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Equilibrium of Land Values from Agricultural and General Economic Factors for Cropland and Pasture Capitalization in Georgia

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Nonagricultural factors impact land values to cause a divergence of discounted cash rents for agricultural land and land values in Georgia. General economic factors are represented by per capita income in nonmetro areas. Cash rents for cropland and pasture have positive impacts on land values. Nonagricultural factors are stronger influences on land values than are cash rents. Greater effective demand exists for pasture than for cropland because pasture is subject to relatively more pricing pressure in northern counties with higher incomes and population. Increased land values have led to increased net wealth for Georgia agricultural producers.

Key Words: capitalization, cash rent, cointegration, equilibrium, error correction mechanism, land values

Land is a limited resource and, with continuous population increases, agricultural land availability may be viewed as a diminishing resource. It is the primary input of crop and livestock production, representing a significant portion of total costs. Values and cash rents represent returns to land inputs for production and are indicators of the financial condition of the agricultural economy. In addition to a production input, land ownership represents wealth to owners. Thus, factors that determine the return of land inputs to production enhance potential for increases in total long-term net farm income.

A report prepared through the U.S. Department of Agriculture's Economic Research Service (USDA/ERS) summarizes much of the previous research concerning the relationship between land values and farm income (Stam, 1995). Divergence in land values and cash rents occurs when changes in discounted cash rents do not fully explain changes in land values. One explanation is that broad economic trends outside of the farm sector have an impact on land values. Another possible cause of divergence is expectations of increased land values by owners and potential purchasers.

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Expectations that become self-fulfilling despite prevailing market conditions are termed "rational bubbles." Empirical studies do not provide definitive evidence for rational bubbles, and questions regarding their existence remain to be resolved.

Asset pricing theory assumes land is valued only for its economic return, and specifies there is a precise equivalence between land values and the discounted income from that land. Besides rational bubbles, several market factors can also be linked to a divergence in land values and discounted rents. Among causes of divergence in values and rents are market forces such as risk aversion, government programs, taxes, and borrowing constraints, as well as nonpecuniary benefits from land, all of which have empirically similar appearances as rational bubbles (Clark, Fulton, and Scott, 1993).

Previous research on farmland value determination is notable for a lack of consensus (Robison and Koening, 1992). Farmland value models have tended to work well for a respective data set, but unsatisfactorily for alternative time periods and/or locations (Stam, 1995). Robison and Colyer (1994) reached a similar conclusion for land value models, despite the increasing complexity of applied formulations. Clark, Fulton, and Scott (1993) examined the relationship between values and rents in an application of time-series analysis. Their findings show that the standard capital asset pricing model is appropriate only when values and rents have identical orders of integration.

Capitalization rates for cash rents indicate the importance of net farm income to maintaining the wealth of agricultural landowners. A standard capital asset pricing model utilizing cash rents for land focuses on issues related to agricultural productivity and income derived from land. Expansion of the standard asset pricing model to include general economic factors determines the nonagricultural impacts on farmland values. The objective of this analysis is to compare the capitalization of cash rents and nonagricultural impacts on land values for Georgia cropland and pasture.

Data

Cash rents and values are reported for cropland and pasture from 1967 to 1994 by the Economic Research Service (USDA/ERS). Values are continued since 1997 and cash rents since 1994 by the USDA's National Agricultural Statistics Service. Missing data years are estimated by interpolation. All nominal monetary data are converted to real values by the GDP implicit price deflator of the Bureau of Economic Analysis (U.S. Department of Commerce). Prevailing interest rates are represented by the prime rate reported by the Federal Reserve. Real interest rates are calculated by deducting the percentage change from the preceding period of the implicit price deflator. Land values and cash rents represent levels during the early months of each year, while interest rates are published at the end of each year. Thus, real interest rates are lagged one year to achieve correspondence with values and rents. Annual data are available from 1967 to 2002 for a total of 36 observations.

A plot of Georgia cropland and pasture values is presented in figure 1. As observed from this chart, each value increased from 1967 to the late 1970s at similar rates. Decreases followed during the next decade of the 1980s, and resulting values were similar to 1967 levels. Land values have increased since 1991. Cropland values have increased at an average annual rate of 2.8% for a total increase of 102% since 1967, and pasture values have increased 321% for an average rate of 8.9%.

