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Canada

STUDIES OF LEASE-BUY DECISIONS AND MODELS FOR FORECASTING LAND PRICES

by

LAURENCE BRUCE BELL BAKER

A thesis submitted to the Faculty of Graduate
Studies and Research of McGill University in partial fulfilment of the
requirements of the degree of
Doctor of Philosophy

Department of Agricultural Economics
McGill University
Macdonald Campus
Montreal

May 1994

ISBN 0-315-94576-1

Canada

SHORT TITLE

LAND VALUE FORECASTS

LAURENCE BRUCE BELL BAKER

ABSTRACT

Ph.D AGRICULTURAL ECONOMICS

The choice between purchasing land or entering into a long-term lease is analyzed using a deterministic cash analysis both from the tenant's and landlord's perspective. It is less financially stressful to start farming through a lease agreement than by purchasing the assets. The lease period of landlord indifference between these choices is determined for each combination of input variables.

Land value and income forecasting models are developed and presented. These models are based on two similar but conceptually different statistical tests. Each test results in different forecasting models which has implications for the use of such models in the future.

Consumption-based asset pricing models are tested using agricultural rental income. These models, although appealing both intuitively and theoretically are found wanting in terms of their formulation as the model results are highly sensitive to the data employed. This concern increases with the level of data aggregation.

RÉSUMÉ

Ph.D AGRO-ÉCONOMIE

Le choix entre l'achat de terrain ou la location à long terme est analysé en utilisant une analyse déterministe du comptant entre le locataire et le laudateur. Pour commencer à cultiver, le stress financier est moindre avec un bail qu'avec un achat de biens. La période de location entre ces choix est déterminée pour chaque combinaison des variables d'entrées.

Des modèles prévisionnels de valeurs du terrain et du revenu sont développés et présentés. Ces modèles reposent sur deux test statistiques semblables mais conceptuellement différents. Chacun de ces tests résulte en des modèles prévisionnels différents, se répercutant ainsi sur leur utilisation éventuelle.

Des modèles de prix reposant sur les biens de consommations sont évalués en utilisant la méthode des revenus agricoles de location. Ces modèles sont intuitivement séduisant mais, théoriquement, ils laissent à désirer dans leur formulation. En effet, les résultats obtenus avec les modèles sont très sensitifs par rapport aux données employées. Ce problème s'accroit avec le niveau d'agrégation des données.

ACKNOWLEDGEMENTS

I would like to thank the following individuals for their help and guidance. Dr. Randall E. Westgren, Chairman, Department of Agricultural Economics, McGill University and thesis supervisor, for his encouragement and assistance in the initiation of this degree programme. Dr. H. Garth Coffin, Department of Agricultural Economics, McGill University and Dr. Art Moreau, Department of Finance, McGill University, who as members of my committee provided help both in the orientation and the accomplishment of the programme of study.

Thanks and recognition are also due to Dr. Paul J. Thomassin, Department of Agricultural Economics. Dr. Thomassin was Acting Chairman of the department for the final year of the programme and was instrumental in smoothing over some administrative rough edges for me. Also from the Department of Agricultural Economics, Dr. John C. Henning has provided help and guidance when requested. Both Drs. Thomassin and Henning have been co-authors with me on previously published work and the team relationship that we have had for many years has helped a great deal for this degree.

I would like to thank Dr. Micheal Sampson, Department of Economics, Concordia University for his help and encouragement associated with the third paper in this thesis. Dr. Mao-Wei Hung, Department of Finance, McGill University provided help for the final paper of the thesis which was prepared as the required paper for Dr. Hung's course "Empirical Research in Finance". My thanks are extended to Elizabeth Buck, who co-authored the third paper of this thesis.

Elizabeth has provided encouragement and moral support when necessary. I wish her well with her own studies.

My thanks are offered to Dr. Katrine Stewart, Chair, Department of Plant Science, McGill University, and Dr. Daniel Cloutier, Agriculture Canada, l'Assomption Sub-station, Quebec for their encouragement, guidance, and unfailing good humour. Dr. Cloutier also provided translation services.

Finally, I would like to thank my family for their understanding. My wife Marta has seen me spend almost half our married life together as a graduate student and she has encouraged me all the way. My three children, Thomas, Christopher and Nina, while not fully understanding the degree understand only too well that Dad is not at home to help them with their school work when required. This thesis brings to a close my formal education so that I can provide the necessary time and effort to help them with theirs.

Thank you everyone.

FOREWORD

This thesis is a compilation of four research papers, each presented as a separate chapter, around the theme of agricultural real estate valuation. These papers provide a distillation of thinking of the subject, starting with questions related to choice between purchasing or leasing real estate, through the forecasting of real estate values and income levels, to the consideration of the specification of the utility function that might be appropriate for the consumer/investor interested in these agricultural assets.

As three of these papers are co-authored papers, one has been published as a refereed paper, and one has been published in abstract form in a conference proceedings issue the following guidelines are included here to clarify McGill University's position regarding the use of such material for theses submissions.

> "*Candidates have the option*, **subject to the approval of their Department**, *of including, as part of their thesis, copies of the text of a paper(s) submitted for publication, or the clearly-duplicated text of a published paper(s), provided that these copies are bound as an integral part of the thesis. If this option is chosen,* **connecting texts, providing logical bridges between the different papers, are mandatory.**
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> *The thesis must still conform to all other requirements of the "Guidelines Concerning Thesis Preparation" and should be in a literary form that is more than a mere collection of manuscripts published or to be published.* **The thesis must include, as separate chapters or sections:** *(1) a Table of Contents, (2) a general abstract in English and French, (3) an introduction which clearly states the rationale and objectives of the study, (4) a comprehensive general review of the background literature to the subject of the thesis, when this review is appropriate, and (5) a final overall conclusion and/or summary.*
>
> *Additional material (procedural and design data, as well as descriptions of equipment used) must be provided where appropriate*

and in sufficient detail (eg. in appendices) to allow a clear and precise judgement to be made of the importance and originality of the research reported in the thesis.

In the case of manuscripts co-authored by the candidate and others, **the candidate is required to make an explicit statement in the thesis of who contributed to such work and to what extent;** *supervisors must attest to the accuracy of such claims at the Ph.D. oral Defense. Since the task of the examiners is made more difficult in these cases, it is in the candidate's interest to make perfectly clear the responsibilities of the different authors of co-authored papers."*

The following table identifies the papers (chapters) included in this thesis, their disposition, and the co-authors and their responsibilities. Three of the four chapters in this thesis are co-authored papers, and one paper has been entirely written by the candidate. The following table indicates the percentage contribution of each of the authors for each paper. The co-authors did not take responsibility for individual sections of each work, so a percentage has been used to identify each party's contribution to the work. All remaining parts of this thesis have been entirely prepared by the candidate, Laurie Baker.

The published and presented papers are duplicated in this thesis as they originally appeared except that the format has been changed to conform with the standard expected for the submission of theses at McGill University. The editorial changes that have been made are as follows: (1) table and equation numbers have been changed, (2) the reference sections for each paper have been deleted from the end of the papers and all references are presented in an all encompassing reference list at the end of the thesis, and (3) the appendices for each paper have been re-sited at the end of the thesis, and numbered accordingly.

Chapter Titles, Disposition, and Co-authorship Contributions.

Chapter	Title	Disposition	First Author (%)	Second Author (%)
1	Financing of New Farm Entrants: The Long-Term Leasing Option.	Published in *CJAE*[1] 39(1991): 255-269.	Laurie Baker (50%)	Paul J. Thomassin (50%)
2	Sensitivity of Long-Term Lease Rates and Time Horizons: A Deterministic Analysis.	Presented at *CAEFMS*[2] & *WAEA*[3] meetings in Edmonton 1993. Abstract published in Conference Proceedings.	Laurie Baker (90%)	Paul J. Thomassin (10%)
3	Unit Root Tests and Their Impact on Land Value Forecasts.	Will be submitted for publication following acceptance for thesis.	Laurie Baker (80%)	Elizabeth Buck (20%)
4	Consumption-Based Asset Pricing Models and Agricultural Real Estate Valuation.	Will be submitted for publication following acceptance for thesis.	Laurie Baker (100%)	n.a.

[1] Canadian Journal of Agricultural Economics.
[2] Canadian Agricultural Economics and Farm Management Society.
[3] Western Agricultural Economics Association.
n.a. Not applicable.

Originality

The first paper (chapter 1) was published, following peer review, in the *Canadian Journal of Agricultural Economics*. This paper's originality relates to the way in which the lease rate is calculated based on the legal rights associated with the rental property. The basis for this paper was first published by the same authors in 1988 (Baker and Thomassin 1988) but no attempt was made at that time to ascertain the cash flow implications of this type of lease contract. The second paper (chapter 2), chosen for presentation at professional meetings by a review process, has built upon the first paper and extended the analysis. Thus the material is original.

The third paper (chapter 3) was submitted to the *American Journal of Agricultural Economics* in November 1993. Although the paper was not accepted for publication by that journal the following comment from one of the reviewers recommends that it should be re-submitted to another journal.

> "I know of no study that compares the Dickey-Fuller, Dickey-Pantula and Box-Jenkins approaches in the identification of the order of integration required to make series stationary. I would, however, suggest that the *American Journal of Agricultural Economics* is the wrong journal to submit this paper. An applied statistics journal, where the readers are more interested in a comparison of test conclusions than the implications in explaining an economic relationship, would be a much better choice."

The theoretical models are not new but their application and their findings are original. The final paper (chapter 4), again not new in terms of theoretical work, is new in terms of application. This paper will be submitted for publication in a peer reviewed journal.

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INTRODUCTION AND ORGANIZATION OF THE THESIS

Financial stress, defined as difficulty in meeting financial obligations, in Canadian farming has been of concern for many years, and thus much attention has been paid to farm businesses that have gone or are going out of business. In an attempt to alleviate this financial stress alternative forms of debt financing have been investigated, some with more success than others, as measured by the interest shown in them by the farmer clientele of the financial institutions. This concentration on ownership, with the attendant debt financing may have been a result of the emphasis placed on these characteristics of the Canadian family farm, as espoused by farm groups and policy makers. (See Gilson 1992 for an historical sketch of this subject).

Recently, there has been a growing interest in alternatives to ownership, such as leasing, joint ventures, and franchising. The research papers (chapters) in this thesis present a progression both in the author's interest in the subject of financial stress and in alternatives to ownership of the real estate required for a farm business. The papers in this thesis all relate to the central theme of land valuation. This is important as any consideration of financial stress must first identify what has contributed to that stress. For most Canadian farms, and in particular for crop farms, the largest category of asset (in total dollar amount) will be real estate. Thus, it may be assumed that for most farmers there will be a high debt loading associated with these assets. Therefore, as the level of this debt increases there will be a concomitant increase in the amount of cash that is

needed to be generated to service the debt. This may result in financial stress, particularly if the interest rate changes unfavourably for the farmer before the debt is retired.

Given this discussion of financial stress and the acquisition of real estate, some thought should be given to the value attached to the asset in question. As the price of the asset is bid up, there is an increasing probability that the level of financial stress associated with its purchase will also rise. Therefore, it is imperative that the farmer who is purchasing the real estate not pay more for the asset than can be justified. For the purpose of this thesis this justification will be focused on economic rather than non-economic (intrinsic) factors. It is recognized that intrinsic arguments might weigh heavily for some purchasers, but not perhaps for those most vulnerable to financial stress, the beginning farmer. This discussion of the value that is attached to real estate will be developed in more depth in the connecting section between chapters 2 and 3. This thesis will concentrate on the market value of agricultural land as opposed to the agricultural use value of the land. (See Robison and Koenig 1992 for a discussion of the difference between these measures of land valuation).

The first paper (chapter 1) titled "Financing New Farm Entrants: The Long-Term Leasing Option" was written for presentation at the annual meeting of the Canadian Bankers' Association, held in Winnipeg in 1989. It was subsequently published as a refereed journal article in the Canadian Journal of Agricultural Economics. The paper was co-authored by Paul J. Thomassin of the Department

of Agricultural Economics, McGill University, Macdonald Campus. This research was carried out to determine whether long-term leasing might be a viable alternative to ownership for the acquisition of agricultural real estate.

Chapter 2 presents the results of the continuation of the first paper's analysis, titled "Sensitivity of Long-Term Lease Rates and Time Horizons: A Deterministic Analysis", also co-authored by Paul J. Thomassin, which was prepared for presentation at the CAEFMS/WAEA (Canadian Agricultural Economics and Farm Management Society and Western Agricultural Economics Association) international joint meetings held in Edmonton in 1993. The objective of this research was to determine the correct lease term to achieve the desired investment neutrality for a landlord. As well, the sensitivity of the results to changes in the underlying variables was investigated.

In any analysis of lease versus purchase the value of the underlying asset must be addressed. The determination of the value of agricultural land can be made using the capitalization formula. However, the assumption is made that the value (price) of the land so generated is the value to use. This has important implications for the success of lease or purchase options because of the financial stress that might result. Chapter 3 presents a research paper titled "Unit Root Tests and Their Impact on Land Value Forecasts" co-authored by Elizabeth Buck, graduate student in the Department of Agricultural Economics, McGill University, Macdonald Campus. This research paper originated as a critique of a paper by Clark et al (1993a). It became evident during the research that the paper should

be re-directed to focus on land value time series forecasting models to move the investigation beyond the work completed by Clark et al (1993a). The final paper titled "Consumption-based Asset Pricing Models and Agricultural Real Estate Valuation" is presented in chapter 4. This paper presents research carried out using the generalized method of moments (GMM) technique of nonlinear two stage least squares. The results of this analysis are parameter estimates for risk and intertemporal consumer preference which may be employed for asset pricing.

Reference lists are not included for each research paper (chapter), but a compiled reference list is placed at the end of the thesis. Connecting sections are presented between the chapters to draw the chapters together into one cohesive document.

CHAPTER 1

Financing of New Farm Entrants: The Long-Term Leasing Option[1]

by

Laurie Baker and Paul J. Thomassin

Faculty Lecturer and Assistant Professor, Respectively

Department of Agricultural Economics

McGill University, Macdonald Campus

[1] All notes appear at the end of the paper.

Abstract

The financing of agriculture has received much attention in recent years, with particular emphases on the financing of new farm entrants. This has been brought about by the underlying economic conditions of the agricultural production system and the policy responses to these conditions. Canadian agriculture has experienced an almost complete "boom and bust" cycle in commodity prices since 1971. This led to a cycle in real estate values causing financial stress on farms which resulted in an increase in farm failures. In response to this situation various financial instruments have been proposed to alleviate this financial stress. Unfortunately these have had no appreciable effect on the financial wellbeing of Canadian farms. Most of these responses take as given that Canadian farms should be owned and operated by the same economic unit. This paper suggests that long-term leasing of real estate would reduce the financial stress for these farms by removing the "cost of ownership" component of a farm purchase, and thus reduce the cash flow required to enter farming. A cash flow analysis is used to support these arguments using a Saskatchewan grain farm case example.

Le financement agricole a reçu beaucoup d'attention depuis ces dernières années, tout particulièrement en ce qui attrait au financement de la relève agricole. Ceci faisant suite aux conditions économiques actuelles du système de production agricole et des réformes politiques qui en découlent. L'Agriculture Canadienne a vu son prix des denrées soumis à un cycle presque complet de "boom and bust"

depuis 1971. Le cycle des valeurs immobilières qui s'en suivit a crée un stress financier qui entraina une augmentation des faillites agricoles. Pour remédier au problème plusieurs outils financiers ont été proposés. Malheureusement leur impact sur le bien-être financier des fermes canadiennes n'a pas eu l'effet escompté. La plupart de ces réponses prennent pour acquis que les fermes canadiennes devraient être possédées et opérées par la même unité économique. Ce papier suggère que la location à long terme des propriétés agricoles devrait réduire le stress financier, en éliminant le coût à la propriété lors de l'achat d'une ferme; permettant ainsi de réduire le fond de roulement requis pour débuter en agriculture. L'analyse du fond de roulement est utilisé pour supporter ces arguments en employant comme example le cas d'une ferme céréalière en Saskatchewan.

Introduction

Concerns about the financing of new farm entrants have been with us for a long time. The present situation regarding this financing is perhaps slightly different than at other times due to the cycle of farm values and financing that North American agriculture has been through since the end of the 1960's. Since that time asset values (particularly land) have escalated through to 1982, however land values declined until 1988-89 at which time they once again increased (FCC 1991). This increase was 4.9% in 1988-89 and 3.9% in 1989-90 for Canada. In Saskatchewan

the year-by-year changes were 0.4% in 1988-89 and -0.5% in 1989-90 (FCC 1991, 2). Saskatchewan was the only province showing a downturn in land values in 1989-90. The amount of increase and then decrease in value varied greatly with farm location.

During the 1970's land values were driven up by (a) favourable commodity (crop) prices, (b) relatively low interest rates, and (c) relatively high inflation rates. In fact for part of the time the real interest rate (nominal rate less the rate of inflation) was negative (Agriculture Canada 1988). In other words borrowing money allowed a business to grow faster than a business that did not borrow money for growth. This very favourable climate for the use of "leverage" was noted and stressed by educators, farm management advisors and financial agents.

The problem attached to this strategy of leverage relates to when the loan (mortgage) has to be renegotiated, assuming that it has not been fully repaid. If it is renegotiated when at a lower interest rate than the one in place when the loan was initiated, the farmer will be better off, assuming that the rate of return remains constant. Unfortunately, the reverse is also true, and this is what happened during the early 1980's. For example, a mortgage loan (25 years, with the rate set for 5 years) taken out in 1977 at a nominal interest rate of 10.29% might have been renegotiated in 1982 when the nominal interest rate was 18.04% (FCC 1989, 19). This change in the interest rate would result in an increase of approximately $12,000 (principal and interest) per year on a $200,000 mortgage; which could result in financial stress for the farm business in question.

During the 1980's many farmers were required to renegotiate their mortgages at these higher rates and became failed farms. These were not all beginning farmers, but included farms that had (prior to the loan in question) equity levels that would be considered to be secure. It is usually assumed that the higher the level of equity in a farm business, the lower is its level of balance sheet risk. This does not however address the problem of cash flow risk which is a function of the debt service ratio (Ashmead 1987). As stated above, the commodity prices, particularly grains, were high during the mid-1970's. They are no higher today in current dollars, and thus with higher input costs the farmers' level of profitability is much reduced today from the 1970's (Agriculture Canada 1990, 29).

Institutional Structural Change

Most of the potential solutions that have been suggested accept as given that the underlying structure of Canadian agriculture will not change, at least in one fundamental area which relates to farm ownership[2]. It is generally assumed that farming must be (land) ownership based and in fact many definitions of family farms include the concept of land ownership as a requirement (Strange 1988, Ehrensaft 1983, Richardson et al. 1982).

If commodity prices rise in the future, with a resulting rise in net farm income, farmers will be more capable of paying for their farms. However, financial stress may result if land values then turn down again with farmers having to renegotiate mortgages that were taken out when land values were increasing. This

fundamental problem will continue unless something is done to change the underlying structure of Canadian agriculture. The change that is suggested in this paper is to explicitly separate land ownership from land use.

Long-Term Leasing and Farm Entry

Purchasing farm land does not give one unlimited rights to use the property. For example mineral rights usually reside with the government. Environmental concerns and new legislation may restrict certain farming enterprises in close proximity to cities and bodies of water. In purchasing the land one is in fact purchasing the rights, or legal interest in the land, and not really the land itself. These rights are the important element. If the discussion can concentrate on rights rather than land ownership, it is easier to address the concept of leasing rights to the land instead of trying to purchase them.

The leasing of these rights has one advantage in that it will be cheaper than buying them, assuming a finite lease term. This is because when the lease term is over the "use" rights revert back to the lessor who has retained the "ownership" rights throughout the lease term. In a lease agreement the lessee has the right to use the property which is a sub-set of the total bundle of rights of ownership (Barlowe 1978). The difference between the cost of purchase for a farm and a long-term lease of the property, given a finite period, provides an estimate of the cost of ownership entailed in the purchase decision.

The lease terms that are being addressed must be longer than the terms

that are generally experienced in Canada at present. Short-term lease periods of less than 5 years, with 1-3 years being typical, almost invariably lead to "mining" of the soil and thus a degradation of the land base[3]. The length of the lease may vary. For example, lease terms of 25 and 45 years have been analyzed by Baker and Thomassin (1988). Shorter lease terms, for example ten years, could be used to ease the intergenerational transfer of the family farm. Whatever the lease term, leasing will lower the cash stress on a beginning farmer through the first crucial years of farming when, due to debt levels, the risks of financial failure are highest.

Calculation of Lease Payments

The determination of the lease rent is a critical factor for this institutional change to be a viable alternative. The method used to estimate the lease rent values the right of the lessee to "use" the property and the right of the lessor to the reversionary interest at the termination of the lease. This is done by setting the market value of the land and buildings equal to the present value of the lease rents and the reversionary interest (equation 1-1).

$$\text{Value of land and Buildings} = PV(LR) + PV(RI) \qquad (1\text{-}1)$$

where:

PV = Present Value
LR = Lease Rents
RI = Reversionary Interest

The long-term lease defines the finite time period over which the land can be used by the lessee and provides for the reversionary interest of the lessor. The

lease rent payment explicitly determines the cost of using the asset. Assuming that the lease payments are made at the end of each rental period, equation 1-1 can be rewritten.

$$\text{Value of Land and Buildings} = \sum_{t=1}^{n} \frac{LR}{(1+k_n)^t} + \frac{RI}{(1+k_r)^n} \qquad (1\text{-}2)$$

where:

k_n = nominal discount rate
k_r = real discount rate
t = finite period of lease rents
n = number of years of lease.

The first term in equation 1-2 determines the cost to the lessee of obtaining the "use" rights for the land and buildings over some finite time period (t). The lease rents are in nominal dollars and are discounted using the nominal discount rate.

The second term estimates the value of the reversionary interest of the land and buildings to the lessor when the property is returned at the end of the lease period. With perfect information the future value of the land and buildings would be known and would be discounted by the appropriate nominal discount rate. In the absence of perfect information, the reversionary interest for a long-term lease can be estimated using two possible methods: (1) inflate the current value of the land and buildings over the lease term and discount by the nominal discount rate, or (2) take the current value of the land and buildings and assume it will be the same in constant dollars and discount it using the real discount rate.

Regardless of which method is used to determine the present value of the

reversionary interest the value will be the same, i.e. the difference between the real and nominal discount rates is the rate of inflation. The latter method was used to estimate the present value of the reversionary interest in this paper. It should noted that this term can be estimated if the current market value of the land and buildings and the real interest rate are known. Both of these values would be available to the lessor.

Case Farm Example Comparison of Leasing Versus Buying

The case farm chosen for illustrative purposes is a grain farm in Saskatchewan starting in 1988 as the base year and analyzed through 1994. Details of this farm are presented in Appendix Table 1-A-1 along with the data sources employed. The farm has 1150 acres under wheat, barley, and canola. The total value of the farm is $525,089 for the purchase option with this being broken down as:

Current Assets	$79,067
Intermediate Assets	$114,918
Long-Term Assets	$331,104

These assets are assumed to be financed in the following fashion: Current 100%, Intermediate 100% (chattel mortgage), Long-Term 75% (financial institution at 12.5%) and 25% (family at 8%).

