THE UNIVERSITY OF MANITOBA

PRICE STABILITY AND MARKETING ALTERNATIVES FOR GRAIN CORN IN MANITOBA

by

Marcia Elaine Glenn

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ABSTRACT

Price Stability and Marketing Alternatives for Grain
Corn in Manitoba

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While there have been large increases in grain corn production in Manitoba, there has been little or no investigation as to how a marketing system should develop to meet the needs of this expanding industry. It was the purpose of this study to first examine the characteristics of the Manitoba grain corn industry and second to use one of these characteristics, price stability, as a criterion for evaluating possible marketing mechanisms. While the first goal was dealt with quantitatively, the second stage was undertaken through the use of an analytical technique proposed by Schmitz et al. This tool determined the gains or losses accruing to producers under conditions of either price stability or instability. Upon determination of the type of pricing condition that would provide the greatest gains to producers, marketing alternatives were outlined that might achieve these various price conditions.

Examination of some of the characteristics of the Manitoba grain corn industry, revealed several pertinent points. First, from a production standpoint there is room for considerable expansion in corn acreage and therefore supply. More importantly perhaps, is the analysis that indicated that there is equally as great a demand for the commodity. Con-

sideration of the Manitoba market provided evidence that producers consider corn a cash crop and therefore it displays much the same annual production patterns as rapeseed, flaxseed and the other speciality crops.

As later empirical analysis examined the effect of price stability on producer gains, it was important to consider past price trends. Average annual Manitoba corn prices follow very closely those quoted on the Chicago Board of Trade(CBT) and in doing so, were found to display the fairly variable price characteristics of such a pricing mechanism.

This price recieved by Manitoba producers is presently achieved in one of the four ways. The first is a simple producer to producer transaction with negotiated price. The second enables the producer to deliver to his primary elevator, for a daily price also determined from the CBT. Producers can also, either individually or as a part of the Manitoba Corn Growers Marketing Association, sell their crop to various feed mills in Manitoba, Alberta or B.C. These mills also quote prices based on Chicago prices, but these will vary between companies depending on the exchange differential and/or tariff benefit that is passed on to producers. The fourth outlet for corn is the distillery at Gimli, Manitoba. Calvert of Canada requires 50,800 tonnes of high quality corn annually, and if Manitoba producers are able to satisfy the specifications, they receive a price determined by Calvert, monthly.

Possible marketing mechanisms were to be discussed after examining characteristics of an optimal pricing strategy. Through a method proposed by Schmitz et al., the gains resulting from price stabilization can be estimated. Whether a firm or producer will gain from price stabilization was shown by Schmitz et al., to depend on four parameters: price elasticity of supply, profit margin, contribution to total revenue and relative aversion to risk.

Their testing criterion was estimated using various combinations of these four parameters for grain corn. The values were chosen after examination of producer records, supply estimations and production budget estimates. Sensitivity analysis using various ranges revealed that the gains from price instability (as determined by the magnitude of the producer surplus) increased with increases in (a) the profit margin, and (b) the price elasticity of supply and decreased with increases in (c) contribution to total revenue and (d) the relative aversion to risk.

One of the combinations was considered for the illustration of a pricing strategy. The values of the parameters for this evaluation were chosen to represent an "average" Manitoba corn producer, and resulted in a negative one indicating that producers would be better off with price stability.

The remaining point which was considered was the type of marketing mechanisms that exist and the corresponding price conditions that they would provide. There arose five alternatives: the Canadian Wheat Board with a pooled price, the Winnipeg Commodity Exchange with a variable price, together as a part of the Domestic Feed Grains Policy where a producer has the choice of pooled or open market price, the Manitoba Corn Growers Marketing Association with a transaction or pooled price and sales to the elevator companies for either a daily price or a pricing pool such as are presently operated for crops such as lentils.

ACKNOWLEDGEMENTS

I would like to take this opportunity to express special appreciation to those individuals who contributed guidance, direction and support throughout the course of this thesis. A special thank you is devoted to my major advisor, Dr. E.W. Tyrchniewicz, who was willing to assume such a position mid-way through the term of the project. I acknowledge that this required additional time and effort on the part of Dr. Tyrchniewicz and I wish to assure that it was greatly appreciated.

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A sincere appreciation is also expressed to Professor R. Harris for special guidance in the overall methodology of the thesis. This direction facilitated the ever important continuity that is desired in such an analysis.

Acknowledgements would not be complete without the inclusion of a very special thanks to my parents, R.D. Glenn and M.J. Glenn, and a special friend Stephen Miville. Without the underlying encouragement and support of these individuals, the undertaking and completion of this thesis would have been somewhat less enjoyable.

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INTRODUCTION

1.1 PROBLEM STATEMENT

Corn, has been grown in North and South America as far back as history describes. While many of the present day cereal grains have developed from wild grasses from central Asia, Asia Minor and Africa, it is believed that corn had its origins in the western hemisphere, more particularly in the Americas. Corn is classified into a single botanical species *Zea mays* and the earlier cultivars grown by the American Indians were of a form quite similar to our modern day varieties.

Corn was introduced to the Canadian prairies, and more specifically Manitoba, over 100 years ago. It has since undergone a somewhat peculiar development. While it has, since that date, always been found in some minor proportion, the production levels have been quite variable. The first period when corn was of particular interest was in the thirties. During this time there were severe drought conditions. Stem rust was proving to be devastating to the wheat crops and the grasshopper problem had reached an all time high. For these reasons producers and researchers turned to other crops in hopes of finding hardier, more resistant cropping alternatives. These old varieties of corn, such as Gehu, Falconer and North West Dent, obtained yields of 1,890-2,268 kg/ha which, to present day producers, would be considered crop failures. Acreage of these varieties, however, increased throughout the thirties until a high of 40,470 hectares was seeded in 1942. After this the interest in corn production declined. There are several reasons cited for this decline: there had been the discovery of new rust resistant varieties of wheat, the climatic conditions had returned to normal with cooler seasons and more moisture, the grasshopper population had diminished and there was no market development to keep pace with the increases in corn production. Thus corn acreage and research were stymied for a period until the 1960's when again, there was renewed interest in the development of corn.

This rejuvination of the corn industry can be largely attributed to three factors. The first is the development of the hybrids. While these were introduced to Canada in 1937, it took many years to improve on their characteristics and make them feasible for large scale acreages on the prairies. The second reason is the markets that had developed for the increased corn production. Both the western Canadian feed mills and Calvert Distillery of Canada in Gimli, Manitoba showed serious interest in Manitoba grain corn production and indicated that markets would be available should the quality of corn meet the necessary standards. The third factor causing increased interest in grain corn production is the Canadian grain marketing system itself. In recent years producers have desired alternatives to the traditional Canadian Wheat Board crops. These options have come in the form of specialty or cash crops which have been sought to ease the cash flow problems existing on the prairies. Without expanding on the details of the Canadian grain marketing and transportation problems,[1] it will suffice here to say that

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1 Booze,Allen and Hamilton Inc., Grain Transportation and Handling in Western Canada, Grains Group, Ottawa, July 1979.

the presence of such difficulties has only hastened the development and advancement in acreages of crops such as corn.

The real expansion in the corn industry has occurred over the last 8 years. Between 1972[2] and 1980, seeded acreage increased from 5,261 to 62,129 hectares and it has been estimated that had weather conditions been more favorable, the acreage would have exceeded 70,000 hectares in 1980.[3] Production figures reveal a corresponding increase. More specifically, total production has increased by a factor of 12 since 1972, with 1980 production levels exceeding 210,000 tonnes.[4] Despite the fact that these figures imply that there has been no corresponding increse in yield over this same time period, this is not the case. Yields have also improved, but the unfavorable weather conditions for corn production in 1979 and 1980 inhibited the realization of these potential yields.

Regardless of these unfortunate weather conditions these production increases are substantial. The potential impact of grain corn in western Canada is, however, far greater than even these figures suggest. Given present varieties requiring 2,300 corn heat units[5] for full development, over 200,000 hectares could be utilized for grain corn produc-

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[2] 1970 and 1971 displayed unusual production characteristics and were therefore omitted here.

[3] Manitoba Department of Agriculture, Manitoba Agriculture Yearbook 1979, Queen's Printer, Winnipeg, Manitoba, 1979. pp. 62-63. Discussions with Metro Daciw of Economics Division, M.D.A. for predicted acreages.

[4] See Table 1.

[5] As indicated in the leaflet "Corn Heat Units in the Prairies" distributed by Manitoba Department of Agriculture, corn heat units measure heat available and provide a system which rates corn hybrids and geographic regions in the same terms.

tion.[6] At today's yields (4,000 kg/ha) and prices (approximately $140.00/tonne), this translates to a gross return of more than $110 million.[7] This represents an increase of 45 percent over the revenue that would be received if the same land had been sown to wheat.[8] Furthermore this may be only the lower limit, as research and development of hardier and higher yielding varieties continues.

While the technical aspect is vital to estimating production potential, producer incentive is at least as important. Despite adverse weather conditions in 1979 and 1980, present reports indicate that producers are encouraged about the prospects for grain corn and again considered it in their 1981 management strategies. Indicative of this are the acreage predictions for 1981, which are 110,000 hectares, from latest estimates.[9] Given the present producer interest and actual technical ability there have been estimates that western Canada will be self-sufficient in grain corn by 1985.[10] This means that the 25,000 to 127,000 tonnes that have in the past been imported into western Canada from the

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[6] C.F. Framingham, et al., The Potential Impact of Corn and Potato Production and Processing in Manitoba, Volume 1.1, Research Bulletin No. 79-1, Department of Agricultural Economics, University of Manitoba, Nov. 1979, p. 36.

[7] Manitoba Department of Agriculture, Ibid., 202,350 hectares x 4,000 kg/ha x $140.00/tonne = $113 million.

[8] Ibid., p. 50, and based on 1981 Manitoba Department of Agriculture Cost of Production Figures, Wheat: 202,350 hectares x 1,728 kg/ha x $220.50/tonne = $77.1 million - $7,478,856 (total costs) = $69.6 million. Corn: 202,350 hectares x 4,000 kg/ha x $140.00/tonne = $113.3 million - $11,612,867 (total costs) = $102.7 million. See Table A1 for a more detailed description of the calculations.

[9] Statistics Canada 22-002, preliminary estimate of grain corn acreage in Manitoba, June 26, 1981.

[10] Rogalsky, op. cit., 230,000 acres to achieve self-sufficiency.

United States will be replaced by western Canadian grain corn. This is a significant amount when one considers this amounted to $21 million in 1974 when imports exceeded 147,000 tonnes.[11]

Despite these actual and estimated increases, there has been little study on the nature and characteristics of the Manitoba grain corn industry. In order to understand and aid in the development of a marketing system to meet the needs of this growing industry, several factors must be examined. These include the policies and regulations governing grain corn, in addition to the production and price patterns and relationships that exist. Such a discussion will hopefully provide the background information through which a specific evaluation tool can be used in the consideration of a marketing mechanism. The technique that was chosen for this analysis was price stabilty and its effect on producer welfare.

1.2 SCOPE AND OBJECTIVES

In light of the existing technical potential for corn, and the seeming willingness of producers to grow the crop, the objectives of this study can be outlined more specifically by the following four goals:

1. To provide a descriptive analysis of the Manitoba grain corn industry including: demand and supply potential, price and production trends, imports of American corn, the Domestic Feed Grains Policy, the feed market in British Columbia, and the Ontario grain corn market.

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[11] See Table 7, p. 44.

2. To apply the theorem proposed by Schmitz et al., that a producer's desire for price stability depends on four parameters: price elasticity of supply, profit margin, contribution to total revenue and aversion to risk,[12]
3. To use the results obtained from objective two to draw conclusions about the type of pricing policy that would be best suited to grain corn producers,
4. To suggest alternative marketing mechanisms that could provide the type of price, stable or unstable, that results in the greatest welfare gains for producers.

As outlined by objective one, it was the attempt of this thesis in part, to assimilate some of the facts and figures surrounding the Manitoba grain corn industry. Chapter two undertakes to do so in substantial detail. The remainder of the thesis, however, devotes attention to only one aspect of the characteristics outlined in Chapter two. After consideration of some of the general features of the corn industry price stability was chosen for further analysis. While the remaining three objectives deal specifically with this aspect of the market, it is not because the other factors are not vital to the study of the industry, rather, it was necessary to reduce the problem to a managable size and in doing so attempt to reveal some useful conclusions regarding the marketing of grain corn. Price stability and its affect on producer welfare is therefore the only criterion used in this evaluation.

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[12] A. Schmitz, H. Shalit and S.J. Turnovsky, "Producer Welfare and the Preference for Price Instability," A.J.A.E., Vol.63, No.1, Feb. 1981, pp.157-160.

1.3 OUTLINE OF THE STUDY

Development of these four objectives will proceed in the following order. Objective one will be dealt with in Chapter 2 and will attempt to provide a qualitative framework for a more specific examination of the problem. Chapter 3 will present a detailed examination of the Schmitz et al., proposition on producer welfare and price stability. The fourth chapter will describe the specific model used in this analysis, and the techniques used in arriving at the relevant values for the four parameters. Chapter 5 provides the discussion of results and the last chapter provides a summary of the first two objectives and then elaborates in some detail on the latter two. Chapter 5 also presents the limitations involved in this study and suggests some possibilities for further research.

Chapter II

BACKGROUND TO THE PROBLEM

Chapter 1 provided a brief look at the nature and potential of the Manitoba grain corn industry, in addition to alluding to the complexity of the grain marketing system in which it resides. Several of these features, however, seem to warrant much closer examination. It will be the intention of Chapter 2 to provide more information on these matters. This discussion will include an examination of potential supply and demand, past and present production trends, management practices, price relationships, Domestic Feed Grains Policy, the British Columbia feed grains market and a brief look at Ontario's corn markets. After this discussion one particular characteristic, price stability, will be used in the remainder of the thesis, in an evaluation of its effect on corn producers welfare gains. Then, using the results obtained from this analysis, alternative marketing mechanisms will be considered which could provide various price conditions.

2.1 POTENTIAL SUPPLY

Grain corn production in Manitoba is presently in the midst of a tremendous expansionary phase. As is evident in Table 1 acreage has increased from approximately 1,500 hectares in the early seventies, to 50,000 hectares in the late seventies. In 1980, hectares planted exceeded 62,000. In production figures this area provided over 217,000

Table 1

Corn Statistics

Year	Acreage in Manitoba (hectares)	Yield in Manitoba (Kg./ha.)	Production in Manitoba (tonnes)	Price ($/tonne)
1970	1,416	3,139	4,445	62.99
1971	3,683	3,035	11,177	49.21
1972	5,261	3,380	17,781	61.02
1973	6,475	3,452	22,354	120.07
1974	2,024	2,384	4,826	144.42
1975	4,856	3,923	19,050	120.10
1976	6,900	4,232	29,200	118.94
1977	9,700	4,062	39,400	98.35
1978	35,600	4,140	147,300	110.25
1979	52,600	3,769	198,550	118.00
1980	62,729	3,470	217,670	153.56

Source: Manitoba Department of Agriculture, _Manitoba Agriculture, 1979 Yearbook_, Queen's Printer, Winnipeg, Manitoba, 1979, p. 63.

tonnes in 1980, which represents a tenfold increase from the total production estimates for 1975. While it is not entirely clear from Table 1, yield too, has improved substantially over the years. Hamilton, a researcher at the Brandon Research Station, states that:

> Corn is a crop built for continual improvements--genetically there has been an increase of about one bushel per acre per year since the introduction of hybrid corn more than 40 years ago.[13]

He goes further to point out that another bushel per acre per year has been attained through better management practices in the way of optimal planting times, fertilizer and weed control systems. The limitations on supply include those physical in nature, such as heat and moisture availability, and soil type as well as managerial practices that are corn specific.

The present hybrid varieties recommended for Manitoba require at least 2,100 corn heat units and the better yielding varieties need 2,300 or above.[14] More specifically, the corn heat unit (CHU) rating system calculates the heat available for plant development during the day and night, averages these values for each day and then sums them to determine the total corn heat units available during the season. These values are calculated for many points within a geographic area and then a CHU map can be drawn connecting the points of equal CHU's. Figure 1 depicts such a map for Manitoba. A more useful map is the one in which the probabilities are calculated which correspond to the respective CHU contours. Presently, 2,300 CHU's are required for grain corn production

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13 R.I. Hamilton, "Corn--New Gold on the Prairies, The Manitoba Co-operator, March 6, 1980, p. 26.

14 See the Corn Recommendations from Manitoba Department of Agriculture in Table A2.

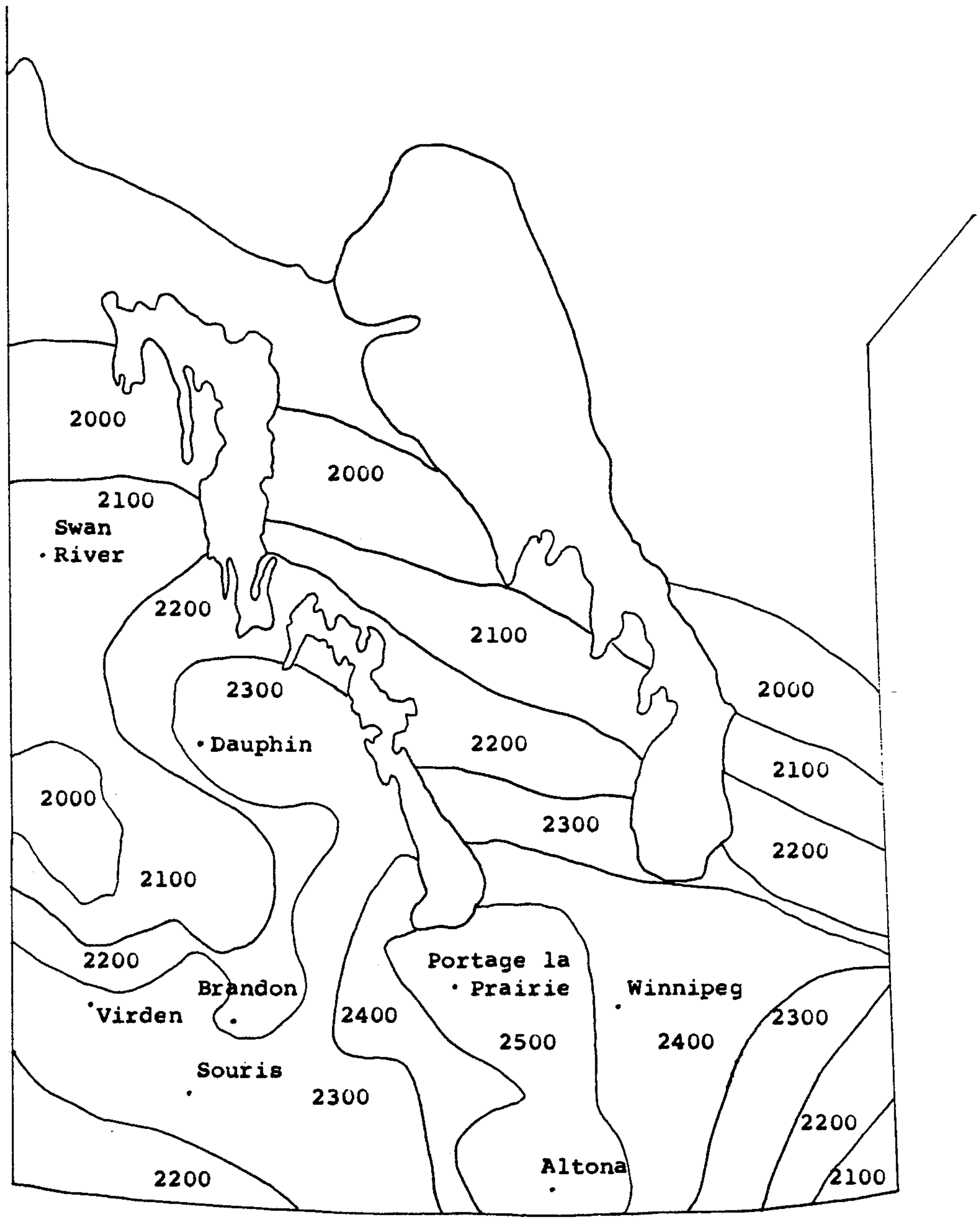

Figure 1
Average Number of Corn Heat Units Received in Manitoba

Source: D.J. Major, et al., Corn Heat Units on the Prairies, Alberta Corn Committee, Manitoba Corn Committee, Saskatchewan Corn Committee, Jan. 1976.

and 2,100 for corn destined for silage. Figure 2 shows the areas in Manitoba that will obtain, in 9 years out of 10, at least 2,300 CHU's.

There are two additional features that must be considered in regards to the physical conditions necessary for production of grain corn. The first is the moisture level. Manitoba is typically a moisture deficit region. That is, the amount of moisture that evaporates and transpires from the soil is less than that remaining in the soil in the spring plus that received during the growing season. This deficiency usually amounts to about eight inches by the end of August, but it can range from 2 to 12 inches. These low moisture levels lead to the second factor that need be considered, the soil type. Grain corn is best suited to well-drained sandy loam to clay loam soils. These loams provide the good moisture retention capacitites required for growth. Figure 3 indicates those areas that have suitable soil types for grain corn production, combined with 2,300 corn heat unit contours having a probability of .9. Combining these two limiting factors results in a potential acreage of 216,500 hectares for grain corn production in Manitoba.[15] It is evident from this that there exists plenty of room for further growth in acreage, even with the present limitations of 2,300 corn heat units. Should this limit be decreased through further improvements in plant growth and development to 2,100 CHU for instance, this potential would almost double to include an additional 170,000 hectares.[16]

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[15] C. Framingham et al., The Potential Impact of Corn and Potato Production and Processing in Manitoba, Volume 1.1, Research Bulletin No. 79-1, Department of Agricultural Economics, University of Manitoba, Winnipeg, Manitoba, Nov. 1979, p. 41.

[16] Ibid.

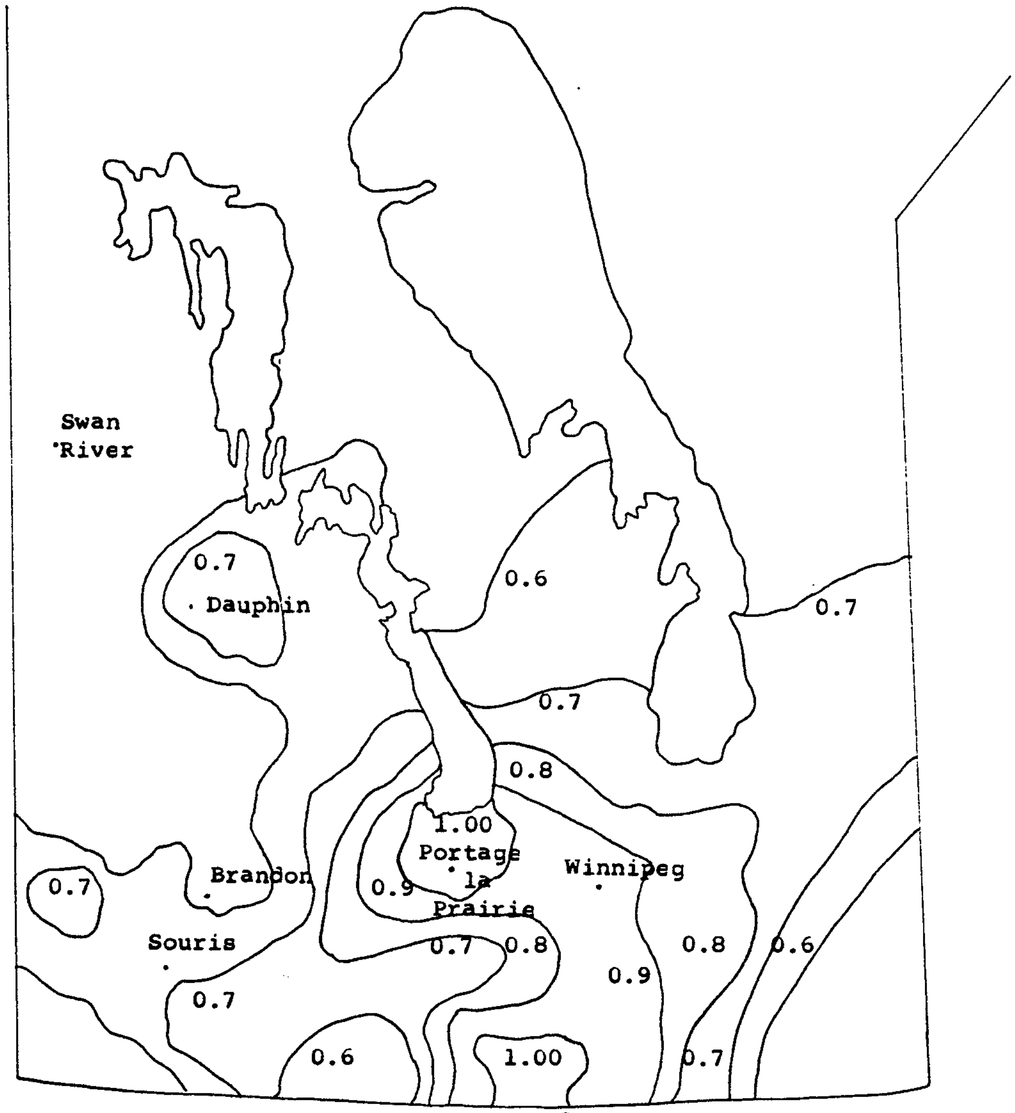

Figure 2

Probability of Receiving 2,300 Corn Heat Units

Source: Same as Figure 1.

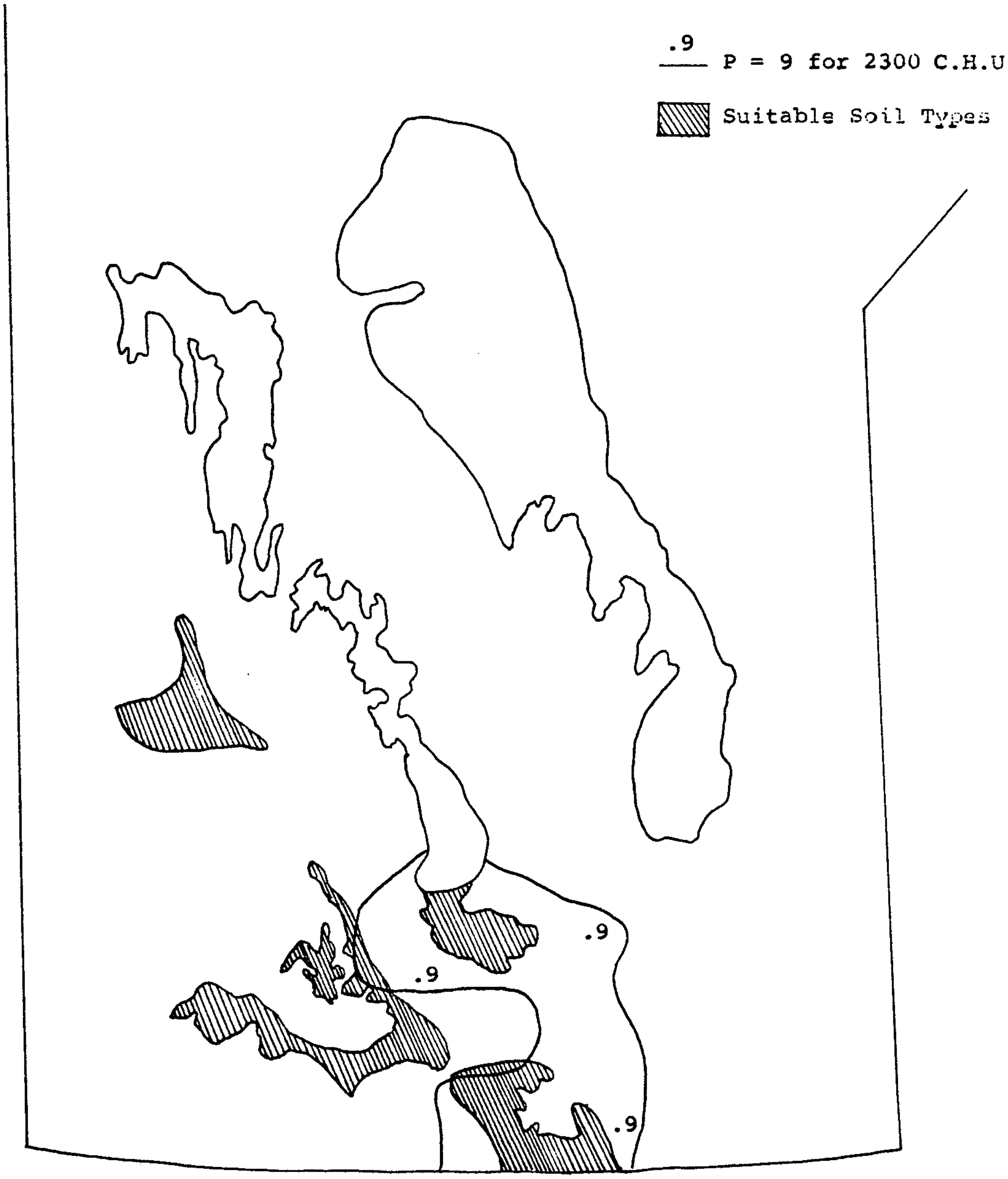

Figure 3

Regions Suitable for Grain Corn Production

Source: Adopted from C. Framingham et al., The Potential Impact of Corn and Potato Production and Processing in Manitoba, Research Bulletin No. 79-1, Dept. of Agric. Econ., University of Manitoba, Wpg., Man.

There are several factors worth mentioning in regards to special management practices for grain corn. Proceeding chronologically from seeding to harvest time, the following points are of particular interest. The date of planting is very important in corn production and the optimal period is from May 1 to May 15. Tests have shown that there is a loss of about one bushel per acre per day in yield when corn is planted after the first week in May.[17] This is a significant amount considering that there is no additional cost incurred for early planting. At 1980 prices a delay of seven days could result in a decrease in total revenue of $27.30/ acre ($60.06/hectare).[18] This illustrates the importance of early seeding for grain corn.

A very important consideration when examining corn production is the particularly high level of weed and pest management required. Corn is unusually susceptible to weed populations which tend to reduce yields substantially. One of the most common solutions to this problem is the application of the herbicide atrazine. Atrazine is very effective for weed control, but it also has lasting residual qualities. This creates difficulties when it comes to using corn in a rotation scheme. While many areas in the corn-belt of the United States practice continuous cropping, the build-up of diseases and insects under such a program tends to make monoculture cropping somewhat less than satisfactory. There are some alternative crops that have been developed which are resistant to atrazine but these are not of the high yielding varieties typical of the more traditional prairie crops.

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[17] Hamilton, op. cit., p. 26.

[18] Manitoba Department of Agriculture: $3.90/bu. x 7 days = $27.30/acre ($60.06/hectare).

In addition to the special management required for grain corn production, there are two additional pieces of machinery required. To ensure proper seeding and therefore growth, a corn planter is essential. This will cost from $13,000 to over $20,000 depending on the size required. The second piece of machinery required is a corn header which is attached to the combine. Such an attachment minimizes losses at harvest by a series of snapping rolls and a stripper plate which shells the corn instead of the typical style of thrashing. A corn header usually costs approximately $9,000 which combined with the corn planter requires an additional investment of up to $30,000. There is one further implement that is often used in grain corn production. The row crop cultivator can be very useful for mechanical weed management when it is not desirable to use the herbicides which leave residues.[19]

The two remaining factors to consider in regards to grain corn production are drying and irrigation. As recommended by the Manitoba Corn Committee:

> drying of the corn is essential when harvested above 18 percent moisture content unless it is placed in airtight storage, preserved in acid, or is frozen.[20]

They also recommend that corn be harvested at 27 percent moisture to minimize field losses, cracking and splitting. The result is that most farmers must dry their crop before storage. This presents another cost for grain corn producers. They can either have their corn custom dried which amounts to about $19.69/tonne ($.50/bushel) or they can purchase

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[19] Prices determined by consultation with Sylvio Sabourin, Research Associate, Department of Agricultural Economics, University of Manitoba.

[20] Manitoba Corn Committee, Field Corn in Manitoba Agdex publication No. 111, 1979, p. 32.

their own drier and perform the task themselves.[21] Producers having their own driers often engage in custom drying which helps pay for the initial investment.

Grain corn is particularly conducive to irrigation because of its fairly high moisture requirements. The increase in yield is substantial as indicated by Mr. R. Mitchell's crop at Ross Farms in Shilo where yields of 7,245 kg/ha were obtained in 1980 as compared with the provincial average of about 3,528 kg/ha.[22] In addition to this improvement in yield, irrigation will also increase the potential area for grain corn production substantially. It will allow land that is presently unsuitable for corn production, because of moisture deficits or soil type, to be utilized. Thus, while potatoes, vegetables and silage corn have to date been the most profitable crops for irrigation, it appears that grain corn too, is showing increasing feasibility.

2.2 POTENTIAL DEMAND

As mentioned previously there exist two traditional markets for grain corn grown in Manitoba. The first is the distilling industry which has a plant located at Gimli, Manitoba. Calvert of Canada requires 50,800 tonnes of corn annually to meet its distilling requirements.[23] While Manitoba production levels are high enough to easily satisfy these demands, the quality factor has sometimes been limiting. The year 1979

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[21] Determined by consultation with Sylvio Sabourin, Research Associate, Department of Agricultural Economics, University of Manitoba.

[22] Determined by consultation with Dr. D.F. Kraft, Associate Professor, University of Manitoba.

[23] Determined by consultation with Ed Ward of Calvert of Canada, Gimli, Manitoba.

examplified this situation. Due to the very wet spring experienced in that year, the quality of Manitoba corn was not up to standards and consequently American corn was brought in for the purpose. These quality specifications are as follows:

1. Minimum bulk density--700 kg/m . Corn not meeting this requirement is sometimes purchased at discount prices, providing all the other quality factors for a Canada No. 1 grade are met.

2. Maximum moisture content--14 percent.

3. Maximum limits of damaged corn--

   a) Heat damage--0.1 percent

   b) Total damage--3.0 percent

4. Maximum cracked corn and foreign material--2 percent

5. Odor:

   a) Corn must be free of burnt and noxious odors

   b) Oil dried corn will not be accepted

   c) Propane or natural gas fired dryers are recommended with intake air temperature not exceeding 60 C.[24]

Thus as long as Manitoba corn is able to meet these requirements, the distilling industry provides an outlet for at least 50,800 tonnes.

The remaining corn produced in Manitoba is used in the western Canadian livestock industry as an ingredient in feed. It is particularly attractive for poultry producers as it contains the very high energy levels necessary to meet the physiological requirements of poultry. While this would provide the most important outlet, corn can and would also be used in the swine, dairy and beef industries as long as the price proved economical.

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[24] Manitoba Corn Committee, op. cit., p. 34.

Before examining the potential demand for grain corn by the western Canadian livestock industry it is important to at least mention the palatibility concerns that are often raised regarding the feeding of corn. The Canadian consumer has traditionally become accustomed to white meat in poultry and white fat in pork and beef. As far as digestibility and patability for the animal are concerned, corn could be utilized almost 100 percent in most rations as is the case in the American livestock industry. Consumers in Canada, however, have shown a distinct preference for the white meat and fat provided by grain fed animals over the slightly yellowish tinge, characteristics of meat from corn fattened animals. This point is not of major concern, because Canadian corn is in relatively short supply and American corn does not usually prove to be as feasible as Canadian feed grains, but it is worth noting as these types of concerns are a part of a livestock producer's decision on what exactly his feed ration will be composed of.

Given that the Canadian consumer is likely to adjust to the slightly different coloured meat, what is the potential for grain corn by the prairie livestock industry? To derive some sort of estimate as to the magnitude of this market, a linear program was used. As feed mills use similar methods to determine their least cost rations, such a tool can be easily adapted to show utilization of any particular ingredient. Least cost rations for various price levels of corn were calculated.[25] The rations for 15 livestock groups were used along with 27 feed ingredients. Upon determination of the amount of corn used in the ration for

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[25] For a more detailed discussion on the parametric program used see M. Glenn "Demand Analysis for Grain Corn in Western Canada," Working Paper, Department of Agricultural Economics, University of Manitoba, July 1980.

one animal, this value was multiplied by the total number of that type of animal raised in Manitoba, Alberta, Saskatchewan and British Columbia for one year. The aggregate demand of the 15 groups provided the total demand for grain corn at one specific price. Parametrically varying the price of corn, the price of all other feedstuffs remaining constant, results in a demand schedule. By plotting these points, the typical downward sloping demand curve results, (Figure 4). Such a calculation was carried out three times, with the prices for each of the other feedstuffs changed to those existing in the years 1973, 1976 and 1978. This provided three scenarios through which to evaluate demand. The years 1973, 1976 and 1978 represented conditions of high, low and moderate protein/energy price ratios respectively.

The prices of corn actually received by Manitoba corn growers in 1976 and 1978 were 11.89¢/kg and 11.025¢/kg, respectively.[26] As is evident from Figure 4 these prices correspond to potential demands of approximately 85,000 tonnes for 1976 and 425,000 tonnes for the 1978 crop year. If one compares this to the actual production figures for those years (Table 1), 29,200 tonnes in 1976 and 147,300 tonnes in 1978, it becomes clear that potential demand exceeded actual production substantially.

This gives some idea of the size of the feed market that is open to corn. There is one further consideration in regards to the demand for corn that should be mentioned before concluding the remarks on potential demand. Gasohol plants utilize cereal grains and grain corn in a process to produce grain alcohol, which when combined with gasoline will reduce consumption of the exhaustable resource. Corn is particularly

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[26] The year 1973 will not be considered further because of the unusual conditions existing in the protein meal market at that time.

