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CAPITAL MARKET SEGMENTATION AND US FARM REAL ESTATE PRICING: A STUDY OF THE EFFECTS OF BARRIERS TO NONFARM EQUITY CAPITAL IN AGRICULTURE

by

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1. Introduction

Policy concerns over the role of external equity capital in agriculture, in general, and in farm real estate, in particular, are well-documented in the literature, [Scofield (1972), Carter and Johnston (1978), Moore (1979), Brake and Boehlje (1985), Matthews and Harrington (1986), and Fiske Batte and Lee (1986)]. These concerns have motivated research attempting to analyze the supply conditions of external equity capital in agriculture, [Barry (1980), Irwin, Forster and Sherrick (1988), Arthur, Carter and Abizadeh (1988), and Bjorson and Innes (1992)]. The main feature shared by work in this area is to investigate the market equilibrium trade-off between risk and return across assets. Much attention has focused on estimating the equilibrium rate of return in farm real estate markets using models that assume perfect arbitrage conditions and costless inter-market spanning activities. In particular, the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT) have been utilized extensively in modelling farmland returns. Under costless arbitrage, these models allow comparing investment performance across the financial and farm real estate markets. The empirical evidence from the CAPM shows that farm real estate contributes little or no market risk to a well-diversified portfolio of assets and offers super risk-adjusted returns. This suggests that farm real estate markets would outperform the financial market on a risk-adjusted basis.

The evidence of super risk-adjusted returns obtained in the literature indicates that there have been unexploited profit opportunities in agriculture. If so, why has the arbitrage process between farm and nonfarm equity markets failed to eliminate these profit opportunities? In other words, the question is why farmland markets have not been spanned by a group of nonfarm investors seeking to arbitrage such unexploited profit opportunities until an equilibrium relationship between farm and nonfarm asset markets is restored. A possible answer to this question is that farmland may have been priced in a segmented capital market where costly arbitrage has created barriers to the flow of nonfarm capital into agriculture. These barriers, if they exist, would invalidate the ability of both the CAPM and the APT to represent asset pricing in agriculture and would have implications for the functioning of equity markets in agriculture.

This paper presents and tests a model of segmented capital market equilibrium. The model extends the traditional CAPM by taking explicitly into consideration the existence of barriers to the flow of external equity capital into farm real estate markets. These barriers are modelled in a way that accommodates some fundamental differences between the financial and farm real estate markets. In particular, the segmented market model explicitly acknowledges the costs of arbitrage across the two markets. Testing capital market segmentation involves testing whether assets are priced in an integrated capital market versus an alternative that takes an explicit account of the existence of impediments to the flow of capital into agriculture. The integrated market model is the standard CAPM. The alternative model is the variant of the CAPM which incorporates the specific imperfection leading to market segmentation.

Testing whether farmland is priced in a segmented or in an integrated economy has important implications for understanding the functioning of the capital market as well as for the analytical approach to asset pricing in agriculture. The debate over the role of nonfarm equity capital in agriculture takes a different form depending upon whether the capital market is segmented or integrated. When segmentation exists, policies designed to promote more reliance on nonfarm investment may be ineffective. Moreover, restricted flow of capital into farmland markets can invalidate a class of pricing models (e.g. the CAPM and the APT) that assume costless inter-market spanning in modeling the trade-off between risk and return across assets in a market equilibrium framework. The relevance of these models hinges squarely on an implicit assumption of fully integrated and highly efficient capital markets, an assumption that would no longer hold under costly arbitrage.

Although description of various barriers to nonfarm investment has been the subject of some recent studies, [e.g. Fiske, Batte, and Lee (1986) and Matthews and Harington (1986)], no attempt has been made to provide a formal framework capable of testing for their existence, measuring their magnitudes, and analyzing their effects on the choice of asset pricing models in agriculture. The present paper adopts a methodology that allows for directly testing whether there exist barriers to nonfarm investment in agriculture and for measuring their magnitudes. The approach provides a possible explanation as to why the traditional arbitrage-based pricing models may fail to explain equity prices in farmland markets. It poses a more general model with friction that can help better represent the functioning of farm equity markets. This research also contributes to the policy debate concerning the development of an efficient equity market in agriculture. Deciding whether farmland is valued in an integrated or segmented capital market is crucial for understanding the fundamental factors that determines asset values in agriculture. This, in turn, is an essential prerequisite for a better evaluation of the effectiveness of alternative farm equity policies.

The paper is organized as follows. Section 2 reviews the literature. Section 3 provides a general description of the model and an outline of the tests. Section 4 presents the model. Section 5 provides the testing procedures, data description, and the empirical results. Finally, Section 6 summarizes and concludes.

2. Review of literature

2.1 Review of some segmentation models

Modeling asset prices in segmented capital markets has been discussed by Rubinstein (1973), Black (1974), Glenn (1976), Mayers (1976), Stulz (1981), Errunza and Losq (1985), and Amershi and Ramamurtie (1991). In this literature, the global economy is viewed as composed of a finite number of markets. This arises as a result of the existence of some restrictions on the ability of different groups of investors to trade in different classes of assets in the economy. These restrictions induce various types of barriers to the flow of arbitrage capital across different equity markets. As a result, investors do not diversify their holdings over a wide range of assets and an entire class of arbitrage-based pricing models breaks-down.

Legal barriers to capital flows across national boundaries are recognized as a prominent source of segmentation in the international economy, [e.g. Black (1974), Stulz (1981), and Errunza and Losq (1985)]. The usual setting in this context is a two-country world (Country 1 and Country 2). Residents of one country (e.g. Country 1) are assumed to have unequal access to the other country's market. In particular, while residents of country 2 can engage in unrestricted arbitrage activities in country 1's market, the opposite does not hold. There exist some barriers that make it costly for residents of Country 1 to invest in Country 2. These barriers are usually modeled as implicit taxes on holdings of Country 2's assets by residents of Country 1. A segmented international market structure occurs, the world market portfolio is not mean-variance efficient, and the CAPM cannot price assets internationally. However, a segmented capital market equilibrium model holds.

Barriers to inter-market flow of capital are also recognized as a source of segmentation in domestic economies, [e.g. Glenn (1976) and Amershi and Ramamurtie (1991)]. Amershi and Ramamurtie (1991) present a model in which information costs result in that the economy is naturally segmented into different conglomerations of assets termed as 'regional markets'. In this model, there are one central market and a finite number of regional markets. The central market consists of all publicly known assets. Trades in this market are common knowledge among all agents in the economy. Each regional market, on the other hand, specializes in trading a certain class of assets. Traders in each of these markets have complete knowledge of trades in their market but limited knowledge about those taking place in other regional markets. They only know of their existence. As a result, there exist costly arbitrage activities due to the information costs that traders in one market have to incur in the process of analyzing profitable opportunities in other markets. These costs are the prime reason for the observed lack of diversification over a broad class of assets and for the segmented market structure. However, possibilities of inter-market spanning activities exist. But since these activities are costly, agents get rent on whatever private information they have.

2.2 Review of empirical work

Empirical tests of equity markets integration have been developed in international finance literature. The tests are usually joint tests of a hypothesis that equity markets are integrated internationally and that the underlying pricing model holds against some alternative models.