For the leasing option, the rental rate is determined using equation 1-2 above. Re-writing equation 1-2, to solve for the present value of the lease rents:

$$\text{Market Value of Land} - \frac{RI}{(1+k_r)^n} = \sum_{t=1}^{n} \frac{LR}{(1+k_n)^t} \qquad (1\text{-}3)$$

The value of land and buildings which will be leased for 25 years has a market value of $331,104 (value of the long-term assets in the purchasing option). The present value of the reversionary interest, using a 4 percent real discount rate (Burt 1986), is $124,202.67. The present value of the lease rental payments is therefore equal to $331,104 - $124,202.67 or $206,901.33. To determine the annual lease rent, one uses an annuity factor for the length of the lease, 25 years, and a given interest rate. The interest rate chosen in this case was 12.5%, the same rate used by banks to finance long-term assets. The annuity factor is 0.131943, and therefore the annual lease rental rate is $27,299.27. For this Saskatchewan farm, the per acre lease rental rate is $23.74.

For the leasing option the assets are valued in total at $398,090 and are broken down as follows:

Current Assets	$103,570
Intermediate Assets	$114,918
Long-Term Assets	$179,602

The larger current asset figure is accounted for by the first year's lease payment being added to the money required to finance the cost of production for year 1. The machinery is assumed to be the same as for the purchase option, and the long-term assets are equal to $179,602, i.e. the present value of the deferred portion of future lease rents. It is important to recognize that the long-term lease

provides the producer (lessee) with the legal right to use the land and buildings for 25 years at a particular lease rate. This right of use is a long-term asset and is shown as such in the beginning balance sheet position. An off-setting entry of $179,602 is made as a long-term liability which is charged a zero rate of interest. Each year the present value of the future lease rents is re-estimated for both assets and liability sides of the balance sheet. In this way, there is no impact on the equity position of the farm, however, there will be an impact on the ratio analysis of this farm.

Results

Some of the results of the simulations are presented in Table 1-1. The simulation was estimated for a seven year time frame to evaluate cash flow and balance sheet positions for each option. It is clear from the results that the ownership option is in financial stress and is a candidate for foreclosure. The leasing option, over this time period, is economically viable.

In terms of net farm income without market gains the ownership option has a negative net farm income in six of the seven years compared to the leasing option which has a negative net farm income in only the second year of the simulation. The equity position in the ownership option increases in the first three years of the simulation then decreases to approximately $5,000 at the end of the seventh year. With the leasing option the amount of equity increases in every year with an ending equity position of over $116,700.

Table 1-1: Results of simulating purchase versus lease options[a]

Variable	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
NFI[b] (O)	$3,089	($16,693)	($13,544)	($18,152)	($2,941)	($1,206)	($4,309)
NFI[b] (L)	$11,415	($1,533)	$3,073	$338	$14,606	$17,554	$17,193
Equity (O)	($1,650)	$30,090	$36,614	$13,493	$11,993	$10,331	$4,917
Equity (L)	$10,612	$24,837	$38,494	$47,947	$71,287	$95,187	$116,727
Debt (O)	$508,896	$528,731	$534,222	$532,020	$521,162	$516,486	$522,710
Debt (L)	$351,467	$330,470	$320,298	$306,619	$293,660	$276,148	$262,532
Cash (O)	$830	$734	$847	$1,223	$1,406	$1,649	$2,260
Cash (L)	$9,639	$11,534	$18,807	$20,779	$35,709	$41,820	$45,234
For prin (O)	$28,266	$3,777	$3,145	($4,504)	$8,259	$8,022	$3,328
Prin (O)	$9,123	$10,233	$11,478	$12,874	$14,442	$16,200	$18,172
For prin (L)	$34,398	$16,854	$17,782	$12,105	$24,020	$25,085	$23,218
Prin (L)	$6,392	$7,191	$8,090	$9,101	$10,239	$11,518	$12,958
ROA[c] (O)	0.1194	0.0774	0.0726	0.0625	0.0934	0.0953	0.0909
ROA[c] (L)	0.1564	0.1183	0.1263	0.1132	0.1520	0.1481	0.1400
ROE[d] (O)	infinite	(37.4902)	0.5904	(0.7609)	(0.1503)	(0.0518)	(0.2260)
ROE[d] (L)	infinite	1.8631	0.8893	0.3595	0.5743	0.4117	0.2958

[a] The values in the table include contingencies and/or gains from market changes where appropriate. The results for the ownership option are identified by (O) and those for the leasing option by (L).

[b] Net Farm Income without market changes.

[c] Return on Assets is equal to earnings before interest (and/or rent) divided by beginning total assets, with contingencies taken into account.

[d] Return on equity with gains is equal to net income after gains divided by beginning net worth, with contingencies taken into account.

The amount of debt held by the ownership option increases over the first three years and then gradually decreases to $522,710, which is only $2,379 less than the amount at the start of the simulation. The debt steadily declines for the leasing option to $262,532 which is $135,559 less than at the start of the simulation. The amount of cash on hand is never more than $2,260 for the ownership option in year seven, while for the leasing option the amount of cash increases steadily to $45,234 at the end of the seventh year.

Comparing the dollars available for principal payments with the actual principal payment owed gives an indication of the economic viability of the operation. With the ownership option, principal payments cannot be made in six of the seven years. The only year when principal payments can be made are in the first year. This option is under financial stress and would be a candidate for foreclosure by a financial institution. The leasing option is able to make its principal payments in all years. In the seventh year it has funds available for other uses of $10,259.

The leasing option has a better return on assets over the time period. It should be noted that the assets and returns structure of each option is different. The ratio for the ownership option declines over the first four years of the simulation, increases through year six, and then declines in year seven. In the leasing option the ratio oscillates year-by-year between a high of 0.1564 in the first year and a low of 0.1132 in year four. The leasing option has a better return on equity than the ownership option. In five of the seven years the returns on equity

are negative for the ownership option. The leasing option has a positive return on equity in all years.

Discussion

Comparing the results of the ownership and long-term leasing options indicate that the leasing option is far superior in terms of both cash flow and balance sheet evaluations. The ownership option investigated in this case would not be able to pay its principal payments in six of the seven years which might result in foreclosure or quit claims proceedings. The small amount of cash on hand at any time over the seven years and the negative net farm income generated would suggest that ownership is not a viable economic means for farm entry over the time period analyzed.

The analysis would indicate that long-term leasing is an economically viable way of entering into agriculture at this time. The ability to pay one's principal payment in each year and to have funds available for alternative uses is a positive indicator for a new farm entrant. Using this means to get into production agriculture provides for a growing equity position, a greater amount of cash on hand, and a decrease in one's debt position. The cash and balance sheet positions associated with long-term leasing would indicate that this farm was economically viable over the period analyzed. Unlike the ownership option, the leasing option provides the new farm entrant with a means of entering production agriculture with a greater chance of financial success.

The economic viability of the long-term lease option over the ownership option is a function of the difference in annual payments for the use of the land. To finance the land and buildings portion of this Saskatchewan grain farm requires an annual payment of $40,519.61 for the ownership option. Again, this assumes that 75 percent of the land and buildings is financed by a financial institution at 12.5% and the remaining 25 percent is financed by family at a preferred rate of 8 percent. The cost of leasing the land and buildings, using the method above, was $27,299.27. Therefore, the "cost of ownership" is the difference between these amounts or $13,220.34 per year. Over a twenty-five year mortgage or lease rental this amounts to a present value of $100,196.97 using a 12.5 percent discount rate. This annual cost of ownership is substantial and for the new farm entrant would be the difference between being able to make the principal payments or not in six out of the seven years. Obviously, this cost of ownership provides a significant amount of financial stress for the new farm entrant.

It should be noted that it was assumed that the mortgage was financed 75 percent by a financial institution and 25 percent by family at a preferred interest rate. This was done to provide a valid comparison of the ownership and leasing options. The preferred interest rate given to the new farm entrant by the family does give an advantage to the ownership option since under the long-term lease option everything is financed at the higher rate charged by the financial institution. The financially superior results with the long-term leasing option would continue to exist even if the new farm entrant was assumed to have some level of equity as

they entered in agriculture. This equity, which would be used to decrease the financing of the land and buildings in the ownership option, would be used to decrease the financing of machinery and current liabilities in the long-term leasing option. The "cost of ownership" would remain and therefore the annual cost of financing would be lower in the long-term leasing option. The only difference in the conclusions of the analysis could be the ability of the purchasing option to remain economically viable, i.e. able to pay all interest and principal payments every year. However, the long-term leasing option would continue to out-perform the ownership option.

The high level of equity required for production agriculture today usually necessitates that the new farm entrant have some financing from family members or a "gift" of a portion of the farm from the parents. This has an impact on who is able to enter into production agriculture. If a gift of land is required for new farm entrants to become economically viable then this limits the number and selection of individuals to those whose families are currently involved in production agriculture. This has potential policy implications for Canadian agriculture.

The lease rental rate is derived from the methodology used. In the case farm example chosen the resulting rate of return on the land and buildings is 8.25 percent (annual lease rental divided by the value of land and buildings). This is higher than the "standard" rate of 5.00 percent which is common for short term leases of one to five years (Schoney and Pederson 1989). The difference can be explained because of the premium that is required for the landlord to commit the

property to a lessee for an extended time period.

For the lessor to be interested in leasing the land and buildings in a long-term lease arrangement the income from the lease should be comparable to other potential investments. If the value of the land and buildings were sold and invested at nine percent the annual income would be $29,799.36. The lease rental rate of $27,299.27 would result in a shortfall to the lessor of $2,500.09 or $2.17 per acre. In addition to this shortfall from the investment the lessor would have to pay the taxes on the property. In the first year, real estate taxes were estimated to be $2,798.00. A potential windfall for the lessor would occur if the value of the land and buildings were to increase at a rate greater than inflation. The lessor would benefit from these capital gains since he/she holds the reversionary interest in the property.

The availability of farm land that could be leased on a long-term basis is not well known at this time. However, there were approximately 800,000 acres in the hands of financial institutions as of 1 January, 1986 (Agriculture Canada 1986, 44). There are indications that this figure may in fact have been a conservative estimate as a survey carried out by the National Farmers Union in 1989 estimated that 1.5 million acres have been taken by lenders due to loan defaults in the three prairie provinces alone (Manitoba Co-operator 1989). These financial institutions do not want to be "default" landlords but with the correct changes to relevant legislation they might either be willing to become landlords, or to pass the land into the hands of qualified landlords. An example of this type of institutional arrangement was

proposed by F. Gregory Hayden with the Family Farmland Reserve (Hayden 1986).

The development of a long-term leasing option for new farm entrants in Canadian agriculture will require a change in the institutional framework of the agricultural sector. First, laws which limit who can own farmland and how that farmland can be managed would have to be changed. It could be possible to introduce legislation which would allow mutual funds, for example, to invest in farmland. This would provide this type of investment fund with a means to diversify its portfolio with a low market risk opportunity. Other existing institutional structures, such as the Farm Credit Corporation, could be modified to allow it to manage farmland with long-term leases. Second, legislation could be enacted which would provide some real estate tax relief to the lessor who becomes involved with long-term leasing. This would decrease the differential in returns on investment if the land and buildings were sold or leased out on a long-term basis. Finally, the agricultural economics profession and government policy makers would have to adjust their definition of the family farm away from the ownership concept to one which would view land and buildings as an input into the production of agricultural commodities. This would focus attention on the use aspect of the land and buildings as opposed to the ownership aspect.

Conclusions

This paper has attempted to highlight some of the problems associated with farm purchases. It is suggested in this paper that unless the underlying institutional

structure of Canadian agriculture is changed, which means first and foremost a change in personal and business attitudes, the problems that are faced will always be there and they will be felt on a cyclical basis. If farming resources, and in particular farm land, can be viewed in terms of the rights of use that are attached to them then it will be easier to divorce ownership from management of the farm. In this way farm managers can concentrate on the acquisition of resources for their productive potential and not for their capital gains potential.

The analysis employed in this paper provides some indications as to the relative chances of success of a purchase option versus a long-term leasing option for one set of circumstances. The chances of success for a purchase option will always improve as the level of debt is lowered in relation to the value of the assets being purchased. This implies that other sources of capital are available. Most persons with a non-farm background who have an interest in farming cannot be gifted either all or part of the assets required and there is thus some level of barrier to entry involved. Long-term leasing would provide a means whereby these individuals could enter farming. It might also provide a way for the next generation to enter into the family farm without the financial pressure of a purchase decision. Alternatively it could decrease the cash flow risk which can result in farm titles being transferred to the lender. An estimate indicates that as of April 1991 1,865 farms in Saskatchewan have had their titles transferred to FCC (Friesen 1991, 8).

Finally, the annual "cost of ownership", or "lease advantage" of $13,220.34 that has been calculated for the case farm scenario analyzed in this paper can be

put into perspective when it is compared to the level of government support provided to Canadian farmers, as follows:

> Between 1986 and 1989, Canadian farmers with sales over $10,000 received, on average, $19,000 annually in direct payments from federal and provincial programs (Agriculture Canada n.d., 2).

Thus, if long-term leasing can help to alleviate financial stress experienced by Canadian farmers, perhaps it can contribute to a decrease in requirements for agricultural support payments.

NOTES

[1] This paper is a rewrite of a paper originally presented at the Canadian Agricultural Finance Conference "Changes, Choices, Challenges: Servicing the Rural Economy". October 31, 1989. The Westin Hotel, Winnipeg, Manitoba.

[2] Examples of mortgage instruments that have been developed are the Commodity Based Mortgage (since discontinued) and Shared Risk Mortgage offered by the Farm Credit Corporation.

[3] "Economic theory suggests that insecure property rights lead to the premature depletion of resources. If a farmer cannot capture the future gains that arise from conservation decisions, he or she will have no incentive to conserve. Indeed, "resource users will adopt a utilization plan that they themselves would regard as wasteful depletion if their property rights were more stable" (Ciriacy-Wantrup, S.V. (1968). Resource Conservation: Economics and Policies. California Agricultural Experiment Station, Davis). Thus, if a farmer has an exceptionally short planning

horizon because of expectations that he will either sell the farm shortly or the landlord will cancel the lease, there is little if any incentive to conserve because there are few if any gains to be made by so doing." (Batie 1982, 37)

ACKNOWLEDGEMENT

The authors wish to thank three anonymous Journal referees for their helpful comments. One of them in particular contributed to a great improvement in this paper. Responsibility for content, however remains with the authors.

CONNECTING SECTION 1

The results presented in the previous paper indicate that the use of long-term leasing could provide the farmer with an opportunity to build their equity holdings with a view to a successful purchase decision being made in a later time period. For the years under study, 1988 as the base year with projections to 1994, the leasing option resulted in an increase in equity whereas there was an erosion of equity for the purchase option. It was assumed that for a landlord to be willing to enter into a long-term lease agreement, the landlord should be provided with a rate of return on the lease that is equivalent to the rate of return that they could earn by selling the farm and investing the sale proceeds in Canada savings bonds. This investment alternative was assumed to provide the landlord with an equivalent risk level as that from committing to a long-term lease contract. This is not strictly true. It is usually assumed that the risk of default is zero with government bonds, whereas this could not be assumed for a lease contract. Aside from that and for the purposes of the study, the relative risks of the two alternatives are assumed to be equal. It should be noted that this rate of return would be expected to be higher than the "standard" lease rate for short-term leases in Canada which is taken to be about 5% of the value of assets leased.

Following publication of the first paper (Baker and Thomassin 1991), a comment was published (Turvey 1992) to which a response appeared in the same journal (Baker and Thomassin 1992). The concerns that Turvey expressed about the analysis focused on (a) capital gains in land values, (b) omission of taxes, and

(c) the focus on a cash analysis. He felt that we had not adequately allowed for capital gains in land values. We argued that as we could not guarantee them they were dealt with through the real discounting of the reversionary interest in equation 1-3 in the previous paper.

With respect to taxes, we concurred with Turvey but felt that details of that nature could cloud the issue, particularly if in fact the tax impacts are minimal. This subject is re-addressed in the concluding chapter of this thesis. Concerning the cash analysis, Turvey used a capital budgeting approach to show that his arguments were more valid than those that we had presented. We could not then, nor can we now, support this argument as he neglected the cash flow risk arguments that we focused our analysis upon. The cash analysis was chosen to focus attention on the ability of farms to finance their operations through time. The capital budgeting approach assumes that all cash flows will be adequate, whereas this cannot be assumed to be the case.

A final area of concern about the analysis, expressed by the paper reviewers, related to the leverage assumptions made in the first paper. It was argued that the buyer would (a) be unfairly disadvantaged by such a high level of leverage, and (b) the buyer might (would) not be able to find a lender willing to finance their business to the stated level of leverage. In response to the first of these concerns we argued that any other (lesser) level of leverage would unfairly disadvantage the leasing option because the lessee would be financing the costs of the lease with a 100% leverage position. In answer to the second of these

concerns we would argue that this level of leverage might be reasonably representative for beginning farmers in Canada, particularly if the family financing portion of the contract is personal.

Although, as stated above, an assumption of investment neutrality between leasing and bond investment was made, the results of the analysis indicate that the landlord would be made slightly worse off by leasing as opposed to the sale and investment option. Thus absolute neutrality was not in fact attained. This results because the lease term (time horizon) was set and not allowed to float. The term used for the analysis was taken to be 25 years, whereas the "normal" Canadian lease will be 1-3 years. It was hypothesized that allowing the lease term to float would allow for the attainment of investment neutrality originally assumed. This is the basis for the second paper in this thesis.

CHAPTER 2

Sensitivity of Long-Term Lease Rates and Time Horizons: A Deterministic Analysis[1].

by

Laurie Baker and Paul J. Thomassin

Faculty Lecturer and Associate Professor, Respectively

Department of Agricultural Economics

McGill University, Macdonald Campus

[1] All notes appear at the end of the paper.

The Problem and Study Objectives

The financial stress that has affected Canadian farmers, particularly since the end of the 1970s, has led to numerous potential solutions being analyzed and discussed by members of the agricultural economics profession. Some of these relate to an alleviation of the financial stress of a purchase decision through a subsidization of the mortgage interest rate applicable to the loan. These approaches follow the "traditional" view of debt financing, in one form or another, being the means of farm financing to be used in Canada[2]. An alternate suggestion has been made by Baker and Thomassin (1988, 1991, 1992) that relates to the acquisition of a farming "future" through the leasing of the necessary real estate as opposed to the purchase of it. This approach is not without its detractors. Some feel that this goes against the "historic" trend of purchase, and thus might lead to a landed class and an unlanded class with the former being absentee landlords, with all the negative connotations this term implies, and the second group who face a non-farming future when the lease term expires. Although these concerns have some validity, it is the contention of these authors that any concentration on these concerns clouds the issue and side-tracks the discussion away from where it should be, and that is related to the issue of financial stress and possible ways to alleviate it.

Baker and Thomassin (1991) chose a lease term of 25 years for a case farm scenario[3] as one that would be long enough to provide the tenant with the incentive to conserve the resource base for future years. This lease term would

also be considerably shorter than an expected working lifespan for a typical farmer. These authors argue that although long-term leasing could be used to acquire farming rights for a full working lifespan, it could also be employed to provide an entry vehicle for farm families whereby equity is built during the lease period and then on termination of the lease agreement used to reduce the financial stress of a purchase of a farm business. This purchased farm business might be the same one that was leased, if leased from family members, or an unrelated farm entirely. The results of that analysis indicated quite clearly that a beginning farmer would have been able to start a farm business under such a long-term leasing arrangement, even with a low equity percentage in the business. The conclusion was therefore drawn that such a long-term leasing arrangement could be used to generate equity which could ease a mortgage purchase for the property once the beginning phase was complete.

The lease term of 25 years, and the lease payment of $27,299.27 per year, resulted in the landlord being made worse off by $2,500.09 per year when compared to the option of the landlord selling the real estate and investing the sale proceeds in Canada Savings Bonds (CSB)[4]. This should be of concern to anyone who might be interested in becoming a landlord. One option suggested by Baker and Thomassin (1988) might be to offset such a "loss" to the landlord through a forgiveness of real estate taxes of the same amount. This would work for the landlord but would either leave the legislative authority with less tax revenue, or necessitate that this shortfall in tax revenue be made up by an "over taxing" of the

other taxpayers in the same jurisdiction. This second scenario would be politically unacceptable. Therefore, any lease rates and terms generated for a leasing arrangement should be derived given an assumption that the landlord must be indifferent between selling, and investing the proceeds in a risk-free investment vehicle such as Canada Savings Bonds, and committing the real estate to a lessee for a fixed term at a mutually set lease rate. It is hypothesized that the lease rate and term so set would be quite variable year-to-year due to expected changes in the underlying variables used to derive them.

The analysis for this paper therefore extends that carried out by Baker and Thomassin (1991) and derives a lease term that results in the landlord being indifferent between renting the real estate or selling it and investing the proceeds. This analysis is then extended further to investigate the effect on lease term, lease payment, and cost of ownership for the chosen case farm as the input variables to the analysis are varied. Comparisons with mortgage purchase options are included for selected years.

The Analysis

The first part of the analysis calculates the lease term over which the landlord is indifferent between leasing and selling and the cost of ownership for a 1150 acre grain farm in Saskatchewan producing wheat, barley and canola. This cost is estimated to be $73,247.95 over 30.75 years. The period of 30.75 years is that period of "landlord indifference", and the "cost of ownership" of $73,247.95 is the

difference between buying the farm compared to leasing it. This is a cost advantage of $9,407.49 per year in favour of the lease from the perspective of the lessee, whereas previously mentioned the landlord is neither advantaged nor disadvantaged by the agreement. The method used to calculate this ownership cost can be found in Baker and Thomassin (1988, 1991). These values compare to a cost of ownership of $100,196.97 for a 25 year lease on this property, which provides a lease advantage to the lessee over ownership of $13,220.34 per annum (Baker and Thomassin 1991). These results indicate that, as expected, the cost of ownership and thus the annual lease advantage will decline as the lease term increases, with the expectation of a cost of ownership of $0 for an infinite term lease[5]. The per acre lease rent for the 30.75 year contract is calculated to be $25.91 compared to that calculated by Baker and Thomassin (1991) of $23.74 per acre for a 25 year contract. The lessor would be indifferent between selling the asset or leasing it at a per acre rent of $25.91 for any lease period up to but not greater than 30.75 years. For lease terms greater than 30.75 years, the lessee would have to pay more per acre to encourage the lessor to enter into such a contract.

The second part of the analysis calculates both the cost of ownership and the indifference lease periods under various assumptions with respect to interest and inflation rates and beginning equity levels for the case farm in question. This part of the analysis uses the case farm with an initial indifference lease term of 30.75 years. Each of the input variables for this case farm are presented in Table

2-1, along with the results of the analysis. The analysis is divided into two sub parts. In the first part each of variables 5 through 9 in Table 2-1 (Part 1), are looked at in isolation (holding all other variables at the value that they are given in table 1) to determine the effect on (a) the indifference lease term, (b) annual rental payment (total and per acre), and (c) the cost of ownership for the real estate in question. In the second part of the analysis a selected number of "representative" situations are investigated to determine if leasing would in fact be a viable option, and if so to what extent.