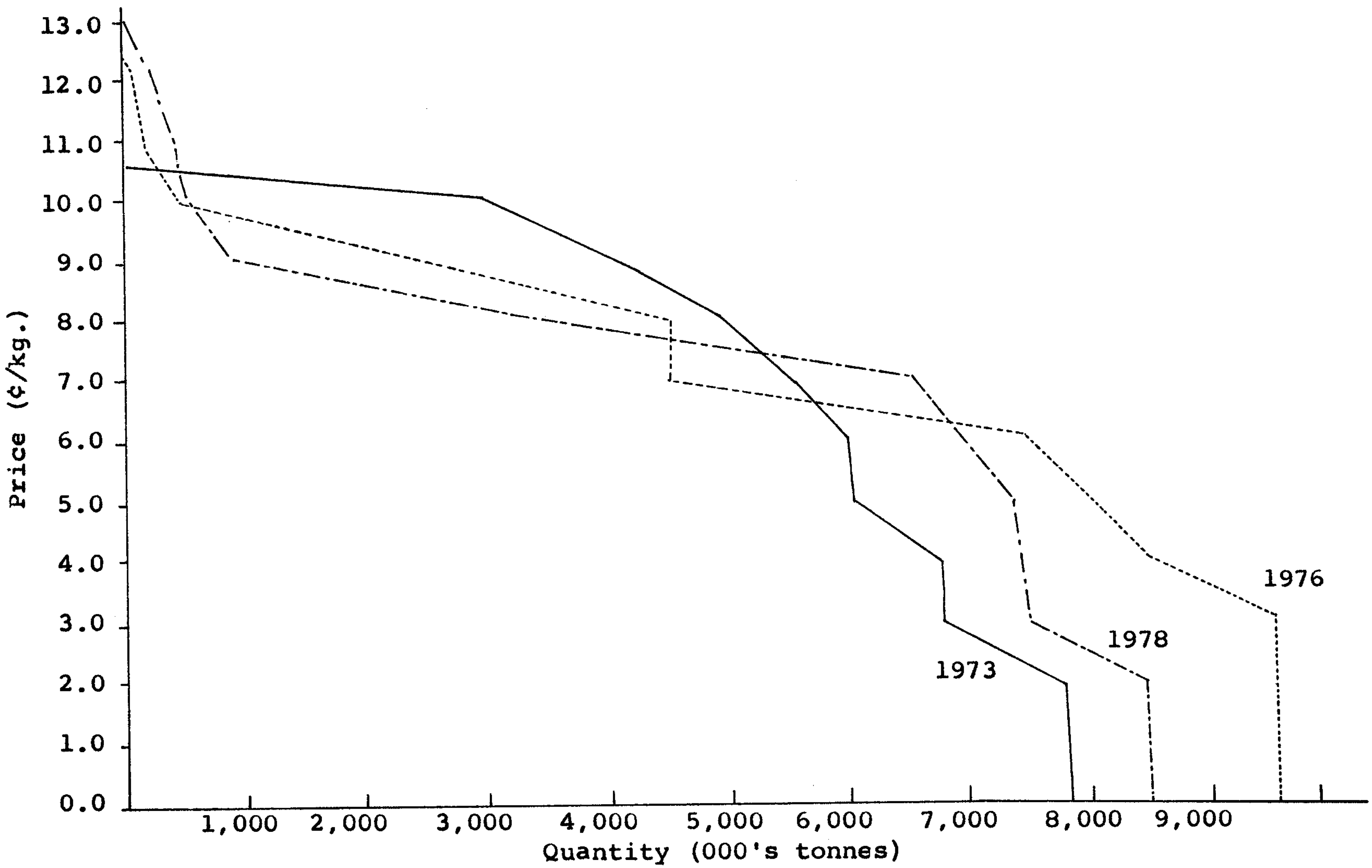

Figure 4
Potential Demand for Grain Corn

Source: M.E. Glenn, Demand Analysis for Grain Corn in Western Canada, Working Paper, Department of Agricultural Economics, University of Manitoba, July, 1980.

suited to gasohol production because of its high carbohydrate and low protein content.[27] While gasohol production does not prove to be feasible until oil prices reach $50 per barrel, if they do so, this will provide yet another market outlet for grain corn.

2.3 PRODUCTION TRENDS AND RELATIONSHIPS

Wheat and barley are the major crops grown on the Canadian prairies and more specifically in Manitoba. Upon close examination, however, it becomes evident that barley and wheat production trends display very different characteristics. Figure 5, shows acreage figures for wheat, barley and grain corn in Manitoba, (Tables A3 and A4 in Appendix A). When wheat acreage is on the rise, barley acreage tends to decrease. The identical trend is also found to be evident in Figure 6, for the combinations of wheat-rapeseed and wheat-flaxseed, (Table A5 in Appendix A). As producers move out of wheat production, there tends to be an overall increase in acreage of all other crops. When the price of wheat is strong, production of that crop is increased, and when the price of wheat begins to decline, producers tend to move out of wheat production into one of the other crops.

If Figures 5 and 6 are examined closely it becomes clear that while barley, flaxseed and rapeseed tend to display the same turning points, the magnitude of these changes vary greatly. Barley acreage fluctuates within a 250,000 hectare range, while both flaxseed and rapeseed have varied from a low of 100,000 hectares to a high in 1979 of 550,000 hectares. Even accounting for the fact that rapeseed was a fairly recent

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[27] J. Hunter, "Irrigation Pays Off With Bumper Crops," The Manitoba Cooperator September, 11, 1980.

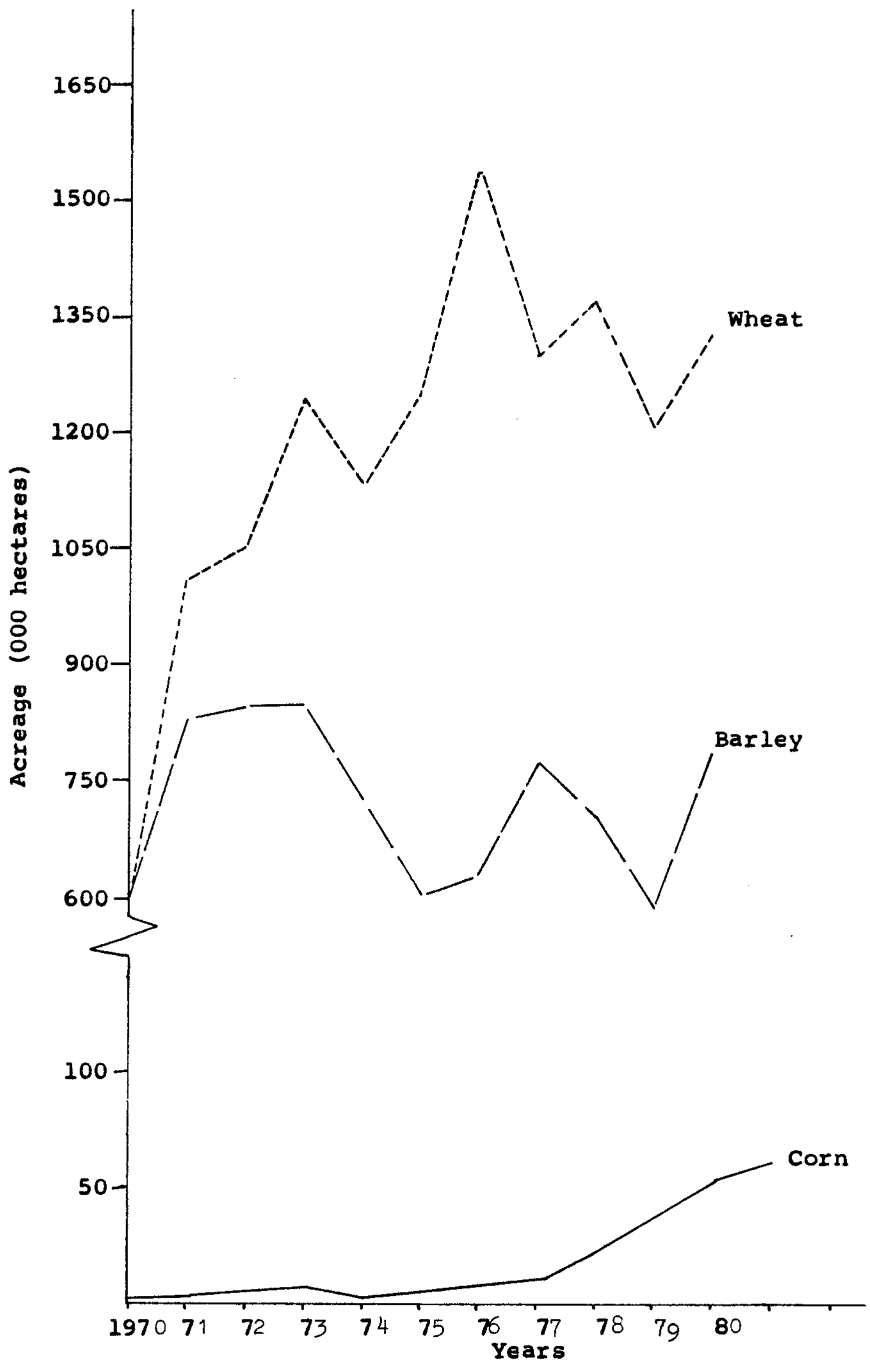

Figure 5

Acreage of Barley, Wheat and Corn in Manitoba, 1970-1980

Sources: Canada Grains Council, Canadian Grains Industry Statistical Handbook '80, Canada Grains Council, Winnipeg, Manitoba, 1980, pp. 3, 4, 9, and 10; Manitoba Department of Agriculture, Manitoba Agriculture, 1979 Yearbook, Queen's Printer, Winnipeg, Manitoba, 1979, pp. 51, 53 and 63.

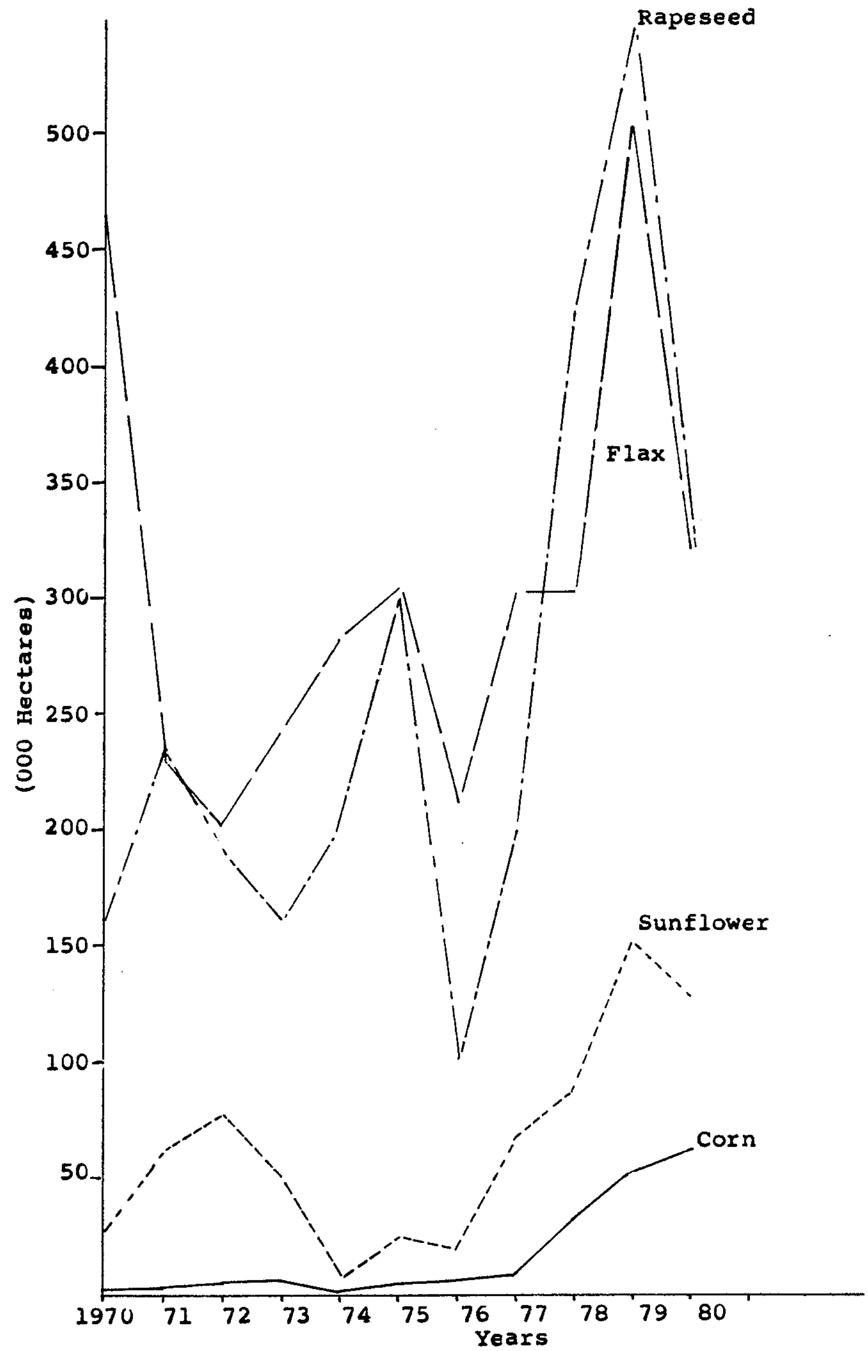

Figure 6

Acreage of Corn, Flax, Rapeseed and Sunflowers in Manitoba, 1970-80

Source: Manitoba Department of Agriculture, Manitoba Agriculture, 1979 Yearbook, Queen's Printer, Winnipeg, Manitoba, 1979, pp. 57, 63, and 69.

innovation on the prairies this 450,000 hectares indicates a much greater degree of sensitivity to price changes. This movement into and out of cash crops[28] is a result of the low or high price of wheat, in addition to other factors such as quota levels and delivery opportunities on the Board crops. When the price of wheat is low, however, most producers do appear to move to some degree into barley production in order to retain at least some level of stability or security in revenue. This is ensured by the Board's pooling mechanism which operates only for wheat, barley and oats. Producers will also increase their acreages of the higher priced and often higher risk crops as well.

Where then does corn fit into these patterns of production? Corn, in its present status can be considered as a cash crop. It is displaying the same type of growth and development that rapeseed did in the sixties, but as is evident from both Figures 5 and 6, corn has not yet become as sensitive to the price and production fluctuations that are apparent in the other crops. Corn acreage followed a very consistent level for the sixties and early seventies averaging about 3,000 hectares per year. This production was likely from producers in those regions which obtained quite high levels of CHU's and adequate moisture levels to produce small quantities of corn to supplement their feed requirements or perhaps supply Calvert distillery in Gimli. It was not until the mid-seventies that grain corn production actually began a steady rise. Increases in acreage levels from about 5,000 hectares in 1975, to over 62,000 hectares in 1980, is indicative of the importance corn has achieved in such a short period of time. More importantly perhaps, is

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[28] Cash crops refer to flaxseed, rapeseed, sunflowers and other speciality crops.

the fact that the levels for 1979 and 1980 are considered much lower than were anticipated because of the particularly bad weather conditions in those two years. These increases are steady, however, and there is little fluctuation that might be attributed to response to price changes.

The actual production figures, shown in Figure 7, display the same type of behavior, (Table A5 in Appendix A). In fact they reinforce the trend because of the increases in yield matching the increases in acreage. There is, however, an exaggeration in Figure 7. It appears from this that corn production surpassed both flaxseed and sunflowers in 1980. While this is true, it is accounted for by the fact that corn has a higher bushel weight than either flaxseed or sunflower and thus the tonnage per hectare is quite a bit higher.

2.4 PRICE RELATIONSHIPS AND STABILITY

This section on price relationships and stability provides the background information specific to the later empirical analysis. When the possible marketing alternatives are examined using the concept of producer welfare, they must be done so with regards to these existing price trends that will now be discussed. The price of grain corn is basically derived from the Chicago price of corn. For a producer with corn to sell, there are actually four selling options each with a slight variation in price determination. The first involves selling to a local feedlot operator. The price at which this transaction is made will either be that negotiated between buyer and seller or perhaps the daily street price quoted by one of the grain companies. A producer can also

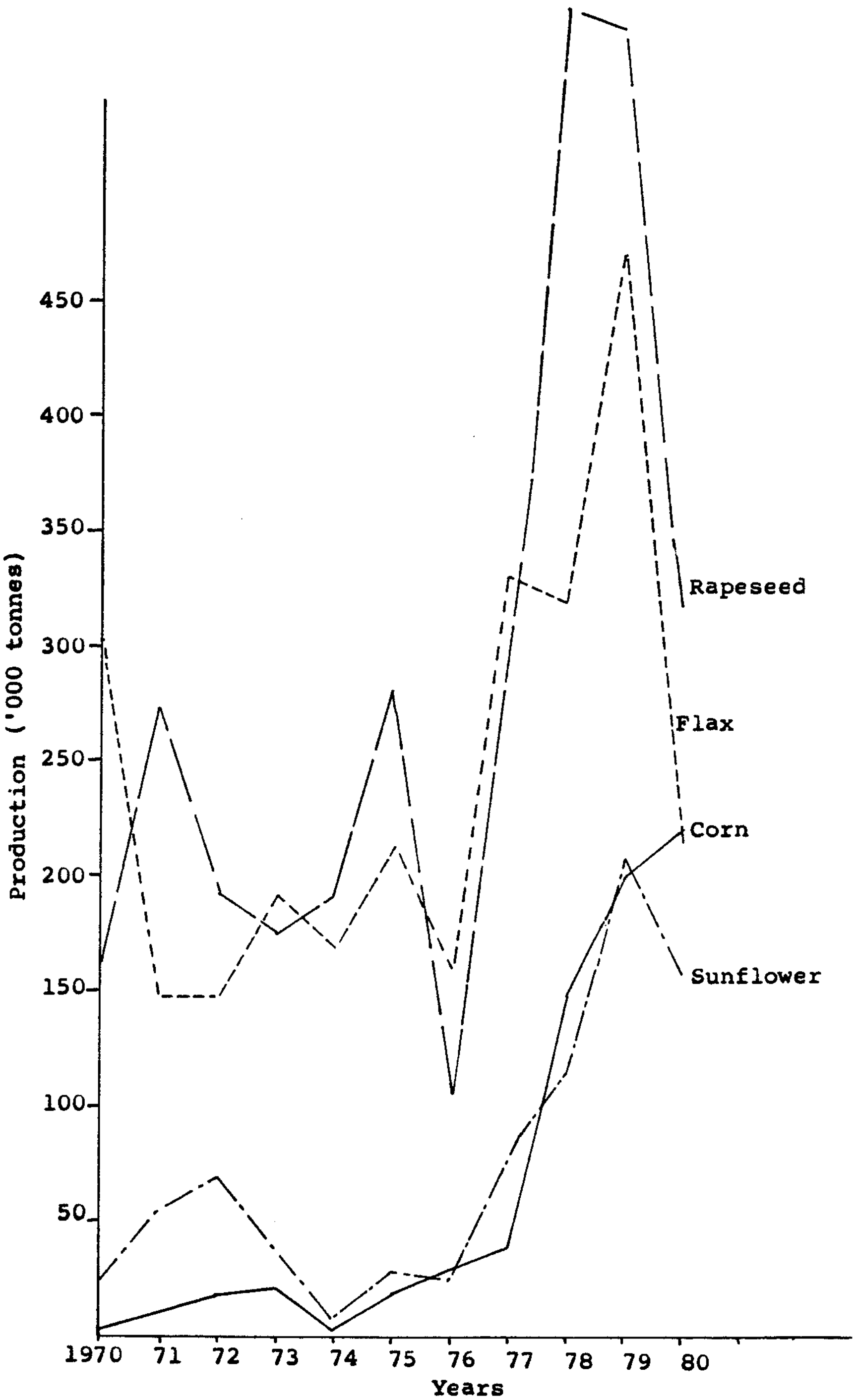

Figure 7

Production of Corn, Flax, Rapeseed and Sunflowers in Manitoba, 1970-80

Source: Manitoba Department of Agriculture, Manitoba Agriculture, 1979 Yearbook, Queen's Printer, Winnipeg, Manitoba, 1979 pp. 57, 63 and 61.

sell this corn to a local elevator for the daily street price.[29] This price is actually calculated twice a day, once in the morning and once at the close of the Chicago Exchange. The price quoted is the price of Chicago corn of the nearest futures month converted to the metric equivalent.[30] There is no tariff of $1.97/tonne ($.05/bushel) added, nor is there a conversion to Canadian dollars. This calculation of price implies that corn growers are receiving excessively low price for Manitoba corn relative to that received in the U.S. This price, however, is only a quoted daily price and there are few sales transacted at this level. Manitoba Pool quotes these simple prices to provide a starting point from which more detailed negotiations can take place, (Table 2).

The third option is available only to those Manitoba producers having the high quality corn suitable for distilling. Calvert distillery in Gimli, Manitoba quotes, on the fifteenth of every month, the prices it is willing to pay producers. This price calculation is somewhat more detailed. The base price is the closing Chicago price on the fourteenth of the month for the nearest futures month converted to Canadian dollars. To this is added a freight differential, duty and product pay back, and two additional payments for Seagram quality and premium.[31]

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[29] These deliveries are, however, subject to the restrictions placed on the elevator companies in regards to holdings of non-quota grain.

[30] Determined by consultation with Art Harden of Manitoba Pool Elevators, Winnipeg, Manitoba.

[31] More specifically the freight differential refers to an additional payment equivalent to the transport costs of moving similar corn from American sources; the duty is a part of the $1.97/tonne ($.05/bu) import tariff; the product pay back is a government subsidy given to Calvert to encourage the use of Canadian corn and which is added directly to the price recieved by producers; and the additional payments for Seagram quality and premium result from the specific quality requirements necessary for distilling purposes.

Table 2

Manitoba Pool Elevators,
Monthly Average Prices for Grain Corn

	1977	1978	1979	1980	1981
January		84.20	93.47	107.97	142.14
February		83.70	96.97	106.74	
March		89.24	98.24	105.26	
April		94.13	105.05	105.34	
May		99.25	108.33	110.03	
June		102.91	115.81	112.59	
July		94.00	119.48	124.45	
August	77.72	88.29	110.93	134.90	
September	77.31	86.35	109.23	138.25	
October	74.22	92.77	112.25	143.08	
November	77.85	92.51	109.71	150.83	
December	79.72	91.81	112.30	145.13	

Source: Manitoba Pool Elevators daily price quotations 1977-1981. See Table A6 in Appendix A for daily price quotations.

This calculation can perhaps best be illustrated by an example. The following are the figures used for determination of the January 15, 1981 price quoted by Calvert distillery:

Chicago Closing Price on January 14, 1980
  in Canadian dollars,
+ .55 1/4 freight differential
+ .02 1/2 duty and product payback
+ .08 Seagram's quality
+ .12 premium

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$4.54/bushel = $178.76/tonne

Table 3 records all of the available prices from Calvert distilleries for the years 1976 to 1981.

The fourth and final option available to Manitoba corn producers is to sell their crop, either individually or through the Manitoba Corn Growers Marketing Association, on a contractual arrangement to the feed mills. Such feed mills might be located in either Manitoba or Alberta or B.C.

The conditions of these sales are of two varieties. They can either be forward sold or unrestricted (i.e., sale made after production is completed). With forward selling there are two further categories under which sales can be made. The first are production contracts. "A production contract usually refers to an agreement in which buyer and seller agree to transact the <u>production</u> from a given piece of land, or a specified quantity of product to be produced, with the price either open (to be determined at some later date) or fixed for a proportion (but not

Table 3

Calvert of Canada, Monthly Prices For Grain Corn

	1976	1977	1978	1979 ($/tonne)	1980	1981
January	-	119.7	104.84	109.36	134.07	178.76
February	-	116.94	106.12	111.43	135.25	
March	-	118.72	110.64	115.17	135.15	
April	119.40	117.93	-	119.60	133.38	
May	-	112.02	-	124.33	138.70	
June	-	-	-	131.32	138.30	
July	-	-	-	142.83	155.53	
August	-	-	-	130.53	-	
September	128.76	95.78	-	128.85	167.93	
October	120.09	97.85	108.38	136.34	180.73	
November	107.20	104.74	108.08	135.55	175.32	
December	-		108.87	140.47	175.32	

- indicates not available.

Source: Ed Ward, of Calvert of Canada Limited, in a personal interview January, 1981.

all) of the anticipated production."[32] The other type of forward selling is a deferred delivery contract in which the buyer and seller agree to take delivery or deliver a specified volume of grain, again price either specified or pricing arrangements agreed upon. The first of these methods is rarely applicable for use by the association and is much more predominant for individual producer sales. Both the unrestricted, in which the selling contract is made after completion of harvest, or the deferred delivery contract are much more common for use by the association.

The pricing arrangements for each of these two methods has to date involved direct transfer from user to producer for each individual sale made. Regardless of their location, the daily quotations are also based on Chicago futures prices. Feed mills will also often pay the producer part of that premium resulting from the tariff and exchange differential. The degree to which that is paid, however, depends largely on the company itself and the supply and demand situation that is being experienced at the time.

While corn is presently priced as described above, in 1974 there was a trial period in which grain corn was traded on the Winnipeg Commodity Exchange (WCE). The market proved to have insufficient volume, and corn was removed from the trading floor. With the recent increases in corn production, the question has again arisen over the possibility of having grain corn traded on the Winnipeg Commodity Exchange. There has been no official move in that direction, and therefore Manitoba producers must

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

rely on the Chicago Exchange for their price determination.

To examine this relationship between the Chicago and Manitoba price, consider Figure 8 and Table 4. The prices plotted in Canadian dollars, depict the price of American corn and the price received by Manitoba producers as estimated by the Manitoba Department of Agriculture. The important concept to obtain from Figure 8 is the correspondence of turning points that is evident. Average annual corn prices received by Manitoba producers follow closely to those received by their American counterparts. U.S. corn has, however, traditionally been higher priced than Manitoba corn, (Figure 8). This can be attributed to two factors. The most important is that American corn is usually higher quality than Manitoba corn and the price reflects this premium. Also when Manitoba corn growers were expanding into the B.C. markets in the mid seventies, they found it necessary to offer their corn at discount prices relative to U.S. supplies. This differential decreased to the present situation where Manitoba corn is priced on par with American corn of equal quality.

Figure 8 indicates that in 1975 the Manitoba corn price exceeded the American price. This may be due to the difference in harvest times and the manner in which the two countries record their prices. American prices are determined on a calender year basis while the Canadian prices are quoted for the crop year, Aug.-July. This would place the price peak experienced in 1974 in the U.S. in the following year in Canadian price quotations.

As far as stability of Manitoba corn prices is concerned, there seem to be fairly wide fluctuations in price on an annual basis. Such price

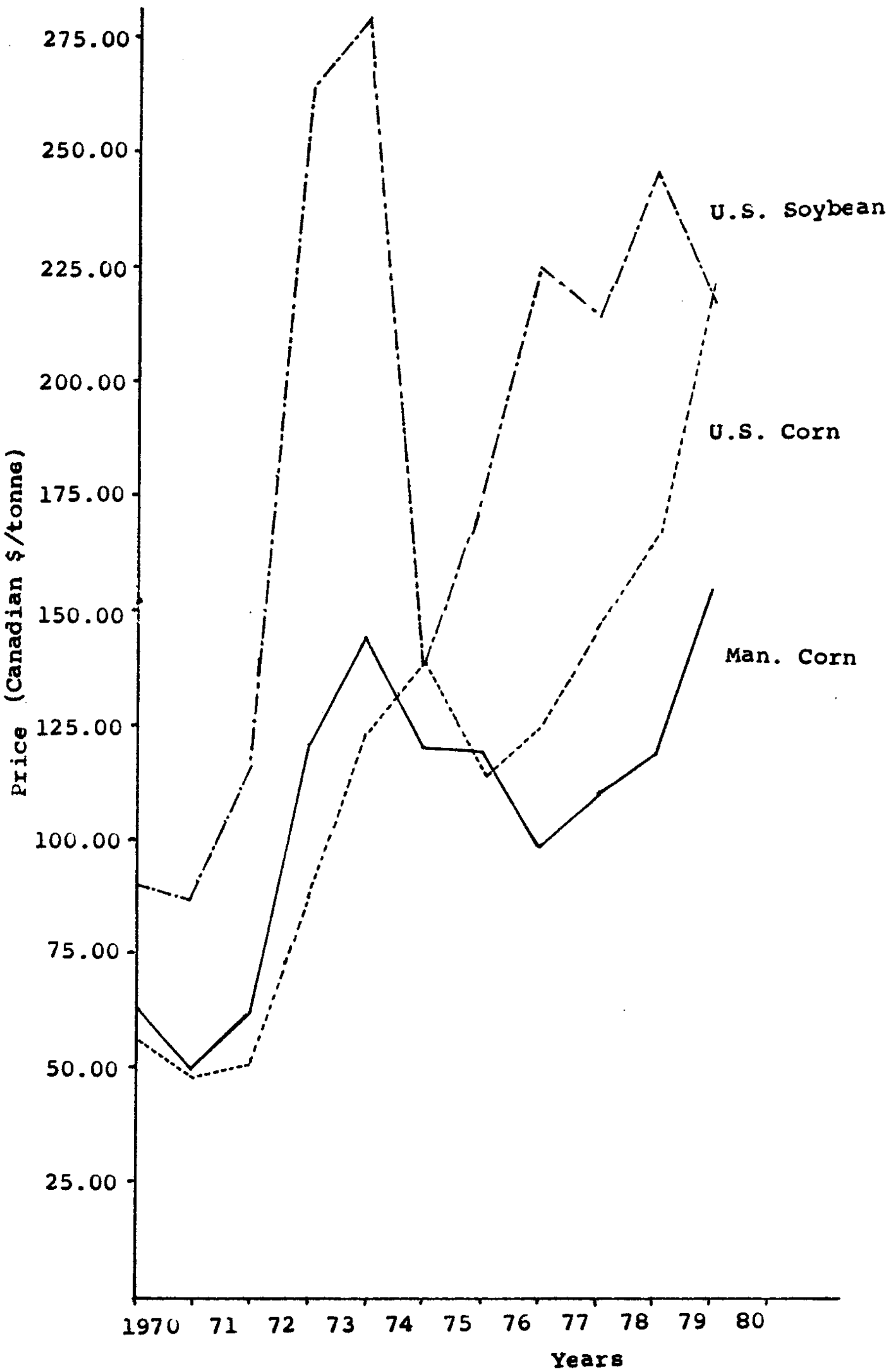

Figure 8

Prices of U.S. Corn, U.S. Soybeans and Manitoba Corn

Source: See Table 1 and 4.

Table 4

Average Annual Prices for American Corn and Soybeans (44% Protein), 1970-1980

Year (January to December)	Corn[a] Price in U.S. (Can.$/tonne)	Soy 44% Protein[b] Price in U.S. (Can.$/tonne)
1970	56.25	91.04
1971	47.73	87.20
1972	50.68	114.50
1973	86.71	263.02
1974	128.17	280.21
1975	138.19	139.07
1976	113.39	176.77
1977	123.40	225.15
1978	146.08	215.63
1979	165.98	246.48
1980[p]	221.46[p]	218.52[p]

[p]preliminary

[a]1970-1974 Corn prices are quoted from Chicago and 1975-1980 are those quoted at Kansas City.

[b]All soy meal prices are for Decatur.

Source: U.S.D.A., Feed Situation from Feed Market News, A.M.S., U.S.D.A., various issues 1970-1980.

variability results in income variability which is typical of the agricultural industry. More importantly to producers perhaps, is the monthly, weekly or even daily fluctuations in price that occur. As it will become more evident later in this work, there is much debate over the gains from price stability. While a procedure to test the gains or losses resulting from price stabilization will be developed in much greater detail later, it is important here to examine the past and present variability that has existed for these prices.

In this regard consider Figure 9. These average monthly corn prices are calculated as simple averages of Manitoba Pool's daily quotations. It is clear that there exists an increasing trend in prices over the period for which prices are available.[33] It also appears that there is some sort of seasonal variability existing in this price series. To isolate this seasonality effect, a seasonal index was calculated from the time period January 1977 to December 1980.[34] Figure 10 shows the results of these calculations, verifying the hypothesis that a seasonal variability does exist. The price of Manitoba corn tends to peak in late spring and early summer , and then fall as crop expectations become known in late summer. It then maintains a somewhat lower than average price throughout the remaining months. This is somewhat variant from the normal seasonal price adjustments expected where price rises from the time of harvest, equal to the costs of storage. Regardless of this there is definitely monthly instability in corn prices quoted to Manitoba producers.

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[33] Manitoba Pool began quoting daily prices for corn in August 1977.

[34] W. Purcell, Agricultural Marketing, Reston Publishing Co. Ltd., Reston, Virgina, 1979.

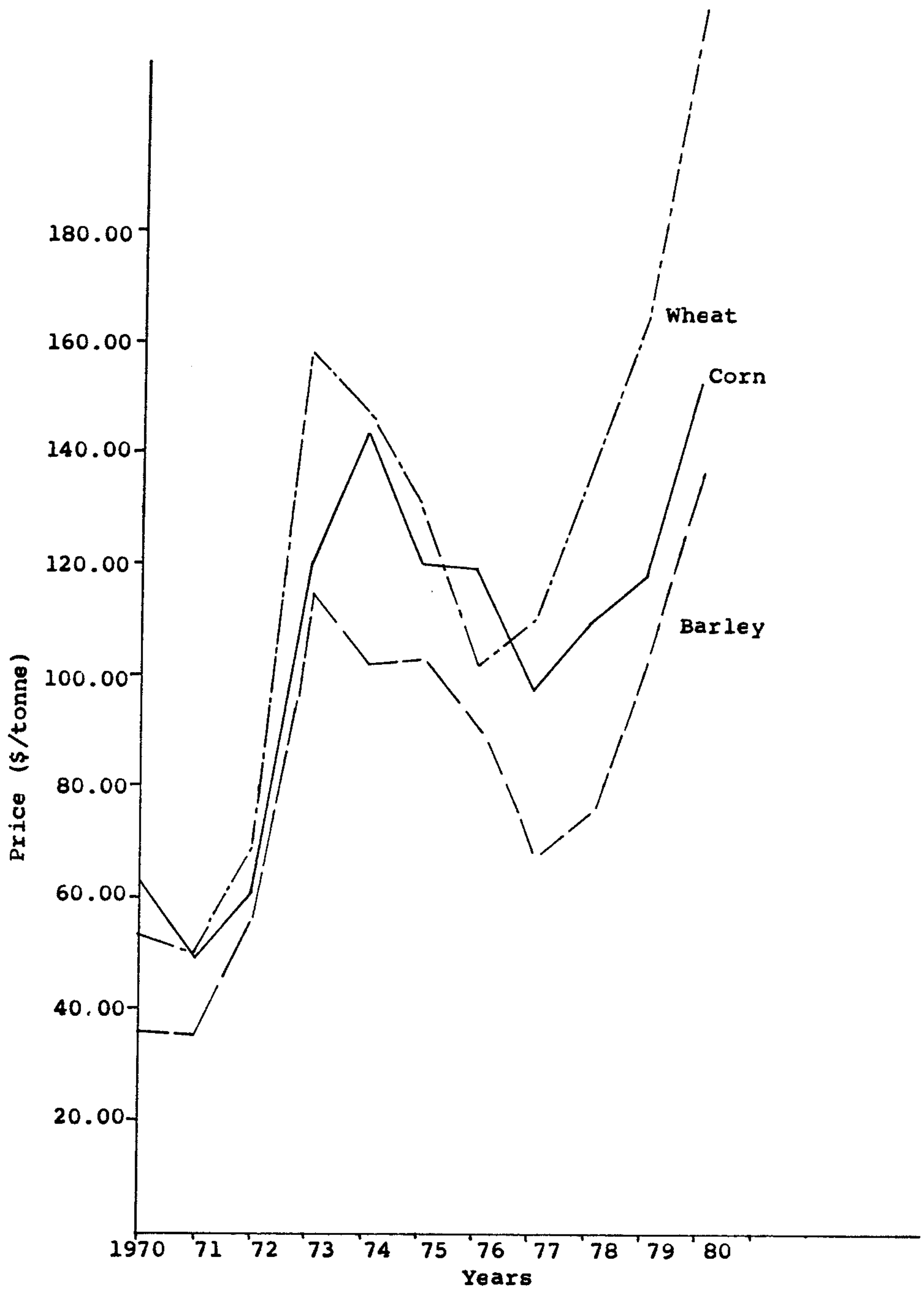

Figure 9

Price of Barley, Wheat and Corn Received by Manitoba Producers, 1970-1980

Source: Manitoba Department of Agriculture, Manitoba Agriculture, 1979 Yearbook, Queen's Printer, Winnipeg, Manitoba, 1979, pp. 51, 53 and 63.

Figure 10

Manitoba Pool Elevators, Monthly Average Corn Prices, 1977-1981

Source: See Table 3

There are two further methods that will be considered here to test for instability in corn prices. The first is the calculation of variances and standard deviations for the individual months based on daily price quotations. Table 5 and Figure 11 display the results. Comparing these standard deviations to a constant price, where the variability is zero there seems to be a significant divergence. Monthly standard deviations reaching highs of $5.60 (in May of 1978) meant that there was a 67 percent chance of the price ranging from $93.69/tonne to $104.85/tonne in that 30 day period. This seems to indicate further that there is in fact a great deal of instability in the daily prices quoted to producers. These very large fluctuations do not occur every month, but as seen in Figure 11 they are quite frequent.

There does appear to be some sort of pattern arising in the first two years of deviations. The spring-summer months seem to have the higher standard deviations, while the fall-winter months tend to be smaller. Such a pattern is, however, non-existent in 1980 where the apparent instability seems to begin in the summer and continue on until the end of the year. Therefore, as the deviations from the mean are greater than zero this suggests that there is in fact a daily instability in grain corn prices.

