion and convenience yield the net total cost of storage [m(t)S(t)] can be represented by:

$$m(t)[S(t)] = O(t)[S(t)] + r(t)[S(t)] - c(t)[S(t)] \quad (4.4)$$

where:

$$\frac{\delta m(t)[S(t)]}{\delta o(t)} > 0;$$

$$\frac{\delta m(t)[S(t)]}{\delta r(t)} > 0;$$

$$\frac{\delta m(t)[S(t)]}{\delta c(t)} > 0.$$

To determine the quantity stored, (i.e. the equilibrium in the storage market), the marginal revenue received from stock holding must equal its marginal cost. Brennan (1958) specified the marginal revenue [U'(t)S(t)] as the difference of the current price in t and the expected price in t+1,[53] i.e., [EP(t+1) - P(t)].

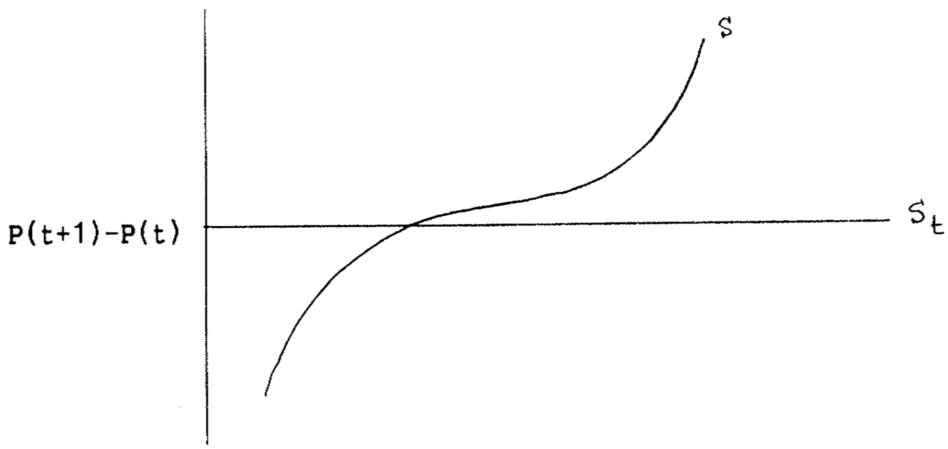
The sum of all firms' maximization of net revenue curves (4.6) yields the industry supply of storage curve (Figure 4.2) which is depicted by:

---

[53] <u>Ibid</u>.

$$U'(t) = g(t)[S(t)] \qquad (4.6)$$

Figure 4.2: Storage Supply Curve



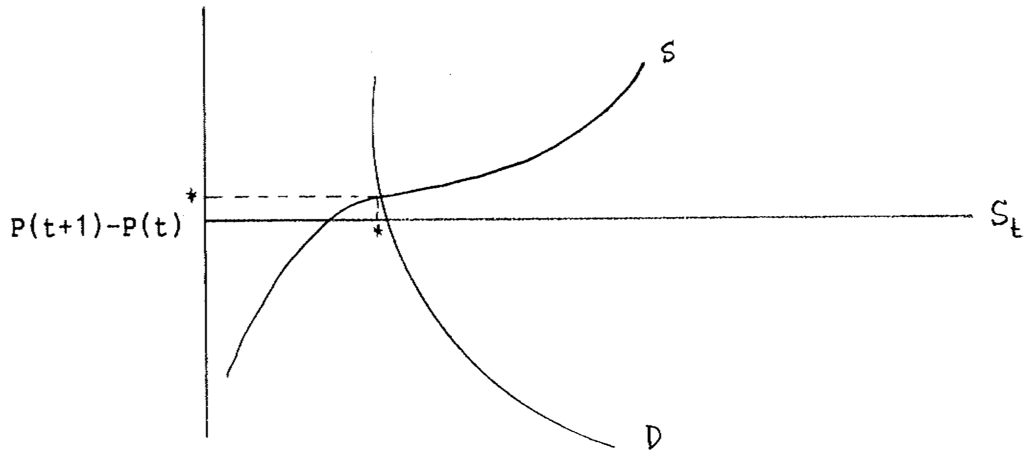
Source: Working (1949), p. 1259.

The equilibrium in the storage market (i.e. the amount of stocks held for carryover) occurs at the intersection of the supply of storage and demand for storage curves, as shown in Figure 4.3. Notationally this equilibrium is denoted by:

$$g(t)[S(t)] = Ef(t+1)[S(t) + H(t+1) - S(t-1) - f(t)[S(t-1) + H(t) - S(t)] \qquad (4.8)$$

The equilibrium level of rapeseed storage is found to be S(t)*.

Figure 4.3: Storage Market Equilibrium



Source: Brennan (1958), p. 57.

4.1.2 Cash Market

The market for rapeseed consists of the demand for exports and domestic requirements interacting with current stocks at time (t). However, the demand for rapeseed is derived from the demand for its byproducts; rapeseed oil and rapeseed meal.[54] In the context of this discussion, the price of the oil and meal byproducts in both export and domestic markets relative to the cost of the raw seed to the crusher/ processor is an important factor influencing the demand for rapeseed. Therefore the quantity of rapeseed demanded at time (t) is:

$$Y(t) = f[Pbi(t) - P(t]) \qquad (4.9)$$

where: Pbi(t) = price of byproducts at time t

P(t) = price of rapeseed at time t

[54] Kulshreshtha et al, (1979), pp. 9-13.

Economic theory suggests that given Pbi(t), the quantity of rapeseed demanded [Y(t)] will equal the quantity supplied from storage at the market equilibrium price (P(t)). Therefore forming a new equation for cash market equilibrium:

$$Y(t) = (St-1) - St \qquad (4.10)$$

where: (St-1) = Ending Stocks at time t-1

S(t) = ending stocks at time t

4.1.3 Futures Market

The futures market, a public marketplace where buyers and sellers gather to trade futures contracts, achieves equilibrium (i.e. equilibrium price, PF) when the demand for contracts equals the supply of contracts available.

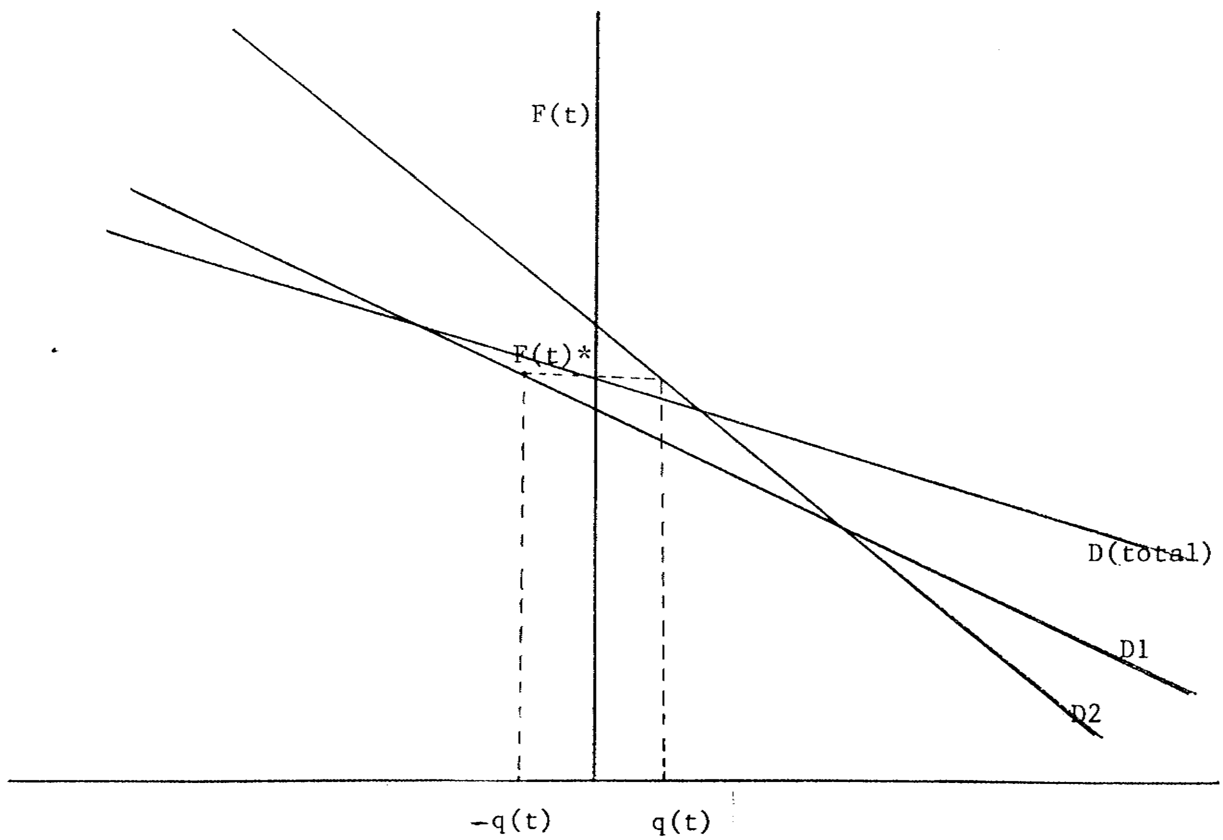
Kahl (1979) represented this equilibrium graphically in a two-person case.[55] In Figure 4.1 the curve D1 represents short futures positions and D2 represents long futures positions respectively.[56] The aggregation of these curves yields a futures contract curve, FC, which intersects the vertical axis at the equilibrium futures price PF, where the total number of long positions (+qt) equals the number of short positions (-qt).[57] Any alteration to supply of or demand for futures contracts, eg. via changes in convenience yield or in risks of stock hold-

[55] Kahl, (1979), pp. 108-112.

[56] Ibid.

[57] Ibid.

Figure 4.4: Equilibrium in the Futures Market: The Two Person Case



Source: Kahl (1979), p. 111.

ing, will shift the FC curve and thereby change PF.[58]

In Section 3.2 it was established that PF is an unbiased estimator of upcoming cash prices, and therefore can be included in equation 4.1 as a proxy for the variable representing price expectations Pt+1. By incorporating PF into equation 4.1, the storage, cash, and futures market equations can be solved for. This will be described in the following section.

4.2 THEORETICAL DETERMINATION OF STORAGE, CASH AND FUTURES MARKET EQUILIBRIA

This section will incorporate the three markets (storage, cash and futures) discussed in the preceeding section into a simultaneously determined set of behaviorial equations representing the monthly equilibriums in the rapeseed market. The framework of a quarterly econometric model for the simultaneous determination of futures and cash prices in the U.S. corn market was utilized.[59]

Subotnik and Houck (1979) listed three major assumptions that were required to develop their model:[60]

1. Market participants are profit maximizers given their specific aversion to risk.

---

[58] Ibid.

[59] A. Subotnik and J. Houck, A Quarterly Econometric Model for Corn: A Simultaneous Approach to Cash and Futures Market. Technical Bulletin 318, University of Minnesota, Agricultural Experiment Station, St. Paul, 1979, pp. 1-6.

[60] These assumptions were also required for the empirical model included in Chapter V of this study.

2. All aspects of the three markets to be incorporated into the model are competitive.

3. Futures prices yield an unbiased estimate of upcoming cash market prices.

A fourth assumption that must be added to Subotnik and Houck's is:

4. That a convenience yield is gained from stock holding.

Given the above assumptions, the expected profits of a Canadian or Japanese crusher/processor of rapeseed are:

$$E(t)[Y(t),S(t)] = Pbit * f(Yt) - PtYt + (PFt - Pt)St - C(St) \qquad (4.11)$$

where: $E(t)$ = expected profits at time t

$C[S(t)]$ = cost function for carrying stocks from time t to t+1

$f[Y(t)]$ = production yield of rapeseed byproducts

$PF(t)$ = rapeseed futures price at time t for delivery t+1

From Equation 4.11 the first order profit maximizing conditions with respect to Y(t) gives:

$$\frac{\delta E(t)[Y(t),S(t)]}{\delta Y(t)} = Pbi(t) * f'[Y(t)] - P(t) \qquad (4.12)$$

rearranging (4.12):

$$Pbit * f'[Y(t)] = P(t) \qquad (4.13)$$

where: $f'[Y(t)]$ = marginal product of $Y(t)$

Equation (4.13) is the function for current demand for rapeseed including domestic and export crushing demand and may be rewritten as:

$$Y(t) = Y(t)[P(t), Pbi(t)] \qquad (4.14)$$

where: $Y(t)$ = current demand for rapeseed at time t

This function is predicted to have the usual input demand relations:

$$\frac{\delta Y(t)}{\delta P(t)} < 0; \qquad \frac{\delta Y(t)}{\delta Pbi(t)} > 0.$$

Taking the first order conditions of (4.11) with respect to S:

$$C'(S) = PF(t) - P(t) \qquad (4.15)$$

where: $C'(S)$ = marginal cost of carrying stocks from time t to t+1

Since the supply for current utilization must arise from the previous periods' ending stocks, the current rapeseed supply is:

$$Q(t) = S(t-1) - S(t) \qquad (4.16)$$

where: $Q(t)$ = quantity of rapeseed supplied to cash market at time (t)

By combining (4.15) and (4.16):

$$C'[S(t-1) - Q(t)] = PF(t) - P(t) \qquad (4.17)$$

Therefore:

$$Qt = Qt(PFt - Pt, St-1) \qquad (4.18)$$

which is assumed to have the following properties of input supply relations:

$$\frac{\delta Q(t)}{\delta PF(t)} < 0; \qquad \frac{\delta Q(t)}{\delta[PF(t)-P(t)]} < 0.$$

Only if PF(t) and S(t-1) are known and the identity

$$Y(t) = Q(t) \qquad (4.19)$$

is given can the equations (4.7 and 4.11) yield estimates of the endogenous variables Y(t), Q(t), P(t), S(t). But the futures price in time t [PF(t)] is not found exogenous to the cash market, and therefore must be incorporated into another behavorial function in the simultneous model.

To include PF(t) within the system of simultaneously determined variables, Subotnik and Houck divided market participants into two specific groups: those who actually carry stocks into time (t) and those who do not but will attempt to enter the market during (t).[61] They further assume, and it is intuitive that those who hold stocks have lower marginal cost of storage curves (equation 4.8) than those who do not hold stocks. This is represented by curves AB and HI, respectively, in Figure 4.2.[62]

---

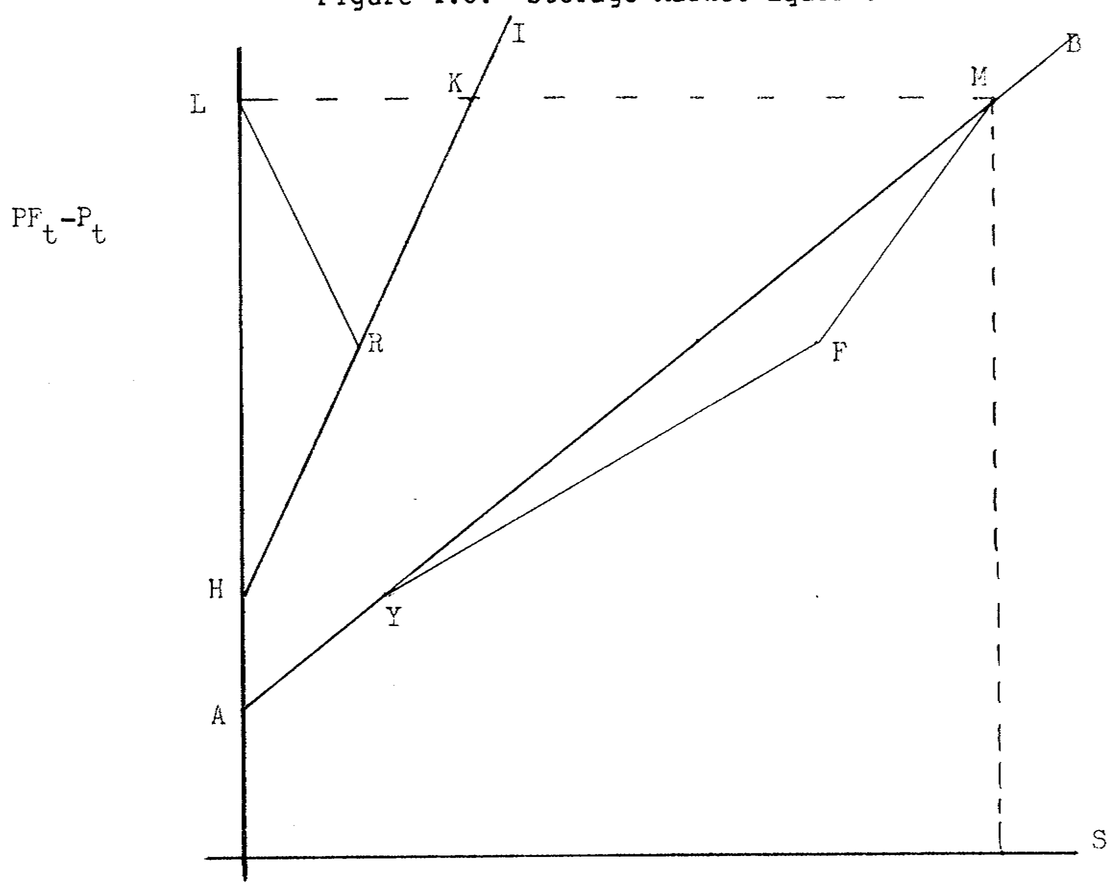
[61] Ibid.

[62] Ibid.

Figure 4.2.[62]

Many of those adverse to holding physical rapeseed stocks may be exporters without access to storage facilities, or processing companies wary of subsequent price changes. Consequently these market participants secure futures contracts as insurance for the availability of future stocks and as protection from unfavorable price changes.

Figure 4.5: Storage Market Equilibrium



Source: Subotnik and Houck, p. 5.

[62] Ibid.

point, (R), however, the convenience yield is less than the risk associated with additional stock holdings. After this point even if the basis is increased further the quantity of stocks held will decline and be replaced with futures contracts as a supply source.[63]

The extreme of this stockholding aversion occurs at point L when some risk averse participants do not hold any physical stocks and instead purchase LK stocks in the form of futures contracts. The stocks KM remain unhedged and are held by the less risk averse market participants.