Table 2-1 (Part 1): Initial Situation Input Values:

1.	Market Value of Land and Buildings	$331,104
2.	Market Value of Machinery and Equipment	$114,918
3.	Land Area (acres)	1150
4.	Lease Term (years)	30.75
5.	Percent of Capital Acquisition as Downpayment (%)	25
6.	Nominal Interest Rate (%)	12.50
7.	Real Interest Rate (%)	4.00
8.	Canada Savings Bond Rate (%)	9.00
9.	Interest Rate from Family (%)	8.00

Table 2-1 (Part 2): Initial Situation Result Values:

Annual Rent (Total)	$29,793.70
Annual Rent (per acre)	$25.91
Difference to Landlord (Lease-Sell: TOTAL)	($5.66)
Difference to Landlord (Lease-Sell: PER ACRE)	($0.00)
Cost of Ownership	$73,247.95

Downpayment

The assumption is made that for a purchase option to be exercised for this property a downpayment will be provided by family members, but an interest rate of 8% will be charged on this money. If the amount of this downpayment is changed from the initial situation it would be expected to have an impact on the cost of ownership of the property. For example, any increase in the size of the downpayment would obviously decrease the mortgage requirement by an equal amount. Thus there would be a decrease in the annual cash payment to retire the outstanding mortgage and a corresponding increase in the "desirability" of acquiring the property in question through a mortgage backed purchase agreement. For any decrease in the downpayment, the opposite argument holds. There would be no impact on lease rates because the method utilized to calculate the lease rate is not impacted on by the downpayment, just the prevailing interest rates. The percentage downpayment for this analysis was scaled from 50% to 100% and the resulting costs of ownership are presented in Table 2-2.

Table 2-2: Impact of Changing Downpayment Percentage on Cost of Ownership

Percentage Downpayment	Cost of Ownership
50	$47,369.52
75	$21,491.10
85	$11,139.73
95	$788.36
95.5	$270.79
95.75	$12.00
96	-$246.78
97	-$1,281.92
100	-$4,387.33

As expected, as the downpayment percentage increases, the cost to acquire the ownership rights on the property declines. As indicated in Table 2-2, the cost of ownership for these rights becomes negative as the downpayment percentage increases above 96%. This is because the cost for this money at 8% is less than the lease rental rate of approximately 9% of the value of the real estate. The implication of this result is that a downpayment of 96% on this property makes a purchase option preferable to the leasing option.

Nominal Interest Rate

If the nominal interest rate on funds borrowed from a banking institution is varied, holding all other variables constant as in Table 2-1, it is hypothesized that as the nominal rate declines, so should the rental payment. There should however be an

increase in the cost of ownership on the property in question as future dollars are discounted less due to the lease being calculated using the nominal interest rate. In the case of the cost of ownership, as the nominal rate declines, there is an expectation of an increasing present value of the annual difference between leasing and purchase costs. This present value is the calculated cost of ownership. The results of this analysis are presented in Table 2-3. The nominal interest rate is scaled from a high of 14% to a low of 9%. Over this range the annual rental payment declines from $33,065.09 ($28.75 per acre) to $22,465.24 ($19.53 per acre). Similarly, the cost of ownership increases from $67,618.62 to $91,808.70.

Table 2-3: The Impact of Nominal Interest Rate on Rental Payment and Cost of Ownership - (30.75 year lease term)

Nominal Rate	Annual Rent (Total)	Annual Rent (per acre)	Lease-Sell Total	Lease-Sell Per Acre	Cost of Ownership
14	33,065.09	28.75	3,265.73	2.84	67,618.62
13.5	31,968.00	27.80	2,168.64	1.89	69,378.08
13	30,877.33	26.85	1,077.97	0.94	71,251.15
12.5	29,793.70	25.91	(5.66)	(0.00)	73,247.95
12	28,717.75	24.97	(1,081.61)	(0.94)	75,379.70
11.5	27,650.16	24.04	(2,149.20)	(1.87)	77,658.85
11	26,591.69	23.12	(3,207.67)	(2.79)	80,099.22
10.5	25,543.10	22.21	(4,256.26)	(3.70)	82,716.21
10	24,505.24	21.31	(5,294.12)	(4.60)	85,526.99
9.5	23,478.98	20.42	(6,320.38)	(5.50)	88,550.68
9	22,465.24	19.53	(7,334.12)	(6.38)	91,808.70

The results presented in Table 2-3 are generated assuming that the rental period of 30.75 years will remain fixed. In this case it is expected that the landlord may or may not be indifferent between selling or renting the property. In general, the higher the rental payment the greater the advantage of leasing to the landlord, and the lower the rental payment the greater will be the relative disadvantage to the landlord. This information is provided in columns 4 and 5 of Table 2-3. At a nominal interest rate of 14% the landlord is better off by $3,265.73 ($2.84 per acre) per year by leasing the property rather than selling it and investing the proceeds in Canada savings bonds. At the other end of the range, at an interest rate of 9% the landlord is worse off by $7,334.12 ($6.38 per acre) per year if involved in a rental arrangement as opposed to the investment option.

The above analysis was repeated with the lease term adjusted to that period over which the landlord would be indifferent between selling and investing as opposed to the leasing option. The results of this analysis are presented in Table 2-4. In this case it is hypothesized that as the nominal interest rate decreases the lease term will become longer. The resulting cost of ownership may increase or decrease, with the direction of change being dependent on whether the "saving" in the discounted future dollars due to the lower nominal interest rate is more or less outweighed by the "loss" due to the increased discount period of the longer lease term.

Table 2-4: The Impact of Nominal Interest Rate on Rental Payment and Cost of Ownership - (Varying lease term)

Nominal Rate	Lease Term	Annual Rent (Total)	Annual Rent (Per Acre)	Lease-Sell (Total)	Cost of Ownership
14	24.45	29,797.20	25.91	(2.16)	97,669.49
13.5	26.25	29,807.08	25.92	7.72	90,000.99
13	28.30	29,794.99	25.91	(4.37)	81,986.27
12.5	30.75	29,793.70	25.91	(5.66)	73,247.95
12	33.70	29,790.75	25.90	(8.61)	63,853.42
11.5	37.40	29,802.88	25.92	3.52	53,566.31
11	42.10	29,803.54	25.92	3.95	42,616.91
10.5	48.45	29,803.54	25.92	4.18	30,842.24
10	57.80	29,799.97	25.91	0.61	18,268.53
9.5	74.55	29,799.36	25.91	(0.00)	4,862.97
9	>99				

N.B. The lease minus sell difference on a per acre basis is $0/acre for each case.

The results presented in Table 2-4 indicate that in fact the cost of ownership declines as the nominal interest rate declines, even though the lease term increases. This is because for the nominal interest rates chosen the highest rate is 1.55 times the lowest rate, whereas over the same range the longest lease term is 4.04 times the shortest lease term. At an interest rate of 14% the lease term is 24.45 years and this becomes more than 99 years at an interest rate of 9%. Full results are not presented for a lease term in excess of 99 years as this would legally imply ownership. Over the same range the cost of ownership declines from

$97,669.49 to less than $4,862.97. Over this range the lease payment is the same. It should be noted that the differences in the values within columns 3 to 5 is the result of rounding the lease term to the nearest 0.05 of a year. On a per acre basis the difference to the landlord between selling and investing versus leasing is $0.00. By varying the lease term it is possible to ensure that the landlord is indifferent between leasing and selling the property. Thus the annual rental payment, in total and on a per acre basis, is the same regardless of the nominal interest rate. As the lease term increases there is an expectation of a decline in the cost of ownership.

Real Interest Rate

It is hypothesized that as the real interest rate is increased, holding all other variables constant at the values set in Table 2-1, there should be a decrease in lease term and a consequent increase in the cost of ownership for the property. As the real interest rate is increased there is an expectation of an increased rental payment because the calculated reversionary interest in the property at termination of the lease contract will be expected to decline. To ensure that the annual lease payment remains constant the lease term must decrease. The results of this analysis are presented in Table 2-5 and they indicate that at a real interest rate of 2% the lease term will be 64.20 years with a cost of ownership of $63,415.32. With a real interest rate of 6%, the lease term would be 16.40 years with a cost of ownership of $107,742.43.

Table 2-5: The Impact of Real Interest Rate on Rental Payment and Cost of Ownership - (Varying lease term)

Real Rate	Lease Term	Annual Rent (Total)	Annual Rent (Per Acre)	Lease-Sell (Total)	Cost of Ownership
2	64.20	29,795.87	25.91	(3.49)	63,415.32
2.5	51.30	29,797.69	25.91	(1.67)	64,403.31
3	42.50	29,803.67	25.92	4.31	66,194.82
3.5	35.95	29,803.61	25.92	4.25	69,065.34
4	30.75	29,793.70	25.91	(5.66)	73,247.95
4.5	26.45	29,789.97	25.90	(9.39)	78,812.15
5	22.75	29,791.37	25.91	(7.99)	86,054.76
5.5	19.45	29,793.66	25.91	(5.70)	95,442.02
6	16.40	29,787.64	25.90	(11.72)	107,742.43

N.B. The lease minus sell difference on a per acre basis is $0/acre for each case.

Canada Savings Bond Rate

There is an expectation that as the Canada savings bond rate is increased the lease term should increase and the cost of ownership should decline. The decline in the cost of ownership is consistent with the increase in lease term. The relationship between savings bond rate and lease term is that as the bond rate increases the landlord could earn more from selling the asset and investing the proceeds. For a viable lease agreement to be set, the landlord must be provided with an equivalent return from leasing as could be earned through the sale and investing option. The results of this analysis are presented in Table 2-6 with the Canada savings bond rate being scaled from 5 to 11%. At 5% the lease term is

4.75 years with a cost of ownership of $266,184.04 and at a rate of 11% the lease term has increased to 53.75 years with a consequent decline in the cost of ownership to $11,183.07.

Table 2-6: The Impact of Canada Savings Bond Rate on Rental Payment and Cost of Ownership - (Varying lease term)

CSB Rate	Lease Term	Annual Rent (Total)	Annual Rent (Per Acre)	Lease-Sell (Total)	Cost of Ownership
5	4.75	16,417.94	14.28	(137.26)	266,184.04
5.5	7.75	18,122.37	15.76	(88.35)	232,133.98
6	10.75	19,827.93	17.24	(38.31)	202,018.02
6.5	13.75	21,511.02	18.71	(10.74)	175,384.98
7	16.80	23,177.23	20.15	(0.05)	151,465.53
7.5	19.95	24,830.59	21.59	(2.21)	129,709.97
8	23.30	26,495.64	23.04	7.32	109,458.10
8.5	26.85	28,140.18	24.47	(3.66)	90,825.24
9	30.75	29,793.70	25.91	(5.66)	73,247.95
9.5	35.15	31,462.09	27.36	7.21	56,507.12
10	40.15	33,110.44	28.79	0.04	40,796.54
10.5	46.15	34,766.45	30.23	0.53	25,711.45
11	53.75	36,425.58	31.67	4.14	11,183.07

N.B. The lease minus sell difference on a per acre basis is $0/acre for each case.

Downpayment Interest Rate

As previously mentioned, in the initial situation (presented in Table 2-1), the downpayment provided by family sources is financed at 8%. If this rate is altered

it is expected that this should impact on the cost of ownership for the property but not on the lease rate or term.

The results of this analysis, over the range: 8% to 0% are presented in Table 2-7. At 8% the cost of ownership is $73,247.95 and at a rate of 0% this cost would have declined to $37,309.88. The cost of ownership when the rate on the downpayment is 0% will be a function of the prevailing nominal rate charged by the financial institution for the debt capital involved.

Table 2-7: The Impact of Downpayment Interest Rate on Cost of Ownership - (Varying lease term)

Downpayment Interest Rate	Cost of Ownership
8	$73,247.95
7	$67,902.94
6	$62,754.63
5	$57,827.70
4	$53,146.70
3	$48,735.05
2	$44,613.92
1	$40,801.11
0	$37,309.88

Representative Situations

This section presents an analysis of this case farm where the input variables in Table 2-1 are set to represent those in effect at specific times in the recent past. The years chosen for this part of the analysis are 1977, 1981, 1984, and 1992

which can be compared to the base year for the analysis of 1988. These years were chosen to represent years in which wide swings in the input variables were seen. The market values for the case farm's real estate and machinery were indexed (1981=100) to be representative of the actual situation in those years. In the case of the real estate, the values were indexed using the appropriate Saskatchewan values. The results of the analysis are presented in Table 2-8.

The 1988 column in Table 2-8 (Part A) re-presents information provided in Table 2-1, against which the other situations will be compared. The following additional information is added to that for 1988: the annual mortgage payment required to finance the purchase of the property ($39,201.19), and the annual saving to the tenant which results from the lease as opposed to purchasing the property ($9,407.49). The rationale for choosing the years indicated in Table 2-8 is as follows. Western Canadian farms had experienced an unusually prosperous period in 1973-74 which led to a strong upswing in asset values. By 1977 the real rate of interest was virtually zero with, reasonable nominal and savings interest rates[6]. By 1981 there had been a dramatic increase in asset values and all interest rates. The nominal interest rate was 18.38%; the rate for Canada savings bonds was 15.29%, and the savings rate was slightly higher yet at 15.42%.

Asset values continued to increase to 1984, by which time the average value of real estate in Saskatchewan was about two and one half times the value that it was in 1977. At this time all interest rates had moderated. The information for 1988 indicates a further moderation of most interest rates, with a dramatic

Table 2-8: Simulation Results for Representative Situations.

Part A----> Part B---->

	1992	1988	1984[1]	1981	1977[2]	1984[3]	1977[4]
Land & Buildings	$290,512	$331,104	$502,516	$488,354	$207,062	$502,516	$207,062
Mach. & Equip.	$116,142	$114,918	$114,041	$97,388	$60,868	$114,041	$60,868
Land Area (ac)	1150	1150	1150	1150	1150	1150	1150
Lease Term (yrs)	6.2	30.75	30.40	26.25	>99[5]	31.55	>99[5]
Downp't. (%)	25	25	25	25	25	25	25
Nominal Rate (%)	9	12.5	13.58	18.38	10.29	13.58	10.29
Real Rate (%)	6.5	4.00	7.71	6.79	0.16	7.71	0.16
CSB Rate (%)	7.03	9.00	12.42	15.29	8.14	12.50	8.14
Family Rate (%)	2.5	8.00	7.68	15.42	6.00	7.68	6.00
Annual Rent (Total)	$20,418.24	$29,793.70	$62,405.80	$74,648.42	$3,119.14	$62,820.35	$16,854.85
Annual Rent (per ac)	$17.75	$25.91	$54.27	$64.91	$2.71	$54.63	$14.66
Landlord Savings (total)	($4.75)	($5.66)	($6.69)	($20.90)	($13,735.71)	$5.85	$0.00
Landlord Savings (per ac)	($0.00)	($0.00)	($0.01)	($0.02)	($11.94)	$0.01	$0.00
Cost of Ownership	$182,805.45	$73,247.95	$4,689.47	$68,576.20	$155,262.71	($130.08)	$21,784.96
Mortgage to Buy (Total)	$60,166.08	$39,201.19	$63,056.18	$87,404.84	$19,096.66	$62,802.36	$19,096.66
Savings to Tenant (per yr)	$39,747.84	$9,407.49	$650.38	$12,756.42	$15,977.52	($17.99)	$2,241.81

Footnotes and Sources for this table are presented on the next page.

Footnotes for Table 2-8.

[1] This year is for comparison of CSB rates with the other 1984 column.
[2] The lease term is not an indifference term to the landlord.
[3] This column indicates effect of a "slight" change in the CSB rate for comparison with first 1984 column.
[4] The Lease payment has been adjusted to leave the landlord indifferent between leasing and selling.
[5] The lease term generated is more than 99 years. No attempt to calculate exact indifference term as >99 years implies legal ownership.

Sources for Table 2-8.

Real Estate:

1977--FCC. 1986. Farm Credit Statistics. Ottawa: Table 26, p. 31.

1981/1984--FCC. 1989. Farm Credit Statistics. Ottawa: Table 27, p. 35.

Mach. & Equip:

1977--FCC. 1987. Farm Credit Statistics. Ottawa: Table 23, p. 29.
1981/1984--FCC. 1989. Farm Credit Statistics. Ottawa: Table 24, p. 32.

Nominal Interest Rate:

FCC. 1985. Farm Credit Statistics. Ottawa: Table 14, p. 16.

Real Interest Rate:

Agriculture Canada. 1988. Farm Inputs and Finance: Market Commentary. Ottawa: Table 3, p. 14. December.

CSB:

Agriculture Canada. 1988. Farm Inputs and Finance: Market Commentary. Ottawa: Table 3, p. 14. December.

Family Rate (Savings Rate):

FCC. 1985. Farm Credit Statistics. Ottawa: Table 14, p. 16.

1992 input values:

Personal communication with Agriculture Canada personnel.

decline in real estate values. Information for 1992 has been included (a) as it is current, and (b) because interest rates were lower than for any of the other years included in the analysis. The years chosen for this analysis cover a cycle in both asset values and interest rates, and thus will represent a number of quite different possible combinations for the input variables for the analysis.

Two columns are presented in Table 2-8 for 1977. The first column indicates that the indifference lease term for the landlord will be more than 99 years. As this implies legal ownership, no attempt was made to identify the exact lease term. Because of this, the annual rent for this year is very low ($3,119.14) which results in a large leasing disadvantage to the landlord ($13,735.71). As this situation is not to the advantage of the lessor, the other results, cost of ownership and annual saving to the tenant, are questionable. Therefore the analysis was repeated (Part B) with the lease payment being set at a level that would leave the lessor indifferent between leasing and selling. This is done by adding the leasing disadvantage ($13,735.71) to the annual lease payment ($3,119.14). In this case the annual lease payment is $16,854.85 which results in a cost of ownership of $21,784.96 which itself results in an annual leasing advantage to the lessee of $2,241.81.

The results in Table 2-8 indicate that as the nominal interest rate increases, so does the annual rental payment. On the other hand, as the CSB rate increases relative to the cost of funds, bank plus family sources, the cost of ownership declines, as does the leasing advantage to the lessee. This is the case in 1984.

The weighted cost of debt capital for each year is as follows: 1992 = 7.38%, 1988 = 11.38%, 1984 = 12.11%, 1981 = 17.64%, and 1977 = 9.22%. The difference between these and the CSB rate in each year is 0.35% (1992), 2.38% (1988), -0.31% (1984), 2.35% (1981), and 1.08% (1977). If the CSB rate in 1984 had been 12.50%, instead of 12.42% as was the case, with all other input variables remaining the same as in Table 2-8, the spread between the weighted cost of debt and the Canada savings bond rate would have been -0.39%. This very small change from that shown in Table 2-8 provides different results, as shown in Table 2-8. In this case the indifference lease term has increased slightly, from 30.40 to 31.55 years. The annual rental payment has increased by just over $400. The major change in the results is that the cost of ownership has now become negative. The implication of this result is that, on an annual basis, the tenant would in fact have been more advised to buy the property than to have rented it. The difference is marginal, but it indicates the sensitivity of the results. Alternatively, if in 1984 all input variables are set at the levels shown in Table 2-8 with the exception of the interest rate charged on family funds being set at 7% (instead of 8%), the cost of ownership is now -$375.95 which is a leasing disadvantage to the lessee of $52.14 per year. This implies that ownership is the preferable option. All other results remain as in Table 2-8.

Conclusions

The information presented in this paper identifies the sensitivity of lease rates and terms to changes in the underlying variables. What is apparent, is that there may be no "easy" way to identify the "best" lease or purchase scenario without some preparatory work. Lease rates and terms are very sensitive to changes in the underlying variables, and thus both rates and terms will be expected to change dramatically year-to-year due to changes in prevailing economic conditions.

NOTES

[1] Paper prepared for presentation at the CAEFMS/WAEA International joint meetings, Edmonton, July 12, 1993.

[2] For a history of policy respecting the family farm and its financing, see Gilson (1992).

[3] The details of the case farm are provided in Baker and Thomassin (1991).

[4] Canada savings bonds were chosen as being similarly risk weighted as a lease arrangement.

[5] The term "cost of ownership" might seem somewhat confusing, particularly if it is assumed to be $0 for a perpetual lease (with an infinite term). What is meant by this term is the cost to acquire the ownership rights to the property. These are, as discussed in Baker and Thomassin (1988, 1991), the present value of the reversionary interest in the property when it reverts to the landlord. Therefore, this is the (present) value of the potential of a sale of the property. As the lease term

becomes longer, ceteris paribus the present value of the reversionary interest will decline. If there is a perpetual lease on the property, the rights will never revert to the owner, and thus there will be no sale. Thus the cost to acquire this property for future sale will be $0.

[6] The savings interest rate is being used in this analysis as that rate charged by family members for the downpayment used in the case of a purchase option being exercised on the property.

CONNECTING SECTION 2

In any discussion of leasing versus ownership as forms of real estate acquisition, the valuation of the property in question is of paramount importance. If the lease rate is to be set using the normal approach in Canada, 5% of the value of the real estate, it is obvious that the value of land will impact the lease rate used. If the lease rate is to be set using the approach described in chapter 1 of this thesis, the value of the real estate will impact the resulting lease rate because of the way in which the reversionary interest in the property is used in the analysis. The value of the asset will obviously have a direct bearing on the financing costs of a purchase decision. Thus, the value that is placed on the asset will have a relationship with the resulting success or financial stress of the investment.

For the purposes of the following discussion, definitions of value are taken as being: ***Cash Value***: The amount of cash received, or expected to be received, from the sale of the asset in question. ***Intrinsic Value***: The value received, or expected to be received, from the ownership of the asset in question but NOT denominated in cash. This can therefore be thought of as psychic income. There is no doubt that farmers, and other investors, will receive psychic income from the ownership of assets such as land. However, no attempt is made in this thesis to quantify this psychic income or the intrinsic value of the property.

A traditional, and somewhat simplistic method used for the valuation of agricultural land is the capitalization formula, which for an infinite time horizon is $V = R/i$; where V is the value of land, R is the annual economic rent from the

property, and i is the appropriate discount rate to use. Assume that we are interested in valuing a piece of land with R = $80/acre/year and i = 4%. Also assume no growth in annual "rent" R. Therefore, the value (V) = $2,000/acre. If the land is purchased for $2,000 now (t=0) a terminal value of $2,000 can be attached to it, entered in the proposed termination year if that year is some finite period from t=0. This can be argued because there are still an infinite number of future periods remaining after the termination of the investment. These represent the future "earnings" periods for the purchaser of the land. If no termination year is proposed for the investment, there is no justification for the use of a terminal value. Thus there is only NEED for a terminal value if a FINITE period is being used to "assess" the economics of a purchase decision. Now assume that the land will be purchased over a 20 year period, given that this is the length of the mortgage period for the land purchase. The terminal value at t=20 will be $2,000, due to the remaining INFINITE periods, assuming for simplicity of exposition no growth in the rent derived from the property. The rent in this discussion will be that income earned from the productive use of the asset and will not include psychic income.

If the land is purchased to be gifted to the next generation there will be a lower purchase price using the net present value (NPV) approach than using the capitalization approach. Theoretically the capitalization approach is correct as it captures all of the future rent streams into the future, regardless of who owns the land or who pays for the land. It must be kept in mind though that the future is infinite, and therefore the purchaser will not receive all the income streams from

the land into perpetuity. Unfortunately, the NPV approach assumes that the terminal value will enter the cash flow stream as cash. If in fact the terminal value will only enter as psychic income or an estimate of future rents but not as cash, the NPV approach should give a lower value to the property than it is perhaps worth to the purchaser. In this case the farmer should pay less for the asset. Does this imply a form of windfall gain for the future generations and perhaps a form of loss to the selling generation? Maybe, but it is not clear that this is a problem other than one of re-distribution of wealth.