Errunza and Losq (1985) test an international pricing model in which individuals choose portfolios that are mean-variance efficient. The authors use monthly return data from the US and other nine countries. Errunza and Losq reject the hypothesis that equity markets are integrated. They fail to reject an alternative model in which US investors are unable to hold equities traded in a group of developing countries.

Jorion and Schwartz (1986), on the other hand, provide a test of whether Canadian and US capital markets are integrated using monthly return data from both countries. The authors reject the international version of the CAPM and find that integration, or the mean-variance efficiency of the world index, is rejected by the data. They fail to reject segmentation as the alternative model and are able to trace its sources to some legal barriers based on the nationality of the issuing firms.

More recently, Wheatly (1988) tests the hypothesis that international capital markets are integrated using a simple version of the Consumption-Based Asset Pricing Model and monthly data from eighteen countries. Wheatly finds little evidence against the joint hypothesis that equity markets are integrated internationally and that the asset pricing model holds.

Although there are some empirical studies investigating the question of segmentation in domestic markets, they adopt different approaches than the one followed in the present study. Examples of work in this area include Rosenberg (1974), Lease, Lewellen, and Schlarbaum (1976), and Kidwell and Koch (1983). Our paper apparently is the first to apply the empirical procedures found here in a domestic setting. Moreover, it is the first study that formally investigates the question of barriers to non-farm investment in farm real estate markets.

3. Preliminaries

3.1 A general description of the model

The segmented market model employed in this paper has some of the same features found in the literature reviewed in Section 2.1. We consider a model that incorporates a specific imperfection to the CAPM. This imperfection relates to an assumed 'limited ability' of non-farm investors to hold equity in farm real estate markets due to some portfolio inflow restrictions. These restrictions are modeled as proportional information and search costs that a non-farm investor has to incur in order to invest in farm real estate markets. Thus, they have the same impact as if they were taxes on the value of a non-farm investor holdings of farm real estate. Although non-farm investors face barriers to farm real estate markets, the opposite does not hold. In particular, we assume that investors specializing in trading in farm real estate (labeled as farm investors) face no barriers to investment anywhere in the economy.

The above set-up can be accommodated in an economy that has two markets: Market 1 and Market 2. Market 1 is a non-farm equity market. It is a general market where all investors trade. We assume that this market trades only in standardized financial claims. The trades take place on a central exchange where information relevant to asset values and cash flows are available to all agents in the economy. Market 2 is a restricted market where only a subset of investors trade. It trades in specialized type of equities; namely farm real estate. These equities are real and heterogenous in nature. This heterogeneity causes Market 2 to be composed of a finite number of sub-markets. Each sub-market has unique characteristics in terms of its traded equity (i.e. soil, climate, etc.). Investors in Market 2, i.e. farm investors, have complete knowledge of trades in these sub-markets and in the general market. Thus, they face no barriers to investment anywhere in the economy. On contrast, those investors who only trade in Market 1 incur information and search costs proportional to the value of their equity holdings in any of the restricted sub-markets. These costs arise as a result of the attributes of equities traded in Market 2 and behave as if they were taxes on the value of a non-farm investor's holdings of farm real estate. Since it is costly for a group of investors to diversify their holdings over all equity markets in the economy, a segmented market structure occurs, each of the two groups of investors hold different portfolios, and the CAPM does not obtain. Instead, a segmented capital market equilibrium model holds. Moreover, equities traded in the restricted markets would command 'super' risk premiums to compensate restricted investors for any information costs they have to incur in the process of spanning these markets.

One assumption made in the model is asymmetric information. This assumption is intended to accommodate observed characteristic differences between the two markets. Financial assets are generally traded on central exchanges where information relevant to asset values and cash flows are readily available on an intra-daily basis. One can argue that, except for small transactions fees, a farmer may not find it difficult to access these markets. This does not generally hold for a non-farm investor trying to hold equity in farm real estate markets. These markets are heterogenous and local in nature. They trade in real and specialized types of equity. There is no central market capable of mapping different attributes of equity into a common risk-return space. Moreover, data available on real estate values and cash flows are not market-based. Rather, they are based on opinion surveys and on appraisal valuations. These characteristics of farm real estate markets create serious complications regarding the quality and availability of information to non-specialized investors.

The model ignores sources of segmentation within each of the two markets. There are many reasons to believe that farm investors also face information barriers within farm real estate.[1] Such barriers may also exist within the financial market.[2] The model is intended to capture the effects of barriers to non-farm investment in farm real estate markets. This may justify ignoring all sources of segmentation that could exist within each

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[1]In general, real estate markets provide a classic example of segmentation; see, for example, Goodman (1981), Bajic (1985), and Amershi and Ramamurtie (1991).

[2]Amershi and Ramamurtie (1991) cite studies showing evidence that information barriers exist as to investment in small company stocks. Rosenberg (1974) reports evidence of different portfolio compositions of institutional versus individual investors. Lease, Lewellen, and Schlarbaum (1976) report results of a survey showing that financial portfolio compositions vary significantly across demographic groups in the population.

market. Moreover, there exist enough distinct characteristics between the two markets to justify treating each of them as a segment of its own.

The arbitrage costs incorporated in the model can be thought of as instruments representing various kinds of barriers facing non-farm investment in agriculture. For example, they may represent different types of transactions costs including information and search costs. They may also represent barriers created by legal restrictions imposed by some states on certain types of non-farm investors. It is possible that the general effect of all of these kinds of barriers will be the same as taxes on (or costs proportional to) the value of a non-farm investor's holdings in farm real estate markets.

3.2 An outline of the tests

The tests conducted in this paper are tests of a model that prices assets in an integrated market versus the alternative that takes an explicit account of some barriers to inter-market spanning activities. The integrated market model is the standard CAPM. Equity markets are defined to be integrated if assets of equal risk, not necessarily traded in the same market, are priced to yield the same risk-adjusted returns. Thus, a test of capital market integration is a joint test of the model that prices assets in an integrated economy and of capital market integration.

The CAPM provides a theoretical framework that prices all assets in an integrated market. Its main prediction is that the market portfolio is mean-variance efficient. The validity of this prediction hinges upon an implicit assumption of costless arbitrage activities. This would insure that the separation property holds.[3] All market participants in the simple economy outlined in Section 3.1, regardless of tastes and wealth distribution,

[3]The separation theorem is the corner stone of the CAPM's prediction that the market portfolio is mean-variance efficient. For an exposition of the theorem, see, for example, Stapleton and Subrahmanyam (1980).

would divide their wealth between two mutual funds. The first is the risk-free asset and the second is the market portfolio. Consequently, each asset in this economy, irrespective of the particular market it is traded in, would be priced in equilibrium to yield an expected return that is linear and positive function in its market risk. Thus, if markets are integrated, all assets will plot on a well-defined pricing line. The higher the risk of an asset, the higher is its expected rate of return.

The restrictions imposed by the CAPM are tested using time series of annual real return data from US financial and farm real estate markets. If the two markets are integrated, the test results should indicate that the market proxy is mean-variance efficient. This will give evidence that the hypothesized barriers to farm real estate markets are ineffective and that there are no significant costs associated with spanning farm real estate markets by non-farm investors.