An extension of the previous discussion involves the examination of the annual standard deviations, (Table 6). These were calculated in the same manner as those above, except that they used the monthly averages. There are two series used for this analysis. One provided by Calvert distillery which are those prices quoted on the fifteenth of every month and the other are the monthly averages calculated from Manitoba Pool's

Table 5

Monthly Standard Deviations for Corn Prices, August 1977 to January 1981

	1977	1978	1979	1980	1981
January		1.4631	2.2479	2.2969	2.0429
February		.1947	.8633	1.8440	
March		3.5886	.8494	1.9038	
April		2.2894	3.3176	1.1250	
May		5.6018	1.5367	2.6294	
June		1.9464	5.4045	.9722	
July		3.2244	4.8941	4.5385	
August	1.0212	1.3436	1.4535	2.1844	
September	2.8020	.9224	1.3771	2.4526	
October	1.1604	1.5915	3.0711	5.1456	
November	.9166	1.1269	2.3410	2.2308	
December	2.3053	.9412	2.6167	4.9736	

Source: Calculated from daily prices quoted by Manitoba Pool Elevators. (Table A6 in Appendix A)

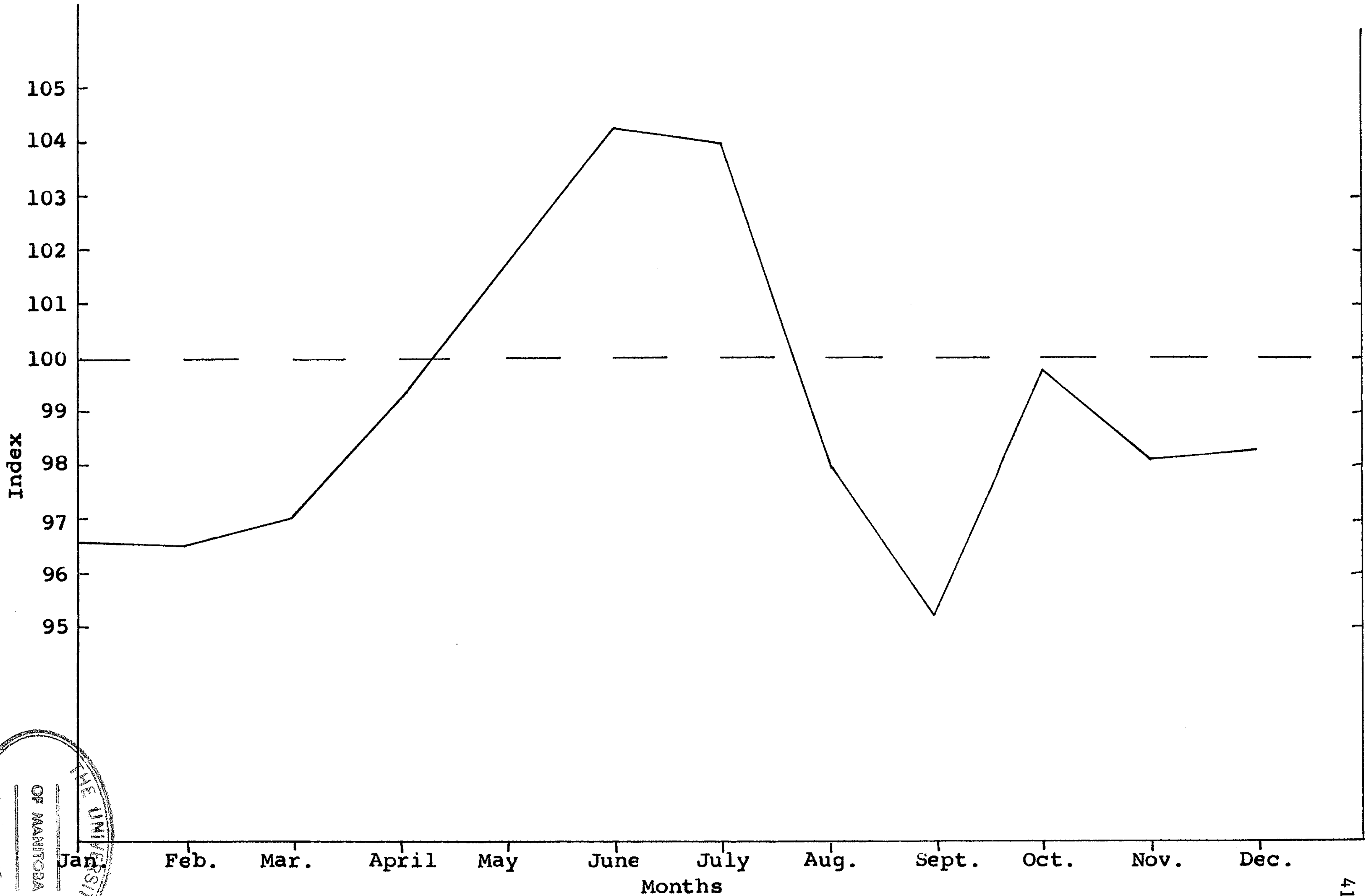

Figure 11
Seasonality Index
(Calculated for Prices From Jan. 1977 to Dec. 1980)

Table 6

Yearly Averages, Standard Deviations and Variance
for Corn Prices Quoted by: A) Calvert of Canada and B) Manitoba Pool

	1976	1977	1978	1979	1980	1981
A. Distillery Prices[a]						
N	4	8	6	12	11	1
$\bar{X}$	118.86	110.46	107.82	127.15	151.79	178.76
Var.	58.9425	82.6329	3.5344	115.1733	343.2768	
SD	8.8651	9.7179	2.0594	11.2091	19.4320	
B. Manitoba Pool[b]						
N		5	12	12	12	
$\bar{X}$		77.36	91.60	107.65	123.71	
Var.		3.1603	30.1748	56.4765	285.92	
SD		1.9875	5.7374	7.8493	17.66	

[a] Table 2

[b] Table 3

daily quotations. Both of these annual series display standard deviations that are often far greater than those determined for daily prices. This is to be expected considering the daily limits placed on the open market pricing mechanism from which the daily prices are derived. Also indicated are the ranges in prices that exist throughout the selling year, which is a very important consideration for producers trying to decide when to sell his crop. There is another point of interest that arises upon closer examination of Table 6. While it was not clear from the monthly standard deviations, the magnitude of the deviation appears to have increased over the last four years. Again the importance of such a prospect will become clearer later in the discussion of price stability. It will suffice to conclude here that there is instability in prices, both on a daily and monthly basis.

2.5 AMERICAN IMPORTS

Table 7 reports the tonnage of corn that has moved over the U.S.-Canadian border in the last 10 years. The early seventies experienced fairly low levels of imports, averaging about 35,000 tonnes in the first three years of the seventies. The year 1973 marked the first increase in movement to approximately 79,000 tonnes and then during the next three years over double that quantity moved into Canada. This can be explained by two factors. The first becomes evident when the price trends are examined for those years (Figure 12). Wheat prices reached an all time high during 1973 and remained relatively high for the next two years. Such prices would induce producers to increase their wheat acreage, likely at expense of the feed grains and cash crops. Both

Table 7

Imports of U.S. Corn and Livestock on Farms, 1970-1980

Year	Imports of[a] U.S. Corn Into Western Canada (tonnes)	Cattle on[b] Farms July 1 (000 head)	Hogs on[b] Farms July 1 (000 head)
1970	40,491	7,536.0	3,512.0
1971	35,598	8,057.0	3,845.6
1972	45,180	8,539.0	3,367.6
1973	78,874	8,998.0	3,426.2
1974	158,944	9,845.0	2,997.7
1975	131,135	10,177.0	2,001.3
1976	167,345	9,934.0	2,066.3
1977	97,330	9,492.0	2,155.0
1978	61,429	8,809.0	2,249.0
1979	77,857	8,736.5	2,701.5
1980		8,775.5	2,953.0

Sources: [a]Figures obtained from confidential Statistics Canada file.

[b]Canada Grains Council, Canadian Grains Industry, Statistical Handbook '80, Canada Grains Council, Winnipeg, Manitoba, 1980, p. 207 and 208.

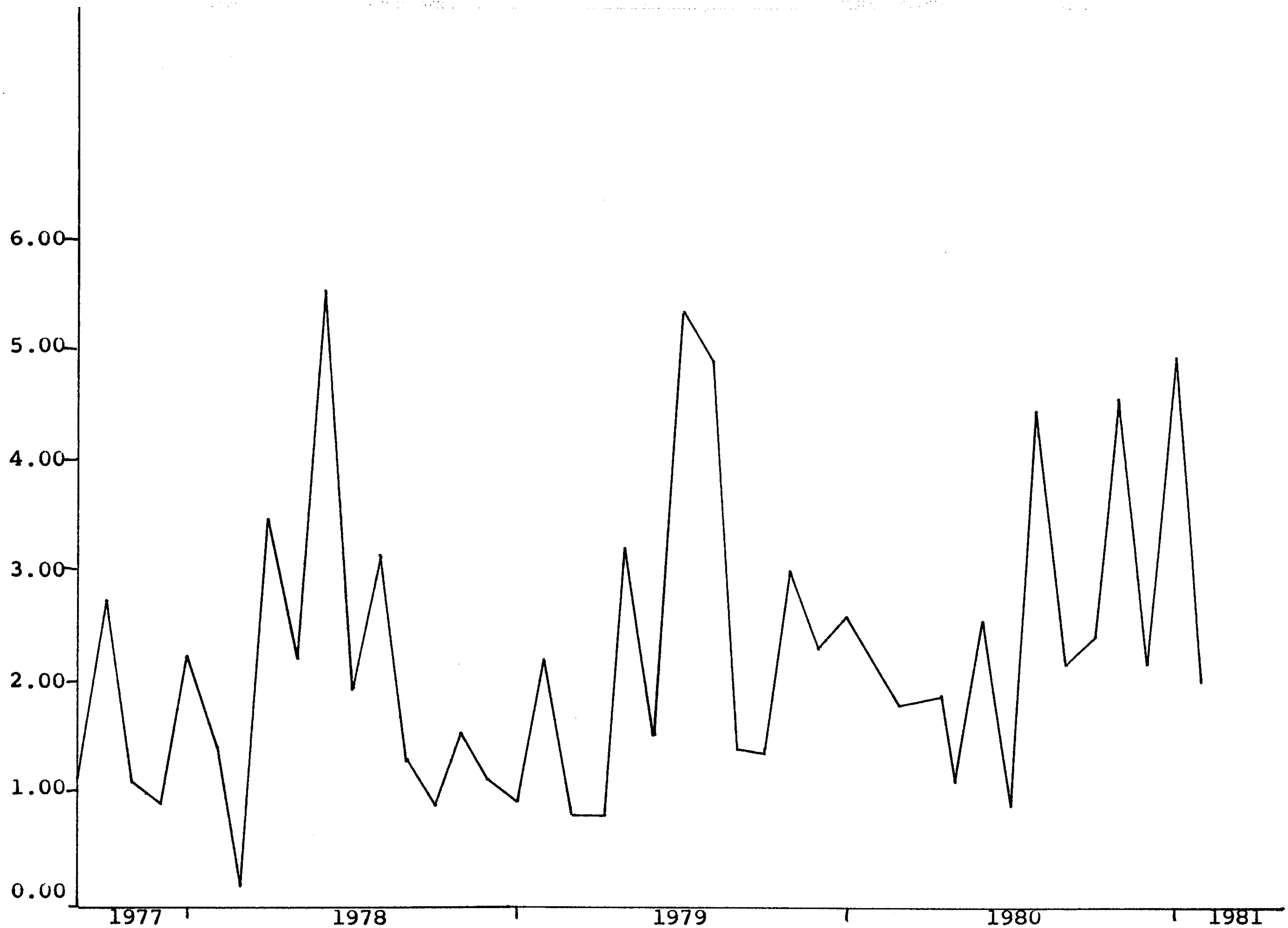

Figure 12
Monthly Standard Deviations for Corn Prices, August 1977 to January 1981

Source: See Table 5.

Figures 5 and 6 indicate that this was in fact the case. With the acreage of barley at such a low level it was necessary to import larger quantities of grain corn from the U.S. to fulfill the feed requirements. The second explanation for the large level of imports during the 1973-1975 period, is the expansion of the livestock industry at that time. Table 7 also shows how the number of cattle in western Canada increased by over 2,000,000 million head from 1971 to 1975. This increase in livestock numbers, in addition to low feed grain production accounts for the high levels of corn imports from the United States in those years. This area of imports warrants more serious investigation, but there are problems encountered when attempts are made to breakdown these values much further.

2.6 DOMESTIC FEED GRAINS POLICY

The domestic feed grains industry represents the largest single customer for the cereal grains produced in Canada as is exemplified in Figure 13. It has accounted for 12, 56 and 92 percent respectively of the total wheat, barley and oat disposition. Earlier days in the development of the livestock industry across Canada, feed grain was obtained largely from on-farm supplies, supplemented perhaps by nearby producer's surpluses. The surplus production levels experienced by prairie producers in the sixties, however, led to depressed feed grain prices in the West and with them, reduced feed costs. Consequently, lower prices for meat were available in and from western Canada.[35] Conversely, in the

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[35] See A.G.Wilson,"An Assessment of the Present Feed Grain Marketing Policy in Canada," Paper prepared for the 6th Annual Meeting of the Canada Grains Council, Oct. 1975.

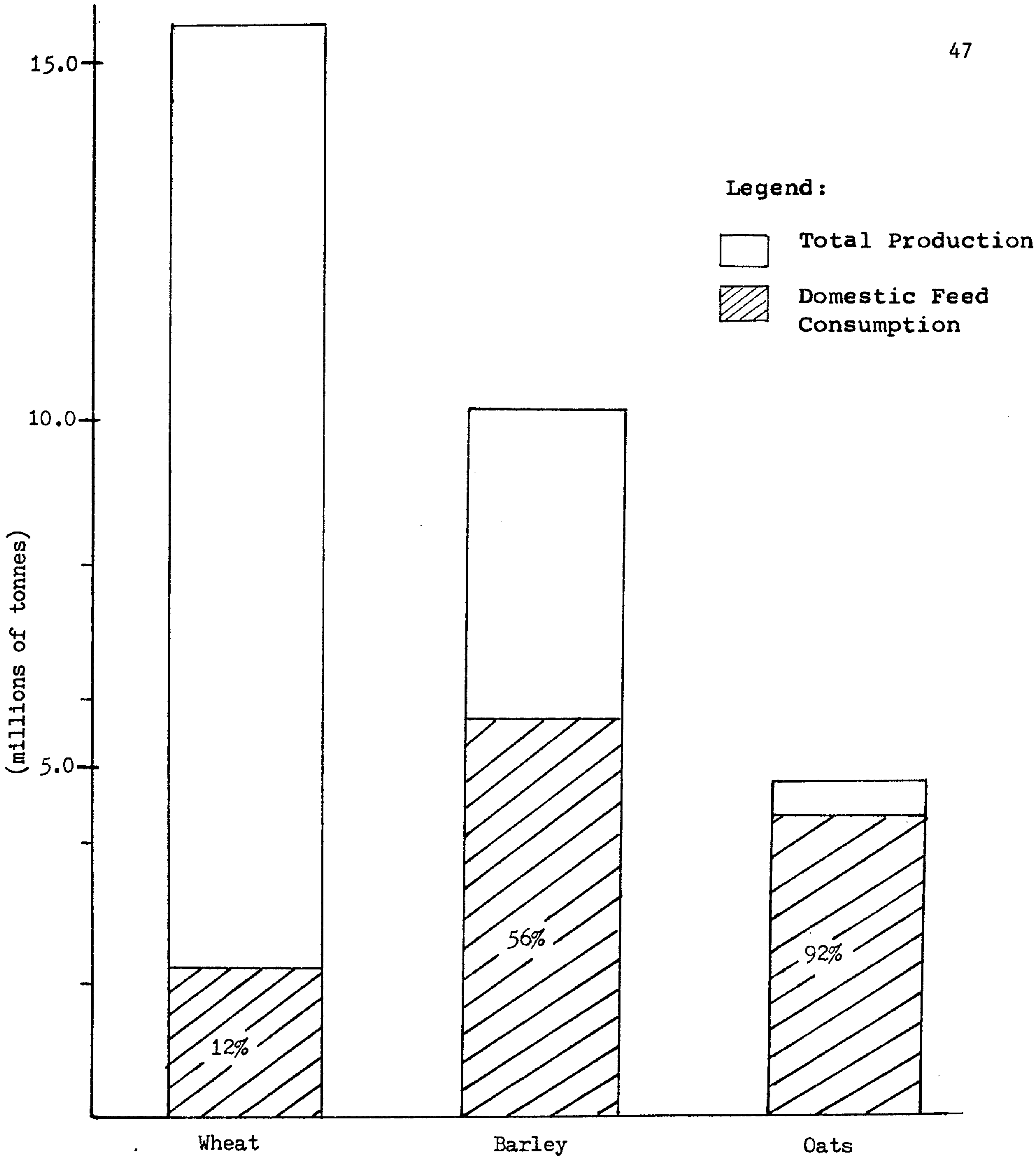

Figure 13

10-Year Average Feed Grain Consumption of Wheat, Oats and Barley Compared to Production 1968/69 - 1978/79

Source: Canada Grains Council, Canadian Grains Industry Statistical Handbook '80, Canada Grains Council, Winnipeg Manitoba, 1980.

East prices remained high, and eastern livestock producers were unable to obtain the low cost feed supplies that were available to their western counterparts. This disparity led to demands by eastern feeders to rectify this situation and establish a more "equitable" arrangement across the country. It is the attempt to achieve such a goal that has been subject of much debate in the past decade and has led to the formulation of the Domestic Feed Grain Policy that exists today. This section will briefly describe the policies that have been implemented since 1970 and discuss the present status of the Domestic Feed Grains Policy.

The two major coarse grains, barley and oats, came under the jurisdiction of the Canadian Wheat Board in 1948. From that date until 1973, the Wheat Board was the sole outlet for feed grain grown in the designated area.[36] Similarly, the Board became the exclusive supplier of prairie feed grains to eastern livestock operators.

The price quoted by the Canadian Wheat Board to eastern feeders was that set according to the international market, which was influenced to a large extent by American corn and soymeal supplies. The deliveries to this market were closely regulated by the Board's quota system and often presented difficulties to western grain producers. Rather than waiting for quotas to increase, prairie grain farmers would often have to sell their coarse grains to the local market at depressed prices.[37] The differential existing between local prairie feed grain prices and those

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[36] Designated area refers to the area in western Canada in which the Canadian Wheat Board is the sole purchaser of wheat, oats and barley for export purposes. The area is comprised of all of Manitoba, Saskatchewan, Alberta and a small area in the Peace River district of British Columbia.

[37] Wilson, "An Assessment of the Present Feed Grain Marketing Policy in Canada," op. cit.

quoted to eastern feeders by the Canadian Wheat Board widened to such an extent in the late sixties and early seventies, that eastern pressures began to mount to rectify these disparities.

Western producers also had complaints regarding the existing policy. In addition to the depressed prices which were received for grain sold to local markets:

> ... the present system insulated the prairie feed grain producer from his market place and rendered the individual grower incapable of making correct production plans to satisfy market requirements in the future.[38]

The inability of this program to satisfy the needs of livestock feeders and grain producers led to the development of a feed grains policy known as the Interim Policy. This policy, which was initiated in August 1973, was a transitional policy which would aid the introduction of a more comprehensive national feed grains policy that was to be introduced in 1974. There were two new features of the new policy. The first allowed free interprovincial movement of coarse grains within the designated area representing a new outlet for western grain producers. The second innovation provided for the development of a purchase and storage program underwhich:

> ...the Agricultural Products Board was to offer to purchase off-Board[39] feed grains from producers at a price initially mid-way between the initial price for Board grains and the expected final return.[40]

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[38] E.F. Marritt, <u>An Assessment of the Canadian Feed Grains Market</u>, Canada Grains Council, 1970, p. 20.

[39] Off-Board refers to wheat, oats and barley sold directly to feed mills or feed lot operators in the prairie region by grain producers.

[40] Government of Canada, <u>Domestic Feed Grains Plan and Proposals</u>, in Canada Grain Council's, <u>Domestic Feed Grain Policy Study</u>, October 1979, p. 16.

This plan was to alleviate the need of prairie grain producers, because of cash flow problems, to sell to local markets at depressed prices. This monitored price, which was determined every two weeks, set a floor price on prairie coarse grains in accordance with the Canadian Wheat Board's initial price and, hopefully, stabilized, to some degree, these non-Board prices.

The inability of the formula price to maintain a competitive position in regards to the American price rendered the Interim Policy a disappointment. In addition to the particularly unstable world conditions present during this period, the policy did not insure that the established price was less than the United States price of corn. While

> the formula itself provided for an 'equitable' basis for prices...in that transportation, handling and marketing costs were negotiated and written into the formula pricing policy...the basic price on which the formula was applied to obtain the C.W.B. selling price was not directly related to the competitive fair price.[41]

Furthermore, there was a

> lack of such an adjustment process to ensure that prices on the prairies would reflect corn competitive prices at Montreal in a period of rising price expectation and relatively unimpeded movement to market.[42]

As a result, grain backed up on the prairies and grain producers had to again resort to unloading their feed grain through local markets at depressed prices. In the East, the margins existing between American corn prices and those quoted by the Canadian Wheat Board to eastern livestock feeders for prairie grains caused a large inflow of American corn during

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[41] Food Prices Review Board, Feed Grains Policy in Canada, December 1975, pp. 9-10.

[42] Canada Grains Council, Domestic Feed Grain Policy Study, October 1979, p. 20.

this period.[43]

The Interim Policy was in effect until August of 1974, when a more permanent feed grain policy was defined. The objectives of the new policy were outlined by the Government of Canada as follows:

1. To provide a fair and equitable base price for feed grains across Canada. It was recognized that the costs of handling transportation and storage when added to the base price, will cause the final or end price to vary depending upon distance transported, length of storage time, handling and the like but the base price itself should be equitable across the country.

2. To provide relief for the producer against depressed feed grain prices such as occurred on the prairies in 1967 and 1969 when producers were forced by circumstance to sell feed grains at prices often below cost of production.

3. To encourage the growth of livestock and feed grains across Canada according to natural factors and the natural potential of the various regions of Canada.[44]

Achievement of these goals was formalized by the following program revisions. The major one was the transfer of responsibility of the handling and pricing of domestic feed grain from the Canadian Wheat Board to the hands of the private trade. Under this open market system the users of feed grain in eastern Canada will have access to western grain in the same manner as has feeders in the prairies and at prices determined by the Winnipeg Commodity Exchange.

There was concern, however that this policy might lead to congestion at certain times of the year. If such a case presented itself, the Interim Policy enabled the CWB and private trade to engage in grain

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[43] Canada Grains Council, Canadian Grains Industry Statistical Handbook '79, p. 111.

[44] Government of Canada, New Feed Grains Policy, May 22, 1974 in Canada Grain Council's Domestic Feed Grains Policy Study, October 1979, p. 22.

"switching"[45] to ensure supplies at a given time. In addition to this switching mechanism, the Canadian Government funded a storage program for up to 4 million tonnes at an annual cost of $40 million[46] to further ensure adequate supplies of feed grains for livestock producers in feed deficit areas.

There are three additional points arising in regards to this policy. The first was the agreement that some modification of the Feed Freight Assistance Policy[47] was required to ensure that the third objective, "growth according to natural factors," would be upheld. No changes, however, were made in 1974. The second point was the establishment of a grain stabilization fund for feed grains. This provision was a part of a larger CWB policy set up to provide relief for producers of all Board grains, in the way of a $15,000 cash advance if the need arose.[48] This would hopefully remove the necessity to sell grain at depressed price, should cash flow problems persist. The third point reinstated the option avaiable if a farmer chose not to sell to the open market, nor to a local market.[49] The Canadian Wheat Board still controlled export and non-feed markets of coarse grains and could also sell to the domestic

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45 Switching involves the paper exchange of non-Board grain in country elevators for Canadian Wheat Board grain of like kind and grade already in terminal position.

46 Canada Grains Council, October 1979, p. 25.

47 The Feed Freight Assistance program was initiated in 1942 and subsidizes feed grain movement from the surplus area in the prairie to the deficit areas in eastern Canada and British Columbia.

48 Canada Grains Council, October 1979, p.29.

49 The 1974 policy also removed the restrictions on the inter-provincial movement of feed grain in the designated area. Thus the local market now referred to the entire prairie provinces and the Peace River District of British Columbia.

market should the demand arise, therefore grain producers could deliver to the CWB if desired. The price offered by the Canadian Wheat Board in domestic markets was to be that determined "having regard to competitive price levels in the domestic export markets and in consultation with the Canadian Livestock Feed Board."[50] The intent from this, is to eliminate the problems that had arisen in earlier years when Canadian prices were higher than American prices and subsequently, imports increased.

Although the policy instituted in 1974 remedied many of the difficulties facing the domestic feed grain market, by August 1976, it was evident that further improvements were required. The first was the changes that would be made in the Feed Freight Assistance program. The subsidies were completely removed from grain moving from the prairies to points west of Montreal and in British Columbia, the rates were reduced by $4.40 per tonne.[51]

The second modification was the transfer of the reserve stocks to locations closer to the deficit areas. This made supplies available in selected cities with much the same release criteria as outlined previously by the policy. There were also provisions outlined for further expansions of the storage program at later dates. The federal government was to absorb the carrying charges on all reserve grain and they also made additional monies available for construction of new inland elevators.

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[50] Canada Grains Council, October 1979 p. 24.

[51] They were restored to their former levels in 1977. Ibid., p.25.

The third, and perhaps most controversial issue to discuss in regard to the modifications of the Domestic Feed Grains Policy in 1976, was the introduction of the "corn competitive pricing mechanism." While the 1974 policy merely stated that the Canadian Wheat Board would offer domestic feed grain at prices competitive with those for American corn, the 1976 specified the manner in which such could be accomplished.

> The purpose of the new pricing structure was to ensure that feed grains would always be available in Canada at prices tied to the cost of U.S. corn imported into eastern Canada.[52]

Briefly, the corn competitive price now sets the price of feed wheat, oats and barley according to their relative composition of energy and protein as compared to that of #3 United States corn and 49 percent soybean meal landed in Montreal.[53] This flexible pricing mechanism determines the price quoted by the Canadian Wheat Board to eastern feeders and feed mills.

The open market still exists as a market outlet and much of the domestic supplies move through this means. In fact, the corn competitive price operates largely as a ceiling price for the domestic market, with the majority of sales being carried out through the open market. Much of the time, the prices on the Commodity Exchange are below that set by the corn competitive pricing mechanism, indicating that Canadian feed grains have generally been underpriced compared with American corn.[54]

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[52] Ibid., p. 40.

[53] More detailed descriptions can be found in Canada Grains Council, Domestic Feed Grain Policy Study, October 1979, p. 40; H.G. Coffin, "Feed Grain Utilization and Pricing Formulas in Canada," Grain Facts, Vol. 8, No. 12, 1977, p. 4; P. Perkins, "New Feed Grain Pricing Mechanism," Grain Facts, Vol. 8, No. 2, 1976, p. 9.

[54] Canada Grains Council, October 1979 pp. 258-260.

While the tariff for American corn is not specified in the Feed Policy itself, it is an important factor in both the pricing of Canadian feed generally and the movement of Manitoba corn west more specifically. The tariff level was reduced from $3.15/tonne to $1.97/tonne in the summer of 1979 as a result of the GATT negotiations. It is added on directly to the price of United States corn landed in Montreal when calculating the corn competitive prices. It is also included in the price determined by the Manitoba Corn Growers Association for Manitoba corn. The inclusion of the $1.97/tonne ($.05/bushel) import tariff allows producers additional income over that which would be obtained under no trade restrictions. The concern is that if this tariff was reduced further or even removed entirely, would it still be economically feasible to produce corn on the prairies competitive with American corn.

The Domestic Feed Grain Policy does not at present have any jurisdiction over corn grown in Manitoba other than its qualification for Feed Freight Assistance. Where it is of concern for corn producers, is its possible interference in the establishment of a price that is competitive with American corn. While the corn competitive price was in fact designed to ensure competitive pricing, little of the domestic feed supplies are priced or delivered to this market.[55] The price determining mechanism operating in the open market, however, may establish somewhat distorted prices because of institutional factors interfering with its operation. In a study done by the Canada Grains Council in 1979, it is shown that the corn competitive price is usually above that determined

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[55] Canadian Wheat Board, <u>The Canadian Wheat Board Annual Report, 1979/80</u>, Winnipeg, Manitoba, 1981, pp.54 and Table VI in Addenda Statistical Tables.

on the Winnipeg Commodity Exchange. This indicates that these grains are generally underpriced if compared to their nutritional value relative to corn. This results in a greater demand for feed wheat, oats and barley because of the lower price. As Manitoba corn prices are based on the price of United States corn it will theoretically be overpriced when compared to Canadian feed grains. The logical conclusion from this is that corn is losing markets because of the comparatively low prices existing for the other feed grains. It is important to point out, however, that all grain corn produced in Manitoba in the past few years has been marketed in the current year, with no surplus carrying over to the following season.[56]

The fact that price differentials have existed between the Canadian Wheat Board price and exchange price, has led to criticisms of the present Domestic Feed Grain Policy. Other difficulties have also arisen. Misuse of grain switching led to its suspension in 1978. It was later reinstated, but only at reduced levels. Congestion of handling facilities has led to the initiation of combined quotas on the deliveries of wheat, oats and barley to the Canadian Wheat Board and to open market. In one recent study, it was stated that the present policy has cost prairie grain producers $142,000,000, (between August 1976 and July 1979), because of the differentials existing between open market and corn competitive prices.[57] The result is the continuing discussions on

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56 The year 1979 was an exception to this trend. The wet spring in that year caused a lower quality crop than had been the case in most other years. There was consequently some difficulty in marketing the lower quality corn.

57 Saskatchewan Natural Products Marketing Council, The Domestic Feed Grain Market Performance: 1976 to 1979, 1979, p. 2.

the future of the Domestic Feed Grain Policy.

2.7 BRITISH COLUMBIAN FEED INDUSTRY

The above discussion on the policies governing the feed grains industry, enables a better understanding of the British Columbian market specifically. This market is of major concern because a large quantity of grain corn grown in Manitoba moves to this area.

The consuming areas of feed grain in British Columbia are concentrated in the southern mainland. Particularly, the Fraser Valley and Vancouver Island. Supplies move to this market from the Peace River District of British Columbia, Alberta, the United States and from Manitoba. These shipments from out-of-province have played an important role in the expansion of the British Columbian livestock industry. British Columbia is a feed grain deficit area and without supplies from Alberta, United States, and Manitoba, their meat production would decrease substantially. This would mean importing meat from either the United States or other parts of Canada. All of the feed grain moving to the southern mainland from Canadian points, however, qualify for Feed Freight Assistance,[58] so British Columbia livestock operators can readily obtain lower cost feeds. This means lower meat price for British Columbia consumers than would otherwise be the case if meat was imported to the area.

The data available for the quantities of grain moved to B.C. under Feed Freight Assistance is limited and Table 8 provides the values available. While these figures imply that there have been significant

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[58] Feed Freight Assistance from Carman, Manitoba to Chilliwack, British Columbia amounts to $11.42 per tonne.

increases in grain moved to B.C. under the Assistance Program, one must be careful about drawing any definite conclusions. It was not possible to obtain a breakdown of this grain quantity moved and one can only assume that a large proportion of this figure was in fact corn.

Table 8

Freight Assisted Shipments of Feed to B.C.,1970-1979

Years	Freight Assisted Shipments of Feed into B.C. (tonnes)
1970	2,200
1971	2,300
1972	800
1973	400
1974	...
1975	...
1976	...
1977	6,300
1978	20,300
1979	29,500

... not significant

Source: Canada Grains Council, Canadian Grains Industry Statistical Handbook 80', Canada Grains Council, Winnipeg, Manitoba, 1980, p.200.

The fact that feed grains do move at a lower cost than finished livestock, has been cause for much concern for prairie livestock producers. This seems to conflict with one of the objectives of the Domestic Feed Grains Policy, "to encourage the growth of livestock and feed grains...according to natural factors." As the prairies are a grain surplus area and British Columbia a deficit region, it would seem to suggest that there is a comparative advantage for raising livestock in the prairie provinces. The presence of a transportation subsidy on feed grains and not livestock appears to distort this natural advantage. The same problem presents itself in the east and is even further intensified because of the presence of the Crow benefit as well. While Feed Freight Assistance has been removed for grain moving to points west of Montreal, all grain traveling to Thunder Bay qualifies for statutory rail rates. The fact that the Crow's Rates do not apply in the movement of feed grain to the British Columbia interior does, however, enable trucking to be competitive with rail as both qualify equally for the Feed Freight Assistance subsidy. Manitoba corn has in the past moved both by rail and truck. This trucking option is useful for Manitoba corn growers because it enables competitive transport by trucks without the delivery restrictions found on rail moved grains. The result is improved delivery to the B.C. mills which enhances the marketability of Manitoba corn.

As described previously, under the present feed grains policy, coarse grains are usually priced in one of three ways: corn competitive, futures, and off-Board pricing. As grain corn does not come under the jurisdiction of the Canadian Wheat Board nor is it traded on the WCE, it is priced through a negotiation process between B.C. buyers and Manitoba sellers. The formation of the Manitoba Corn Growers Association enabled Manitoba corn producers to use collective action in this negotiation process. In doing so, they could guarantee supplies and in turn demand equitable prices from the B.C. mills. Although the Association does not have a specific price formula they do have the following guidelines:

> The Minneapolis cash price for Number 2 yellow corn plus exchange, freight, tariff and brokerage to Winnipeg.[59]

While such a system appears to be functioning adequately at present, with the predicted production increases, it may be necessary to develop a pricing mechanism more in line with that used for the other feed grains.

2.8 ONTARIO CORN MARKETING

Quebec, and more particularly Ontario, in the late 60's and early 70's depicted a situation similar to that presently being experienced in Manitoba today. Corn production levels were increasing dramatically, due to both improvements in yield and increases in acreage, and there was the desire to improve the marketing and pricing systems to handle the increased volumes. This is the case today in Manitoba, and producers in this area are raising the same types of concerns that their eastern counterparts did 10 years ago:

> Grain corn production has increased rapidly in Ontario but little development has occurred in the marketing system. Ontario corn prices are closely related to United States corn prices but potential exists for the creation by Ontario corn producers of a marketing system which could stabilize corn prices and improve the level of income derived from corn without resorting to excessive trade restrictive practices.[60]

In 1969, when the above statement was made, the corn pricing mechanism was basically the following:

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[59] D. Wilkins, "Tapping the Western Corn Market," Country Guide, July 1979, p. 24.

[60] G.C. Pearson, "Grain Corn and Orderly Marketing," Canadian Farm Economics, Vol. 14, No. 2, June 1969, p. 1.

> Using Chicago future prices and taking into account transportation charges and exchange rates on American currency as well as local demand-supply conditions, grain brokers, dealers and processors make daily bids to local elevators for their cash grain. The local elevator then chooses the best bid, from which it deducts its margin. The best bid minus the margin is the price the country elevator quotes to growers that day.[61]

There has been some modification of this pricing mechanism since that date that can be largely attributed to the efforts of a corn growers marketing agency. While western Canadian feed grains come under the jurisdiction of the Domestic Feed Grains Policy, those grains grown in the East are largely free from regulation. The Association of Ontario Corn Growers now quotes a price of Chatham corn, plus the $1.97/tonne tariff that would be paid on American corn, plus agency marketing costs. In a recent study by Martin, Groenewegen and Pidgeon, three factors affecting this price stand out as the most important:

> ...the land locked location of the Chatham market, variations in the local supply-demand balance, and competition with U.S. corn.[62]

They go further to explain that these three factors result in three alternative price and basis scenarios. Without going into detail on each of these points the conclusion was that:

> ...the southwestern Ontario price falls relative to the price of U.S. corn as the point of competition moves eastward...[63]

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61 A.G. Sorflaten, The Country Grain Elevator Industry In Ontario, Part 1, Farm Economics, Co-operatives and Statistics Branch, Ontario Department of Agriculture and Food, Toronto, 1969, p. 38, in G.C. Pearson, "Grain Corn and Orderly Marketing," C.F.E., Vol. 14, No. 2, p. 3.

62 L. Martin, J.L. Groenewegen, and E. Pidgeon, "Factors Affecting Corn Basis in Southwestern Ontario," A.J.A.E., Vol. 62, No. 1, Feb. 1980, p.107.

63 Ibid., p. 107.

from Ontario through to Quebec and the Maritimes and finally into an export situation. This indicates the importance of local supply and demand of corn in price determination in Ontario, a factor that does not prove to be of major importance for Manitoba prices.

Ontario corn, like Manitoba corn, qualifies for Feed Freight Assistance, but only available, on movements of corn to points east of Montreal.

While the eastern market differs from the British Columbia market in some respects, much can be learned from their experiences, particularly in regard to the developments in an effective and orderly pricing and marketing system.

2.9 SUMMARY

As outlined in objective one, it was the purpose of this chapter to provide some insight into the nature of the Manitoba grain corn industry. After an examination of some of the characteristics of the Manitoba grain corn industry, several pertinent points arose. First, from a technical standpoint there is room for considerable expansion in corn acreage even with present technology. More importantly perhaps, is the fact that there is equally as great a demand for the commodity. In fact, under certain price conditions potential demand greatly exceeds that of potential supply.

Several other points that become evident upon examination of the Manitoba market include the evidence that producers consider corn a cash crop and therefore follow much of the same production patterns as rapeseed, flaxseed and the other speciality crops. However, these production trends to date do not display the extreme supply adjustments characteristic of flaxseed and rapeseed. As far as price was considered, it was shown that prices follow very closely those quoted on the Chicago Board of Trade and in doing so, display the fairly variable prices characteristic of such a pricing mechanism.