If a farmer assumes a terminal value for the NPV approach it implies that the farmer will sell the property to someone else. This may not be a reasonable assumption. If a farmer buys land with the expressed goal of passing the land as a gift to the next generation in 20 years time, then it is hypothesized that the terminal value to the present buyer of the land should be zero even though there will be an infinite stream of cash flows to be expected from the property. This assumes that no cash value is placed on psychic income. If any terminal value is applied to a land purchase decision when in fact it should not be, the present value of the land, and thus its purchase price, will be higher rather than lower. Is this a contributory factor to the financial stress facing Canadian farmers? It is hypothesized that the answer would be yes.

Both of these approaches assume that the purchase price for the land, and thus the loan amount, was correctly set in the first place. This is perhaps an heroic assumption. Also, it is an unfair assumption in that it assumes that the level of the

terminal value used in the analysis is correct. Again, this may (will?) add to the financial stress for the farmer in question. Perhaps a terminal (cash) value should be included in the analysis, but multiplied (before discounting) by the probability that the land will in fact be sold. For example:

(a) An investor buys land knowing that they will re-sell the land in 20 years. In this case the terminal value could be multiplied by 1.00.

(b) Alternatively, a farmer decides on purchasing land that (s)he will pass to the heirs as a gift. Therefore, the terminal value can be multiplied by a factor of 0.00.

(c) Finally, a farmer could use a factor of 0.50 if (s)he might/might not re-sell land at a later date. Or the probability could move away from 0.50 based on the farmer's own estimate of the probability of re-sale in the future. Results of these scenarios are presented in Table 2-2-1.

Table 2-2-1: Investment Scenarios.

	Investment Cost	$100,000
	Terminal Value	$100,000
	Time Horizon	20 years
	Discount Rate	9% (on cash flows)
	Discount Rate	4% (on terminal value)
	Yearly Cash Flow	$8,000
	Growth in Cash Flows	0%
(a)	Probability of re-sale = 100%	NPV = $18,667.06
(b)	Probability of re-sale = 0%	NPV = ($26,971.63)
(c)	Probability of re-sale = 50%	NPV = ($4,152.29)

Therefore, the maximum bid prices for this land for these scenarios are:

(a) $100,000 + $18,667.06 = $118,667.06

(b) $100,000 - $26,971.63 = $73,028.37

(c) $100,000 - $4,152.29 = $95,847.71

If a terminal value is to be chosen, the problem becomes one of what value? The above examples perhaps provide exactly the opposite result from that expected by most farmers. It might be expected that in fact farmers would be willing to pay more rather than less if they want the farm for future generations, even if they want to pass it to the next generation as a gift. This would be a case of them placing a high intrinsic value on ownership, even though they might not recover the purchase price differential through production. Thus, it may not be possible to justify this on economic grounds if a cash analysis is used. However, it may be possible to justify the purchase by using some intrinsic valuation. There is a problem of this intrinsic valuation in that the purchase price will be related to the size of loan required to pay for it, and thus the debt servicing required for that loan.

This brings the discussion back again to the question of how the value is set in the first place. Not only is this a question of terminal values ("To use or not to use?"), it is also a question of the forecasted annual (net) returns or rents to be expected from the property. If the value of the real estate follows past values (see Just and Miranowski 1993) it is hard to justify asking a tenant to pay for the past when they are only interested in the future. In fact, any buyer should only be

interested in the future with no regard for the past. Perhaps the past should be treated as "sunk costs". Unfortunately there is ample anecdotal evidence to indicate that increases in surplus cash from production will be capitalized into real estate values. This may be just a case of an increase in incomes being seen as an upturn in incomes to be expected in future time periods.

The foregoing comments focus attention on the importance of determining the "correct" value for the real estate that is to be purchased or leased. An associated concern relates to the accuracy of forecasts of future land values. The first two chapters of this thesis concentrate on lease-buy decisions and the following two papers focus on forecasting land values. Thus, there are two streams of research in the thesis. Both of these research streams are associated with land values, but each has a particular focus. The research paper presented in chapter 3 addresses this subject of forecasted values based on models selected by two statistical tests. The underlying forecasting model has a time series structure which, intuitively at least, is an attractive format for this purpose.

CHAPTER 3

Unit Root Tests and Their Impact on Land Value Forecasts

by

Laurie Baker and Elizabeth Buck

Faculty Lecturer and Graduate Student, Respectively

Department of Agricultural Economics

McGill University, Macdonald Campus

Introduction

Research into land valuation has been of interest to agricultural economists for many years, with studies by Castle and Hoch (1982), Aiston (1986), Burt (1986), Featherstone and Baker (1987), and Falk (1991) in North America and Lloyd et al (1991), and Hallam et al (1992) in Europe. Both cross section and time series analysis techniques have been employed, with varying degrees of success measured either by the explanatory or forecasting power of the derived models. In particular, the work by Clark et al (1993a) and Just and Miranowski (1993) accentuate two different approaches to farmland valuation in the United States. Just and Miranowski (1993) have developed a farmland pricing model using cross section techniques, which yields highly accurate predictions. Clark et al (1993a) employ a time series analysis of land value and land rents to raise questions about whether the traditional model of land valuation is complete they used the Dickey and Pantula (1987) unit root test to show that the series have different time series representations, supporting their conclusion that the traditional model is incomplete. Unfortunately they do not provide the reader with a forecasting model for either land value or rent. Forecasts are important to anyone interested in land valuation and are often the only reason for carrying out a time series analysis of an economic series. This test, described in a later section of this paper, is a relatively new test which is gaining some support for use in time series analyses. Applications of this unit root test to other economic time series can be found in Mills (1991a, 1991b, 1991c), Taylor (1992), Clark and Youngblood (1992), and

Clark et al (1993b).

Time series model-building techniques require stationary data (see note 1). Unit root tests have been developed as a tool to determine the degree of differencing required to achieve stationarity. The present paper compares the forecasting accuracy of time series models of land value and rent developed using two unit root tests. In time series analysis it is generally assumed that the longer the series the better. The longest time series used for this research had 81 observations, aggregated for the United States with the shortest series of 32 observations for just one state, Illinois (see note 2).

Transformation of Data Series

Following advice of authors such as Mills (1990) and Kennedy (1992) that in a time series analysis the analyst should look carefully at the data before any analysis is carried out, all data series were first transformed into logs and plotted against time. First differences of the logged series were also plotted against time. In the following cases the plot of the first differences suggests that these series might be random walk processes: assets (USA long series), assets (USA short series), income (USA short series), rent (Illinois transformed), and rent (Illinois untransformed). In all cases there was either a random scatter, suggesting stationarity, or a cyclical movement (land price, both transformed and untransformed Illinois series), suggesting the business cycle or a random walk. In all cases the plots (not presented in the paper but available from the authors)

centre around zero, with no indication of any underlying trend. This supports the argument that a once-differencing of each series is enough to induce stationarity and implies that there is no need for further differencing.

Unit Roots: Identification and Corrections

Researchers have demonstrated that most economic series are nonstationary (Nelson and Plosser 1982 and Baillie and Bollerslev 1989). The Box-Jenkins (BJ) approach to time series analysis assumes that any nonstationarity of the data can be removed by differencing, although this is not the only method by which stationarity can be imposed. Furthermore, Mills (1990) indicates the order of difference rarely exceeds two. The characteristics of an ARIMA(p,d,q) model, (i.e. the order of the autoregressive process, the degree of differencing and the order of the moving average process) must be determined in the first step of this method. Several statistical tests for the presence of a unit root in the autoregressive polynomial of economic time series have been developed to determine the degree of differencing. The majority of these tests assume that there is only one unit root (see note 3).

Dickey and Pantula (1987) have shown that if economic theory suggests that the series being tested could have more than one unit root, the testing strategy should begin with the highest order of differencing considered possible (i.e. the most general economic model). This is the test strategy adopted by Clark et al (1993a), although they fail to support their assumptions with a theoretical

argument. There are conflicting reports in the literature of the consequences of over- or under-differencing. Dickey and Pantula (1987) assume that over-differencing will not affect forecasting. However, Mills (1990) warns that over-differencing a nonstationary series to induce stationarity can increase the variance of the differenced data beyond that of the original data and can lead to a non-invertible model if there is a moving average (MA) process.

Once a series has been made stationary it implies that its residuals will embody only the stochastic elements of the data. There are two ways in which this can be accomplished: the trend stationary (TS) approach or the difference stationary (DS) approach (see Nelson and Plosser 1982). If unit roots exist in the data, the series will not be stationary, and a DS approach should be employed to induce stationarity. If there is no evidence of unit roots, the TS approach should be used.

The TS approach can be illustrated as follows:

$$X_t = Ae^{\mu t} \tag{3-1}$$

Where μ is the growth rate.

$$Y_t = \ln(X_t) = \alpha + \mu_t + C_t + \varepsilon_t \tag{3-2}$$

Where C_t is a cyclical component, such as the business cycle, and ε_t is the unpredictable error term. The concern is how to measure C_t. This is done by regressing Y_t on a constant (α) and a trend (μ_t), and the estimate of the business cycle is the residual from the regression. Thus the growth has been filtered out of the equation and we have:

$$Y_t = \alpha + \mu_t + C_t \qquad \sim \text{iid } (0,\sigma^2) \qquad (3\text{-}3)$$

The DS approach can be illustrated as follows:

$$X_t = Ae^{\mu t}$$

$$Y_t = \ln(X_t) = \alpha + \mu_t \qquad (3\text{-}4)$$

$$\nabla Y_t = Y_t - Y_{t-1} = (\alpha + \mu_t) - (\alpha + \mu_t - 1) \qquad (3\text{-}5)$$

The α's cancel, thus we have:

$$\nabla Y_t = \mu_t + C_t \qquad (3\text{-}6)$$

As in the case of the TS approach, the residuals from this regression are the business cycle. In both approaches we can think of the residuals, C_t, as being partly predictable and partly white noise. If so, the series have been successfully made stationary. This is done for each of the data series under investigation in this article.

Thus all data series (see note 2) were tested twice, as follows: (a) using the augmented Dickey-Fuller test (see Dickey and Fuller 1979), and (b) using the Dickey and Pantula test (see Dickey and Pantula 1987). The Dickey-Fuller test is a test for the presence of a single unit root. If more than one unit root is to be tested for, the test can be run sequentially. On the other hand, the Dickey and Pantula test is designed to test for the presence of multiple unit roots by requiring the researcher to make an arbitrary judgement as to the level of differencing at which to start the testing procedure. The Dickey and Pantula test thus tests for the greatest number of unit roots expected, whereas the Dickey-Fuller test starts on the assumption that only one unit root may exist in the data series. Although

economic theory should be used to guide the choice of differencing required by the Dickey and Pantula test, it is not clear as to how the theory is so used. For the purposes of this paper the highest level of differencing is taken as three to agree with that chosen by Clark et al (1993a).

Augmented Dickey-Fuller Unit Root Test:

The augmented Dickey-Fuller approach can be presented as follows:

$$\nabla Y_t = \hat{\alpha}_0 + \hat{\alpha}_1 Y_{t-1} + \hat{\alpha}_2 T_t + \hat{\alpha}_3 \nabla Y_{t-1} + \hat{\alpha}_4 \nabla Y_{t-2} + \hat{\alpha}_5 \nabla Y_{t-3} + \varepsilon_t \qquad (3\text{-}7)$$

Where: $\nabla Y_t = Y_t - Y_{t-1}$ 1st difference
T_t = Time trend.
∇Y_{t-1}, ∇Y_{t-2}, ∇Y_{t-3} are lagged values of the differenced data series which are included in the equation to account for the business cycle.

The null hypothesis is: $\hat{\alpha}_1 = 0$ versus the alternate hypothesis of: $\hat{\alpha}_1 \neq 0$. Where $\hat{\alpha}_1 = (1 - \phi_1)$. If $\phi_1 = 1$ it implies that there is a unit root and thus $\hat{\alpha}_1 = 0$. The estimated coefficient for $\hat{\alpha}_1$ is tested twice as follows: (a) $N(\hat{\alpha}_1)$, where N is the number of observations, is checked against the critical ρ_r value in Fuller (1976. Table 8.5.1). If $N(\hat{\alpha}_1)$ is greater than the critical value we can accept the null hypothesis and assume the presence of a unit root. (b) $\hat{\alpha}_1/SE(\hat{\alpha}_1)$ is checked against the critical τ_r value in Fuller (1976. Table 8.5.2). Once again, if $\hat{\alpha}_1/SE(\hat{\alpha}_1)$ is greater than the critical value, we can accept the null hypothesis and conclude that there is evidence of a unit root. This procedure was carried out for each data series, and the results are presented in Table 3-1.

The results presented in Table 3-1 indicate the presence of a unit root in

each of the data series with the exception of "income" in both the long and short USA series. This implies that the difference stationary (DS) approach should be used for all series except income which would follow the trend stationary (TS) approach.

Table 3-1: Augmented Dickey-Fuller Test Results.

Data Series	Test Statistics	
ASSETS (Long)	$N(\hat{\alpha}_1) = -4.49126^{*}$ $\hat{\alpha}_1/SE(\hat{\alpha}_1) = -2.59^{*}$	$\rho_r = -19.8$ $\tau_r = -3.5$
INCOME (Long)	$N(\hat{\alpha}_1) = -68.0318$ $\hat{\alpha}_1/SE(\hat{\alpha}_1) = -4.1457$	$\rho_r = -19.8$ $\tau_r = -3.5$
ASSETS (Short)	$N(\hat{\alpha}_1) = -3.96862^{*}$ $\hat{\alpha}_1/SE(\hat{\alpha}_1) = -1.77524^{*}$	$\rho_r = -19.8$ $\tau_r = -3.5$
INCOME (Short)	$N(\hat{\alpha}_1) = -36.9704$ $\hat{\alpha}_1/SE(\hat{\alpha}_1) = -3.88039$	$\rho_r = -19.8$ $\tau_r = -3.5$
LAND PRICE (Tran)	$N(\hat{\alpha}_1) = -4.4988^{*}$ $\hat{\alpha}_1/SE(\hat{\alpha}_1) = -1.96337^{*}$	$\rho_r = -17.9$ $\tau_r = -3.6$
RENT (Tran)	$N(\hat{\alpha}_1) = -6.58672^{*}$ $\hat{\alpha}_1/SE(\hat{\alpha}_1) = -1.37262^{*}$	$\rho_r = -17.9$ $\tau_r = -3.6$
LAND PRICE (UnTran)	$N(\hat{\alpha}_1) = -5.45076^{*}$ $\hat{\alpha}_1/SE(\hat{\alpha}_1) = -2.497^{*}$	$\rho_r = -17.9$ $\tau_r = -3.6$
RENT (UnTran)	$N(\hat{\alpha}_1) = -6.9428^{*}$ $\hat{\alpha}_1/SE(\hat{\alpha}_1) = -1.38773^{*}$	$\rho_r = -17.9$ $\tau_r = -3.5$

* Shaded cells denote the presence of a unit root at the 5% significance level.

The Dickey and Pantula Unit Root Test:

The Dickey and Pantula approach is as follows:

Step 1: $\nabla^3 Y_t = \hat{\alpha}_0 + \hat{\alpha}_1 \nabla^2 Y_{t-1} + \varepsilon_t$ 3 Unit Roots? (3-8)

Step 2: $\nabla^3 Y_t = \hat{\alpha}_0 + \hat{\alpha}_1 \nabla Y_{t-1} + \hat{\alpha}_2 \nabla^2 Y_{t-1} + \varepsilon_t$ 2 Unit Roots? (3-9)

Step 3: $\nabla^3 Y_t = \hat{\alpha}_0 + \hat{\alpha}_1 Y_{t-1} + \hat{\alpha}_2 \nabla Y_{t-1} + \hat{\alpha}_3 \nabla^2 Y_{t-1} + \varepsilon_t$ 1 Unit Root? (3-10)

Where: $\nabla Y_t = Y_t - Y_{t-1}$ 1st difference
$\nabla^2 Y_t = \nabla Y_t - \nabla Y_{t-1}$ 2nd difference
$\nabla^3 Y_t = \nabla^2 Y_t - \nabla^2 Y_{t-1}$ 3rd difference

The null hypothesis is: $\hat{\alpha}_1 = 0$ versus the alternate hypothesis of: $\hat{\alpha}_1 \neq 0$ for each step.

As for the previous unit root test $\hat{\alpha}_1 = (1 - \phi_1)$. If $\phi_1 = 1$ it implies that there is a unit root and thus $\hat{\alpha}_1 = 0$.

Step 1: If $\hat{\alpha}_1 = 0$, there is evidence of 3 unit roots. If $\hat{\alpha}_1 \neq 0$ go to step 2.

Step 2: If $\hat{\alpha}_1 = 0$, there is evidence of 2 unit roots. If $\hat{\alpha}_1 \neq 0$ go to step 3.

Step 3: If $\hat{\alpha}_1 = 0$, there is evidence of 1 unit root.

If $\hat{\alpha}_1 \neq 0$ there are no unit roots.

For each step of this test the t statistic for $\hat{\alpha}_1$ is compared to the critical τ_u in Fuller (1976. Table 8.5.2). If the calculated value is greater than the critical value the null hypothesis can be accepted and it is assumed that the tested order of unit roots is confirmed, at the 5% significance level. The results for this test are presented in Table 3-2, and they indicate that in most cases the number of unit roots determined for the data series are different than those found using the Dickey-Fuller test and reported in Table 3-1. A comparison of the unit root tests is

presented in Table 3-3. The difference in the results of these two unit root tests has implications for forecasting results because the models derived for this purpose, based on these results, will be different. This will be explained in detail later in this paper.

Table 3-2: Dickey and Pantula Test Results

Data Series	Step 1 (3 Unit Roots)	Step 2 (2 Unit Roots)	Step 3 (1 Unit Root)
ASSETS (Long)	t = -11.478 τ = -2.89	t = -3.8487 τ = -2.89	t = -1.0939* τ = -2.98
INCOME (Long)	t = -19.869 τ = -2.89	t = -9.6182 τ = -2.89	t = -4.5646 τ = -2.89
ASSETS (Short)	t = -7.8372 τ = -2.93	t = -2.5754* τ = -2.93	n.a. n.a.
INCOME (Short)	t = -10.587 τ = -2.93	t = -6.0683 τ = -2.93	t = -1.4917* τ = -2.93
LAND PRICE (Tran)	t = -6.5933 τ = -3.00	t = -1.7093* τ = -3.00	n.a. n.a.
RENT (Tran)	t = -10.747 τ = -3.00	t = -3.5877 τ = -3.00	t = -1.8461* τ = -3.00
LAND PRICE (UnTran)	t = -6.532 τ = -3.00	t = -1.7032* τ = -3.00	n.a. n.a.
RENT (UnTran)	t = -10.989 τ = -3.00	t = -3.4881 τ = -3.00	t = -1.3855* τ = -3.00

* Shaded cells denote the presence of the number of unit roots noted for the appropriate column at the 5% significance level.

Table 3-3: Unit Roots and Stationarity for Dickey-Fuller (DF) and Dickey and Pantula (DP).

SERIES	UNIT ROOTS		TS or DS		DIFFERENCING FOR STATIONARITY	
	D-F	D&P	D-F	D&P		
ASSETS (USA Long)	1	1	DS	DS	1	1
INCOME (USA Long)	0	0	TS	TS	0	0
ASSETS (USA Short)	1	2	DS	DS	1	2
INCOME (USA Short)	0	1	TS	DS	0	1
LAND PRICE (Illinois TRAN)	1	2	DS	DS	1	2
RENT (Illinois TRAN)	1	1	DS	DS	1	1
LAND PRICE (Illinois UNTRAN)	1	2	DS	DS	1	2
RENT (Illinois UNTRAN)	1	1	DS	DS	1	1

Autoregressive Processes: Identification

A. Based on Dickey-Fuller Test

Evidence of the presence of a unit root was found in all series except "Income" (both the long and short series). Thus, these two series were regressed following the TS approach, while all remaining series were once-differenced then regressed on a constant. The residuals of these regressions were examined by (a) visual inspection, and (b) the Box-Pierce Q test to determine if the residuals were

stationary. If a visual inspection of a plot of the residuals indicates a white noise scatter, it implies that the process is stationary.

The Box-Pierce test statistic is as follows:

$$Q^{*} = N\Sigma^{m}_{k=1}\,\hat{\varrho}^{2}_{k} \sim \chi^{2}_{m-p} \qquad (3\text{-}11)$$

Where: N = number of observations.
k = number of lags.
p = number of parameters.

The calculated test statistic (Q^{*}) is checked against the appropriate χ^{2} value. If the calculated statistic is less than the critical value, we can assume that the residuals are not serially correlated.

In each case, the visual inspection and the Box-Pierce test supported the conclusion that the residuals were in fact stationary. Results of the Box-Pierce test are presented in Appendix Table 3-A-1. The residuals (TS or DS) were subjected to a Box-Jenkins (BJ) identification procedure (see note 4). The autocorrelation function (ACF) and partial autocorrelation function (PACF) were examined to determine the ARIMA model best suited for each series. The results of this procedure are presented in Table 3-4.

Table 3-4: Results of BJ Identification Procedure Using Dickey-Fuller Test Results.

SERIES	ACF	PACF	PROCESS
ASSETS (Long)	DAMPED EXPONENTIAL	CLEAR CUT-OFF AFTER K=1	ARIMA(1,1,0)
INCOME (Long)	NO CLEAR PATTERN	NO CLEAR PATTERN	ARIMA(0,0,0)
ASSETS (Short)	DAMPED EXPONENTIAL	CLEAR CUT-OFF AFTER K=1	ARIMA(1,1,0)
INCOME (Short)	>0 for K=1 =0 for K=2...	>0 for K=1 =0 for K=2...	ARIMA(1,0,1)
LAND PRICE (Illinois Tran.)	DAMPED EXPONENTIAL	CLEAR CUT-OFF AFTER K=1	ARIMA(1,1,0)
RENT (Illinois Tran.)	NO CLEAR PATTERN	NO CLEAR PATTERN	ARIMA(0,1,0)
LAND PRICE (Illinois Untran.)	DAMPED EXPONENTIAL	CLEAR CUT-OFF AFTER K=1	ARIMA(1,1,0)
RENT (Illinois Untran.)	NO CLEAR PATTERN	NO CLEAR PATTERN	ARIMA(0,1,0)

Assets (long and short) and land price (Illinois transformed and untransformed) are an AR(1) process. However, the results of interest from Table 3-4 are the question of whether income (USA long series) and rent (Illinois transformed and untransformed) are in fact random walk processes. Also, in the case of income (USA short series) it would be acceptable to use an AR(1) for an ARIMA(1,0,1) for the stationarity condition, but not for the invertibility condition (Mills 1990, 88). The ACF and PACF for income (USA short series) are not clearly "standard" for an ARIMA(1,0,1) however, raising an element of doubt as to it actually being a mixed process. The conclusion of an ARIMA(1,0,1) is drawn when

both the ACF and PACF are exponentially decaying after the first lag, which itself might or might not exceed 2 times the standard error (Mills 1990, 130). In the case of income (USA short series), the first lag for both the ACF and the PACF are significant, using the 2 times SE rule, but there is no evidence of an exponential decay after that. It appears to be a much clearer cut-off after the first lag, with non-significant values appearing in an oscillating manner. Therefore, we believe that a straightforward AR(1) might be acceptable (see note 5).