A failure of the model's restrictions to hold, however, provides only a necessary, but not a sufficient, condition for segmentation to be the preferred model. While it is theoretically true that when equity markets are segmented the separation property of the CAPM breaks-down, it is possible that rejecting the mean-variance efficiency of the market proxy arises because of some deficiencies in the underlying model rather than because of equity markets segmentation. As such, it is important to test the restrictions imposed by the alternative model which incorporates the specific imperfection leading to segmentation.

As in the standard CAPM, the alternative segmentation model predicts that each index's expected return is a linear function of its market risk. However, the model places some restrictions on the asset pricing line. It predicts that there exists a pricing line representing the risk-return trade-off in the non-farm equity market. Each farm real estate sub-market, on the other hand, is characterized by a pricing line which lies above and parallel to that of the non-farm equity market.[4] Thus, with segmentation, each farm real estate return index would plot significantly above the asset pricing line predicted by the model for financial assets. The distance by which a farm real estate return index plots off this line represents the difference between the expected real return a non-farm investor would require to invest in the particular farm real estate sub-market and the expected real return he would require on a financial asset of equal risk. It would give a direct measure of the implicit tax rate he faces to invest in the restricted sub-market.

4. The model

4.1 Assumptions

Consider an economy which has two markets: A financial market (denoted by S) and a farm real estate market (denoted by E). The farm real estate market contains a total number of M heterogenous sub-markets. There is a fixed supply of N risky equities in this economy. Shares of the first n_1 equities are traded in the financial market. Each of the remaining $N-n_1$ equities corresponds to one of the M farm real estate sub-markets, (i.e. $M = N - n_1$). Equity i is defined to be financial if we write $i \in S$ while it belongs to the i-th farm real estate sub-market if we write $i \in E$.[5]

The n_1 financial assets and the M farm real estate markets pay random returns at the end of one period. The N dimensional vector $\underline{R}$ contains these returns and is given by

$$\underline{R} = (R_1, R_2, ..., R_{n1}, R_{n1+1}, ..., R_N)'. \quad (1)$$

This vector is assumed to be normally distributed with mean $E(\underline{R})$ and covariance matrix [V]. The first n_1 rows of [V] contain covariance and variance terms related to the financial

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[4]In general, the slope of the pricing lines in this case cannot be larger than that of the CAPM. The general effect of segmentation is to change the general level of equity prices.

[5]Henceforth, we will refer to the i-th farm real estate sub-market simply as the i-th farm real estate market.

assets while the remaining $N-n_1$ rows contain those terms related to farm real estate markets. In addition, there exists a risk-free asset with a rate of return denoted by R_f.

The set of traders in the economy contains a total number of K investors. We partition this set of K investors into two subsets which are not necessarily disjoint. An investor k is defined to be a non-farm investor if we write $k \in S$ while he is a farm investor if we write $k \in E$. We assume that while farm investors face no barriers to investment anywhere in the economy, the opposite does not hold. In particular, non-farm investors are assumed to face simple barriers to investment in each of the M farm real estate markets. If a non-farm investor k holds an interest in farm real estate market i then his end of period return is given by $R_i - \tau_i$. Here, R_i is the return in farm real estate market i for a farm investor and τ_i is a non-random proportional information and search costs that a non-farm investor has to incur in order to invest in this market. Notice that τ_i is expressed as a percent per year of the value of a non-farm investor's holdings of farm real estate. Since it has the same effect as if it was a tax on the value of k's holdings in the i-th farm real estate market, τ_i will be referred to as the 'implicit tax rate' in farm real estate market i. We assume that each τ_i is the same for all $k \in S$. Letting $\underline{\tau}$ be an N dimensional vector with zeros in the first n_1 rows and a typical element of τ_i in the remaining $N-n_1$ rows, the relevant end of period vector of returns to a non-farm investor becomes

$$\underline{R} - \underline{\tau} = (R_1, ..., R_{n1}, R_{n1+1} - \tau_{n1+1}, ..., R_N - \tau_N)'. \qquad (2)$$

We assume that markets are perfect in the usual sense of the CAPM except for the unequal access assumption. All investors can borrow and lend at the risk-free rate, R_f, and have homogeneous beliefs regarding the mean vector, $E(\underline{R})$, and the covariance matrix, [V]. Each maximizes a utility function which depends positively on the expected end of period wealth and negatively on the variance of this wealth. This implies that investor k acts so as to minimize the variance of the return of his portfolio under the constraint that its expected return must be equal to an exogenously given return, R^k.

Letting $\underline{\omega}^k$ be the N dimensional vector of fractions of investor k's wealth, W^k, invested in the n_1 financial assets and in the M farm real estate markets, respectively, the problem of investor k is to

$$\underset{\{\underline{\omega}^k\}}{\text{minimize}}\ (1/2)\ \underline{\omega}^{k\prime}\ [V]\ \underline{\omega}^k \tag{3}$$

subject to the following constraints

$$\underline{\omega}^{k\prime}\ (E(\underline{R}) - \underline{\tau}) + [1 - \underline{\omega}^{k\prime}.\underline{1}]\ R_f = R^k \qquad \text{if} \quad k \in S \tag{4a}$$

$$\underline{\omega}^{k\prime}\ E(\underline{R}) \qquad + [1 - \underline{\omega}^{k\prime}.\underline{1}]\ R_f = R^k \qquad \text{if} \quad k \in E \tag{4b}$$

where E(.) denotes the expectation operator and $\underline{1}$ is an N dimensional vector of ones. The left hand side of Expression (4a) corresponds to the expected return on a non-farm investor's portfolio which is defined as the sum of (a) the expected return on his holdings of risky equities net of all costs associated with his holdings in the restricted markets and (b) the return on the risk-free asset. Expression (4b) has the same meaning except that $\underline{\tau}$ is set to zero since k is a farm investor.

The above problem is a portfolio selection problem when there are barriers to a particular market facing a group of investors. Letting L^k be the Lagrangian function corresponding to the minimization problem and λ^k be the multiplier associated with the constraints given in (4), investor k's portfolio must satisfy the following first order conditions

$$dL^k/d\underline{\omega}^k = [V]\ \underline{\omega}^k - \lambda^k[E(\underline{R}) - R_f.\underline{1} - \underline{\tau}] = \underline{0} \qquad \text{if} \quad k \in S \tag{5a}$$

$$dL^k/d\underline{\omega}^k = [V]\ \underline{\omega}^k - \lambda^k\ [E(\underline{R}) - R_f.\underline{1}] \quad = \underline{0} \qquad \text{if} \quad k \in E \tag{5b}$$

Conditions (5) are the first order conditions for the two respective groups of investors.

4.2 The model with no barriers to non-farm investment

Assume that there are no barriers to non-farm investment in farm real estate markets. In this case $\underline{\tau}$ is identically zero in (2), (4a), and (5a). The investment opportunity set facing investors in both groups will be identical and λ^k will be equal across all investors in the economy. The separation property would hold: each non-farm investor will hold equities in farm real estate markets in the same proportions as those of farm investors and the market portfolio will be mean-variance efficient.[6] Thus, the solution to (3) subject to (4) yields the traditional CAPM and the familiar integrated market pricing equation will hold as

$$E(\underline{R}) = R_f.\underline{1} + \underline{\beta}\,[E(R_m) - R_f], \tag{7}$$

where $\underline{\beta} = \{\beta_i = \text{cov}\,(R_i,R_m)/\sigma_m^2\}$ is an N dimensional vector of market risks, R_m is the random end of period return on the market portfolio, and σ_m^2 is the variance of R_m.