Figure 2 shows a 28% decrease in real cash rents for cropland during 1967–2002, representing an average annual rate of 0.8%. During this period, pasture rents decreased at an annual average of 1.2% for a total decrease of 42%. Except for the decade preceding the late 1970s, trends for real cash rents generally correspond to trends for values. By 1979, real values had more than doubled, while rents were unchanged. Cropland values and rents declined by approximately 50% during the 1980s. Since 1990, cropland values have increased by 100%, but rents have increased only by 50%. Pasture trends were similar to those of cropland until 1990. Since 1990, pasture values have increased at a faster rate than cropland values. Pasture rents have decreased, while cropland rents have increased.

Capitalization of cash rents is calculated by dividing rent by a discount factor, usually an appropriate interest rate. Figures 3 and 4 show a close relationship between Georgia land values and discounted rents until 1973 for cropland and pasture, respectively. Differences in values and discounted rents have increased over time, especially for pasture since 1990.

Two primary causes of divergence between values and discounted rents are increasing incomes of potential land buyers and encroachment onto agricultural land for nonagricultural uses. A comparison of data from the University of Georgia and the U.S. Census Bureau reveals that real household median income increased by 16% from 1989 to 1999. During this period, population increases into rural areas are signified by an increase in the number of Georgia counties classified as metropolitan areas. There were 70 counties classified as metropolitan areas by the 2000 Census, a 67% increase from 1990 when 42 counties were counted as metropolitan.

These data can be compared to previous Census data for income and population changes. From 1969 to 1979, real household median income increased by 8.3%, while the increase from 1979 to 1989 was 21.2%. Of the 159 counties in Georgia, only 13 were classified as metropolitan in 1970. A 146% increase brought the total to 32 in 1980, but only 20% of all counties were classified as metropolitan. This was followed by a 31% increase in 1990, when 26% of all counties were metropolitan. By 2000, 44% of counties in Georgia were classified as metropolitan areas, causing pressure for increased land values in the remaining farming areas. Thus, increased income and population have been factors for a divergence in land values and discounted rents since the mid-1970s, and the effects of population and commercial expansion have increased as an influence in recent years.