The Domestic Feed Grains Policy, which presently operates for wheat, barley and oats, outlines for the marketing and pricing of these coarse grains in one of three ways. The simplist, is the producer to feedlot operator sale for a negotiated price. Feed grains can also be sold on quota to the Canadian Wheat Board for the initial price set by the Board. The grains marketed in this manner are either exported or sold to eastern or B.C. feed mills for a 'corn competitive' price determined daily by the Board. The Winnipeg Commodity Exchange also prices feed grains, and producers have the option of marketing their grain in this manner. This usually involves delivery of the Non-Board feed grain to primary elevators for the quoted street price, but also allows producers to sell contracts on their crop and arrange for delivery independently.

Corn is presently priced and marketed in one of four ways. The first involves the simple producer to producer transaction with negotiated price. The second enables the producer to deliver to his primary elevator, for a daily price quoted by the elevator company. This price is derived from the Chicago Board of Trade. Option number three is of particular interest as it involves the B.C. feed industry as a possible outlet for corn. Producers can, either individually or as a part of the Manitoba Corn Growers Marketing Association, sell their crop to various feed mills usually in Manitoba, Alberta or B.C. These mills also quote prices based from Chicago. The prices, however, will vary between companies depending on the exchange differential and/or tariff benefit passed on to producers. The fourth outlet for corn involves the distillery at Gimli, Manitoba. Calvert of Canada requires 50,800 tonnes of high quality corn annually. If Manitoba producers are able to satisfy the specifications, they receive a price quoted on the fifteenth of every month which is also derived from the Chicago Board of Trade.

While the problem arising from the discussions in Chapter two is very broad and overwhelming, it raises some questions that might be dealt with more specifically. For instance, what kind of market structure is best suited to meet the needs of this growing and complex industry? In an attempt to answer even this fairly general question, an analytical tool was chosen to deal with one facet of concern. As described previously, price stability and its effect on producer gains, was chosen for empirical analysis in this thesis. This will hopefully provide some aid in the evaluation of marketing alternatives.

Chapter III

THEORETICAL FORMULATION

The inquiry into the possible marketing mechanisms for grain corn can be approached in several ways. The possibilities range from a purely descriptive treatment, to that of a highly complex simulation of comparative grain flows through various marketing channels. While this thesis presented a detailed descriptive analysis as well, the empirical technique to be used will be that, developed by Schmitz et al.[64] It is the purpose of this chapter to examine the proposition set forth by Schmitz et al. and to review the theoretical expectations for the parameters required for the analysis. They maintain that a firm, (or in this case an agricultural producer), will prefer stable or unstable prices depending on its aversion to taking risk,the contribution to total income provided by good X, the profitability of good X, and the production sensitivity displayed by the manager in response to changes in price. By applying the theorem proposed by Schmitz et al., under a range of simulated conditions for each of the four factors, it will be possible to draw some conclusions about the desirability of price stability. From these results it will then be possible to speculate about how grain corn should be marketed in order to achieve the preferred level of price stablitiy.

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64 Schmitz, Shalit, and Turnovsky, op. cit.,pp.157-160.

3.1 CONCEPTUAL FRAMEWORK

A detailed account of the literature related to the theory of producer welfare and price stability can be found in Appendix B. It provides much of the ground work for the subsequent discussion of the Schmitz et al., proposition. In an attempt to extend the discussion still further, Schmitz et al., put forth several new propositions. More particularly they utilize Tisdell's recent contributions which first examine stability in input prices and second consider the question of the effect of price instability on a multi-product firm.[65] The objective of the Schmitz et al., paper was:

> ...to explore further the welfare implications of price instability for a multi-product firm to determine whether or not a theoretical argument can be made for why a firm engaged in production of more than one type of commodity may prefer price stability for some of the commodities it produces but not for the entire set.[66]

Schmitz et al., develop an algebraic relationship that shows that the welfare gains from price stability depends on several factors. Through isolation of these factors for the case of grain corn, it will be possible to explore whether price stability or instability would make producers better off.

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[65] C. Tisdell, "Extension of Oi's Price Instability Theorem," Journal of Economic Theory, Vol. 17, Feb. 1978, pp.130-133.

[66] Schmitz, Shalit, and Turnovsky, op. cit., p. 157.

[67] W.Y. Oi.,"The Desirability of Price Stability Under Perfect Competetion," A.J.A.E., Vol.50, No.2, May 1968, pp.257-277.

[68] C.Tisdell, "Price Instability and Average Profit," Oxford Economic Papers, Vol.22, 1970, pp.1-12.

While Oi[67] and Tisdell[68] held that price alone could be considered the relevant measure for determination of producer surplus, others like Zucker[69] considered that total revenue would be a better assessment. Schmitz et al., argue that because the type of producers considered in their paper, (agricultural producers), are price takers, Oi and Tisdell's measurement will suffice. They also maintain, that these producers are generally small decision making units which will likely have non-neutral attitudes towards risk. To incorporate this concept into the analysis Schmitz et al., utilize the procedure developed by Sandmo and Leland.[70] More specifically, a utility function of profits will be used to assess the gains and losses accruing from price stabilization.

While the hypothesis presented by Schmitz et al., is discussed in terms of both the single and multi-product firm, for both output and input prices, this study will only pursue the discussions on output prices.

Before proceeding with the discussion on the multi-product firm, consider first the simpler case of the single product firm. As mentioned previously the firm chooses to maximize its expected utility from profits $E[U(\pi)]$. The utility function is assumed to be a von Neumann-Morgenstern function that is twice differentiable. The first differential of the utility function is assumed to be greater than zero reflecting the positive, marginal utility of profit. The second differential,

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69 A. Zucker, "On the Desirability of Price Instability: An Extension of the Discussion," Econometrica, Vol.33, No.2, April 1965, pp.437-441.

70 A. Sandmo, "On the Theory of the Competitive Firm Under Price Uncertainty," A.E.R., Vol.61, No.1, March 1971, pp.54-73; H.E. Leland, "Theory of the Firm Facing Uncertain Demand," A.E.R., Vol.62, No.2, June 1972, pp.278-291.

$U''(\pi)$, which represents the rate of change of the marginal utility can be either positive, or negative depending upon the risk preference of the individual firm.

The profit being referred to is derived from the concave production function.

$$(1)\ y = f(x_1, \ldots x_n) \qquad f_i > 0,\ f_{ii} < 0,\ i = 1, \ldots n$$

where $x = x_i, \ldots x_n$ is a vector of inputs and y is the sole output. The input and output prices are represented by $w = (w_1, \ldots w_n)$ and p, respectively. Schmitz et al., specify explicity that these prices are "assumed to be random variables with known probability distributions having means $E(w_i) = \bar{w}_i$ and $E(p) = \bar{p}$, and a finite variance-covariance matrix."[71] They make one further assumption before proceeding with their analysis, to maintain that the firm's decisions are always made ex post and adjustments are possible when prices change. To facilitate the practical application of this theorem it is assumed that these adjustments can include the quantity of a good placed on the market as well as the actual quantity produced.

Given the assumptions stated above, Schmitz et al., work through the following optimization problem in order to obtain the desired relationship.

$$(2)\ \text{Max } U(\pi)$$

$$\text{subject to } \pi = pf(x) - \sum_{i=1}^{n} W_i X_i$$

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71 Ibid., p. 4.

By setting the first differential equal to zero, the first order conditions are obtained:

$$(3)\ U'[pf_i(x) - w_i] = 0$$

or simply

$$(3')\ pf_i(x) - w_i = 0$$

The sufficient conditions for a maximum require that the second differential be negative. These conditions are, however, implicitly satisfied through the concavity property of the production function. Next by solving (3′) the optimal values of inputs and outputs can be obtained.

$$(4)\quad \begin{aligned} x_i &= \phi^i\ (p,\ w_1, \ldots w_n) \\ y &= \Psi\ (p,\ w_1, \ldots w_n) \end{aligned}$$

Again from the concavity of the production function the following properties can be deduced:

$$(5)\quad \begin{aligned} &\frac{\delta x_i}{\delta w_i} < 0 \qquad\qquad i = 1, \ldots n \\ &\frac{\delta y}{\delta p} > 0 \end{aligned}$$

From here Schmitz et al., substitute (4) into π and the result is the firm's utility based on the optimal input and output levels.

$$(6)\ U[\pi] = U[p\Psi(p, w_1, \ldots w_n) - \Sigma\, w_i\, \theta^i\, (p, w_1, \ldots w_n)]$$

$$= V(p, w_1, \ldots w_n)$$

This V(p,w) function, which is an expression of the firm's utility resulting from the optimal output level, is then applied, using Jensen's inequality rule, to study the effects of stabilization. That is, EV(p,w) will be greater than or less than $V(\bar{p},\bar{w})$ as V is convex or concave, respectively. Consequently, the concavity properties of V(p,w) will determine the producer's welfare resulting from stabilization programs.

Two further steps are required before attaining the final algebraic expression that can be used for the analysis of stabilization. In compliance with Jensen's inequality the firm will lose from having p stabilized at its mean if $\frac{\delta^2 V}{\delta p^2} > 0$, and similarly will gain if $\frac{\delta^2 V}{\delta p^2} < 0$. The second derivative of V with respect to p will result in the relationship desired. The first derivative becomes

$$\frac{\delta V}{\delta p} = U' \cdot [y + \Sigma\, (pf_i \cdot w_i)\, \frac{\delta x_i}{\delta p}$$

(7)

$$= U'y$$

and the second derivative is

$$(8) \quad \frac{\delta^2 V}{\delta p^2} = U' \frac{\delta y}{\delta p} + U'' y^2$$

Schmitz et al., rewrite this expression in the following manner:[72]

$$(9) \quad \text{sgn}\left(\frac{\delta^2 V}{\delta p^2}\right) = \text{sgn}\left[\left(\frac{\mu}{1+\mu}\right)\varepsilon - r\right]$$

where

$r = \frac{-\pi U''}{U'}$ (Arrow-Pratt measure of relative risk aversion),

$\varepsilon = \frac{\delta y}{\delta p} \cdot \frac{p}{y}$ (price elasticity of supply, which by definition is positive),

$\mu = \frac{py - \sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i x_i}$ (profit margin, as measured by the profit to cost ratio).

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[72] The sgn symbol indicates that the function is signum where $\text{sgn}(x) = \frac{|x|}{x}$.

These three factors then, determine whether producers gain from stability or price instability. If producer are found to be risk neutral, r reduces to 0 and the criterion (9) will depend solely on the slope of the supply curve. If r is positive and the supply curve depicts its usual upward slope, producers gain from price instability. Similarly, if $r < 0$, indicating that producers are risk takers, they will gain from price instability. As producers become more risk averse, however, their gains from instability diminish. For the remaining parameters there is a direct relationship between the gains from instability and the size of both the elasticity of supply (ε) and the profit margin (μ). Schmitz et al., use the following example to illustrate their case: "If the firm's utility function is logarithmic so that $r = 1$ and the profit margin is, say, 20 percent so that $\mu = .2$, the preference for risk will apply if and only if the elasticity of supply is greater than 6."[73]

Having dealt with the simple case of the single product firm, Schmitz et al., develop the analogous argument for the multi-product firm. The only additional assumption required for this extension is that now, the firm is producing several outputs m, the prices of which are represented by $p = p_1 , .. p_m$ and are assumed to be random. The production process of the firm expands to include the additional outputs and becomes

$$(10)\ H(Y_1, \dots Y_m, X_1, \dots X_n) = 0$$

All the remaining assumptions, are the same as those stated for the case of the single product firm.

The optimization problem proceeds as follows:

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[73] Schmitz, Shalit, and Turnovsky, op. cit., p. 158.

$\text{Max } U(\pi)$

where

$$(11)\quad \pi = \sum_{j=1}^{m} P_j Y_j - \sum_{i=1}^{n} w_i x_i$$

The production process H, represents the constraining conditions and is applied using the Lagrangean multiplier λ. The result is the Lagrangean expression (12).

$$(12)\quad \mathcal{L} = U\left[\sum_{j=1}^{m} P_j Y_j - \sum_{i=1}^{n} w_i x_i\right] + H(Y_1, \ldots Y_m, X_1, \ldots X_n)$$

By differentiating with respect to x then y, and setting equal to zero, the first order conditions can be obtained:

$$(13a)\quad U'(\pi)\, P_j + \lambda H_j = 0 \qquad j = 1, \ldots m$$

$$(13b)\quad -U'(\pi)\, w_i + \lambda H_{m+i} = 0 \qquad i = 1, \ldots n$$

where

$$H_j = \frac{\delta H}{\delta Y_i}(Y_1, \ldots Y_m, X_1, \ldots X_n)$$

$$H_{m+i} = \frac{\delta H}{\delta X_i}(Y_1, \ldots Y_m, X_1, \ldots X_n)$$

To satisfy the second order conditions, the principal minors of the following bordered Hessian matrix must alternate in sign.

$$(14) \quad \begin{bmatrix} U''(P,-w)\ (P,-w)^{1} + \lambda(H_{ij}) & h \\ h & 0 \end{bmatrix}$$

where

$$h = (H_1,\ldots H_m,\ H_{m+1},\ldots H_{m+n})$$

$$(P,-w) = (P_1,\ldots P_m,\ -W_1,\ldots -w_n)$$

and (H_{ij}) is the Hessian of H. The matrix (14) reduces to

$$(14') \quad \begin{bmatrix} \lambda(H_{ij}) & h \\ h & 0 \end{bmatrix}$$

and is completely independent of the utility function because all decisions are made <u>ex post</u>.

As in the single product firm, the necessary conditions provide some useful marginality relationships:

$$(15a)\quad \frac{w_i}{P_j} = \frac{-H_{m+i}}{H_j} = \frac{\delta Y_j}{\delta X_i} \qquad j = 1,\ldots m \quad i = 1,\ldots n$$

$$(15b)\quad \frac{P_j}{P_k} = \frac{H_j}{H_k} = \frac{\delta Y_k}{\delta Y_j} \qquad j, k = 1,\ldots m$$

$$(15c)\quad \frac{w_i}{w} = \frac{H_{m+i}}{H_{m+e}} \frac{-\delta X_e}{\delta X_i} \qquad i, e = 1,\ldots m$$

There are two additional relationships that evolve from the second order conditions.

$$(16a)\quad \frac{\delta Y_j}{\delta P_j} > 0 \qquad j = 1,\ldots m$$

$$(16b)\quad \frac{\delta X_i}{\delta w_i} < 0 \qquad i = 1,\ldots n$$

The relationship of importance here, is the first one (16a) which shows that if the price of the j^{th} product rose, there would be a corresponding increase in output j. Schmitz et al., show how these relationships imply that all cross-price derivatives are symmetric and yield the fol-

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[74] Ibid., p. 159.

lowing properties for the two matrices B, C:[74]

(17a) $B = \frac{\delta Y_i}{\delta P_i}$ is positive definite

(17b) $C = \frac{\delta X_i}{\delta w_j}$ is negative definite

Like those obtained for the single product firm, the optimal levels of output and input can be derived from the first order conditions:

$$(18)\quad X_i = \phi^i (p,w) \qquad i = 1, \ldots, m$$

$$Y_j = \Psi^j (p,w) \qquad j = 1, \ldots, n$$

Using these solutions in the profit function and then in the utility function, the firm's utility resulting from its optimal decisions can be obtained.

$$(19)\quad U[\pi] = U\left[\sum_{j=1}^{m} P_j \Psi^j (p, w) - \sum_{i=1}^{n} w_i \phi^i (p, w)\right]$$

$$= V(p_1, \ldots p_m, w_1, \ldots w_n)$$

This expression can then be used to provide the basis for analyzing the effect of price stabilization of either outputs or inputs. Only price stability of products will be considered here.

Schmitz et al., maintain that, assuming k commodity prices, $1 \leq k \leq m$ (taken for convenience to be commodities 1, ... k), are subject to stabilization, whether or not producers benefit from such a policy depends upon the convexity/concavity properties of V in terms of $p_1, \ldots p_k$ --the prices being stabilized.[75] This proposition is illustrated by the following matrix.

$$(20)\ A(k) = \left[\frac{\delta^2 V}{\delta p_i \, \delta p_j} \right] \qquad i, j = 1,\ldots k \quad 1 \leq k \leq m$$

If A(k) is found to be positive definite, the producers will gain from price instability. On the other hand producers will gain from stabilization if A(k) is negative definite. A third option exists for the A(k) matrix, that being neither positive nor negative definite. Under these circumstances nothing can be concluded about the gains or losses from stability.

To derive the actual elements of the A(k) matrix, it is necessary to take the second partial derivatives of equation (19) with respect to prices and using the first order optimality conditions (15). The A(k) matrix then becomes:

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[75] Ibid.

$$A(k) = \begin{bmatrix} U''Y_1^2 + U' \frac{Y_1}{P_1} & \cdots\cdots & U''Y_1Y_k + U'\frac{Y_1}{P_k} \\ \vdots & & \vdots \\ U''Y_1Y_k + U' \frac{Y_k}{P_1} & \cdots\cdots & U''Y_k^2 + U' \frac{Y_k}{P_k} \end{bmatrix}$$

and when simplified becomes

$$(21)\quad A(k) = U'[B(k)-ry(k)y(k)'/\pi] \qquad k=1,\ldots y_k$$

Three symbols which require explanation are; B(k) which is the first principal k x k minor of B: y(k) which equals $(y_1, \ldots y_k)$; and r which is again the coefficient of relative risk aversion. The authors conclude from this matrix that B(k) is positive definite while the matrix y(k)y(k) is positive semi definite.

While the matrix A(k) provides a general criterion through which to evaluate the price stability of any subset of output prices from 1 to k, in the case of only one price stabilized, A(k) can be reduced to an expression very similar to that described for the single product firm:

$$(22)\quad \text{sgn}\left(\frac{\delta^2 V}{\delta p_j^2}\right) = \text{sgn}\left[\left(\frac{\mu}{1+\mu}\right)\frac{\varepsilon_j}{\alpha_j} - r\right]$$

where:

$$\varepsilon_j = \frac{\delta Y_j}{\delta p_j} \cdot \frac{p_j}{Y_j}$$ (elasticity of supply of good j, with respect to its own price),

$$\alpha_j = \frac{P_j Y_j}{\sum_{j=1}^{m} P_j Y_j}$$ (share of total revenue contributed by good j),

with μ measuring the profit margin and r the relative aversion to risk as described for the single product firm.

3.2 APRIORI EXPECTATIONS

The relationships between profit margin and risk aversion and the gains from stability are the same as those described for the single product firm. As the relative risk aversion coefficient increases, illustrated by a larger numerical value, the gains from stability will increase. Conversely as the profit margin increases, the gains from stability will diminish. Schmitz et al., state that the gains from instability will increase as the price elasticity of supply increases. Why this proves to be the case becomes clear when Figure 14 is examined.

The supply curves in Figure 14 represent three degrees of elasticity. All have slopes less than 1 which is typical of agricultural commodities.[76] The demand curves are horizontal to exemplify the fact that the producers are price takers and have no effect on the price levels. D_0 indicates the first equilibrium level, and D_1 and D_2 illustrate a price increase and decrease of equal proportions. Instability is defined as two prices with an equal probability of occurrence, and stability refers to the arithmetic mean of those two prices. As elasticity increases so will the desire for price instability. It is evident from Figure 14 that the greater the elasticity, the greater is the increase in quantity supplied for a specific increase in price. Similarly, the greater the elasticity, the greater the decrease in quantity supplied for a specified decrease in price. To a producer this means that the greater the sensitivity to price fluctuations (i.e., the greater the elasticity) the greater is the ability or desire to take advantage of price fluctuations. That is, the ability to decrease the amount supplied to the market when prices are low and likewise increase the quantity supplied to the market when prices are high. Thus as elasticity increases, holding all other parameters constant, there will be a corresponding increase in the preference for risk.

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[76] It is assumed that although supply is constant for a given year, producers can chose to vary the quantity they supply to the market at any point in time and that this amount is directly related to the price.

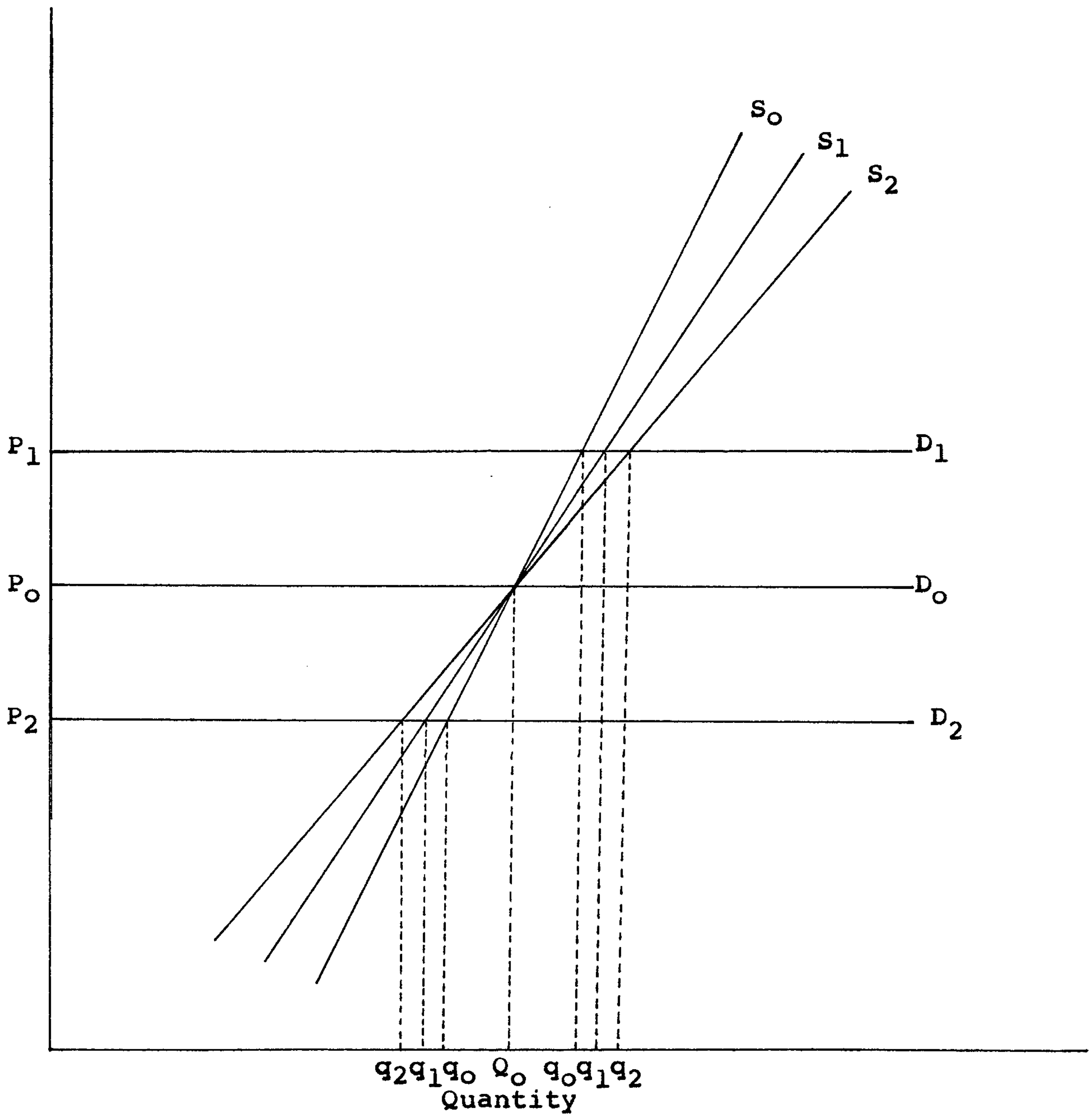

Figure 14

Expectations For Various Supply Curves

In addition to the elasticity, profit margin and risk preference, the multi-product firm must also consider the contribution to total revenue provided by the commodity of concern. Schmitz et al., conclude that "the [multi-product] firm is more likely to prefer price instability in those products which contribute a relatively small proportion of its total revenue...[and therefore]...a risk-averse firm may prefer instability in some of the markets for its products and not in others."[77] Holding the values of the other parameters constant, there will come a critical point at which the contribution to total farm income is high enough so as to produce gains from stability. This critical point will vary depending on the values of the other parameters, but as α increases there will always be a point at which the transition will occur.

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77 Ibid.

Chapter IV

MODEL SPECIFICATION

As stated previously one of the objectives of this study is to examine the possible marketing alternatives for grain corn grown in Manitoba. While the types of marketing systems can be categorized in several ways (controlling party, degree of regulation, etc.) price stability and its effect on producer welfare was used in this analysis as the evaluation criterion. The type of pricing condition (stable or unstable) which would provide the greatest gains to corn producers can be arrived at through the described technique, regardless of the marketing systems that could be associated to either condition. Upon determination of the type of price condition best suited to corn growers, (based on the elasticity of supply, aversion to risk, profit margin and contribution to total revenue) only then, would it be possible to suggest a marketing system that would provide such a price.

While the mathematical formulation of the Schmitz et al., theorem was described in detail in the previous chapter, it remains to be shown precisely how such a proposition will be used in the case of grain corn in Manitoba. The elaboration of this point shall proceed in five stages. The first will restate the criterion that will be used and show the form which the results will assume. The next four parts will consist of discussions regarding each of the four parameters that will be used in the testing criterion. Each individual component will be defined, calculated and a range of values provided that will ultimately be used in this analysis. Lastly, there is an accompanying appendix (Appendix D) to this chapter which provides a discussion of utility theory. It includes a historical review, elicitation procedures, forms and properties of utility functions.

4.1 SPECIFICATION OF THE TESTING CRITERION

To restate Schmitz et al.'s hypothesis, they propose that the gains from price stabilization depends on four parameters; the price elasticity of supply, the profit margin, the contribution to total revenue and a producer's aversion to risk. These four factors are combined in the following equation, which is derived from the second derivative of the firm's utility function with respect to price;

$$(22)\ \operatorname{sgn} \frac{\delta^2 V}{\delta^2_{P_j}} = \operatorname{sgn} \quad \frac{\mu}{1+\mu} \frac{\varepsilon_j}{\alpha_j} - r$$

The symbols α , ε, μ, and r are the same as described in the previous section and by testing these parameters for various ranges, it is possible to determine at which individual combinations of elasticity, profit, contribution to revenue and aversion to risk, producers will gain or lose from price stabilization. As described previously, in compliance with Jensen's inequality, the firm will lose from having price stabilized at its mean if $\frac{\delta^2 V}{\delta^2_{P_j}} > 0$. Similarly it will gain if $\frac{\delta^2 V}{\delta^2_{P_j}} < 0$. More specifically if the sgn criterion produces a negative value, price stability will provide greater gains for producers and conversely if a positive value results, producers will gain from instability in price. At values equal to zero, there can be no conclusions drawn about the gains from stability.

There is one further point to mention before preceeding to the detailed description of the four parameters, that is the notation "sgn" preceding the testing criterion. This refers to a signum function which forces an equation to oscillate in value between negative one and positive one. It does so by taking the absolute value of the result and dividing it by the value itself. This might perhaps be better explained by the following illustration:

$$\text{sgn } (X) = \frac{|x|}{x}$$

It becomes evident that such a notation forces the outcome of the equation to be -1, 0 or +1. The use of the signum function indicates that it is not the magnitude of the testing criterion that is of importance, but rather the sign which it carries. Again a negative one denotes gains from stability and a positive one indicates that instability will provide greater gains.

4.2 DESCRIPTION OF THE FIRST PARAMETER-PROFIT MARGIN

Consider first the profit margin which is denoted by the symbol μ. This factor is obtained by subtracting the total costs of production of good X from the total gross revenue it obtains, all divided by the total costs. The algebraic expression for the profit margin is:

$$(23) \quad \mu = \frac{py - \sum_{i=1}^{n} w_i X_i}{\sum_{i=1}^{n} w_i X_i}$$

The profit margin that will be used in this exercise is derived from the cost of production budgets compiled by the Manitoba Department of Agriculture. Budgets for the years 1978, 1979, and 1980 can be found in Table C1, (in Appendix C), with a detailed accounting of costs specified.[78] Briefly, they determine the total costs, on a per acre basis, of seeding and harvesting a grain corn crop. The costs in these budgets comprise all operating costs such as fuel, chemicals, insurance, drying, etc., in addition to fixed costs which are defined as taxes, investment of land and machinery and depreciation on buildings and machinery. Labour costs are also included in the calculations of total cost.

While operating, fixed and labour costs are all used by Manitoba Department of Agriculture to determine total costs, for the purposes of this paper they tend to over estimate the costs of production as perceived by farmers. More specifically depreciation and investment costs combined contributed $87.06 to total costs in 1980 which represented the largest component, 40 percent, of total costs. Utilization of depreciation costs are rarely, if ever considered in the actual calculation of expenses, except for taxation purposes. Therefore depreciation costs will be omitted for this calculation of total costs.

Investment costs will also be ignored for the determination of total costs for this study, but for somewhat more complicated reasons. While it does seem quite reasonable to consider such a cost as an integral component of the costs of production, there are two factors which prohibit its inclusion here. The first is that investment cost, as calculated by MDA, for land, buildings and machinery are only spread over a

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[78] Farm Management Section, Manitoba Agriculture," Farm Planning and Organization Crop Planning Guide Special Crops", 1978, 1979 and 1980.

200 acre field. This would increase their weighting to a much higher level than would realistically be the case for most producers in Manitoba, which operate larger than 600 acre farms. The second and perhaps more substantial reason is that these investment costs, particularly for land, which comprised 75 percent of total investment costs in 1980, do not consider the fact that these represent a financial investment for the future. While such is not the case for buildings and machinery to any large degree, land price inflation over the last decade has made any such investment extremely profitable. To include such purchase costs as expenses against present income, but not to consider their actual value if sold, causes overestimations of production costs. For these reasons then, both depreciation and investment costs will be omitted from the determination of total costs $\sum_{i=1}^{n} w_i X_i$.

The other manner in which profit margins could be obtained is through a survey. While such a method would be desirable, the results would not likely provide any greater degree of accuracy than those that were chosen. Few producers maintain farm records with the level of detail that are required to attain such costs as individual fuel, repairs and maintenance costs per crop, so at best, farmers would have to estimate these figures anyway. The MDA cost of production budgets provide these estimates, along with several other calculations that are corn specific. An additional factor that favors the use of average production budgets over individual farmer's calculations, is that this analysis desires only to test ranges of the various parameters. Such does not, therefore, warrant the additional cost and involvement of producer surveying.

The profit margin μ then, is determined for three years, using MDA cost of production figures (omitting depreciation and investment) and average annual yields and prices as obtained from 1979 Manitoba Yearbook. These are used in equation (23) and the results of which are summarized in Table 9.

Table 9

Determination of Profit Margin

Year	Total Costs Per Acre $\sum_{i=1}^{n} W_i X_i$	Price ($/bu.)	Yield (bu./acre)	Profit Margin (μ)
1978	120.80	2.80	65.90	+.527
1979	133.60	3.00	60.00	+.347
1980	133.42	3.90	54.80	+.602
Ave.				+.492

Source: See Table 1 and in Appendix C see Table C1.

In compliance with the results shown in Table 9 , values equal to .2, .3, .4, .5 and .6 were considered in this analysis. The testing was limited to these values as they covered the range of numbers most likely to describe Manitoba corn producers. It would also be interesting perhaps, to examine extreme values of the profit margin such as those negative or highly positive in value. These will not, however, be considered in this analysis.

4.3 DESCRIPTION OF THE SECOND PARAMETER-CONTRIBUTION TO TOTAL REVENUE

The next parameter to be considered is the contribution to total revenue. As described by Schmitz et al., it is calculated in the following way:

$$(24)\quad \alpha_j = \frac{P_j\, Y_j}{\sum_{j=1}^{m} P_j\, Y_j}$$

In attempting to choose relevant ranges for this factor, the producer surveys done for the ongoing crop simulator program at the University of Manitoba, Department of Agricultural Economics were consulted. Schmitz et al., do not specify in their paper whether they refer to gross or net income in their calculation. It was decided here, that due to the magnitude of gross costs and revenues for corn in comparison to the more traditional crops, distortions in α would result if gross costs and revenues were used and thus net returns would provide a more accurate description. Such a calculation was performed by the Crop Simulator for 16 corn growers (see Table C2 in Appendix C). Of these 16 producers, six were engaged in corn production under irrigation but they were also included in the same manner.

The range of values was wide, and varied from contributions of 1 percent to 80 percent of total farm income. The initial analysis, in attempts to consider all relevant ranges, used the two extreme points, the mean, and the mean plus and minus one standard deviation. More specifically α assumed values equal to .01, .04, .25, .47 and .80. After a preliminary analysis, the gap between .04 and .25 proved too wide to provide the sensitivity required. To remedy this, additional trials were run using α values equal to .10, .15 and .20, representing a contribution to revenue of 10 percent, 15 percent and 20 percent, respectively. These additional values proved satisfactory as will be evident later when the results are examined. The ranges chosen for the profit margin and contributions to total revenue provide six times eight or 48, possible combinations under which the sgn criterion must be examined.

4.4 DESCRIPTION OF THE THIRD PARAMETER-PRICE ELASTICITY OF SUPPLY

A simple price elasticity is calculated by the following expression:

$$(25)\quad \varepsilon_j = \frac{\delta Y_j}{\delta P_j} \cdot \frac{P_j}{Y_j}$$

and signifies the relative change in quantity supplied for a relative change in price. There are difficulties concerning the calculation of a price elasticity coefficient for grain corn grown in Manitoba. Due to the recent appearance of large acreages of corn in the West, data problems arise when attempting to estimate supply elasticities. With only five or six years of data it becomes difficult to obtain an adequate number of degrees of freedom to make any econometric technique significant.

In order to obtain some idea of the value that this parameter will assume, it is necessary to examine some other studies that derive price elasticities. There are basically two types of functions to consider. First, those done for corn in eastern Canada and the United States. These will hopefully reflect any physiological aspects of corn production that might become evident in a supply estimation. The second type are supply curves estimated for western Canadian feed grains and more particularly barley production. Through consideration of these studies it will hopefully provide some insight into western producers attitudes and behaviors inherent in cropping decisions.

Table 10 provides a summary of 18 related studies that attempt such estimations. A wide range of elasticities, from .04 to 1.50, were obtained, although most are in the inelastic range of the supply curve. Those elasticities that have astericks associated with them are of particular interest. These studies included five estimations of barley acreage in western Canada, three of which are for the sixties and early seventies while two are for 1955-1969. The earlier two studies done by U.S.D.A., used final realized price of barley lagged one year as the dependent variable. This resulted in elasticity coefficients of .29 and .66. The only difference in the two equations is that the one obtaining the very low elasticity used number of consuming animals, while the other used stocks of barley on farms August 1 of the crop year. Of the remaining three estimations, two used final price[79] lagged one year as the exogenous variable, and found elasticity coefficients of .70 and .74.

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[79] K.D. Meilke and H. de Gorter, "A Quarterly Econometric Model of the North American Feed Grains Industry," in Commodity Forecasting Models for Canadian Agriculture, Vol.1, Agriculture Canada, Policy, Planning and Economics Branch, Oct. 1978. pp.15-42.

Table 10

Summary of Price Elasticities of Supply

	Endogenous	Elasticity	Exogenous	Source and Years
1.	Corn Acreage in U.S.	.07	Price of Corn ÷ Price Soy	C.F.M.,[a] 1951-75 (quarterly data)
2.	DEC acreage of feed grains in Eastern	.04	Average price of Chatham Corn$_{t-1}$	C.F.M.,[a] (corn 75 percent +)
3.	Acreage of Barley and Oats in Western Canada	S.R. .45 L.R. 1.22	Feed Grain Price (U.S. dollars)	Bjarnason, 1951-63 (in U.S.D.A.)
4.	Acreage Barley in Western Canada	* .66	Final realized price of Barley$_{t-1}$	U.S.D.A., 1955-69
5.	Acreage Barley in Western Canada	* .29	Final realized price of Barley$_{t-1}$	U.S.D.A., 1955-69
6.	Acreage Oats in Western Canada	.29	Final realized Price$_{t-1}$	U.S.D.A., 1955-69
7.	Acreage Oats in Western Canada	.16	Final realized Price$_{t-1}$	U.S.D.A., 1955-69

(Continued)

Table 10 (Continued)

Endogenous	Elasticity	Exogenous	Source and Years
8. Acreage of Feed Grains in Western Canada	.19	Final Realized price of barley$_{t-1}$	U.S.D.A., 1955-69
	.66	Final realized price of oats$_{t-1}$	
9. Acreage of Feed Grains	.14	Final realized price of barley$_{t-1}$	U.S.D.A., 1955-69
	.51	Final realized price of oats$_{t-1}$	
10. Acreage of Corn in Eastern Canada	*1.04	Corn Price$_{t-1}$	U.S.D.A., 1955-69
11. Acreage of Corn in Eastern Canada	* .96	Corn Price$_{t-1}$	U.S.D.A., 1955-69
12. Acreage Barley in Western Canada	* .236	Final Price	W.P. Number 3,[b] 1959-1977
13. Eastern Barley	.648	Ontario Farm Barley Price$_{t-1}$	W.P. Number 3,[b] 1959-77

(Continued)

Table 10 (Continued)

	Endogenous	Elasticity	Exogenous	Source and Years[a]
14.	Eastern Oats	.076	Ontario Farm Oats $Price_{t-1}$	W.P. Number 3, 1959-77
15.	Eastern Corn	*.690	First Quarter Chicago Corn	W.P. Number 3, 1959-77
16.	Acres Barley Western Canada	1.50	Initial $Payment_{t-1}$	Meilke
17.	Acreage of Barley Western Canada	*.70	Final $Payment_{t-1}$	Meilke
18.	Acreage Barley Western Canada	*.74	Farm Barley $Price_{t-1}$	Jolly and Abel in Meilke

[a]C.F.M. - Commodity Forecasting Models

[b]W.P. Number 3 - Working Paper Number 3

Note: For a complete reference of sources see bibliography.

