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Population, Income, and Farmland Pricing in an Open Economy

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Abstract: Farmland valuation models usually incorporate local purchasing power as one of the pricing factors. A plausible rationale is that a larger population and higher income per capita imply increasing demand for agricultural products and farmland. In this paper, we study the relationship between the agricultural land prices, the regional population, and income per capita in an open economy setting in nominal and real variable terms using data from 1929 to 2018 at the state level. We show that in most areas of the United States, agricultural land prices are less affected by the state population or personal income. The valuation of agricultural land should not factor in the local purchasing power factors, with a few exceptions.

Keywords: agricultural product; land valuation; real estate; purchasing power; local output; trade

JEL Classification: G10; R32; Q24

1. Introduction

Conventional pricing models believe that agricultural land values of an area are usually determined by a series of factors at the regional level: local purchasing power, land productivity, and land market demand and supply interactions. These factors should be distinguished with the set of microfactors that determine a single farmland asset, such as size, amenity, access to convenient traffic, etc. We study the relationship between state-level population, state income per capita, and state-level farmland price. In an economy where the liquidity of population and capital input is limited and the demand for agricultural products is restricted to local markets, farmland's price should be positively related to the population and income per capita of the economy. The Proposition I presented in Section 2 and its proof provide the reasoning for this argument. However, in an open economy, how important are population and purchasing power related to the farmland price? Specifically, how are the farmland prices in the United States related to the population and income per capita? Our study aims to address these questions.

The meaning of answering these questions roots from the risk of using the above-mentioned argument in the farmland pricing process. It is a widely-observed practice to misuse the doctrine derived from a closed economy setting to guide farmland valuation. We attempt to clarify if the following assertion is unwarranted: the price range of a farmland lot located in a "rich" area with high population density ought to be at the higher quantile due to the greater opportunity cost and greater demand for its products. Our efforts focus on switching from a static closed economy model to a dynamic, open economy setting by introducing external farmland price and investment opportunity variables.

There is a large body of literature studying the determinants of farmland prices. The previous studies approach this topic from three perspectives: examining the impacts of individual factors, the impacts from marketplace transactions, or the impacts from macroeconomic variables.

From the individual factor effect perspective, Terry et al. (1982) is one of the earliest holistic studies on farmland value determinants. Their study shows that bordering roads, year sold, soil capability class, grain sorghum yield, and percent cropland have the greatest influence on land value. Severen et al. (2018) use a forward-looking Ricardian approach to incorporate the CCSM 3 and Hadley 3 models and conclude that land markets capitalize climate change forecasts. Malaitham et al. (2018) conclude that the distance to the main road, time to the CBD station, and the distance to the shopping mall affect farmland value in the Bangkok metropolitan area of Thailand. Uematsu et al. (2013) split the pricing of farmland by land and amenity value. They show that natural amenity increases with farmland values, and such a relationship is more significant for high-end farmland. Buck et al. (2014) highlight the value added to farmland by water and water rights accessibility. Hauer et al. (2017) document the impact of land use change on land value using the Alberta case. Boisvert et al. (1997) also confirm the important role of environmental pollution in farmland price modeling.

From the marketplace transaction perspective, Hüttel et al. (2016) analyze institutional investors' role in farmland pricing and point out that privatization agencies conduct transactions with premia. In contrast, individual agencies perform oppositely. Lehn and Bahrs (2018) use a quantile-to-quantile plot to examine German standard farmland values. They find inconsistent relationships across the estimated quantiles, with results that show that nonagricultural factors are more significant at the high-end farmlands. Stokes and Cox (2014), alternatively, study the farmland price from a different angle. They survey the speculative behavior of agricultural outputs at the marketplace and confirm the speculative value of farm real estate. Drescher et al. (2001) suggest that agricultural production attributes and demand factors impact farmland prices. Their research is the first one we identify that provides a theoretical foundation of demand factors functioning on farmland valuation. In this paper, our incorporation of purchasing power is set up to emphasize the demand for farmland outputs.

From the macroeconomic perspective, the value of sales per acre, average farm size, and the percentage of farmland significantly affect Oregon's farmland values, as presented by Sandrey et al. (1982). They also show that population density plays an important role in the value of farmland in Willamette Valley. Their study is the first one we identify to investigate the impact of the population on farmland transactions. Besides, our method is consistent with theirs about using the demand for agricultural products as a proxy of income per acre. Just and Miranowski (1993) conclude that inflation and real return changes are the dominating factors determining farmland prices. Weerahewa et al. (2008) address the role of urban growth. In the course of urbanization, the price of raw lands is increased significantly by developers. This process escalates the opportunity costs of maintaining the agricultural use of farmland. Kuethe et al. (2013) suggest that common trends influence farmland returns in alternative investments and general macroeconomic conditions. Based on Just and Miranowski (1993) and Weerahewa et al. (2008), we establish our model with all real terms. Bellemare and Lee (2016) confirm the impact of price volatility and income uncertainty regarding the agricultural economic policy. Nilsson and Johansson (2013) suggest that agricultural and nonagricultural factors are influential determinants of agricultural land prices. They estimate the marginal effects and indicate that nonagricultural factors are more important in regions with high agricultural land prices. Borchers et al. (2014) also conclude that farmland's output level only partially determines its price and that nonagricultural factors impact land value. Our results are consistent with theirs after introducing the local population and state income per capita into our model. Their study inspires our investigation to go beyond the endogenous land productivity considerations, normally regarded as the dominating factor of farmland value.

However, there is a significant gap in past literature. To our knowledge, no study has contributed to building a microeconomic foundation and analyzing the effects of the macroeconomic variables. Past studies either address the influence of individual microeconomic variables, such as distance to highway, water accessibility, and environmental factors or investigate the influence of transactions and demand for agricultural products. Besides, most of the studies on farmland prices are conducted as case studies for a region as small as a county, or, at most, one state. We believe that there is a need to clarify the joint effects from both markets on land prices: the factor market and the product market.

Another significant gap exists in the determinants of farmland value. Previous studies do not distinguish between the level variables and the incremental variables. In other words, it is unclear if the population affects land prices or the change of population influences the change in the land price. The same situation applies to the investor and consumer purchasing power. While the level variables describe the impact of inventory, the incremental variables represent agricultural real estate market response to an independent variable shock impulse. The investigation of the incremental variables in this study enables us to learn if the impact from population and purchasing power are short term via impulse-response or long term via cumulative variables.

Lastly, our study proposes an open economy model instead of the conventionally used closed economy model. The major difference between these two models is that in an open economy, we do not assume local investors and consumers to be restricted to target the local farmland and its output. Recognizing the mobility of capital as well as population brings the survey of farmland price to a greater picture that considers states in the U.S. as a general factor and product market. This universal market idea avoids the robustness concern that a set of farmland value determinants in one region is less valid in a different area.

Section 2 presents the open economy farmland value model and explains the possible failure of the local population's impact and purchasing power. The data and regressions we conduct regarding the farmland price in the 48 continental states in the U.S. are explained in detail in Section 3. In Section 4, the effect of population and income per capita on farmland price, as well as the impact on the change in population and income per capita on farmland price, is described. Finally, the conclusion in Section 5 suggests the possible future research path.

2. The Model and Method

Proposition I: If an economy has limited population mobility, and the demand to agricultural industry outputs are self-sufficient, then the farmland price of this economy is positively driven by its population and income per capita.

Proof. Let $\mathcal{F}$ denote the farmland price in this closed economy. The farmland price is a function of a series of factors, stated in Equation (1):

$$\mathcal{F} = \mathcal{F}(\theta, \lambda, \xi) \quad (1)$$

where θ is the price of the agricultural products and their derivatives that are not risk hedging; λ stands for the accessibility of capital inputs; and ξ refers to the productivity of the land by the geographical nature. Holding ξ constant, i.e., regarding the land production rate as an exogenous variable that does not affect population or purchasing power, the farmland price is determined by the price level of the products from the land, the accessibility of capital input, and the land productivity developed in Equation (2).

$$\mathcal{F} = \mathcal{F}\left(\theta, \lambda, \overline{\xi}\right) \quad (2)$$

Assume $\mathcal{F} = \mathcal{F}(\cdot)$, $\theta = \theta(\cdot)$, and $\lambda = \lambda(\cdot)$ are differentiable, given the Law of Demand for a closed economy,

$$\frac{\partial\theta(\beta,\kappa)}{\partial\beta} > 0,\ \frac{\partial\theta(\beta,\kappa)}{\partial\kappa} > 0,\ \frac{\partial\lambda(\beta,\kappa)}{\partial\beta} > 0,\ \frac{\partial\lambda(\beta,\kappa)}{\partial\kappa} > 0,\ \text{and}\ \frac{\partial\mathcal{F}}{\partial\theta} > 0$$

where κ denotes the population; and β represents the income per capita of the economy.