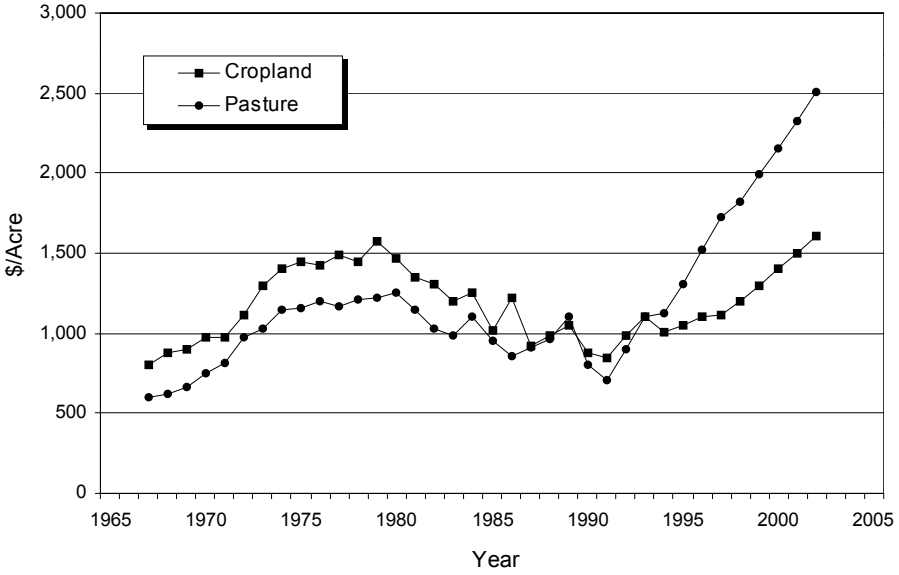

Figure 1. Real values (2000 = 100) for Georgia cropland and pasture, 1967–2002

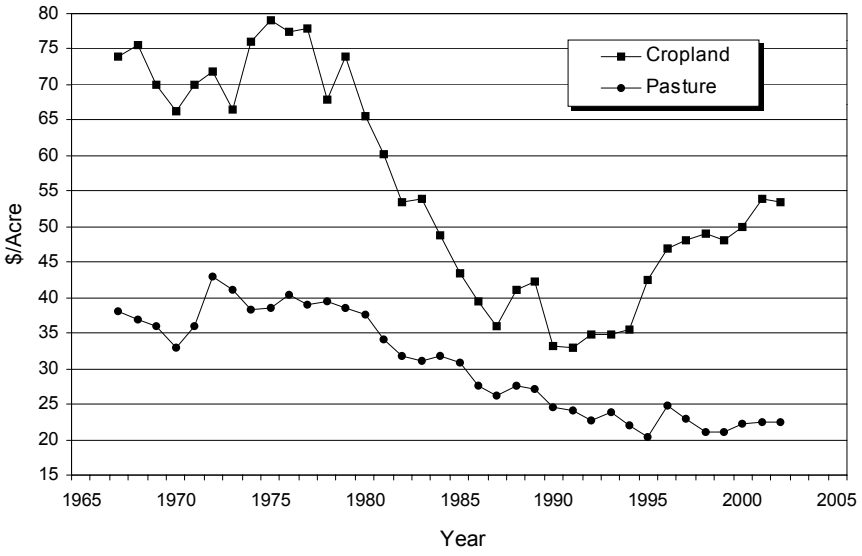

Figure 2. Real cash rents (2000 = 100) for Georgia cropland and pasture, 1967–2002

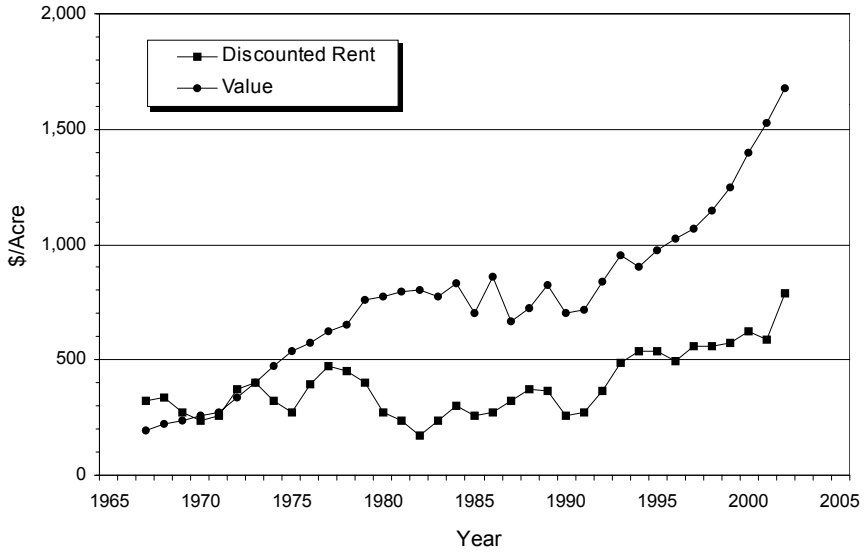

Figure 3. Cropland values and discounted cash rent, 1967–2002

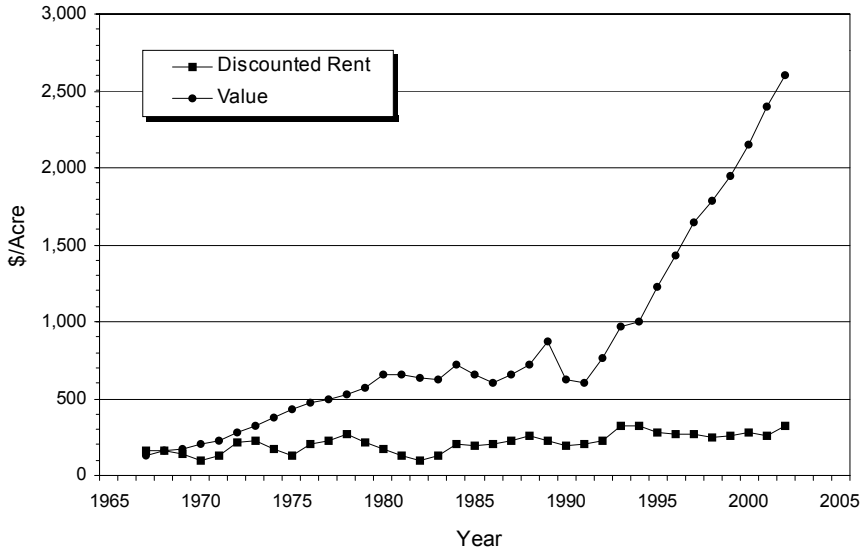

Figure 4. Pasture values and discounted cash rent, 1967–2002

The Model

Rent is the income derived from land and represents the return as an input. A discount rate represents the rate of return from invested capital that could be alternatively applied for land rental. Expected capital gains from land ownership must be at least equal to discounted rental rates in order for purchasing to be a viable investment alternative (Clark, Fulton, and Scott, 1993). Some of the changes in land values over time are attributed to factors that are not readily quantifiable for empirical representation. Examples of these variables are anticipated effects of current and future government programs, risk aversion, and the expected value of land due to the supply-and-demand relationship between a limited resource and an increasing population.