The total demand for stocks (carryout) for use in time (t) is equal to the demand for physical stocks by those holding them and the demand for stocks by non-holders, which is represented by the curve AYFM with the FM portion of the curve illustrating:

$$DS(t) = DS[PF(t) - P(t)] \qquad (4.20)$$

where: DS = demand for carryout stocks at month ending

Subotnik and Houck concluded that the above function reflects the storage costs of the higher-cost participants and their adverse response to risk.[64] The curve intersects the supply of stocks curve (AB) at point M achieving equilibrium in the storage market. The equilibrium levels of St and PFt can therefore be determined at any given level of Pt.

---

[63] Ibid.

[64] Ibid.

Combining the demand for storage function (4.20) with the current demand (4.14), and the current supply function (4.18) which are constrained by the market clearing identity (4.19) and the period to period quantity balance (4.16) allows the five endogenous variables Y(t), Q(t), PF(t), P(t), and S(t) to be determined simultaneously. Of particular importance to this study are the variables PFt and Pt which represent the basis.

The theoretical discussion for simultaneous determination of cash and futures prices developed by Subotnik and Houck provides an excellent foundation from which the empirical model of pricing relationships in the rapeseed industry were formulated in this chapter. The following chapter develops the empirical simultaneous equation model of the rapeseed market.

Chapter V

DEVELOPMENT OF THE EMPIRICAL MODEL

This chapter outlines the measures required to develop the empirical model of basis behavior. Initially this chapter discusses several of the factors influencing basis changes. This is followed by a general discussion of the rapeseed market, which in conjunction with the theoretical discussion of inter-market relationships in Chapter IV provide the foundation for the components of the structural model. The establishment of structural equations permits empirical analysis of the factors contributing to the basis and its behavior, as described in the following Chapter. The final sections of this chapter will present the data sources, the empirical model, and the measurement technique utilized in the investigation of the empirical model.

5.1 SOURCES OF BASIS CHANGE

Numerous factors will be presented to explain the observed behavior of the Vancouver rapeseed basis. The first factor regards the overall increase in grain and oilseed production (5 percent since crop year 1976/77) accompanied by diversification into specialty crops as a source of basis influence.[65] Concommitant with these production changes was a program of grain storage system rationalization, which caused a 16.5 percent decline in storage capacities of prairie elevators.[66] Thus, if

[65] Statistics Canada, Grain Marketing Unit, unpublished data.

present in a free market for storage, the increased volume and diversity of crops seeking a smaller quantity of available binspace would cause an increased price (i.e. cost) of storage.[67] The increased efficiency of elevator throughput through facility modernization and increased rail movement coupled with increased rapeseed processing capacity may have lessened the impact of declining storage capacities. Over the last twelve years (1970-1982) the volumes handled have increased substantially (35%) and therefore have caused the effects of decreased storage space to be alleviated. This discussion has assumed free markets for storage, however the Canadian grain handling system, is governed by the Canadian Grain Commission, which sets maximum elevation, storage and processing charges.[68] Over the time span of this study (1977 to 1983) these tariffs were allowed to increase. If costs and competition warrant these tariff increases it is expected they will be fully reflected in the basis. This factor can be incorporated into the empirical model by examining the effects of a variable representing a general increase in the tariffs.

A second factor influencing basis behavior also concerns inventories of rapeseed. As discussed in Chapter I, production variability has generated highly variable inventory positions. Carryover stocks were critically low in the months preceeding some harvests and therefore an

---

[66] Canadian Grain Commission, Background Information on Primary and Terminal Elevators, paper prepared for Elevator Tariff hearings, Winnipeg, April, 1984.

[67] Paul, (1970) supports this hypothesis as he determined there is a positively-sloping storage supply curve suggesting that as uncommitted binspace dwindles its marginal value increases.

[68] Canadian International Grains Institute, Grains and Oilseeds, Handling, Marketing and Processing, CIGI, Winnipeg, 1975. pp. 11-12.

anticipated high convenience yield consistent with a narrowing of the basis would be hypothesized. To include factor's effects a variable depicting the seasonality of street prices was incorporated into the street price equation.

The third factor pertaining to rapeseed basis behavior concerns railcar allocation policies for export destined rapeseed. Until March 1980, railcars for grain and oilseed movement were allocated by the Canadian Wheat Board (CWB). Subsequently the Grain Transportation Authority (GTA) was assigned the responsibility. The method of allocation used by the CWB and initially adopted by the GTA was "allocation toward sales". If a sales commitment was exhibited by an exporting firm the car allocation agency would provide cars in sufficient quantity to move the desired volume of grain to terminal positions.[69]

This procedure was successful for all grains marketed except rapeseed, where two major difficulties arose. The CWB method of allocation is claimed to have allowed trucking and other unconfirmed export sales movements of rapeseed into the terminal positions which created a periodic buildup of "free" stocks.[70] In order to reduce this terminal congestion the CWB and later the GTA would reduce car allocations for rapeseed movement, expecting that market pressure would eventually remove rapeseed from the terminals to meet export commitments. This method of market clearing gave holders of free stocks an advantageous position in the market and an opportunity to obtain high prices.[71]

---

[69] Grain Transportation Authority, Annual Review, Winnipeg, 1982.

[70] Grain Transportation Authority, Allocation Towards Sales, Winnipeg, August 1981, p. 1.

However, the IBI/Theo Joseph Inc. study determined that if these "free" stocks were at sufficiently low levels with deliveries against the futures price being restricted, then certain marketing techniques applied by exporting firms created pricing abnormalities in the rapeseed market.[72] Vertically integrated exporting firms lowered the export price to take advantage of the practice of allocating all cars necessary to fulfill export contracts and thus increase market share. An increased market share raised the terminal throughput and therefore, increased elevation tariff income. In order to maintain a profitable position the elevator companies also reduced street prices and this practice widened the basis in late 1979 because the futures price did not fall by the same amount. Some producers then refused to deliver to the elevators in anticipation of a narrowing of the basis. Others allowed the rapeseed to enter the elevator system unpriced on storage tickets. Since both groups anticipated price increases, they believed it unnecessary to hedge on the futures market to protect against price declines. With unpriced rapeseed in stock the elevator companies also found it unnecessary to hedge with a short futures position. With 50 - 80% of the rapeseed in the elevator system unpriced, by mid-1980 the establishment of long futures positions by elevator and processing companies (traditionally short hedgers) to hedge their sales coupled with restricted deliveries to the futures market caused dramatic price increases for rapeseed futures contracts. These long positions served to further widen the basis. Since the GTA allocated cars solely for export purposes, delivery

---

[71] Grain Transportation Authority, Annual Review, 1980-81, Winnipeg, 1982, p. 6.

[72] IBI Group/Theo Joseph Inc., (August, 1981).

to the futures market was made only in small amounts by trucking and rail movements and in the form of producer cars. Grain available on the futures market could be sold in the lower priced cash market only at a loss and therefore isolated the futures market from the cash market.

To correct these problems, during October of 1980 the GTA announced a new allocation policy to be implemented by December 1980, which based its total rapeseed car allocation on confirmed export sales plus a working level of rapeseed instore Vancouver to facilitate cash and future market requirements.[73] However, the car allocation each company received would be proportional to the amount of rapeseed handled at the primary elevator level.[74] This allowed the GTA to dissolve the association of exports and car allocation and therefore eliminate the tendency of lower export prices to increase market shares to the ultimate disadvantage of the rapeseed producer and the advantage of the importing nation. As well the new system allowed deliveries to the futures market which enabled the arbitrage function to operate, forcing basis to return to a more normal level.[75] Some companies attempted to circumvent by selling the rapeseed to their export arm and moving the rapeseed to prairie terminal elevators, thereby increasing their proportion of rapeseed moved through the prairie elevator system which allowed them to receive extra cars. Moving more grain allowed them to discount the export price. To eliminate this process the GTA amended the method of rapeseed car allocation in February of 1981, to allow only 10% of rapeseed shipments

---

[73] GTA, 1982. Ibid.

[74] Ibid.

[75] IBI Group/Theo Joseph Inc., 1981, Ibid., p. 15

through inland terminals. Those shipping through inland terminals would receive cars in proportion to ownership of rapeseed within the terminals.[76]

This new policy achieved its major goal but encountered much criticism from the grain handling and marketing sectors of the industry, whose members believed that the new system did not provide sufficient export incentives, and that returns would be only minimally increased if grain companies sold directly to importers rather than to an export firm. The exporting companies feared that sufficient cars would not be available to fill a specific export contract, thus forcing the exporters to purchase stock on the cash market at high prices.[77]

Under this industry pressure, the GTA commissioned two consulting groups, the IBI Group and Theo Joseph Inc. in May of 1981 to make recommendations for a more universally accepted allocation system. In August 1981 the consultant's report was presented to the GTA but some clauses were immediately rejected by the GTA and the grain exporting industry, for it supported the present allocation system and insisted upon extension of the allocation towards delivery proportions system to include all grains.[78] The report also suggested the adoption of an export credit system whereby holders of confirmed export contracts would be given allocation vouchers; when movement of rapeseed to port was required the exporting firm would present the voucher to the rail companies for allo-

---

[76] Ibid., p. 16.

[77] Ibid., p. 16.

[78] Ibid., p. 32.

cation of cars.[79] This recommendation was rejected due to the purported tendency for credits to accumulate a capital value.

The GTA, through industry input, internal research and adoption of information improvement methods as recommended in the IBI report, presented a new allocation policy in November 1981 which was implemented on February 24, 1982.[80] The new system was designed to allocate total cars committed to rapeseed on the basis of export sales but would not guarantee sufficient cars to cover a single sale, and therefore would build in adequate uncertainty in the market to facilitate the use of the futures market as a method of covering risk. The new system would also assure sufficient "buffer stocks" in the Vancouver market to guard against a physical shortage of commodity in port and to prevent windfall profits being made by holders of such stocks.

The adopted system estimates the requirements of rapeseed in Vancouver eight weeks prior to export dates and includes a necessary working stock to act as a buffer against shortages. The potential supply is approximated by including import stocks, amounts of grain on route and open orders. The net requirement is then calculated as the difference of potential requirements and potential supply, with the GTA providing necessary cars to move the required rapeseed to port.[81] Once the total number of cars to move rapeseed has been established, 95% of the cars are allocated among the private trading companies proportional to their

---

[79] Ibid., p. 35-37.

[80] GTA, "Allocation Procedures to Take Effect February 24, 1982", Policy Statement, Winnipeg, 1981.

[81] Ibid.

net requirements for export sales, as with flaxseed and rye. The alternate 5% is allocated among producers whose delivery to the Vancouver cash market is to to prevent price cutting by exporters to increase their throughput.[82] The GTA also agreed to allocate cars to the futures market if no significant market advantage would be achieved by the delivery and if the GTA were notified as early as possible of car requirements.[83]

When the system was introduced to the industry in November of 1981 it immediately came under criticism from many participants in the industry. Producer groups such as the Western Barley Grower Association and provincial rapeseed associations felt the Canada Grain Act, which allowed all producers to load their own railcars to by-pass elevation tariffs, was being compromised if producers were limited to 5% of total allocations.[84]

The private grain companies were concerned with the GTA's insistence that they purchase the remaining 5% of the sale contract which left them at the mercy of brokers in charge of the producer car shipments, who forced sales at premium prices.[85] Despite these arguments, the GTA implemented the policy on February 24, 1982. Although the system is similar to the allocation procedure prior to October 1980, the

---

[82] Since August 1, 1983, the split for cars between private companies and producer cars was changed to 93 percent and 7 percent respectively.

[83] GTA (1981), Ibid.

[84] Western Barley Grower, January 1982. Calgary, p. 1.

[85] Pioneer Grain Co. Ltd., News Release re: "Producer Car -- Right or Wrong", February 11, 1982.

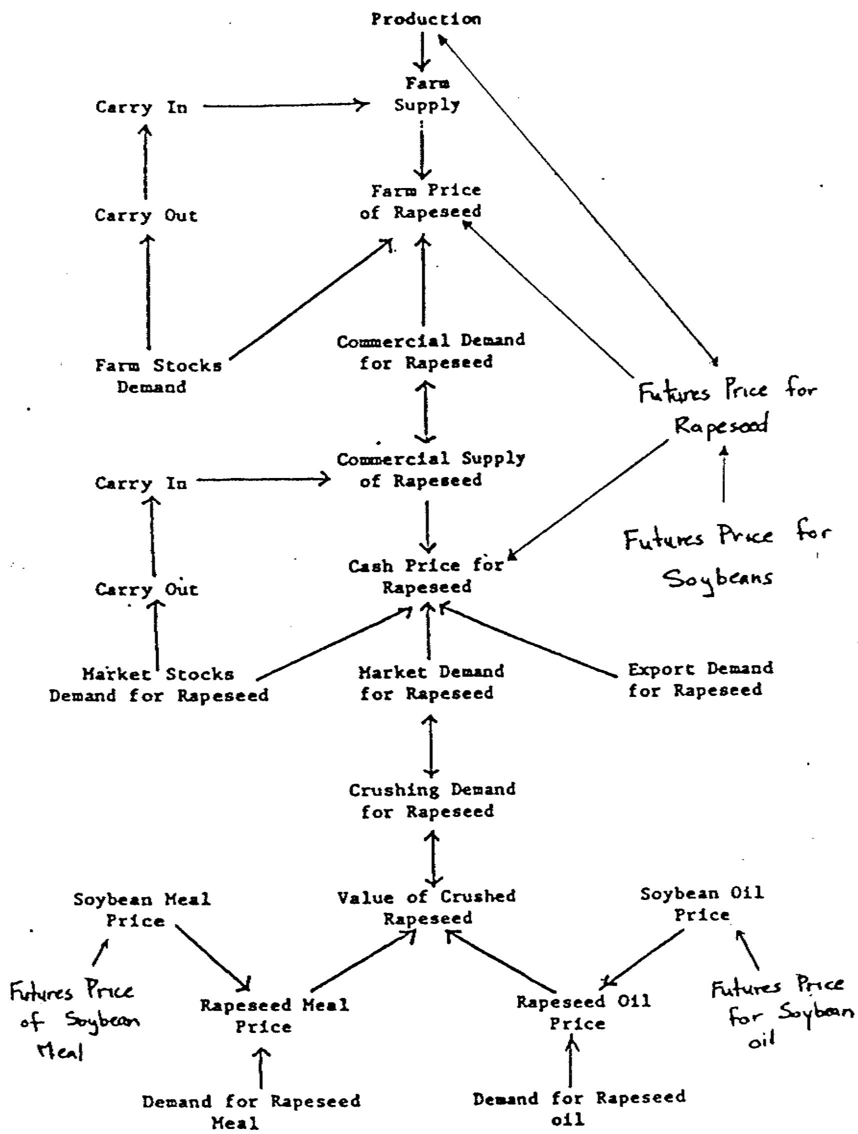
pricing anomalies of 1980 and 1981 should be avoided in the future because the GTA refuses to guarantee sufficient car allocations and thus will allow the futures market to perform its designated task of risk shifting and price discovery. This study incorporates railcar allocation and transportation factors into the analysis of basis behavior because of the impact allocation has on futures, cash and street prices.

5.2 INTRODUCTION TO THE EMPIRICAL MODEL

For the development of the econometric model for the analysis of rapeseed basis behavior, a generalized description of the rapeseed market is required to provide the framework from which the components of the system of equations can be derived. The flow diagram (Figure 5.1) exhibits the simultaneous stock, demand and price relationships of the rapeseed market, which will be incorporated into the empirical model as endogenous variables.

The total supply of rapeseed is composed of farm, commercial (elevator and processor) and export stocks. This model will further assume that any harvested production will automatically be moved into one of these stock positions. The interaction of rapeseed supply and demand functions establishes the equilibrium price at the street, cash and futures market level.

Figure 5.1: Diagrammatic Representation of Canadian Rapeseed Industry



Source: after Kulshreshtha et al (1979)

Farm stocks and production during harvest months constitute the primary supply available for commercial use. The interaction of primary supply and commercial demand (composed of primary country elevators and regional commercial crushers) establishes the farm level, or as discussed in Chapter I, the street price.

Farm marketing plus commercial inventories constitute the commercial supply, which interacts with export market demands to establish the Vancouver "cash price".

The export demand for rapeseed is dominated by Japanese purchases which was outlined in preceeding chapters and is expected to yield highly visible effects upon domestic market pricing.

An additional factor influencing canola marketing is the availability of the major substitute good, soybeans. While soybeans have incurred a loss of domestic market share to rapeseed, soybean oil is essentially the world price setter for edible oil products. Rapeseed prices are to a large extent residually determined from the price of soybean and other major substitute products (corn, cottonseed, palm kernel, etc.). However, rapeseed prices are also affected by internal market factors in Canada, Japan, and the European Economic Community. Those factors include tariff structures, substitutability, and product preference.

The rapeseed futures price is the equilibrium price level determined for a specified futures contract resulting from contract buyer and seller interaction as discussed in preceeding chapters.

The derivation of the basis also has been previously discussed in Chapter III and as a residual of the endogenously determined price variables it is affected by factors influencing these prices. Moreover, the identification and estimation of these factors will analyze the behavior of the basis.

5.3 THE EMPIRICAL MODEL

The following section will present and discuss the empirical model used for the analysis of basis behavior. Included will be a short exposition of each equation reviewing the incorporated variables and their expected relationship to the dependent variable.

The model is designed to identify the variables contributing to basis movement, and is composed of ten endogenous variables determined from eight behavioral and two identity variables.

The basis variables Bs and Bc are derived from the identity equations 5.9 and 5.10, respectively, when estimated equilibrium values of the required endogenous price variables are applied. The eight remaining endogenous variables, SXP, SEP, FS, QDD, QDX, PS, PC and PF are determined from the eight behavioral equations. Table 5.2 presents the model utilized in the empirical analysis of this study.

5.4 BEHAVIORAL EQUATIONS

Equation 5.1: Rapeseed Stocks in Export Storage

SXP = f(LPC, LTW, LSXP, QDX)

where:

SXP Visable stocks of rapeseed at west cost (Vancouver and Prince Rupert) export positions expressed as monthly average of weekly stocks reported (000's tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.