B. Based on Dickey and Pantula Test

Referring to Table 3-3, all series that exhibit a different number of unit roots from those identified by the Dickey-Fuller test were subjected to the ARIMA identification (BJ identification) procedure of the SHAZAM econometric program. These series are: Assets (Short), Income (Short), and Land Price (for both transformed and untransformed Illinois series). All of these series contain at least 1 unit root and thus need to be differenced for stationarity. The appropriate level of differencing was used for this procedure, and the results are presented in Table 3-5.

These results are quite different from those identified using the degree of differencing determined by the Dickey-Fuller procedure. We are of the opinion that these results may in fact be due to over-differencing the series in question. It is interesting to note that each of these series is shorter than the series (USA long) of assets and income for which there is no difference in unit root identification between the two testing approaches. More information is required to determine

Table 3-5: Results of BJ Identification Procedure Using Dickey and Pantula Test Results.

SERIES	ACF	PACF	PROCESS
ASSETS (Short)	NO CLEAR PATTERN	NO CLEAR PATTERN	ARIMA(0,2,0)
INCOME (Short)	NO CLEAR PATTERN	NO CLEAR PATTERN	ARIMA(0,1,0)
LAND PRICE (Tran)	NO CLEAR PATTERN	NO CLEAR PATTERN	ARIMA(0,2,0)
LAND PRICE (UnTran)	NO CLEAR PATTERN	NO CLEAR PATTERN	ARIMA(0,2,0)

whether in fact the Dickey and Pantula test may imply the presence of more unit roots than the Dickey-Fuller test as the sample size diminishes. Clark et al (1993b, 158) state the following:

> De-Jong et al (1992), among others, pointed out that Dickey-Fuller tests have very low power against plausible stationary alternatives. This means that Dickey-Fuller tests tend to find unit roots within a time series with disturbing regularity. This low power stems mainly from the fact that under Dickey-Fuller unit root tests the existence of a unit root is taken as the null hypothesis.

The results presented in this paper suggest that perhaps the Dickey and Pantula approach is more likely to indicate the presence of unit roots than is the Dickey-Fuller approach, as criticized in the above quote. This is supported by the forecast results as presented in a later section of this paper.

Autoregressive Processes: Choice of Correct Process

The next task is to determine the correct order of AR(p) process to use as this will be of importance for forecasting. It will also provide supporting evidence of the B-J identification procedure. To determine the correct AR(p) process, the Schwarz Criterion (SC) was employed. The SC can be defined as follows:

$$SC(k) = \ln(\hat{\sigma}^2_k) + [\ln(N)k]/N \qquad (3\text{-}12)$$

Where: k = number of p'th order AR(p).
N = number of observations.

This tends to weight parsimony slightly more heavily that does the Akaike Information Criterion (AIC) which can be defined as:

$$AIC(k) = \ln(\hat{\sigma}^2_k) + (2k)/N \qquad (3\text{-}13)$$

In fact, the results from the SC do not differ from those using the AIC. To carry out the SC, it is necessary to fit an AR(p) of increasing order to each series and then choose the order of AR(p) that results in the SC being minimized. This procedure was carried out for each series using the residuals (C_t) from equation 2 for TS and equation 6 for DS, for an AR(0) to AR(5), as follows:

AR(0): $C_t = \mu_t + e_t$ Where: μ_t is a constant. (3-14)

AR(1): $C_t = C_{t-1} + e_t$ (3-15)

AR(2): $C_t = C_{t-1} + C_{t-2} + e_t$ (3-16)

AR(3): $C_t = C_{t-1} + C_{t-2} + C_{t-3} + e_t$ (3-17)

AR(4): $C_t = C_{t-1} + C_{t-2} + C_{t-3} + C_{t-4} + e_t$ (3-18)

AR(5): $C_t = C_{t-1} + C_{t-2} + C_{t-3} + C_{t-4} + C_{t-5} + e_t$ (3-19)

The results, presented in Appendix Table 3-A-2, of applying the SC test to the data series indicate that the "best" process to use is an AR(1) for all series (see note 6). This is obviously in conflict with the results found by applying the BJ identification procedure based on both the Dickey-Fuller and the Dickey and Pantula test results. If series are AR(p) as opposed to MA(q), the p'th order for the AR(p) process must be as large as the number of unit roots found for the series. Therefore, for each series having 2 unit roots, they should be specified as AR(2) for the estimating and forecasting phases of the analysis.

A χ^2 test for over-fitting was carried out to support the SC test using the following test statistic:

$$\Lambda = N\ln(\hat{\sigma}^2_R/\hat{\sigma}^2_U) \sim \chi^2_r \qquad (3\text{-}20)$$

Where: N = number of observations.
$\hat{\sigma}^2_R$ = for the "restricted" AR(p); for example the AR(1).
$\hat{\sigma}^2_U$ = for the "unrestricted" AR(p); for example the AR(3).

The null hypothesis is: AR(1) versus the alternate hypothesis: AR(3).
Each series was subjected to this test where the AR(1) was compared to an AR(3) to ascertain whether anything would be lost by fitting an AR(1) rather than an AR(3). The results of this test, presented in Appendix Table 3-A-3, indicate that for each series nothing is lost by fitting an AR(1) rather than an AR(3). This supports the results of the SC presented in Appendix Table 3-A-2.

The order of differencing raises interesting questions for statisticians and economists. From a statistical perspective it might be acceptable to difference enough times to ensure stationarity of a series, but this raises troubling questions

for an economist. The differencing of a data series once is quite compatible with economic theory, in that it can be interpreted as the change in the underlying variable. A second differencing of the series will imply the rate of change of the series. It now becomes virtually impossible to justify a third differencing except to make a series stationary. The data series under discussion in this article do not require to be differenced more than once. Therefore, we maintain that the Dickey and Pantula approach can be questioned on these grounds as well as on our statistical test results, and thus the technique includes unnecessary complications which cannot be justified.

Data Quality

We contend that a simplistic (parsimonious) approach has more validity than a more sophisticated approach when the data is highly aggregated. Given the long time period over which data collection techniques have changed and been refined many anomalies may occur. To examine this concern, a test for under-fitting was carried out for assets (USA short series) and income (USA short series). These series were chosen as the scatter plots of the first differences were most indicative of a stationary process. The purpose of this test was to determine if we in fact gain anything by modelling these series by an AR(1) process, or just by white noise AR(0).

This test of under-fitting employs the Box-Pierce (Q) test statistic as defined in equation 3-11 above. The Q statistic for a fitted AR(0) is compared to the Q

statistic for the AR(1) process. A stationary series should indicate no autocorrelation in the lags for the autocorrelation function from these processes. The null hypothesis is that autocorrelation = 0 for all lags, versus the alternate hypothesis of there being autocorrelation in the lags. The first 12 lags are used in this test, with the assumption being made that this period is sufficient from which to draw conclusions regarding autocorrelation. The results for this under-fitting procedure, presented in Appendix Table 3-A-4, are as follows: Assets (USA short series) exhibit significant autocorrelation in the first 12 lags for the AR(0), assuming a 95% probability. There was no indication of any autocorrelation in these lags for the AR(1) process, assuming a 95% probability. It can therefore be concluded that the AR(1) is preferred over the AR(0) for assets (USA short series). The result for income (USA short series) is more interesting. The autocorrelations for the first 12 lags for the AR(0) process are not significant. Neither were they significant for the AR(1) process. Does this imply a purely random (white noise) process? It might help to explain the "apparently" mixed process found through the Box-Jenkins identification procedure.

Comparison of Forecasts Using Dickey-Fuller and Dickey and Pantula Results

Forecasts of each of the 8 data series were estimated, using the forecast routine in the SHAZAM package (ARIMA forecast), with the application of the appropriate degree of differencing as illustrated in Table 3-3. The forecasts are ex post and the

accuracy of the forecasts can be judged by a comparison of their mean squared errors (MSE's), with the lower the resulting MSE the better. These forecast results are presented in Table 3-6.

In the unit root testing carried out, four of the series exhibit different results for the two unit root tests. Thus there is a need to difference these series differently to achieve stationarity. For those four series, the forecasts for three of them are better with the Dickey-Fuller results as opposed to the Dickey and Pantula results of the unit root tests. In each of these cases the results are quite different. For income (USA short) the forecast based on the Dickey and Pantula result is better than that for the Dickey-Fuller result, but only marginally so. This would imply, in the time series analysis of the data series under consideration in this article, that the Dickey-Fuller unit root test produces better forecasts than does the Dickey and Pantula unit root test. Except for income (USA long), none of the forecasts appear to be very close to the actual data. This is shown by the MSE's for each series in Table 3-6, as well as by the plots of the forecasts (not shown).

We argued previously that the Dickey and Pantula test appeared to "produce" the same or more unit roots than the Dickey-Fuller test in the smaller samples when compared to the long sample where there was no difference between the results from these two tests. Concerns of unit root test results, in terms of their accuracy and in particular the accuracy in small samples, is addressed by Cochrane (1991). Mills (1990) provides evidence that there are more dangers in using the TS model when in fact the DS model should be applied, than

if the reverse occurs.

Table 3-6: Forecast Comparisons Between Unit Root Tests.

SERIES	TEST AND DEGREE OF DIFFERENCING		MEAN SQUARED ERROR (MSE)
ASSETS (Long)	D-F D & P 0*	1 1	0.231754 0.231754 0.179145
INCOME (Long)	D-F D & P	0 0	0.089147 0.089147
ASSETS (Short)	D-F D & P 0*	1 2	0.228371 0.818368 0.178505
INCOME (Short)	D-F D & P	0 1	0.212634 0.208196
LAND PRICE (Tran)	D-F D & P 0*	1 2	0.572438 2.279521 0.486029
RENT (Tran)	D-F D & P	1 1	0.208388 0.208388
LAND PRICE (UnTran)	D-F D & P	1 2	0.378082 2.346061
RENT (UnTran)	D-F D & P	1 1	0.022136 0.022136

* Forecast produced with zero differencing assuming a TS process.

Thus, if in doubt, a case can be made for the DS model over the TS model. However, this does not necessarily guarantee that the forecasts from the DS model will be superior to those derived from the TS model. This can be illustrated by the results identified by a 0* differencing in Table 3-6. For the three series concerned the results of the TS model are superior to the DS model for both Dickey-Fuller

and Dickey and Pantula where they apply.

This result of the forecast based on the TS model being superior to that obtained from the DS model is perhaps not surprising if one considers the conceptual underpinning of each model, and the number of observations used on which to base the forecast. Forecasting based on the TS model implies a trend based on all observations in the data series, whereas the DS model just uses the last two observations (being the last difference) as the base for forecasts. Because the DS model is based on differencing the data series it results in one less observation than the TS model for a first differencing. As the degree of differencing increases, the number of observations declines. Therefore, the DS model must always imply that fewer observations are being used than for the equivalent TS model. What is perhaps surprising in the results presented in Table 3-6 is the degree of improvement in the forecasts based on the TS model as compared with the DS models; in particular the models based on the Dickey and Pantula unit root test. The degree of improvement, measured as %MSE, over the Dickey-Fuller models averages 19.9%. For the comparison with the Dickey and Pantula models, the improvement averages 59.9%. Thus, the TS models are empirically superior for forecasting.

Conclusions

This article presented a comparison of methodologies employed to determine the "correct" time series process for forecasting purposes. The data series considered

are for real estate values (defined as assets or land price), and income (also defined as rent). In order to develop a forecasting model, it is normal to first check for the presence of unit roots in the original data set(s). The presence of unit roots implies that the series are not stationary, which itself implies that the mean and the variance of the series are not independent of time. If stationarity can not be assumed, erroneous forecasts will result. If unit roots are found in the data series, the difference stationary (DS) approach is required to make the series stationary, whereas the trend stationary (TS) approach can be used for the cases where no evidence of unit roots is found.

There is no consensus on which unit root test is best, therefore two unit root tests have been employed for this. The "traditional" test has been to use the Dickey-Fuller (1979) test which is designed to test for the presence of 1 unit root. Recently, there has been a growing concern that a series that contains more than 1 unit root may be used in time series analysis without the second (or more) unit root being detected. The test suggested by Dickey and Pantula (1987) is one test that can be used to test for multiple unit roots. Both of these tests have been applied to the same data sets and based on the results, different forecasts have been derived.

The Dickey-Fuller test identified unit roots in all series except for income in both of the USA series. By contrast, the Dickey and Pantula test identified unit roots in all series except income (USA long series), and it identified 2 unit roots in 3 of the series. Therefore, in order to derive forecasts for these series, the series

must be (a) made stationary using different processes, either TS (no unit roots) or DS (if unit roots are found), and (b) different levels of differencing must be used in the forecast routine to account for the number of unit roots found.

Visual inspection of residuals and the Box-Pierce Q test were employed to support the Dickey-Fuller test. In each case the results of the Dickey-Fuller test were supported. This adds weight to the results, as compared to the results from the Dickey and Pantula test. The "correct" order of autoregressive (AR(p)) process was determined with the Schwarz Criterion. This was supported in each case by a test of over-fitting, using a χ^2 test. Also, a Box-Jenkins identification run on each data series supported an AR(1) process. This conflicts with the Dickey and Pantula test in that 2 unit roots must imply at least an AR(2) and not an AR(1).

A test of under-fitting was carried out on 2 of the data series. This was done because the plot of the 1st difference of the logged data looked like white noise. In one case (assets in the USA short series) the test was rejected which implies that the AR(1) is preferred over an AR(0). In the other case (income in the USA short series), the test was not rejected and so an AR(0) is as preferable as the previously determined AR(1). This leads us (a) to question the quality of data that is being used for this research, or (b) to assume that income might be nothing more than a purely random process. If this is the case, it has important implications for the application of the capitalization formula to the valuation of farmland. Clark et al (1993a) argue that the capitalization formula is too simplistic for its purpose and should be improved. They base this argument on unit root tests. We would go

further in saying that if income is just a random process, no amount of sophistication in the model will improve forecasts, or estimates for that matter. Concerning the quality of the data, long time series cover changes in data collection and reporting, not to mention changes in definitions and even changes in technology. This should be of most concern with the USA long series.

Forecasts were produced for each series taking account of the results of the unit root tests. In all cases except one the forecasts, measured by the MSE's, were superior using the AR(p) suggested by the Dickey-Fuller test. Once again this tends to support the results of the diagnostic tests described above. Time series analysis is often faulted as being relatively devoid of an economic theoretical foundation. It can also easily become an exercise in "data dredging", ie. looking for the best result with no regard for theoretical concerns. This can be illustrated by the forecast results, identified as 0^*, presented in Table 3-6. Forecasts for 3 series were derived assuming that the TS approach to stationarity was in fact justified instead of the previously derived and justified DS approach. In each case these unjustified models resulted in forecasts that are better than those derived through the (justified) DS approach. This casts doubt on any logical (theoretic) approach to model choice with time series analysis. It is interesting to note that Baillie and Bollerslev (1989), having introduced the concept of the difference stationary model, state "An alternative "trend stationary" model, where a stationary component is added to a deterministic trend term, has generally been found to be less appropriate" (p. 167). This is however not supported by the results presented in

this paper.

We would claim that the Dickey-Fuller test is superior to the Dickey and Pantula test if these tests are used as one step in the development of a forecasting model. It must be clearly understood that this might be brought about by the data quality question, and "cleaner" data series might indeed support the relative sophistication of the Dickey and Pantula test. Unfortunately, the forecasts produced by the time series analysis as carried out for this paper would appear to be quite imprecise when compared to the results produced using cross section methodology by Just and Miranowski (1993).

NOTES

1. For a data series to be stationary it must not show any tendency to move away from its centering value. It can oscillate around the centering value over time, but it will always be drawn back to it. If in fact the data series wanders away from the centering value, with no indication that it will be drawn back to it, it can be assumed that it is a nonstationary process. A stationary series might exhibit a cyclical pattern that can be used for forecasting purposes. If the series is not first made stationary, this cyclical pattern might be clouded by the nonstationary trend in it. In order to determine whether there is a cyclical pattern in the data, it must therefore be looked for in a stationary series.

2. The data series considered in this article are identified as follows: USA long series (1910-90), USA short series (1950-90), Illinois transformed (transformed

following Burt (1986)), and Illinois untransformed. The Illinois data were left untransformed to identify any problem that might exist with them, as the capitalization model can be applied to nominal data as well as real data. The data were provided to the authors by J. Stephen Clark and are presented in Appendix Tables 3-A-5 to 3-A-12.

3. Testing for stationarity is usually done by first looking for the presence of unit roots in the data series. Roots can be (a) implosive, (b) unitary, or (c) explosive. If they are implosive it means that the roots (r_1, r_2 etc) are inside the unit circle, thus the roots of the polynomial cross the X axis with absolute values less than 1. These roots are not a problem for stationarity. Explosive roots cross the X axis with absolute values greater than 1. Unit roots cross the X axis when X = 1. In determining whether a series is stationary or not, the testing procedure looks for unit roots. If a unit root is detected, the series is differenced and if the residuals are white noise it can be assumed that (a) the series is stationary, and (b) there are no explosive roots in the series. If a unit root is not detected, the series is de-trended and if the residuals are white noise it can be assumed that (a) the series is stationary, and (b) there are no explosive roots in the series. Thus, the unit root is the <u>most important</u> root to identify. Consider the two following examples:

(1) Given an autoregressive process such as an AR(1): $Y_t = \phi Y_{t-1} + a_t$

If $\phi < |1|$ it implies that the series is stationary.

(2) Given an autoregressive process such as an AR(2): $Y_t = \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + a_t$

Use the following variant of the quadratic formula: $r_1, r_2 = \phi_1 \pm \{[\phi^2_1 + 4\ \phi_2]^{1/2}\}/2$

If $|r_1|$, $|r_2| < 1$, the series is stationary.

If $[\phi^2_1 + 4\ \phi_2] < 0$, the roots are complex. In this case check the value for ϕ_2.

If $\phi_2 < |1|$, the series is stationary.

4. The Box-Jenkins procedure was carried out through the ARIMA (identification) procedure of the SHAZAM Econometrics Computer Program (see White et al 1990).

5. The ARIMA(1,0,1) was forecast using SHAZAM but was identified to be a non-stationary model in the AR(p) process. Therefore, the assumption of it being an AR(1) process was upheld.

6. The calculated SC can be either derived by employing the formula, as presented in equation 12, or read from the SHAZAM output directly. The output presents a SC and a SC(log). The latter one is the appropriate one to use.

ACKNOWLEDGEMENT

We gratefully acknowledge receipt of the data for this article as supplied by J. Stephen Clark. Also, the advice generously provided by Michael Sampson, Department of Economics, Concordia University, Montreal is gratefully acknowledged.

CONNECTING SECTION 3

The results presented in chapter 3 are disappointing in that the accuracy of the time series forecasts are not particularly good. Plots of the forecasts (not presented in the paper but available from the authors) are poor, and particularly so when compared with the forecast plot provided in Just and Miranowski (1993 Figure 2) shown below as Figure 3-1. However, the results presented in the previous paper (chapter 3) that point to the underlying data series being (perhaps) nothing more than random processes with unit roots is supported by the following quote from Pagan and Wickens (1989, 965):

> Most asset prices are thought to be random walks and there is evidence that a large number of macroeconomic series including GDP and many of its components have a unit root.

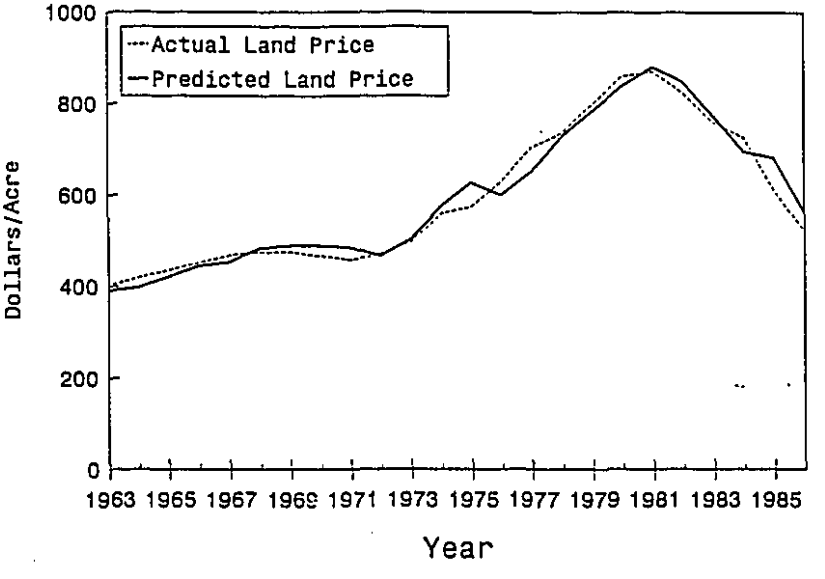

Figure 3.1: Actual and predicted U.S. land prices with sample period 1963-1982 and post sample period 1983-86.

Source: Just and Miranowski (1993).

The approach and particular variable choices of Just and Miranowski (1993) should be carefully checked against other time periods. Their research was able to closely approximate an unusual period when asset values virtually mushroomed and then started to decay again. Their model should be checked over other periods when the opposite was true. It may be that the cross-section approach to model formulation is superior for forecasting purposes, but not necessarily, particularly if the asset prices are indeed little more than random walks. The concern about random walks and forecasting becomes greater as the forecast period becomes longer. Thus, long-run forecasting using time series techniques can be assumed to be a questionable procedure.

Just and Miranowski (1993) derive their model for land price forecasting based on the risk aversion of the farmer investor. The final chapter of this thesis employs a consumption-based asset pricing model using the generalized method of moments (GMM) procedure to estimate parameters for risk aversion and the relevant intertemporal discount rate for the investor. Therefore, this paper is focused on the utility function of the investor. The interest in this research is motivated by the connection made by Just and Miranowski (1993) between consumption and production. Although this relationship is assumed in the consumption-based asset pricing model, and in the teaching of economics it is not always obvious in research presented in this area in agricultural economics.

CHAPTER 4

Consumption-Based Asset Pricing Models and Agricultural Real Estate Valuation

by

Laurie Baker

Faculty Lecturer

Department of Agricultural Economics

McGill University, Macdonald Campus

Introduction

This paper looks at the use of consumption-based asset pricing models based on the work by Hansen and Singleton (1982, 1983, 1984), and Ferson and Harvey (1992), to investigate whether they have a part to play for agricultural real estate valuation. This relates to the assumptions made regarding the appropriate utility function for agricultural real estate investors. Explicit assumptions concerning investors' utility functions are not always made in research that deals with either the valuation of agricultural real estate or the forecasting of their future values. A recent paper in this area by Just and Miranowski (1993) provides impressive ex post forecasts for land values in the United States with their research based on a particular utility function for the investor, that being that the investor exhibits constant absolute risk aversion.