The standard capitalization formula is written as:

$$V_t = \frac{1}{r_t} R_t, \tag{1}$$

where V_t is the value of land, R_t is the cash rent, and r_t is the real interest rate, all prevailing during period t. Purchasers of land are likely to respond to proportional changes in factors that are relative to land values, and a multiplicative model specification is more appropriate than an additive specification (Burt, 1986).

As farmland prices are influenced by agricultural rents, there are general economic factors outside of agriculture which also influence prices. Population increases create demand for additional land to meet housing and commercial needs. An effective increase in demand for farmland is determined by changing income levels in areas associated with agriculture. Nonmetro areas are designated by the Bureau of Economic Analysis, and population and income are reported for these areas in Georgia. A variable denoted as P_t represents per capita personal income in nonmetro areas and is a general economic determinant of farmland values. Similar to interest rates reported for the end of each year, income is lagged one year for correspondence with values and rents reported for the early months of each year. By designating unmeasured factors of land values as N, a regression model is derived from (1) as follows:

$$V_t = \left(r_t^{\beta_1} R_t^{\beta_2} P_t^{\beta_3}\right) N. \tag{2}$$

Taking natural logarithms of (2) results in a model to estimate β_1, β_2, and β_3, and these parameter estimates for the model specified in logarithms may be directly interpreted as elasticities. Dickey-Fuller (DF) tests for land values, cash rents, real interest rates, and per capita income do not reject the hypothesis of unit roots that indicate nonstationarity (Greene, 2003). Results are !1.76 for cropland values and !1.26 for rents. For pasture, the DF results are !0.34 for land values and !0.68 for rent. Nonmetro per capita personal income has a test statistic of !1.83, and real interest rates have a test statistic of !0.95. A second DF test on the first differences indicates each variable is I(1).

Regression of nonstationary time series may lead to spurious results with unjustifiable inferences (Gujarati, 2003). However, variables that are individually I(1) may have a linear combination that is I(0), and stationary. If a combination of variables is I(0), regressions are not spurious and parameter estimates are meaningful. The estimated equation for testing a possible cointegrated relationship among variables is expressed as:

$$\ln(V_t) = N + \beta_1 \ln(r_t) + \beta_2 \ln(R_t) + \beta_3 \ln(P_t) + \gamma_t, \tag{3}$$

where γ_t represents maximum-likelihood residuals that are independent and normally distributed. Gujarati (2003) demonstrates the Engle-Granger (EG) test for cointegration by evaluating the residuals in (3) for stationarity. DF critical values are not appropriate for testing a cointegrated relationship among more than two variables, and asymptotic critical values are presented by Davidson and MacKinnon (1993). EG statistics of -6.92 for cropland and -4.88 for pasture are less than the critical value of -4.29 at the 99% significance level, and cointegrated relationships are established for (3).

Estimated parameters from (3) are long-run responses and represent equilibrium relationships among the explanatory variables and land values. As income from cash rents increases, land value as an asset increases, and expectations are for cash rents and values to have a positive relationship. Higher interest rates cause the effective cost of purchasing land to increase for all values, and a negative relationship should exist between real land values and real interest rates. Per capita income represents effective demand for farmland from outside the farm sector, and this general economic variable is expected to have a positive relationship with land values.

Results

Estimates for the capitalization of cash rents in (3) are presented in table 1. Durbin-Watson results indicate first-order autocorrelation in the least squares residuals and maximum-likelihood estimates are calculated with corrected variables. Cash rents are capitalized into cropland values at a rate of 0.57% for cropland and a rate of 0.70% for pasture due to a 1% change in cash rents. Nonmetro income is an important determinant for land values, but much more so for pasture than for cropland. For cropland, a 1% change in income leads to an increase of 0.92%, while the increase is 1.66% for pasture. Greater coefficient estimates of rents and income for pasture than cropland indicate stronger demand for pasture. A consequence of increasing land values from nonagricultural factors for both cropland and pasture is that USDA/ERS balance sheet data show increased real equity (2000 = 100) per Georgia farm from $100,000 in 1967 to over $450,000 in 2002.