LPC One period lag of monthly average cash price ($/tonne).

LTW One period lag of monthly sum of weekly rapeseed stocks in transit to west cost export positions (000's tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.

LSXP One period lag of SXP.

QDX Monthly, quantities of rapeseed exported, (000's tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.

Where it is expected that the rapeseed stocks in export position are assumed to be directly related to previous period stocks (LSXP) and previous period stocks in transit to port (LTW), assuming they can reach port in the current month (i.e. $\delta SXP/\delta LTW, \delta LSXP>0$). Current exports (QDX) are expected to be inversely related to SXP (i.e. $\delta SXP/\delta QDX<0$). The sign associated with the coefficient of the lagged cash price variable (LPC) is anticipated to be positive, as higher cash prices attract more exports and therefore greater utilization of terminal facilities (i.e. $\delta SXP/\delta LSXP>0$).

Equation 5.2: Rapeseed Stocks at Elevator Positions

$$SEP = f(PS, LSEP, TCAP, QE)$$

where:

SEP Visible stocks of rapeseed at prairie elevators and terminal positions expressed as monthly average of weekly stocks reported (000's tonnes).
Source: Canadian Grain Commission, Grain Statistics Weekly.

PS Rapeseed, monthly average street price (as discussed in Section 3.3 Description of Basis Data).
Source: Canadian Grain Commission.

LSEP One period lag of SEP.

TCAP Total storage capacity of prairie elevators (and prairie terminals) (mil bus).
Source: Canadian Grain Commission, Background Information on Primary and Terminal Elevators, April, 1984.

QE Monthly average of producer rapeseed elevator delivery quotas (bu/acre).
Source: Canadian Wheat Board.

Where it is expected that the stocks in prairie elevator positions are a direct function of the previous month's stocks (LSEP) (i.e. $\delta SEP/\delta LSEP>0$). Also expected to be directly related to SEP are total prairie elevator storage capacity (TCAP) (i.e. $\delta SEP/\delta TCAP>0$). If capacity declines as has been observed, the ability to hold rapeseed stocks declines as well.[86] Predicted to be inversely related to SEP are elevator delivery quotas (QE) (i.e. $\partial SEP/\partial QE<0$). The negative sign, expected to be associated with QE, is due to the tradition of quotas increasing when elevator stocks are low and the acquisition of farm stocks is difficult. Also expected to be inversely related to elevator stocks is PS, the street price (i.e. $\partial SEP/\partial PS<0$). When prices are high stocks will be low as the high prices are needed to attract stocks. Conversely low prices indicate adequate elevator stocks.

Equation 5.3: Farm Stocks of Rapeseed

$$FS = f(PS, LFS, I, QT, YLFS)$$

where:

FS Monthly farm stocks (000's tonnes).
Source: unpublished data, Grain Marketing Unit, Statistics Canada.

LFS One period lag of FS.

I Monthly average of Canadian prime interest rate (percent).
Source: Bank of Canada Review.

QT Total rapeseed quota (QT = QE + QC)

YLFS Twelve period lag of FS.

---

[86] Canadian Grain Commission, Ibid., 1984.

Intuitively, current farm stocks (FS) are a direct function of the previous period's stocks (LFS) (i.e. $\delta FS/\delta LFS>0$). Also a twelve period lag variable (YLFS) is incorporated to account for the general trend of high stocks after harvest and lowering of the stocks as the crop year proceeds to next harvest. The opportunity cost factor discussed in the preceeding equation holds for the variable I in this equation as well and therefore is expected to be inversely related to FS (i.e. $\delta FS/\delta YLFS>0$). The total delivery quota coefficient (QT) also is expected to also be inversely related to FS (i. $\delta FS/\delta QT<0$) for quota opens when demand requires it or as stocks become more difficult to attain in both the elevator and crushing sectors of the rapeseed industry.

<u>Equation 5.4</u>: <u>Volume of Rapeseed Demanded for Domestic Crushing</u>

$$QDD = f(LSCP, DCM, YLQDD, QC)$$

where:

QDD — Monthly domestic rapeseed crush (000's tonnes).
Source: Statistics Canada, Oils and Fats, Catalog 32-006.

LSCP — Rapeseed stocks at crush/processor position, a monthly average of weekly stock reports (000's tonnes).
Source: Canadian Grain Commission, Grain Statistics Weekly.

DCM — Domestic rapeseed crush margin ($/tonne).
i.e. byproduct revenue - crushing costs - street price.
Source: Grain Marketing Unit, Statistics Canada, unpublished data.

YLQDD Twelve period lag of QDD.

QC Monthly average of producer rapeseed crusher delivery quotas (bu/acre).
Source: Canadian Wheat Board

Where it is expected that the quantity of rapeseed crushed each month (QDD) is a function of the domestic crush margin which is the revenue received from the sales of rapeseed byproducts oil and meal minus the cost of the raw seed. Therefore, the greater the crush margin the larger the volume crushed, and thus a positive sign is expected to be associated with the coefficient (i.e. $\delta QDD/\delta DCM>0$). The twelve period lag dependent variable (YLQDD) is also expected to be directly related to QDD, because the seasonality of production, and a chronic problem of short carryover stocks causes domestic crushing to lessen later in the crop year (i. $\delta QDD/\delta YLQDD>0$). Therefore specific months will be associated with particular levels of crushing demand. As well the single period lag of stocks held by crushers (LSCP) is hypothesized to be positively related to QDD for as stocks are depleted by crushing and are not replenished the quantity crushed will decline (i.e. $\delta QDD/\delta LSCP>0$). Crushing quota (Qc) coefficients are foreseen to adopt a negative sign (i.e. $\delta QDD/\delta QC<0$), because high quotas usually indicate supplies short of demand and therefore lower crushing levels. Conversely low delivery quotas indicate surplus stocks and therefore high crushing capacity utilization.

Equation 5.5: Volume of Rapeseed Demanded for Export

QDX = f(JSS, JRM, LSXP, RPCS)

where:

QDX Monthly, quantities of rapeseed exported, (000's tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.

JSS Monthly average stocks of rapeseed and soybeans in store Japan (tonnes). Source: Fats and Oils Monthly, Japanese Oilseeds Processors Association, Tokyo.

JRM Japanese rapeseed crush margin ($/tonne). Sources: Fats and Oils Monthly, Japanese Oilseeds Processors Association, Tokyo. (See Appendix 2).

LSXP One period lag of stocks in export position (000's tonnes).

RPCS Ratio of the monthly average cash prices ($U.S.) of soybeans (basis Chicago) and rapeseed (basis Vancouver).

The equation to estimate the quantity of rapeseed demanded for export contains several factors particular to the Japanese/Canadian rapeseed market relationship. The first of these is the exchange rate and substitute product price impact (RPCS) upon rapeseed demand. As the value of the yen in Canadian dollars increases (decreases) relative to the yen in United States dollars the substitution of rapeseed for soybeans should increase (decrease) (i.e. $\partial QDX/\partial RPCS>0$). As explained by Swallow (1983), the exchange rate substitution effect may not be as great as anticipated, as the amount of rapeseed oil consumed in Japan is somewhat fixed due to dietary habits and crushing technology restrictions.[87] Hence, only if the changes in the exchange rate ratio are large will significant substitution effects occur.[88]

The Japanese rapeseed crush margin (JRM) is likewise predicted to be positively related to the QDX (i.e. $\partial QDX/\partial JRM>0$). As crushing becomes more (less) profitable the quantity of rapeseed imported will increase (decrease) until demand effects cause the price of rapeseed imports to rise, which decrease the JRM.

The stock of oilseeds (JSS = soybean and rapeseed) coefficient will have a negative sign because as stocks increase, the opportunity cost (insurance, lost interest, new storage facilities, etc.) increases (i.e. $\partial QDX/\partial JSS<0$). Therefore it is in the best interest of the crushing industry in Japan to hold only a working supply, as in most years world supplies of oilseeds exceed demand.

Stocks in export positions in the previous period (LSXP) are expected to be positively related to QDX (i.e. $\partial QDX/\partial LSXP>0$). The opportunity cost of holding large stocks into subsequent time periods is large, not only in the traditional sense of insurance and lost interest but in the constriction placed upon the export logistics which hampers exports of other products. Since the movement of export of stocks is

---

[87] Swallow, Ibid., pp. 14-15.

[88] Umemoto, E. XCAN, Tokyo, Interview, March, 1984.

the major priority, they are sold even at decreased world prices.

ceteris paribus will cause export demand to increase.

Equation 5.6: Street Price

PS = f(PF, DQRE, QDD, YLPS, LFS, LSEP)

where:

PS Rapeseed, monthly average street price (as discussed in Section 3.3 Description of Basis Data).
Source: Canadian Grain Commission.

PF Rapeseed, monthly average futures price (as discussed in Section 3.3 Description of Basis Data).
Source: Winnipeg Commodity Exchange.

DQRE Dummy variable representing elevator quota delivery restrictions.

DRQE = 1 when average monthly quota (bu/acre) < crop year average yield (bu/acre).
DRQE = 0 when average monthly quota (bu/acre) < crop year average yield (bu/acre).

QDD Monthly domestic rapeseed crush (000's tonnes).
Source: Statistics Canada, Oils and Fats, Catalog 32-006.

YLPS Twelve period lag of PS.

LFS One period lag of monthly average farm stocks (000's tonnes).

LSEP One period lag of monthly average stocks in elevator postion (000's tonnes).

Where it is expected that the futures price PF is expected to be positively related to the street price, as dictated by basis theory discussed in Chapter 3 (i.e. $\partial PS/\partial PF>0$). The yearly lag of street prices (YLPS) a seasonality variable, will also be directly related to PS, as an intra-crop year street price trend is apparent and is discussed in more detail in Section 3.3 (i.e. $\partial PS/\partial YLPS>0$).

The coefficient for domestic crushing demand (QDD) is likewise predicted to have a positive sign (i.e. $\partial PS/\partial QDD>0$). Basic economic theory stipulates that as demand increases (decreases), given a fixed supply, PS will increase (decrease).

Another variable included in this equation is elevation tariff variable (TAR), which accounts for the general increase in the total costs of storage (discussed in Chapter III) incurred during the time frame of this study. These costs are deducted from the futures price to establish the street price and therefore TAR will be inversely related to PS (i.e. $\partial PS/\partial TAR<0$).

The variable DRQE is predicted to be inversely related to the street price. Under delivery restrictions producers are eager to fill their allowable volume to obtain some cash flow. Cognizant of the needs of farmers, the street price may be discounted, because despite the discounted price and the uncertainty of future quota levels encourages producers to deliver. Therefore $\partial PS/\partial DRQE<0$.

The variable LFS is expected to be inversely related to the street price (i.e. $\partial PS/\partial LFS<0$). The higher the supply of a product (FS) ceterius paribus the lower the price where equilibrium is achieved.

The variable LSEP is expected to be inversely related to the street price (i.e. $\partial PS/\partial LSEP<0$). High elevator stocks should lessen the demand for additional stocks. Therefore the offering price is predicted to fall.

Equation 5.7: Export Cash Price

$$PC = f(PF, PCSB, LCLP)$$

where:

PC Rapeseed, monthly average cash price (as discussed in Section 3.3 Description of Basis Data).
Source: Winnipeg Commodity Exchange.

PF Rapeseed, monthly average futures price (as discussed in Section 3.3 Description of Basis Data).
Source: Winnipeg Commodity Exchange.

PCSB Monthly average soybean cash price (basis Chicago) (\$/tonne).
Source: Chicago Board of Trade, annual reports, 1977-1983.

LCLP One period lag of quantity of rapeseed loaded onto producer cars for delivery to west coast (tonnes).
Source: Canadian Grain Commission, Grain Statistics Weekly.

As in the discussion of the relationship of PF and PS in equation 5.6, the positive relationship of PF and PC is discussed in detail in Basis Theory, Chapter 3 (i.e. $\delta PC/\delta PF>0$). The competition between soybeans and rapeseed for shares in the international oilseed market due to their substitutability causes the relationship between the soybean cash price (PCSB) and PC to be hypothesized as positive (i.e. $\delta PC/\delta PCSB>0$).

As discussed in section 5.1, the effects of railcar allocations on PC were a great concern to grain companies and the GTA. The variable LCLP, the one period lag of cars loaded by producers attempts to account for the effects of uncommitted stocks in storage in the current month. It is expected that as the amount of uncommitted rapeseed increases (decreases) the cash price will decrease (increase) because there is more (less) competition among exporters to attain stocks to supplement their supplies (i.e. $\delta PC/\delta LPC<0$).

Equation 5.8: Futures Price

$$PF = f(PC, PFSB, LPF, I)$$

where:

PF Rapeseed, monthly average futures price (as discussed in Section 3.3 Description of Basis Data). Source: Winnipeg Commodity Exchange.

PC Rapeseed, monthly average cash price (as discussed in Section 3.3 Description of Basis Data). Source: Winnipeg Commodity Exchange.

PFSB Monthly average soybean futures price for a specified contract at least 90 days previous to final delivery day. Source: Chicago Board of Trade, annual reports 1977-1983.

I Monthly average Canadian prime interest rate.

Where it is expected that the relationship of PC to PF over the time frame of this study cannot on an a priori basis be hypothesized and will be determined upon estimation of the equation.

The relationship of soybean and rapeseed cash prices discussed in the preceeding equation also holds for the association of soybean (PFSB) and rapeseed future prices. Therefore this relationship is expected to be positive as their product substitutability dictates (i.e. $\partial PF/\partial PFSB>0$).

The interest rate variable (I) is incorporated into this equation to account for the increased (decreased) cost of holding stocks given a rise (fall) in interest rates. Therefore it is expected that the coefficient will bear a positive sign (i.e. $\partial PF/\partial I>0$).

Another variable included in this equation is the futures price in the previous period (i.e. t-1). This variable is predicted to have a positive relationship to the dependent variable, because price expectations in t-1 will effect current expectations. Therefore $\partial PF/\partial LPF>0$.

IDENTITY EQUATIONS

Equation 5.9: Street Basis

$$BS^* = PF^* - PS^*$$

where:

BS* Estimated street price basis.

PF* Rapeseed, estimated futures price, from equation 5.8.

PS* Rapeseed, estimated street price, from equation 5.6.

Equation 5.10: Cash Basis

$$BC^* = PF^* - PC^*$$

where:

BC* Estimated cash Price Basis.

PF* Rapeseed, estimated futures price, from equation 5.8.
discussed in Section 3.3 Description of Basis Data).
Source: Winnipeg Commodity Exchange.

PC* Rapeseed, estimated cash price, from equation 5.7.
in Section 3.3 Description of Basis Data).
Source: Winnipeg Commodity Exchange.

5.5 ESTIMATION TECHNIQUE

The Two Stage Least Squares (2SLS) method will be the technique employed for estimation of the system of simultaneous equations aggregated in the empirical model. Originally deveoped by Theil (1953), it is applied to a single equation within a system and eliminates as much simultaneous equation bias as possible.[89] As the name suggests, the regression is carried out in two stages:[90]

Stage 1: Regress each endogenous variable on all the exogenous variables in the simultaneous system to obtain estimates of the endogenous variables.

Stage 2: The estimated values of the endogenous variables and the exogenous variables included in the specific equation act as regressors in the estimation of the single equations of the system.

The following assumptions are made when estimations via 2SLS are undertaken:[91]

1. the disturbance term must satisfy the assumption of zero mean, constant variance and zero covariance.
2. the explanatory variables are not perfectly multicollinear.

---

[89] Koutsoyiannis, p. 384.

[90] Peter Kennedy, A Guide to Econometrics, MIT Press, Cambridge Mass., 1979, pp. 114-116.

[91] Koutsoyannis, pp. 391.

3. the model is correctly specified with all exogenous variables identified and macrovariables aggregated properly.
4. the sample size is sufficiently large and equations properly identified.

If the assumptions of 2SLS are satisfied the estimates attained from this technique have the following properties:[92]

1. the estimated parameters are asymptotically unbiased, i.e. as n --> infinity the bias declines.
2. the estimated parameters are consistent, i.e. their distribution collapses on the true parameter as n--> infinity.

Because of its simple conception, its properties of asymptotic consistency, and the efficiency of its estimated parameters was 2SLS selected as the estimation technique for the empirical analysis.[93]

To summarize, this chapter has presented (1) the hypothesis concerning causes of observed basis behavior, (2) the structural equations, including their component variables and their data sources, and (3) a description of the empirical model estimation technique that is employed in the next chapter.

---

[92] Ibid., p. 392.

[93] Kennedy, p. 24.

5.6 SUMMARY OF THE DATA BASE OF THE EMPIRICAL MODEL

The following section summarizes the data base utilized in the empirical model. Table 5.1 lists all of the variables and their source. The actual observations used are given in Appendix 1.

TABLE 5.1

Endogenous and Exogenous Variables of the Empirical Model

Endogenous Variables

SXP	Visable stocks of rapeseed at west cost (Vancouver and Prince Rupert) export positions expressed as monthly average of weekly stocks reported (000's tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.
SEP	Visible stocks of rapeseed at prairie elevators and terminal positions expressed as monthly average of weekly stocks reported (000's tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.
FS	Monthly farm stocks (000's tonnes). Source: unpublished data, Grain Marketing Unit, Statistics Canada.
QDD	Monthly domestic rapeseed crush (000's tonnes). Source: Statistics Canada, Oils and Fats, Catalog 32-006.
QDX	Monthly, quantities of rapeseed exported, (000's tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.
PS	Rapeseed, monthly average street price (as discussed in Section 3.3 Description of Basis Data). Source: Canadian Grain Commission.
PC	Rapeseed, monthly average cash price (as discussed in Section 3.3 Description of Basis Data). Source: Winnipeg Commodity Exchange.
PF	Rapeseed, monthly average futures price (as discussed in Section 3.3 Description of Basis Data). Source: Winnipeg Commodity Exchange.
BS*	Street Price Basis. BS = estimated futures price (PF*). minus estimated street price (PS*) (i.e. BS* = PF* - PS*).
BC*	Cash Price Basis. BC = estimated futures price (PF*) minus estimated cash price (PC*) (i.e. BC* = PF* - PC*).