Whereas Hansen and Singleton (1982, 1983, 1984), Ferson and Harvey (1992), and many other authors test their consumption-based asset pricing models with consumption data series such as nondurables and services and investment with stock market returns, this research focuses on the productive return on total farm asset values as the investment variable and employs nondurables alone, and nondurables and services as the consumption variable. This agricultural investment series is not as quantitatively "rich" as that for stock market returns and this shortcoming will be discussed in more depth in a later section of this paper. The justification for this research is the relationship between these models of asset pricing and the capitalization formula as used for real estate valuation. The latter

models value the asset as the sum of all future returns expected from the asset, discounted to the present at an appropriate discount rate. The former models weight this discounted stream of all future returns by a measure of the marginal utility of consumption.

The objectives of this paper are as follows. First, to estimate the parameter for relative risk aversion for a consumer/investor. The resulting parameter estimates will provide evidence to accept or reject the models. This parameter is constrained to be the inverse of the elasticity of intertemporal substitution. Thus, a high parameter estimate for relative risk aversion implies that the consumer/investor has a very low elasticity of intertemporal substitution. Given the chosen models, statistical tests (χ^2) will be used to either accept or reject the models.

Second, excess returns will be used in the place of the single asset return, without the use of instrumental variables. The excess returns considered will be related to (a) the agricultural asset, (b) long term government bonds, and (c) corporate (Aaa) bonds. If the parameter estimates (of α) are very large, in absolute terms, it would support the equity premium puzzle, which was presented by Mehra and Prescott (1985). This relates to the relationship that exists between the return to risky equity and relatively risk-free assets, such as T-bills. Mehra and Prescott (1985) found that the concavity parameter has to be very large (absolutely) to explain the large excess returns of stock versus the risk-free rate. In their conclusion, Mehra and Prescott (1985, 158) state:

> The equity premium puzzle may not be why was the average equity return so high but rather why was the average risk-free rate so low...if α is near zero and individuals nearly risk-neutral, then one would wonder why the average return of equity was so high.

It is taken for granted that equity should have a certain premium over the return for the risk-free asset to reflect the risk associated with taking the risky asset as an investment. It is of interest to look at this in terms of the return to be expected from an investment in an agricultural asset such as real estate. The return to the agricultural asset being used for this analysis is the rent associated with the property which will be an indicator of the productive returns to land. This will however, not be an indicator of the capital gains associated with the property. Perhaps it should be, given the capitalization formula, but it can only be assumed for the purposes of this research to represent productive returns. It is hypothesized that these productive returns will be lower than those equity returns from the stock market. Thus, there is an expectation that the concavity parameter estimate should be less in absolute terms than found by Mehra and Prescott (1985).

Third, the excess returns analysis will be extended by estimating the pricing errors associated with these excess returns. Instrumental variables will be used for this analysis. Finally, the models will be tested statistically to either accept or reject them for asset pricing.

Theoretical Models

Hansen and Singleton (1982) assume that the consumer has a time-additive utility function which can be written, following the convention of equation (1) of Ferson and Harvey (1992), as follows:

$$E \{ \beta [U' (C_{t+1}) / U' (C_t)] R_{t+1} | \Omega_t \} = 1. \qquad (4\text{-}1)$$

Where: β = intertemporal discount rate.
$U' (C)$ = marginal utility of consumption, in the appropriate time period.
R_{t+1} = real rate of return on investment in the next period.
Ω_t = all public information.

The rationale for this is that an investor, faced with a choice of consumption today or investment now for future consumption, will make the choice based on the utility function that they have. Therefore, some thought must be given to the utility function that is assumed for the consumer.

Hansen and Singleton (1982) further assume that the consumer has a constant relative risk aversion (CRRA) utility function which they present as follows (page 1278):

$$U = \{ (C_t)^{\gamma} \} / \gamma \qquad (4\text{-}2)$$

Where: $\gamma = < 1.$

The marginal utility can be expressed as $U' (C_t) = (C_t)^{\alpha}$

Where: $\alpha \equiv \gamma - 1$

This utility function (4-2) can be substituted into equation (4-1) to get the following

Euler equation:

$$E\{ \beta [C_{t+1} / C_t]^{\alpha} R_{t+1} | Z_t \} = 1 \qquad (4\text{-}3)$$

Where: β = intertemporal discount rate.
α = concavity (preference) parameter.
C_t = current consumption.
R_t = current return (%) on investment.
Z_t = vector of instruments.

The expression within the conditional expectation operator $E\{\bullet\}$ at time t is an error term u_{t+1} with a conditional mean equal to zero, which assumes knowledge at time t. Assuming that the instruments Z_t are known at time t, it implies that $E(u_{t+1} | Z_t) = 0$. This results in an assumption that $E(u_{t+1} Z_t) = 0$. Thus, the analytical approach used attempts to solve for the parameter estimate of α given this restriction.

It is hypothesized that the estimated discount parameter, β in the above models, will be less than but close to 1 (see Mehra and Prescott 1985). In attempting to resolve the equity premium puzzle posed by Mehra and Prescott (1985), Kocherlakota (1990) sets $\beta = 1.139$ which implies that the economy is booming. This is certainly not the case in either the US or Canada at this time, nor would it be a fair reflection of the average historical performance of either economy over the time period to be considered in this analysis. Thus there is an expectation of $\beta < 1$ for this research.

No assumption regarding size is made for the concavity (preference) parameter, represented as α in equation 4-3, for the models (Euler equations) to

be estimated, other than the expectation that the estimates will be close to one, with α=1 implying risk-neutrality on the part of the investor. The estimate for this parameter can be very close to 1 (see Hansen and Singleton 1984) or in fact far away from 1. Mehra and Prescott (1985), citing various studies argue that this parameter is expected to be close to 1. In fact, they allow it to move between 0 and -9. Kocherlakota (1990) used a larger value as he set this preference parameter as γ = 13.7, resulting in α = -12.7 for α = 1 - γ. This, along with his β = 1.139 was used to resolve the equity premium puzzle that was posed by Mehra and Prescott (1985).

The sign for the preference parameter (α) indicates that preferences are in the concave region of the parameter space. If the preference parameter estimate is positive it implies the estimate is in the convex region of the parameter space which is an implausible result economically. As the estimate departs from 1, we can say that it is a measure of relative risk averse behaviour with degree of risk aversion increasing as the estimates becomes greater absolutely. Debt financing is usually assumed to be a less risky form of financing than equity for a business. Based on the overwhelming importance of debt financing as compared to equity financing in agriculture, both in the US and Canada, it is hypothesized that the preference parameter will have a negative sign and be a relatively large number.

Empirical Procedure

The econometric technique used for the analysis is the generalized method of moments (GMM). This is a non-linear technique which employs instrumental variables, Z_t in equation 4-3. The choice of these instrumental variables will have an impact on the "fit" of the model. The variables chosen as instruments are lagged values of both the consumption (C_{t-n}) and investment (ROA_{t-n}) variables in the Euler equations, and lagged values of the real commercial paper rate (I_{t-n}) and money supply ($M2_{t-n}$). The choice of these variables was justified either by their relationship with the capitalization formula, or that they have a bearing on consumers' willingness and ability to invest. The number of lags used in the analysis was 1, 2, 3, 4, 5, 6. The analysis using the Hansen and Singleton (1982, 1984) Euler equation (equation 4-3 above) was run using (a) nondurables and services, and (b) nondurables as the consumption variable. The combinations of consumption variables and instruments employed in the analysis of equation 4-3 are presented in table 4-1.

For the analysis to consider the equity premium puzzle, the appropriate Euler equation is as follows:

$$E \{ [C_{t+1} / C_t]^{\alpha} [R_{i,\,t+1} - R_{f,\,t+1}] \} = 0 \qquad (4\text{-}4)$$

Where: $R_{i,\,t+1}$ = return to the risky asset at time t+1.
$R_{f,\,t+1}$ = return to the risk-free asset at t+1.

In this equation the rate of return to the investment is replaced by the appropriate excess return and the instrumental variables are removed.

Table 4-1: Choice of instrumental variables.

CONSUMPTION VARIABLE[1]	INSTRUMENTS[2]
1. NDS	C_{t-n} and ROA_{t-n} for n = 1,..., 6
2. NDS	C_{t-n} , ROA_{t-n} and I_{t-n} for n = 1,..., 6
3. NDS	C_{t-n} , ROA_{t-n} , I_{t-n} and $M2_{t-n}$ for n = 1,..., 6
4. ND	C_{t-n} and ROA_{t-n} for n = 1,..., 6
5. ND	C_{t-n} , ROA_{t-n} and I_{t-n} for n = 1,..., 6
6. ND	C_{t-n} , ROA_{t-n} , I_{t-n} and $M2_{t-n}$ for n = 1,..., 6

[1] NDS = nondurables and services
ND = nondurables
[2] C = consumption
ROA = investment
I = real commercial paper
M2 = money supply

Thus, the method of moments technique finds the concavity parameter estimate that will set the Euler equation to zero. Because of the removal of the instruments, it is hypothesized that the resulting concavity parameter estimates will be much greater (absolutely) than those found when instruments are included in the analysis. Instead of just one asset return being employed in the analysis, as for the first part of the analysis, now three excess returns are analyzed. These are for the real estate asset, government bond excess return, and that for the corporate bond. The degrees of freedom for this model will be reduced from the previous model.

It is hypothesized that the excess returns should be highest for the real estate asset and lowest for the government bond, with the corporate bond being between these two. This is assumed because equities "normally" have higher

returns than do debt instruments.

For the final analysis in this paper, the excess return of $(R_{i,t+1} - R_{f,t+1})$ in equation 4-4 is replaced by $(R_{i,t+1} - R_{f,t+1} - \lambda_i)$ in the following equation:

$$E \{ [C_{t+1} / C_t]^{\alpha} [R_{i,t+1} - R_{f,t+1} - \lambda_i] \} = 0 \qquad (4\text{-}5)$$

Where: λ_i = pricing errors for the excess returns.

The lambda pricing errors can give an indication as to how well the models "fit". The expectation is that, due to there being some concern for the quality of the data employed in the analysis, it might be reasonable to expect that these errors will not be as small as desirable. In a perfectly specified model using data of unquestionable quality, the expectation would be that $\lambda_i = 0$. These lambdas are the same as "Jensen's alphas" in beta models, such as the capital asset pricing model (CAPM) (see note 1).

Data Sources

The data used for the analyses presented in this paper are presented in the Appendix, Tables 4-A-1 to 4-A-11, and are for the USA. Data for real total asset values and real income from those assets were available for the period 1910-1990. Also available for the same period were data for the implicit personal consumption expenditure (PCE) deflator, population, real commercial paper rates and money supply (M2). Data for personal consumption expenditures disaggregated into durables, nondurables, and services, long-term government bond rates, and corporate (Aaa) bond rates were only available for the 1929-1990 period. The rates

for 3 month T-bills were available for the period 1931-1990. Therefore, the period chosen for the analysis was set as 1929-1990 for the analysis of the "standard" Hansen and Singleton model, and 1931-1990 was chosen as the appropriate period for the analyses concerning tests of the consumption-based asset pricing model, based on the work of Mehra and Prescott (1985) and Ferson and Harvey (1992).

Those data not already in constant terms were deflated using the implicit personal consumption expenditure deflator (DEFL) to base year 1972=100. It was assumed that the data for income is expressed as that earned by the end of the period in question. The total asset values are at december 31 of each year. Therefore the data for income were used to calculate the return on assets (ROA) as a percentage, as follows:

$$ROA_t = (INC_t) / ((ASS_{t-1} + ASS_t) / 2) \qquad (4\text{-}6)$$

Where: INC_t = Real income from total assets in year t.
ASS_t = Total assets in year t.

This lagging of the total asset series results in the time period for the analysis being set as 1930-1990 (Hansen and Singleton model) or 1931-1990 for the testing analyses, which results in 61 and 60 observations respectively.

As mentioned in the introductory section of this paper, the data series for real total asset values and the income from those assets are not as rich quantitatively as those used by most authors who look at this analytical approach.

Stock market data is available in voluminous quantity which explains why it is used in so many studies in this area. The choice of that investment variable can also be justified as it being a proxy for any investment opportunity available to the investor. As is the case with all time series techniques, the more data points that the researcher has the better the results are likely to be, assuming of course that the data has a certain quality. Because so much stock market data is available, the time series of stock returns does not have to be very long to get a large number of data points.

Unfortunately, this is not the case for this research. Given the data series available for this paper, there are only at most 61 observations which cover a very long period over which there have been changes in technology and data collection techniques. During the early 1930's the depression was not indicative of average returns expected. Also, during the years associated with the second world war there was obviously a dramatic change in the attitudes of the population of the USA. This can be seen in the data for personal consumption expenditures on durable goods during that period. Thus, this data series was not used for the analysis, both because of the previously identified problem of "representativeness" and also because of "the difficulty of imputing a service flow to the stock of durables" (Hansen and Singleton 1983, 257). The series for both nondurables and services appear to be much less affected by the war years. They were therefore used for the analysis. It would be expected that asset values in agriculture would have been similarly affected (negatively) by the great depression. However, it was

decided to use these years to enrich (quantitatively if not qualitatively) as much as possible the data series used in the analysis.

There is a potential problem with using annualized data in that it might be affected by the interpolation used when it was originally compiled (see Hansen and Singleton 1983, footnote 6, 258). This is likely also a problem in US census information as it is known to be a problem in Canadian census data. A perusal of the national income data presented in the Statistical Abstracts of the United States (various issues) indicates that the reporting, and thus presumably also the collection, of the information increased dramatically following the second world war. Prior to the war years, there was an obvious bias towards the reporting of agricultural information, with little attention being paid to the national accounts. This explains why there is no breakdown of personal consumption expenditure data for the years prior to 1929. In fact, even a total of these expenditures was not presented for earlier years.

Results

The results of the analysis using the Hansen and Singleton (1982, 1984) Euler equation (4-3) and the combinations illustrated in Table 4-1 are presented in Tables 4-2 to 4-7. As hypothesized, the estimates for the discount parameter (β) are close to, but less than 1 for each equation run, and each one is very precise. Thus, there is no evidence of a booming economy. All estimates of the preference (concavity) parameter (α) are negative when the consumption variable is

nondurables (ND).

Table 4-2:
INSTRUMENTAL VARIABLE ESTIMATES FOR 1929-1990 (ANNUAL)
(Consumption = NDS, Return = ROA)
(Instruments = Lagged Consumption and Returns)
(Standard Errors in parentheses).

Using Following Estimating Equation:

$$E\{ \beta [C_{t+1} / C_t]^{\alpha} R_{t+1} - 1 \} = 0$$

NLAG	$\hat{\alpha}$	$\hat{\beta}$	χ^2	DF	PROB[x]
1	-0.61205 (0.23623)	0.98566 (0.0049661)	9.4588	1	.997143
2	-0.11499 (0.27897)	0.97432 (0.0061359)	10.787	3	.985808
3	0.29409 (0.34826)	0.96457 (0.0084034)	9.7599	5	.914272
4	0.28740 (0.28313)	0.96372 (0.0072758)	8.7769	7	.725548
5	0.22208 (0.16957)	0.96489 (0.0053375)	10.021	9	.637787
6	0.37352 (0.18709)	0.96263 (0.0049588)	8.9549	11	.374538

[x] PROB calculated as a linear interpolation.

Table 4-3:
INSTRUMENTAL VARIABLE ESTIMATES FOR 1929-1990 (ANNUAL)
(Consumption = NDS, Return = ROA)
(Instruments = Lagged Consumption, Returns and Real Commercial Paper Rate)
(Standard Errors in parentheses).

Using Following Estimating Equation:

$$E\{ \beta [C_{t+1} / C_t]^{\alpha} R_{t+1} - 1 \} = 0$$

NLAG	$\hat{\alpha}$	$\hat{\beta}$	χ^2	DF	PROB[x]
1	-0.61310 (0.21528)	0.98549 (0.0044889)	7.5603	2	.976494
2	0.066120 (0.26363)	0.97092 (0.0059094)	12.823	5	.974865
3	0.27110 (0.33059)	0.96420 (0.0078355)	12.972	8	.881405
4	0.20117 (0.14920)	0.96470 (0.0040020)	12.038	11	.626339
5	0.10218 (0.090193)	0.96629 (0.0035569)	11.661	14	.367587
6	0.0086526 (0.060249)	0.96906 (0.0026187)	10.735	17	.135833

[x] PROB calculated as a linear interpolation.

Table 4-4:
INSTRUMENTAL VARIABLE ESTIMATES FOR 1929-1990 (ANNUAL)
(Consumption = NDS, Return = ROA)
(Instruments = Lagged Consumption, Returns, Real Commercial Paper Rate & M2)
(Standard Errors in parentheses).

Using Following Estimating Equation:

$$E\{ \beta [C_{t+1} / C_t]^{\alpha} R_{t+1} - 1 \} = 0$$

NLAG	$\hat{\alpha}$	$\hat{\beta}$	χ^2	DF	PROB[X]
1	-0.63713 (0.19802)	0.98611 (0.0039033)	7.4040	3	.936864
2	-0.0033530 (0.24084)	0.97258 (0.0052953)	13.786	7	.943144
3	0.18020 (0.29139)	0.96478 (0.0066213)	14.934	11	.801757
4	0.13748 (0.10496)	0.96514 (0.0029528)	13.438	15	.431667
5	-0.021234 (0.046445)	0.96939 (0.0018435)	12.593	19	.148608
6	-0.030600 (0.024383)	0.96947 (0.0009839)	11.035	23	.018406

[X] PROB calculated as a linear interpolation.

Table 4-5:
INSTRUMENTAL VARIABLE ESTIMATES FOR 1929-1990 (ANNUAL)
(Consumption = ND, Return = ROA)
(Instruments = Lagged Consumption and Returns)
(Standard Errors in parentheses).

Using Following Estimating Equation:

$$E\{ \beta [C_{t+1} / C_t]^{\alpha} R_{t+1} - 1 \} = 0$$

NLAG	$\hat{\alpha}$	$\hat{\beta}$	χ^2	DF	PROB[x]
1	-0.54101 (0.14776)	0.98024 (0.0032191)	10.018	1	.997901
2	-0.24684 (0.16915)	0.97545 (0.0034905)	12.672	3	.994444
3	-0.34904 (0.15920)	0.97650 (0.0038893)	11.655	5	.958293
4	-0.61992 (0.12243)	0.97961 (0.0037715)	10.012	7	.799072
5	-0.47166 (0.11025)	0.97696 (0.0035755)	10.396	9	.668525
6	-0.48646 (0.085858)	0.97548 (0.0031192)	9.8791	11	.458252

[x] PROB calculated as a linear interpolation.

Table 4-6:
INSTRUMENTAL VARIABLE ESTIMATES FOR 1929-1990 (ANNUAL)
(Consumption = ND, Return = ROA)
(Instruments = Lagged Consumption, Returns and Real Commercial Paper Rate)
(Standard Errors in parentheses).

Using Following Estimating Equation:

$$E\{ \beta [C_{t+1} / C_t]^{\alpha} R_{t+1} - 1 \} = 0$$

NLAG	α	β	χ^2	DF	PROB[X]
1	-0.52884 (0.11063)	0.97993 (0.0026146)	9.6468	2	.991574
2	-0.44389 (0.16300)	0.97900 (0.0032222)	13.167	5	.977226
3	-0.46276 (0.11836)	0.97851 (0.0031961)	11.901	8	.830286
4	-0.43328 (0.071477)	0.97568 (0.0028151)	12.822	11	.684673
5	-0.33432 (0.056700)	0.97385 (0.0022905)	11.901	14	.386514
6	-0.44610 (0.026214)	0.97476 (0.0018876)	10.698	17	.133778

[X] PROB calculated as a linear interpolation.

Table 4-7:
INSTRUMENTAL VARIABLE ESTIMATES FOR 1929-1990 (ANNUAL)
(Consumption = ND, Return = ROA)
(Instruments = Lagged Consumption, Returns, Real Commercial Paper Rate & M2)
(Standard Errors in parentheses).

Using Following Estimating Equation:

$$E\{ \beta [C_{t+1} / C_t]^{\alpha} R_{t+1} - 1 \} = 0$$

NLAG	α	β	χ^2	DF	PROB[x]
1	-0.57393 (0.10154)	0.98044 (0.0025794)	10.377	3	.982728
2	-0.39442 (0.15457)	0.97824 (0.0030214)	13.419	7	.934193
3	-0.36029 (0.10487)	0.97623 (0.0028213)	13.709	11	.750348
4	-0.37493 (0.064362)	0.97440 (0.0025408)	13.455	15	.432955
5	-0.34312 (0.045234)	0.97337 (0.0019228)	12.302	19	.133608
6	-0.43602 (0.024236)	0.97462 (0.0008979)	10.824	23	.016282

[x] PROB calculated as a linear interpolation.

This is an acceptable result economically as it implies that the preference parameter is in the concave region as expected, meaning that the investors exhibit risk-averse behaviour. They are however smaller in absolute terms than expected, with none of them being less than -0.61 nor greater than -0.25. With the exception of the concavity parameter (α) for NLAG=2 in Table 4-5, the estimates are significant based on the 2*SE rule. The results imply that the investor represented by the model is exhibiting more risk-neutral behaviour than was originally expected.

The same cannot be said for the results based on the consumption variable being nondurables and services (NDS). In these cases the sign is correct for the first one or two lags but there is a sign reversal after NLAG=2 at the most. In Table 4-4 the sign changes back to the "expected" negative for NLAG=5 and 6. A positive concavity parameter estimate implies risk loving behaviour, which is an unacceptable result. This result may have arisen with the inclusion in nondurables of services which have a much more stable year-by-year growth in real terms than do nondurables, as identified by Ferson and Harvey (1992). The concavity parameter estimates for both the NDS and ND equations are more uniform than those found by Hansen and Singleton (1984).

The χ^2 tests relate to the number of over-identifying restrictions identified by the degrees of freedom (DF) where the restrictions are that $E(u_{t+1}\ Z_t) = 0$. The number of degrees of freedom is determined by the difference between the number of orthogonality conditions (number of asset returns multiplied by the number of instruments employed in the analysis) and the number of parameters being

estimated. For each of the models in Tables 4-2 to 4-7, there are two parameters being estimated (α and β) and one asset return. All of the models are thus overidentified. This can be determined to be the case if the number of parameters to be estimated is less than the number of orthogonality conditions.

As Hansen and Singleton (1982, 1282) explain, "PROB is the probability that a χ^2 (DF) random variate is less than the computed value of the test statistic under the hypothesis that the restrictions are satisfied". The restrictions that they refer to are that the expected value of the error terms is zero. The aim of the GMM technique is to determine parameter estimates that will equate the Euler equation with zero. The higher the value of PROB, the more evidence there is against the model for asset pricing.

These results indicate the following. There is more evidence against these models (a) for shorter rather than longer lags, and (b) for less rather than more instrumental variables. The use of nondurables and services as opposed to the use of just nondurables as the consumption variable would appear to provide marginally more support for the models, but there is the sign problem to be dealt with. In fact, the probability (PROB) statistic is greater than 50% for the majority of the models. That the model is more supported as the number of lags increases is the same result that Hansen and Singleton provide in their errata (1984), although the results presented here are much better than they found for longer lags of the instrumental variables in terms of the χ^2(DF) estimates. The results improve as the list of instruments is increased, which is to be expected. This might still be

the case if any instruments were included in the analysis. However, only instruments that were perceived to be relevant were used in this analysis. In summary however, the models should be rejected except for the longest lags because the probability values are so high for the majority of models estimated.