Results for interest rates indicate a negative coefficient sign is statistically significant only in the cropland estimate. Lack of statistical significance of interest rates for pasture may be explained by the strong response of pasture values from per capita income. In Georgia, relatively more pasture land than cropland is closer to higher

Table 1. Cointegration Estimates for Capitalization of Cash Rents of Georgia Cropland and Pasture

	CROPLAND			PASTURE		
Variable	Parameter Estimate	Probability > | *t* |	*t*-Value	Parameter Estimate	Probability > | *t* |	*t*-Value
N (Constant)	!3.8890	0.0804	!1.81	!11.0891	0.0121	!2.67
Cash Rent	0.5698	0.0007	3.79	0.6967	0.0275	2.31
Real Interest Rate	!0.1912	0.0184	!2.49	!0.0731	0.4758	!0.72
Nonmetro Income	0.9235	< 0.0001	4.76	1.6600	0.0002	4.29
AR(1) Coefficient	!0.6951	< 0.0001	!5.49	!0.8991	< 0.0001	!10.17
R^2	0.83			0.92		
Durbin-Watson	0.68			0.37		
Degrees of Freedom	32			32		

income suburban areas, especially in the fringes of metropolitan Atlanta. The strong response from income changes coupled with relatively higher incomes in areas more associated with pasture may dampen the impact of higher land costs for pasture that is caused by increased interest rates.

Although cointegration indicates there is long-run equilibrium between variables, there may be disequilibrium in the short run represented by the error terms in (3). Gujarati (2003) shows that corrections for disequilibrium are accomplished with the error correction mechanism (ECM). First differences of the dependent variable are regressed with first differences of the explanatory variables and the lagged residual from the cointegrating regression of (3). The ECM regression equation is written as:

$$(4) \qquad \Delta\ln(V_t) \; ' \; N \% \beta_1 \Delta\ln(r_t) \% \beta_2 \Delta\ln(R_t) \% \beta_3 \Delta\ln(P_t) \% \beta_4 \mu_{t\&1} \% g_t ,$$

where $\mu_{t!1}$ is the lagged error value from the cointegrating equation.

Results from estimation of equation (4) are presented in table 2. Significance of coefficients for the lagged error terms indicate how quickly equilibrium is restored. For pasture, β_4 for the lagged residuals is not significantly different from zero, indicating any disequilibrium is restored in the current period. Thus, land prices adjust to changes in the explanatory variables in the same period in which the changes occur. This contrasts with land prices for cropland, where β_4 is statistically significant. Land prices do not adjust to changes in the explanatory variables until the period following the changes. Differences in adjustment are attributed to the relatively stronger demand indicated for pasture than for cropland. Pasture is generally in closer proximity to suburban areas than cropland, and faster adjustment of pasture can be attributed to the stronger demand for the conversion of land to housing and recreational purposes.

Table 2. ECM Estimates for Capitalization of Cash Rents of Georgia Cropland and Pasture

	CROPLAND			PASTURE		
Variable	Parameter Estimate	Probability > | *t* |	*t*-Value	Parameter Estimate	Probability > | *t* |	*t*-Value
N (Constant)	0.0147	0.4382	0.79	0.0515	0.0621	1.94
Cash Rent	0.4284	0.0171	2.52	0.7998	0.0128	2.65
Real Interest Rate	0.0034	0.9634	0.05	0.0436	0.6502	0.46
Nonmetro Income	0.4696	0.4147	0.83	0.0392	0.9604	0.05
Lagged Residuals	!0.5785	0.0038	!3.14	0.0324	0.8616	0.18
R^2	0.45			0.22		
Degrees of Freedom	30			30		

Nonmetro income dominates agricultural factors represented by cash rents in table 1. This causes the divergent trends in cash rents and land values depicted in figures 3 and 4. These divergent trends in the returns to cash rent and market value of farmland provide interesting implications on recent structural changes in the farming sector. Cash rents are determined by expected net returns from production and could be bounded by the so-called "break-even" rent, which is the remaining amount of money after cash operating costs have been covered by the farm's revenues (Lazarus, 2000). The persistent risks experienced by farmers through the years—for example, low commodity prices and unpredictable weather, among other factors—have apparently kept "break-even" rent at low levels, thereby restricting the landlord's tendency to charge cash rents that are synchronized with the accelerating trend in farmland prices.