<u>Exogenous Variables</u>

LTW One period lag of monthly sum of weekly rapeseed stocks in transit to west cost export positions (000's tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.

LSXP One period lag of SXP.

LQDX One period lag of exports (000's tonnes).

LSEP One period lag of SEP.

TCAP Total storage capacity of prairie elevators (and prairie terminals) (mil bus). Source: Canadian Grain Commission, Background Information on Primary and Terminal Elevators, April, 1984.

I Monthly average of Canadian prime interest rate (percent). Source: Bank of Canada Review.

QE Monthly average of producer rapeseed elevator delivery quotas (bu/acre). Source: Canadian Wheat Board.

QC Monthly average of producer rapeseed crusher delivery quotas (bu/acre). Source: Canadian Wheat Board

QT Total rapeseed quota (QT = QE + QC)

LSCP Rapeseed stocks at crush/processor position, a monthly average of weekly stock reports (000's tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.

LFS One period lag of FS.

DCM Domestic rapeseed crush margin ($/tonne). Source: Grain Marketing Unit, Statistics Canada, unpublished data.

YLQDD Twelve period lag of QDD.

YLFS Twelve period lag of FS.

YLPS Twelve period lag of PS.

LPF One period lag of PF.

JSS Monthly average stocks of rapeseed and soybeans in store Japan (tonnes). Source: Fats and Oils Monthly, Japanese Oilseeds

Processors Association, Tokyo.

JRM — Japanese rapeseed crush margin ($/tonne). Sources: Fats and Oils Monthly, Japanese Oilseeds Processors Association, Tokyo. (See Appendix 2).

RPCS — Ratio of the monthly average cash prices ($US) of soybeans (basis Chicago) to rapeseed (basis Vancouver).

DRQE — Dummy variable representing elevator quota delivery restrictions. DQE = 1 when average monthly quota (bu/acre) < crop year average yield (bu/acre). DQE = 0 when average monthly quota (bu/acre) > crop year average yield (bu/acre).

PCSB — Monthly average soybean cash price (basis Chicago) ($/tonne). Source: Chicago Board of Trade, annual reports, 1977-1983.

LCLP — One period lag of quantity of rapeseed loaded onto producer cars for delivery to west coast (tonnes). Source: Canadian Grain Commission, Grain Statistics Weekly.

PFSB — Monthly average soybean futures price for a specified contract at least 90 days previous to final delivery day. Source: Chicago Board of Trade, annual reports 1977-1983.

TAR — Tariff charges administered by elevator companies. Includes maximum charges for elevation and one month's storage and elevation.

Chapter VI

EMPIRICAL RESULTS

The empirical analysis conducted in this study is centered upon the estimation of the system of simultaneous equations 5.1 to 5.10 inclusive. The initial section presents the two-stage least-squares (2SLS) estimates of the behavioral equations together with appropriate econometric statistics. Also included in this section will be a discussion of the hypotheses concerning basis changes as proposed in Section 5.1. The final section of this chapter will compare the model's predicted values of street and cash price basis to actual basis observations.

6.1 DISCUSSION OF MODEL ESTIMATION RESULTS

This section will present and discuss the empirical results determined from the estimation of the econometric model. Included are, statistical test results, comparisons of results to a priori expectations, and a discussion of the fit of estimated street and cash price bases to the observed bases' levels.

6.1.1 2SLS Estimation of Econometric Model of Rapeseed Markets for Months August, 1977 to July, 1983

(see below)[94]

---

[94] * indicates signficant t-test statistic at the 5 percent level; ** indictes significant t-test statistic at the 10 percent level.

Stocks in Export Position:

$$SXP = 62.51^{**} - 0.10\ PC + 0.08\ LTW^{*} + 0.61\ LSXP^{*} - 0.92\ QDX^{*}$$
$$(1.56) \quad (-0.87) \quad (1.94) \quad (6.07) \quad (-1.64)$$

MSE = 206.54   h = 1.72

The empirical results verified that previous period stocks and prairie shipments are directly related to current export position stocks. Also conforming to a priori expectations was the indirect relationship of previous exports and one period lagged cash prices to the dependent variable. All of the above independent variables with the exception of the lagged cash price were significant at the confidence levels specified in the previous section.

The Durbin-h statistic indicated a statistically nonsignificant first order autocorrelation test. The correlation matrix (Appendix 3) displayed no severe multicollinearity, and the Spearman Rank Correlation Coefficients indicated that the hypothesis of homoscedasticity could not be rejected (Appendix 5).

Stocks in Prairie Elevator Position:

$$SEP = -172.02 - 0.01\ PS + 0.80\ LSEP^{*} + 33.47\ TCAP^{**} - 1.05\ QE^{*}$$
$$(-0.65) \quad (-0.02) \quad (13.47) \quad (1.38) \quad (-1.66)$$

MSE = 305.60   h = 1.14

The results of this equation indicate that the street price has much less effect upon the attraction of farm deliveries than do quota restrictions, which were significant and of the expected relationship to the dependent variable. Also signficant was the positive relationship of storage capacity to stocks. The most signficant variable represented previous period stocks, which as predicted a priori were positively related to current prairie stocks.

The equation was free of autocorrelation as indicated by the insignificant h statistic. Multicollinearity and heteroscedasticity were not present either, as indicated in Appendices C and E respectively.[95]

Farm Stocks:

(see footnote 95 below)

$$FS = 235.59 - 0.20\ PS + 0.74\ LFS^{*} - 59.85\ QT^{*} + 0.12\ YLFS^{**}$$
$$(0.11) \quad (-0.03) \quad (5.70) \quad (-2.22) \quad (1.59)$$

MSE = 418.18 h = 1.41

Lagged farm stocks and the seasonality indicator of farm stocks (YLFS) were significant and showed positive relationships to the dependent variable as expected a priori. Also conforming to a priori predictions was the total quota variable which was inversely related to

[95] The original 2SLS estimation of equation 5.3 was found to have autocorrelated error terms, as the Durbin h-statistic exceeded the critical value. This was corrected for (as suggested by Johnston, 1972) by performing an instrumental regression to predict the lagged dependent variable using the other independent variables. Using this predicted variable in the estimation technique, an autocorrelated corrected regression is performed. The corrected version is reported. The original estimation is reported in Appendix F.

farm stocks. The coefficient of the interest rate variable although having the expected sign was insignificant. The street price was also insignificant and the coefficient was the same sign as theoretically predicted. This result supports the findings of the previous equation which determined that street prices did not signficantly influence elevator stocks of rapeseed from farm deliveries. Therefore quotas have considerably greater effects upon farm and elevator stocks than do street prices during the study period.

The problem of correlated error terms was corrected for in the regression yielding consistent estimates.

Multicollinearity between the independent variables is not severe (Appendix 3). The Spearman Rank Coefficients in Appendix 5 indicate that the equation is free of heteroscedasticity.

<u>Domestic Crushing Demand</u>:

$$QDD = 14680.5 + \underset{(1.53)}{.51}\,DCM^{*} + \underset{(1.91)}{4.78}\,YLQDD^{*} + \underset{(5.33)}{2.64}\,QC^{*} + \underset{(1.93)}{4.78}\,FS^{*} \quad (2.81)$$

QDD = 14680.5 + .51 DCM* + 4.78 YLQDD* + 2.64 QC* + 4.78 FS*

(1.53) (1.91) (5.33) (1.93) (2.81)

MSE = 154.81 D.W. = 1.78

This equation performed reasonably well as all coefficients were of the *a priori* sign and were statistically significant. The domestic crush margin was directly related to the quantity crushed as were the stocks held in crush positions in the previous period. The variable representing seasonality of crushing (YLQDD), as predicted, was highly signficant and therefore supported the suggestion that the domestic crushing industry is very dependent upon the seasonality of supply (i.e. carryover in the latter half of the crop year). The statistically significant quota variable indicates that an increase in quota may allow domestic crushing to increase. Further research to determine whether quotas restrict crushing or if capacity is the limiting factor is warranted.

The Durbin-Watson statistic was used for this equation and determined that the hypothesis of zero autocorrelation could not be rejected. Multicollinearity was less severe than in other equations (Appendix 3), and it was also free of heteroscedasticity.

Export Demand:

QDX = 250.35* - 0.15 JSS* + 0.22 JRM* + 0.71 SXP* + 0.16 ~~RUPC~~ RRCS

(4.01) (-1.77) (1.47) (2.13) (0.79)

D.W. = 2.19 MSE = 1467.41

The general fit of the export demand equation was poorer than in comparison to other equations as indicated by the MSE, however, this may be adequate given the Japanese buying practices, discussed in Chapter II. Japan purchases a specified quantity each year, which is very price inelastic.[96] Above this level, crush margins, storage and processing capacities, exchange rate, prices of substitutes and future domestic consumption effects will determine additional purchases.[97] These factors

---

[96] Umemoto, (1984).

[97] Ibid.

are very difficult to model on a monthly basis and perhaps require a smaller time period such as bi-weekly or weekly periods to show significant relationships.

As expected, the lagged stocks in export storage variable was inversely related to QDX. The two Japanese market variables, Japanese oilseed stocks and Japanese rapeseed crushing margins were significant and were indirectly and directly related to the dependent variable respectively as anticipated in the discussion of the empirical model (Section 5.5.).

The ratio of prices (soybeans/rapeseed $U.S.) was not statistically significant. This result supports the belief that certain levels of Japanese demand is very price inelastic. It has also been suggested that exchange rate effects have only been relevant since Janaury 1983 and therefore would not exhibit its significance in this study period's analysis.[98]

The equation is free of autocorrelation, multicollinearity (Appendix 3), and heteroscedastic problems (Appendix 5).

<u>Street</u> <u>Price</u>:

$$PS = \underset{(3.24)}{143.28^*} + \underset{(3.95)}{0.40^*}\,PF - \underset{(-2.02)}{.034}\,LSEP^* - \underset{(-1.26)}{5.14}\,DRQE^{**} + \underset{(0.68)}{.072}\,YLPS$$

$$- \underset{(-2.25)}{0.89}\,TAR^* - \underset{(0.26)}{.04}\,QDD$$

---

[98] <u>Ibid</u>.

D.W. = 1.92 MSE = 125.89

As predicted, the futures price variable (PF) was statistically signficiant and directly related to the dependent variable. Also statistically significant but inversely related to the street price was the elevator stocks variable (LSEP). From this it can be concluded that stocks destined for export (i.e. in the primary elevator system) effect the street price. Similarly the dummy variable (DRQE) which represents restrictive elevator delivery quotas was inversely related to the street price. This indicates that the street price was discounted when allowable levels of rapeseed deliveries (bu/acre) were less than the average yields of rapeseed during the respective crop years.

The statistical significance of the elevation tariff variable (TAR) indicates that the majority of an increase in tariffs is reflected in the basis via a reduction in the street price.

Contrary to the literature reviewed, the yearly lagged street price representing seasonality of rapeseed street pricing was found to be insignificant.[99] This could be a result of the limited sample size and therefore is an indicator that further data may be required, it could however also prompt the rejection of the hypothesis of significant street price changes in response to pre and post harvest supply conditions and therefore narrowing and widening of the basis.[100] Further re-

[99] Carter, (1984).

[100] Another attempt to determine seasonality included the use of a dummy variable representing the first quarter of the crop year (i.e. the months August, September and October). This variable proved to be statistically insignificant. The equation is reported as initially

search in this area is warranted.

The current crushing demand variable (QD) was statistically insignificant as well. Possible explanation could result from the seasonality of the crushing period in which plants operate in times of low stocks, and continue to purchase for crush even when prices are rising just to ensure supply stability. Also, domestic purchases of raw seed are not the sole demand factor associated with the street price. Purchases for export by line elevator companies also affect PS as indicated by the variable LSEP above.

The Durbin's h-statistic indicated an acceptance of the null hypothesis of zero autocorrelation. The correlation of coefficient matrix (Appendix 3) shows no indication of multicollinearity and the Spearman Rank Correlation Coefficients are insignificant and therefore do not reject the theory of homoscedastic residuals.

<u>Cash Price</u>:

$$PC = 164.40^{*} + 0.35\ PF^{*} + 6.11\ PCSB^{*} - 2.82\ LCLP^{**}$$
$$(5.77) \qquad (3.52) \qquad (2.39) \qquad (-1.29)$$

D.W. = 1.67 MSE = 163.62

The cash price equation performed well as all varibles were significant and of the expected relationship to the dependent variable. The futures price and the cash price of the substitute crop, soybeans, all are directly related to current cash rapeseed prices. Confirming the

---

specified.

hypothesis that railcar allocations affect Vancouver cash prices, the lagged producer cars loaded variable was determined to be inversely related to the dependent variable as predicted a priori. It can be reasoned that as the amount of producer cars loaded in previous periods increases their availability in current months and therefore the spot price paid in Vancouver decreases as shown by the indirect relationship of cash prices to LCLP.

The equation was free of autocorrelated error terms, multicollinearity (Appendix 3) and heteroscedasticity (Appendix 5).

<u>Futures</u> <u>Price</u>:

$$PF = 31.27^{**} + 0.12\ PC^{**} + 7.09\ PFSB^{*} + 0.61\ LPF^{*} + 0.28\ I^{*}$$
$$(1.28) \qquad (1.35) \qquad (3.26) \qquad (7.55) \qquad (2.56)$$

h = 1.88 MSE = 64.52

This equation also performed well with all calculated t-statistics being much greater than the critical values at the 5 percent confidence level. The one period lagged futures price, the current soybean futures price, and the current cash price are all directly related to the dependent variable as theoretically predicted in Section 5.5. Also conforming to a priori expectations was the positive relationship of interest rates to the futures price. This result substantiates the part of the second hypothesis of Section 5.1 which predicted a general increase in the basis, as a result of interest rate increases, since the futures price incorporates these costs to time t+1.

The equation was free of first order autocorrelation, multicollinearity (Appendix 3), and the Spearman Rank Correlation coefficients indicated no heteroscedasticity (Appendix 5).

6.2 COMPARISON OF ACTUAL AND PREDICTED BASIS VALUES

Identities 5.9 and 5.10 generated estimates of monthly average street and cash bases for the study period. This section will compare the estimated basis with the observed basis to determine the effectiveness of the empirical model's representation. The first part of this section discusses the methods of comparing the actual and predicted basis levels. The second and third subsections contain the analysis of the predicted street and cash basis values respectively as they pertain to those observed.

6.2.1 Methods Employed to Compare Predicted and Actual Basis Levels

Three methods will be used to measure the accuracy of the estimated basis values. The first method is a simple comparison of the plots of the observed bases with the predicted basis value to observe whether the general trends and changes of the actual basis are captured by the predicted levels generated by the model. A more statistically sound measure of accuracy of the estimates (i.e. goodness of fit) is needed however to increase one's confidence in the model. This study employs two such measures, the inequality coefficient and the linear regression method.[101]

---

[101] Koutsoyiannis, pp. 492 - 495.

The Theil's inequality coefficient uses the root mean squared prediction error and the actual observed values to obtain a testable statistic of goodness of fit.[102] The coefficient is calculated as:

$$U = \frac{\Sigma(Pr - A) / n}{\Sigma(A) / n}$$

where: Pr(t) = predicted change in the dependent variable

A(t) = actual change in the dependent variable

n = number of periods predicted

If Pr(t) = A(t), then U = 0, and it can be concluded that the model predicts perfectly.

If Pr(t) = 0, then U = 1, and the model predicts no better than the naive hypothesis of zero change [i.e. A(t+1) = A(t)].

If U > 1 the fit of the model is worse than a zero change prediction. Therefore the closer the U-statistic is to zero the better the fit of the model to the actual observations.

The other test of goodness of fit, the linear regression method was suggested by Cohen and Cyert (1961).[103] It consists of regressing the

---

[102] By using the predicted and actual changes in a variable lower boundaries (i.e. zero) are set as a fixed base from which the actual and predicted variables are measured and comparisons can be more easily made across models. The use of the root mean square percent error alone expresses the goodness of fit relative to the mean value of the actual observations, and therefore cannot be compared to different models. (Koutsoyiannis, p. 493.)

[103] Kalmer J. Cohen and Richard M. Cyert, "Computer Models in Dynamic Econometrics", QJE, Vol. 75, (1961), pp. 112-127.

actual basis values upon the estimated values such that:

$$A(t) = bo + biPr(t) + v(t) \qquad (6.1)$$

If the predicted values are a perfect fit, then $Pr(t) = A(t)$ for all t and the regression results would be:

$$bo = 0, \text{ and}$$

$$bi = 1$$

The further the coefficients differ from zero and one respectively the more biased are the model's predictions. To determine whether the coefficients differ significantly from their theoretical values separate tests must be employed.

A t-test is performed upon the intercept term to determine its significance in the regression (6.1). If the t-statistic is found to be insignificant at the chosen confidence level the hypothesis bo = 0 cannot be rejected.