The results of the second part of the analysis, to test for the equity premium puzzle are presented in Table 4-8. A discussion of this analysis and the results is presented following this table.

Table 4-8:
Concavity Parameter Estimates For Excess Returns (Annual Data 1931-1990)
(Standard Errors in Parentheses).

Using Following Estimating Equation:

$$E\{[C_{t+1}/C_t]^{\alpha}[R_{i,t+1} - R_{f,t+1}]\} = 0$$

Excess Return[1]	NDS[2]	ND[3]
ROA[4]	-11.310 (2.3138)	-15.570 (4.3995)
Government Bond	-27.339 (4.3312)	-15.538 (4.3977)
Corporate Bond	-27.041 (4.3163)	-15.563 (4.3900)

[1] Excess returns are calculated with the risk-free rate for 3 month T-bills.
[2] NDS = nondurables and services.
[3] ND = nondurables.
[4] ROA = return on assets (assets being agricultural real estate).

The parameter estimates provided in Table 4-8 are very large, in absolute terms, when compared to those presented in Tables 4-2 to 4-7. This is (a) because

the asset return has been replaced with the appropriate excess return, and (b) no instrumental variables are employed for this analysis. They are more in line with those reported by Kocherlakota (1990), but quite considerably smaller than some of the estimates reported by Ferson and Harvey (1992). The absolute size of these estimates is an indication of the equity premium puzzle discussed above. The estimates are perhaps larger than expected given the earlier comments on the agricultural productive returns and what can be seen from the data.

Ferson and Harvey (1992) do not present results of the analysis that they conducted using annual data, however they indicate that these consumption-based models might be better used on annual data than with data collected on a shorter basis (they employ quarterly data series) because decisions as to consumption or investment are not made regularly on a short-run basis. This is likely the case in agriculture where the decision to invest in agricultural real estate will not be made with the same frequency as the decision to invest in the stock market.

The signs are as hypothesized, implying risk averseness on the part of the consumer/investor. All of the equations, for which results are presented in Table 4-8 are just identified because the number of parameters to be estimated (1) is equal to the number of orthogonality conditions (1). The situation of just one orthogonality condition results because the only instrumental variable that is included in these models is a constant. If more instruments were included in each equation, the results would be that each model would be overidentified.

The data series reveal the rates of return, and excess rates of return

(measured to the risk-free T-bill) that are presented in Table 4-9. No data series for stock market equities was used for analysis in this research study. In its place the real rate of return on agricultural land is used. This is the productive return which does not include any capital gains on the asset. The data indicate that there is a small negative (productive) return to the agricultural asset. It is argued, and evidence would support it, that equities should have higher returns than risky debt, which in turn has a higher return than relatively risk-free debt (T-bills). Thus, this negative return appears to make no sense. Assuming for the present that the data quality is not questionable, it implies that farmers will expect to earn their rate of return on agricultural real estate from capital gains and not from the production from the asset.

Table 4-9:
Real Rates of Return and Excess Returns (1931-1990)

REAL RETURN	%	EXCESS RETURN	%
T-BILL	3.33	N.A.	N.A.
ROA	3.06	ROA - T-BILL	-0.27
G-BOND	5.95	G-BOND - T-BILL	2.62
C-BOND	7.00	C-BOND - T-BILL	3.67

N.A. Not applicable.

The results of the third part of the analysis concerning pricing errors are presented in Table 4-10. These results illustrate the following. The size of the

concavity parameter estimate is dramatically reduced from those shown in Table 4-8, due to the inclusion of the lambda parameters. The signs for the concavity parameters are as expected, but the estimate using NDS is not significant. The probability values are very poor, with both being well in excess of 99%. These probability values provide little confidence in the models and suggest that they in fact be rejected.

Table 4-10:
Concavity Parameter Estimates, Pricing Errors and Estimation Accuracy
(Annual Data 1931-1990) (Standard Errors in Parentheses).

Using Following Estimating Equation:

$$E\{[C_{t+1}/C_t]^{\alpha}[R_{i,t+1} - R_{f,t+1} - \lambda_i]\} = 0$$

CONS	$\hat{\alpha}$	χ^2 (5 D.F)	PROB	λ_1	λ_2	λ_3
NDS	-0.3035 (0.25707)	21.759	>.998	-0.0098036 (0.0065223)	0.012561 (0.0052400)	0.019994 (0.005338)
ND	-1.1897 (0.28344)	17.596	.995899	-0.023674 (0.0066362)	0.0020062 (0.0057130)	0.010426 (0.005827)

λ_1 = Pricing error (ROA - T-BILL).
λ_2 = Pricing error (GBOND - T-BILL).
λ_3 = Pricing error (CBOND - T-BILL).

The pricing errors are negative for the asset return and positive for the bond returns. All the pricing errors are small and precise but the estimates for the asset return using NDS, government bond and corporate bond using ND as the consumption variable are not significant. The pricing errors are between 1 to 2.4% per annum, with the smallest error being for the excess returns to the asset using

NDS, and the greatest error for the excess returns to the asset using ND. These errors compare favourably with those reported by Ferson and Harvey (1992).

Conclusions

This paper has presented results of consumption-based asset pricing models where the usual investment variable, stock market returns, is replaced with the (productive) returns to agricultural real estate. None of the models tested provide much confidence in their continued use on the data sets that were employed for this research. However, the results of this research provide indications of the need for more work in this area. As previously mentioned, Just and Miranowski (1993) derived excellent forecasts using a model of land valuation based on the assumption of constant absolute risk aversion of the investors. The results presented in this paper do not support their findings and imply that other utility functions be considered. They did not however use generalized method of moments analysis for their research.

This seemingly contradictory situation might be explained when one again considers the quality of the data being employed for the analysis. In their paper, Just and Miranowski (1993) used cross-section data for the period 1963 to 1986. Although a much shorter time period than that considered for this analysis, they had agricultural data on a state basis. It seems plausible to argue that state level data will be of higher quality than that aggregated to the national level. Unfortunately, this highlights the concern of longer rather than shorter data series

being preferable for time series analyses. As the time series lengthens, it becomes harder if not impossible to acquire the data in any other form than highly aggregated.

The analysis tended to support the equity premium puzzle work of Mehra and Prescott (1985) and Ferson and Harvey (1992). Also, the results of the pricing error analysis agreed with results presented by Ferson and Harvey (1992) but the models have to be rejected due to extremely low confidence statistics. An argument can be made to accept the models (equation 4-3) if long lags are used. For the analysis using ND as the consumption variable (Tables 4-5, 4-6, and 4-7), the significant PROB statistics occurred for NLAG=6, 5, and 4 respectively. Ferson and Harvey (1992) utilize quarterly data and set NLAG=4 for much of their analysis. This is defensible given four quarters in a year. For this research annual data was used. It is not possible to choose the correct NLAG value to use for the models with the same logic. In the absence of such logic, it is argued that the models should be rejected.

NOTES

1. "Jensen's alphas" are assumed to be equal to zero when the CAPM is estimated using ordinary least squares (OLS). Thus, the alpha estimate (intercept) has a value of zero. Francis and Kirzner (1988, 778) state the following:

> This alpha estimates the excess returns averaged over the sample period used to estimate the characteristic line in risk-premium form regression. If the *i*th asset was correctly priced so that it yielded no returns either in excess of the appropriate risk-premium or less than the appropriate risk-premium, $E(r_{it} - R_t) = 0$, then the alpha intercept will have a value of zero, $A = 0$.

THESIS CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Conclusions

This thesis is comprised of four papers (chapters) with three connecting sections. The first paper considered the choice of acquiring the use of agricultural real estate by purchase or long-term (25 years) lease agreement. Given that the normal lease period in Canada is short, 1-3 years, it was assumed that for a landlord to be interested in entering into such an agreement they would have to be made at least as well off with the lease as if they sold the property and invested the sale proceeds in an investment such as CSB's. Although the CSB is assumed to be virtually risk-free and land rental contracts are not, the opportunity rate of return for the CSB was assumed for the land rental contract.

The results of this investigation indicate that the person wishing to acquire the use of the land would be better to lease than to buy the real estate. It might be hypothesized that there could be occasions where the reverse is true, for example when very high downpayments of equity are in hand, but these were not investigated in this paper. They are, however considered in the second paper of this thesis. This advantage to leasing can be seen with a comparison of excess cash available under both alternatives.

For the purchase option, the principal payments cannot be made in six out of the seven years for the analysis. This means that the debt level increases instead of the expected decrease, and the business quickly becomes a candidate

for foreclosure. In the case of the leasing option, the principal payments can be covered in all years of the analysis. Thus, the level of debt is brought down resulting in an increasing equity ratio. In this case the leasing farmer is able to build an equity downpayment which can be used for a future purchase decision.

Although it was assumed that the landlord should be indifferent between entering into a long-term lease contract and selling and investing the proceeds, the resulting solutions did not quite accomplish this goal. The landlord was made $2,500.09 per year worse off under the lease contract than if (s)he had sold the property and invested in CSB's. As the length of the lease contract increases the annual rental payment also increases. This compensates the landlord for foregoing his/her own rights (use or disposition) to the property for a longer rather than a shorter period. It can therefore be hypothesized that a lease term longer than 25 years would provide the landlord with the "indifference" between the choices that they face.

The second paper addresses this question directly. The objectives of the paper were to derive "indifference" lease terms and rental rates, given changes in the level of the decision variables. Setting the level of the decision variables at that for the first paper, the indifference lease term increases to 30.75 years from 25 years, and the annual lease payment increases to $29,793.70 from $27,299.27. The analysis indicates that the equity downpayment would have to reach about 96% before the acquirer would prefer the purchase option over the leasing option.

The lease term is sensitive to changes in the nominal interest rate with the

term fluctuating between a low of 24.45 years with the nominal rate being 14%, to a high of greater than 99 years for a nominal rate of 9%. As both of these rates are well within recent fluctuations of that rate, these results indicate that lease terms might be quite variable and perhaps should not just follow the norm of 1-3 years. The rate earned on CSB's has an impact on the solution to this problem of lease term "indifference". With a CSB rate of 5% the lease term is 4.75 years, and the lease term becomes 53.75 years for a CSB rate of 11%. Again, both of these CSB rates are well within recent fluctuations.

Of the representative years analyzed (1977, 1981, 1984, 1988, and 1992), the acquirer of the real estate for productive purposes would be better off to use long-term lease agreements rather than purchase options. This obviously would remove any chance of capital gains for the acquirer. The same argument holds true for capital losses. The solutions to the scenarios considered in both of these first two papers take as given that the purchase price for the real estate has been correctly set. As this is the value used in the calculation of the lease rental payment, there is an obvious impact on both the purchase and lease options.

The third paper in the thesis uses two related statistical tests to choose forecasting models for land values and income using United States data. Although these tests are very similar conceptually, (a) they are different quantitatively, and (b) their use leads one to specify slightly different models for forecasting purposes. The forecasts derived are unfortunately not very good. This is disappointing, particularly when the forecasts are compared to those produced using cross-

section econometric techniques (see Just and Miranowski 1993).

Testing carried out for this paper supported earlier work that claims that major macro-economic series may be just random walk processes (see Pagan and Wickens 1989). If this is true, it implies that a model that is a good forecaster during one period might or might not be a good forecaster in other time periods. Unfortunately, models that perform well for ex post forecasts often perform very poorly for ex ante forecasts.

The final paper for this thesis presents results of tests of consumption-based asset pricing models using agricultural investment data. Normally, these models are tested using stock market data. This is an advantage because these data are available in great quantity. On the other hand, agricultural investment data are not so quantitatively "rich". It was not the intent of this research to find the "best" model; rather three well known models were tested using agricultural data. The models are predicated on the underlying utility function for the investor.

Most of the models tested should be rejected. Those that can be accepted must be accepted under lag conditions that are hard to justify theoretically. This itself raises interesting methodological questions, but the resolution of this debate is outside the scope of this thesis. The models do however, focus attention on the relationship between the consumption-investment trade-off, and the choice of the investor's utility function. Perhaps too few papers published in agricultural economics journals look at such relationships.

Suggestions for Further Research

The publication of the first paper (chapter 1) resulted in a comment being written to the *Canadian Journal of Agricultural Economics* (Turvey 1992), with a reply as a follow-up (Baker and Thomassin 1992). One of Turvey's concerns was that we had handled the analysis in the absence of taxes. This was not strictly true, in that income taxes on the acquiring farmer are taken into account. However, his concern warrants attention in further work. This is true as it relates to capital gains taxation and the handling of real estate taxes. At this time in Canada, small businesses have a once in a lifetime exemption of about $400,000 for capital gains. A similar exemption of $100,000 for individual Canadians was abolished in the federal budget of 22 February, 1994. An exemption of $400,000 will cover many farmers' gains, but an abolition of this exemption would mean that questions of taxation would have greater import for farm investors. Thus, research into lease versus buy decisions should now be looked at giving full consideration to the taxation implications.

The first two papers presented in this thesis focus on cash leases, whereas lease contracts are available presently in Canada based on either cash payments or a share (of production) basis. Future research should consider lease-buy decisions using share leases as well as cash leases. The cash flows considered in the first two papers are deterministic which implies that risk has not been explicitly considered. Further analysis should look at stochastic cash flows to investigate whether the results presented here are supported in a risky environment.

The third paper identifies questions related to the quality of the data used in these analyses. Unless one carries out an original survey, one is condemned to using data acquired by others. In time series analyses this is worrisome because of changing data collection techniques, and changing definitions. The research should be carried out using Canadian data. American data were used for the paper in this thesis because the paper originally started life as a critique of a published paper (see Clark et al 1993a). It would be interesting to see if these time series models perform differently using Canadian data, both at the national and provincial level, given the different production/marketing systems in place in Canada.

The question of data quality was raised in the conclusions to the paper in the context of the statistical tests. As the two tests under investigation in the paper are designed for the same purpose, the detection of unit roots, it is not possible to definitively state which one is superior. Using the available data, it appeared to us that the older test (Dickey-Fuller test) was superior. Cleaner data might in fact support the more recent of these tests (Dickey and Pantula test). This is an important issue, particularly if different models result from the use of these tests. Thus, more work is warranted in this area.

The final paper in this thesis also raises questions of data quality. The data for personal consumption should be reliable as the collection of national account data, particularly since the second world war, has received much attention by governments both in the United States and in Canada. The data related to agricultural investment should also be of good quality, but it is a thinner series.

State level data might be of higher quality and more reliable, as it will suffer less from aggregation problems. However, it is not possible to get data series by state over such a long time period.

As the number of observations declines in analyses such as that carried out for the third and final papers in this thesis, there is an increasing concern for the reliability of the results. Ferson and Harvey (1992) recognize this concern and comment that for analyses with as few as 50 observations the results are valid. Unfortunately, 50 observations constitute a series that is smaller but very close to the same size as that used for the fourth paper. State level data will result in shorter series than 50 observations.

In summary, further research should be carried out on the question of data quality. The models and tests used in papers three and four are quite sophisticated. Unfortunately, the degree of sophistication might be being off-set (entirely or to a degree) by the lack of sophistication in the data employed for the analyses.

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APPENDIX TABLE FOR CHAPTER 1

Table 1-A-1: Input Data.

Crops:*		WHEAT	BARLEY	CANOLA
(acres)	1988	713	230	207
	1989	736	253	161
	1990	759	253	138
	1991	748	253	149
	1992	753	250	147
	1993	748	251	151
	1994	754	248	148
Yields:*		WHEAT 32 bu/acre	BARLEY 56 bu/acre	CANOLA 23 bu/acre
Soil Zone:		Black Soil Zone		
Costs of Production:* (1988)		Wheat $59.88/acre (no rent)		$83.62/acre ($23.74 rent)
		Barley $63.48/acre (no rent)		$87.22/acre ($23.74 rent)
		Canola $68.66/acre (no rent)		$92.40/acre ($23.74 rent)
Prices:** (1988)		Wheat $4.70/bu		
		Barley $2.36/bu		
		Canola $6.08/bu		
Price Growth Rates:***		Wheat 1989 -12.30%		1992 -4.60%
		1990 -7.80%		1993 +5.10%
		1991 -4.60%		1994 +14.70%
		Barley 1989 -8.40%		1992 -3.90%
		1990 0.00		1993 +2.60%
		1991 -3.90%		1994 +9.20%
		Canola 1989 -8.30%		1992 -7.30%
		1990 0.00		1993 +5.80%
		1991 -7.30%		1994 +7.20%
Cost Growth Rates:***		Production Expenses	1989 +4.70%	1992 +2.60%
			1990 -2.50%	1993 +4.10%
			1991 +0.80%	1994 +5.60%
		Overhead Expenses	1989 +2.90%	1992 +5.00%
			1990 +4.70%	1993 +5.00%
			1991 +7.80%	1994 +4.90%
		Machinery	1989 +2.50%	1992 +2.80%
			1990 +3.60%	1993 +3.30%
			1991 +1.40%	1994 +3.70%
		Buildings:	1989 +3.60%	1992 +3.90%
			1990 +3.90%	1993 +4.00%
			1991 +3.60%	1994 +4.60%

	Land:		1989 +18.70%	1992 -4.90%	
			1990 +2.50%	1993 -4.90%	
			1991 -7.70%	1994 -4.50%	
Machinery Market Value:****	$114,918				
Buildings Market Value:****	$43,857				
Land Market Value:****	$287,247				
Present Value of Lease Rents:	1988	$179,602		1992	$158,505
(Start of year)	1989	$174,634		1993	$152,693
	1990	$169,467		1994	$146,649
	1991	$164,094		1995	$140,362
Interest Rates:***	Current	1988	12.00%	1992	12.10%
		1989	13.00%	1993	11.90%
		1990	12.25%	1994	11.80%
		1991	12.25%		
	Intermediate	1988	12.50%	1992	12.75%
		1989	12.75%	1993	12.00%
		1990	12.00%	1994	12.00%
		1991	12.00%		
	Long-Term:	1988	11.38%	1992	11.38%
		1989	11.38%	1993	11.38%
		1990	11.38%	1994	11.38%
		1991	11.38%		

SOURCES:

* Acreages: The percentage allocation to wheat, barley, and canola for the Saskatchewan case farm was based on the percentage allocated to these crops in the prairie provinces for each year (Medium Term Outlook, Agriculture Canada 1990).

Yields and Costs of Production: With the exception of the lease rental cost, Schoney, et al. 1988. Rental cost calculated using the methodology explained in the paper.

** Canadian Wheat Board 1989, Halm 1989 (Averaged:1981/2-1985/6).

*** Agriculture Canada 1990.

**** Statistics Canada 1986.

APPENDIX TABLES FOR CHAPTER 3

Table 3-A-1: Box-Pierce (Q^*) Test Results Based on Dickey-Fuller Test.

Test statistic is as follows: $Q^* = N\Sigma^m_{k=1} \hat{\varrho}^2_k \sim \chi^2_{m-p}$

SERIES	$Q^* = N\Sigma^m_{k=1} \hat{\varrho}^2_k$	χ^2_{m-p}
ASSETS (Long)	3.232	19.6751
INCOME (Long)	0.9153	19.6751
ASSETS (Short)	4.848	19.6751
INCOME (Short)	5.968	19.6751
LAND PRICE (Tran)	7.9918	19.6751
RENT (Tran)	5.5986	19.6751
LAND PRICE (UnTran)	7.9391	19.6751
RENT (UnTran)	5.1646	19.6751

N.B. This test employs 12 lags (k = 1 ... 12) and a 5% significance level.

Table 3-A-2: Results of Schwarz Criterion (SC) Tests for Data Series.

SERIES	AR(p) -- SCHWARZ	MINIMUM
ASSETS (USA Long)	AR(0) = -5.8417 AR(1) = -6.1915 AR(2) = -6.1255 AR(3) = -6.0631 AR(4) = -5.9926 AR(5) = -5.9243	<------ AR(1)
INCOME (USA Long)	AR(0) = 0.20722 AR(1) = 0.20490 AR(2) = 0.26829 AR(3) = 0.33314 AR(4) = 0.40325 AR(5) = 0.47335	<------ AR(1)
ASSETS (USA Short)	AR(0) = -5.5488 AR(1) = -5.9407 AR(2) = -5.8877 AR(3) = -5.7901 AR(4) = -5.6724 AR(5) = -5.5506	<------ AR(1)
INCOME (USA Short)	AR(0) = -1.7558 AR(1) = -1.9548 AR(2) = -1.9280 AR(3) = -1.8195 AR(4) = -1.7791 AR(5) = -1.7058	<------ AR(1)
LAND PRICE (Illinois Tr.)	AR(0) = -4.3567 AR(1) = -5.0437 AR(2) = -4.9084 AR(3) = -4.8343 AR(4) = -4.7723 AR(5) = -4.5973	<------ AR(1)
RENT (Illinois Tr.)	AR(0) = -3.0480 AR(1) = -3.0716 AR(2) = -2.9384 AR(3) = -2.7892 AR(4) = -2.6513 AR(5) = -2.6027	<------ AR(1)
LAND PRICE (Illinois Unt)	AR(0) = -4.2196 AR(1) = -4.9685 AR(2) = -4.8366 AR(3) = -4.7693 AR(4) = -4.7373 AR(5) = -4.5708	<------ AR(1)
RENT (Illinois Unt)	AR(0) = -3.0222 AR(1) = -3.0432 AR(2) = -2.9063 AR(3) = -2.7575 AR(4) = -2.6148 AR(5) = -2.5468	<------ AR(1)

Where SC is calculated as: $SC(k) = \ln(\hat{\sigma}^2_k) + [\ln(N)k]/N$

Table 3-A-3: Results of the χ^2 Test for AR(p) Over-fitting Based on Dickey-Fuller Test.

Test statistic is as follows: $\Lambda = N\ln(\hat{\sigma}^2_R/\hat{\sigma}^2_U) \sim \chi^2_r$

SERIES	$\Lambda = N\ln(\hat{\sigma}^2_R/\hat{\sigma}^2_U)$	χ^2_r
ASSETS (Long)	0.905664	5.99146
INCOME (Long)	-482.9424	5.99146
ASSETS (Short)	4.126173	5.99146
INCOME (Short)	4.547425	5.99146
LAND PRICE (Tran)	3.300478	5.99146
RENT (Tran)	0.965495	5.99146
LAND PRICE (UnTran)	3.634655	5.99146
RENT (UnTran)	0.863072	5.99146

Table 3-A-4: Results of the χ^2 Test for AR(p) Under-fitting Based on Dickey-Fuller Test.