The other study used current barley prices and the elasticity reflected this difference by decreasing to .24.[80] Therefore, there seems to be some evidence to suggest that an elasticity coefficient in the .6-.7 range would be appropriate.

The studies examined for eastern Canadian corn acreage reinforced this choice. The three estimations of particular interest here, also have astericks associated with them.[81] The time periods are similar to those for barley, two being for late fifties and sixties, while the remaining one estimates supply for 1959-77. The results obtained are 1.04, .96 and .69, respectively.

It was decided from these to initially use an elasticity coefficient of .75. Such an inelastic value is supported by the fact that most agricultural commodities display relatively inelastic supply curves. To test the effects on the desirability for stability, of changes in supply elasticities, the testing criterion also was calculated using an elasticity of .60 and .90. These were chosen to reflect slight increases and decreases in the sensitivity of supply. The studies described previously also suggest that it would be useful to test these additional points.

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80 J.C. Lowe and T.M. Petrie," Grains and Oilseeds Block of Food and Agriculture Regional Model," Working Paper No. 3, Agriculture Canada, Policy,Planning and Economics Branch, 1979.

81 E. Missiaen and A.L. Coffing, "Canada: Growth Potential of the Grain and Livestock Sectors," Foreign Agricultural Economic Report No. 77, Economic Research Service, U.S.D.A., June 1972; Lowe and Petrie, op. cit.

4.5 DESCRIPTION OF THE FOURTH PARAMETER-RELATIVE RISK AVERSION COEFFICIENT

The fourth parameter is a measure of producer's aversion to risk. While there are several ways to obtain a coefficient of risk aversion, Schmitz et al., use the Arrow-Pratt measure which is calculated by the following expression:

$$(26) \quad r = \frac{-Y\ U''(Y)}{U'(Y)}$$

When attempting to derive useful ranges for testing, three possibilities exist. The first is the process of eliciting individual utility functions for a random sample of corn producers. This would require the formulation of a system of events and corresponding probabilities from which a decision maker would make his relevant choices. Such a process has been used by several researchers such as Officer and Halter; Lin, Dean and Moore; Buccola and French; Binswanger; and others.[82] They use the various forms of functions and elicitation procedures that can be found discussed in Appendix D and arrived at very diverse results. The only real conclusion that was found in common was the fact that producers, and other decision makers are generally risk averse. The difficulty and cost involved with the actual estimation of individual utility functions is very clearly noted in all of the studies reviewed and provides one of the reasons why such a procedure was not used

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[82] For a more complete discussion on these authors works see D.L. Young, "Risk Preferences of Agricultural Producers: Their Use in Extension and Research," A.J.A.E., Vol. 61, No. 5, 1979, pp. 1063-1069.

here. Young, in a paper which reviewed many of the recent articles estimating utilities, makes it clear that future researchers should ask "why it is important to know producer risk preferences...(and)...recognizing the added cost of measuring risk preferences and the unproven reliability of the measures, it is necessary to evaluate within the context of the specific problem whether attempted measurement is worthwhile."[83] Considering the objectives outlined for this analysis such a task does not seem warranted and therefore survey and elicitation procedures will not be used.

The second manner in which ranges of relative risk aversion could be chosen involves using these utility functions that have been derived by other researchers, performing the necessary calculations and then estimating r. Several reasons make this approach unsuitable. The first and foremost is that many of the utility functions that were cited were polynomial functions of a quadratic or cubic degree.[84] These types of functions, however present difficulties when using them to derive risk factors.[85] Hildreth recognized these disadvantages and described how a polynomial can provide a good approximation of utility but only in

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83 Young, op. cit., p. 1,067.

84 S.T. Buccola and B.C. French, "Long-Term Marketing Contracts: Intra-Firm Optima and Inter-Firm Agreement," A.J.A.E., Vol. 61, No. 4, Nov. 1979, pp. 648-656; W. Lin, G. Dean and C. Moore, "An Empirical Test of Utility vs. Profit Maximization in Agricultural Production," A.J.A.E., Vol. 56, No. 3, August 1974, pp. 497-508; R. Officer and A. Halter, "Utility Analysis in a Practical Setting," A.J.A.E., Vol. 50, No. 2, 1968, pp. 257-277.

85 See Appendix D.

86 C. Hildreth, "What Do We Know About Agricultural Producers' Behavior under Price and Yield Instability?" A.J.A.E., Vol. 59, No. 5, Dec. 1977, pp. 899-902.

a specified range.[86] He suggested several alternative functions found by Keeney and Rauffa that might be useful in addition to one derived himself[87] These were all increasing concave functions that allowed the required property of decreasing absolute risk aversion. While such functions do provide much more complex curves it is not possible to determine if they represent average utility functions for Manitoba corn producers.

There are two remaining types of utility functions that are often estimated. The first is a linear function which is rejected on the basis of its simplistic nature. The second are functions in which the equations include risk factors as a variable. These and forms enforcing constant r values defeat the purpose for which they would be used here. An interesting observation to draw from these, however, is the range of r values they use. All studies considered used values ranging from 0 to positive 2 which were considered to be expansive enough to include all the relevant values.[88]

Six values of r were chosen for the following reasons. The first is the fact that a utility function of the form

$$U(x) = \log_e x$$

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87 Ibid., p.900.

88 J. Apland, B.A. McCarl and W.L. Miller, "Risk and the Demand for Supplemental Irrigation: A Case Study in the Corn Belt," A.J.A.E., Vol. 62, No. 1, Feb. 1980, pp. 142-145; L. Brink and B. McCarl, "The Tradeoff Between Expected Return and Risk Among Cornbelt Farmers," A.J.A.E., Vol. 60, No. 2, May 1978, pp. 259-263.

89 Recall Anderson et al., op. cit., pp. 65-108 and Arrow, op. cit., pp. 90-120.

is considered to be the most common.[89] This function produces an r coefficient of one. Secondly, from the mathematical proposition described for the demand for liquid assets, Arrow concluded that generally the relative risk aversion must hover around 1.[90] The third reason for choosing the values used was the fact that the studies that were reviewed in this area, although were not using relative risk aversion specifically, did use range from 0 to 2 as their relevant ranges.

Thus six values of r were used in the sgn criterion. Risk preference was indicated by r=1.0, neutrality towards risk was shown by zero, and varying degrees of risk aversion were represented by 0.5, 1.0, 1.5, and 2.0. It was considered that these six values would provide results sensitive enough to draw some useful conclusions.

The ranges chosen for each of the parameters can be found summarized in Table 11.

Table 11

Ranges of Parameters

ε_j	μ_j	α_j	r
.60	.2	.01	-1.0
.75	.3	.04	0.0
.90	.4	.10	0.5
	.5	.15	1.0
	.6	.20	1.5
		.25	2.0
		.47	
		.80	

90 Arrow, op. cit., p. 110.

It is now possible to calculate the 720 possible combinations of these parameters in the equation:

$$\operatorname{sgn}\left[\left(\frac{\mu}{1+\mu}\right)\frac{\varepsilon_j}{\alpha_j} - r\right]$$

and evaluate the results.

Chapter V

ANALYSIS OF THE RESULTS

5.1 ORGANIZATION OF THE RESULTS

As previously specified, the criterion proposed by Schmitz et al., will be applied using 720 combinations of four parameters. The values of those utilized have been discussed in detail and a summary of which can be found in Table 11. It will be the objective of this chapter to discuss the results of these calculations.

First, consider briefly, a restatement of the manner in which these results will be found. The testing criterion is in the form of a signum function which forces the values to be negative one, positive one or zero. It does so, by applying the sgn rule $f(x) = \frac{|x|}{x}$. In this case a negative one indicates that producers will be better off with price stability, while a positive one denotes that greater gains result from instability in price.[91] If sgn f(x) equals zero there can be no conclusions drawn as to whether or not a producer will gain or lose from price stabilization.

Given that the testing criterion provides three possible conclusions, it is now necessary to derive a system through which these can best be displayed. Due to the nature the criterion itself, with four

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[91] As outlined previously, the criteria for measurement of gains is the area of producer surplus. Producer gains and preference are used interchangably here and imply that producer welfare will be maximized under the specified condition.

parameters and one result, a five dimensional diagram would be required to accurately illustrate the results. To avoid this technical difficulty another manner was derived. Figures 15 through 22 depict the result.

For each individual figure, two of the parameters, elasticity and profit margin are held constant. The remaining two, risk aversion and contribution to total revenue are allowed to assume their respective ranges. For instance in Figure 15A elasticity was held constant at .60 while profit margin was maintained at .20 or 20 percent. The Y-axis records the six levels of risk aversion that were tested and the X-axis indicates the contribution to total revenue ranging from 1 to 80 percent. Each point on the plane of this diagram indicates that the value of the testing criterion for that particular combination of parameters, was positive one. For instance when ε=.6, μ=.2, r=2.0 and α=.01, the testing criterion equaled one. This indicates that producers will be better off if prices are allowed to fluctuate about the mean. The absence of a point at a particular combination of r and α indicates that the testing criterion produced a value of -1 and that price stability provides greater gains.[92] Each individual diagram shows the sensitivity of the testing criterion to changes in α and r, holding ε and μ constant.

To show how changes in ε and μ affect the result, it is necessary to compare several diagrams. Each of Figures 15 through 19 contain three diagrams which hold μ constant and vary ε through its relative ranges. In this way it is possible to make comparisons as to how ε af-

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92 As mentioned previously the testing criterion could also produce a value of zero. This occurred only once in the ranges that were considered here and is indicated by an * in the Figures. The parameter combination producing a zero value is ε=.6, μ=.6, r=1.5 and α =.15.

Sensitivity Analysis Results I
(μ=.20, r=50, α=80)

A

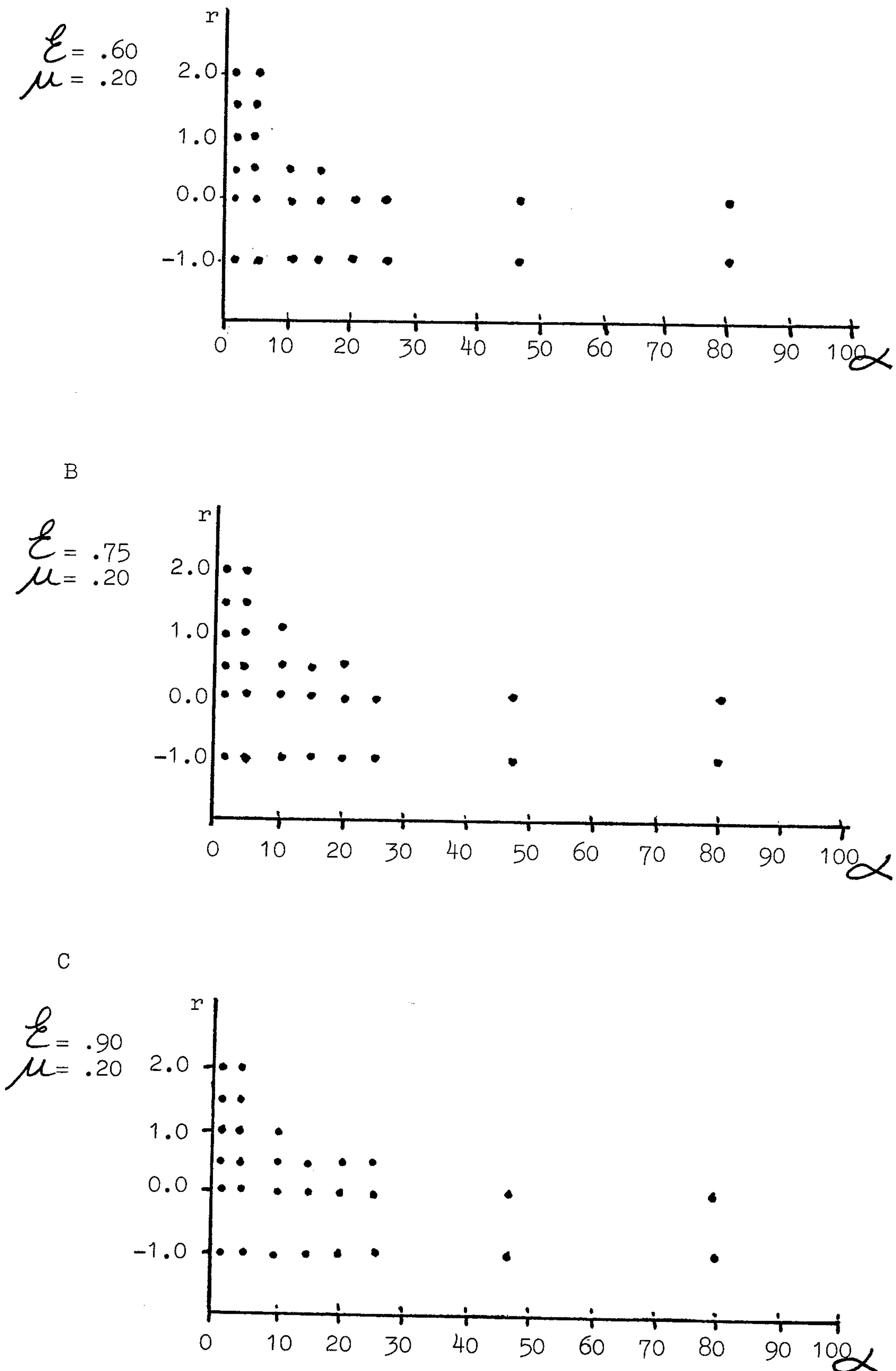


Figure 15

Sensitivity Analysis Results II
(μ=.30, r=50, α=80)

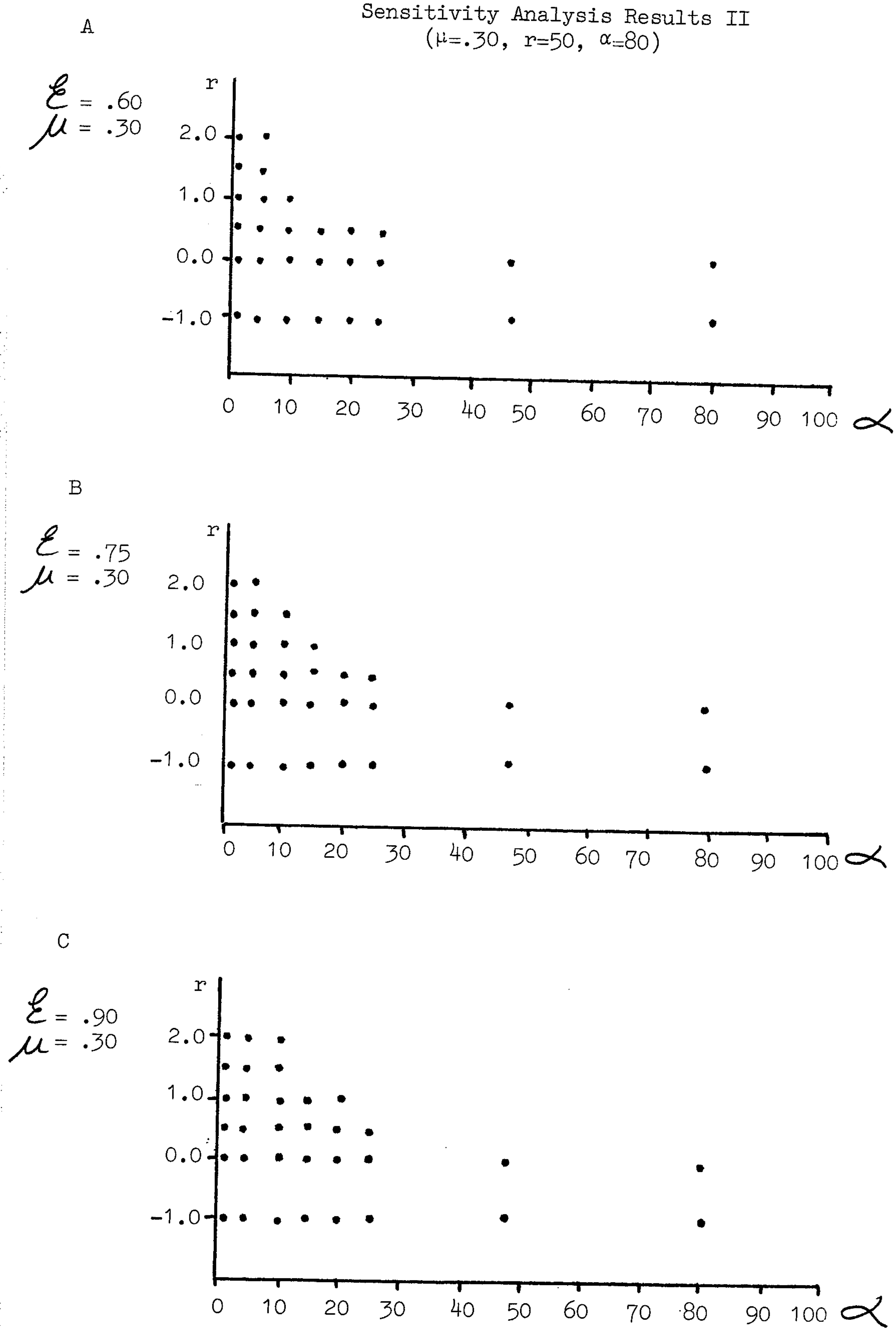
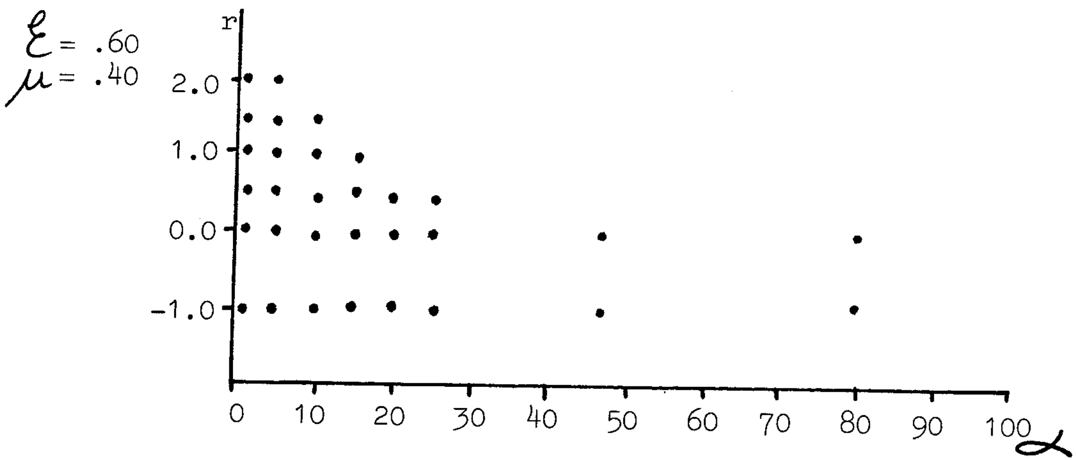


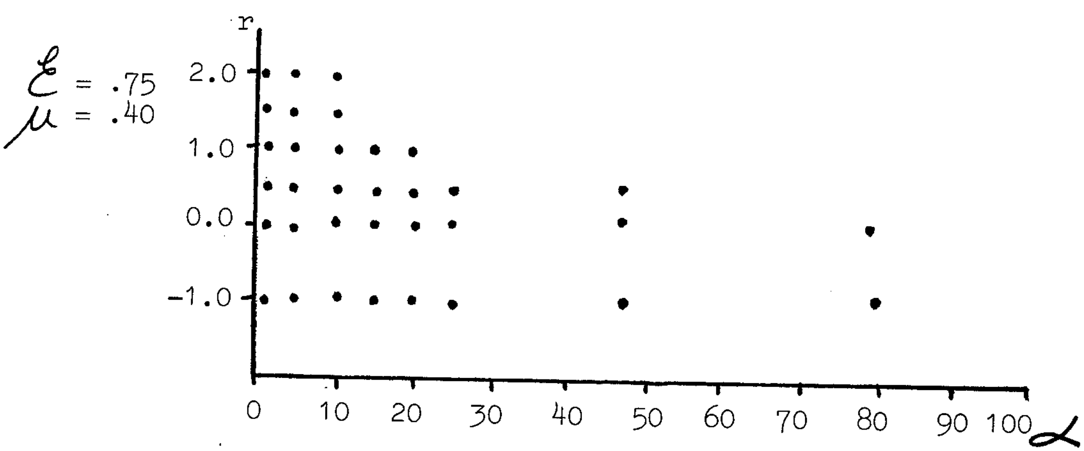
Figure 16

Sensitivity Analysis Results III
(μ=.40, r=50, α=80)

A



B



C

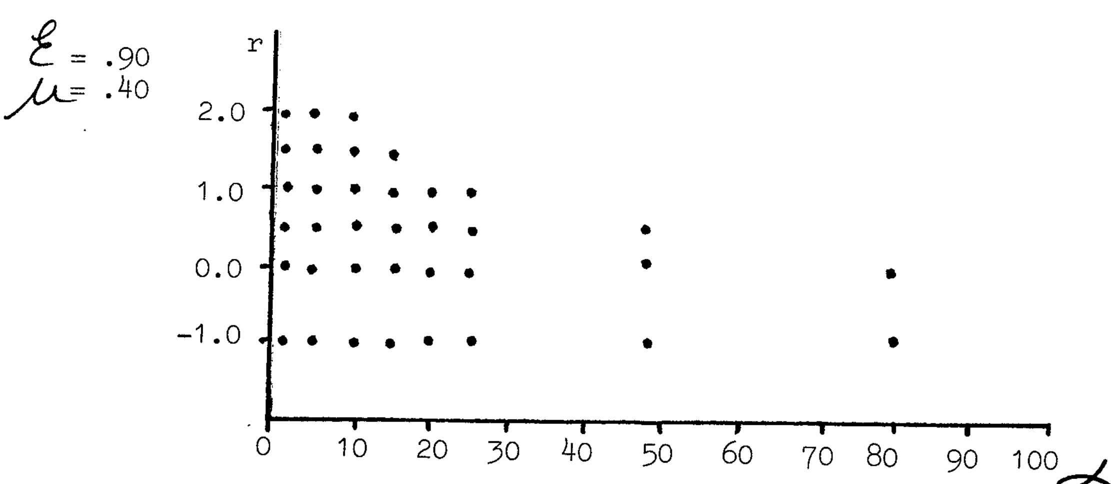


Figure 17

Sensitivity Analysis Results IV
(μ=.50, r=50, α=80)

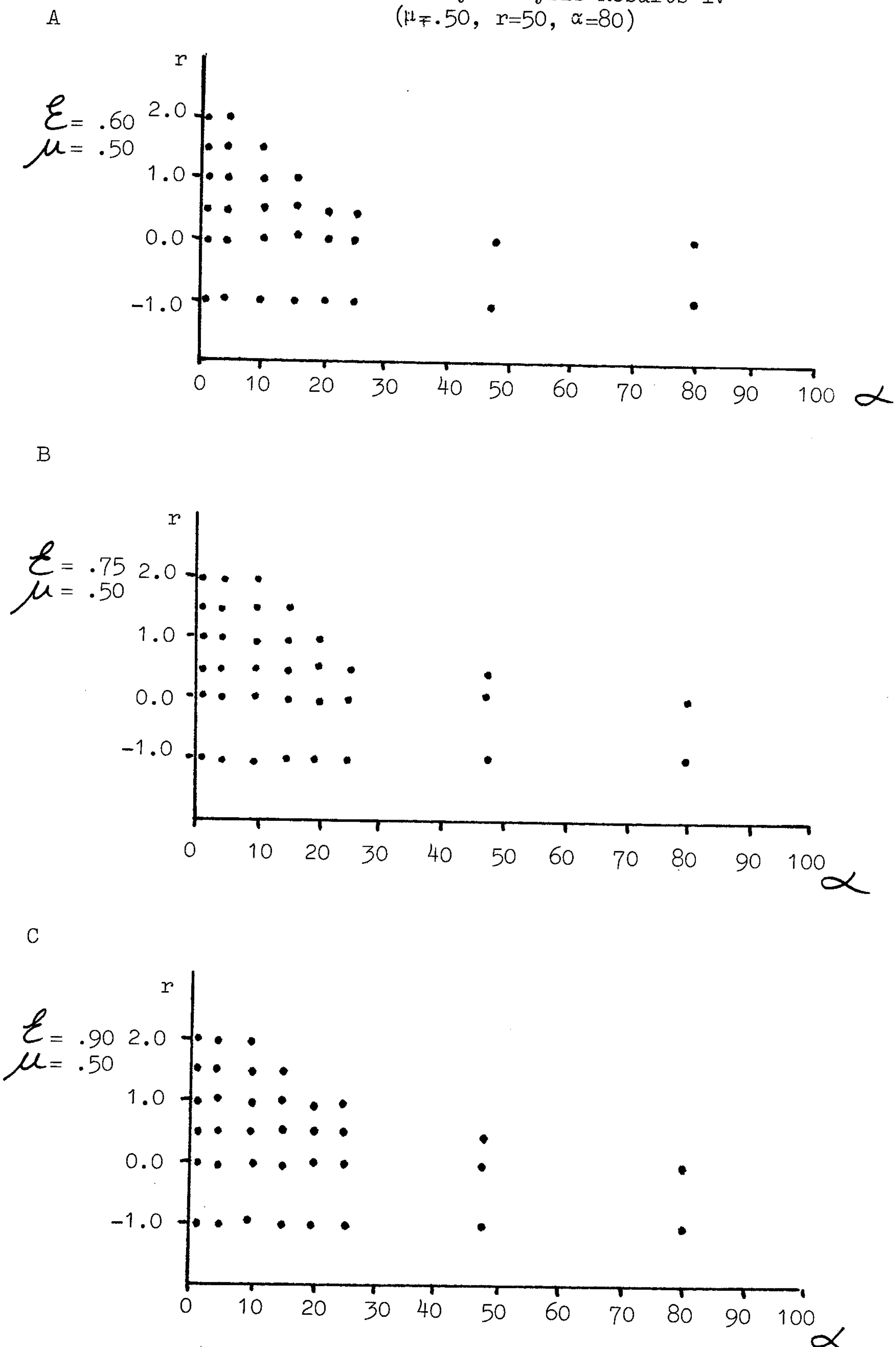


Figure 18

Sensitivity Analysis Results V
(μ=.60, r=50, α=80)

A

B

C

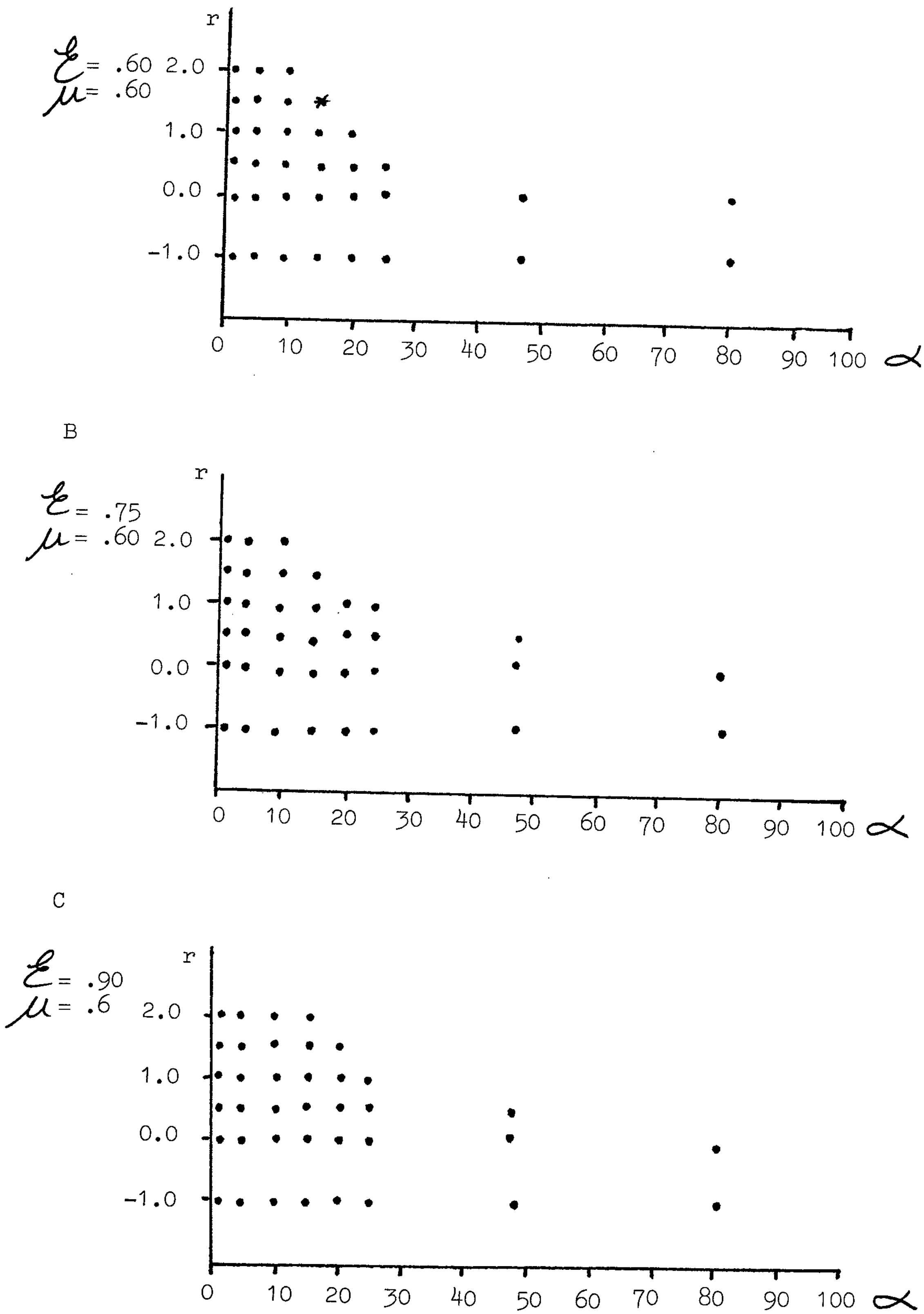


Figure 19

Sensitivity Analysis Results VI
($\mathcal{E}$=.6, μ is varied, r=50, α=80)

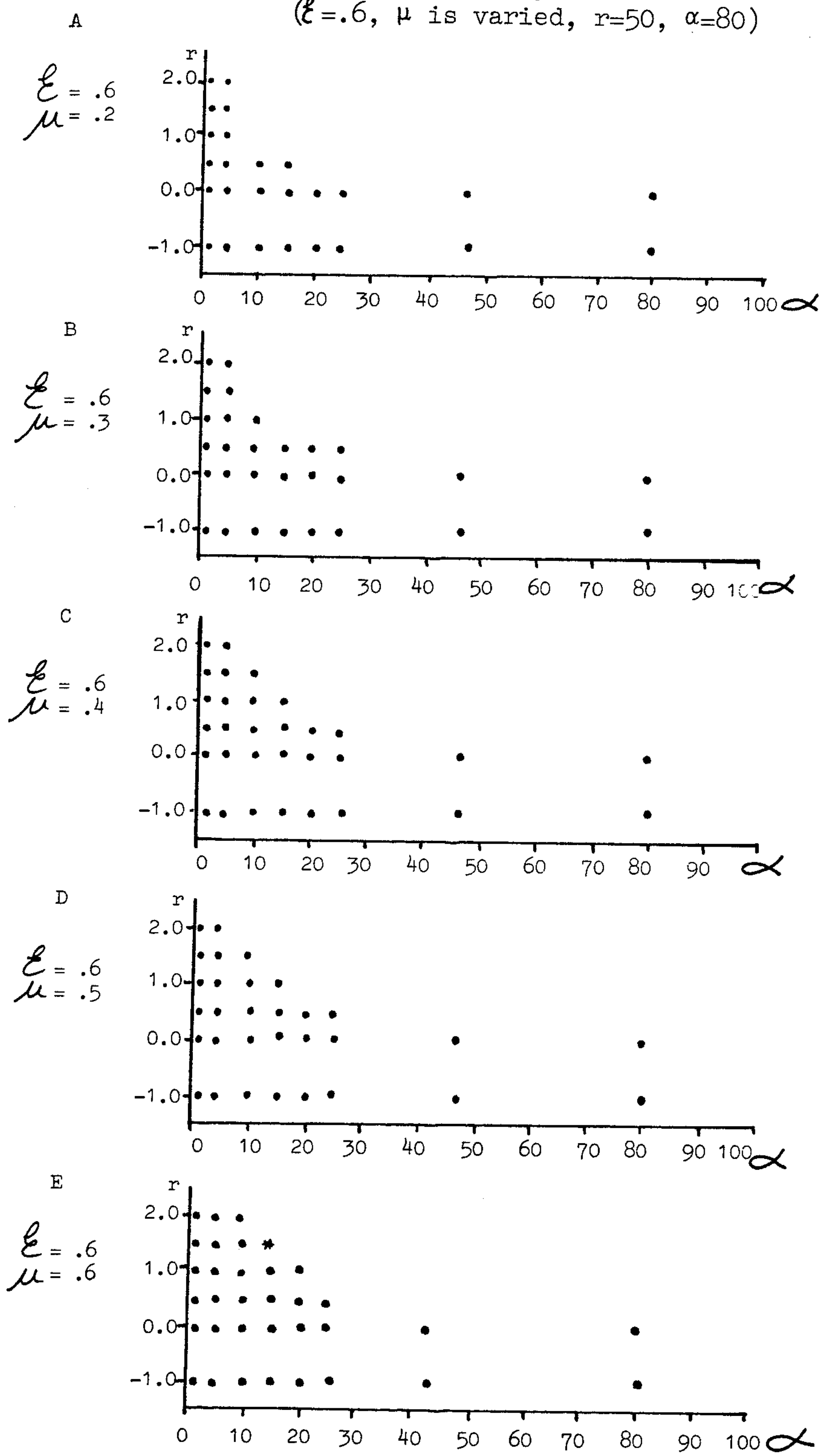


Figure 20

Sensitivity Analysis Results VII
($\mathcal{E}$=.75, μ is varied, r=50, α=80)

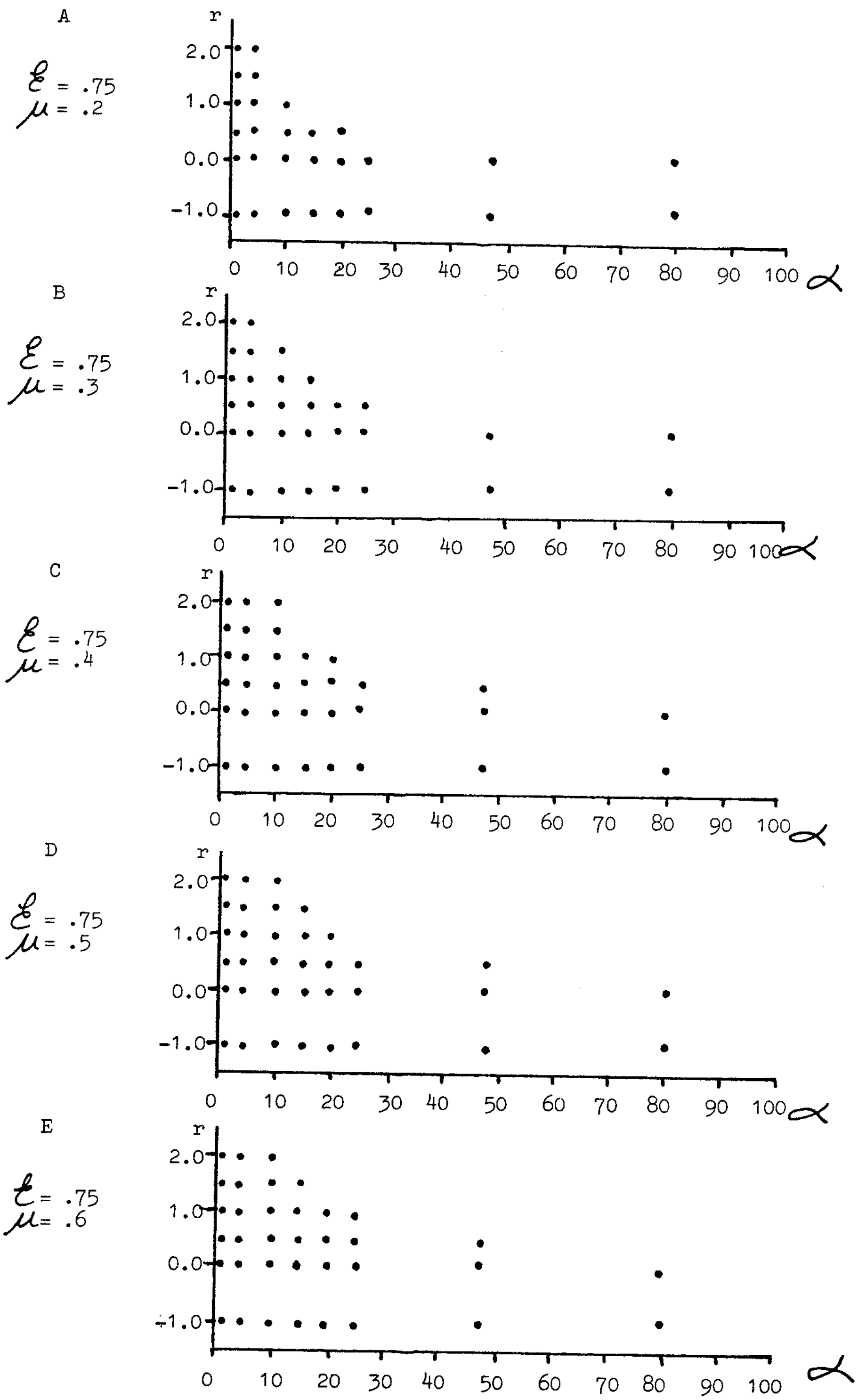


Figure 21

Sensitivity Analysis Results VIII
($\mathcal{E}$=.9, μ is varied, r=50, α=80)

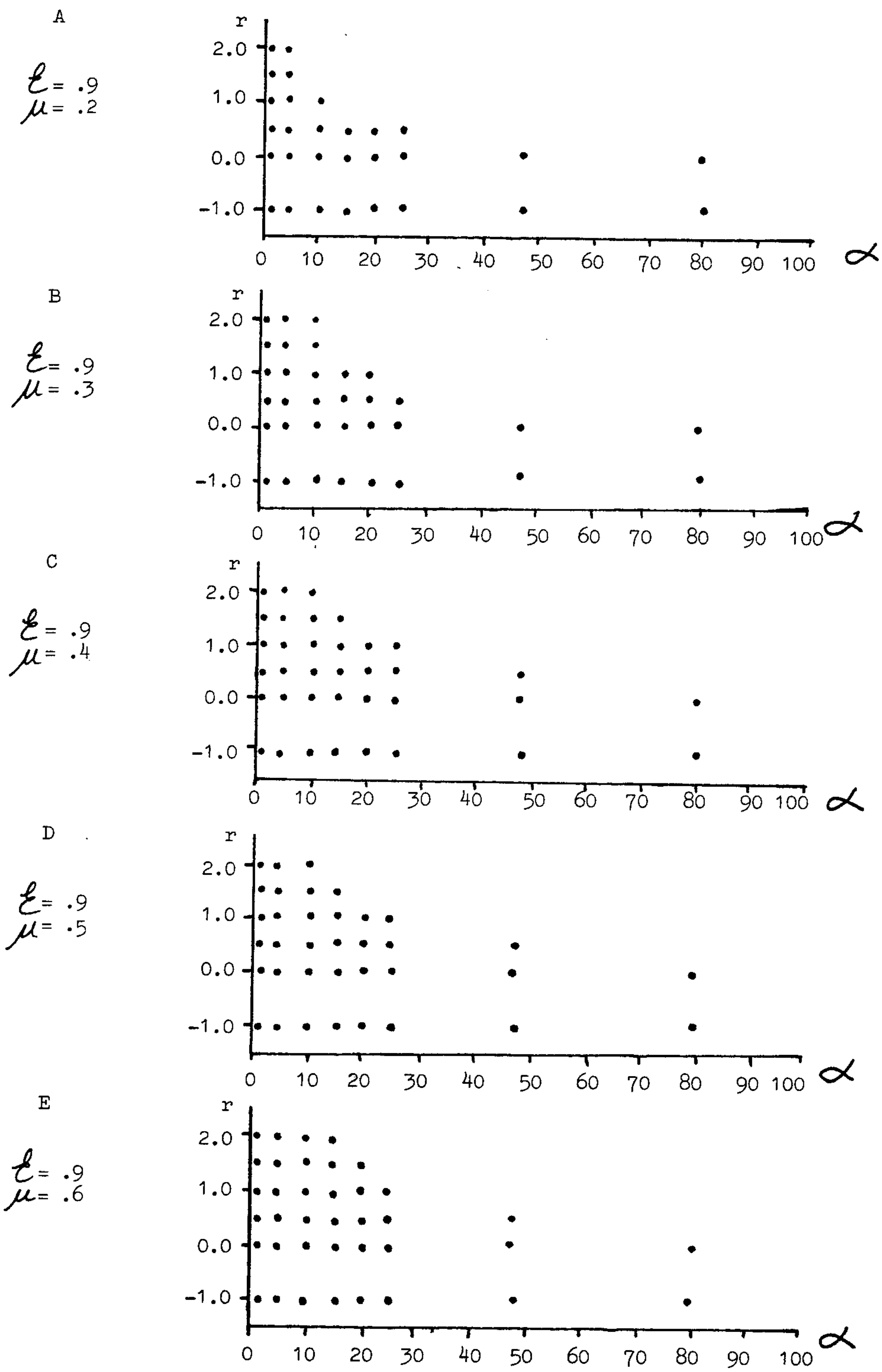


Figure 22

fects the sgn criterion. The more points on the diagram the larger the number of α -r combinations that will be equal to one, denoting that instability provides greater welfare gains. Given a particular combination of r and α say, 1.0 and 10 percent respectively, as elasticty (μ held constant) or profit margin (ε held constant) increases, the greater will be the number of points and thus the greater are the gains from instability. Figures 20 through 22 illustrate the cases where elasticities are held constant and profit margins vary through the specified ranges. Although Figures 15-19 contain the same diagrams as 20-22, they do so in a different order. This aids in the analysis of the effects of changes in the parameters on the testing criterion.