To test whether the bi coefficient differs significantly from one an imposed restriction F-test is performed. This test compares the error terms of regression 6.1 with the error terms of a restricted regression (i.e. bi = 1). The test statistic F* is calculated as:

$$F^* = \frac{(\Sigma er - \Sigma e) / c}{\Sigma e / (n - k)}$$

where: er = sum squared of residuals from restricted regression

e = sum squared of residuals from unrestricted regression

c = number of restricted parameters

n-k = degrees of freedom

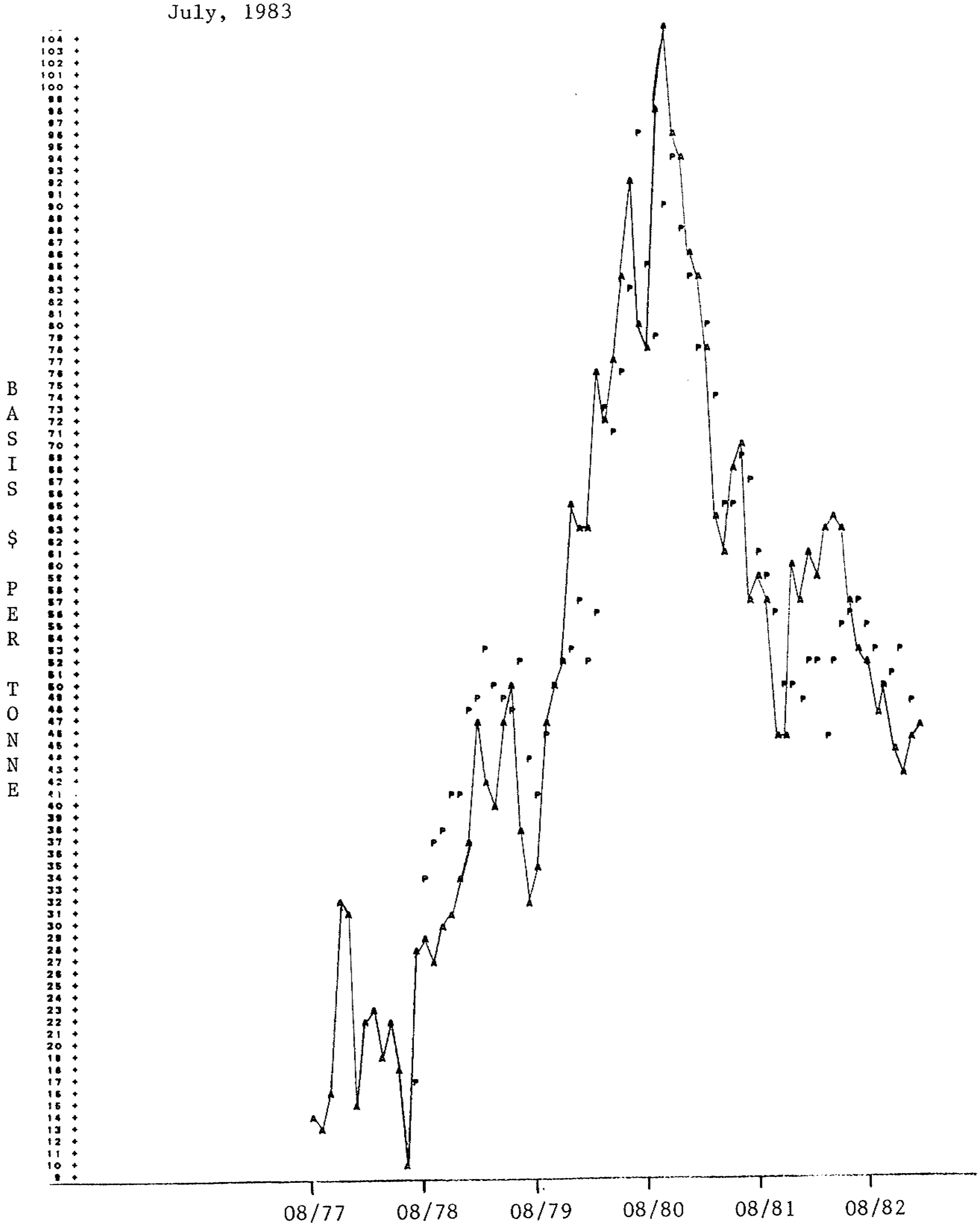
If F*<F critical then the null hypothesis bi=1 cannot be rejected. It can therefore be concluded that estimated values are not significantly different than the observed values, and the model is a good fit.

6.3 DISCUSSION OF RESULTS

6.3.1 Estimated Versus Observed Street Price Basis

The estimated monthly street price bases (BS*) derived in equation 5.9 were calculated by taking the mathematical differences between the estimated monthly average street and futures prices obtained from equations 5.6 and 5.8 respectively. Figure 6.1 presents the plot of both the actual and predicted basis values for the study period August, 1977 to July, 1983.

Figure 6.1: Observed and Predicted Street Price Bases August, 1977 to July, 1983



Where A = actual observation
P = predicted observation

From the plots of the observed and predicted street price bases it is apparent that the predicted values track closely to the observed values.

The statistical tests support the graphical evidence of the model's good fit. Theil's inequality coefficient was found to be 0.23 which indicates that the model's predictions of basis change is far superior to the naive zero change hypothesis.

The linear regression measure of goodness of fit also indicates that the model simulates basis movement well. The regression was estimated such that:

$$BS = -2.09 + 1.04\ BS^*$$
$$(-0.16)\quad(14.8)$$
$$\text{R-square} = 0.80$$

where: BS = actual street price basis

BS* = predicted street price basis

At the 10 percent level of significance for a "two-tail" test (or the 5 percent level for the "one tail test) the critical t statistic with 58 degrees of freedom equals 1.67. Since the computed t statistic is less than the critical t value ($0.46 < 1.67$) the null hypothesis $bo = 0$ cannot be rejected.

To determine whether the coefficient bi was significantly different from one give $bo = 0$ the F-statistic (F^*) was computed (as described in the previous section) to be 0.014.[104] At the 5 percent significance lev-

[104] The calculation of the test statistic is shown in Appendix 4.

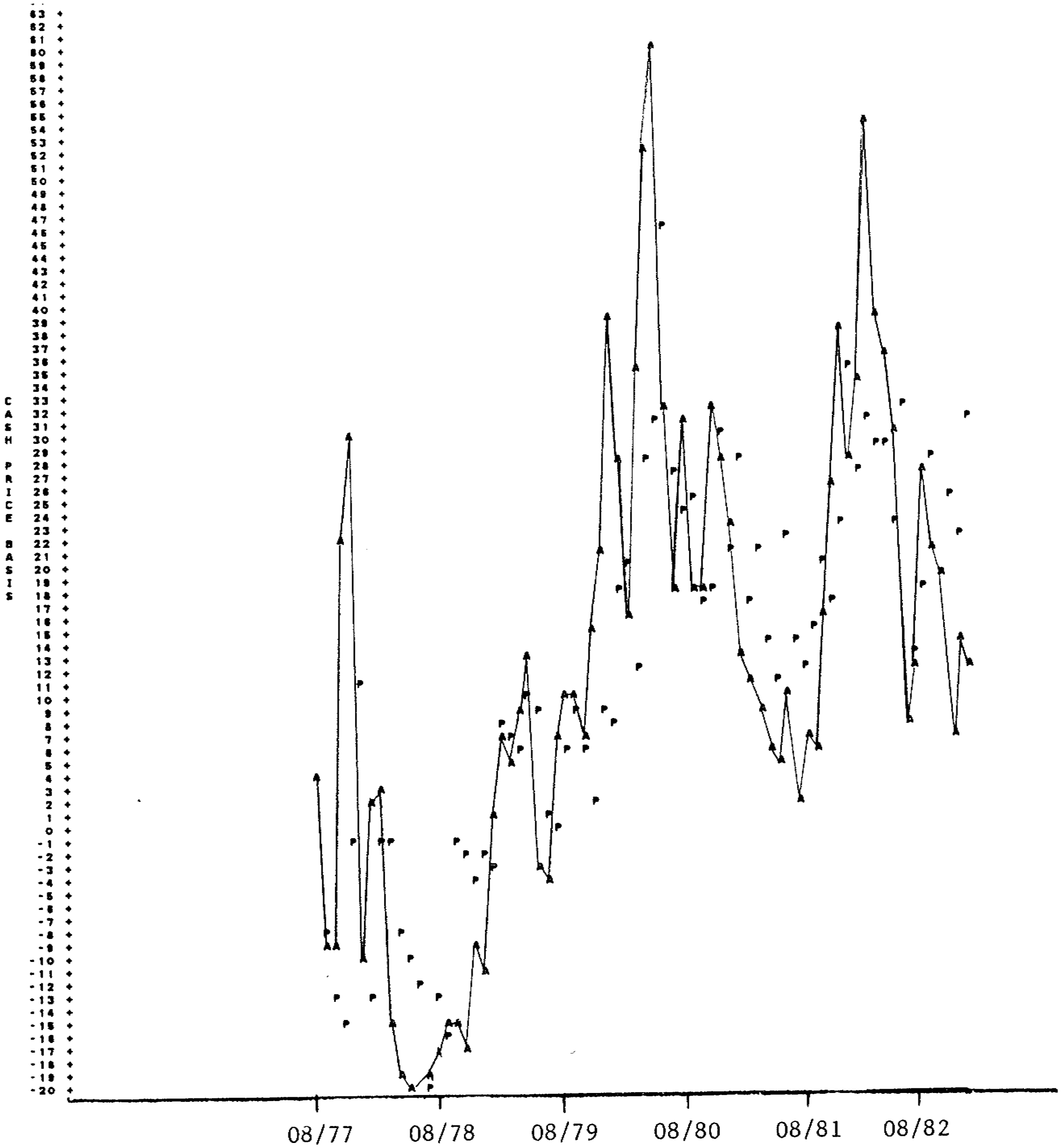
el the critical F value is 3.15. Since F* is less than F critical the null hypothesis bi = 1 cannot be rejected.

Hence, the acceptance of both null hypotheses allows one to conclude that the model's predictions are not significantly biased from the observed basis values and therefore represent street price basis behavior well.

6.3.2 Estimated Versus Actual Cash Bases

The estimated monthly cash price basis (BC*) are calculated in identity 5.10 from the estimated cash and futures prices derived from equations 5.7 and 5.8 respectively. The cash price bases are plotted in Figure 6.2 along with the observed basis values (BC) for the study period August, 1977 to July, 1983.

Figure 6.2: Observed and Predicted Cash Price Bases August, 1977 to July, 1983



Where A = actual observation
P = predicted observation

From the inspection of Figure 6.2 it is evident that the estimated cash bases follow the general trends of the observed cash bases. They are however not as closely related as the estimated and actual street bases.

To determine its goodness of fit the inequality coefficient is calculated to be 0.42. Since the inequality coefficient is much less than 1.0 it can be concluded that the models' predicted changes are superior to the "naive" no change hypothesis. As noted in the visual inspection of the predicted and observed basis plots, the higher inequality coefficient of the cash price basis as compared to the street price basis indicates the model does not perform as well as the street price basis model.

The linear regression measure of goodness of fit also denotes that the cash price model simulates the observed basis movements well. The regression results were as follows:

$$BC = 0.29 + 0.97\ BC^*$$
$$(0.15) \quad (9.55)$$
$$R\text{-square} = 0.60$$

where: BC = actual cash basis

BC* = estimated cash basis

Since the computed t-statistic is less than the critical t value (0.10 < 1.67) at the 5 percent confidence level the null hypothesis bo = 0 cannot be rejected.

Assuming bo = 0 the F-test statistic (F*) was calculated to determine whether bi is significantly different from one. F* was found to be 0.068.[105] As a result of F* being smaller than F critical (0.068 < 3.15) at the 5 percent confidence level the null hypothesis bi = 1 cannot be rejected. Similar to the street basis model's performance, the acceptance of both null hypothesis permits the conclusion that the cash basis model's predictions are not significantly biased from the observed basis values. Therefore the model's results represent the cash basis well.

As previously noted, the cash basis estimates do not conform to their observed basis levels as well as the street price basis estimates do to their respective observed levels. The major difficulty associated with the modelling of the cash basis appears to be the observed basis level's high degree of variability.[106] This high variance stems from the physical constraints inherent to the export market, as discussed in Section 5.1. These physical constraints (i.e. terminal storage space, and railway rolling stock) have forced institutional constraints to be placed upon the market. Railcar allocations for movement of grains from prairie storage to export position are regulated such that holders of uncommitted stocks in export position could hold an advantageous market position. Any small market swing is quickly reflected in the value of these free stocks, which is the futures price for rapeseed in store Vancouver. Compounding this marketing problem is the inability of grain companies to actively deliver to the futures market. These market commitments must also be serviced through the free stocks (producer car de-

---

[105] Shown in Appendix 4.

[106] The variance of the cash price basis was found to be 524.23, which exceeds the street price variability of 373.76.

liveries). Hence arbitrage is not efficient, leaving the market susceptible to high price volatility, as encountered throughout the study period.

With the completion of this discussion of the estimated bases's goodness of fit the analytical portion of this study is complete. Prior to the presentation of the final summary and conclusions, it will be useful to highlight the major findings of this chapter.

6.4 SUMMARY OF ANALYSIS

This chapter has reported the findings of the empirical model which represents the Canadian rapeseed industry and simultaneously determines the storage, cash and futures markets' equilibirum levels. Of particular significance and the major goal of this study was the identification of factors contributing to the level and behavior of the street and cash bases (equations 5.9 and 5.10 respectively).

The rapeseed street price was found to be directly related to the futures price. The elevation tariff variable was inversely related to the street price, as was the quota delivery restriction variable. Counter to the hypothesis that the street price is significantly affected by seasonal fluctuations, the yearly lagged street price was found to be insignificant.

The rapeseed cash price was found to be directly related to the current futures price and the cash price of soybeans. As expected *a priori*, the volume of grain in export position delivered by producer car was inversely related to the cash price.

The futures price was determined to be a function of the cash price, the soybean futures price, and the one period lagged futures price. Another factor that directly contributed to the futures price as expected a priori was the interest rate variable.

In estimating stock equations (elevator and farm levels) it was found that street price effects were insignificant, which is counter to a priori expectations and basic economic theory. Concommitantly the quota level variables were significant. This may indicate that institutional constraints influence storage and sales decisions greater than the price variables.

Also examined in this chapter were the goodness of fit tests of the estimated street and cash basis levels to their respective observed levels. The estimated bases were found to statistically fit well, however the fit of the street price basis was superior to the fit of the cash basis. This inferior fit was due to the high variance associated with the observed cash price.

The next and final chapter will present a summary of this study, outlining its major conclusions and providing suggestions for future research into the area of rapeseed marketing and basis behavior.

Chapter VII

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

With the technological and physiological advancements that have taken place over the last twenty years in the rapeseed industry, such as lower erucic acid content in oil, lower glucosinolate presence in meal and the development of traizene resistant varieties for better weed control, production problems are no longer the sole obstacle preventing the industry from achieving its potential importance within Canadian agriculture. Marketing problems also exist, and may be considered as significant as production problems. These marketing problems include:

1. the presence of Japanese and European Economic Communities' protectionist tariff policies which restrict the imports of Canadian rapeseed value added byproducts, oil and meal.
2. regulatory controls on delivery of rapeseed to Vancouver against futures contracts.
3. the attainment of rail transportation rates that favour the movement of the value added products, oil and meal from western to eastern Canada, instead of raw seed.
4. restrictive post-harvest delivery quotas place marketing constraints upon rapeseed growers, processors and exporters.
5. concentration and vertical integration of elevator and exporting companies which may allow some measure of market power to be exerted at opportune moments.

6. restricted railcar and terminal storage availability causes the movement of rapeseed to export position to be governed by a regulatory body and not totally by market situations.

This study provides an economic analysis of another major marketing concern, the variability and behavior of the basis. It identifies institutional and economic factors contributing to the basis level from August, 1977 to July, 1983. Understanding the factors that influence basis behavior would aid producers, and crusher/processors in their production, marketing, and hedging decisions. It would also aid policy makers in developing methods to reduce and stabilize the basis.

The initial chapter of this study outlines the problem setting and the need for its investigation. The problem arises from the increased variability and the excessive level of the rapeseed basis observed during the study period. An excessive basis does not accurately represent the costs associated with marketing and therefore is prohibitive to both rapeseed production and marketing as it indicates street prices are discounted greater than necessary. The other problem concerning basis behavior is its variability. A hedger is able to reduce his risk of cash price changes through the transformation of cash price risk to basis change risk via the futures market. Traditionally in most well-developed markets, the risk associated with basis change is signficiantly lower than cash price changes; however, as the variability of the basis increases, the risk reduction capability of hedging on the futures market declines.[107] The lack of opportunities for price risk management detracts from production and/or marketing of rapeseed. This study has at-

[107] Carter and Loyns, 1983. p. 44.

tempted to identify factors contributing to basis behavior, thus allowing industry participants and policy makers to better understand rapeseed basis behavior .

A literature survey was presented in Chapter II, and considered the following topics:

1. Previous studies of the Canadian rapeseed industry: (a) production response studies, (b) processing industry studies, (c) marketing studies.
2. Review of empirical studies of basis behavior.

Chapter III reviewed the current theories of basis behavior originating from Working's (1949) theory of storage, for a seasonally produced, storable commodity. Based on these postulates, a theoretical behavioral pattern for a ninety day (previous to contract maturity) basis is derived. This pattern is then compared to the observed ninety day rapeseed street and cash bases. The observed behavior of the rapeseed basis during the time period of this study is highly variable and consequently inconsistent with the theoretical expectations. The effects of this high basis variability upon hedging effectiveness is also discussed in Chapter III.

The fourth chapter presented a theoretical discussion of the simultaneous determination of futures and cash prices. Adopting a model estimating the quarterly equilibrium of the Chicago corn futures and cash markets,[108] the theoretical equilibriums of the individual rapeseed cash P(t), futures PF(t), and storage markets were derived. However, as each

[108] Subotnik and Houck, p. 5.

of the above markets are not determined independent of each other, the theory is expanded to the simultaneous determination of the equilibrium levels in each. The simultaneous determination of P(t) and PF(t) provides an estimation of the basis (PFt - Pt). Hence any factors influencing PF(t) or P(t) affects the basis.

This theoretical discussion of the rapeseed market equilibrium provides the foundation from which the empirical analysis of rapeseed basis behavior of this study originates.

Chapter V contains the empirical section of this study. It is composed of four sections:

1. a discussion of factors believed to influence basis levels,
2. general discussion of the participants and their interrelationships in the rapeseed market,
3. establishment of behavioral equations, their components, and expected relationships to the dependent variables,
4. discussion of estimation technique.

The first section includes a discussion of proposed factors that influence the bases levels. The first hypothesized influence is the storage and elevation tariff increases (allowed by the Canadian Grain Commission) which are expected to be fully reflected in the basis.

The second factor is rapeseed stock carryovers from month to month. It has been noted (Carter, 1984) that low carryover stocks primarily in May, June, July (i.e. months previous to new crop harvest) cause high convenience yields and consequently narrows the basis. Therefore the effects of month-ending stocks at the farm, elevator, crusher and export positions was incorporated into the model.

The third factor represents transportation constraints. During the time period of this study several different policies for rapeseed car allocations were implemented by government agencies. Each method of allocation affected street, cash and futures prices differently. As a result of these policies, car allocation effects upon cash prices required inclusion in the empirical analysis.