Applying the Chain Rule, we arrive at

$$\frac{\partial\mathcal{F}}{\partial\beta} > 0,\ \text{and}\ \frac{\partial\mathcal{F}}{\partial\kappa} > 0$$

□

Proposition I states that a closed economy's farmland price is positively driven by its population and income per capita in a closed economy. We revise the model and introduce external factor markets and product markets.

This study proposes Proposition II below and provides a theoretical basis to argue that higher local population and local purchasing power does not necessarily increase the local farmland price.

Proposition II: Allowing for population and capital mobility, and not requiring the demand for agricultural industry outputs to be self-sufficient, the accessibility of capital inputs on out-of-state farmland is the determinant regarding whether its population and income per capita positively drive the farmland price of a state.

Proof. Let $\mathcal{F}^{\gamma}$ represent the out-of-state farmland price without loss of generality. Though there are different price levels out of the state under discussion, we use $\mathcal{F}^{\gamma}$ to denote a single farmland price that the local investors and consumers target. This simplifies the model setting. Consistently, we use γ to denote the accessibility of capital inputs on out-of-state farmland.

We assume that there are two types of agricultural outputs in the state under discussion. The first type is either uniquely produced in the state, or the majority of the product is produced in the state at the overall market level so that out-of-state consumers rely on this state's production. In either case, the state has the dominating pricing power for this product, and the product is priced at θ^1. The other product this state produces is a general product that is also widely supplied by other out-of-state farmlands. The state is a price taker and has no influence on the output pricing. The price of this general product is θ^2.

The farmland price of a state is the weighted average of the prices of the farmlands $\mathcal{F}^1$ and $\mathcal{F}^2$ that produce both types of products, stated in Equation (3). The weights of the prices of the farmlands producing different outputs are ω_1 and ω_2, respectively.

$$\mathcal{F} = \omega_1\mathcal{F}^1\left(\theta^1,\lambda,\xi\right) + \omega_2\mathcal{F}^2\left(\theta^2,\lambda,\gamma,\xi\right) \tag{3}$$

where λ stands for the accessibility of capital inputs in the state; and ξ refers to the productivity of the land by the geographical nature. We continue to hold ξ as constant. Then the price of the farmland that produces the unique or dominating product is determined by the price level of the product, the accessibility of capital input, and the land productivity, stated in Equation (4). Note that there is no role for out-of-state farmland price because the product under discussion is not produced out of state significantly enough to affect the output price.

$$\mathcal{F}^1 = \mathcal{F}^1\left(\theta^1,\lambda,\overline{\xi}\right) \tag{4}$$

Similarly, the price of the farmland that produces the general product is determined by the price level of the product, the accessibility of capital input of both the current state (λ) and out-of-state (γ), and the land productivity, presented in Equation (5). There is an implicit role for out-of-state farmland price $\mathcal{F}^{\gamma}$, because the capital input γ is related to $\mathcal{F}^{\gamma}$ from Equation (6).

$$\mathcal{F}^2 = \mathcal{F}^2\left(\theta^2, \lambda, \gamma, \overline{\xi}\right) \tag{5}$$

$$\mathcal{F}^{\gamma} = \mathcal{F}^{\gamma}\left(\theta^2, \gamma, \lambda, \overline{\xi}^{\gamma}\right) \tag{6}$$

Assume all functions are differentiable, given the Law of Demand, the following relationships still hold:

$$\frac{\partial\theta^1(\beta,\kappa)}{\partial\beta} > 0,\ \frac{\partial\theta^1(\beta,\kappa)}{\partial\kappa} > 0,\ \frac{\partial\lambda(\beta,\kappa)}{\partial\beta} > 0,\ \frac{\partial\lambda(\beta,\kappa)}{\partial\kappa} > 0,\ \text{and}\ \frac{\partial\mathcal{F}^1}{\partial\theta} > 0$$

where κ denotes the population; and β represents the income per capita of the economy. This case for the unique product is similar to the close economy conclusion. However, the case for general product is different:

$$\frac{\partial\theta^2(\beta,\kappa)}{\partial\beta} = 0,\ \frac{\partial\theta^2(\beta,\kappa)}{\partial\kappa} = 0,\ \frac{\partial\lambda(\beta,\kappa)}{\partial\beta} > 0,\ \frac{\partial\lambda(\beta,\kappa)}{\partial\kappa} > 0,\ \frac{\partial\gamma(\beta,\kappa)}{\partial\beta} > 0,\ \frac{\partial\gamma(\beta,\kappa)}{\partial\kappa} > 0$$

However, most importantly,

$$\frac{\partial\mathcal{F}^2\left(\theta^2,\lambda,\gamma,\overline{\xi}\right)}{\partial\gamma} < 0,\ \text{or equivalently,}\ \mathcal{F}^2_{\gamma}\left(\theta^2,\lambda,\gamma,\overline{\xi}\right) < 0$$

Taking the full derivative of the farmland price by assuming the linearity of $\mathcal{F} = \mathcal{F}(\cdot)$,

$$\frac{\partial\mathcal{F}}{\partial\beta} = \omega_1\mathcal{F}^1_{\theta^1}\left(\theta^1,\lambda,\overline{\xi}\right)\frac{\partial\theta^1(\beta,\kappa)}{\partial\beta} + \omega_2\mathcal{F}^2_{\theta^2}\left(\theta^2,\lambda,\gamma,\overline{\xi}\right)\frac{\partial\theta^2(\beta,\kappa)}{\partial\beta} + \omega_2\mathcal{F}^2_{\gamma}\left(\theta^2,\lambda,\gamma,\overline{\xi}\right)\frac{\partial\gamma(\beta,\kappa)}{\partial\beta}$$

and

$$\frac{\partial\mathcal{F}}{\partial\kappa} = \omega_1\mathcal{F}^1_{\theta^1}\left(\theta^1,\lambda,\overline{\xi}\right)\frac{\partial\theta^1(\beta,\kappa)}{\partial\kappa} + \omega_2\mathcal{F}^2_{\theta^2}\left(\theta^2,\lambda,\gamma,\overline{\xi}\right)\frac{\partial\theta^2(\beta,\kappa)}{\partial\kappa} + \omega_2\mathcal{F}^2_{\gamma}\left(\theta^2,\lambda,\gamma,\overline{\xi}\right)\frac{\partial\gamma(\beta,\kappa)}{\partial\kappa}$$

Applying the Chain Rule, we arrive at the conclusion that

$$\begin{gathered}\frac{\partial\mathcal{F}}{\partial\beta} > 0,\ \text{if and only if} \\ \frac{\omega_1\mathcal{F}^1_{\theta^1}\left(\theta^1,\lambda,\overline{\xi}\right)\frac{\partial\theta^1(\beta,\kappa)}{\partial\beta} + \omega_2\mathcal{F}^2_{\theta^2}\left(\theta^2,\lambda,\gamma,\overline{\xi}\right)\frac{\partial\theta^2(\beta,\kappa)}{\partial\beta}}{\omega_2\frac{\partial\gamma(\beta,\kappa)}{\partial\beta}} > \left|\mathcal{F}^2_{\gamma}\left(\theta^2,\lambda,\gamma,\overline{\xi}\right)\right|\end{gathered} \tag{7}$$

and

$$\begin{gathered}\frac{\partial\mathcal{F}}{\partial\kappa} > 0,\ \text{if and only if} \\ \frac{\omega_1\mathcal{F}^1_{\theta^1}\left(\theta^1,\lambda,\overline{\xi}\right)\frac{\partial\theta^1(\beta,\kappa)}{\partial\kappa} + \omega_2\mathcal{F}^2_{\theta^2}\left(\theta^2,\lambda,\gamma,\overline{\xi}\right)\frac{\partial\theta^2(\beta,\kappa)}{\partial\kappa}}{\omega_2\frac{\partial\gamma(\beta,\kappa)}{\partial\kappa}} > \left|\mathcal{F}^2_{\gamma}\left(\theta^2,\lambda,\gamma,\overline{\xi}\right)\right|\end{gathered} \tag{8}$$