Test statistic is as follows: $Q^* = N\Sigma^m_{k=1}\ \hat{\varrho}^2_k \sim \chi^2_{m-p}$

SERIES	$Q^* = N\Sigma^m_{k=1}\ \hat{\varrho}^2_k$	χ^2_{m-p}
ASSETS (Short)	30.552	19.6751
INCOME (Short)	14.1942	19.6751

Table 3-A-5: ASSETS USA -- LONG SERIES ($ MILLION)

YEAR	$	YEAR	$	YEAR	$	YEAR	$
1910	207367	1931	139877	1952	218546	1973	390291
1911	210033	1932	126521	1953	210354	1974	373754
1912	211503	1933	129423	1954	215537	1975	406932
1913	215137	1934	129136	1955	217766	1976	447472
1914	214859	1935	135431	1956	223726	1977	470236
1915	219286	1936	137603	1957	229230	1978	518465
1916	214311	1937	136201	1958	249441	1979	551169
1917	206920	1938	134950	1959	247777	1980	546820
1918	195106	1939	137980	1960	246236	1981	511208
1919	195629	1940	137534	1961	255517	1982	476985
1920	173688	1941	145389	1962	261745	1983	450645
1921	164046	1942	157970	1963	268322	1984	393007
1922	165932	1943	168811	1964	275396	1985	339901
1923	158544	1944	177908	1965	290021	1986	310840
1924	154273	1945	183346	1966	297887	1987	316595
1925	150620	1946	187522	1967	304087	1988	317846
1926	148075	1947	189136	1968	307572	1989	307826
1927	152014	1948	194785	1969	306142	1990	300123
1928	155955	1949	194946	1970	303488		
1929	157529	1950	212367	1971	316012		
1930	149925	1951	226850	1972	343422		

SOURCES:

Featherstone and Baker (1987) for 1910-1984.
J. Stephen Clark for updated information.

Table 3-A-6: INCOME USA -- LONG SERIES ($ MILLION)

YEAR	$	YEAR	$	YEAR	$	YEAR	$
1910	9796	1931	1717	1952	7444	1973	25572
1911	5893	1932	-6420	1953	3967	1974	16832
1912	10453	1933	2026	1954	2634	1975	13206
1913	6856	1934	2403	1955	4107	1976	7509
1914	8915	1935	8623	1956	4107	1977	7028
1915	9531	1936	5176	1957	3827	1978	12614
1916	9459	1937	8782	1958	6899	1979	14101
1917	19695	1938	3537	1959	2953	1980	6823
1918	16228	1939	3754	1960	5634	1981	12577
1919	13285	1940	3851	1961	5985	1982	7529
1920	6255	1941	7955	1962	5408	1983	4454
1921	1000	1942	12420	1963	6068	1984	11835
1922	4376	1943	11633	1964	4115	1985	13040
1923	5017	1944	7493	1965	6715	1986	12057
1924	4559	1945	6748	1966	7062	1987	14655
1925	8847	1946	10213	1967	5957	1988	14079
1926	6609	1947	8172	1968	4518	1989	16777
1927	6511	1948	12077	1969	6164	1990	15396
1928	7242	1949	5220	1970	5424		
1929	7641	1950	7243	1971	6088		
1930	2637	1951	9868	1972	11549		

SOURCES:

Featherstone and Baker (1987) for 1910-1984.
J. Stephen Clark for updated information.

Table 3-A-7: ASSETS USA -- SHORT SERIES ($ MILLION)

YEAR	$	YEAR	$	YEAR	$	YEAR	$
1950	212367	1961	255517	1972	343422	1983	450645
1951	226850	1962	261745	1973	390291	1984	393007
1952	218546	1963	268322	1974	373754	1985	339901
1953	210354	1964	275396	1975	406932	1986	310840
1954	215537	1965	290021	1976	447472	1987	316595
1955	217766	1966	297887	1977	470236	1988	317846
1956	223726	1967	304087	1978	518465	1989	307826
1957	229230	1968	307572	1979	551169	1990	300123
1958	249441	1969	306142	1980	546820		
1959	247777	1970	303488	1981	511208		
1960	246236	1971	316012	1982	476985		

SOURCES:

Featherstone and Baker (1987) for 1950-1984.
J. Stephen Clark for updated information.

Table 3-A-8: INCOME USA -- SHORT SERIES ($ MILLION)

YEAR	$	YEAR	$	YEAR	$	YEAR	$
1950	7243	1961	5985	1972	11549	1983	4454
1951	9868	1962	5408	1973	25572	1984	11835
1952	7444	1963	6068	1974	16832	1985	13040
1953	3967	1964	4115	1975	13206	1986	12057
1954	2634	1965	6715	1976	7509	1987	14655
1955	4107	1966	7062	1977	7028	1988	14079
1956	4107	1967	5957	1978	12614	1989	16777
1957	3827	1968	4518	1979	14101	1990	15396
1958	6899	1969	6164	1980	6823		
1959	2953	1970	5424	1981	12577		
1960	5634	1971	6088	1982	7529		

SOURCES:

Featherstone and Baker (1987) for 1950-1984.
J. Stephen Clark for updated information.

Table 3-A-9: LAND PRICE ILLINOIS -- UNTRANSFORMED SERIES ($/ACRE)

YEAR	$	YEAR	$	YEAR	$	YEAR	$
1959	551	1967	775	1975	1610	1983	3215
1960	550	1968	805	1976	2005	1984	2630
1961	535	1969	830	1977	2720	1985	2200
1962	550	1970	820	1978	3010	1986	1885
1963	580	1971	825	1979	3400	1987	1731
1964	605	1972	895	1980	3500	1988	1860
1965	650	1973	995	1981	3605	1989	2040
1966	730	1974	1335	1982	3280	1990	2080

SOURCES:

Received from J. Stephen Clark.

Table 3-A-10: RENT ILLINOIS -- UNTRANSFORMED SERIES ($/ACRE)

YEAR	$	YEAR	$	YEAR	$	YEAR	$
1959	17	1967	29	1975	80	1983	102
1960	21	1968	24	1976	103	1984	91
1961	23	1969	.30	1977	89	1985	110
1962	26	1970	33	1978	95	1986	84
1963	29	1971	34	1979	110	1987	95
1964	27	1972	48	1980	108	1988	63
1965	30	1973	85	1981	93	1989	97
1966	33	1974	107	1982	90	1990	93

SOURCES:

Received from J. Stephen Clark.

Table 3-A-11: LAND PRICE ILLINOIS -- TRANSFORMED SERIES ($/ACRE)

YEAR	$	YEAR	$	YEAR	$	YEAR	$
1959	780.4533	1967	952.0885	1975	1284.916	1983	1505.150
1960	764.9513	1968	951.5366	1976	1522.399	1984	1193.285
1961	736.9146	1969	938.9140	1977	1952.620	1985	966.6081
1962	746.2687	1970	886.4865	1978	2018.779	1986	808.6658
1963	775.4011	1971	854.9223	1979	2092.308	1987	709.4262
1964	797.1014	1972	895.0000	1980	1955.307	1988	734.3071
1965	841.9689	1973	941.3434	1981	1853.470	1989	769.8113
1966	919.3955	1974	1146.907	1982	1592.233	1990	747.9324

SOURCES:

Received from J. Stephen Clark.

Table 3-A-12: RENT ILLINOIS -- TRANSFORMED SERIES ($/ACRE)

YEAR	$	YEAR	$	YEAR	$	YEAR	$
1959	23.60255	1967	34.75082	1975	59.30958	1983	46.05344
1960	28.67953	1968	27.29606	1976	74.40591	1984	40.01606
1961	31.37609	1969	32.47837	1977	60.40549	1985	46.80004
1962	34.74996	1970	34.09373	1978	59.52506	1986	35.18457
1963	38.20086	1971	33.77412	1979	62.10873	1987	37.19376
1964	35.05777	1972	46.31863	1980	54.77548	1988	23.95886
1965	38.20677	1973	76.07973	1981	44.00415	1989	34.98736
1966	40.41003	1974	83.47657	1982	41.25136	1990	31.86698

SOURCES:

Received from J. Stephen Clark.

APPENDIX TABLES FOR CHAPTER 4

Table 4-A-1: REAL TOTAL ASSET VALUES (USA) (MILLIONS OF 1972 $)

YEAR	$	YEAR	$	YEAR	$
1929	157,529	1950	212,367	1971	316,012
1930	149,925	1951	226,850	1972	343,422
1931	139,877	1952	218,546	1973	390,291
1932	126,521	1953	210,354	1974	373,754
1933	129,423	1954	215,537	1975	406,932
1934	129,136	1955	217,766	1976	447,472
1935	135,431	1956	223,726	1977	470,236
1936	137,603	1957	229,230	1978	518,465
1937	136,201	1958	249,441	1979	551,169
1938	134,950	1959	247,777	1980	546,820
1939	137,980	1960	246,236	1981	511,208
1940	137,534	1961	255,517	1982	476,985
1941	145,389	1962	261,745	1983	450,645
1942	157,970	1963	268,322	1984	393,007
1943	168,811	1964	275,396	1985	339,901
1944	177,908	1965	290,021	1986	310,840
1945	183,346	1966	297,887	1987	316,595
1946	187,522	1967	304,087	1988	317,846
1947	189,136	1968	307,572	1989	307,826
1948	194,785	1969	306,142	1990	300,123
1949	194,946	1970	303,488		

SOURCES:
Featherstone and Baker (1987) for 1929-1984.
J. Stephen Clark for updated information.

Table 4-A-2: REAL INCOME FROM ASSETS (USA) (MILLIONS OF 1972 $)

YEAR	$	YEAR	$	YEAR	$
1929	7,641	1950	7,243	1971	6,088
1930	2,637	1951	9,868	1972	11,549
1931	1,717	1952	7,444	1973	25,572
1932	-6,420	1953	3,967	1974	16,832
1933	2,026	1954	2,634	1975	13,206
1934	2,403	1955	4,107	1976	7,509
1935	8,623	1956	4,107	1977	7,028
1936	5,176	1957	3,827	1978	12,614
1937	8,782	1958	6,899	1979	14,101
1938	3,537	1959	2,953	1980	6,823
1939	3,754	1960	5,634	1981	12,577
1940	3,851	1961	5,985	1982	7,529
1941	7,955	1962	5,408	1983	4,454
1942	12,420	1963	6,068	1984	11,835
1943	11,633	1964	4,115	1985	13,040
1944	7,493	1965	6,715	1986	12,057
1945	6,748	1966	7,062	1987	14,655
1946	10,213	1967	5,957	1988	14,079
1947	8,172	1968	4,518	1989	16,777
1948	12,077	1969	6,164	1990	15,396
1949	5,220	1970	5,424		

SOURCES:
Featherstone and Baker (1987) for 1929-1984.
J. Stephen Clark for updated information.

Table 4-A-3: PCE DEFLATOR (USA) (%) 1972=100

YEAR	%	YEAR	%	YEAR	%
1929	0.359	1950	0.569	1971	0.965
1930	0.350	1951	0.606	1972	1.000
1931	0.315	1952	0.620	1973	1.057
1932	0.279	1953	0.632	1974	1.164
1933	0.269	1954	0.637	1975	1.253
1934	0.290	1955	0.644	1976	1.317
1935	0.297	1956	0.656	1977	1.393
1936	0.301	1957	0.678	1978	1.491
1937	0.312	1958	0.692	1979	1.625
1938	0.307	1959	0.706	1980	1.790
1939	0.305	1960	0.719	1981	1.945
1940	0.309	1961	0.726	1982	2.061
1941	0.332	1962	0.737	1983	2.136
1942	0.367	1963	0.748	1984	2.205
1943	0.401	1964	0.759	1985	2.276
1944	0.424	1965	0.772	1986	2.331
1945	0.441	1966	0.794	1987	2.440
1946	0.478	1967	0.814	1988	2.533
1947	0.529	1968	0.846	1989	2.650
1948	0.560	1969	0.884	1990	2.781
1949	0.558	1970	0.925		

SOURCES:
Featherstone and Baker (1987) for 1929-1984.
J. Stephen Clark for updated information.

Table 4-A-4: TOTAL POPULATION (USA)

YEAR	(' 000)	YEAR	(' 000)	YEAR	('000)
1929	121,770	1950	152,271	1971	207,661
1930	123,188	1951	154,878	1972	209,896
1931	124,149	1952	157,553	1973	211,909
1932	124,949	1953	160,184	1974	213,854
1933	125,690	1954	163,026	1975	215,973
1934	126,485	1955	165,931	1976	218,035
1935	127,362	1956	168,903	1977	220,239
1936	128,181	1957	171,984	1978	222,585
1937	128,961	1958	174,882	1979	225,055
1938	129,969	1959	177,830	1980	227,722
1939	131,028	1960	180,671	1981	229,958
1940	132,594	1961	183,691	1982	232,192
1941	133,894	1962	186,538	1983	234,321
1942	135,361	1963	189,242	1984	236,370
1943	137,250	1964	191,889	1985	238,492
1944	138,916	1965	194,303	1986	240,680
1945	140,468	1966	196,560	1987	242,836
1946	141,936	1967	198,712	1988	245,057
1947	144,698	1968	200,706	1989	247,343
1948	147,208	1969	202,677	1990	249,924
1949	149,767	1970	205,052		

SOURCES:

U.S. Department of Commerce. (1975). Historical Statistics of the United States: Colonial Times to 1970. House Document No. 93-78, Part 1. Bureau of the Census. Washington, D.C.

U.S. Department of Commerce. (Various Issues). Statistical Abstracts of the United States. Bureau of the Census. Washington, D.C.

Table 4-A-5: MONEY SUPPLY -- M2 (BILLIONS OF CURRENT $)

YEAR	$	YEAR	$	YEAR	$
1929	46.60	1950	150.81	1971	472.00
1930	45.73	1951	156.45	1972	525.00
1931	42.69	1952	164.92	1973	858.00
1932	36.05	1953	171.19	1974	906.00
1933	32.22	1954	177.16	1975	1,023.00
1934	34.36	1955	183.69	1976	1,164.00
1935	39.07	1956	186.87	1977	1,287.00
1936	43.48	1957	191.82	1978	1,389.00
1937	45.68	1958	201.12	1979	1,631.00
1938	45.51	1959	210.09	1980	1,629.00
1939	49.27	1960	210.67	1981	1,794.00
1940	55.20	1961	221.24	1982	1,952.00
1941	62.51	1962	233.92	1983	2,186.00
1942	71.16	1963	249.15	1984	2,374.00
1943	89.91	1964	264.73	1985	2,569.00
1944	106.82	1965	285.89	1986	2,811.00
1945	126.63	1966	308.02	1987	2,911.00
1946	138.73	1967	331.78	1988	3,071.00
1947	146.00	1968	361.60	1989	3,227.00
1948	148.11	1969	385.17	1990	3,339.00
1949	147.46	1970	401.29		

SOURCES:

U.S. Department of Commerce. (1975). Historical Statistics of the United States: Colonial Times to 1970. House Document No. 93-78, Part 2. Bureau of the Census. Washington, D.C.

U.S. Department of Commerce. (Various Issues). Statistical Abstracts of the United States. Bureau of the Census. Washington, D.C.

Table 4-A-6: REAL COMMERCIAL PAPER RATES (%)

YEAR	%	YEAR	%	YEAR	%
1929	7.345	1950	-4.377	1971	1.150
1930	10.454	1951	-1.661	1972	0.828
1931	14.736	1952	0.212	1973	-0.790
1932	11.353	1953	1.230	1974	-0.277
1933	-0.093	1954	1.262	1975	0.377
1934	-3.807	1955	0.759	1976	0.205
1935	-1.262	1956	0.212	1977	-0.212
1936	-1.555	1957	0.788	1978	-0.290
1937	-0.040	1958	1.135	1979	1.017
1938	1.798	1959	1.634	1980	2.158
1939	0.590	1960	2.129	1981	6.832
1940	-3.538	1961	2.124	1982	7.150
1941	-8.112	1962	1.453	1983	5.428
1942	-8.276	1963	2.039	1984	6.480
1943	-6.170	1964	2.744	1985	4.350
1944	-3.944	1965	1.974	1986	4.590
1945	-5.189	1966	2.531	1987	3.220
1946	-8.026	1967	2.054	1988	3.560
1947	-7.451	1968	1.605	1989	4.190
1948	-0.911	1969	2.826	1990	2.660
1949	2.036	1970	3.151		

SOURCES:
Featherstone and Baker (1987) for 1929-1984.
U.S. Department of Commerce. (Various Issues). Statistical Abstracts of the United States. Bureau of the Census. Washington, D.C.

Table 4-A-7: PCE -- NONDURABLES (BILLIONS OF CURRENT $)

YEAR	$	YEAR	$	YEAR	$
1929	37.7	1950	98.1	1971	277.7
1930	34.0	1951	108.8	1972	299.0
1931	29.0	1952	114.0	1973	334.0
1932	22.7	1953	116.8	1974	376.0
1933	22.3	1954	118.3	1975	407.3
1934	26.7	1955	123.3	1976	444.0
1935	29.3	1956	129.3	1977	478.8
1936	32.9	1957	135.6	1978	528.2
1937	35.2	1958	140.2	1979	613.3
1938	34.0	1959	146.6	1980	682.9
1939	35.1	1960	151.3	1981	744.2
1940	37.0	1961	155.9	1982	772.3
1941	42.9	1962	162.6	1983	817.8
1942	50.8	1963	168.6	1984	873.0
1943	58.6	1964	178.7	1985	919.4
1944	64.3	1965	191.1	1986	952.2
1945	71.9	1966	206.9	1987	1,011.1
1946	82.4	1967	215.0	1988	1,073.8
1947	90.5	1968	230.8	1989	1,146.9
1948	96.2	1969	245.9	1990	1,217.7
1949	94.5	1970	263.8		

SOURCES:

U.S. Department of Commerce. (1975). Historical Statistics of the United States: Colonial Times to 1970. House Document No. 93-78, Part 2. Bureau of the Census. Washington, D.C.

U.S. Department of Commerce. (Various Issues). Statistical Abstracts of the United States. Bureau of the Census. Washington, D.C.

Table 4-A-8: PCE -- SERVICES (BILLIONS OF CURRENT $)

YEAR	$	YEAR	$	YEAR	$
1929	30.3	1950	62.4	1971	293.4
1930	28.7	1951	67.9	1972	322.4
1931	26.0	1952	73.4	1973	352.3
1932	22.2	1953	79.9	1974	393.0
1933	20.1	1954	85.4	1975	437.0
1934	20.4	1955	91.4	1976	489.0
1935	21.3	1956	98.5	1977	547.4
1936	22.8	1957	105.0	1978	618.0
1937	24.4	1958	112.0	1979	756.2
1938	24.3	1959	120.3	1980	852.7
1939	25.0	1960	128.7	1981	953.5
1940	26.0	1961	135.1	1982	1,050.4
1941	28.1	1962	143.0	1983	1,164.7
1942	30.8	1963	152.4	1984	1,269.4
1943	34.2	1964	163.3	1985	1,395.1
1944	37.2	1965	175.5	1986	1,508.8
1945	39.8	1966	188.6	1987	1,637.4
1946	45.3	1967	204.0	1988	1,785.2
1947	49.8	1968	221.3	1989	1,911.2
1948	54.7	1969	242.7	1990	2,059.0
1949	57.6	1970	262.6		

SOURCES:

U.S. Department of Commerce. (1975). Historical Statistics of the United States: Colonial Times to 1970. House Document No. 93-78, Part 2. Bureau of the Census. Washington, D.C.

U.S. Department of Commerce. (Various Issues). Statistical Abstracts of the United States. Bureau of the Census. Washington, D.C.

Table 4-A-9: 3 MONTH T-BILL RATE (MARKET RATE %)

YEAR	%	YEAR	%	YEAR	%
1929	N.A.	1950	1.20	1971	4.33
1930	N.A.	1951	1.52	1972	4.07
1931	1.40	1952	1.72	1973	7.03
1932	0.88	1953	1.90	1974	7.84
1933	0.52	1954	0.94	1975	5.78
1934	0.26	1955	1.73	1976	4.97
1935	0.14	1956	2.62	1977	5.27
1936	0.14	1957	3.23	1978	7.19
1937	0.45	1958	1.78	1979	10.07
1938	0.05	1959	3.37	1980	11.43
1939	0.02	1960	2.87	1981	14.03
1940	0.01	1961	2.36	1982	10.61
1941	0.13	1962	2.77	1983	8.61
1942	0.34	1963	3.16	1984	9.52
1943	0.38	1964	3.54	1985	7.47
1944	0.38	1965	3.95	1986	5.97
1945	0.38	1966	4.86	1987	5.78
1946	0.38	1967	4.29	1988	6.67
1947	0.61	1968	5.34	1989	8.11
1948	1.05	1969	6.67	1990	7.50
1949	1.11	1970	6.39		

SOURCES:

U.S. Department of Commerce. (1975). Historical Statistics of the United States: Colonial Times to 1970. House Document No. 93-78, Part 2. Bureau of the Census. Washington, D.C.

U.S. Department of Commerce. (Various Issues). Statistical Abstracts of the United States. Bureau of the Census. Washington, D.C.

N.A. Not Available.

Table 4-A-10: GOVERNMENT LONG-TERM BOND (%)

YEAR	%	YEAR	%	YEAR	%
1929	3.60	1950	2.32	1971	5.74
1930	3.29	1951	2.57	1972	5.63
1931	3.34	1952	2.68	1973	6.30
1932	3.68	1953	2.94	1974	6.99
1933	3.31	1954	2.55	1975	6.98
1934	3.12	1955	2.84	1976	6.78
1935	2.79	1956	3.08	1977	7.06
1936	2.69	1957	3.47	1978	7.89
1937	2.74	1958	3.43	1979	8.74
1938	2.61	1959	4.07	1980	10.81
1939	2.41	1960	4.01	1981	12.87
1940	2.26	1961	3.90	1982	12.23
1941	2.05	1962	3.95	1983	10.84
1942	2.46	1963	4.00	1984	11.99
1943	2.47	1964	4.15	1985	10.75
1944	2.48	1965	4.21	1986	8.14
1945	2.37	1966	4.66	1987	8.64
1946	2.19	1967	4.85	1988	8.98
1947	2.25	1968	5.25	1989	8.58
1948	2.44	1969	6.10	1990	8.74
1949	2.31	1970	6.59		

SOURCES:

U.S. Department of Commerce. (1975). Historical Statistics of the United States: Colonial Times to 1970. House Document No. 93-78, Part 2. Bureau of the Census. Washington, D.C.

U.S. Department of Commerce. (Various Issues). Statistical Abstracts of the United States. Bureau of the Census. Washington, D.C.

Table 4-A-11: CORPORATE (Aaa) BOND (%)

YEAR	%	YEAR	%	YEAR	%
1929	4.73	1950	2.62	1971	7.39
1930	4.55	1951	2.86	1972	7.21
1931	4.58	1952	2.96	1973	7.44
1932	5.01	1953	3.20	1974	8.57
1933	4.49	1954	2.90	1975	8.83
1934	4.00	1955	3.06	1976	8.43
1935	3.60	1956	3.36	1977	8.02
1936	3.24	1957	3.89	1978	8.73
1937	3.26	1958	3.79	1979	9.63
1938	3.19	1959	4.38	1980	11.94
1939	3.01	1960	4.41	1981	14.17
1940	2.84	1961	4.35	1982	13.79
1941	2.77	1962	4.33	1983	12.04
1942	2.83	1963	4.26	1984	12.71
1943	2.73	1964	4.40	1985	11.37
1944	2.72	1965	4.49	1986	9.02
1945	2.62	1966	5.13	1987	9.38
1946	2.53	1967	5.51	1988	9.71
1947	2.61	1968	6.18	1989	9.26
1948	2.82	1969	7.03	1990	9.32
1949	2.66	1970	8.04		

SOURCES:

U.S. Department of Commerce. (1975). Historical Statistics of the United States: Colonial Times to 1970. House Document No. 93-78, Part 2. Bureau of the Census. Washington, D.C.

U.S. Department of Commerce. (Various Issues). Statistical Abstracts of the United States. Bureau of the Census. Washington, D.C.