Section two of chapter discussed the overall rapeseed market, outlining the major participants and their interrelationships. At the points of supplier/purchaser interaction the equilibrium prices in the storage, street, cash and futures markets are achieved, which is a major focus of this study. Also included in this discussion are the effects of the international soybean market upon the rapeseed industry. Thus, this section summarized many of the components to be included in the empirical model.

The identification of the behavioral equations is presented in the third section of Chapter V. The final section of this chapter discussed the two-stage least-squares estimation technique employed in the empirical analysis.

Chapter VI presents the empirical and statistical results of the two-stage least squares estimation technique applied to the simultaneous equation model of the rapeseed market developed in Chapter V. This includes an analysis of factors predicted to influence the street or cash price basis. Also discussed in this chapter were the results of the goodness of fit tests applied to the predicted street and cash bases as they related to their respective observed levels.

7.1 SUMMARY OF TWO-STAGE LEAST SQUARES REGRESSION RESULTS

7.1.1 Stocks in Export Position

The empirical results verified that previous period stocks and prairie shipments are directly related to current export position stocks. Also conforming to a priori expectations were the indirect relationships of previous exports and one-period lagged cash prices to the dependent variable. All of the above independent variables with the exception of the lagged cash price were significant at the confidence levels specified.

7.1.2 Stocks in Prairie Elevator Positions

The results for this equation indicate that the street price has much less effect upon the attraction of farm deliveries than quota restrictions. A positive relationship of storage capacity to stocks was also found. The most significant variable represented previous period stocks, which as predicted *a priori* were positively related to current prairie stocks.

7.1.3 Stocks in Farm Position

The initial regression results indicated the presence of severe positive autocorrelation and thus a second regression technique correcting for autocorrelation was employed with the following results. The variable lagged farm stocks and the seasonality indicator of farm stocks (YLFS) were statistically significant and showed positive relationships to the dependent variable as expected a priori. Also conforming to a priori predictions was the total quota variable which was inversely related to farm stocks. The coefficient of the interest rate variable although having the expected sign was insignificant. The street price was also insignificant and the coefficient was of the opposite sign to that theoretically predicted. This result supports the findings of the previous equation which determined that street prices did not significantly influence elevator stocks of rapeseed from farm deliveries. Therefore quotas have considerably greater effects upon farm and elevator stocks than do street prices during the study period.

7.1.4 Domestic Crushing Demands

This equation performed reasonably well as all coefficients were of the a priori sign and only one was insignificant. The domestic crush margin was directly related to the quantity crushed as were the stocks held in crush positions in the previous period. The variable representing seasonality of crushing (YLQDD), as predicted, was highly signficant and therefore supported the suggestion that the domestic crushing industry is very dependent upon the seasonality of supply (i.e. carryover in the latter half of the crop year). Only the quota coefficient was insignificant, possibly indicating that during the study period crusher quotas were not a deterrent factor to the crushing industry, and that stock levels were more important in determining crusher production.

7.1.5 Export Demand

Given the higher mean squared error of this equation relative to other equations within the model, the general fit of the export demand equation was disappointing. However, this fit may be adequate given the Japanese buying practices, discussed in Chapter II. Japan purchases a specified quantity each year, which is very price inelastic.[109] Above this level, crush margins, storage and processing capacities, exchange rates, prices of substitutes and future domestic consumption effects will determine additional purchases.[110] These factors are very difficult to model on a monthly basis and perhaps require a smaller time period such as bi-weekly or weekly periods to show significant relationships.

Three of the four independent variables were signficiant at the 5 percent confidence level. As expected the stocks in export storage variable was directly related to QDX. Japanese oilseed stocks and Japanese rapeseed crushing margins were statistically significant and were respectively indirectly and directly related to the dependent variable as anticipated in the discussion of the empirical model (Section 5.5).

The variable representing the exchange rate and the price of the substitute commodity soybeans was determined to be insignificant. It has been suggested that exchange rate effects have only been relevant since Janaury 1983 and therefore would not exhibit its significance in this study period's analysis.[111] This also supports the hypothesis that

---

[109] Umemoto, (1984).

[110] Ibid.

[111] Ibid.

certain levels of Japanese demand are very price inelastic, and not subject to price competition from substitute products.

7.1.6 Street Price

The street price was inversely related to elevation tariffs and delivery quotas. Both were determined to be statistically significant. Also significant and displaying the predicted direct relationship to street price was the variable representing current futures prices.

Contrary to the literature reviewed, the yearly lagged street price representing seasonality of rapeseed street prices was found to be insignificant.[112] This could be a result of the limited sample size and therefore is an indicator that further data may be required, it could however also prompt the rejection of the hypothesis of significant street price changes in response to pre and post harvest supply conditions and therefore narrowing and widening of the basis. Further research in this area is warranted.

7.1.7 Cash Price

The cash price equation performed well as all varibles were significant and of the expected relationship to the dependent variable. The futures price and the cash price of the substitute crop, soybeans, all are directly related to current cash rapeseed prices. Confirming the hypothesis that railcar allocations affect Vancouver cash prices, the lagged producer cars loaded variable was determined to be inversely re-

---

[112] Carter, (1984).

lated to the dependent variable as predicted a priori. It can be reasoned that as the number of producer cars loaded in previous periods increases their availability in Vancouver during current months increases. Therefore the spot price paid in Vancouver decreases. This is shown in the indirect relationship of cash prices to LCLP.

7.1.8 Futures Price

This equation also performed well with all calculated t-statistics being much greater than the critical values at the 5 percent confidence level. The one period lagged futures price, the current soybean futures price, and the current cash price are all directly related to the dependent variable as theoretically predicted in Section 5.5. Also conforming to a priori expectations was the positive relationship of interest rates (I) to the futures price. This result substantiates the second hypothesis of Section 5.1 which predicted a general increase in the basis, as a result of increased opportunity cost of storage.

7.2 SUMMARY OF ESTIMATED AND OBSERVED BASES COMPARISONS

From the plots of the observed and predicted street price bases levels (Figure 6.1) it was apparent that the predicted values track closely to the observed levels. The statistical tests supported the graphical evidence of the model's "good fit".

The plot of the cash price basis indicated a somewhat poorer fit of the estimated to the observed basis levels. However, the statistical tests (Theil's inequality coefficient and linear regression techniques) indicated that the deviations of the estimated values from the observed levels were not statistically significant. The major reason for the slightly poorer fit is the high degree of variability in the cash price market. This variability is inherent in the market due to the physical (rail and storage capacities) and institutional (producer car allocations and futures market delivery restrictions) constraints.

7.3 CONCLUSIONS AND RECOMMENDATIONS

This study has investigated factors contributing to street and cash bases behavior. The significance of the tariff variable (TAR) in the street price equation indicates that the street basis is subject to general inflation over time as the storage and elevation charges administered by the Canadian Grain Commission are allowed to typically increase on an annual basis. Hence, hedgers in the primary markets should be cognizant of these carrying charge increases if the hedge is placed during periods of elevation and storage tarrif revisions. Failure to anticipate these changes reduces the efficiency of the hedge. Hedgers should also be conscious of changes in the interest rate. Increases (decreases) in interest rates widens (narrows) the basis through higher (lower) futures price. Fluctuations in the basis caused by interest rate changes also reduce hedging efficiency.

The significance of the quota variable in the street price equation, and the quota variables' in the the farm and elevator stock equations indicates that quota restrictions have contributed to recent rapeseed basis behavior. When farm stocks are in ample supply in the presence of restrictive elevator delivery quotas (usually for the six to eight months after harvest) grain companies and/or crushing firms reduce the street price relative to the futures price. They do this knowing that the cash flow problems facing producers and the present uncertainty attached to forthcoming quota levels and space considerations encourages producers to "fill" their quota immediatley after harvest despite the discounted prices. Grain companies are also reluctant to forward contract for amounts beyond the opening quota level and this adds to the pressure on farmers to sell immediatley after harvest.

Policy makers, in times of abnormally high basis levels may consider the the removal, or at least the raising, of delivery quotas as a means of reducing the basis. The practice of payments of cash advances has aided the producer in withholding some of his deliveries and extending his storage period. However, removal of institutional restrictions (i.e. delivery quotas) would allow producers to generate the best economic storage decisions for themselves.

This study further determined that the cash basis variability was greater than the variability of the street basis. Much of this greater variance was explained by the volatility of the Vancouver cash price, which stems from railcar allocation policies as they apply specifically to producer cars. The free stocks delivered to export positions via producer cars are the major supply source in the cash market and constitute only a small percentage of total rapeseed export stocks (currently 7 percent). If these free stocks are allowed to build up in terminals through continued producer car deliveries and storage of previous deliveries the cash price will decline and the bases will widen accordingly. Alternatively, if the level of free stocks falls, either through lower producer car deliveries or increased export sales, the cash price will be bid up, narrowing the basis.

Compounding these problems are institutional restrictions that prohibit delivery of rapeseed to the futures market by non-producers. This does not allow full arbitrage to be conducted between cash and futures markets. A cash and futures market only reflects the enviroment that it operates within. Policy makers should strive to reduce institutional constraints (i.e. transportation problems, storage capacities and port congestion etc.) to allow the cash and futures markets to operate more efficiently.

To overcome the problem of highly variable cash bases observed during the study period, corrective measures were imposed by policy makers throughout the time frame of this study. These measures, which are discussed in greater detail in Chapter 5, rectified many of the problems of basis variability. The solution appeared to be to better control the volume of free stocks held in export positions by forcing exporters to purchase free stocks delivered by producer cars in order to fulfill their export commitments. This discourages the discounting of export sales and allows free-stocks to be held at a semi-constant level. Occasional build up and shortfalls do occur and are reflected in the cash basis. Therefore hedgers in the cash market should pay particular attention to producer car movements (both current and projected) and free stocks in terminal positions.

To reduce and stabilize the cash basis to levels reflecting only the full carrying charge would seemingly require policy makers to revamp the entire transportation, storage and railcar allocation system. The new system would allow all market particpants to directly deliver stocks for fulfillment of futures market commitments and would allow full arbitrage to take place between the cash and futures markets.

In addition to reducing the variability of the cash basis, the street basis is stabilized through these policy measures. Since the street price is established by firms participating in both the cash and primary markets, those firms who face cash basis variability must pass along the risk of hedging in this market to their primary stock suppliers in the forms of lower and/or more volatile prices (this is also discussed in Chapter5). Hence, any means that stabilizes the cash market will in turn stabilize the primary market.

This study has shown that the observed basis behavior in both the cash and primary markets is undesirable, as it is detriment to the stability and further economic development of the rapeseed industry in Canada. Only through institutional change can the problem be totally alleviated, but, through thoughtful planning and action by hedgers and policy makers, the problem can be minimized.

BIBLIOGRAPHY

Agriculture Canada. Farm Forcasting Model. Ottawa: Agriculture Canada, March, 1983.

__________________________. Oilseeds in Canada -- An Oilseed System Reference. Ottawa: Agriculture Canada, Food Systems Branch, 1977.

Bank of Canada. Bank of Canada Review. Ottawa: Bank of Canada, all issues, 1977-1983.

Brennan, M.J. "The Supply of Storage, American Economic Review, 48(1):50-72.

Canadian Grain Commission. Grain Statistics Weekly. Winnipeg: Canadian Grain Commission, Economics and Statistics Division, all issues August 1977 - July 1983.

___________________. Background Information on Primary and Terminal Elevators. Winnipeg, Canadian Grain Commission, Economics and Statistics Division. 1984.

Canadian International Grains Institute. Grains and Oilseeds: Handling, Marketing, and Processing, 2nd Edition. Winnipeg: CIGI, 1977.

Carter, C.A. Street and Futures Price Relationships in Canadian Open Market Grains, Extension Bulletin No. 84. _____. Winnipeg: Department of Agricultural Economics, University of Manitoba, 1984.

_______________ and Loyns, R.M.A. Hedging Canadian Grains. Winnipeg: Winnipeg Commodity Exchange, 1983.

Cassidy, H.J. Using Econometrics, a Beginner's Guide. Reston: Reston Publishing Company, Inc., 1981.

Craddock, W. "A Premilinary Demand Analysis and Price Prediction of Canadian Rapeseed and It's Joint Products, Rapeseed Meal and Oil". Winnipeg: University of Manitoba, 1973.

Chicago Board of Trade. Statistical Annual. Chicago: Chicago Board of Trade, 1977-1983.

Durbin J. "Testing for Serial Correlation in Least Squares Regression When Some of the Regressors are Lagged Dependent Variables". Econometrica, 38 (May 1970), 410-21.

Erling-Tyrell, T. "Canola Meal - A Market Mover" in Proceedings, 16th Annual Convention, Canola Council of Canada. Victoria, March 1983. Winnipeg: Canola Council of Canada, 1983.

Furtan, W.H., Nagy, J.G., and Storey, G.G. The Canadian Rapeseed Industry: The Economic Implications of Changes in Transportation and Tariff Costs, Technical Bulletin 78-1. Saskatchewan Department of Agricultural Economics, University of Saskatchewan, 1978.

____________________. "The Impact on the Canadian Rapeseed Industry from Changes in Transport and Tariff Rates". American Journal of Agricultural Economics. 61, 238-48.

Gray, R.W. "The Characteristic Bias in Some Thin Futures Markets". Food Research Institute Studies. 1 (No.3), 1960.

Grain Transportation Authority. Annual Review. Winnipeg: Grain Transportation Authority, all issues 1980-1983.

____________________. Allocation Towards Sales. Winnipeg: Grain Transportation Authority, August, 1981.

Griffith, G.R. and Meilke, K.D. A Description of the Market Structures and Agricultural Policies in Five Regional Oilseed and Oilseed Product Markets. Guelph: School of Agricultural Economics and Extension Education. University of Guelph, 1980.

____________________. A Structural Econometric Model of the World Markets for Rapeseed, Soybeans and Their Products. Guelph: Research Report 82:5, School of Agricultural Economics and Extension Education, University of Guelph, 1982.

Hieronymus, T.A. Economics of Futures Trading. New York: Commodity Research Bureau, Inc., 1971.

Hughes, D. "Selling Canola Oil to North Americans". Proceedings, 16th Annual Convention, Canola Council of Canada: Victoria, March 1983. Winnipeg: Canola Council of Canada, 1983.

IBI/Theo Joseph Inc.

Japanese Oilseed Processor Association. Statistics for 19__. Tokyo: Japanese Oilseed Processor Association, Tokyo, all issues, 1977-1983.

Johnston, J. Econometric Methods, 2nd edition. New York: McGraw-Hill, 1972.

Kahl, K. "An Analysis of Intertemporal Basis Movements". Ph.D. dissertation, North Carolina State University at Raleigh, 1979.

Kaldor, N. "Speculation and Economic Stability". Review of Economic Studies. VII (1939-40). 1-12.

Kennedy, P. A Guide to Econometrics. Cambridge: The MIT Press. 1979.
Koutsoyiannis, A. Theory of Econometrics, 2nd edition. London: MacMillan Press Ltd., 1977.

Kulshreshtha, S.N., Banerjee, A.K., Furtan, W.H. and Storey, G.G. "Quarterly Rapeseed, Rapeseed Oil and Rapeseed Meal Forecasting Model", FARM. Ottawa: Agriculture Canada, 1983.

Kwon, O.Y. and Uhm, I.H. "Provincial Rapeseed Acreage Models and Some Policy Implications". Canadian Journal of Agricultural Economics, 28, No.3 (1980): 37-50.

Lowe, J.C. and Petrie, T.M. "Agriculture Sector Model: Grains and Oilseed Supply Block". Ottawa: FARM, Forcasting Model, 1979.

Lowen, D. "Making the Best from the '82 Crop", Proceedings, 16th Annual Convention, Canola Council of Canada: Victoria, March 1983. Winnipeg: Canola Council of Canada, 1983.

Loyns, R.M.A. Marketing and Marketing Strategies for Manitoba Farm Products. Winnipeg: Extension Bulletin No. 81-1, Department of Agricultural Economics and Farm Mangement, University of Manitoba, 1981.

Maddala, G. Econometrics. New York: McGraw-Hill, 1977.

Nagy, J.G. and Furtan, W.H. The Socio-Economic Costs and Returns From Rapeseed Breeding in Canada. Saskatoon: Technical Bulletin, BL: 77-1. Department of Agricultural Economics, University of Saskatchewan, 1977.

Natural Products Marketing Council. Performance of the Rapeseed Marketing System. Regina: Saskatchewan Agriculture, 1981.

Nosker, D. Futures Handbook for Farmers. St. Louis: Doane Agricultural Services Inc., 1981.

Paul, A.B. "The Pricing of Binspace: A Contribution to the Theory of Storage". American Journal of Agricultral Economics. 52(1,1970) 1-12.

Peck, A.E. "Futures Markets, Supply Response and Price Stability", Quartely Journal of Economics. 90(3-1976):407-423.

Perkins, P. An Economic Review of Western Canada's Rapeseed Processing Industry. Edmonton: Alberta Agriculture, 1976.

Pioneer Grain Company Ltd. Producer Car -- Right or Wrong - A Response. Winnipeg: News Release, February 11, 1982.

Rigaux, L.R. A Preliminary Paper on the Canadian Edible Oils Industry. Winnipeg.

Statistics Canada Grain Trade of Canada. Ottawa: Statistics Canada (22-201), various issues.

_______________. unpublished data. Winnipeg: Statistics Canada, Grain Marketing Unit.

Subotnik, A. and Houck, J.P. A Quarterly Econometric Model for Corn: A Simultaneous Approach to Cash and Futures Markets. St. Paul: Technical Bulletin 318-1979, Agricultural Experiment Station, University of Minnesota, 1979.

Swallow, B.M. "Policy Analysis of Canadian/Japanese Trade of Rapeseed". Saskatoon: University of Saskatchewan, M.Sc. Thesis, 1983.

Telser, L.G. "Safety First and Hedging". Review of Economic Studies 6(1-1955):1-16.

Umemoto, H.E. General Manager, XCAN, Far East Ltd., Tokyo: Personal Correspondance, April, 1984.