If Equations (7) and (8) are violated, the regional population and income per capita do not positively affect the regional farmland value. This is due to the dilution of consumer purchasing power to regional agricultural products from out-of-state suppliers. The distraction of investor investment focuses on the out-of-state agricultural real estate property opportunities. □

3. Data and Regressions

We define farmland as land where the systematic and controlled agriculture use is conducted to produce food for humans and farm-raised animals. It includes cropland, pasture, or rangeland. We use the state-level population, income per capita, and farmland prices to investigate the empirical relationships between the demand for agricultural products, the investment capacity to farmland properties, and farmland value. The annual data is of the 48 continental states from the year 1930 to 2018. The state population data and income per capita data are cited from the Bureau of Economic Analysis (BEA). The farmland prices are cited from the National Agricultural Statistics Service Database (NASS) of the United States Department of Agriculture (USDA). The farmland price data from 1997 to 2018 are concluded from the census data, and the data from 1930 to 1996 are from the survey data. We choose to use the agricultural land asset value measured in dollar per acre variable, including the land's amenities. This is because the farm amenities are regarded as part of the agricultural production and operation practice. As Just and Miranowski (1993) and Weerahewa et al. (2008) suggest, we use real-term variables to conduct the regressions. The annual Consumer Price Index cited from the Federal Reserve Economic Data (FRED) from St. Louis Federal Reserve Bank is used to convert variables from nominal terms to real terms.

There are two reasons that we employ data for a long period of time. Firstly, the population data and the income data are surveyed or partially surveyed and interpolated on an annual basis. To maintain an accurate and meaningful dataset, we do not increase the frequency of the dataset to quarterly or higher to gain a greater number of observations. Secondly, the impact of purchasing power is not immediately transferred and reflected in the land price concurrently. To avoid drawing a spurious conclusion due to a short time window, we conduct our investigation with a long time span to allow for a gradual impact.

To facilitate the comparison and understand the influence of money supply and interest rate change, we present the population's regressions and state income per capita on state farmland price all on nominal terms in the Appendix A. The difference between the regression coefficients is reported in Table 1.

Using the real terms in our empirical model calibration allows us to separate the monetary effect on income per capita growth from the real growth on the income per capita. Accordingly, the farmland prices are deflated by the same deflator to exclude the impact of interest rate and money supply. These effects are engaged nationwide, and therefore excluding the nominal monetary returns does not change the relative prices of the farmlands in the state and out of state.

In this study, two groups of regressions are performed on the real term variables: the level and the change. The level variables reflect the cumulative effects of population and income on land prices. The incremental variables imply the short run impulse generated by population and income and their impacts on the concurrent change of farmland price. Equation (9) describes the regression function using the level variables. Equation (10) describes the regression function using the incremental variables.

$$\mathcal{F} = \mathcal{F}(c(\gamma, \xi), \beta, \kappa) \tag{9}$$

$$\Delta\mathcal{F} = \mathcal{F}(c(\gamma, \xi), \Delta\beta, \Delta\kappa) \tag{10}$$

Table 1. Comparison of nominal and real term variables' regression significance.

		Real Level	Nominal Level	Real Change	Nominal Change	Real Change Sub-I	Real Change Sub-II	Real Change Sub-III
Population	Significantly Positive	68.75%	18.75%	43.75%	31.25%	12.50%	35.42%	16.67%
	Significantly Negative	4.17%	18.75%	0	2.08%	0	0	0
	Not significant	27.08%	62.50%	56.25%	66.67%	87.50%	64.58%	83.33%
IPC	Significantly Positive	58.33%	97.92%	27.08%	95.38%	0	16.67%	31.25%
	Significantly Negative	10.42%	2.08%	0	0	6.25%	2.08%	0
	Not significant	31.25%	0	72.92%	4.17%	93.75%	81.25%	68.75%
Nation	Population	Significantly Positive	Significantly Negative	Significantly Positive	Not significant	Significantly Positive	Not significant	Not significant
	IPC	Not significant	Significantly Positive	Not significant	Significantly Positive	Not significant	Not significant	Not significant

This table presents the percentage of regression coefficients being positively significant, negatively significant, or not significant at 10% level, among the 49 regressions conducted on the 48 U.S. continental states, and the whole nation. IPC stands for income per capita. The real level refers to the regressions from the state population and the state income per capita on the state farmland price in real terms. The nominal level refers to the regressions from state population and state income per capita on state farmland price in nominal terms. The real change refers to the regressions from the change of state population and the change of state income per capita on the change of state farmland price in real terms. The nominal change refers to the regressions from the change of state population and the change of state income per capita on the change of state farmland price in nominal terms. The three subperiods are from 1930 to 1958, 1959 to 1988, and 1989 to 2018.

4. Results from Empirical Evidence

In this section, we report the regressions described in Equations (9) and (10) conducted on the 48 continental United States, as well as the entire United States. By comparing the number of coefficients being significantly presented in Table 1, we conclude that the population incremental variables positively influence farmland price. In contrast, the income per capita level variables have weaker impacts on farmland prices. In other words, farmland values are less sensitive to a transient change of state personal income but are more responsive to the short term change of state population—Tables 2 and 3 present the detailed comparisons.

We detect a significant number of states that violate the conditions presented in Equations (7) and (8) in Tables 2 and 3. In fact, as Table 2 suggests, there is no significant relationship between state population and state farmland price in 27.08% of the states. Similarly, 31.25% of the states do not have a significant relationship between state income per capita and state farmland price. A few states are carrying higher farmland prices when the population and income are lower. At the national level, although the population positively influences the farmland price, the real income does not change the land price.

The short-run impact of population and income are reported in Table 3. We do not find any adverse relationship between population change, income change, and land price change. However, we detect more insignificant impacts in the short run. The violations to Equations (7) and (8) are more widely seen at the short-run level. State-level farmland prices in the United States do not follow the closed economy model proposed in Proposition I, but they follow the open economy model proposed in Proposition II.

In addition, we fail to find a deterministic pattern for states that have higher land prices with higher population and income, versus the ones that do not. The geographical distribution is scattered and does not follow a regional group character. We attribute it to the diversity of agricultural products and the heterogeneous nature of farmland property investment opportunities. While the model presented in this study categorizes the farmland outputs into two types: unique and general, the business practice introduces more complicated classifications.

We also study the subperiod identifications. Our time series samples are divided into three segments: 1930–1958, 1959–1988, and 1989–2018. These divisions should not be interpreted as structural breaks, as we do not use significant business cycles or policy changes to guide the division. This grouping method's merit is to warrant an equal number of observations in three separate regressions so that the significance of the regression coefficients is comparable. Tables 4–6 report the regression outputs.

The results show that the change of state income per capita better explains the change of farmland price over time, whereas the results are mixed for the impact of population change. A plausible explanation is that increasing state income per capita influences the land price from two channels: higher personal income increases the demand for agricultural products and the farmland property investment opportunities. The dual effects on both the product market and the factor market enhance purchasing power's impact on real assets and financial assets.

We present the regression results at the United States national level to serve as a benchmark of comparison with each individual state. In fact, the outputs of some of the states are comparable to smaller economies in other parts of the world. The regression at the national should be compared with other economies with caution due to the size effect.

Table 2. The impact of state level population and income per capita on agriculture land price, real variables.