5.2 DESCRIPTION OF THE RESULTS

Intuitively one would expect that as an individual's aversion to risk increases, so would the gains from stability in price. Similarly, as a particular crop contributes an increasingly greater percent to a producer's total revenue, the gains from price stability in that crop would increase. From isolated examination of any of the diagrams in Figures 15 through 22 it becomes evident that as contribution to total revenue increases, combined with an increasing aversion for risk results in increasing gains from price stability. Take Figure 15A for instance. At very low levels of contribution to income (α), 1 percent or 4 percent, even the most risk averse individuals (indicated by an r value of 2.0) will be better off with price instability. But as corn begins to contribute more to total revenue, say 10 percent, those individuals with a 'normal' aversion to risk (r=1), or anything above that, no longer gain from instability. Only the slightly risk averse, (r=.5) and those individuals that are risk takers (r=.1) or risk neutral (r=.0) will gain from instability. When corn contributes 20 percent or over to total revenue only risk takers or those neutral to risk will gain from price instability.

If μ is held constant at that level and elasticity of supply is increased to .75, the results are somewhat different. Figure 15B illustrates the effect of this change. While the same point pattern exists for combinations of r and α at lower levels of α (α=.01 and α=.04), when α=.10 the similarity ceases. Whereas stability provided greater gains at α=.10 and r=1.0 when ε was .6 and μ=.2, when ε is increased to .75 such a combination between r and α indicates that instability is the better condition. As elasticity increases, holding the other three parameters constant, there are increasing gains from instability. This is consistent with the apriori expectations described in Chapter 3. When α becomes 15 percent and r drops to .5, again stability is preferred, but unlike 15A this preference continues until α exceeds 20 percent (in 15A stability was preferred at levels over 15 percent when r=.5). It is not until $\alpha \geq .25$ that instability is optimal and then only by those producers that are risk neutral or risk takers. Figure 15C differs from 15B by only one point. A shift from preference for instability to stability occurs when there is a 25 percent contribution to total revenue and r=.5. In Figure 15B, this combination produces a negative one, but in 15C a positive 1 was obtained, denoting that instability still provides greater gains at that level. When ε=.90, it is not until the contribution to total revenue reaches somewhere between .25

and .47, that the transition from instability to stability is made for producers with even the smallest degree of risk aversion (r=.5).

If the profit margin is increased to 30 percent, so that μ=.30, the same type of trend becomes evident. Figure 16 displays the results of holding the profit margin constant at .3 and varying elasticity from .60 to .75 to .90. The most inelastic supply schedule produces points which indicate that price instability is optimal by slightly risk averse individuals up until contribution to total revenue exceeds 25 percent. If one considers a risk aversion coefficient of 1 to be the norm, instability in price provides greater gains but only if corn contributes less than 15 percent to total revenue. Again when α is very low, 1 percent or 4 percent, all producers will be better off with a fluctuating price. Moving to 16B, where the elasticity is increased to .75, it becomes clear from the increased number of points, that it produces greater welfare gains from price instability. Whereas Figure 16A lacked points when; a) r=1.5 and α=.10 and b) r=1.0 and α= .15, Figure 16B has points at those locations. Again, the conclusion to draw from this, is that the greater the elasticity the greater are the gains from price instability.

Figure 16C reinforces this premise still further. It has two additional points beyond those added in 16B. The first is for very risk averse producers, having risk coefficients equal to 2. These managers should, from this analysis, prefer price instability up to the point where corn contributes 10 percent of the total revenue. Assuming of course, profit margin is equal to .30 and elasticity is equal to .90. The second additional point is found where α =.20 and the risk coefficient assumes its 'Everyman's value r=1.

If similar comparisons are made through Figures 17, 18 and 19, where the profit margins are held constant and the elasticities proceed through their three scenarios, it becomes evident that the trend described for Figures 15 and 16 continues. That is, as elasticity increases, holding all other parameters constant, there are greater gains from price instability. Diagramatically, this is evident by the fact that there are always more points in scenario B in each of the figures than there are in scenario A. Similarly, there are always more points in scenario C than are found in scenario B. As previously explained, each point represents greater gains for producers, from price instability. It logically follows that the more points a diagram displays, the greater the number of α -r combinations that will indicate instability. These parameters (α and r) increase in value from the origin, and the greater the number of points on a figure, also indicates that, as price elasticity of supply increases producers who are more risk averse and/or who have corn contributing a greater proportion to total revenue will progressively prefer price instability over stabilized price.

The most extreme case when elasticity is increased and profit margin is left unchanged, is found in Figure 19 scenario C. This figure illustrates a situation when corn contributes almost 50 percent of total revenue and the producer is slightly risk averse (r=.5). Under these conditions he will still gain from price instability over a price stabilized at the mean. The other extreme situation portrayed by Figure 19C, is the instance where corn contributes 20 percent to total revenue and the risk coefficient indicates a fairly high degree of aversion, (r=1.5). For this combination of parameters; α =.20, r=1.5, ε=.90,

μ=.6, the testing criterion indicates that instability still provides greater gains

There is one further situation in Figure 19 warranting specific mention. When elasticity equals .6, the case portrayed by Figure 19A, there is one point which is marked by an * rather than a mere dot. The coordinates of this *, are r=1.5 and α =.15. At this combination of parameters producers are indifferent in their preference for stability or instability. This situation is produced when the testing criterion equals zero and indicates that both price stability and instability produce the same gains.

Having shown the effects of increasing price elasticity of supply on the gains from stability, by regrouping the Figures 15 through 19 and allowing profit margin to increase and holding elasticity constant, several additional conclusions can be drawn. Figures 20, 21 and 22 describe the cases where elasticities are equal to .60, .75 and .90, respectively. The letters A, B, C, D, E associated with each figure distinguish the ranges of profit margins that were used; .2, .3, .4, .5, .6, respectively.

Using the same procedure described previously, consider Figure 20. This figure illustrates the situation where elasticity is held constant at .6 and the profit margin is allowed to vary through its chosen ranges. Again, the more points found on an individual diagram, the greater are the gains from price instability. If one compares 20A with 20E it becomes evident that as profit margin increases there are greater gains from price instability. When the profit margin is 20 percent, only at very low α values, when corn contributes 1 percent to 4 percent of total revenue, are there gains for all producers from instability. Even when corn provides only 10 percent of total revenue, most producers (r=1.0) will prefer stability. If one examines the mid-range profit margin values (μ=.4) of Figure 20C, it becomes evident that most producers (r=.1) will gain from instability as long as corn contributes less than 20 percent of total revenue. This increases up to contributions less than 25 percent, when profit margin is increased to its extreme of μ=.60. This provides evidence to support the expectation that there is a positive correlation between profit margin and the preference for instability in price.

Examination of Figures 21 and 22, each with scenarios A through E, serves as further evidence to the conclusions drawn from Figure 20. There is a significant increase in the number of points found on the individual diagrams as one proceeds from scenario A, when μ=.2 through to scenario E where μ=.6. While, a typical producer (r=1) will prefer stability in price, when the profit margin is .2 and corn contributes less than 15 percent to total revenue, (remember that elasticity is held constant at .75) if the profit margin is found to be 60 percent, the same producer will prefer instability up to the point where corn contributes to income between 25 and 47 percent. A more sensitive analysis would tell the exact place where this producer would be indifferent, but such an elaboration did not seem warranted for the limited additional information that would be gained.

Figure 22 reflects the exact same trend as that prescribed for 20 and 21. That is, there is an increasing preference for instability as the profit margin improves. Figure 22 also depicts the extreme situation of a price elasticty equal to .90 and μ =.6 and ε=.9. The results are the same as those described for Figure 19C. Even very risk averse individuals (r=2.0) will prefer instability when corn composes less than 20 percent of total revenue. A more typical producer (r=1.0) will prefer instability up to the point where corn forms less than 47 percent of total revenue.

There are four conclusions to be drawn from this discussion of the empirical results. All of these are consistent with the expectations set forth in Chapter 3. The conclusions are as follows: (a) the gains from price stability will increase with increases in the size of the risk aversion coefficient; (b) conversely as the profit margin increases there will be increased gains from instability; (c) like the relationship described for the profit margin, the gains from stability and the price elasticity of supply are inversely related, and lastly; (d) the proportion that a particular commodity contributes to total revenue positively influences the gains from price stability. These conclusions then, provide the basis for examining the grain corn pricing mechanisms in Manitoba and from which some marketing recommendations may be made.

Chapter VI

SUMMARY AND CONCLUSIONS

6.1 PROBLEM STATEMENT AND OBJECTIVES

Grain corn grown in Manitoba has increased in importance to the point where it is now considered a permanent cropping alternative for those producers receiving adequate CHU's. However, little discussion has evolved on how corn should best be priced and marketed so as to provide the greatest gains for these producers. In an attempt to consider this in more detail the following objectives were undertaken in this thesis:

1. To provide a descriptive analysis of the Manitoba grain corn industry including: demand and supply potential, price and production trends, imports of American corn, the Domestic Feed Grains Policy, the feed market in British Columbia, and the Ontario grain corn market,
2. To apply the theorem proposed by Schmitz et al., that a producer's desire for price stability depends on four parameters: price elasticity of supply, profit margin, contribution to total revenue and relative aversion to risk,
3. To use the results obtained from objective two to draw conclusions about the type of pricing policy that would be best suited to grain corn producers,

4. To suggest alternative marketing mechanisms that could provide the type of price, stable or unstable, that results in the greatest welfare gains for producers,

It was the attempt through objective one to assimilate some of the facts surrounding the Manitoba grain corn industry. Objective two and three chose one of these characteristics, price stability, and examined it in greater detail. Objective four, which will be dealt with in this chapter, discusses the possible marketing mechanisms for corn in light of the findings on price stability and producer gains. Several of the other characteristics discussed in chapter two could have been used for a similar discussion, but this analysis is limited to price stability and its effect on producer welfare.

6.2 SUMMARY OF THE EXAMINATION OF THE MANITOBA CORN INDUSTRY

The first objective included an examination of the price and production relationships existing for grain corn and its substitutes in the feed industry and competitors for land use. Several interesting features became evident. Given present technology, there is potential to produce over 750,000 tonnes of corn. With improvements in the hardiness and development characteristics this potential is expected to double in the near future. At least as important, is the potential demand that is evident. A linear program was used to calculate the potential utilization of corn, by prairie livestock, under alternative price scenarios. This model indicated that excess demand existed in the corn market for both of the years tested, (1976 and 1978). Should the relative price relationships presently existing for feed grains continue, this excess demand should persist.

Corn acreage and production has tended to increase steadily over the past 10 years. Any acreage fluctuations that did occur were found to parallel those of barley, flax, rapeseed and other speciality crops, but not to the extremes evident in these crops. All of these crops, including corn, displayed inverse relationships between their acreage levels and that of wheat acreage.

Upon examination of the daily, monthly and yearly Manitoba corn prices, using a seasonality index and other statistical tests, it became clear that instability existed in each of these time periods. It was important to determine this factor because it is critical for the policy prescriptions that are later derived from the empirical results. As expected, the annual prices recieved by Manitoba producers were shown to follow Chicago corn and Canadian barley prices very closely. There was a notable premium paid for American corn, however. This can be accounted for by both, the higher quality corn produced and the discounts that were offered by Manitoba growers to encourage use of their corn.

The Domestic Feed Grains Policy, which presently operates for wheat, barley and oats, outlines for the marketing and pricing of these coarse grains in one of three ways. The simplist, is the producer to feedlot operator sale for a negotiated price. Feed grains can also be sold on quota to the Canadian Wheat Board for the initial price set by the Board. The grains marketed in this manner are either exported or sold to eastern or B.C. feed mills for a 'corn competitive' price determined daily by the Board. The Winnipeg Commodity Exchange also prices feed grains, and producers have the option of marketing their grain in this manner. This usually involves delivery of the Non-Board feed grain to primary elevators for the quoted street price, but also allows producers to sell contracts on their crop and arrange for delivery independently.

Corn does not come under the jurisdiction of the Feed Grain Policy and it is marketed and priced somewhat differently. Sales are transacted either by individual producers or jointly through the Manitoba Corn Growers Marketing Association. The prices under which these sales are made are determined either by negiotation between buyer and seller, or by the price quoted monthly by Calvert's distillery, or the street price quoted by the various grain companies daily. All of these prices are tied to the Chicago Board of Trade prices for American corn, but actual calculations will vary.

British Columbian livestock operators have provided a new outlet for Manitoba corn and this market is still expanding. All corn moving to B.C. qualifies for Feed Freight Assistance and thus trucking has proven to be a feasible transporting alternative. Such an option has allowed Manitoba corn growers to ship corn to B.C. without the delivery restrictions placed on rail moved grain. This has enabled Manitoba corn growers to expand further into these markets because of assured delivery and supply.

The Ontario corn growers function largely independently although a marketing association does exist. The prices they receive for corn are tied directly to the Chicago Board of Trade price as American corn represents the major competitor in their market.

6.3 SUMMARY OF THE RESULTS

Schmitz et al., proposed that "...a firm engaged in the production of more than one type of commodity may prefer price stability for some of the commodities it produces but not for the entire set."[93] Chapter 3 provides a presentation of their theorem, and Chapter 4 describes the measurement and ranges of the respective parameters that were used in the application of this theorem to corn producers. Chapter 5 illustrates the results. It follows from the Schmitz et al., theorem that that agricultural producers in Manitoba, should prefer price stability in some of their commodities while not in others.

There are four parameters that are required for an application of the Schmitz et al., theorem to the corn industry. The preference for price stability depends on the contribution to total revenue provided by corn, the revenue/cost or profit ratio found to be applicable for corn production, the production sensitivity to price changes displayed by corn growers, and the desire for risk shown by corn producers. Derivation of the ranges of these parameters was based on examinations of producer records, supply elasticity estimations for corn and barley and production budget estimates.

Consistent with expectations, as the risk aversion coefficient increased (indicating a greater aversion to risk) so did the gains from stability in price. With increases in the profitibility of corn production there was a decrease in the preference for price stability. As producers became more responsive to price changes,(i.e.,increases in price elasticity of supply), there was a corresponding increase in the

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93 Schmitz, Shalit and Turnovsky, op. cit., p. 157.

gains from price stability. As the commodity under consideration contributed a proportionally greater percent to total income, the preference for price instability in that crop would diminish.

In an attempt to determine the pricing mechanism that provides the greatest gains for the largest number of grain corn producers, one must first determine what values the parameters should assume in order to provide the best representation of Manitoba corn producers. In an attempt to estimate this, the elasticity of supply was assumed to be .75. This illustrated a mid-range inelasticity in accordance with previous studies consulted. The relative risk aversion coefficient was set at one indicating an "average" producer with a logarithmic utility function. The profit margin was assumed to be .3 which was chosen to illustrate a conservative lower mid-range value. Based on the values of these three parameters Figures 16B or 21B become the appropriate ones for consideration. From either of these figures the following conclusion arises: price instability will provide greater gains up to the point where corn contributes 15 percent or under to total revenue. If corn comprises more than that, price stability provides greater gains.

It is important to consider one further scenario, that of an increase in profit margin to .4. With α and r remaining constant this causes a slight change in conclusions. In this case a producer will be better off with price instability up to the point where corn contributes 20 percent or less to total revenue. If he produces any more grain corn than that, price stabilization will result in greater gains.

If the majority of grain corn producers had corn acreages that provided 20 percent or less of total income, a pricing mechanism that allowed instability would be preferred. If, however, corn provided more than 20 percent of income, stable price conditions would be preferred.

In dicussions with three producers it was discovered that corn most often provided producers in their areas, 25-33 percent of income. This would imply that price stability would provide the greatest returns. It is again important to point out, however, that if the profit margins were higher or the aversion to risk lower, both quite conceivable alternatives, such would not be the case. It would require individual surveys and calculations for each producer to determine exactly the pricing mechanism that would suit him. These then could be aggregated to determine an overall mechanism for the industry.

6.4 POLICY IMPLICATIONS

Prior to discussing how a presciption for price instability or stability can be incorporated into a marketing scheme, reconsider the alternatives that exist. The first is that corn comes solely under the jurisdiction of the Canadian Wheat Board. This would ensure that both Eastern and B.C. feed mills buy all their Manitoba corn from the Board for a price set by the Board. Presently this price is the corn-competitive price which is set in alliance with U.S. corn and soymeal prices. While this price is quoted daily to buyers of feed, the proceeds obtained from the sales are combined in a 'pool account'. Initial payments are made to producers for grain delivered, based on the expected price that will be obtained for the year. Should the proceeds in the pool account exceed the administration costs and the initial payments allocated, the surplus is distributed to all producers based on the quantity delivered. This ensures a stable price for grain producers for a one year period.

Corn could also come to again be priced in the open market. To make such an option workable, the WCE would have to develop a system of multi-delivery points for Ontario users and offer a contract size of 20 tonnes.[94] If such were possible, this price would be variable, typical of those determined by such a trading system.

The third alternative, which presently exists for other grains, is a combination of the first two. That is, to have corn placed under the authority of the Domestic Feed Grains Policy. This option would enable corn producers to sell either to the Canadian Wheat Board, or to transact sales to elevator companies for a daily street price determined from a Chicago base. Although corn is not traded on the WCE, it would be possible for a producer to hedge his crop on the barley futures market, which provides the similar price movements necessary for this type of price protection. Producers could also hedge their corn on the Chicago Board of Trade in the American corn futures market, which would provide similar protection. Such a transaction, however, would also require an additional hedge to reduce the risk of fluctuations in the exchange rate.

The final alternatives that exist for marketing grain corn shall be dealt with under two headings. Although some of the details of each will be similar this should facilitate easier examination of these two alternatives. The first category involves an already existing organization called the Manitoba Corn Growers Marketing Association. This is a

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94 Discussions with D. Ford, President of the Winnipeg Commodity Exchange, July 14, 1981.

voluntary association founded in 1979 and provides producers wishing to engage in a collective marketing scheme an option for such sales. It serves to arrange the sale of corn to respective buyers by contacting members of the association with corn to sell, making an offer, and arranging for transport. These buyers include feed mills in B.C. and Alberta as well as grain companies stationed in Winnipeg. The conditions of these sales are of two varieties; forward sold or unrestricted.

The present pricing arrangements for this Marketing Association involves the direct transfer of transaction price from user to producer. If the association were to pool the revenues received for all of their sales, a stabilized price could be derived in which each producer received an average annual price from sales throughout the year. Thus either stabilized or fluctuating prices could be maintained under a marketing association, depending on the desires of the member producers.

The last alternative for grain corn producers is to arrange for sales individually. Many producers in Manitoba engage in this practice, relying largely on production contracts and deferred delivery sales to reduce their price risks. There is also the option of unrestricted sales, in which producers arrange for the sale of their crop after harvest is complete. Another option exists for producers wishing to reduce risk of price fluctuations. This is to hedge corn futures on the Chicago Board of Trade. The bulk of these individual sales, however, are presently made to local grain companies, for a daily street price set by the company. This raises another pricing possibility.

Recently some of the grain companies have set up pooling accounts for certain specialty crops such as lentils. Under such a scheme the grain companies agree to sell the particular crop, but rather than pay the specific transaction price, they pool the price so that all producers receive an average price from the total volume of sales. This insures that individual producers do not receive a higher or lower price because of the delivery and marketing opportunities of the grain company. Such a program provides a stabilized price and could easily work for a commodity such as corn. Thus, if price stability were desirable, this method represents a manner in which it could be achieved without a marketing organization. Conversely if producers prefer an unstable price, the traditional unrestricted sale, production contract or deferred delivery contract with no pricing arrangement would provide such a condition. A combination of both, set and variable price, can be achieved through production contracts or deferred delivery contracts if part of the price is arranged at time of agreement and the remainder left to be determined at time of delivery.

Combining these options with the results on price stability and producer welfare obtained for objective three, imply that four of the five marketing alternatives just outlined for corn might presently be applicable. Recall that as long as corn contributed more than 20 percent to total income, the elasticity was equal to .75, the profit margin assumed a value of 30 percent or 40 percent, and the coefficient of risk aversion indicated an "average" producer, corn growers would be better off if price was stabilized at its mean. In discussions with several producers corn almost always contributed more than 20 percent to income and therefore stability in price should be preferred.

This prescribed stability could be obtained in one of the following ways. The first is for the Corn Growers Marketing Association to pool the revenues received from sales for a year and distribute an average price to producers. Such a mechanism is found operating for California cotton growers set up as a voluntary co-operative organization. Another option that seems plausible is to allow and encourage the private grain companies to engage in an annual pooling scheme like they presently operate for other specialty crops. It is unlikely that both alternatives together would be realistic or even desirable as the duplication of services would prove too costly for either organization. The Canadian Wheat Board pooling mechanism, operated as a sole market outlet or as a combined entity under the Domestic Feed Grains Policy, can also provide a stable price. The only option that can not comply with the pricing specifications derived for the "average" Manitoba producer is the futures market. Any one of the other options, however, could provide the price stability required to achieve maximum welfare gains for corn producers given, the assumptions made about the values of the parameters.

Variations in any of the values of the parameters result in somewhat different conclusions. If, for instance either or both the elasticity or the profit margin were found to be larger, price instability would provide greater gains and a pooled price would reduce returns. Or if these corn producers were found to be somewhat less risk averse than the average producer, again instability in price might be preferred. If the empirical results indicated that producers would be better off with price instability, the marketing alternatives would be somewhat different. The three pooling mechanisms that could be set up by the Manitoba Corn Growers Marketing Association, the grain companies or the CWB, would be unsuitable. Pricing systems such as those found associated with the WCE, a transaction price of the marketing association or a daily price quoted the grain companies, would provide the variable price required.

The empirical results indicate that if the values of the parameters are chosen to represent an 'average' Manitoba corn grower, so that $r= 1$, $\varepsilon=.6$ and $\mu=.3$ or $.4$, as long as corn contributes less than 20 percent to farm income, price instability will provide the greatest gains. It follows from this that producers should not increase production levels to above this 20-25 percent level if an unstable pricing mechanism prevails. It is reasonable to suggest, therefore, that the presence of an instable price could place downward pressure on grain corn production levels at the individual farm level. While this has not yet proven to be the case, (recall that corn usually contributes over 33 percent to farm income), this could be attributed to the fact that corn producers are slightly more sensitive to price changes, or the profitability is somewhat higher than was estimated, or that these producers are greater risk takers than were the values used for the policy prescription. The turning point will occur at some combination of values, however, and at this point price stability will provide greater returns than price instability. If an unstable pricing mechanism is in place, production level increases should cease at these critical points. This implies that the type of pricing mechanism may have an influence on the production levels that crops will attain.

6.5 LIMITATIONS

These results obtained for grain corn are useful for determining the type of pricing mechanism that will be best suited to grain corn. There are of course limiting assumptions associated with this proposition and its results and any and all conclusions drawn from them must be considered in that light. Most of the limiting assumptions and difficulties in extension of the analysis have been dealt with throughout the discussions. However, it is worth restating the most important ones here.

The first and foremost is the aggregation problems inherent in this analysis. These arise in two distinct forms. The first is in the measurement of the four parameters used in the Schmitz et al., theorem. While profitability, risk aversion and contribution to total revenue present difficulties in measurement, they are not of major concern. Estimations of the price elasticities of supply do, however, warrant special note. The coefficients of price elasticity used, are derived from studies done for eastern and western Canada and the U.S. corn belt. In addition to the normal measurement and econometric biases, the aggregation for an estimation of industry supply will be a source of bias in this study. The sgn funtion is used in the context of an individual firm and using an industry supply curve might result in a distortion of the adjustment sensitivity.

The second type of limitation arising from aggregation, operates in the reverse manner. Given that the sgn function operates for an individual multi-product firm, the question arises of how far these individuals can be aggregated in order to draw some conclusions about the grain corn industry as a whole. Due to the nature of the parameters and the testing criterion, values of the parameters can be chosen to represent an 'average' producer. It is then possible to draw conclusions for the industry based on this estimation.

The next limitation that will be discussed here is that associated with the definition of stability and instability. These definitions or rather assumptions have been a constant source of criticism since Oi's original article in 1961. A stable price is one which is defined as the arithmetic mean of one high and one low price. Assuming a normal distribution of prices, instability in price refers to the two high and low prices from which the stable or mean price is derived. By definition these high and low prices have an equal probability of occurrence (p=.5) and when combined with any positive MC curve resulted in greater gains for producers than if a stable price existed. For these purposes it seemed most reasonable to assume that it was desirable to remove the daily, weekly, and monthly price fluctuations and define a stable price as the average annual price for the year. The skewness of the price distribution was not tested here and it was assumed that the distribution of prices was approximately normal. This time period for stabiliy also proves to be consistent with the time period of production which is annual for Manitoba corn.

A third limitation or concern that must be raised in regards to the empirical analysis is the measurement of the parameters. While the difficulty in obtaining true estimates of profit margin, contribution to income and price elasticities of supply can not be mitigated, the real problems arise when attempts are made to derive utility functions. As was described in the model specification, this study chose values of the relative risk aversion coefficient after consultation with other studies and examination of the theory associated with the measure itself. Choosing values in this manner did not detract from the results as the purpose of this study was to test the sensitivity of the criterion to various ranges of parameters that were estimated for corn producers. The conclusions were still drawn based on the "Everyman's" utility function of the logarithmic form with a relative risk aversion coefficient equal to one. The derivation of utility functions for individual producers will prove to be a lengthy task, the results of which are still to be viewed with suspicion.[95]

The limitations thus far have been concerned with difficulties encountered with the study at hand. It is important to point out, however, that the empirical analysis undertaken for the examination of corn price stability relies completely on the assumptions made by Schmitz et al. The properties of the production function used in their optimization problem were accepted without modification. While it was not within the scope of this paper to do otherwise, there was the need to bring to the readers attention the limitations that could result from thse assumptions.

While the limitations presented here certainly do not cover all the concerns that arose in regards to this study, they do note the most serious ones and the ones that would be of major concern for researchers

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95 Recall Young, op. cit., p.1,067, "...[reseachers should ask] why it is important to know producer risk preferences...[and]... recognizing the added cost of measuring risk preferences and the unproven reliability of the measures, it is necessary to evaluate within the context of the specific problem whether attempted measurement is worthwhile."

attempting to expand in this area.

6.6 SUGGESTIONS FOR FURTHER RESEARCH

The first suggestion that comes to mind is the development of an extensive survey to measure individual producers values of profit, contributions to total revenue, sensitivity to price changes and utility functions. Such an analysis would be a major undertaking both in time and expense. It would, however, provide exact observations for the four parameters and for which the testing criterion could then be used. The implications for policy and pricing recommendations could then be made based on these results. There would be difficulties encountered in the measurement of these parameters and concerns raised in regards to survey form and technique, therefore, careful consideration must be given to the value and advancement gained from the expanded effort.

The second suggestion for future researchers is to use the technique developed by Schmitz et al., and applied here for grain corn, for some other commodity. Having shown how such an analysis can be applied and having outlined some of the difficulties and concerns arising from its use, other researchers could now apply the technique for other crops and livestock or any firm with a multi-product output. Actually, the values of the parameters chosen for corn show where the tradeoffs lie between price stability and instabilty under these specified conditions. These same tradeoffs apply for any commodity under the same range of parameters. It would be possible, therefore, to suggest desirable pricing conditions for other commodities based on this analysis,(as long as the parameters displayed values within the range used here).

Following from the previous discussion on the effect of price stability on production levels, a further suggestion for research arises. The lower levels of production were examined here in the attempt to determine a pricing and then marketing policy that would provide the greatest gains to present producers. It would be useful to extend this analysis and discussion to derive the levels at which production would be inhibited because of the pricing system in place.

On a more theoretical note, there are two suggestions in regards to further work that might be done. The first concerns the measure of risk aversion that was utilized. Close examination of the Arrow-Pratt measure of relative risk aversion reveals that there are difficulties encountered in use of such a method. While such problems arise with any measure of risk preference, it might be a useful exercise to test some of the different types that exist. Some other methods include absolute measure of risk aversion and the partial measure.

A second theoretical improvement that warrants mention is the use of arithmetic mean as the definition of stability. Some of the literature criticising Oi's paper suggested that a weighted mean would provide a more realistic estimate of stability. Evaluating the testing criterion under such an assumption might change the conlusions drawn. It would be interesting to examine the effects of different definitions of stability and instability on the conclusions drawn from Schmitz et al.'s, proposition.

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Appendix A

BACKGROUND TO THE PROBLEM

Table A1

Wheat and Corn Production Costs and Revenues

	Corn	Wheat
Total Costs: ($/acre)[a]	$ 222.94	$ 147.92
- Land Investment Cost	40.00	40.00
- Machinery Depreciation	27.67	10.00
- Machinery Investment Cost	13.45	6.60
Costs: (per acre)	$141.82	$91.32
(per hectare)	57.39	36.96
Costs for 202,350 hectares		
Number of Hectares	202,350	202,350
X Costs	57.39	
Total Cost: ($)	$ 11,612,867.00	$ 7,478,856.00
Total Revenue[b]		
Price: ($/tonne)	$ 140.00	$ 220.00
X Yield: (Kg./hectare)	4,000.00	1,728.00
X Number of Hectares	202,350.00	202,350.00
Total Revenue: ($)	$113,320,000.00	$77,100,206.00

(Continued)

Table A1 (Continued)

	Corn	Wheat
Net Revenue		
Total Revenue	$113,320,000.00	$77,100,206.00
Total Cost	11,612,867.00	7,478,856.00
Net Revenue	$102,707,133.00	$69,621,350.00

Source: [a]Farm Management Section, Manitoba Department of Agriculture, Cost of Production Budgets for 1981.

[b]Manitoba Department of Agriculture, Manitoba Agriculture 1979 Yearbook, Queen's Printer, Winnipeg, Manitoba 1979, pp. 53 and 60. Also personal interview with Metro Daciw, Manitoba Department of Agriculture.

Table A2

Performance of Corn Hybrids
Morden, Winnipeg, Brandon 1979-80

Heat Unit Rating	Brand Name	Variety Name	Hybrid Type***	Days to Silk	Stalk Break 1-5**	Root Lodg. 1-5**	Grain Density % of Mean	Grain Moist %	Grain Yield % of Mean	Plant Yield % of Mean	Plant Moist %
2150	Pioneer	3995	3W	69	1.8	1.6	102	21.9	92	91	57.4
	Asgrow	RX17	3W	73	2.1	2.1	102	23.1	92	85	60.9
	N.King	PX403	3W	72	2.5	1.8	104	21.3	101	93	54.7
2200	Pickseed	2111	SC	73	2.0	1.5	101	23.5	101	86	59.2
	Pioneer	3886	DC	72	1.6	2.0	102	24.4	100	97	62.8
	Pioneer	3996	3W	73	1.6	1.6	100	25.0	96	92	57.1
	Asgrow	RX22	3W	75	2.3	1.9	100	22.8	104	91	53.3
	Hyland	HL2200*	SC	72	2.2	1.7	100	25.5	103	-	-
	Pioneer	3994	3W	72	1.4	2.0	99	24.0	100	98	62.1
2250	Pioneer	3993	3W	72	1.4	1.5	101	25.4	101	91	63.9
	Pride	R090	OC	74	2.2	1.2	100	21.5	118	-	-
	Pride	1108	SC	75	1.8	1.7	102	22.3	106	97	58.2
	Pride	1111*	SC	74	1.7	1.0	99	22.9	100	-	-
2300	Dekalb	DK23	3W	75	2.4	1.3	101	22.0	95	90	61.3
	Warwick	TX17	3W	75	2.1	2.1	99	24.1	96	89	61.1
	Dekalb	DK24	3W	76	2.4	1.7	100	23.1	107	104	65.1
2350	PAG	501	3W	75	2.1	1.4	100	23.0	98	87	61.7
	Pickseed	PS2555*	SC	75	1.4	2.2	100	24.3	103	-	-
	Pride	R102	3W	75	1.7	1.9	97	26.5	87	93	63.8
	Hyland	HL3208	3W	74	2.3	1.7	100	27.3	103	91	63.7
	Pickseed	XR14	SC	75	1.9	2.0	98	26.2	103	90	64.6
2400	Stewart	244	3W	76	1.8	1.9	98	25.8	102	94	65.7
	Trojan	T737	3W	77	1.7	2.3	96	27.3	91	94	62.9

* On the recommended list for the first time.
** Ratings 1 to 5: 1 is best, 5 poorest.
*** SC denotes single cross, 3W three-way cross, DC double cross; OC other cross.

- Hybrids are grouped according to maturity or Heat Unit Ratings. Within each group they are listed in alphabetical order.
- Density mean = 693 kg/m^3 (56 lbs/bu).
- Silage yield mean = 12.4 t/ha (5.4 t/ac).
- Grain yield mean = 5.87 t/ha (81.1 bu/ac).
- Density and yield are recorded as percentages of the test means.
- Heat unit ratings are based on heat units required to mature grain corn.
- DM denotes dry matter.