4.3 The model with barriers to non-farm investments

In this case, $\underline{\tau} > \underline{0}$. Contrary to the above case where $\underline{\tau} = \underline{0}$, the investment opportunities facing each group of investors will not be the same. The first order conditions (5) can be written as

$$[V]\,\underline{\omega}^k = \lambda^k[E(\underline{R}) - R_f.\underline{1} - \underline{\tau}] \quad \text{if} \quad k\in S \tag{8a}$$

$$= \lambda^k[E(\underline{R}) - R_f.\underline{1}] \quad \text{if} \quad k\in E \tag{8b}$$

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[6]This can be seen by setting $\underline{\tau} = \underline{0}$ in (5) and considering the ratio between two different first order conditions corresponding to the i-th and the j-th assets. This ratio is given by

$$\underline{V}_i.\underline{\omega}^k/\underline{V}_j.\underline{\omega}^k = [E(R_i)-R_f] \,/\, [E(R_j)-R_f], \qquad k = 1, 2, ..., K,$$

where $\underline{V}_i$ is the i-th row of [V] and $\underline{V}_i.\underline{\omega}^k$ is the covariance of the return of the i-th equity with that of k's portfolio. The above expression gives a system of N-1 equations in N-1 unknowns, ω_i^k/ω_j^k. The solution to this system gives the ratio between the optimal demands of any two risky assets in an investor's portfolio. Since the right hand side of this expression does not contain any taste variables, the solution must be the same for all K investors in the economy. All will hold the same portfolio of risky assets, the market portfolio.

A number of implications for optimal portfolio demands in both groups follow from (8a) and (8b). Optimal portfolio composition will be the same for all traders within each group. However, the distortion caused by the implicit taxation will cause optimal portfolios of non-farmers to be heavy in financial assets and light in farm real estate as compared to the case where such taxation does not exist. The opposite holds for farm investors who will take heavy positions in farm real estate and light positions in financial assets. Since the optimal mix of risky assets will not be the same for both groups of traders, the separation property will not hold and the market portfolio will not be mean-variance efficient. The traditional CAPM does not hold.[7] Instead, a segmented capital market equilibrium obtains.

To derive the asset pricing equation in this segmented economy, multiply both sides of (8) by W^k and sum over all k to get

$$[V] \sum_{k} \underline{\omega}^k W^k = \sum_{k \in S} \lambda^k W^k [E(\underline{R}) - R_f.\underline{1} - \underline{\tau}] + \sum_{k \in E} \lambda^k W^k [E(\underline{R}) - R_f.\underline{1}]. \qquad (9)$$

With fixed aggregate supply of equities, the following market clearing condition must be satisfied

$$\sum_{k} \underline{\omega}^k W^k = \underline{\omega}^m W^m, \qquad (10)$$

where $\underline{\omega}^m = \{\omega_i^m\}$ is an N dimensional vector with ω_i^m being the fraction of the it-h equity in the aggregate market wealth, W^m, and, thus, the right hand side of (10) is the N dimensional vector of aggregate market values of the available equities in the economy. Imposing the above condition on (9), defining $\lambda = \sum_{k \in S} \lambda^k W^k$ and $\lambda^* = \sum_{k \in E} \lambda^k W^k$, and rearranging yields

$$[V] \underline{\omega}^m W^m = (\lambda + \lambda^*) [E(\underline{R}) - R_f.\underline{1}] - \lambda \underline{\tau}, \qquad (11)$$

where the left hand side of (11) is an N dimensional vector with a typical element of

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[7]Proofs are found in Shiha (1992).

$\{cov(R_i, R_m) W^m\}$.

Define $\overline{\tau_i} = \lambda\tau_i / (\lambda + \lambda^*)$ to be the fraction of the implicit tax paid by non-farm investors on their holdings in farm real estate market i and use this definition to rewrite Equation (11) as

$$[V]\, \underline{\omega}^m W^m = (\lambda + \lambda^*)\, [E(\underline{R}) - R_f.\underline{1} - \underline{\overline{\tau}}], \qquad (12)$$

where $\underline{\overline{\tau}}$ is an N dimensional vector whose first n_1 rows are zeros and each of the remaining $(N - n_1)$ has a typical element of $\overline{\tau_i}$. Pre-multiply both sides of (12) by $\underline{\omega}^{m\prime}$ to get

$$\sigma_m^2 W^m = (\lambda + \lambda^*)\, [E(R_m) - R_f - \overline{\tau}_m], \qquad (13)$$

where $\overline{\tau}_m = \underline{\omega}^{m\prime} . \underline{\overline{\tau}}$. Here, $\overline{\tau}_m$ can be interpreted as the total implicit taxation paid by non-farm investors as a percentage of the aggregate market wealth. Substituting (13) in (12) and rearranging yields

$$E(\underline{R}) = R_f.\underline{1} + \underline{\overline{\tau}} + \underline{\beta}\, [E(R_m) - R_f - \overline{\tau}_m], \qquad (14)$$

For a financial asset, Equation (14) is given by

$$E(R_i) = R_f + \beta_i\, [E(R_m) - R_f - \overline{\tau}_m] \qquad i \in S, \qquad (14a)$$

and for the i-th farm real estate market, this equation is given by

$$E(R_i) = R_f + \overline{\tau_i} + \beta_i\, [E(R_m) - R_f - \overline{\tau}_m] \qquad i \in E. \qquad (14b)$$

The above equations characterize asset pricing in a segmented capital market equilibrium. All financial assets will plot on a pricing line given by (14a). This line characterizes risk and return relationship in the financial market. Each farm real estate market, on the other hand, will be characterized by a pricing line, (14b), that lies above, and parallel to, that of the financial market. The distance by which each of these lines plot above the financial market pricing line would represent the magnitude of the barriers to investment that a typical non-farm investor faces in the particular farm real estate market. It would equal to the annual rate of the average implicit taxation caused by such barriers.

In the absence of any barriers, $\overline{\tau_i} = \overline{\tau_m} = 0$ in (14) and the traditional CAPM pricing line (7) obtains. Equities of equal risk would be priced to yield the same expected risk-adjusted returns regardless of the particular market they represent. Comparisons between (7) and (14b), on the one hand, and between (14a) and (14b), on the other hand, reveal that in a segmented market equilibrium, each farm real estate market would display 'super' risk-adjusted premiums and would appear to 'outperform' the financial market on a risk-adjusted basis. The magnitudes of such premiums are given by $\overline{\tau_i}$ and are explained by the implicit taxation that a non-farm investor has to incur in order to invest in the restricted markets. Moreover, with segmentation, a statement about the risk-return characteristics in farm real estate markets cannot be made based on model (7) for if the two markets were integrated, (i.e. if $\underline{\tau} = \underline{0}$), a whole different set of equilibrium equity prices would occur and, consequently, a whole new risk-return relationships would emerge for all assets in a global economy equilibrium.