	Dependent variable: Real state land price (1930–2018)									
State	AL	AR	AZ	CA	CO	CT	DE	FL	GA	IA
Intercept	−2702.0490 ***	285.7594	617.8436 ***	−1119.4900 ***	−7.2831	−2022.1940 ***	−1113.4480	380.6376 *	−937.2626 ***	−16824.5400 ***
	(612.1409)	(449.0517)	(146.1928)	(314.2345)	(34.9004)	(569.2497)	(1448.6580)	(211.3133)	(147.2625)	(3490.2070)
State population	1.0973 ***	−0.0591	0.9686 ***	−0.0381	0.1484 ***	0.7116 **	−1.9740	0.2614 ***	0.4009 ***	7.1554 ***
	(0.2513)	(0.2855)	(0.0582)	(0.0445)	(0.0525)	(0.3405)	(1.7352)	(0.0481)	(0.0715)	(1.4620)
State ipc	0.0056	0.0669 ***	−0.0874 ***	0.1690 ***	0.0112 **	0.1771 ***	0.1984 ***	0.0034	0.0195	−0.0014
	(0.0145)	(0.0097)	(0.0110)	(0.0360)	(0.0052)	(0.0119)	(0.0150)	(0.0224)	(0.0127)	(0.0233)
State	ID	IL	IN	KS	KY	LA	MA	MD	ME	MI
Intercept	−116.7629	−3079.9920 *	−4580.3610 ***	307.3188	−4016.7170 ***	−2276.2590 ***	4534.3980 **	−1468.5990 ***	−1923.5810 ***	−314.5724
	(77.3259)	(1580.9070)	(1152.2610)	(605.2129)	(692.3808)	(387.1118)	(1836.5790)	(465.6290)	(370.6176)	(487.2043)
State population	1.3432 ***	0.4922 **	1.6898 ***	0.0816	1.7563 ***	1.3461 ***	−1.5763 ***	0.8652 **	2.6528 ***	−0.0084
	(0.2474)	(0.2352)	(0.4249)	(0.3747)	(0.2922)	(0.1775)	(0.4554)	(0.4159)	(0.5242)	(0.1155)
State ipc	0.0110	0.0386	−0.0361	0.0190 *	−0.0091	−0.0334 ***	0.2865 ***	0.0697 *	0.0181 **	0.0951 ***
	(0.0087)	(0.0308)	(0.0391)	(0.0099)	(0.0143)	(0.0121)	(0.0212)	(0.0362)	(0.0078)	(0.0181)
State	MN	MO	MS	MT	NC	ND	NE	NH	NJ	NM
Intercept	−3011.7990 ***	−4221.4660 ***	747.3507	−340.3919 ***	−836.4540 ***	−2735.3200 ***	−4021.7500 ***	−2395.1620 ***	−2913.4510 ***	13.7025
	(1114.1960)	(847.2459)	(929.1902)	(94.3383)	(197.4197)	(351.9770)	(820.1660)	(245.5641)	(946.7977)	(15.8406)
State population	1.4691 ***	1.3824***	−0.2525	0.6284 ***	0.4129 ***	4.6705 ***	3.5549 ***	6.8677 ***	0.4630 *	−0.0828
	(0.5262)	(0.2761)	(0.4893)	(0.2347)	(0.0817)	(0.5767)	(0.6921)	(0.8808)	(0.2597)	(0.0702)
State ipc	−0.0288	−0.0311 *	0.0659 ***	0.0122 ***	0.0378 ***	0.0151 ***	−0.0103	−0.0334 *	0.2120 ***	0.0170 ***
	(0.0329)	(0.0180)	(0.0142)	(0.0035)	(0.0131)	(0.0016)	(0.0093)	(0.0173)	(0.0254)	(0.0035)
State	NV	NY	OH	OK	OR	PA	RI	SC	SD	TN
Intercept	205.9501 ***	−446.1155	−840.209	460.7416	−128.2145 **	−1475.731	4356.309 *	−466.8615**	−3107.134***	−2359.023 ***
	(46.912)	(298.922)	(725.6913)	(281.4381)	(53.2966)	(1163.9100)	(2448.174)	(198.0439)	(447.5603)	(331.5895)
State population	0.3036 ***	0.0640 ***	0.1227	−0.0856	0.6481 ***	0.0989	−12.8862 ***	0.4648 ***	5.2470 ***	1.0941 ***
	(0.0242)	(0.0234)	(0.1168)	(0.1527)	(0.1153)	(0.1235)	(3.7932)	(0.1485)	(0.7391)	(0.1502)
State ipc	−0.0005	0.0330 ***	0.0886 ***	0.0315 ***	−0.0080	0.1137 ***	0.4884 ***	0.0381 ***	0.0032	−0.0189
	(0.0020)	(0.0034)	(0.0174)	(0.007)	(0.0097)	(0.0094)	(0.0361)	(0.012)	(0.0036)	(0.0141)
State	TX	UT	VA	VT	WA	WI	WV	WY	United States	
Intercept	90.6431 *	76.5364	−896.6787 *	−1676.0220 ***	284.5692 ***	−424.3346	−2677.6570 ***	−107.9027 ***	−1075.908 **	
	(52.0011)	(59.7196)	(476.941)	(259.8049)	(68.2611)	(1028.6140)	(816.3555)	(34.2693)	(412.3740)	
State population	0.0115	0.9245 ***	0.3900	5.1691 ***	−0.0065	0.0942	1.3897 ***	0.4202 **	0.0140***	
	(0.0153)	(0.1026)	(0.2692)	(0.9109)	(0.0971)	(0.4201)	(0.4455)	(0.1862)	(0.0051)	
State ipc	0.0271 ***	−0.0173 **	0.0425	0.0346 ***	0.0412 ***	0.0734 **	0.0668 ***	0.0085 ***	−0.0181	
	(0.0078)	(0.0077)	(0.0312)	(0.0069)	(0.0122)	(0.0302)	(0.0026)	(0.0015)	(0.0240)	

This table presents the impact of state level cumulative population and deflated income per capita on deflated agriculture land prices. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. The standard errors of the regression coefficients are reported in the parentheses. IPC stands for the income per capita.

Table 3. The impact of state level population growth and income per capita growth on agriculture land price growth, real variables.

Dependent variable: real state land price change (1930–2018)										
State	AL	AR	AZ	CA	CO	CT	DE	FL	GA	IA
Intercept	16.6371	18.2233	−43.7277 *	74.6595	−1.7836	47.5057	90.5426	−77.6346	−23.2777	29.0005
	(12.4868)	(14.6269)	(25.716)	(65.1233)	(8.8595)	(52.3264)	(61.7895)	(54.7747)	(32.9197)	(41.9524)
State population change	0.4327	0.4192	1.0000 ***	0.0052	0.1835	1.7473	−2.4675	0.5177 **	0.6142 **	2.8225 **
	(0.2813)	(0.3799)	(0.2674)	(0.1557)	(0.1332)	(1.3067)	(2.9664)	(0.2157)	(0.2914)	(1.3872)
State ipc change	0.0036	0.0145	0.0195	0.0183	0.0113**	0.0424	−0.0047	0.0308	0.0129	0.0211
	(0.0133)	(0.0170)	(0.0179)	(0.0257)	(0.0057)	(0.0295)	(0.0492)	(0.0312)	(0.025)	(0.0319)
State	ID	IL	IN	KS	KY	LA	MA	MD	ME	MI
Intercept	−45.2326 **	22.1559	−5.6133	4.0102	3.9788	−36.2801 *	74.0930	11.9509	−5.7563	32.7566
	(17.3410)	(45.6099)	(45.0370)	(12.1764)	(16.6766)	(20.0717)	(54.7223)	(84.8751)	(9.4222)	(21.6238)
State population change	3.8981 ***	0.3390	1.2636 *	0.4208	0.9582 **	1.0932 ***	−0.1042	0.6783	2.4790 ***	0.1219
	(0.8169)	(0.3747)	(0.7426)	(0.5101)	(0.3749)	(0.3073)	(0.8117)	(1.4513)	(0.7546)	(0.2152)
State ipc change	0.0315 ***	0.0445	0.0432	0.0080	0.0278	0.0715 ***	0.0486	0.0512	0.0238 ***	0.0112
	(0.0119)	(0.0361)	(0.0323)	(0.0098)	(0.0192)	(0.0202)	(0.0405)	(0.0503)	(0.0090)	(0.0147)
State	MN	MO	MS	MT	NC	ND	NE	NH	NJ	NM
Intercept	28.0487	27.2577	22.3076	−3.6214	5.6694	12.3630	11.1953	−27.2653	79.6863	2.2874
	(31.1379)	(18.3130)	(13.5371)	(6.6520)	(25.7834)	(7.7579)	(16.6040)	(23.9545)	(91.0182)	(4.7565)
State population change	0.4353	0.0371	0.1520	1.0917 **	0.3539	2.6521 ***	1.4710	6.6086 ***	0.0961	0.1135
	(0.5747)	(0.3137)	(0.3938)	(0.5290)	(0.2364)	(0.7611)	(0.9913)	(1.7322)	(0.9309)	(0.1819)
State ipc change	−0.0001	0.0019	0.0045	0.0120 **	0.0211	0	0.0024	0.0171	0.0648	0.0024
	(0.0221)	(0.0192)	(0.0190)	(0.0054)	(0.0194)	(0.0034)	(0.0124)	(0.0174)	(0.0583)	(0.0046)
State	NV	NY	OH	OK	OR	PA	RI	SC	SD	TN
Intercept	−3.2571	21.4097 *	29.3550	−2.6887	−22.8010 *	42.8225 *	100.8285	9.6461	10.8824	−12.7518
	(6.8884)	(11.5065)	(32.0081)	(8.2515)	(12.4894)	(24.8012)	(74.7472)	(17.1539)	(9.3796)	(18.4800)
State population change	0.3564 **	0.0148	0.2055	0.4977 ***	1.1484 ***	0.0647	−2.5834	0.5499	1.5830	0.8155 ***
	(0.1459)	(0.0496)	(0.2756)	(0.1772)	(0.2876)	(0.1846)	(6.3985)	(0.3542)	(1.0084)	(0.2656)
State ipc change	0.0008	0.0029	0.0369	0.0185 **	0.0037	0.0250	0.1312 *	0.0018	0.0062	0.0254 *
	(0.0034)	(0.0088)	(0.0280)	(0.0070)	(0.0074)	(0.0263)	(0.0780)	(0.0149)	(0.0060)	(0.0144)
State	TX	UT	VA	VT	WA	WI	WV	WY	United States	
Intercept	−18.4446	−26.4906 **	3.9331	14.354	−0.8782	1.0265	7.5888	−1.4252	−33.8773	
	(12.1305)	(13.0610)	(37.0754)	(9.6371)	(17.2203)	(26.0650)	(12.9035)	(2.5059)	(30.6553)	
State population change	0.0998 **	1.4915 ***	0.3343	2.6485 **	0.2587	0.7442	0.928 **	1.1914 ***	0.0243 *	
	(0.0384)	(0.3516)	(0.4936)	(1.2773)	(0.2212)	(0.4831)	(0.433)	(0.2834)	(0.0126)	
State ipc change	0.0235 ***	0.0030	0.0297	0.0222 **	0.0114	0.0366 *	0.0390 *	0.0059 ***	0.0093	
	(0.0077)	(0.0088)	(0.0252)	(0.0098)	(0.0083)	(0.0217)	(0.0200)	(0.0016)	(0.0113)	