Table A3

Wheat Statistics

Year	Acreage[a] in Prairies (000 hectares)	Production[a] in Prairies (000 tonnes)	Acreage[b] in Manitoba (000 hectares)	Production[b] in Manitoba (000 tonnes)	Price[b] ($/tonne)
1970	4,856	8,505	567	830	53.28
1971	7,643	13,880	1,019	2,014	50.34
1972	8,417	13,962	1,052	1,878	68.34
1973	9,348	15,622	1,254	2,177	158.00
1974	8,701	12,655	1,133	1,606	146.98
1975	9,227	16,329	1,255	2,123	129.71
1976	10,967	22,752	1,538	2,803	102.88
1977	9,790	18,833	1,295	2,748	110.23
1978	10,365	20,575	1,376	2,830	137.79
1979	10,199	16,248	1,214	2,098	165.35
1980	10,927[p]	17,540[p]	1,336	1,905	220.50

[p]preliminary.

Sources: [a]Canada Grains Council, Canadian Grains Industry Statistical Handbook '80, Canada Grains Council, Winnipeg, Manitoba, 1980, p. 3 and 9.

[b]Manitoba Department of Agriculture, Manitoba Agriculture, 1979 Yearbook, Queen's Printer, Winnipeg, Manitoba, 1979, p. 51.

Table A4

Barley Statistics

Year	Acreage[a] in Prairies (000 hectares)	Production[a] in Prairies (000 tonnes)	Acreage[b] in Manitoba (000 hectares)	Production[b] in Manitoba (000 tonnes)	Price[b] ($/tonne)
1970	3,764	8,317	607	1,100	36.74
1971	5,387	12,410	830	2,047	35.82
1972	4,816	10,712	850	1,851	57.87
1973	4,593	9,667	850	1,807	115.28
1974	4,533	8,252	728	1,154	101.97
1975	4,209	8,905	607	1,110	104.72
1976	4,087	9,907	627	1,415	91.86
1977	4,514	11,213	769	2,047	68.89
1978	4,002	9,732	708	1,851	75.78
1979	3,480	7,773	587	1,263	103.34
1980	4,249[p]	9,950[p]	789	1,502	137.81

[p]preliminary.

Sources: [a]Canada Grains Council, Canadian Grains Industry Statistical Handbook '80, Canada Grains Council, Winnipeg, Manitoba, 1980, p. 4 and 10.

[b]Manitoba Department of Agriculture, Manitoba Agriculture, 1979 Yearbook, Queen's Printer, Winnipeg, Manitoba, 1979, p. 53.

Table A5

Rapeseed, Flaxseed and Sunflowers Statistics

Year	Rapeseed Acreage in Manitoba (hectares)	Rapeseed Production in Manitoba (tonnes)	Flax Acreage in Manitoba (hectares)	Flax Production in Manitoba (tonnes)	Sunflower Acreage in Manitoba (hectares)	Sunflower Production in Manitoba (tonnes)
1970	161,872	163,296	465,000	317,525	26,304	23,587
1971	235,119	272,160	229,000	149,872	62,725	52,731
1972	190,200	192,780	202,000	149,872	76,889	68,947
1973	161,872	174,636	243,000	193,055	50,585	39,690
1974	202,300	192,800	283,000	167,700	8,500	8,255
1975	303,500	283,500	304,000	213,500	25,090	29,937
1976	101,000	102,100	212,000	160,000	20,000	24,000
1977	202,000	290,300	304,000	330,100	67,000	79,400
1978	425,000	578,300	304,000	317,400	87,000	115,200
1979	546,300	567,000	506,000	470,074	153,778	208,660
1980	324,000	317,500	324,000	215,900	129,000	158,800

Source: Manitoba Department of Agriculture, Manitoba Agriculture, 1979 Yearbook, Queen's Printer, Winnipeg, Manitoba, 1979, p. 69 and 57.

Table A6

Daily Closing Prices for Grain Corn Quoted by Manitoba Pool

		1977		
August	September	October	November	December
	75.99	73.24	78.36	76.78
	76.78	75.21	79.53	77.18
	77.96	74.03	78.36	75.99
	77.96	75.99	77.96	76.39
	78.75	72.45	79.14	76.39
	79.54	74.42	76.78	78.75
	80.33	74.03	77.77	78.75
	80.33	72.84	77.37	77.57
	79.14	73.24	76.39	80.72
	78.75	73.63	77.57	80.72
78.36	78.75	74.03	79.14	80.72
77.57	79.54	74.03	78.36	80.72
77.57	80.72	72.84	79.14	80.72
78.55	77.57	72.84	78.36	80.72
78.75	77.18	74.81	76.78	80.72
78.75	79.54	74.42	77.18	80.72
77.18	74.42	75.60	77.18	82.69
77.18	73.24	74.81	78.36	82.69
75.60	72.45	75.21	77.18	82.69
	72.45	76.78	77.18	82.69
	72.06		76.78	
N 9	21	20	21	20
$\bar{X}$ 77.72	77.31	74.22	77.85	79.72
Var .927	7.4774	1.2793	.8001	5.0487
SD 1.0212	2.8020	1.1604	.9166	2.3053

1977	
N	5
$\bar{X}$	77.36
Var	3.1603
SD	1.9875

(Continued)

Table A6 (Continued)

January	February	March	1978 April	May	June
82.7	83.4	83.3	93.2	90.8	106.3
81.90	83.8	84.1	94.0	90.0	104.8
81.90	83.8	84.9	94.8	90.0	105.9
81.90	83.7	84.9	95.1	92.0	105.1
86.62	83.7	85.2	96.3	94.0	103.6
97.9	86.9	83.4	86.62	94.2	103.6
86.62	84.0	86.5	97.1	98.4	102.8
86.62	83.8	86.1	96.3	98.4	103.6
84.26	83.7	87.7	94.4	100.0	103.2
84.26	83.7	88.5	95.2	99.6	102.4
84.26	83.7	89.2	93.3	95.0	102.0
84.26	83.7	89.7	95.6	100.8	101.6
84.25	83.7	92.4	94.7	100.8	103.2
84.26	83.8	90.8	94.0	101.6	103.6
84.26	83.8	90.0	93.2	101.2	103.2
84.26	83.8	91.6	89.7	103.5	104.0
84.26	83.8	92.8	91.6	102.8	103.2
83.87	83.8	94.7	90.4	104.7	102.8
84.26	83.8	94.2	90.8	104.7	101.6
83.67	83.1	92.4	92.0	104.7	99.3
83.28		92.4		108.3	98.5
		93.9		107.9	99.7
N 21	20	22	20	22	22
$\bar{X}$ 84.20	83.70	89.24	94.13	99.25	102.91
Var 2.0387	.0360	12.2924	4.9791	29.95	3.6163
SD 1.4631	.1947	3.5886	2.2894	5.6018	1.9464

(Continued)

Table A6 (Continued)

	1978					
	July	August	September	October	November	December
	99.7	90.60	85.8	90.20	93.3	93.7
	99.2	89.0	85.5	92.0	94.1	92.9
	99.3	88.6	85.5	92.1	94.1	92.5
	98.3	87.8	85.9	92.2	93.3	92.5
	97.8	87.0	85.5	93.7	93.0	92.9
	96.0	87.9	86.6	92.9	93.0	92.9
	94.3	88.2	86.7	93.7	92.1	92.1
	93.2	85.9	85.9	92.5	92.1	91.0
	93.6	87.0	85.5	91.4	91.8	90.5
	92.6	89.8	85.4	91.0	90.6	91.0
	89.4	87.8	85.8	90.6	91.0	92.0
	90.6	88.6	86.6	91.8	91.3	92.1
	90.8	90.2	87.8	92.5	90.9	90.9
	93.8	90.2	86.6	93.3	91.7	90.6
	92.1	89.0	86.2	95.3	92.1	90.9
	91.4	89.4	86.6	96.1	92.1	91.3
	92.5	89.0	87.8	94.5	94.5	91.3
	91.8	88.2	88.6	94.1	93.7	91.5
	91.8	86.6			92.9	
	91.8	86.6			92.5	
		86.6				
N	20	21	18	18	20	18
$\bar{X}$	94.00	88.29	86.35	92.77	92.51	91.81
Var	9.877	1.7193	.8036	2.3921	1.2065	.8366
SD	3.2244	1.3436	.9224	1.5915	1.1269	.9412

1978		
	N	12
	$\bar{X}$	91.60
	Var	30.1748
	SD	5.7374

(Continued)

Table A6 (Continued)

	1979 January	February	March	April	May	June
	91.4	95.5	98.2	100.2	110.5	108.7
	90.6	95.7	97.8	99.0	112.7	109.5
	90.2	96.1	98.2	99.4	109.9	109.1
	89.8	95.7	98.2	101.4	107.3	110.2
	90.2	96.5	98.2	102.2	108.1	109.8
	90.2	96.1	97.8	102.6	109.3	111.8
	91.7	97.2	97.8	101.8	108.9	114.6
	92.7	96.8	98.0	106.9	108.5	111.8
	94.9	96.0	97.7	106.6	107.7	113.8
	94.5	97.2	97.3	106.2	107.1	114.2
	93.7	97.2	97.4	107.0	106.3	116.5
	94.1	97.2	97.0	106.5	107.1	115.3
	94.9	97.2	97.0	105.8	106.3	119.3
	94.9	97.6	97.8	106.2	109.3	121.6
	95.6	98.0	98.2	106.6	109.3	126.4
	95.6	98.0	98.2	107.7	107.5	123.2
	95.7	97.6	98.6	108.5	107.5	124.0
	95.3	98.2	99.4	108.2	107.5	120.5
	95.3	97.8	99.0	108.9	106.7	117.3
	95.9	97.8	99.8	109.3	108.7	118.5
	95.7		99.8		108.7	
			99.8			
N	21	20	22	20	21	20
$\overline{X}$	93.47	96.97	98.24	105.05	108.33	115.81
Var	4.8125	.7081	.6887	10.4565	2.2489	27.7485
SD	2.2479	.8633	.8494	3.3176	1.5367	5.4045

(Continued)

Table A6 (Continued)

	1979 July	August	September	October	November	December
	122.4	113.4	108.6	114.2	105.6	114.2
	122.8	109.4	109.0	113.0	106.4	111.1
	125.6	110.2	106.7	113.8	107.2	110.3
	123.6	109.0	107.1	114.6	106.4	109.5
	125.6	110.6	109.5	113.4	107.2	109.1
	122.8	110.6	107.9	111.0	106.8	110.7
	125.2	109.8	107.9	110.6	107.2	110.3
	118.9	107.5	109.4	114.6	109.9	109.9
	120.8	110.6	109.4	114.6	111.5	110.7
	120.0	110.6	109.8	112.7	111.1	109.9
	120.8	111.4	109.4	112.7	110.3	110.7
	122.8	111.0	110.6	113.8	110.7	116.2
	119.6	112.6	109.8	113.4	111.5	116.6
	122.0	110.2	110.6	114.6	112.7	117.0
	118.8	111.0	108.6	116.6	112.6	113.0
	117.3	111.4	108.6	115.6	112.6	113.8
	114.1	111.0	112.2	113.8	111.1	114.6
	114.5	112.2	111.0	108.7	111.1	113.8
	111.0	113.0		105.6	110.7	
	109.5	113.0		107.2	109.9	
	111.0			107.1	111.5	
N	21	20	18	22	21	18
$\bar{X}$	119.48	110.93	109.23	112.25	109.71	112.3
Var	22.8113	2.0069	1.7909	9.0027	5.2193	6.4667
SD	4.8941	1.4535	1.3771	3.0711	2.3410	2.6167

1979		
	N	12
	$\bar{X}$	107.65
	Var	56.4765
	SD	7.8493

(Continued)

Table A6 (Continued)

	1980 January	February	March	April	May	June
	112.8	109.8	102.8	102.8	104.7	114.0
	113.0	109.0	104.8	104.0	105.5	111.8
	111.8	108.3	104.3	105.5	107.9	111.8
	106.8	108.3	103.9	105.5	108.8	111.4
	104.6	107.9	107.9	106.7	109.0	111.4
	105.3	108.7	107.1	108.3	111.2	111.4
	106.3	107.9	106.3	106.3	111.8	111.4
	107.1	108.3	107.1	106.3	107.7	111.4
	105.9	107.1	106.3	104.7	110.0	111.8
	110.3	107.1	107.5	105.1	109.2	112.2
	109.9	105.9	106.7	105.9	109.6	113.4
	109.9	106.3	106.7	105.1	109.4	113.0
	107.9	105.9	107.5	104.7	109.8	113.0
	106.7	105.1	106.3	105.9	109.8	112.6
	106.3	105.5	105.5	105.5	110.1	113.0
	107.9	105.2	104.7	105.1	114.2	113.4
	107.1	104.3	104.7	105.5	109.8	113.8
	106.3	104.3	103.9	105.9	110.6	113.8
	107.1	103.2	102.4	104.7	114.2	113.8
	107.1		102.4	104.3	114.2	113.4
	108.3		101.6	104.3	114.0	
	107.9					
N	22	19	21	21	21	20
$\bar{X}$	107.97	106.74	105.26	105.34	110.03	112.59
Var	5.0358	3.2215	3.452	1.2053	6.5843	.8979
SD	2.2969	1.8440	1.9038	1.1250	2.6294	.9722

(Continued)

Table A6 (Continued)

	1980 July	August	September	October	November	December
	116.1	134.6	142.3	135.0	152.0	153.1
	118.5	133.1	141.7	133.0	152.0	152.0
	118.5	134.6	140.9	137.2	154.0	150.0
	118.5	135.4	141.0	139.1	148.1	147.8
	120.7	134.3	141.6	138.4	147.6	146.5
	120.3	132.9	139.2	139.4	147.6	146.6
	118.5	136.2	138.6	139.8	148.9	141.5
	120.9	135.2	139.6	140.8	148.5	137.1
	122.4	133.1	135.9	143.3	150.1	132.2
	126.8	131.5	136.2	142.7	149.4	137.2
	126.0	132.5	137.0	141.7	150.6	142.2
	128.0	133.3	136.8	142.4	150.3	144.7
	129.1	133.6	137.0	142.4	153.1	146.9
	128.1	134.8	138.1	146.2	149.5	145.9
	124.4	134.5	137.2	145.6	151.0	146.5
	125.4	135.3	136.2	148.1	152.3	147.8
	129.2	138.2	133.9	146.7	152.3	147.6
	128.7	137.0	134.8	150.2	155.3	147.7
	126.4	137.0		151.2		144.1
	127.6	140.9		150.8		143.4
	128.4			150.4		
	127.9					
	131.9					
N	23	20	19	22	19	21
$\overline{X}$	124.45	134.90	138.25	143.08	150.83	145.13
Var	19.7027	4.533	5.6985	25.2743	4.7146	23.5584
SD	4.5385	2.1844	2.4526	5.1456	2.2308	4.9736

1980		
	N	12
	$\overline{X}$	123.71
	Var	285.92
	SD	17.66

(Continued)

Table A6 (Continued)

	1981 January
	144.2
	144.5
	144.6
	144.2
	142.2
	142.6
	142.4
	142.2
	140.4
	137.5
	140.1
	140.3
	141.5
	143.3
N	14
$\overline{X}$	142.14
Var.	3.8755
SD	2.0429

Source: Manitoba Pool Elevators daily price quotations 1977-1981.

Appendix B

REVIEW OF RELATED LITERATURE ON PRICE STABILITY

Over the last two decades there has developed an extensive body of literature on the theory of producer gains from price stability. The discussions began with an article by Oi in Econometrica in 1961.[96] In the same year, Nelson independently drew the same conclusions as Oi, although from a somewhat different angle.[97] Other economists which contributed to this theory and which will be considered here, include; Tisdell, Zucker, Leland, and Sandmo.[98]

Oi[99] developed his theory to resolve the missing elements that classical economics leaves in its attempt to explain risk and uncertainty in a partial equilibrium model. He used the simple competitive firm facing unstable price, and showed how the traditional belief that firms always prefer stability in prices may not be the case. He did so under

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96 W.Y. Oi, "The Desirability of Price Instability Under Perfect Competition," Econometrica, Vol. 29, Jan. 1961, pp. 58-64.

97 R.R. Nelson, "Uncertainity Prediction and Competitive Equilibrium," Q.J.E., Vol. 75, Feb. 1961, pp 41-62.

98 C. Tisdell, "Uncertainty, Instability, Expected Profit," Econometrica, Vol. 31, No. 1-2, Jan.-April, 1963, pp. 243-248; C. Tisdell, "Extension of Oi's Price Instability Theorem," Journal of Economic Theory, Vol. 17, Feb. 1978, pp. 130-133; A Zucker, "On the Desirability of Price Instability: An Extension of the Discussion," Econometrica, Vol. 33, No. 2, April 1965, pp. 437-441; H.E. Leland, "Theory of the Firm Facing Uncertain Demand," A.E.R., Vol. 62, No. 2, June 1972, pp. 278-291; A. Sandmo, "On the Theory of the Competitive Firm Under Price Uncertainty," A.E.R., Vol. 61, No. 1, March 1971, pp. 65-73.

99 Oi, "The Desirability of Price Instability Under Perfect Competition," op. cit., pp. 58-64.

the assumption that firms maximize profits in the short run at each point in time. A further assumption that becomes evident in studying his theory, although not mentioned specifically by Oi, was that the firm must be able to adjust quantity instantaneously to benefit from the change in price. The validity of this assumption was questioned by several authors but this will be discussed in more detail when examining their contributions.

Having presented briefly the basic objective of Oi's paper and the assumptions associated with it, consider now his proof of the statement that "instability in prices will always result in greater total returns."[100] By using the perfectly competitive firm, price was treated as an exogenous variable resulting from uncertain demand conditions. By equating this price, or demand as in the case of the perfectly competitive industry, with the stable upward sloping marginal cost curve, the results are as those depicted in Figure B1. Again, under the assumption that the firm maximizes short run profits, (P = MR = MC), X_1, X_2, X_3 represented the equilibrium output levels under the three price conditions shown. It was then possible to derive a profit function from these equilibrium conditions.

Profit was determined geometrically for each of the individual prices. It was "the area under the price line from zero to the equilibrium output, minus the area under the marginal cost curve over the same

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[100] Ibid., p. 59.

[101] Ibid., p. 59; Oi admitted that strictly speaking this definition of profit differs from the conventional textbook definition because of the exclusion of total fixed costs. However, he qualified this by saying that every text also shows that maximization of our definition of "profit" is equivalent to maximization of the "usual" defi-

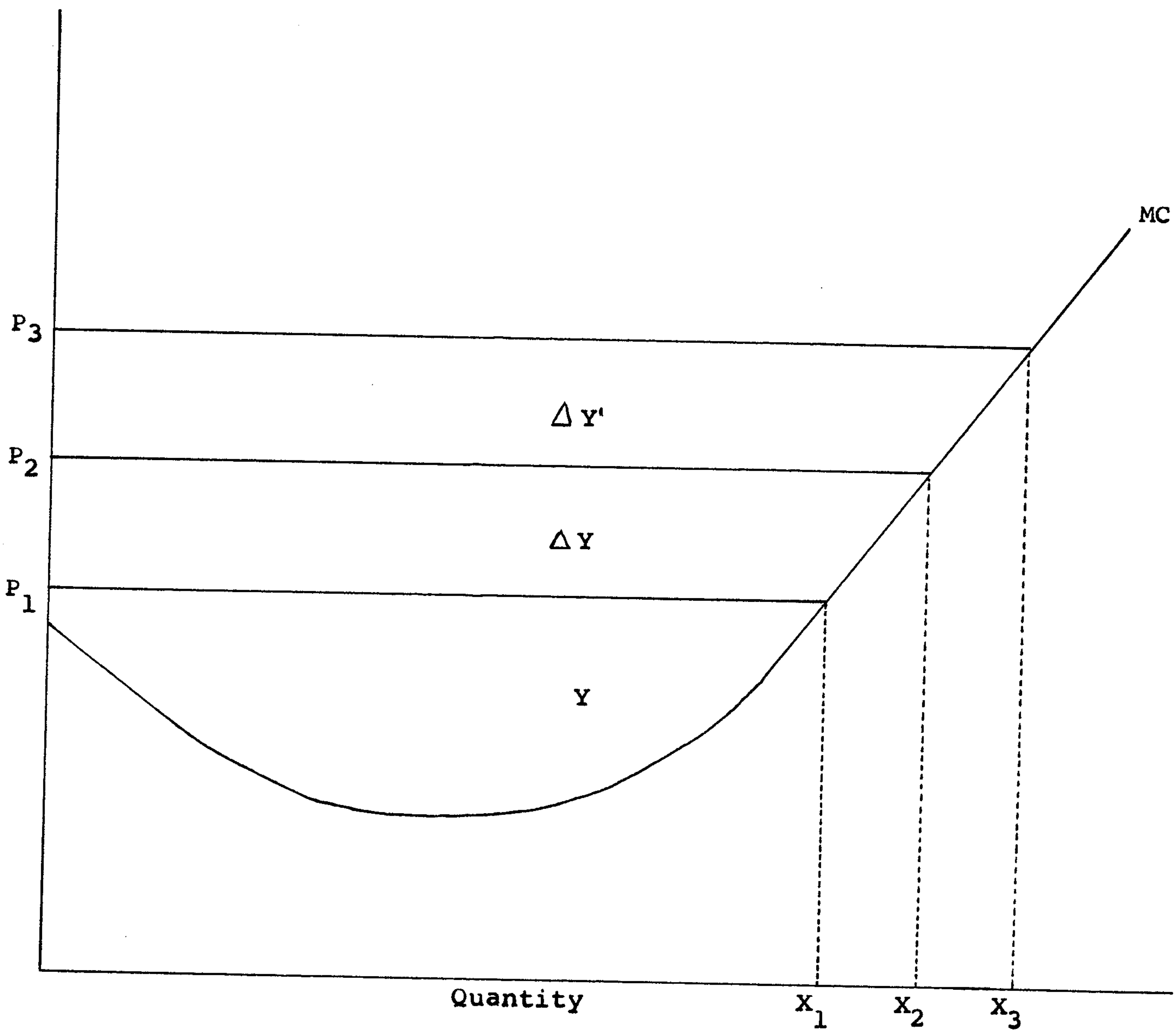

Figure B1

Derivation of Income from Price and Output Equilibira under Perfect Competition

Source: W.Y. Oi, "The Desirability of Price Instability Under Perfect Competition," Econometrica, Vol. 29, Jan. 1961, p. 59.

range of output."[101] This is indicated in Figure B1 by the letter Y for price P_1. The change in profit, resulting from the increase in price to P_2 and P_3 is indicated by the areas called ΔY and $\Delta Y'$, respectively. Plotting the numerical values of these profit areas against price, resulted in Oi's profit function as illustrated in Figure B2. As is evident by the convexity of this curve, this profit function is increasing at an increasing rate. Furthermore, this property ensured that any increases in price resulted in a steadily increasing profit. In reference to Figure B1 the increase in profit resulting from the price movement from P_1 to P_2 was called ΔY, and $\Delta Y'$ represented a further shift in price to P_3. It becomes clear then, that as long as the profit function is convex (which requires that the marginal cost curve be upward sloping to the right), the area $\Delta Y'$ will exceed that of ΔY.

Consider the effect of uncertain demand on the expected profit levels of the firm. To demonstrate this, Oi hypothesized that the firm faces two prices, P_a and P_b in Figure B2. If the firm receives P_a as the price, the corresponding profit will be Y_a. Accordingly, if the price equals P_b, the resulting profit will be Y_b. Oi supposed, however, that the prices P_a and P_b have an equal probability of occurring.[102] Thus, the statistically expected price will be $\bar{P}$ where $\bar{P} = (P_a + P_b).50$ and the expected profit can be determined from taking the height of the

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nition.

102 The plausibility of this assumption that the two prices have equal probability of occurrence, i.e., $\bar{P} = (P_a + P_b).5$ is of vital concern here, and also later, because it is used by Schmitz et al., in their analysis. Its feasibility was discussed in more detail in Chapter 4 and 5.

103 Oi, "The Desirability of Price Instability Under Perfect Competi-

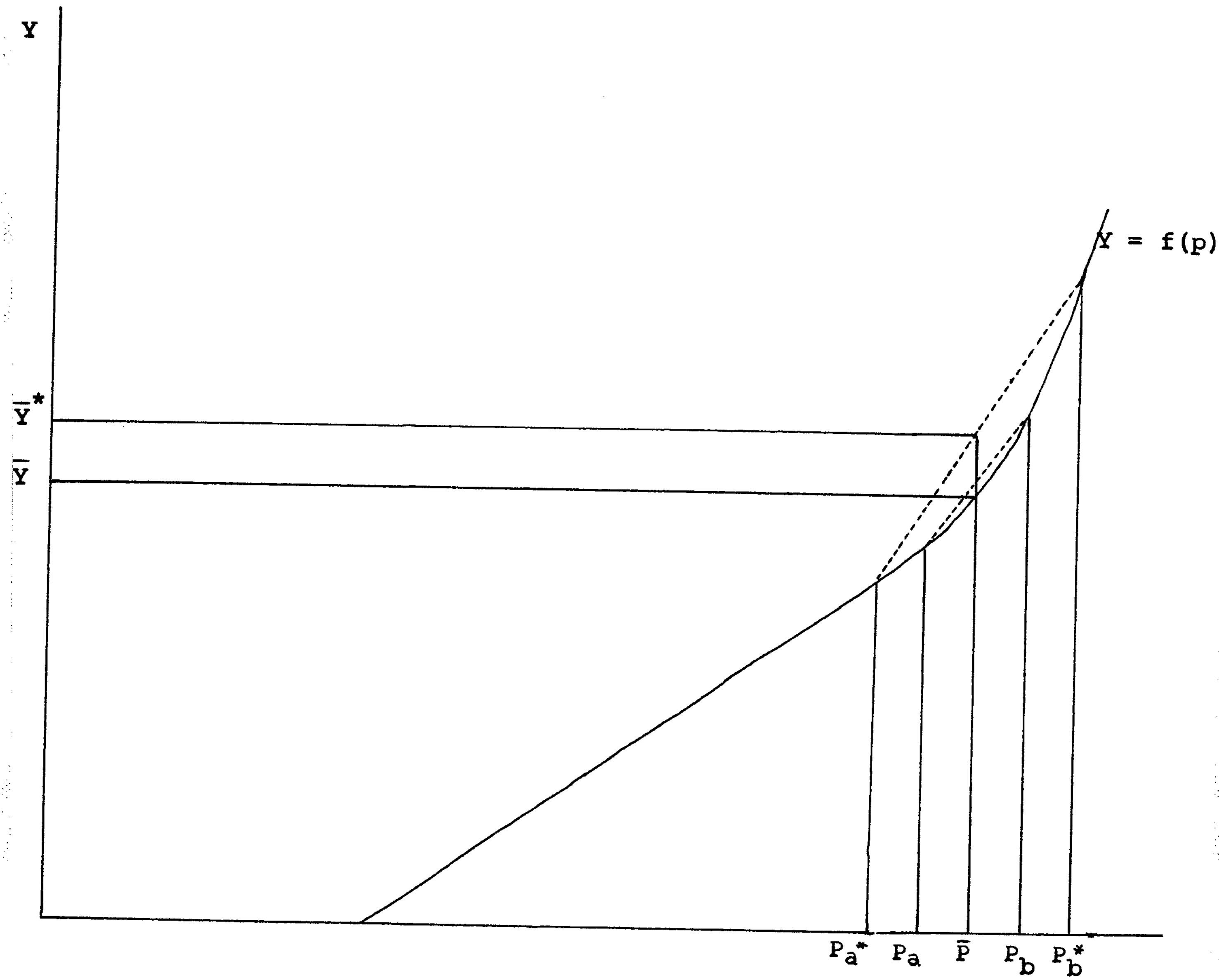

Figure B2

Profit Function and Price Instability

Source: W.Y. Oi, "The Desirability of Price Instability Under Perfect Competition," Econometrica, Vol. 29, Jan. 1961, p. 59.

chord connecting Y_a and Y_b at point $P = \bar{P}$.[103] Suppose now prices assumed points P_a* and P_b*. Applying the same technique as described previously, the expected profit became Y*. As P_a* and P_b* represent increased variability and $\bar{Y}* > Y$, Oi concluded that his basic proposition is correct.

> Proposition: Given a fixed expected value of price P, the greater the variability of price about that expected value, the greater will be the expected profit.[104]

Nelson[105] alluded to the same proposition set forth by Oi, but arrived at it in a somewhat different manner. He set out to show "that the ability to predict [prices], affects: profits or quasi rents, the elasticity of the ex post supply curve, average industry output and average industry price in long run equilibrium, and the variation in market price generated by a given variation in market demand."[106] Nelson developed an extensive paper on the ability to predict price and he demonstrated the actual amount that a firm should be willing to pay for the reduction in uncertainty arrived at through improving the ability to predict. If a firm can predict accurately the occurence of high and low prices it can adjust its output accordingly. However, if the firm produces that output associated with the average price, (or in other words with no prediction as to the high and low prices), the firm will experience lower profits. This results from underproduction in periods of high price and overproduction in periods of low price.

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tion," op. cit., p. 59.

104 Ibid., p. 60.

105 Nelson, op. cit., pp. 41-62.

106 Ibid., p. 41.

Based on this approach, Nelson arives at four basic conclusions. The first two are of concern here:

> First, the better a firm is able to predict, the closer to optimal its output decisions will be, on the average, and the more profit it will make.
>
> Second, the better a firm is able to predict, the more likely it is that high outputs will be produced at high prices and low outputs at low price, or, using the language of this paper, the more elastic will be the _ex post_ supply curve.[107]

While Nelson places his emphasis on the ability of a firm to predict price changes, it can also be seen that if a firm does have _any_ ability to do so, it will be able to attain higher profits from price fluctuations than if prices were stabilized at the mean.

The first article in response to Oi's work was published in _Econometrica_ in 1963. Tisdell[108] generally agreed with Oi's conclusions provided that Oi's assumptions hold true. Tisdell did, however, question the validity of one of these assumptions and devised a set of his own "particularly designed to emphasis the importance of price forecast mistakes when instantaneous adjustment is ruled out."[109] In addition to the four assumptions dealing with the shape of the MC curve, the firm's desire to maximize _expected_ profit, and frequency and distribution of the price levels, Tisdell described a fifth assumption upon which his entire argument rested. This assumption reads as follows: "Output is planned in advance and is unalterable."[110] Having specified these condi-

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107 Ibid., p. 62.

108 Tisdell, "Uncertainty, Instability, Expected Profit," op. cit., pp. 243-248.

109 Ibid., p. 243.

110 Ibid.

tions, Tisdell proved algebraically several propositions. The most crucial of these is his first, which stated that "an attempt to maximize profit at each point of time when price is unstable, results in a smaller profit than when price is stable at the average level, p."[111]

This modification of preplanned output rather than instaneous adjustment, has important implications, both for the examination of the remaining literature and for the analysis to be undertaken. Oi accepts Tisdell's proposition that if output is planned in advance the most optimal pricing strategy would be that of stability.[112] These assumptions of preplanned output are particularly crucial for agricultural commodities because production decisions (seeding) occur prior to knowledge of market price. While Tisdell's revised assumption is valid, it will be assumed that Oi's instantaneous adjustment could have referred to the quantity placed on the market as well as the actual quantity produced. This modification allows Oi's proposition to hold despite the apparent difficulty at initial examination.

Zucker extended the discussion still further.[113] He takes no issue with the claims made by either author, given the assumptions that they state. He did, however, consider the possibility that price might not be the best manner in which to view changes in demand. While he agreed that instability of demand is reflected in price fluctuations, he pointed out the impact is also seen through adjustments in quantity.

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[111] Ibid., p. 244; See Tisdell "Uncertainty, Instability, Expected Profit," for the proof.

[112] W.Y. Oi. "Rejoinder," Econometrica, Vol. 31, No. 1-2, Jan.-April, 1963, p. 248.

[113] Zucker, op. cit., pp. 437-441.

The incorporation of both these factors results in total revenue.[114] The comparison that he suggested, was therefore between fluctuating revenue and a constant mean revenue.

Given the marginal cost curve in Figure B3, Zucker derived the following relationships:

(27) $R_1 = p_1q_1 = A + B$

(28) $V_1 = A$

(29) $\pi = R_1 - V_1 = B$

(30) $R_2 = p_2q_2 = A + B + C + D + E + F$

(31) $V_2 = A + E + F$

(32) $\pi_2 = R_2 - V_2 = B + C + D$

(33) $R^* = p^*q^* = A + B + C + E$

(34) $V^* = A + E$

(35) $\pi^* = R^* - V^* = B + C$

where:

R = revenue,

V = total variable cost,

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[114] In perfect competition, when D is perfectly elastic, the analysis can still apply. The producer will choose to sell or not, based on the level of the demand curve. His total revenue will be higher if demand and therefore price is high, etc.

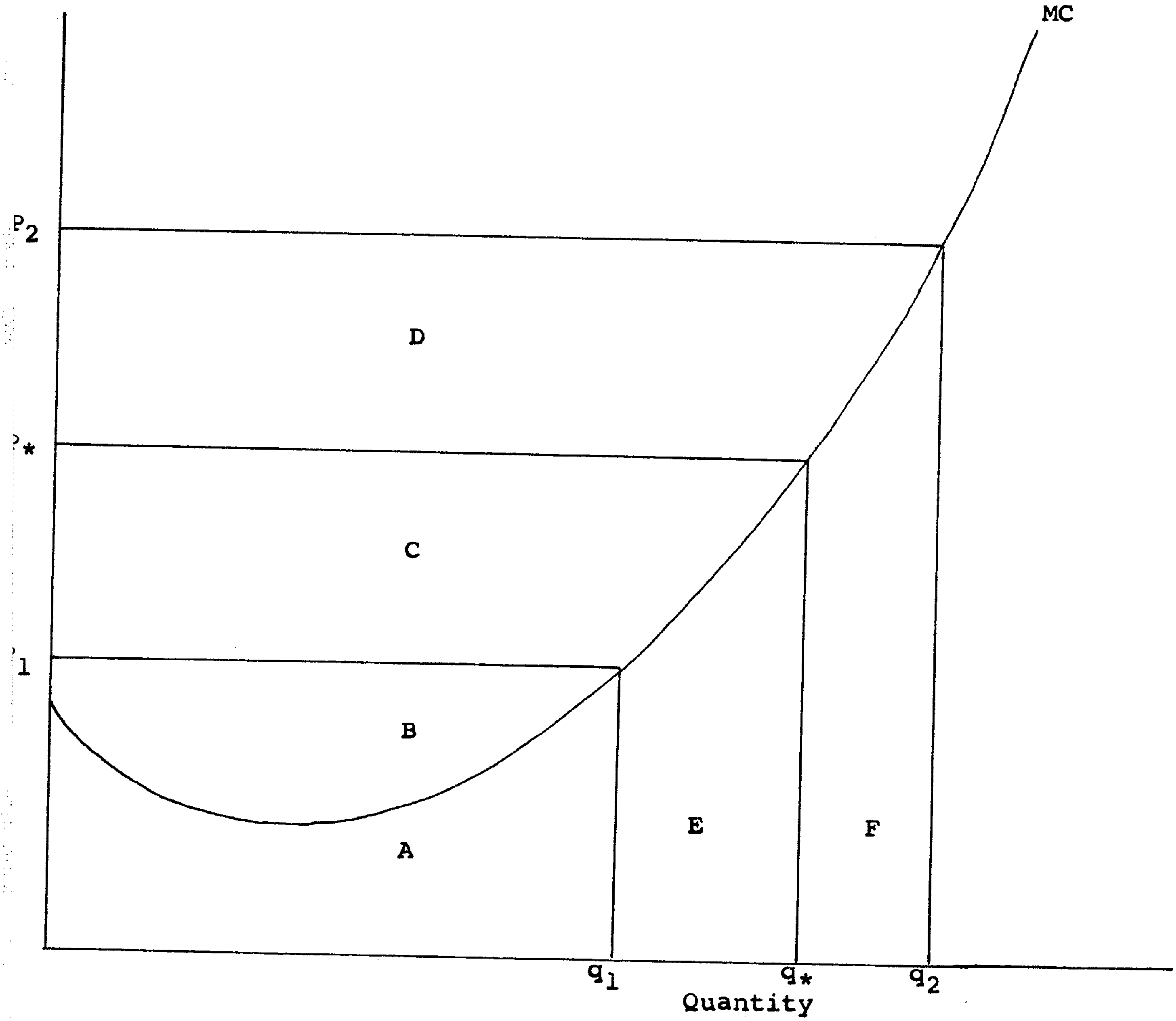

Figure B3

Total Revenue and Price Instability

Source: A. Zucker, "On the Desirability of Price Instability: An Extension of the Discussion," Econometrica, Vol. 33, No. 2, April 1965, p. 438.

π = profit,

$*$ = the constant demand (or price situation).

While equation (35) represents the average profit when revenue remains constant, equation (36) signifies the average profit when revenue is varied.

$$(36)\ \pi_v = \frac{\pi_1 + \pi_2}{2} = \frac{B + C + D}{2}$$

The difference between these two, would indicate any increase or decrease in profit is a result of varied or constant revenue.

$$(37)\ \Delta\pi = \pi_v - \pi_* = \frac{D - C}{2}$$

Now, Zucker assumed that the revenues are, on the average, equal in either situation so that:

$$(38)\ R_* = \frac{R_1 + R_2}{2}$$

or in the areas represented by Figure B3:

$$(39)\ D - C = E - F$$

Using this relationship and assuming that supply displays a constant elasticity, Zucker proved the following theorem: "Under the assumption of constant elasticity of supply, profit is invariant with respect to revenue instability."[115] In fact, he went further to state that instability of prices can result in a very definite disadvantage because of the additional management costs that are likely to be incurred as a result of variable output.