The formulation in this section assumes that all assets can be sold short without limit. While this assumption can be accommodated for financial assets, it seems quite strong for farm real estate and may lead to extreme analytical results. For example, an increase in the implicit tax rate, τ_i, would never induce non-farmers to abstain from investing in the i-th farm real estate market. Rather, they will take large short position in its traded equity. This is quite unrealistic. More importantly, it does not provide an analytical approximation to the observed fact that the majority of farm real estate markets are completely segmented from the non-farm equity markets in the sense that non-farm investors do not hold any equity position in them. To avoid this shortcoming, models (7) and (14) are derived in Shiha (1992) under the additional assumption of no short sales in farm real estate markets. It is shown that although this assumption leads to an improvement in the analytical results, it does not provide any empirical advantages over the models of this section. On the one hand, it is not possible to identify some of the resulting parameters. On the other hand, testing the restrictions implied by the integrated market model (7) versus those implied by the alternative model (14) convey the same empirical inferences whether or not we incorporate short sales constraints on equities traded in the real sector of the economy.

5. The tests

5.1 Testing procedures

A test of market integration is a joint test of the mean-variance efficiency of the market proxy and of equity market integration. With integration, historical return indexes should satisfy the restrictions imposed by (7) regardless of the particular market they are drawn from. This would indicate that the market proxy is mean-variance efficient and that the hypothesized barriers to farm real estate markets are ineffective.

To test the above joint hypothesis, consider a sample of size T drawn from a stationary and normally-distributed time series on a number of N return indexes. This sample is given by

$$\underline{R}_t = (R_{t1}, \ldots, R_{tn1}, R_{tn1+1}, \ldots, R_{tN})', \qquad t = 1, \ldots, T \qquad (15)$$

where the first n_1 return indexes are financial indexes while the remaining $N - n_1$ indexes are drawn from farm real estate markets. The assumption that $\underline{R}_t$ is a normal process implies that

$$\underline{R}_t = \underline{a} + \underline{\beta}\, R_{mt} + \underline{e}_t, \qquad t = 1, \ldots, T \qquad (16)$$

where R_{mt} is the return on the market index,

$$\underline{a}' = (a_1, \ldots, a_{n1}, a_{n1+1}, \ldots, a_N), \qquad \underline{\beta}' = (\beta_1, \ldots, \beta_{n1}, \beta_{n1+1}, \ldots, \beta_N),$$

$$\beta_i = cov(R_i, R_m)/var(R_m), \qquad \underline{e}_t' = (e_{t1}, \ldots, e_{tn1}, e_{tn1+1}, \ldots, e_{Tn}),$$

$$E(\underline{e}_t) = \underline{0}, \qquad \text{and} \qquad E(\underline{e}_t \cdot \underline{e}_t') = \Sigma.$$

Since the explanatory variables across the above N equations are identical, the parameter vectors, $\underline{a}$ and $\underline{\beta}$ are estimable by applying OLS on each equation. However, integration requires that historical return indexes satisfy the restrictions imposed by the CAPM Equation (7). This imposes N-1 nonlinear restrictions on the intercept vector of (16) and leads to the following testable hypothesis

H_1: $$a_i = (1 - \beta_i) . R_f, \qquad i = 1,...,n_1,n_{1+1},...,N \qquad (17)$$

Estimating (16) under H_1 enables us to test the mean-variance efficiency of the market proxy and to get a point estimate for R_f, [Gibbons (1982)]. If integration is the preferred model then H_1 will generally hold.

A failure of Restriction (17) to hold, on the other hand, provides only necessary, but not sufficient, evidence in favor of segmentation as the preferred model. This restriction may fail because of some deficiencies in the underlying model rather than because of market segmentation. Moreover, a mere rejection of H_1 does not allow for any direct measure of the magnitude of possible barriers to investment in farm real estate markets. As such, it is important to test H_1 against the alternative hypotheses implied by the segmentation model (14). This model requires that each return index be a linear function of its market risk and predicts that there will be a number of $1+N-n_1$ asset pricing lines. The first line describes the risk-return relationship in the nonfarm equity market. Each of the remaining $N-n_1$ lines describes the risk-return trade-off in a particular farm real estate market. Model (14) imposes a set of n_1-2 nonlinear restrictions on the intercept vector of system (16) and leads to the following testable hypotheses

H_2: $$a_i = (1 - \beta_i) R_f - \beta_i \overline{\tau}_m, \qquad i = 1,...,n_1 \qquad (18a)$$

$$a_i = \overline{\tau}_i + (1 - \beta_i) R_f - \beta_i \overline{\tau}_m, \qquad i = n_{1+1},n_{1+2},...,N \qquad (18b)$$

$$\overline{\tau}_i > 0, \qquad \text{and} \qquad \overline{\tau}_m \geq 0. \qquad (18c)$$

Estimating (16) under H_2 enables us to test the restrictions implied by the segmentation model and to get point estimates of the parameter vector

$$\Omega = (\underline{\overline{\tau}}^{*\prime}; R_f),$$

where $\underline{\overline{\tau}}^* = (\overline{\tau}_{n1+1},...,\overline{\tau}_N ; \overline{\tau}_m)'$.

Notice that the test of market integration is also a test of H_1 against H_2. The integration model (7) places the following testable restriction on (14)

H_3: $$\underline{\overline{\tau}}^* = \underline{0}. \qquad (19)$$

Estimating the parameters of system (16) under H_1 and H_2 and testing the implied restrictions are done by applying an Iterative Nonlinear Seemingly Unrelated Regression procedure. The procedure is applied till convergence, and, thus, is equivalent to a full maximum likelihood estimation algorithm, [Goldberger (1991)]. We use the likelihood ratio test statistic for testing H_1, H_2, and H_3, respectively.[8] This statistic is asymptotically χ^2_{N-1}, χ^2_{n1-2}, and χ^2_{N-n1+1} under the three respective hypotheses.[9]

5.2 Data

Tests of various restrictions implied by the underlying models are conducted using real annual gross returns on a market proxy and on two different combinations of indexes from US financial and farm real estate markets. The data cover the period from 1949 to 1983. The choice of annual intervals is dictated by the fact that they are the only intervals

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[8]Although Stambaugh (1982), Amsler and Schmidt (1985), and Shanken (1985) point out some undesirable finite sample properties of the likelihood ratio statistic and suggest other statistics, the present study uses the likelihood ratio statistic. While these studies test the CAPM using monthly data, the present study uses annual data. Finite sample properties of the test statistic may not be insensitive to the length of the time interval considered.

[9]In testing the various hypotheses, it is implicitly assumed that the parameters $\underline{a}$, $\underline{\beta}$, $\underline{\Omega}$, and Σ are time-invariant. This assumption may appear to be strong given the long time series employed in the tests. Ideally, one would estimate these parameters over many sub-periods to account for possible time-varying parameters. This can be done if we use monthly or quarterly intervals. We are constrained by the fact that available farm real estate data are annual.

for which data on farm real estate values are available for such a relatively long time period. The choice of the time period is because it is the only period found to have consistent data on farmland rents. Fortunately, this period covers the boom of farmland markets of the seventies and some of the bust that followed in the early to mid-eighties. To capture these effects, the tests are conducted for the entire period, 1949-1983, and for the sub-period, 1949-1978.