This table presents the impact of state level changes of population and the change of deflated income per capita on the change of deflated agriculture land prices for the full period of our study from 1930 to 2018. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. The standard errors of the regression coefficients are reported in the parentheses. IPC stands for the income per capita.

Table 4. The impact of state level population growth and income per capita growth on agriculture land price growth (1930–1958), real variables.

Dependent variable: real state land price change (1930–1958)										
State	AL	AR	AZ	CA	CO	CT	DE	FL	GA	IA
Intercept	10.9130	10.7085	−0.4781	−94.7155 **	1.2416	51.7485 **	29.4163 **	−51.4650 **	14.0848 *	0.9971
	(7.0947)	(7.2585)	(4.3251)	(42.5311)	(6.1680)	(24.9192)	(12.5322)	(21.2133)	(7.6507)	(20.3448)
State population change	−0.0519	−0.1532	0.1867 **	0.4043 ***	−0.0046	0.0567	−0.3883	0.5885 ***	−0.0990	0.2094
	(0.1521)	(0.1911)	(0.0868)	(0.1184)	(0.1631)	(0.5387)	(0.4093)	(0.1528)	(0.1323)	(0.4638)
State ipc change	−0.0028	0.0035	−0.0044	−0.0056	0.0051	−0.0355 **	−0.0036	−0.0089	0.0005	0.0053
	(0.0084)	(0.0106)	(0.0036)	(0.0192)	(0.0047)	(0.0137)	(0.0081)	(0.0159)	(0.0078)	(0.014)
State	ID	IL	IN	KS	KY	LA	MA	MD	ME	MI
Intercept	−0.3401	13.6029	12.2832	1.5134	18.2326 *	23.5380 *	34.3086	0.5931	10.2182	2.1719
	(8.6082)	(18.7699)	(16.9561)	(7.9683)	(10.1023)	(11.9964)	(58.3622)	(21.4538)	(8.0331)	(13.5236)
State population change	0.7044	0.1061	0.4156 *	0.1819	−0.1260	−0.0869	−0.3789	0.8614 **	−1.0612	0.1369
	(0.5893)	(0.1192)	(0.2226)	(0.2581)	(0.2224)	(0.2074)	(0.7703)	(0.3627)	(0.6862)	(0.0945)
State ipc change	0.0093	0.0218	0.0134	−0.0001	−0.0099	0.0050	−0.0258	−0.0209	−0.0152 *	0.0006
	(0.0064)	(0.0142)	(0.0114)	(0.0062)	(0.0149)	(0.0111)	(0.0640)	(0.0128)	(0.0087)	(0.0068)
State	MN	MO	MS	MT	NC	ND	NE	NH	NJ	NM
Intercept	−3.3114	3.832	17.3341 **	2.7683	37.0965 **	2.1831	−4.3832	10.4418	23.2935	1.9186
	(12.1095)	(8.7534)	(6.5074)	(2.7939)	(14.6608)	(3.5637)	(9.4693)	(6.9597)	(36.8246)	(3.0373)
State population change	0.2113	−0.1203	−0.1947	0.0017	−0.1911	−0.0519	0.2971	−0.1150	0.5095	0.0321
	(0.2000)	(0.1269)	(0.1557)	(0.1869)	(0.2005)	(0.2939)	(0.5177)	(0.7027)	(0.3342)	(0.1273)
State ipc change	0.016	0.0059	−0.0112	−0.0010	−0.0122	−0.0041	−0.0021	−0.0064	0.0149	0.0030
	(0.0134)	(0.0104)	(0.0090)	(0.0026)	(0.0163)	(0.0029)	(0.0079)	(0.0090)	(0.0255)	(0.0026)
State	NV	NY	OH	OK	OR	PA	RI	SC	SD	TN
Intercept	0.9329	−4.7132	6.1251	2.3222	−0.0359	21.9868	47.6843 *	22.7950 **	−3.8268	15.8278
	(4.0896)	(12.417)	(20.8923)	(6.6416)	(9.3405)	(12.9259)	(24.2917)	(10.6789)	(5.1293)	(10.747)
State population change	−0.0209	0.0442	0.1829	0.0731	0.2136	−0.1163	0.6339	−0.4328	0.4162	−0.0801
	(0.4533)	(0.0478)	(0.1237)	(0.1615)	(0.2441)	(0.0796)	(1.9952)	(0.3196)	(0.4673)	(0.186)
State ipc change	−0.0004	0.0023	0.0155	0.0051	−0.0010	−0.0167	−0.0253	0.0042	−0.0001	−0.0019
	(0.0017)	(0.0111)	(0.0142)	(0.0092)	(0.0058)	(0.0144)	(0.0230)	(0.0128)	(0.0038)	(0.0117)
State	TX	UT	VA	VT	WA	WI	WV	WY	United States	
Intercept	3.3287	−6.7867	10.2701	4.8579	−10.4965	−1.0895	1.9043	2.0325	−27.7558 **	
	(8.0213)	(5.1429)	(11.5303)	(4.7727)	(12.8013)	(10.7216)	(5.174)	(2.4843)	(13.4865)	
State population change	0.0276	0.1804	0.1603	−0.3197	0.5187 **	−0.0371	−0.0138	−0.1217	0.0184 **	
	(0.0460)	(0.2766)	(0.1784)	(0.6530)	(0.2340)	(0.1792)	(0.1368)	(0.3970)	(0.0067)	
State ipc change	0.0007	0.0007	−0.0161	−0.0138 *	−0.0036	−0.0051	0.0016	−0.0014	0.0028	
	(0.0063)	(0.0039)	(0.0120)	(0.0070)	(0.0072)	(0.0102)	(0.0081)	(0.0022)	(0.0063)	

This table presents the impact of state level changes of population and the change of deflated income per capita on the change of deflated agriculture land prices for the first subperiod of our study from 1930 to 1958. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. IPC stands for the income per capita.

Table 5. The impact of state level population growth and income per capita growth on agriculture land price growth (1959–1988), real variables.