Zucker also considered the possibility of supply curves which are not always constant. If, for example, MC and consequently supply was linear in the relevant region the conclusion reached, depended upon the point elasticity of that point lowest on the MC curve. If for instance $\varepsilon_s = 1$ then $\Delta\pi$ will be zero. But if $\varepsilon_s > 1$ demand instability will be favoured and if $\varepsilon_s < 1$, such as that for most agricultural commodities, demand stability is preferred. Zucker concluded then that: revenue is the relevant factor to consider when examining demand stability and the desire for such stability depends largely on the shape of the MC curves and resulting supply curves.

Subsequent papers by Sandmo[116] and Leland[117] take issue with the assumption set forth by Oi and others that set as the objective of the firm to maximize expected profits. They argued that this is somewhat less than realistic. While it seems more probable that most firms are somewhat risk averse, the assumption of simple profit maximization will not take this into account. Sandmo's discussions are concerned with a

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115 See Zucker, op. cit., p. 439, for a detailed analysis of the proof.

116 Sandmo, op. cit., pp. 65-73.

117 Leland, op. cit., pp. 278-291.

perfectly competitive firm with the implicit assumption that it is a price taker.[118] Leland provides more generalized arguements for price stability under conditions of uncertainty but only Sandmo's work will be examined here.

With the objective of systematically studying the theory of the competitive firm under price uncertainty and risk aversion, Sandmo stated several assumptions. As previously mentioned, his firm is a price taker, yet he qualified this assumption to some degree by maintaining that the firm will have some subjective probability regarding the sale price it will receive. The second criteria outlined was that dealing with output decisions. Sandmo clearly specified that "the decision on the volume of output to be produced must be taken prior to the sales date at which the market price becomes known."[119] This assumption was similar to that set forth in Tisdell's analysis with one exception. Whereas Tisdell required that output be "unalterable," Sandmo allowed for adjustment in output in tune with revisions in expected price or rather expected profit.

In order to deal with the problem that maximizing expected price may be somewhat unrealistic, Sandmo assumed that the objective of the firm is to maximize the expected utility of profits. Using the attitude towards risk as defined by a von Neuman-Morgenstern utility function,

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118 The discussion to date has used perfect competition to refer to the fact that producers are price takers. The remaining assumptions associated with perfect competition, such as perfect knowledge etc., do not in fact hold true. For this reason, this discussion will use perfectly competitive interchangably with purely competitive and will refer only the assumption that the firm is a price taker resulting from the large number of firms or producers in the industry.

119 Sandmo, op. cit., p. 65.

the function becomes a concave, continuous, and differentiable function of profits. The result of differentiating this profit function with respect to output is the necessary and sufficient conditions for a maximum.[120] From here Sandmo agreed that under conditions of certainty, the maximum will be located where price and marginal cost are equal. But when considering the possibility of uncertain demand [or consequently price] Sandmo concluded that "...output is smaller than the certainty output...[and that] optimal output is characterized by marginal cost being less than the expected price."[121]

While Sandmo introduced several additional concepts related to this topic, such as the effect of a marginal increase in risk and further restriction on the utility function by use of the Arrow-Pratt risk aversion functions, his basic propositions remained the same. That is, under conditions of uncertainty, output will be less than that produced under certain conditions. This is a result of the fact that most firms are risk averse to some degree, which seems to cause a reduction in the optimal level of output. This combined with the event that these firms are price takers, will reduce total revenue (output X price = TR) from what it would be if price were known under certainty. The result is that while expected profits may be higher under conditions of price uncertainty, output and consequently revenue will be lowered due to the uncertainty. Therefore, the net gains to an individual firm will depend on its aversion to risk. The more risk neutral, the more the firm will

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[120] Sandmo outlined an interesting point in regards to the second order conditions. Unlike Oi's assumption of upward sloping MC, it is not necessary to assume an increasing MC in Sandmo's equations.

[121] Sandmo, op. cit., p. 66.

tend towards improving profit from instability in price. The more risk averse, the more the firm will reduce output and therefore reduce the ability to achieve higher profits.

Tisdell again considered the question of price instability and producer gains in 1978. In a further extension on Oi's work, Tisdell developed a brief paper to consider the effect of price fluctuations on the profits of a multi-product firm. Applying exactly the same theory as Oi used in the single product firm, Tisdell proposed that a multi-commodity firm will always prefer price variability to stability if its short run objective is to maximize profit.[122]

To prove his proposition regarding the multi-product firm, Tisdell required three assumptions; first that the firm's marginal cost curves remain constant in that they are not subject to random fluctuations; the second is that their supply curves are not perfectly inelastic; and the third that "price uncertainty is not a material consideration."[123] Unlike his earlier criticism of Oi's work, Tisdell maintained the firm's ability to modify output immediately in response to changes in price. By allowing such adjustments, a firm can realize greater profits by neither over producing in periods of high price nor underproducing when low price prevails. Thus, because maximum profit is a convex function of prices, price variability cannot decrease average profitability and may increase it under some circumstances.[124] Therefore in

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122 Tisdell did not consider the points raised by Sandmo and Leland in regards to the use of expected utility instead of expected profit.

123 Tisdell, "Extension of Oi's Price Instability Theorem," op. cit., p. 131.

124 Ibid.,p132.

exactly the same manner that Oi argued for the single product firm, Tisdell concluded that "the more factors and products subject to price variability, the greater on average is the gain of the firm."[125]

This concludes the review of literature that to date have provided the major contributions to the theory of price stability and producer welfare. The discussion is not complete, however, without at least a brief mention of the analogous debate in regards to consumer surplus and price stability. The original work in this area by Waugh preceded that of Oi's.[126] Waugh first presented the hypothesis that consumers would always be better off under conditions of price instability, in 1944. There were only brief discussions by Lovasy and Howell in regards to Waugh's original proposition.[127] It was not until Oi presented his theory, apparently unaware of Waugh's previous discussion, that the extensive examination began. Waugh restated his case after the release of Oi's paper in 1961 and there was at least one further paper published in regards to consumer welfare and price stabilization.[128] This was done in 1971 by Wegge, Sosnick and George and attempted to determine the conditions under which a price stabilization or destabiliza-

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[125] Ibid. Note that Tisdell also includes factor price variability in his theorem. This is because he applied the Hicksian convention of treating factors as negative commodities in his objective function Max = PX.

[126] F.V. Waugh, "Does the Consumer Benefit from Price Instability," Q.J.E., Vol. 58, 1944, pp. 602-614.

[127] G. Lovasy, "Further Comment," Q.J.E., Vol. 59, Feb. 1945, pp. 296-301; L.D. Howell, "Does the Consumer Benefit from Price Instability," Q.J.E., Feb. 1945, pp. 287-295.

[128] F.V. Waugh, "Consumer Aspects of Price Instability," Econometrica, Vol. 34, No. 2, April 1966, pp. 504-508.

tion program would be beneficial or detrimental.[129] The majority of work presented after 1961 was concerned with producer gains or losses from stabilization policies, most of which were discussed earlier.

Massell and Turnovsky integrated the concepts of consumer and producer welfare to determine the overall societal gains from price stabilization.[130] Massell proposed that "using the expected value of the change in producer and consumer surplus as a measure of gain,..price stabilization, brought about by a buffer stock, provides a net gain to producers and consumers taken together."[131] He stated this hypothesis based on several assumptions. Among them is the fact that price fluctuations are the result of parallel shifts in either supply or demand and that the commodity under consideration forms a sufficiently small enough contribution to sales or purchases that the marginal utility to money remains unchanged. Massell also assumes that both consumers and producers are indifferent to risk.

The shape of the supply and demand curves (i.e., the elasticities) again prove to be contributing factors in the preference for stability. More specifically Massell proved that under stabilization, "the likelihood of (producer) gain is greater, the steeper the supply curve

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129 L.L. Wegge, S.H. Sosnick and P.S. George, "The Effect of Price Stabilization on Consumers' Welfare," Western Economic Journal, Vol. 9, Sept. 1971, p. 289.

130 B.F. Massell,"Price Stability and Welfare," Q.J.E., Vol.83, May 1969, pp.284-298; S.J. Turnovsky, "Production Flexibility, Price Uncertainty and the Behavior of the Competitive Firm," International Economic Review, Vol.14, No.2, June 1973, pp.395-413;S.J. Turnovsky, "Price Expectations and Welfare Gains From Price Stabilization," A.J.A.E., Vol.56, 1974, pp.706-716.

131 Massell, op. cit., p.297.

relative to the demand curve."[132] Two additional points arise from the examination of Massell's work. The first is the fact that while Massell was concerned with the utility of money, he assumed the utility function of profit or wealth of the individual consumer or producer is risk neutral. The other factor that Massell stated is that the particular commodity under consideration must contribute a sufficiently small proportion to total sales or purchases that it leaves the utility for money unchanged. He acknowledges the deficiency arising from such an assumption, especially in the case of producers, where a commodity could, form a large part of total revenue but leaves the investigation to others. Several years later, Schmitz et al., also assume that marginal utility of money remains constant, yet they suggest that the contribution to total revenue is a very crucial element in the consideration of the gains and losses to producers from price stabilization.

The second author to consider the joint effect of stabilization was Turnovsky. While most of the previous work was concerned with price variability, Turnovsky maintained that price uncertainty was a more realistic assessment of the actual situation.[133] This was especially true in the case of agricultural producers, where production decisions are made prior to knowing market price.

In his first analysis he considered only producers, and had firms make initial production decisions based on an expected price. Adjustments in output were allowed once the true selling price was known.

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[132] Ibid., p. 293.

[133] Price variability wil be defined as random fluctuations in price, whereas price uncertainty has probabilities associated with various prices.

This enabled the testing of flexibility in output, on the gains from price stability. These were found to depend on the nature of the cost function and the aversion to risk of the individual firm. The result of his work was that conclusions could be drawn about stability only with specific knowledge of actual firm's cost functions.[134]

Turnovsky's second paper dealt largely with attempts to gain estimates of this expected price, both for producers and consumers, and then to evaluate the corresponding gains resulting for each. The two methods prescribed by Turnovsky are an adaptive expectation procedure and secondly, a rational expectations model. The first of these uses only past prices and the associated error term to predict prices. The second allows the inclusion of conditional expectations about other economic factors when forcasting price. Gains from stability, based on a price determined by adaptive expectations, was found to depend solely on the characteristics of the error term. Turnovsky proved this by equating supply and demand for producers and consumers and obtaining the gains or losses that result. He concluded that "stabilizing for supply fluctuations will improve the welfare of producers and deteriorates that of consumers."[135] For stabilized demand fluctuations although total welfare, as measured by the sum of producers' and consumers' welfare, is increased with price stability, one group will likely be hurt.

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134 Turnovsky, "Production Flexibility, Price Uncertainty, and the Behavior of the Competitive Firm,"op. cit., p.395-413.

135 Turnovsky, "Price Expectations and the Welfare Gains from Price Stabilization", op. cit.,p.711.

The rational expectations technique for determining an expected price provides somewhat different results. It indicates that producers can not gain from having price stabilized because of the inherent assumption that some forecasting ability is used in the determination of expected price. Producers are always better off exploiting this knowledge and making the according output decisions.[136]

This concludes the review of related literature on the theory of producer and consumer welfare and price stability. While the discussion was admittedly brief, it should provide the essential groundwork necessary for the understanding of the Schmitz et al., paper.

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136 Ibid., p. 714.

Appendix C

SPECIFICATION OF PARAMETERS

Table C1

Crop Production Costs for Grain Corn

	1980	1979	1978
A. Operating Costs			
Fuel	$ 5.53	$ 6.00	$ 11.00
Repairs and Maintenance	9.01	7.00	
Fertilizer	30.90	32.50	25.60
Chemicals	23.15	16.00	16.00
Insurance	5.45	5.00	5.50
Seed	13.78	13.00	12.00
Drying	18.90	20.00	9.60
Trucking	4.30	20.00	17.60
Miscellaneous	2.91	3.00	2.50
Interest on Operating Capital	8.54	6.00	5.50
TOTAL	$122.50	$126.10	$120.80
B. Fixed Costs			
Taxes	4.40	3.75	3.50

(Continued)

Table C1 (Continued)

	1980	1979	1978
Depreciation:			
Buildings	.94		2.00
Equipment	27.67	$ 15.00	9.50
Investment:			
Buildings	1.00		1.00
Equipment	13.45	8.25	4.75
Land	44.00	40.00	40.00
Storage		4.00	
TOTAL	91.46	71.00	60.75
C. Labour	6.52		12.00
Total Cost (actual)	220.48	196.85	178.05
- Depreciation	28.61	15.00	11.50
- Investment Cost	48.45	48.25	45.75
Total Cost (percieved)	$133.42	$133.60	$120.80

Source: Manitoba Department of Agriculture, Cost of Production Budgets, Farm Management Section, 1978, 1979, 1980.

Table C2

Contribution to Income Summary

Study	Client Number	Land Use	Percent of Total Income
Irrigation	1	I, D	1.1
	9	I	20.7
	15	D	12.6
	27	I, D	-
	102	D	25.3
	108	I, D	22.5
	26	I	80.5
	110	I	7.9
1980 Soy Producers	1	D	63.9
	5	D	12.7
	8	D	37.7
	9	D	11.2
	11	D	30.1
	12	D	38.92
1979 Simulator	56	D	14.2
	7	D	2.9
	8	D	26.9
N			16
X			25.57
Var.			435.12
SD			21.54

I - Irrigated
D - Dry land

Note: Calculated on a net return basis where: Gross Return (yield x price x acres) - Cash Costs = Net Return.

Source: Department of Agriculture Economics, Crop Simulator, January, 1981.

Appendix D

UTILITY THEORY AND THE RELATIVE RISK AVERSION COEFFICIENT

D.1 ARROW-PRATT SPECIFICATION

To understand why Schmitz et al., chose this particular measure of risk aversion it is necessary to examine the work of Arrow and Pratt.[137] Pratt, independently arrived at the same conclusions as Arrow but, because he dealt mainly with the absolute risk aversion coefficient, only Arrow's work will be considered here.[138]

There has evolved much discussion on the theory of uncertainty and utility over the years, beginning with Bernoulli's work in 1738. Much of the debate in the early years concerned the inability to explain the desire of individuals to buy insurance yet engage in gambling. In recent years the discussion has turned to more empirical questions, such as measurement of utility functions and measures of risk aversion. It is to the latter of these problems that Arrow addressed himself. While he set out to specifically show why individuals desire to hold cash balances when they could invest all of their funds in profit earning assets, he arrived at some general conclusions that can be applied in a

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137 See Kenneth J. Arrow, Essays in the Theory of Risk Bearing, North Holland Publishing Co, London, 1971; John W. Pratt, "Risk Aversion in the Small and in the Large," Econometrica, Vol. 32, No. 1-2, Jan.-April, 1964, pp. 122-136.

138 Chapter three of Arrow's book called the "Theory of Risk Aversion" provides the basis for this description of the relative risk aversion coefficient and it should be referred to for any matter requiring further clarification.

much broader, more theoretical sense. In attempting to explain the mix of risky and riskless assets held by an individual, Arrow arrived at two measures of risk aversion; absolute risk aversion and relative risk aversion. Before elaboration of these two measures consider first the definition of a risk averter and the characteristics of the utility function as described by Arrow. "A risk averter is defined as one who starting from a position of certainty, is unwilling to take a bet which is actuarilly fair (a fortiori, he is unwilling to take a bet which is actuarially unfair to him)."[139] Arrow based his characterization of risk aversion on the expected utility hypothesis of Bernoulli and lets

Y = wealth.

$U(Y)$ = total utility of wealth Y.

Given that E indicates the expected value in the sense of probability theory, an individual is always supposed to choose the action which gives him the highest expected value; $E[U(Y)]$. Other assumptions made regarding the nature of the relationship is the U(Y) is taken to be a bounded function,[140] that wealth be regarded as a single commodity and that the utility of wealth be a twice differentiable function where

$U'(Y)$ = marginal utility of wealth.

$U''(Y)$ = rate of change of marginal utility with respect to wealth.

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139 Arrow, op. cit., p. 90.

140 This avoids the St. Petersburg paradox which is described on p. 14 of The Economics of Uncertainty, by Karl Henrik Borch.

It is also assumed that wealth is desirable so that,

$U'(Y)>0.$

Thus U(Y) is a strictly increasing function of Y and the statement that it is bounded can be written,

$\lim_{Y\to 0} U(Y)$ and $\lim_{Y\to +\infty} U(Y)$ exist and are finite.[141]

Under the characteristics described above, the utility function of a risk averter is easily proven to have the condition that U'(Y) is strictly decreasing as Y increases.[142]

Having described the appropriate utility function, Arrow explained why the rate of change of U'(Y), i.e., U"(Y) did not qualify as a measure of risk aversion and showed how a measure, that while based on U"(Y) could be modified so as to remain stable under positive linear transformations of the utility function. The result is two measures:

(40) $$R_A(Y) = \frac{-U''(Y)}{U'(Y)}$$ = absolute risk aversion,

(41) $$R_R(Y) = \frac{-YU''(Y)}{U'(Y)}$$ = relative risk aversion.

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141 Arrow, op. cit., p. 92.

142 Arrow provided a qualification of this and showed that "pure theory joins with economic observation to imply the predominance of risk aversion over risk preference," Arrow, op. cit., p. 93.

Both these measures evoke the properties desired. A positive linear transformation of U(Y) multiplies U"(Y) and U′(Y) by the same factor and thus leaves their ratio the same. If the function considered displays risk aversion, i.e., $U''(Y) < 0$, both measures are positive. There is one additional property of the relative risk aversion coefficient that makes it particularly useful. Not only is it invariant with respect to changes in units of utility but, it is also stable with respect to changes in units of wealth. Such a property is of particular importance to the analysis here for several reasons. The first stems from the fact that Schmitz et al ., do not use wealth (Y) in their utility function but rather profit. Thus no consideration is given to the total value of assets or wealth held by an individual. By use of the relative risk aversion coefficient, the comparison can be made, because the effects of the numerical value of the ratio are removed. The second reason that this measure is more useful is because of the manner in which it is to be applied. The sgn criterion requires that several profit levels be examined and by ensuring that the measure remains invariant to changes in π enables this comparison.

To continue then, with Arrow's discussion on the measure of relative risk aversion, Arrow showed how Pratt arrived at the same result using a concept called an insurance premium and a proportional instead of relative risk aversion value.[143] Regardless of terminology both Arrow and Pratt propound that "the relative risk aversion $R_R(Y)$ is an increasing function of Y."[144]

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143 Pratt, op. cit., p. 133; Arrow, op. cit., p. 97.

144 Arrow, op. cit., p. 96.

Arrow, illustrated by the use of the demand for liquid money, stated the following proposition regarding risk and wealth: if both wealth and the size of a bet are increased in the same proportion, the desire to accept that bet should decrease. Arrow stated, however, that it is important to realize that the variation of relative risk aversion with changing wealth is closely associated with the boundedness of the utility function:

> It can be shown as a mathematical proposition that if the utility function is to remain bounded as wealth becomes infinite, then the relative risk aversion cannot tend to a limit below one; similarly, for the utility function bounded (from below) as wealth approaches zero, the relative risk aversion cannot approach a limit above one as wealth tends to zero.[145]

He concluded from this that the measure of relative risk aversion must have values that oscillate around one. They will be somewhat less for low wealth and somewhat higher for high wealth. This indicates that there is some positive correlation between wealth and relative risk aversion but fluctuations from this can exist. Arrow also suggested that if one were to desire a constant relative risk aversion, the value 1 would be appropriate. This implies a U(Y) function that is logarithmic which can be assumed to be an approximately bounded utility function.

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145 Arrow, op. cit., p. 97 and p. 110.

D.2 BASIS OF UTILITY THEORY

It has been shown how a measure of risk aversion can be attained. It seems appropriate to digress a minute and review some of the theoretical issues associated with the development of and present status of utility theory.

Utility theory began with the principle set forth by Daniel Bernoulli over 200 years ago. In 1738 Bernoulli recognized that one additional dollar was worth more to a poor man than it was to a rich one. He also maintained that this worth or utility was cardinally measurable and that an individual would act so as to maximize the expected value of this utility. Bernoulli's paper went largely unnoticed until it resurfaced again through the work of von Neumann and Morgenstern in the 1940's. They set out to prove the Bernoulli propositions and their conclusions take the form of three axions. They are as follows:[146]

> If we let "$>$" indicate "preferred to" and "=" designate "indifferent to," these axioms are as follows:
>
> Axiom Ia: If P and Q are two probability distributions of outcomes then either $P>Q$, or $Q<P$, or $P=Q$. (Completeness in the ordering or "comparability.")
>
> Axiom Ib: If $P\geq Q$ and $Q\geq R$, then $P\geq R$. ("transitivity").
>
> Axiom II: If $P>Q$ and R is a probability distribution of

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146 J. von Neuman and O. Morganstern, <u>Theory of Games and Economics Behavior</u>, Princeton Univesity Press, Princeton, 1st edn., 1944 as quoted in Clem A. Tisdell, <u>the Theory of Price Uncertainty, Production and Profit</u>, Princeton University Press, Princeton, New Jersey, 1968, p. 25.

an outcome then, aP + (1-a) R aQ + (1-a)R, given $a>0$.

Axiom III: If $P>Q$ and $Q>R$ then there is a number c such that cP + (1-c)R =Q where $o<c<1$. ("continuity")

These formulate Bernoulli's principle and provide the basis for all further work on utility theory. Restated they formalize the important properties; that this concept 'utility' is cardinally measurable (up to a linear transformation) and that it provides some logical ordering of preferences, (with the most preferred being the one with the highest expected value),

D.3 ELICTATION PROCEDURES

Derivation of utility functions, or elication of preferences, as it is also referred to as, can take many forms. They all begin, however, with an interviewer having an individual make a series of decisions. Each decision represents a unique combination of certain and uncertain events. Anderson et al., outline six types of elictation procedures, two of which deal with unidimensional utilities and four with multi-dimensional utility functions.

The ELCE method is the first of those dealing with unidimensional utilities in which consequences can be represented by a single attribute. This method is based on the concept of "Certainty Equivalent" which is defined as "the amount exchanged with certainty that makes the decision maker indifferent between this exchange and some particularly risky prospect."[147] When a person chooses an event that has a certainty

[147] J.R. Anderson, J.L. Dillion and J.B. Hardaker, Agricultural Decision Analysis, The Iowa State University Press, Ames, Iowa, 1977, p. 70.

equivalent less than the expected monetary value the individual is said to be risk averse. Similarly, if the certainty equivalent exceeds that of expected monetary value the decision maker is regarded as a risk taker. Through numerical tests of certainty equivalences and expected monetary values, it is possible to derive the utility function for the respective individual.

The second method of estimating unidimensional utilities is particularly useful for those decision makers with unusually strong aversions to gambling. This more complicated questioning procedure considers preference between acts with "equally likely but risky outcomes." The method is consequentially called ELRO. Again hypothetical gain and loss situations are set up, through which utility points and then functions can be derived.

Money is rarely the only goal in a decision makers considerations. To deal with the difficulties raised by multi-goal individuals or firms there are procedures available which derive multi-dimensional utilities.

Anderson et al., describe the first procedure, known as the "Benchmark Approach," in the following way: "for every multi-attribute consequence, a consequence is found that is indifferent to it and has constant values in all dimensions except one that is preferentially independent of the others (in the sense that preference for values in that attribute are independent of constant values in the other attributes)."[148] If such is not the case, that is, that one of the attributes is not preferentially independent, then this utility function can not be

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[148] Ibid., p. 77.

formalized and the decision is merely the result of the decision maker's attitude. To use the benchmark approach, the individual chooses "benchmark" or average values for each of the specific attributes. The decision makers are then asked to choose between the two attributes, one of which will be the benchmark and the other will assume some trial estimate. By repeating this process for many combinations, indifference curves result. From the schedule resulting from these indifference curves, utility functions can be derived.

The second multi-dimensional approach outlined by Anderson et al., is called the "Quasi-Separable" utility function approach. This approach was originally postulated by Keeney in the late sixties and is based on the decomposition of a multi-attribute utility function into its component parts. Rather than attempting to assess the n-dimensional utility function directly, it is only necessary to describe n one dimensional function $U_i(X_i)$ and the n scaling factors k_i. The k_i values represent the utility specified for a consequence with all its attributes except the ith set at their least preferred amount within the relevant range and the ith set at its most preferred amount within the relevant range.[149]

The "Additive Utility Function Approach" is the most common one used in estimating multi-dimensions utility functions. Required for this approach is the estimation of the unidimensional utilities for each attribute and the scaling factor associated with each. This simpler approach provides reasonable approximations of multi-dimensional utility function but are subject to some criticism because of the assumption of

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[149] Ibid., p. 82.

additivity associated with it.

The Lexicographic Utility functions rank a hierarchy of objectives in order of importance. It contradicts the Bernoulli axiom on continuity in that utility does not assume a cardinal value but rather is expressed as a priority-ordered vector showing the expected utility in each attribute dimension. The individual chooses on the basis of a lexicographic comparison of these vectors.

Individual utility functions were not estimated for corn producers and the techniques for doing are provided only to aid in the examination of of the studies which do attempt to derive utility functions and then calculate risk aversion coefficients from them.

D.4 PROPERTIES OF UTILITY FUNCTIONS

There are some general assumptions associated with utility functions. The first is that individuals always prefer more money to less. This implies that the margainal utility for money (or the first derivative), is strictly positive, increasing monotonically with increases in money. The second property depends upon the risk preference of the individual. If a producer is risk neutral, the rate of change of marginal utility or the second derivative of U with respect to wealth, will be constant and equal to zero. This indicates that he values an additional dollar of income just as highly regardless of whether it is the first dollar of gain or the last. Producer I in Figure D1 displays such a utility function. If $\frac{\delta^2 V}{\delta p^2} > 0$, as is illustrated by Producer II in Figure D1 , an additional dollar of income will be valued less if it is the first dollar gain than if it was gained at some point further along the wealth axis. The third and final type of utility is the most common, and results when $\frac{\delta^2 V}{\delta p^2}$ 0. An individual displaying a utility function with this property is said to be risk averse and values the first additional dollar gain higher than he does the last.

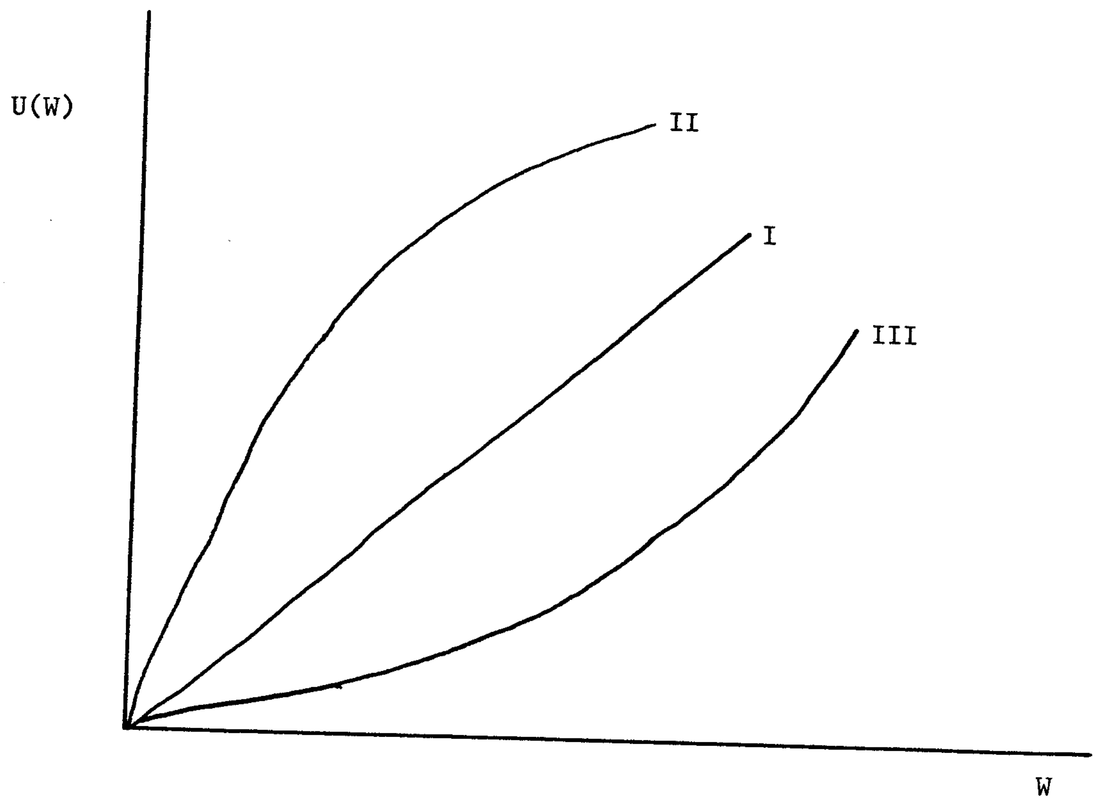

Figure D1

Utility Function for Three Degrees of Risk Aversion

While these three functions describe the characteristics of decision makers in certain ranges, it has been suggested and shown that most individuals display all three types. Friedman and Savage were the first researchers to examine this possibility and did so in an attempt to explain why many individuals buy insurance to avoid risk yet pay to gamble so as to incur risk.[150] A function illustrating such characteristics is found in Figure D2.

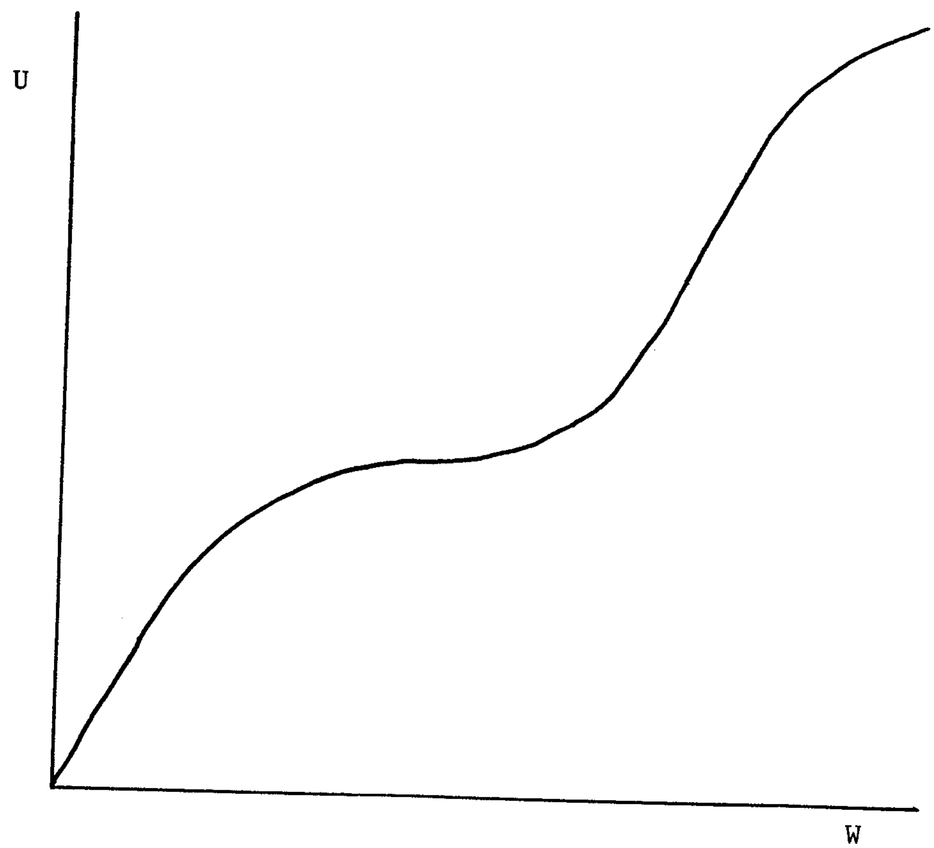

Figure D2

The Friedman and Savage's Function

These utility functions which are first concave at low incomes (risk averse), then convex at the mid-income range (risk preferring) and then concave again at high incomes are commonly explained by two factors. People gamble first because they probably overestimate their chances of success and second to enjoy the sensation of gambling for its own sake.

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150 See Milton Friedman and L.J. Savage, "The Utility Analysis of Choices Involving Risk," The Journal of Political Economy, Vol. 56, No. 4, August 1948, pp. 279-304.

Insurance may also be purchased solely for its own sake but usually people must be mainly influenced by the thought of how they would feel when diaster struck. People can generally be considered as risk averse with minor fluctuations in their utility function indicating a preference for risk at certain monetary levels.

The three axioms alluded to by Bernoulli and formalized by von Neumann and Morganstern provide two additional properties characteristic of all utility functions. These are that the functions are continuous and that they are bound, or at least approximately bounded as in the case of a logarithmic utility.

D.5 TYPES OF UTILITY FUNCTIONS

The simplist of the utility functions are the linear functions. These are simply determined by the equation:

(42) $$U = a + bx$$

where maximizing expected utility yields

(42′) $$E[U] = a + bE[x]$$

These linear functions, which are implied by neoclassical theory of the firm are, however, unrealistic and inadequate for present day analysis of decision making. In fact Anderson et al., state that: "If for some reason individual preference cannot be determined, an arbitary assumption of a theoretically sound decreasing risk-averse utility function for assets (such as 'Everyman's function' $U=\log_e W$) is more defensible

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[151] Anderson, Dillion and Hardaker, op. cit., p. 100.

than arbitrarily assuming linear preference and ignoring risk."[151]

The second type of functions are the polynomials. These can range from quadratic to exponential to the nth degree. They can be generally represented by:

$$(43) \qquad U(x) = x + bx^2 + cx^3 + \ldots$$

and when maximized become

$$(43') \qquad U(x) = E(x+bx^2+cx^3+ \ldots) = E(x) + bE(x^2) + cE(x^3) + \ldots$$

If only mean and variance of x are relevant there are only two moments about the mean which is satisfied by a quadratic utility function. If, however, skewness is also considered relevant, the polynomial becomes cubic with three moments about the mean. As a general rule, moments above the third are not vital to most decision analysis and therefore quadratic and cubic polynomials are most often used.

There are three criticisms of polynomials. The first is that polynomials are not everywhere monotonically increasing. This is crucial in this study because such a requirement is necessary to enable the use of the relative risk aversion coefficient. The second criticism arises if one estimates a quadratic function when in fact the decision maker has a utility function of higher moments. The result will be a misassessment of each decision that is made. The final problem with polynomials is their failure to meet the intuitive requirements of an inverse relationship between aversion and wealth.

Due to the difficulties encountered with polynomials it is necessary to consider two additional forms of utility functions. These two are of the form required by the Arrow-Pratt coefficient. When utility functions are of the form:

(44) $U = \log_e U$

or

(44′) $U = W^c \qquad 0 \; c \; 1$

then the Arrow-Pratt absolute risk aversion measure is positive for risk aversion and for decreasing risk aversion r (W) diminishes with increasing wealth. The risk aversion factor would appear as illustrated in Figure D3.

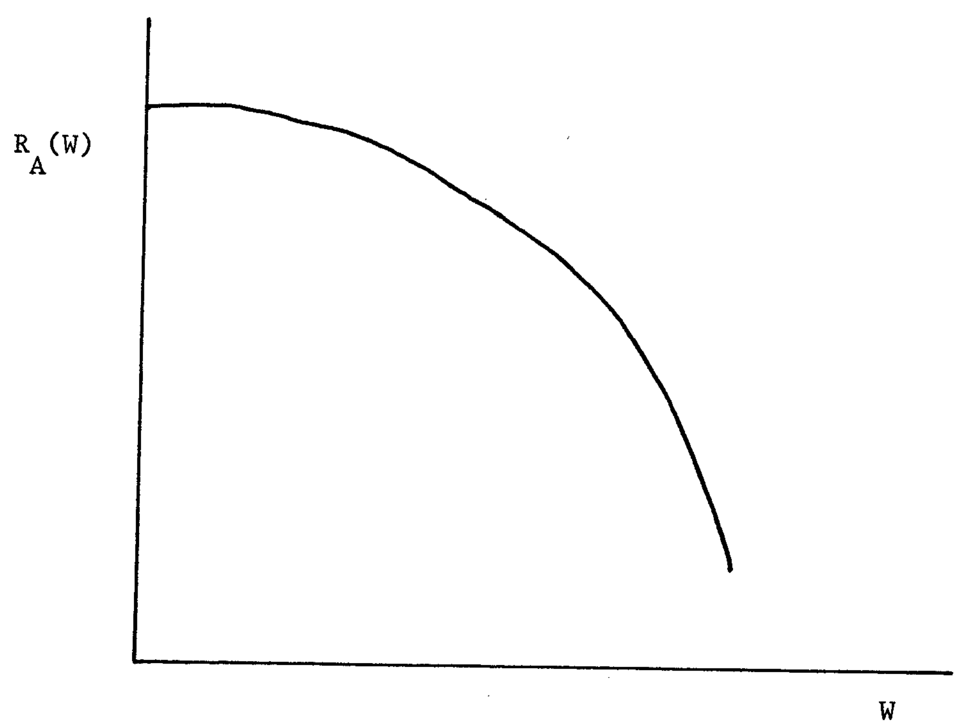

Figure D3

Risk Aversion Factor

To convert this to the relative risk aversion coefficient r is multiplied by the relevant value of W and recall that for a logarithmic function r is equal to 1.

$$U = \log_e W$$

$$U\ (W) = W^{-1}$$
$$U''(W) = -W^{-2}$$

therefore

$$r = \frac{-W\ U\ (W)}{U''(W)} = \frac{-W(W^{-1})}{-W^{-2}} = 1$$

To recap briefly on what has been covered regarding utility theory and its implications for the measure of relative risk aversion, four items have been discussed. The first acknowledged some of the classical work done in the field of utility theory. The second described methods of elictating actual utility functions. Part three outlined the properties associated with the functions while the last section described several specific forms.