Ward, R.W. and Dasse, F.A. "Empricial Contributions to Basis Theory: The Case for Citrus Fruits". American Journal of Agricultural Economics, 59(1-1977):71-80.

Western Barley Grower Association. "Producer Car - A Right or Wrong?". Calgary: Western Barley Grower. January 1982.

Weymar, F.H. "The Supply of Storage Revisited". American Economic Review. 56(5,1966):1226-1234.

Winnipeg Commodity Exchange. Annual Statistics. Winnipeg: Winnipeg Commodity Exchange: 1977-1983.

Working, H. "The Theory of the Price of Storage". American Economic Review. 39, No.6 (1949):1254-1262.

Appendix A

DATA FOR EMPIRICAL MODEL

TABLE A.1

Monthly Average Stocks (000's tonnes)

Date	Stocks in Export Position'	Stocks in Prairie Elevator Position'	Stocks in Crusher Positions'	Farm Stocks*
877	22.88	79.9	12.6	1344.03
977	33.10	137.5	19.5	1909.49
1077	54.50	252.8	34.0	1355.63
1177	54.10	341.8	38.8	1638.04
1277	41.90	354.4	38.0	1505.71
178	42.10	342.3	34.9	1373.08
278	41.30	339.5	35.9	1084.54
378	43.40	366.1	33.7	830.66
478	53.10	300.2	27.9	487.27
578	58.90	328.0	19.4	291.58
678	51.70	263.2	21.9	170.15
778	57.80	231.8	21.4	51.15
878	44.60	199.1	12.3	1881.34
978	40.70	341.9	17.6	3310.16
1078	58.60	513.5	28.1	2376.41
1178	65.20	564.8	35.3	2081.83
1278	41.90	546.8	37.8	1843.33
179	62.90	624.2	34.6	1563.21
279	76.60	621.9	35.3	1370.88
379	57.50	588.5	34.5	1128.80
479	59.40	591.8	35.2	710.15
579	53.10	519.8	28.5	479.02
679	56.90	531.8	26.4	288.81
779	31.90	544.7	31.9	66.14
879	71.40	431.4	33.3	3403.37
979	73.50	453.4	32.5	6007.56
1079	44.10	629.7	36.8	4980.78
1179	60.60	546.7	43.9	4536.19
1279	84.30	495.8	46.8	4027.50
180	77.70	599.4	47.7	3442.79
280	45.60	655.2	44.8	3188.59
380	65.10	590.4	43.3	2672.71
480	90.60	559.6	46.5	2083.99
580	108.90	594.9	37.0	1788.17
680	99.40	672.6	41.9	1245.13
780	96.80	739.1	47.5	485.02
880	89.50	812.4	56.8	1536.28
980	106.10	792.5	44.3	2593.73
1080	103.60	792.8	33.7	2378.34
1180	76.70	766.3	38.5	2156.92
1280	89.70	703.0	47.2	2032.56
181	64.70	663.9	45.2	1908.41
281	68.20	605.4	40.1	1798.25
381	65.00	527.7	45.6	1311.09
481	77.30	531.5	50.2	1083.74

581	85.90	563.6	44.1	761.93
681	61.80	547.4	44.8	404.00
781	71.70	588.9	50.3	1306.96
881	76.00	658.2	48.8	2220.70
981	85.10	606.1	42.1	2211.45
1081	97.40	555.2	45.6	2196.89
1181	106.20	523.4	49.6	2203.18
1281	92.10	542.9	54.2	2175.99
182	71.50	496.1	48.0	2123.79
282	77.90	483.1	47.1	2081.61
382	80.80	498.7	53.3	2037.74
482	81.4	477.9	48.9	1112.26
582	100.5	437.5	45.9	186.31
682	85.7	361.4	44.0	71.00
782	84.3	388.7	38.0	1108.99
882	91.2	379.0	23.9	1961.75
982	90.6	341.0	37.9	1668.53
1082	99.4	395.5	47.4	1407.01
1182	110.5	415.3	46.0	1205.02
1282	89.9	447.8	48.6	934.54
183	93.0	444.2	54.2	763.67
283	92.3	418.1	52.3	598.59
383	84.3	427.2	51.3	463.12
483	91.4	425.7	41.5	338.52
583	100.7	416.8	39.0	234.45
683	110.9	332.6	35.5	124.64
783	69.6	279.1	35.0	40.00

Source: ' Canadian Grain Commission, Winnipeg: Grain Statistics Weekly.

* Statistics Canada, Grain Marketing Unit. Winnipeg: unpublished data.

TABLE A.2

Total Monthly Rapeseed Demand (000's tonnes)

Date	Domestic Crushing'	Exports'
877	17683	61.394
977	58157	48.375
1077	62820	89.675
1177	58543	93.963
1277	51003	69.626
178	52355	100.810
278	54812	104.303
378	60414	73.690
478	63772	109.671
578	56400	91.215
678	51578	99.974
778	42771	70.890
878	23904	78.635
978	63631	116.863
1078	64146	195.088
1178	60119	178.221
1278	64334	96.290
179	61013	177.799
279	52519	148.088
379	69647	165.245
479	63070	124.290
579	60796	225.311
679	73077	140.370
779	22428	129.147
879	73285	219.631
979	77920	202.427
1079	62993	149.800
1179	83609	196.622
1279	83197	106.397
180	84840	143.695
280	79981	89.425
380	81813	143.025
480	88408	140.721
580	81679	145.558
680	77152	113.659
780	35671	91.683
880	79938	126.271
980	93787	83.547
1080	73089	137.804
1180	80706	121.961
1280	82546	84.891
181	84006	96.446
281	98825	111.613
381	97893	83.304
481	90323	144.047
581	95730	102.606
681	90767	140.602

781	40554	139.054
881	96438	114.759
981	101322	106.621
1081	93717	122.360
1181	92068	154.179
1281	90066	72.404
182	80221	93.855
282	82148	118.999
382	60259	93.771
482	67370	138.956
582	82672	93.633
682	58519	138.166
782	34132	111.612
882	72601	103.425
982	101447	105.761
1082	90929	36.201
1182	77082	165.576
1282	84585	126.887
183	92300	99.758
283	87400	95.987
383	71300	110.342
483	62900	106.694
583	60900	75.881
683	78700	120.493
783	61100	124.311

Source: ' Statistics Canada.
Grain Trade of Canada.
Ottawa #22-201, Annual (1977-1983).

TABLE A.3

Average Monthly Prices

Date	Rapeseed Street Price (Can$)'	Rapeseed Futures Price (Can$)*	Rapeseed Cash Price (Can$)*	Soybean Futures Price ($US)**	Soybean Cash Price ($US)**
877	255.74	269.90	265.42	5.41	5.74
977	255.00	268.30	277.72	5.29	5.15
1077	260.70	276.80	285.44	5.37	4.98
1177	261.23	293.50	271.64	6.02	5.74
1277	269.24	300.58	270.49	6.01	5.83
178	272.95	287.73	297.34	5.93	5.66
278	273.10	295.13	293.21	5.80	5.55
378	296.74	320.22	316.82	6.83	6.66
478	304.53	323.65	338.30	6.95	6.90
578	306.10	324.04	343.42	6.90	7.03
678	294.48	312.20	331.92	6.62	6.75
778	255.42	265.83	296.71	6.09	6.59
878	244.86	272.58	296.04	6.25	6.43
978	253.27	281.91	313.13	6.54	6.46
1078	267.40	294.48	309.56	6.87	6.64
1178	271.10	300.96	315.52	7.01	6.66
1278	271.96	301.10	317.76	6.97	6.76
179	272.11	306.00	315.23	7.07	6.84
279	291.63	328.58	339.41	7.62	7.28
379	291.60	328.50	327.33	7.72	7.43
479	267.93	310.40	303.87	7.55	7.32
579	274.49	314.16	308.78	7.44	7.17
679	285.58	332.70	323.24	7.82	7.72
779	291.98	342.08	329.22	7.17	7.19
879	298.76	336.74	339.40	7.25	7.11
979	297.35	329.08	333.32	6.92	6.49
1079	289.37	324.38	317.63	6.89	6.38
1179	282.88	329.70	319.97	7.07	6.39
1279	270.16	319.77	309.32	6.85	6.17
180	263.31	315.26	308.07	6.80	6.39
280	262.75	325.58	310.09	6.62	6.88
380	250.06	313.03	292.29	6.20	5.81
480	240.28	303.68	264.88	6.24	6.02
580	246.40	322.08	294.36	6.41	6.14
680	256.48	328.18	312.25	7.46	7.19
780	278.12	355.01	320.17	7.78	7.37
880	275.17	359.00	306.82	8.63	7.91
980	276.10	367.90	307.78	8.83	8.09
1080	275.10	355.48	323.58	9.30	8.77
1180	297.90	376.38	358.01	8.28	7.69
1280	268.39	366.28	335.54	8.12	7.39
181	251.04	356.18	338.42	7.72	7.31
281	252.70	348.85	330.39	7.65	7.30
381	265.10	359.48	327.36	8.02	7.71
481	277.76	364.20	336.55	7.73	7.52

581	278.44	362.10	339.04	7.38	7.18
681	271.63	349.60	336.71	7.66	7.26
781	279.39	343.40	332.45	7.10	6.89
881	275.94	336.83	328.25	6.84	6.50
981	265.08	332.80	327.26	6.79	6.31
1081	272.10	341.68	336.82	6.71	6.30
1181	272.30	329.47	319.34	6.40	6.23
1281	272.90	324.52	322.86	6.57	6.33
182	280.10	336.73	330.07	6.45	6.20
282	292.16	337.70	331.43	6.30	6.18
382	289.20	335.58	319.26	6.65	6.46
482	293.40	347.98	322.07	6.67	6.58
582	295.10	352.48	314.16	6.33	6.28
682	297.52	354.70	326.56	6.16	6.21
782	286.47	345.18	311.27	5.79	5.78
882	277.30	340.60	286.20	5.48	5.41
982	272.70	337.16	298.60	5.50	5.30
1082	268.87	331.65	295.26	5.83	5.62
1182	281.30	337.85	307.50	5.77	5.63
1282	277.90	330.41	322.46	5.89	5.69
183	279.24	327.80	315.51	6.01	5.83
283	276.27	324.30	297.49	6.09	5.73
383	273.62	320.53	299.67	6.20	5.57
483	282.10	327.13	308.50	5.94	5.58
583	282.53	325.18	318.23	6.37	5.68
683	272.38	318.44	304.80	6.17	5.83
783	274.14	321.01	309.12	7.19	5.85

Source: ' Canadian Grain Commission, Economic and Statistics Division. Winnipeg: unpublished data.

* Winnipeg Commodity Exchange: ($/tonne) <u>Annual Report</u>. Winnipeg: WCE (1977-1983).

** Chicago Board of Trade: ($/bushel) <u>Statistic Annual</u>. Chicago: CBT (1977-1983).

TABLE A.4

Monthly Average Exchange and Interest Rates

Date	Prime Interest Rate	Yen/ $Can	$Can/ $US	Yen/ $US
877	7.50	0.004032	1.0749	266.592
977	7.50	0.004023	1.0733	266.791
1077	7.50	0.004317	1.0988	254.529
1177	7.50	0.004535	1.1092	244.587
1277	7.50	0.004552	1.0972	241.037
178	7.50	0.004569	1.0110	240.994
278	7.50	0.004637	1.1132	240.069
378	7.50	0.004865	1.1256	231.367
478	8.00	0.005151	1.1416	221.624
578	8.50	0.004952	1.1189	225.949
678	8.50	0.005242	1.1216	213.019
778	9.00	0.005633	1.1245	221.019
878	9.00	0.006050	1.1403	188.479
978	9.50	0.006138	1.1663	190.013
1078	10.25	0.006442	1.1827	183.592
1178	10.75	0.006101	1.1728	192.231
1278	10.75	0.006022	1.1795	195.865
179	11.25	0.006020	1.1896	197.608
279	11.25	0.005964	1.1955	200.453
379	11.25	0.005691	1.1739	206.273
479	11.25	0.005307	1.1463	215.998
579	11.25	0.005296	1.1556	215.436
679	11.25	0.005364	1.1723	221.356
779	11.75	0.005379	1.1634	216.286
879	11.75	0.005373	1.1706	217.867
979	12.25	0.005242	1.1652	222.282
1079	13.50	0.005104	1.1755	230.270
1179	14.00	0.004823	1.1796	244.578
1279	14.00	0.004868	1.1696	240.263
180	14.00	0.004896	1.1639	237.725
280	14.00	0.004736	1.1560	244.088
380	14.50	0.004722	1.1731	248.433
480	16.00	0.004743	1.1856	249.968
580	13.30	0.005147	1.1731	227.919
680	11.10	0.005286	1.1515	217.840
780	10.40	0.005211	1.1519	221.052
880	10.50	0.005176	1.1591	223.937
980	10.90	0.005431	1.1646	214.436
1080	11.80	0.005589	1.1690	209.161
1180	13.10	0.005567	1.1860	213.041
1280	16.60	0.005718	1.1968	209.304
181	17.00	0.005894	1.1907	202.019
281	17.10	0.005830	1.1988	205.626
381	16.90	0.005706	1.1912	208.763
481	17.20	0.005541	1.1908	214.907
581	18.90	0.005449	1.2009	220.389

681	19.10	0.005374	1.2040	224.042
781	19.50	0.005216	1.2115	232.266
881	21.10	0.005236	1.2230	233.575
981	20.00	0.005232	1.2007	229.492
1081	18.70	0.005196	1.2028	231.486
1181	16.10	0.005328	1.1874	222.860
1281	15.10	0.005422	1.1851	218.572
182	14.70	0.005306	1.1924	224.727
282	14.80	0.005152	1.2140	238.637
382	15.10	0.005061	1.2204	241.138
482	15.3	.005023	1.2248	243.838
582	15.3	.005204	1.2335	237.029
682	16.4	.005076	1.2753	251.241
782	15.9	.004982	1.2699	254.898
882	14.7	.004809	1.2451	258.910
982	13.4	.004692	1.2347	263.180
1082	11.8	.004530	1.2299	271.501
1182	11.0	.004656	1.2262	263.359
1282	10.5	.005110	1.2382	242.309
183	9.8	.005280	1.2284	232.652
283	9.7	.005204	1.2273	238.838
383	9.5	.005148	1.2262	238.190
483	9.5	.005186	1.2322	237.601
583	9.4	.005233	1.2288	234.818
683	9.5	.005133	1.2322	240.055
783	9.5	.005124	1.2324	240.515

Source: Bank of Canada.
<u>Bank of Canada Review</u>.
Ottawa: Bank of Canada, (1977-1983).

TABLE A.5

Japanese Market Statistics

Date	Japanese Rapeseed Crush Margin ($Can)	Japanese Oilseed' Stocks (tonnes)
877	14.47	317.6
977	23.70	324.4
1077	93.00	159.0
1177	122.73	145.8
1277	97.05	284.1
178	74.95	273.2
278	62.89	228.0
378	93.06	256.0
478	116.82	243.0
578	98.34	273.0
678	86.01	283.0
778	55.63	398.0
878	69.99	438.5
978	76.51	364.0
1078	105.68	207.0
1178	139.67	287.3
1278	142.32	389.9
179	135.61	386.6
279	108.70	382.0
379	142.32	333.0
479	135.61	380.0
579	108.01	431.1
679	113.05	387.0
779	148.13	349.0
879	166.23	389.3
979	137.75	472.0
1079	102.99	373.0
1179	79.00	341.0
1279	72.98	346.0
180	74.87	412.2
280	84.17	288.3
380	104.23	369.4
480	92.70	363.4
580	102.87	411.3
680	151.64	393.7
780	136.16	404.3
880	132.72	402.3
980	152.56	396.0
1080	167.59	355.0
1180	163.98	351.3
1280	160.51	471.7
181	155.47	491.3
281	120.85	471.5
381	120.77	471.2
481	112.61	480.6
581	107.72	541.6
681	84.72	460.5

781	70.32	427.3
881	59.93	435.9
981	76.52	382.0
1081	77.35	302.4
1181	70.95	294.4
1281	81.70	422.6
182	71.24	414.7
282	56.30	406.6
382	51.54	383.2
482	46.92	422.3
582	77.51	421.3
682	91.24	403.9
782	63.74	398.7
882	62.05	429.3
982	67.40	378.8
1082	75.50	428.7
1182	80.91	428.2
1282	110.77	448.9
183	128.70	475.0
283	99.65	403.0
383	89.08	406.0
483	90.80	488.0
583	82.32	433.0
683	83.89	451.0
783	68.75	508.0

Source: ' Japanese Oil Processors Association, Monthly Statistics, Various Issues.

TABLE A.6

Total Prairie Elevator Storage Capacity (000,000's tonnes)

Date	Total Prairie Elevator Storage Capacity
877	9.6
977	9.6
1077	9.6
1177	9.6
1277	9.6
178	9.3
278	9.3
378	9.3
478	9.3
578	9.3
678	9.3
778	9.3
878	9.3
978	9.3
1078	9.3
1178	9.3
1278	9.3
179	9.2
279	9.2
379	9.2
479	9.2
579	9.2
679	9.2
779	9.2
879	9.2
979	9.2
1079	9.2
1179	9.2
1279	9.2
180	9.0
280	9.0
380	9.0
480	9.0
580	9.0
680	9.0
780	9.0
880	9.0
980	9.0
1080	9.0
1180	9.0
1280	9.0
181	8.8
281	8.8
381	8.8
481	8.8
581	8.8
681	8.8

781	8.8
881	8.8
981	8.8
1081	8.8
1181	8.8
1281	8.8
182	8.5
282	8.5
382	8.5
482	8.5
582	8.5
682	8.5
782	8.5
882	8.5
982	8.5
1082	8.5
1182	8.5
1282	8.5
183	8.1
283	8.0
383	8.0
483	8.0
583	8.0
683	8.0
783	8.0

Source: Canadian Grain Commission, Economics and Statistics Division. Winnipeg: CGC Background Information on Primary and Terminal Elevators. April, 1984.