The financial series include real returns on the Treasury bill, long-term government bond portfolio, long-term corporate bond portfolio, and on thirteen NYSE common stock industry portfolios. The T-bill and bond returns are from Ibbotson and Sinquefield (1989). Common stock values and cash dividends are extracted from the monthly files of the Center for Research on Security Prices (CRSP) tapes. The stock portfolios are formed in the following way. Firms listed on the NYSE are grouped into thirteen groups according to the first two digits of their Standard Industrial Classification (SIC) code. For a firm to be included in a particular portfolio it must meet two requirements. First, it must be listed continuously on the exchange in a given year with non-missing outstanding shares or cash dividends records. Second, it must have non-missing value record at the last trading day of the year. For each firm, a value series is constructed as the product of its year-end share price and the number of shares outstanding as of that date. Total cash dividends paid throughout the year are calculated in a similar fashion and summed for the whole year. Each of the two series is then weighted by the firm's market value in its industry and then summed over all firms in the industry. In this way, annual value and cash dividends series are obtained for each industry. These two series form the basis for calculating the returns on the thirteen common stock industry portfolios.

Farm real estate data include real returns on nine regional indexes and on the Continental US index. The indexes are constructed at the state level, the continental US level, and for nine production regions. The Northeast region is excluded due to the existence of strong urban pressures on farm real estate markets. Annual value and rent data are obtained for thirty seven states and for the Continental US from the Farm Real Estate Market Developments and Farm Income Data, respectively, both published by the US Department of Agriculture. Construction of state-level and regional value-weighted return indexes is done as described in Barry (1980) with one exception. Net rent to non-operator landlords is used as a proxy for returns to farm real estate from production. This may not exactly represent production returns occurring to real estate. However, it is the only consistent source of rent data at the state-level available for the entire period. This consistency is the main reason of choosing the time period considered in the present study. Moreover, it can be argued that this cost payment vary closely with returns to farm real estate from production.

The market proxy is constructed as a value-weighted return index on seven classes of assets. These classes include: (1) NYSE common stocks, (2) aggregate value of farmland and buildings at the Continental US level, (3) long-term corporate bonds, (4) long-term government bonds, (5) T-bill, (6) intermediate-term government bonds, and (7) intermediate-term corporate bonds. Returns on the first five classes of assets and aggregate values of NYSE common stocks and of US farmland and buildings are from the same sources described earlier. Returns on the intermediate-term government and corporate bonds and aggregate outstanding values of government and corporate obligations of different maturities are from Ibbotson and Fall (1979) and Ibbotson, Siegel and Love (1985).

Nominal returns are converted into real ones by dividing each series by the inflation rate. The latter is calculated as one plus the percentage change in the CPI as reported in the Council of Economic Advisers (1989).[10]

5.3 Results

Initially, the tests use real returns on the T-bill, on eleven NYSE common stock industry portfolios, and on the nine regional farm real estate indexes. Table 1 shows the results of testing restrictions (17), (18), and (19) over the entire period 1949-1983 and the sub-period 1949-1978. The first column of panels A and B of the table lists results of the likelihood ratio tests for the three respective hypotheses. The second and third columns of each panel list the estimates of the risk-free rate of return, R_f, and their standard errors for the two periods, respectively. Average real returns on the bill are reported in the last row for comparison.

The values of the likelihood test statistic for H_1, the joint hypothesis that asset markets are integrated and that the market proxy is mean-variance efficient, are quite large in both periods. Their probability values are very small, especially in the sub-period 1949-78, indicating corresponding low probabilities of observing a linear relationship between average returns and market risks. The opposite holds for H_2, the hypothesis that asset markets are segmented. The values of its test statistic are quite small in both periods with corresponding high probabilities of observing restriction (18) to hold. This result is further supported by the values of the likelihood test statistic for H_3, the hypothesis that there are no barriers to arbitrage capital to farm real estate markets. The probability values of the test statistic are very small in both periods, indicating that H_3 can be rejected at the conventional levels of significance, (i.e. the 5% level). Since a test of this hypothesis is a

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[10]Descriptive statistics of the data considered are available from the authors upon request.

test of H_1 against H_2, the results indicate that the source of segmentation can be traced to some barriers to nonfarm investments in farm real estate markets.

Table 1

Results of testing various hypotheses implied by models (7) and (14) using real annual returns on twelve financial and nine regional farm real estate indexes.

	Panel A Entire period 1949-1983			Panel B Sub-period 1949-1978		
Hypothesis[a]	λ^b	$\hat{R}_f{}^c$	$S(\hat{R}_f)^c$	λ	$\hat{R}_f$	$S(\hat{R}_f)$
H_1	35.5460 (0.0174)	1.0075 (0.0000)	0.0017	39.1890 (0.0063)	1.001 (0.0000)	0.002
H_2	8.6970 (0.6498)	1.0080 (0.0000)	0.0030	12.1440 (0.3529)	1.0027 (0.0000)	0.003
H_3	26.8491 (0.0028)	---	---	27.0448 (0.0026)	---	---
	Average real T-bill gross returns					
	1.0059			1.0033		

[a]H_1 is the hypothesis that integration model (7) holds, H_2 is the alternative hypothesis that segmentation model (14) holds, and H_3 is a test of H_1 against H_2.

[b]λ is the likelihood ratio statistic for testing H_1, H_2, and H_3. The λ statistics are asymptotically χ^2_{20} ,χ^2_{10}, and χ^2_{10}, respectively, under the three hypotheses; their p-values are in parentheses.

[c]$\hat{R}_f$ is the maximum likelihood estimate of the risk-free real return and $S(\hat{R}_f)$ is its asymptotic standard error. P-values for a one-tailed test of a hypothesis that $R_f = 0$ against an alternative that $R_f > 0$ are in parentheses.

Table 2 lists estimates of the barriers to each of the nine farm real estate regional markets. The first two columns of panels A and B of the table list estimates of the annual implicit tax rates, $\overline{\tau_i}$. These estimates are large and positive with values ranging from a maximum of 3.33% per year in 1949-83 (6.6% in 1949-78) to a minimum of 1.55% per year in 1949-83 (2.73% in 1949-78). The standard errors of the estimates are relatively low. As a result, the p-values of the one-tailed hypothesis that each estimate is non-positive are very small indicating low probabilities of observing non-positive estimates. This holds in both periods and across all farm real estate markets. Comparing the estimates of $\overline{\tau_i}$ to the average real return in each farm real estate market, gives an estimate of the annual 'net' real returns that each market offers to non-farm investors. It is shown in Shiha (1992) that these net returns represent an average of 50% (30%) of the total average historical real returns offered by the nine regional markets for the period 1949-1983 (1949-1978).