Future trends in land values will be affected by changes in nonagricultural household income and population changes. The decade of the 1990s was a period of extremely high income growth which does not presently appear sustainable. This should diminish the effective demand for agricultural land from nonagricultural factors. Population trends are difficult to predict, but trends related to housing density have influence over agricultural land prices. Increasing population density in areas already classified as metropolitan will dampen the demand for land conversion out of agriculture. However, continued increase in the number of counties classified as metropolitan will lead to increased land values due to increased demand.

Farmland Control Arrangements and Risk-Sharing

The structure and conditions of the farmland leasing market have also changed through time as other forms of leasing arrangements have evolved. The *1997 Census of Agriculture* reports declining ratios of rented land to total land operated by farmers in Georgia. Moreover, farmers have started considering share and

hybrid leasing contracts as alternative options to the usual cash leasing arrangement. These circumstances indicate a declining demand for traditional cash rental arrangements.

Share leasing, for example, offers a viable farmland control alternative and is considered an even more highly risk efficient financing alternative for farmers compared to cash leasing and land ownership with debt financing. The risk benefit arises from the positive correlation between the value of production and the resulting rental obligation to the landowner under a share lease contract which ultimately is an effective tool for stabilizing farm incomes (Barry et al., 2000). Share leases also relieve tenant farmers of liquidity burden, as rental payments to landlords are paid only when income is realized (with cash receipts flowing in as landlords disburse their share in production expenses) while partial payments of cash rents might be demanded by landlords in advance (for example, before the crop is harvested), probably more so when farm financial conditions are tight. As a result, the risk and liquidity benefits of share leases could lure farmers away from cash renting, especially during periods of increasing production and income risk. Risk-averse landlords, however, who might also be unwilling to become involved in farming decisions, would probably be inclined to settle with reduced cash rent levels rather than lose a sizable portion of the potential clientele of land renters.

Farm Commodity Program Payments

Among crop farms eligible for government commodity program payments, the impact of these payments on cropland values depends on the nature of farmland control arrangements entered into by the producer. The terms of their share rental arrangements determine the distribution of the payments among landlords and farmer-tenants. Only the portion of the payments captured by the landowners is actually capitalized into cropland values. According to the USDA, the predominant share leasing contracts in most areas of the United States are 1/3-to-2/3 and 1/4-to-3/4 where landlords are entitled only to one-third or one-quarter, respectively, of the farm's gross revenues (Barnard et al., 2001).

In the case of cash rental arrangements, the farm operator receives directly the government payments that accrue to the crop farm. Landlords can, however, increase cash rental rates to capture a share of the subsidy payments, although these incremental rental rates are often not enough to fully capitalize such payments into cropland values (Barnard et al., 2001). In a survey of cash rents paid by Georgia farmers in 2002 conducted by Givan (2003), landowners charge a premium to peanut farmers who are entitled to receive government payments under the new Farm Bill. The state average cash rents per acre for dryland and irrigated peanut farms with designated base acreage are $64.58 and $114.58, respectively. For farms that do not have base peanut acreage, the applicable average cash rents per acre are $36.74 and $85.56 for dryland and irrigated farms, respectively.

Summary and Conclusions

The results of this analysis suggest only a portion of the variation in Georgia farmland values can be attributed to cash rent levels, although these values are theoretically regarded as returns to land as an input to farm production. Land values are greatly influenced by nonagricultural factors that lead to a divergence of discounted cash rents and values. The determination of cash rents depends on expected returns from farming and the residual "break-even" rent level subjected to high volatility due to fluctuating commodity prices and unpredictable weather patterns. Emerging forms of leasing contracts in farming, such as share and hybrid leases, could have also pressured risk-averse landlords to charge more competitive cash rental rates that are not aligned to the actual returns structure of farm businesses. Notably, these alternative leasing arrangements provide liquidity and risk-reduction benefits which become more attractive to farmers especially during periods of high production and income risk.

The cash rent-farmland valuation linkage was found to be stronger for pasture due to greater overall effective demand caused by greater influences from per capita personal income. These farms' relative proximity to major metropolitan centers in the state coincides with nonfarm factors explaining the larger divergence in pasture land values and discounted cash rents. Increasing farmland values have led to increased equity and net wealth for Georgia agricultural producers.

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