Dependent variable: real state land price change (1959–1988)										
State	AL	AR	AZ	CA	CO	CT	DE	FL	GA	IA
Intercept	3.8516	−12.0473	7.2705	166.2563	−24.7913	26.0765	95.7364	62.2669	152.4645 *	−21.6886
	(37.5108)	(51.5527)	(22.7180)	(168.4695)	(27.2907)	(89.4998)	(66.4330)	(105.9706)	(74.7833)	(68.1421)
State population change	1.847 **	2.1736	0.1030	−0.1719	0.8401*	1.0968	−6.9787	0.1834	−1.1247	15.8693 ***
	(0.8572)	(1.7000)	(0.2544)	(0.3346)	(0.4618)	(2.1040)	(5.7888)	(0.3603)	(0.8567)	(3.7166)
State ipc change	−0.0409	−0.0134	−0.0123	−0.1072	−0.0125	0.1406 **	−0.1087	−0.0500	−0.0253	−0.0194
	(0.0347)	(0.0429)	(0.0113)	(0.0784)	(0.0229)	(0.0565)	(0.0679)	(0.0451)	(0.0315)	(0.0531)
State	ID	IL	IN	KS	KY	LA	MA	MD	ME	MI
Intercept	−59.5787 **	−152.9289	−164.3222	8.1090	−105.1599 ***	−223.2427 ***	47.5583	87.2311	17.9881	−22.6783
	(25.4966)	(123.6446)	(102.1078)	(33.8875)	(32.7342)	(46.2670)	(56.3695)	(129.4707)	(17.7176)	(46.6684)
State population change	6.4184 ***	2.5829*	5.8083 **	0.3719	4.4516 ***	3.7105 ***	−0.2273	1.6569	2.4801*	0.7326
	(1.5185)	(1.4757)	(2.5625)	(1.8904)	(0.8575)	(0.8412)	(1.1214)	(2.0944)	(1.2555)	(0.5942)
State ipc change	−0.0049	0.0518	0.0004	−0.0178	0.0527 *	0.2363 ***	0.1611 ***	−0.1156	0.0131	0.0081
	(0.0199)	(0.1145)	(0.0833)	(0.0289)	(0.0304)	(0.0608)	(0.0462)	(0.0939)	(0.016)	(0.035)
State	MN	MO	MS	MT	NC	ND	NE	NH	NJ	NM
Intercept	−50.3853	7.7858	−2.1971	−5.307	45.7402	7.8279	15.2627	−151.7752 **	136.8178	12.1586
	(123.8357)	(61.2872)	(49.3791)	(8.0008)	(112.5752)	(13.3488)	(31.8935)	(55.1737)	(150.0746)	(12.6917)
State population change	2.9022	1.3525	1.2709	2.2871 **	0.2503	2.2088	2.8476	14.9514 ***	0.5132	0.0754
	(3.1709)	(1.6457)	(1.6265)	(0.9355)	(1.4368)	(1.8276)	(2.5432)	(3.3143)	(1.6509)	(0.4596)
State ipc change	−0.0563	−0.0609	0.0033	0.0027	−0.0333	−0.0062	−0.0433 *	0.0306	−0.0316	−0.0181
	(0.0518)	(0.0459)	(0.0548)	(0.0064)	(0.0490)	(0.0045)	(0.0230)	(0.0276)	(0.1141)	(0.0122)
State	NV	NY	OH	OK	OR	PA	RI	SC	SD	TN
Intercept	−7.1970	44.3962 *	−46.4694	−55.7629 **	−86.7648 ***	62.0736	53.0136	−10.1601	6.4548	−126.35 **
	(20.6420)	(23.1391)	(86.7274)	(24.4734)	(24.8459)	(61.0277)	(134.9453)	(67.6862)	(10.9585)	(49.6599)
State population change	0.6131	0.0079	1.3214	1.1754 **	2.9222 ***	0.4580	−11.7432	1.2980	0.1622	3.3943 ***
	(0.6468)	(0.1692)	(1.2965)	(0.4601)	(0.5915)	(0.7944)	(13.8104)	(1.3952)	(1.7164)	(0.9066)
State ipc change	−0.0032	−0.0173	0.0206	0.0692 **	0.0016	−0.0209	0.3569 *	−0.0152	−0.0021	0.0197
	(0.0087)	(0.0245)	(0.0877)	(0.0274)	(0.0177)	(0.0727)	(0.1797)	(0.0416)	(0.0063)	(0.0296)
State	TX	UT	VA	VT	WA	WI	WV	WY	United States	
Intercept	−52.2338	−69.0774 *	108.7734	7.6016	−30.239	−66.8733	15.0486	−4.1731	−38.0548	
	(35.4734)	(38.1335)	(73.5617)	(37.9904)	(54.4506)	(64.7404)	(24.4617)	(4.5012)	(135.5701)	
State population change	0.1441	3.1917 ***	−0.6676	5.7300	0.3536	2.6801	3.2028 ***	1.1926 ***	0.0294	
	(0.1123)	(1.0898)	(1.0133)	(5.6585)	(0.6496)	(1.5987)	(0.9910)	(0.3806)	(0.0541)	
State ipc change	0.0650 **	−0.0174	−0.0172	0.0296	0.0431	0.0046	0.0311	0.0075 *	−0.0271	
	(0.0248)	(0.0284)	(0.0380)	(0.0232)	(0.0359)	(0.0470)	(0.0380)	(0.0042)	(0.0354)	

This table presents the impact of state level changes of population and the change of deflated income per capita on the change of deflated agriculture land prices for the second subperiod of our study from 1959 to 1988. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. The standard errors of the regression coefficients are reported in the parentheses. IPC stands for the income per capita.

Table 6. The impact of state level population growth and income per capita growth on agriculture land price growth (1989–2018), real variables.

Dependent variable: real state land price change (1989–2018)										
State	AL	AR	AZ	CA	CO	CT	DE	FL	GA	IA
Intercept	21.1153	16.417	−66.2225	270.2019 *	28.6893	39.1756	165.765	−168.1688	−173.2011	103.3631
	(24.7479)	(25.4839)	(105.1042)	(143.4991)	(22.3518)	(116.9729)	(178.2702)	(190.251)	(122.9233)	(132.5256)
State population change	0.0645	0.4729	1.2407	−0.2472	−0.1915	4.5352	−9.8249	0.6931	1.4980*	1.6793
	(0.6445)	(0.6893)	(0.8348)	(0.3425)	(0.2594)	(4.1715)	(12.6335)	(0.6051)	(0.7979)	(7.8994)
State ipc change	0.0455 *	0.0492*	0.0691	0.0307	0.0197 **	0.0375	0.0353	0.0757	0.0385	0.0940
	(0.0226)	(0.0253)	(0.0532)	(0.0458)	(0.0089)	(0.069)	(0.1359)	(0.0752)	(0.0629)	(0.0855)
State	ID	IL	IN	KS	KY	LA	MA	MD	ME	MI
Intercept	−194.4253 **	148.9294 *	157.7477	15.8625	36.9408	13.0865	130.0179	−81.1613	−36.7711 *	78.2340 *
	(70.8870)	(74.0616)	(101.6347)	(35.5166)	(45.9326)	(18.6670)	(148.3357)	(262.1013)	(18.9073)	(40.4197)
State population change	7.9759 ***	−0.3605	−1.3191	−0.0004	0.7994	0.3949	−1.4395	0.6702	6.6518 ***	0.2898
	(2.5577)	(0.8807)	(2.1216)	(2.0580)	(1.4820)	(0.2698)	(3.4078)	(5.0109)	(2.3840)	(0.9032)
State ipc change	0.1006 ***	0.0358	0.0724	0.0330	0.0103	0.0291	0.0317	0.2426 *	0.0376*	0.0289
	(0.0309)	(0.0564)	(0.0680)	(0.0201)	(0.0452)	(0.0189)	(0.0972)	(0.1314)	(0.0209)	(0.0378)
State	MN	MO	MS	MT	NC	ND	NE	NH	NJ	NM
Intercept	146.1163 *	51.1709	16.7153	−41.7964	−31.666	−7.0284	24.5922	−52.7747	157.7643	−0.7604
	(75.1370)	(32.6348)	(16.6520)	(27.7290)	(64.8168)	(15.2007)	(58.9105)	(63.2506)	(219.4906)	(8.6945)
State population change	−1.2222	−0.4280	0.2534	3.6584	0.5446	10.6291 ***	0.8558	7.9188	−2.9407	−0.0052
	(1.5254)	(0.7643)	(0.6595)	(2.4797)	(0.4400)	(1.8167)	(3.9940)	(5.8473)	(3.4179)	(0.3251)
State ipc change	0.0308	0.0757 **	0.0502*	0.0413**	0.0608 *	0.0049	0.0424	−0.0086	0.1869	0.0172*
	(0.0346)	(0.0324)	(0.0268)	(0.0166)	(0.0318)	(0.0061)	(0.0294)	(0.0381)	(0.1461)	(0.0097)
State	NV	NY	OH	OK	OR	PA	RI	SC	SD	TN
Intercept	−9.6217	29.3457	115.1553 **	12.0261	13.5705	43.7213	82.2543	−8.5572	20.2768	−16.8014
	(25.4738)	(23.1551)	(50.9444)	(15.6326)	(37.0261)	(53.6272)	(192.9365)	(44.0462)	(41.4735)	(46.8206)
State population change	0.3944	0.0531	−1.2375	0.3693	0.3636	0.3441	−3.7034	0.8657	2.4573	0.9844
	(0.3503)	(0.1251)	(1.2518)	(0.4811)	(0.7417)	(0.6834)	(15.1321)	(0.73)	(4.9919)	(0.6081)
State ipc change	0.0060	0.0064	0.0987 **	0.0086	0.0216	0.0663	0.1838	0.0213	0.0214	0.0244
	(0.0093)	(0.0156)	(0.0436)	(0.0068)	(0.0152)	(0.0540)	(0.1943)	(0.0251)	(0.0196)	(0.0288)
State	TX	UT	VA	VT	WA	WI	WV	WY	United States	
Intercept	−72.8703 *	−59.2635	−99.9752	24.2488	78.7875 *	24.3336	18.1940	−0.4310	121.5215	
	(38.5442)	(50.3990)	(135.8806)	(21.3352)	(41.7348)	(62.8398)	(31.1728)	(5.5716)	(103.8813)	
State population change	0.2221 **	1.7721 *	1.4626	0.0747	−0.5005	1.2491	5.4797 *	2.1600 ***	−0.0294	
	(0.0927)	(0.9373)	(1.5358)	(4.4096)	(0.4159)	(1.4599)	(2.841)	(0.7781)	(0.0368)	
State ipc change	0.0251 **	0.0334 *	0.0857	0.0222	0.0153	0.0727	0.0580	0.0065 ***	0.0323	
	(0.0113)	(0.0195)	(0.0567)	(0.0192)	(0.009)	(0.046)	(0.0487)	(0.0023)	(0.0193)	