TABLE A.7

Monthly Average Rapeseed Delivery Quotas (bu/acre)

Date	Elevator Quota+	Crusher Quota+	Total Quota (QE + QC)	Average Rapeseed Yield* (bu/acre)
877	1.81	1.80	3.60	24.2
977	1.81	1.80	3.60	24.2
1077	1.81	1.80	3.60	24.2
1177	1.81	1.80	3.60	24.2
1277	2.95	5.70	8.70	24.2
178	2.95	5.70	8.70	24.2
278	33.30	35.30	68.60	24.2
378	33.30	35.30	68.60	24.2
478	33.30	52.90	86.20	24.2
578	52.90	52.90	105.80	24.2
678	52.90	52.90	105.80	24.2
778	52.90	52.90	105.80	24.2
878	4.90	4.90	9.80	22.1
978	4.90	4.90	9.80	22.1
1078	4.90	4.90	9.80	22.1
1178	4.90	4.90	9.80	22.1
1278	8.40	8.40	16.80	22.1
179	8.40	8.40	16.80	22.1
279	8.40	8.40	16.80	22.1
379	11.90	11.90	23.80	22.1
479	11.90	11.90	23.80	22.1
579	11.90	11.90	23.80	22.1
679	15.00	15.00	30.00	22.1
779	3.10	3.10	6.20	17.9
879	3.10	3.10	6.20	17.9
979	3.10	3.10	6.20	17.9
1079	3.10	3.10	6.20	17.9
1179	6.20	26.00	32.20	17.9
1279	6.20	26.00	32.20	17.9
180	6.20	26.00	32.20	17.9
280	9.30	26.00	35.30	17.9
380	9.30	26.00	35.30	17.9
480	12.30	26.00	38.30	17.9
580	12.30	40.00	52.30	17.9
680	12.30	40.00	52.30	17.9
780	3.10	40.00	43.10	21.3
880	3.10	40.00	43.10	21.3
980	3.10	40.00	43.10	21.3
1080	3.10	40.00	43.10	21.3
1180	3.10	40.00	43.10	21.3
1280	3.10	40.00	43.10	21.3
181	3.10	40.00	43.10	21.3
281	3.10	40.00	43.10	21.3
381	6.20	40.00	46.20	21.3
481	9.00	40.00	49.00	21.3

581	9.00	40.00	49.00	21.3
681	9.00	40.00	49.00	21.3
781	3.10	26.00	29.10	23.5
881	3.10	26.00	29.10	23.5
981	3.10	26.00	29.10	23.5
1081	6.20	26.00	32.20	23.5
1181	6.20	26.00	32.20	23.5
1281	10.10	42.00	52.10	23.5
182	20.10	42.00	62.10	23.5
282	20.10	42.00	62.10	23.5
382	41.90	42.00	83.90	23.5
482	52.00	52.00	4.00	23.5
582	52.00	52.00	4.00	23.5
682	62.20	62.20	24.40	23.5
782	4.90	14.70	19.60	22.0
882	4.90	14.70	19.60	22.0
982	4.90	25.10	30.00	22.0
1082	9.70	25.10	34.80	22.0
1182	9.70	25.10	34.80	22.0
1282	14.60	40.10	54.70	22.0
183	19.40	40.10	59.50	22.0
283	19.40	40.10	59.50	22.0
383	30.00	50.40	80.40	22.0
483	30.00	50.40	80.40	22.0
583	50.40	50.40	0.80	22.0
683	50.40	70.50	20.90	22.0
783	50.40	70.50	20.90	22.0

Source: +Canadian Wheat Board
*Statistics Canada, Grain Marketing Unit, Winnipeg.

TABLE A.8

Monthly Total Producer Car Loadings (000's tonnes)

Date	Cars Loaded By Producers
877	0.2
977	0.6
1077	0.7
1177	0.5
1277	0.4
178	0.4
278	1.1
378	0.0
478	0.4
578	0.4
678	0.0
778	0.1
878	0.0
978	0.4
1078	1.6
1178	1.2
1278	1.2
179	0.2
279	0.3
379	1.4
479	0.7
579	0.7
679	1.6
779	0.0
879	0.0
979	0.3
1079	0.3
1179	0.5
1279	0.0
180	0.4
280	0.8
380	0.8
480	0.4
580	0.8
680	0.8
780	1.5
880	0.4
980	1.2
1080	0.8
1180	1.6
1280	0.4
181	0.4
281	1.0
381	2.0
481	0.4
581	1.6
681	0.8

781	2.0
881	0.4
981	0.4
1081	3.2
1181	0.4
1281	1.2
182	1.2
282	2.4
382	1.2
482	2.0
582	2.8
682	2.4
782	3.6
882	0.0
982	1.6
1082	0.4
1182	2.0
1282	0.4
183	1.2
283	1.2
383	0.4
483	0.8
583	2.0
683	1.6
783	2.0

Source: Canadian Grain Commission: Grain Statistics Weekly. Winnipeg: CGC (1977-1983).

TABLE A.9

Monthly Average Domestic Crush Margins ($/tonne)

Date	Domestic Rapeseed Crush Margin
877	.
977	.
1077	.
1177	.
1277	.
178	-3.962
278	-13.879
378	56.588
478	56.816
578	61.559
678	28.446
778	30.127
878	76.762
978	103.014
1078	114.834
1178	64.924
1278	83.042
179	85.515
279	111.011
379	84.186
479	74.592
579	80.653
679	96.970
779	96.333
879	87.709
979	97.151
1079	72.557
1179	82.662
1279	68.210
180	57.108
280	57.336
380	33.964
480	34.164
580	46.198
680	30.768
780	82.944
880	71.871
980	103.780
1080	88.593
1180	118.278
1280	28.720
181	67.645
281	86.632
381	78.121
481	63.701
581	49.000
681	49.595

781	71.530
881	53.748
981	32.242
1081	37.645
1181	24.575
1281	6.005
182	6.986
282	2.169
382	-9.594
482	10.569
582	26.779
682	20.674
782	15.146
882	-14.078
982	-3.923
1082	-10.351
1182	-5.300
1282	-19.132
183	-12.834
283	-8.053
383	-9.949
483	14.524
583	11.739
683	-4.888
783	38.579

Source: Statistics Canada. Grain Marketing Unit. Winnipeg: unpublished data.

TABLE A.10

Maximum Tariff for Elevation, Storage and Insurance (1 month) for Rapeseed Allowed by Canadian Grain Commission

Date	Tariff($/tonne)
8/77	6.75
	6.75
	6.75
	6.75
	6.75
	6.75
	6.75
	6.75
	6.75
	6.75
	6.75
	6.75
08/78	7.22
	7.22
	7.22
	7.22
	7.22
	7.22
	7.22
	7.22
	7.22
	7.22
	7.22
	7.22
08/79	8.11
	8.11
	8.11
	8.11
	8.11
	8.11
	8.11
	8.11
	8.11
	8.11
	8.11
	8.11
	8.11
08/80	8.11
	8.30
	8.30
	8.30
	8.30
	8.30
	8.30
	8.30
	8.30
	8.30

	8.30
	8.30
08/81	8.30
	8.30
	8.52
	8.52
	8.52
	8.52
	8.52
	8.52
	8.52
	8.52
	8.52
	9.10
08/82	9.10
	9.10
	9.10
	9.10
	9.10
	9.10
	9.10
	9.10
	9.10
	9.10
	9.10
07/83	9.10

Appendix B

THE JAPANESE RAPESEED CRUSHING MARGIN

			Rapeseed
(A) Cost			
	C&F @ U.S.$/mt		$ ___
	Exchange (Can $1.00=)	x	___
	Ciffing (C&F @ x)	x	108
	C&F Yen/mt		___
	Landing Charges Yen/mt	+	1,000
	Crushing Cost Yen/mt	+	17,000
	Total Cost Yen/mt		___
(B) Revenue			
	(1) Meal @ Yen/mt		___
	YIELD	x	57%
	Meal Revenue Yen/mt		___
.sk			
	(2) Oil @ Yen/kg		___
	x 1000 + Yen/mt	x	1,000
	YIELD	x	39.5%
	Oil Revenue Yen/mt		___
	(3) Total Revenue Yen/mt		___
(C) Net Profit Yen/mt			-7.909 - $35.00

Exchange:

Net Profit (Margin) Can$/mt ______ ______

Appendix C

CORRELATION MATRICES: EXAMINATION OF THE PRESENCE OF MULTICOLLINEARITY

TABLE C.1

Correlation Matrices

Stocks in Export Position Storage: Correlation Matrix

	Intercept	LPC	LSXP	QDX	LTW
Intercept	1.00				
LPC	-.95	1.00			
LSXP	.35	.13	1.00		
QDX	.05	.11	.20	1.00	
LTW	.16	.01	.01	.38	1.00

Stocks in Prairie Storage: Correlation Matrix

	Intercept	PS	LSEP	TCAP	QE
Intercept	1.00				
PS	.57	1.00			
LSEP	.07	.09	1.00		
TCAP	.80	.02	.17	1.00	
QE	.36	.28	.18	.59	1.00

Farm Stocks: Correlation Marix

	Intercept	PS	LFS	QT	I	YLFS
Intercept	1.00					
PS	.98	1.00				
LFS	.15	.11	1.00			
QT	.06	.15	.27	1.00		
I	.21	.04	.15	.05	1.00	
YLFS	.01	.06	.24	.11	.08	1.00

Quantity Demanded for Domestic Crushing: Correlation Matrix

	Intercept	LSCP	DCM	YLQDD	QC
Intercept	1.00				
LSCP	.14	1.00			
DCM	.16	.18	1.00		
YLQDD	.07	.15	.38	1.00	
QC	.01	.47	.25	.07	1.00

Quantity Demanded for Export: Correlation Matrix

	Intercept	RPCS	JSS	JRM	LXSP
Intercept	1.00				
RPCS	.06	1.00			
JSS	.10	.12	1.00		
JRM	.18	.43	.01	1.00	
LXSP	.15	.38	.22	.12	1.00

Street Price: Correlation Matrix

	Intercept	PF	LFS	DQRE	QDD	YLPS	LSEP
Intercept	1.00						
PF	.33	1.00					
LFS	.15	-.07	1.00				
DQRE	.07	.46	.19	1.00			
QDD	.50	.40	.09	.24	1.00		
YLPS	.60	.04	.13	.03	.06	1.00	
LSEP	.10	.12	.28	.41	.24	.02	1.00

Cash Price: Correlation Matrix

	Intercept	PF	PCSB	LCLP
Intercept	1.00			
PF	.43	1.00		
PCSB	.10	.38	1.00	
LCLP	.21	.28	.32	1.00

Futures Price: Correlation Matrix

	Intercept	PC	PFSB	LPF	I
Intercept	1.00				
PC	.74	1.00			
PFSB	.19	.29	1.00		
LPF	.22	.32	.51	1.00	
I	.07	.08	.65	.70	1.00

Appendix D

CALCULATION OF TEST STATISTIC FOR A RESTRICTION IMPOSED ON THE RELATIONSHIP BETWEEN PARAMETERS OF A FUNCTION

$$F^* = \frac{(\Sigma er^2 - \Sigma e^2)/c}{\Sigma e/(n-k)}$$

where: c = number of restrictions
n = number of observations
K = number of regressors
er = sum squared residuals in restricted regression
e = sum squared residuals in unrestricted regression

<u>Street</u> <u>Price</u>:

$$F = \frac{529.38 - 524.33/1}{524.33/58}$$

$$= 0.23$$

<u>Cash</u> <u>Price</u>:

$$F^* = \frac{13031.39 - 13026.33/1}{13026.33/69}$$

$$= 0.027$$

Appendix E

RANK COEFFICIENTS: TEST OF HETEROSCEDASTICITY

TABLE E.1

Rank Correlation Coefficients

$$r = \frac{1 - 6\Sigma \; Di}{n(n-1)}$$

where: Di = difference in rankings
n = number of observations

Stocks in Export Position: Spearman Rank Correlation Coefficients

	LPC	LSXP	LQDX	LTW
SXPRESID	.08	.12	.21	.13

Stocks in Prairie Elevator Position: Spearman Rank Correlation Coefficients

	PS	LSEP	TCAP	QE
SEPRESID	.05	.11	.22	.02

Farm Stocks: Spearman Rank Correlation Coefficients

	PS	LFS	QT	I	YLFS
FSRESID	.06	.04	.11	.07	.05

Quantity Demanded for Domestic Crushing: Spearman Rank Correlation Coefficients

	LSCP	DCM	YLQDD	QC
QDDRESID	.02	.03	.01	.02

Quantity Demanded for Export: Spearman Rank Correlation Coefficients

	RPCS	JSS	JRM	LXSP
QDXRESID	.16	.35	.08	.36

Street Price: Spearman Rank Correlation Coefficients

	PF	LFS	QDD	YLPS	DQRE	LSEP
PSRESID	.10	.07	.15	.15	.19	.04

Cash Price: Spearman Rank Correlation Coefficient

	PF	PCSB	LCLP
PCRESID	.02	.05	.02

Futures Price: Spearman Rank Correlation Coefficients

	PC	PFSB	LPF	INT
PFRESID	-.14	-.07	-.11	.10

Appendix F

ORIGINAL TWO-STAGE LEAST SQUARES ESTIMATION OF EQUATION 5.3 (FARM STOCKS)

$$
\begin{aligned}
FS = & -1343.38 + 7.71\,PS + 0.66\,LFS - 11.83\,QT - 2.34\,I \\
& \quad (-0.72) \qquad (1.16) \qquad (8.81)^{*} \qquad (-3.88)^{*} \qquad (-0.09) \\
& + 0.20\,YLFS \\
& \quad (2.74)^{*}
\end{aligned}
$$

Since the calculated h-statistic (4.21) is greater than the critical values of the normal distribution at the 10 percent significance level (1.96) the null hypothesis of no autocorrelated error terms is rejected.

Appendix G

SUMMARY STATISTICS

The figures in parenthses below the estimated coefficients are their estimated t-statistics which are computed as:

$$t = \frac{b}{s} .$$

where: s = standard error of b

b = estimated coefficient of variable K

A "high" value of t in absolute terms, indicates that the estimated coefficient is statistically different from zero.[113] The asteriks (*) in Table 6.1 indicate significance of the coefficient at the 5 percent level if its associated sign was known a priori (one tail test) or at the 10 percent level of significance if the sign was not known a priori (two tail test) as discussed in Section 5.4.

The remaining statistics being reported (i.e. Durbin-Watson/ Durbin's h, the correlation coefficient matrix and the Spearman rank correlation coefficient) are used to test for deviations from the basic assumptions concerning the linear regression model. These assumptions

---

[113] Henry J. Cassidy, Using Econometrics, Reston Hall Publishing Inc., Reston, Viriginia, 1981. pp. 18-19.

are as follows:[114]

1. The dependent variable can be calculated as a linear function of a specific set of independent variables, and an error term.
2. The expected value of an error term is zero.
3. The error terms if non-zero have the same variance and are not correlated with one another.
4. There is not exact linear relationship between independent variables.

If these assumptions hold when the regression is estimated, the coefficients are considered to be "best linear unbiased estimates (BLUE)." Violations of these assumptions may yield biased or inconsistent estimates and therefore not the best. Hence it is necessary to test if the above assumptions, in particular assumptions 3 and 4 hold.

Autocorrelation, the correlation of the error term in time [u(t)] with the error term of the previous period [u(t-1)] is detected by one of two methods. The first, the Durbin-Watson (D.W.) test of first order autocorrelation, is applied to equations that do not contain lagged dependent variables. When there is no autocorrelation the test statistic (D.W.) approximates 2. The further away the statistic is from 2, "the less confident one can be that there is no autocorrelation in the distrubances" (i.e. the error term).[115] Critical levels exist, such that statistical rejection of the hypothesis of no autocorrelation may be realized.

---

[114] Peter J. Kennedy, <u>A Guide to Econometrics</u>, MIT Press, Cambridge, Mass., 1979, pp. 82-83.

[115] <u>Ibid</u>.

The application of the D.W. test to an equation with lagged dependent variables as regressors biases the d-statistic towards 2 and therefore requires an alternate test of first order autocorrelation, the Durbin h-test:[116]

$$h = a\sqrt{\frac{n}{1 - nv(b)}}$$

where: a = first order autocorrelation coefficient supplied by regression analysis

n = number of observations

v(b) = estimated variance of the coefficient of the lagged dependant variable

If h > 1.960 the hypothesis of zero autocorrelation is rejected at the 10 percent confidence level, because h is normally distributed.[117] If autocorrelation exists in equations containing lagged dependent variables, the estimated coefficients are biased and inconsistent. Therefore autocorrelation must be detected so corrective procedures can be undertaken.[118]

---

[116] J. Johnston, Econometric Methods, McGraw Hill, 2nd edition, New York, 1972, p. 312.

[117] J. Durbin, "Testing for Serial Correlation in Least Squares Regression When Some of the Regressors are Lagged Dependent Variables", Econometrics, Vol. 38, No. 3, May 1970, p. 416.

[118] Kennedy, p. 84.

The presence of multicollinearity (i.e. the changes of the independent variables are highly correlated, makes the separation of each variable's effect on the dependent variable difficult to determine. The presence of multicollinearity can be established by examining the correlation of coefficient matrics in Appendix 3. If the correlation between independent variables approaches unity (i.e. 0.99) severe multicollinearity is present and the determined coeffients of the collinear variables may be unreliable.[119] This however does not require a modification of the functional form unless the theory so dictates.[120] The significance of the variable, a primary objective of this study, is however not affected.

The test of heteroscedasticity is performed by calculating the Spearman rank correlation coefficient:

$$r' = 1 - [6\Sigma D^2 / n(n-1)]$$

where: r' = correlation coefficient

D = difference of ranks of corresponding pairs of observations and residuals

n = number of observations = 72

If the absolute value of r' is greater than the critical value at the 5 percent confidence level, the theory of homoscedasticity is rejected and hetereoscedastic errors are assumed. The critical value is calculated

---

[119] Cassidy, 1981, p. 266.

[120] <u>Ibid</u>.

by:[121]

$$Rc = \frac{1.96^2}{\sqrt{72-1}} = 0.48$$

The consequences of heteroscedasticity for this study are the same as those discussed for autocorrelation.

[121] Koutsoyiannis, 1981, p. 95.