The third and fourth columns of panels A and B in table 2 reproduce estimates of Jensen Measures of Performance, $\tilde{\alpha}_i$, and their standard errors, $S(\tilde{\alpha}_i)$, as reported in Shiha (1992).[11] The last column contains values of a two-tailed test statistic of a hypothesis that observed 'super' risk-adjusted performance of farm real estate is completely explained by

[11]Jensen Measure of Portfolio Performance, $\tilde{\alpha}_i$, refers to the intercept coefficient of regressing real asset returns, in excess of the return on the T-bill, on that of a market proxy. Given the CAPM, the ex-ante value of $\tilde{\alpha}_i$ is zero. Ex-post, however, a significantly positive (negative) value of $\tilde{\alpha}_i$ is said to imply that the asset outperforms (under-performs) the market in the sense that it offers average returns that are higher (lower) than is warranted to compensate the investor for an exposure to its market risk as measured by the slope coefficient in the regression. A zero value of $\tilde{\alpha}_i$ implies that the asset is priced 'correctly'. The persistent result in the agricultural economics literature that farm real estate markets outperform the financial market on a risk-adjusted basis is based on findings that while farm real estate return indexes display positive and significant $\tilde{\alpha}_i$'s but small and insignificant market risks, their financial counterparts have $\tilde{\alpha}_i$'s that are not significantly different from zero but positive and significant market risks.

the costs that a non-farm investor has to incur in order to hold equity in these markets.[12] The results show little evidence against this hypothesis. Estimates of $\tilde{\alpha}_i$ are statistically indistinguishable from those of $\overline{\tau_i}$ as evidenced by the p-values of the test statistic, $\phi(\tilde{\alpha}_i)$. This holds in both periods and across all farm real estate markets.

[12]The test statistic $\phi(\tilde{\alpha}_i)$ is constructed by observing that under the null hypothesis $\tilde{\alpha}_i$ is approximately normally distributed with mean $\overline{\tau_i}$ and a standard deviation equal to its estimated standard error. By standardizing each estimate by its mean and standard deviation a single normal test statistic is obtained for each period. This statistic has the form

$$\phi(\tilde{\alpha}_i) = (\tilde{\alpha}_i - \hat{\tau}_i)/S(\tilde{\alpha}_i)$$

where $\tilde{\alpha}_i$ is the estimate of Jensen Measure of Performance for the i-th farm real estate index, $S(\tilde{\alpha}_i)$ is its standard error, and $\hat{\tau}_i$ is the maximum likelihood estimate of $\overline{\tau_i}$.

Table 2

Maximum likelihood estimates of the magnitudes of barriers (or implicit tax rates $\overline{\tau}_i$) facing non-farm investors to each farm real estate regional market.

Market	Panel A Entire Period 1949-1983					Panel B Sub-period 1949-1978				
	$\hat{\tau}_i$[a] %	$S(\hat{\tau}_i)$ %	$\tilde{\alpha}_i$[b] %	$S(\tilde{\alpha}_i)$ %	$\phi(\tilde{\alpha}_i)$[c]	$\hat{\tau}_i$ %	$S(\hat{\tau}_i)$ %	$\tilde{\alpha}_i$ %	$S(\tilde{\alpha}_i)$ %	$\phi(\tilde{\alpha}_i)$
Lake states	2.48 (0.017)	1.17	2.22	1.29	-0.202 (0.840)	4.90 (0.000)	0.97	4.25	1.13	-0.575 (0.565)
Corn Belt	2.61 (0.054)	1.62	1.94	1.65	-0.406 (0.685)	6.61 (0.000)	1.22	4.68	1.49	-1.295 (0.195)
Northern Plains	3.23 (0.004)	1.23	3.07	1.36	-0.118 (0.845)	5.69 (0.000)	1.08	5.08	1.29	-0.473 (0.636)
Appalachia	2.33 (0.004)	0.89	2.34	1.07	0.009 (0.992)	4.36 (0.000)	0.70	4.37	0.92	0.011 (0.992)
South East	3.04 (0.000)	0.92	3.31	1.20	0.225 (0.822)	4.79 (0.000)	0.72	5.54	1.01	0.743 (0.458)
Delta States	3.33 (0.000)	1.00	3.08	1.26	-0.198 (0.843)	5.01 (0.000)	0.82	5.10	1.02	0.088 (0.930)
Southern Plains	2.63 (0.001)	0.84	2.56	0.98	-0.071 (0.943)	4.06 (0.000)	0.77	3.38	1.02	-0.667 (0.505)
Mountain	3.15 (0.001)	1.00	2.76	1.15	-0.339 (0.735)	4.77 (0.000)	0.83	4.20	1.04	-0.548 (0.584)
Pacific	1.55 (0.050)	0.94	2.01	1.09	0.422 (0.673)	2.73 (0.002)	0.96	2.86	1.17	0.111 (0.911)

Estimates of the implicit tax as a percentage of the market wealth

	Panel A		Panel B	
	$\hat{\tau}_m$[d] %	$S(\hat{\tau}_m)$ %	$\hat{\tau}_m$ %	$S(\hat{\tau}_m)$ %
	0.52	0.62	0.86	0.48

[a] $\hat{\tau}_i$ is the maximum likelihood estimate of $\overline{\tau}_i$ and $S(\hat{\tau}_i)$ is its standard error. Each estimate is expressed as a percentage per year. P-values of a one-tailed test of a hypothesis that $\overline{\tau}_i = 0$ against the alternative that $\overline{\tau}_i > 0$ are in parentheses.

[b] $\tilde{\alpha}_i$ and $S(\tilde{\alpha}_i)$ are reproduced from Shiha (1992) for comparison where $\tilde{\alpha}_i$ is the estimate of Jensen Measure of Performance and $S(\tilde{\alpha}_i)$ is its standard error.

[c] $\phi(\tilde{\alpha}_i)$ is a standard normal two-tailed test statistic for a hypothesis that $\tilde{\alpha}_i = \overline{\tau}_i$; its p-values are in parentheses.

[d] $\hat{\tau}_m$ is the maximum likelihood estimate of $\overline{\tau}_m$ and $S(\hat{\tau}_m)$ is its standard error.

It might be argued, however, that the number of asset equations in the above tests are quite large relative to the number of observations and, consequently, less reliable inferences may occur. As such, the above tests are repeated using a smaller number of equations. The tests use real returns on the Treasury bill, long-term government bond portfolio, long-term corporate bond portfolio, thirteen NYSE common stock industry portfolios, and on the Continental US farm real estate index. These tests can be viewed as tests of the effects of the barriers to the average US farm real estate market.

Tables 3 and 4, respectively, list the test results and the estimates of the implicit tax on the typical non-farm investor. These results are in agreement with those reported earlier. They show that integration, or mean-variance efficiency of the market proxy, can be rejected at the conventional levels of significance (i.e. the 5% and the 10% levels) in favor of the alternative hypothesis of segmented capital market. Moreover, table 4 shows positive and significant estimates of the annual implicit tax rate of 2.36% in 1949-1983 (4.88% in 1949-1978) facing the typical non-farm investor holding equity in the US farm real estate market. These costs represent about 56% in 1949-83 to 90% in 1948-78 of the before-tax average real return on the Continental US farm real estate index.

Table 3

Results of testing various hypotheses implied by models (7) and (14) using real annual returns on sixteen financial indexes and on the Continental US farm real estate index.

	Panel A Entire period 1949-1983			Panel B Sub-period 1949-1978		
Hypothesis[a]	λ^b	$\hat{R}_f{}^c$	$S(\hat{R}_f)^c$	λ	$\hat{R}_f$	$S(\hat{R}_f)$
H_1	25.7363 (0.0579)	1.0109 (0.0000)	0.0024	37.0844 (0.0020)	1.017 (0.0000)	0.002
H_2	10.2346 (0.7448)	1.0080 (0.0000)	0.0033	14.8432 (0.3890)	1.0048 (0.0000)	0.003
H_3	15.5017 (0.0004)	---	---	22.2412 (0.0000)	---	---

Average real T-bill gross returns	
1.0059	1.0033

[a]H_1 is the hypothesis that integration, or mean-variance efficiency, holds, H_2 is the alternative hypothesis that segmentation model (14) holds, and H_3 is a test of H_1 against H_2.