This table presents the impact of state level changes of population and the change of deflated income per capita on the change of deflated agriculture land prices for the third subperiod of our study from 1989 to 2018. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. The standard errors of the regression coefficients are reported in the parentheses. IPC stands for the income per capita.

5. Concluding Remarks

This paper studies two types of models: farmland prices and their interactions with population and income in a closed economy and an open economy. The empirical findings challenge the current state of knowledge that farmland prices are intuitively related to local purchasing power. We show that the farmland prices in many areas in the United States are not related to the population and state income per capita, which translate into purchasing power. We first provide a closed economy model and propose that a greater population and purchasing power increase farmland prices. We then expand the model to include an open economy setting. This shows that with universal products and out-of-state investment opportunities, the determinants of farmland value in a state do not necessarily include local purchasing power on the product or factor market.

Further, we conclude that the following conditions must hold to warrant a positive relationship between land price and product demand: local population, income per capita, agricultural product price, capital accessibility, and land productivity. The conditions are summarized in Equations (8) and (9). Next, we use the 48 continental states' annual data from 1930 to 2018 and empirically measure the relationship. Excluding the impact from inflation and monetary policies, 27.08% of the states do not present a positive relationship between cumulative population and farmland price; 31.25% of the states do not show a positive relationship between cumulative income per capita and farmland price. In addition, 56.25% of the states do not demonstrate a positive relationship between annual incremental population and incremental farmland price; 72.92% of the states do not reveal a positive relationship between annual incremental personal income and incremental farmland price.

It is, therefore, risky to use the closed economy mindset when valuating the farmlands. The price range of a farmland lot located in a "rich" area with high population density does not have to be anchored at higher starting points in auctions and appraisals. On the contrary, investors might identify undervalued investment opportunities in states with lower population and personal income if the closed economy valuation practice pertains.

The next step of research might be looking at the reason for the lack of arbitrage transactions or the arbitrage financial instrument's design. A question raised from our conclusion would be: given the fact that there are high and low farmland prices that are not warranted, arbitrage opportunities exist to bring the land prices back to their fair values. The obvious answer to this question is that there is a limited mobility of farmland property transactions due to real estate investments' nature. However, if the existing financial instruments that securitize the lands provide such arbitrage channels, this would be of great interest to explore.

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Appendix A

Table A1. The impact of state level population and income per capita on nominal agriculture land price, nominal variables.

Dependent variable: Nominal state land price (1930–2018)										
State	AL	AR	AZ	CA	CO	CT	DE	FL	GA	IA
Intercept	−31.9575	−194.1679	205.9384	541.4082 ***	15.0542	−316.3592	−2008.807 **	118.4139	−537.0088	−1988.9
	(123.9849)	(382.1046)	(126.7328)	(145.6664)	(38.4062)	(346.8923)	(926.2268)	(107.1813)	(362.2639)	(2008.162)
State population	0.0082	0.1092	−0.6281 ***	−0.0627 ***	−0.0185	0.1226	2.1988 *	−0.0634 **	0.1298	0.6801
	(0.0399)	(0.2042)	(0.1383)	(0.0104)	(0.0246)	(0.1452)	(1.2556)	(0.0255)	(0.1025)	(0.7645)
State ipc	0.0675 ***	0.0660 ***	0.1843 ***	0.1716 ***	0.0271 ***	0.1817 ***	0.1817 ***	0.1456 ***	0.0642 ***	0.1178 ***
	(0.0022)	(0.0066)	(0.0224)	(0.0065)	(0.0021)	(0.0044)	(0.0083)	(0.0107)	(0.0174)	(0.0106)
State	ID	IL	IN	KS	KY	LA	MA	MD	ME	MI
Intercept	−129.2773	822.5766	484.8618	371.9363	45.5781	−503.3647 ***	914.629	36.8334	−440.3951 ***	503.7348 **
	(173.0678)	(690.685)	(524.9707)	(275.2820)	(305.868)	(121.3129)	(999.6685)	(268.0863)	(103.5029)	(235.0662)
State population	0.1562	−0.1013	−0.1495	−0.1791	−0.0217	0.2043 ***	−0.2229	−0.0334	0.4943 ***	−0.0933 ***
	(0.3034)	(0.0738)	(0.1239)	(0.1364)	(0.1035)	(0.039)	(0.2021)	(0.0935)	(0.1113)	(0.0334)
State ipc	0.0563 ***	0.1207 ***	0.1351 ***	0.0350 ***	0.0823 ***	0.0478 ***	0.2005 ***	0.1353 ***	0.0479 ***	0.1063 ***
	(0.0091)	(0.0078)	(0.0096)	(0.0032)	(0.0047)	(0.0024)	(0.0081)	(0.007)	(0.0014)	(0.0043)
State	MN	MO	MS	MT	NC	ND	NE	NH	NJ	NM
Intercept	1057.748 **	543.5236	−142.7962	56.2600	−351.0578	−1770.709 ***	186.9788	−323.2774 **	−148.1481	15.4392
	(429.6371)	(390.3578)	(360.3162)	(61.0368)	(242.399)	(286.1235)	(701.8118)	(144.7737)	(573.3203)	(14.4536)
State population	−0.3722 ***	−0.1464	0.0783	−0.1173	0.0794	2.8218 ***	−0.1781	0.5174 **	0.0068	−0.0215
	(0.1359)	(0.0955)	(0.1661)	(0.0988)	(0.0596)	(0.4585)	(0.5097)	(0.2344)	(0.1017)	(0.0186)
State ipc	0.0914 ***	0.0694 ***	0.0626 ***	0.0208 ***	0.0949 ***	0.0205 ***	0.0456 ***	0.0796 ***	0.2348 ***	0.014 ***
	(0.0076)	(0.0053)	(0.0047)	(0.0012)	(0.0091)	(0.0011)	(0.006)	(0.0041)	(0.0085)	(0.0008)
State	NV	NY	OH	OK	OR	PA	RI	SC	SD	TN
Intercept	−101.0128 ***	−112.6606	421.9781	−348.9924 **	89.3197	166.4003	1841.792	−100.7898	−1624.723 ***	−8.5037
	(14.3112)	(104.1708)	(334.3464)	(153.693)	(60.2009)	(412.0525)	(1211.302)	(150.2628)	(616.7172)	(184.6501)
State population	0.7149***	0.0091	−0.0599	0.1626 **	−0.0820 **	−0.0228	−2.8183 *	0.0447	2.4078**	−0.0060
	(0.0908)	(0.0067)	(0.0381)	(0.0644)	(0.0385)	(0.0385)	(1.4726)	(0.069)	(0.9476)	(0.0551)
State ipc	−0.0237 ***	0.0459 ***	0.1154***	0.0259 ***	0.0516 ***	0.1141 ***	0.3311 ***	0.0759 ***	0.0210 ***	0.0862 ***
	(0.0058)	(0.0008)	(0.0046)	(0.0027)	(0.0026)	(0.0024)	(0.0113)	(0.0053)	(0.0041)	(0.0048)