[b]λ is the likelihood ratio test statistic for tests of H_1, H_2, and H_3. The λ statistics are asymptotically χ^2_{16}, χ^2_{14}, and χ^2_2, respectively under the three hypotheses; their p-values are in parentheses.

[c]$\hat{R}_f$ is the maximum likelihood estimate of the risk-free real return and $S(\hat{R}_f)$ is its asymptotic standard error. P-values for a one-tailed test of a hypothesis that R_f=0 against an alternative that R_f>0 are in parentheses.

Table 4

Maximum likelihood estimates of the magnitudes of barriers, or annual implicit tax rate $\overline{\tau}_{us}$, facing non-farm investors to the average farm real estate market using real annual returns on the sixteen financial indexes and on the Continental US farm real estate index.

Market	Panel A: Entire Period 1949-1983					Panel B: Sub-period 1949-1978				
	$\hat{\tau}_{us}$[a] %	$S(\hat{\tau}_{us})$ %	$\tilde{\alpha}_{us}$[b] %	$S(\tilde{\alpha}_{us})$ %	$\phi(\tilde{\alpha}_{us})$[c]	$\hat{\tau}_{us}$ %	$S(\hat{\tau}_{us})$ %	$\tilde{\alpha}_{us}$ %	$S(\tilde{\alpha}_{us})$ %	$\phi(\tilde{\alpha}_{us})$
Continental US	2.36 (0.017)	1.00	2.24	1.13	-0.106 (0.915)	4.88 (0.000)	0.70	4.14	0.98	-0.755 (0.450)

Estimates of the implicit tax as a percentage of the market wealth

$\hat{\tau}_m$[d] %	$S(\hat{\tau}_m)$ %	$\hat{\tau}_m$ %	$S(\hat{\tau}_m)$ %
0.45	0.57	0.83	0.41

[a] $\hat{\tau}_{us}$ is the maximum likelihood estimate of $\overline{\tau}_{us}$ and $S(\hat{\tau}_{us})$ is its standard error. Each estimate is expressed as a percentage per year. P-values of a one-tailed hypothesis that $\overline{\tau}_{us}= 0$ against the alternative that $\overline{\tau}_{us} > 0$ are in parentheses.

[b] $\tilde{\alpha}_{us}$ and $S(\tilde{\alpha}_{us})$ are reproduced from Shiha (1992) for comparison where $\tilde{\alpha}_{us}$ is the estimate of Jensen Measure of Performance and $S(\tilde{\alpha}_{us})$ is its standard error.

[c] $\phi(\tilde{\alpha}_{us})$ is a standard normal two-tailed test statistic for a hypothesis that $\tilde{\alpha}_{us}= \overline{\tau}_{us}$; its p-values are in parentheses.

[d] $\hat{\tau}_m$ is the maximum likelihood estimate of $\overline{\tau}_m$ and $S(\overline{\tau}_m)$ is its standard error.

6. Summary and concluding remarks

Historical return data from US financial and farm real estate markets reject integration, or mean-variance efficiency of the market proxy. Indexes of equal risk are not priced to yield the same average real returns irrespective of the particular segment of the economy they are traded in. There is evidence in favor of segmentation as the preferred model. Moreover, we are able to trace possible sources of segmentation to the existence of barriers to nonfarm equity capital. The tests do not reject the hypothesis that these barriers take the form of implicit taxes on the value of nonfarm holdings in different farm real estate markets. The estimates of these implicit taxes are large, positive, and significant. They represent a large percentage of the total annual average rates of return offered by farm real estate markets. They provide an explanation to the persistent result in the literature that farm real estate markets outperform the financial market on a risk-adjusted basis. These results hold in both periods, at each regional farm real estate market level, and at the Continental (or average) market level.

Our findings have important implications for the analytical approach to asset pricing in agriculture. There is little evidence in favor of the relevance of the CAPM in modelling returns in farm real estate markets. There is also little evidence in favor of its ability to account for differential returns across the financial and farmland. The same would hold for the APT. The existence of barriers to the flow of nonfarm capital into agriculture clearly invalidates the ability of both the CAPM and the APT to represent farmland prices. The relevance of this class of pricing models hinges squarely upon an implicit assumption of fully integrated and highly efficient capital market where there are no significant costs associated with inter-market spanning activities. Unrestricted inter-market flow of capital is essential to arbitrage unexploited profit opportunities and to maintain a well-defined equilibrium relationship among different equity markets in the economy.[13] Thus, it appears inappropriate to use the CAPM and the APT as a benchmark for comparing investment performance across the financial and farm real estate markets as it is customary encountered in some recent literature. Moreover, the persistent result in the literature that farm real estate markets offer super risk-adjusted returns appear to be not supported by empirical evidence from the capital market. On the one hand, the model from which such a result is generated is mis-specified given a segmented capital market structure. On the other hand, the apparent superior performance of farm real estate markets relative to the financial markets purely reflects the effects of various barriers facing nonfarm investment in farm real estate markets. It merely represents the unwarranted costs that nonfarm investors have to incur in order to hold equities in farm real estate markets given that the financial market provides them with more readily investment alternatives.

There is evidence that equilibrium equity prices in agriculture are probably better represented by a model that takes an explicit account of the barriers to external capital. This finding has important implications for policy analysis. Since the segmentation model is an equilibrium model, its associated barriers will tend to persist in equilibrium. There is no endogenous convergence toward an integrated market once the economy started with segmentation. This leaves open the role of institutional and policy arrangements in simulating nonfarm equity capital moving to agriculture.

Although an elaborate analysis of various institutional arrangements that can be implemented is beyond the scope of this research, some general policy implications are

[13]This provides an explanation to the finding reported in Shiha (1992) that while historical returns on financial assets satisfy the restrictions implied by the CAPM for the marginal means of cross-sectional returns, the same restrictions fail to hold when tested using farmland returns. Costly inter-market spanning activities may also provide an explanation to the findings reported in Arthur, Carter, and Abizadeh (1988) of non-significant risk premia in their five-factor-APT modelling of asset pricing in agriculture.

immediate. The characteristics of farm real estate markets have a direct linkage to the barriers to external capital. As noted earlier, these markets are diverse, local, and trade in real and highly indivisible equities. This gives rise to information and search costs as a prominent source of barriers. One policy option can be implemented in the long run through pooling or merging existing farmland equity. This may enable a move toward public offering of financial claims on farmland. This would help reduce some of the transactions costs involved in real estate equity markets. It would provide farmers greater flexibility in making their portfolio choices. In particular, it would enable them to diversify their holdings over a wide range of assets. The creation of farmland investment trusts would ease the problems associated with the high capital requirements for entry of new farmers into agriculture.

An important limitation of the present study relates to the quality of farm real estate data as compared to their financial counterparts. The data available on farm real estate values and cash flows, as published by the US Department of Agriculture, are not market-based. They are rather based on opinion surveys and on appraisal valuation. These data are typically collected on annual basis. One way to improve the quality of information in farm real estate markets would be to improve the methods of data collection.

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