Table A1. *Cont.*

State	TX	UT	VA	VT	WA	WI	WV	WY	United States
Intercept	93.7989	118.0770 *	330.2106 *	−77.8119	2.6296	987.7146 ***	−1119.3790 **	−0.1452	366.6344 **
	(81.9072)	(62.5509)	(180.5915)	(75.8189)	(59.1724)	(331.7925)	(440.6486)	(20.6961)	(155.1849)
State population	−0.0132	−0.2460 ***	−0.1133 **	0.1733	0.0106	−0.3122 ***	0.5813 **	−0.0247	−0.0026 ***
	(0.0098)	(0.0828)	(0.0493)	(0.1903)	(0.0236)	(0.0903)	(0.2399)	(0.0663)	(0.0009)
State ipc	0.0422 ***	0.0645 ***	0.0995 ***	0.0665 ***	0.0439 ***	0.1048 ***	0.0687 ***	0.0113 ***	0.0616 ***
	(0.0045)	(0.0051)	(0.0053)	(0.0013)	(0.0025)	(0.0055)	(0.0012)	(0.0004)	(0.0038)

This table presents the impact of state level population and income per capita on the agriculture land prices. All variables are on the nominal terms. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. The standard errors of the regression coefficients are reported in the parentheses. IPC stands for the income per capita.

Table A2. The impact of state level population growth and income per capita growth on agriculture land price growth, nominal variables.

Dependent variable: Nominal state land price change (1930–2018)										
State	AL	AR	AZ	CA	CO	CT	DE	FL	GA	IA
Intercept	−0.5008	−1.1589	−28.9264	78.8812 *	0.2191	19.0017	17.5781	−35.4052	−33.7758	−23.0375
	(6.1040)	(7.3413)	(18.5633)	(43.6476)	(4.7919)	(40.1791)	(58.1165)	(39.5344)	(23.7822)	(32.4400)
State population change	0.1532	0.1773	0.4096 *	−0.1694 *	0.0211	0.3930	−1.5476	0.1640	0.5732 **	1.1214
	(0.135)	(0.1849)	(0.2423)	(0.1003)	(0.0826)	(0.9004)	(2.2882)	(0.1819)	(0.2653)	(0.9171)
State ipc change	0.0632 ***	0.0715 ***	0.0831 ***	0.1296 ***	0.0253 ***	0.1318 ***	0.1411 **	0.1168 ***	0.0468	0.1743 ***
	(0.0077)	(0.0102)	(0.0228)	(0.0199)	(0.0038)	(0.0246)	(0.0631)	(0.0334)	(0.0294)	(0.0364)
State	ID	IL	IN	KS	KY	LA	MA	MD	ME	MI
Intercept	−31.6803 ***	0.0182	−20.3011	−1.7762	−0.7182	−19.8886 **	49.4995	−31.4523	−3.5669	17.0418
	(11.0109)	(28.9871)	(29.0133)	(8.1027)	(9.9167)	(9.4743)	(40.2996)	(63.9235)	(5.8094)	(18.0497)
State population change	1.4831 **	0.0690	0.3013	0.1306	0.2928	0.6047***	−0.3874	0.0094	0.9716 **	−0.0852
	(0.5957)	(0.2095)	(0.4238)	(0.329)	(0.2169)	(0.1374)	(0.5684)	(0.962)	(0.4227)	(0.1462)
State ipc change	0.0869 ***	0.1217 ***	0.1579 ***	0.0367 ***	0.0784 ***	0.0711 ***	0.1071 ***	0.1696 ***	0.0445 ***	0.0816 ***
	(0.0141)	(0.0256)	(0.0296)	(0.0080)	(0.0136)	(0.0094)	(0.0306)	(0.0392)	(0.0068)	(0.0182)

Table A2. *Cont.*

State	MN	MO	MS	MT	NC	ND	NE	NH	NJ	NM
Intercept	−1.4811	−7.2140	−4.7778	−9.4744 **	−12.7773	9.4937	−5.3360	−4.2371	−2.7806	−2.1700
	(18.9151)	(9.9484)	(6.4719)	(4.718)	(14.1968)	(6.3141)	(12.1756)	(17.6536)	(68.1986)	(2.5318)
State population change	0.0361	−0.0201	0.0545	0.3137	0.3098 **	2.0829 ***	0.5375	2.4892 *	−0.2686	−0.0127
	(0.3583)	(0.1594)	(0.1677)	(0.3513)	(0.1517)	(0.5857)	(0.6768)	(1.2621)	(0.6385)	(0.0996)
State ipc change	0.0861 ***	0.0873 ***	0.0817 ***	0.0339 ***	0.0765 ***	0.0122 ***	0.0557 ***	0.0498 ***	0.2235***	0.0190 ***
	(0.016)	(0.0122)	(0.0104)	(0.0053)	(0.014)	(0.0044)	(0.0123)	(0.0143)	(0.0474)	(0.0028)
State	NV	NY	OH	OK	OR	PA	RI	SC	SD	TN
Intercept	−3.0176	12.5872 *	−14.8162	5.7437	−9.2733	2.8832	−3.6663	−8.2977	2.0381	−10.7859
	(4.6348)	(7.4272)	(18.7963)	(4.0958)	(7.3816)	(14.1398)	(64.005)	(8.5176)	(8.3568)	(10.3114)
State population change	0.3180 ***	−0.0095	0.0832	0.2491 ***	0.3210 *	0.0467	−2.6016	0.5954 ***	0.7100	0.4177 **
	(0.1158)	(0.0286)	(0.1334)	(0.089)	(0.1772)	(0.0924)	(4.4595)	(0.2138)	(0.8153)	(0.1634)
State ipc change	0.0071	0.0312 ***	0.1478 ***	0.0189 ***	0.0442 ***	0.1058 ***	0.3053 ***	0.0476 ***	0.0345 ***	0.0662 ***
	(0.005)	(0.0057)	(0.0204)	(0.0037)	(0.0064)	(0.015)	(0.0671)	(0.0105)	(0.0086)	(0.0113)
State	TX	UT	VA	VT	WA	WI	WV	WY	United States	
Intercept	−11.7156 *	−16.5197 **	−15.2076	5.8177	−0.0618	−25.0992	−5.2767	−0.1905	−7.296	
	(6.396)	(7.5435)	(25.4251)	(5.5396)	(7.719)	(15.129)	(8.5931)	(1.5753)	(17.9656)	
State population change	0.0618 **	0.8369 ***	0.1094	0.2849	0.1310	0.2892	0.3414	0.6303 ***	0.0026	
	(0.0241)	(0.2381)	(0.3320)	(0.6977)	(0.1091)	(0.2637)	(0.2511)	(0.1750)	(0.0078)	
State ipc change	0.0338 ***	0.0339 ***	0.0930 ***	0.0549 ***	0.0334 ***	0.1242 ***	0.0760 ***	0.0086 ***	0.0599 ***	
	(0.0051)	(0.0080)	(0.0181)	(0.0059)	(0.005)	(0.0147)	(0.0128)	(0.0010)	(0.0079)	

This table presents the impact of the change of state level population and the change of income per capita on the change of agriculture land prices. All variables are on the nominal terms. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% level. The standard errors of the regression coefficients are reported in the parentheses. IPC stands for the income per capita.

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