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Testing for regional convergence of agricultural land prices

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ABSTRACT

The focus of this paper is on spatial market integration in agricultural land markets. We scrutinize the applicability of the law of one price to land markets and distinguish between absolute and relative versions of this "law". Panel data unit root and stationarity tests are applied to land sale prices in the German state Lower Saxony. Three main clusters with different price developments are detected. Our results indicate that the law of one price holds only locally due to structural differences among regions.

1. Introduction

Recent spikes in food prices and the high liquidity on international financial markets have boosted the demand for land. As a result, agricultural land prices have steadily increased over the past decade in many parts of the world. These developments have triggered a debate on whether current legislation is still appropriate or whether there is a need for revision. Arguments in this debate address all dimensions of sustainability, i.e., economic, social, and environmental aspects. From an economic viewpoint, land market regulations that go beyond a general institutional framework ensuring functioning markets, such as defined property rights, should fulfil two preconditions. First, a (potential) market failure exists that may lead to economically and/or socially inferior land market outcomes. Second, envisaged regulations are supposed to lead to superior results. Actually, policy makers and stakeholder groups, such as farmers, often refer to market failures when justifying the need for policy interventions. Thus, we want to explore if empirical evidence of failures in agricultural land markets exists. In a first approach to this topic, we refer to the notion of market efficiency. Land market efficiency can be considered from at least two perspectives. The first approach focuses on the relation between land sale prices and land rental prices, and tests the validity of the present value model of land prices (e.g., Gutierrez et al., 2007). Test results can be used to identify the presence of speculative bubbles or boom and bust cycles in land markets (Falk, 1991). The relationship between land sale prices and land rental prices, however, is more complicated than presumed by simple present value models (Turvey et al., 2003). The second approach, which we adopt in this paper, is to study market efficiency using the concept of spatial market integration. If markets are integrated, the law of one price (LOP) holds, that is, price differences of homogenous products or factors in spatially separated markets should not exceed transportation costs and other transaction costs; otherwise, arbitrage opportunities would exist (Fackler and Goodwin, 2001).

The general objective of this paper is to empirically investigate the linkages of agricultural land prices across time and space and to infer conclusions on land market efficiency from these findings. In commodity markets, efficiency is commonly explained using the concept of market integration, either vertically or horizontally. In land markets, however, the concept of spatial market integration has rarely been applied and thus the question arises as to whether the notion of the "law of one price" is applicable at all in this context. The adoption of spatial market integration techniques is hampered by special characteristics of the production factor "land". First and foremost, land is immobile and hence it is not obvious how trade and arbitrage processes can work. Second, and related to the first point, regional market power may exist that prevents land prices in different regions from convergence. Finally, land is an extremely heterogeneous production factor, which complicates price comparisons. Despite these peculiarities, one can nevertheless expect that economic responses to spatial price differentials will take place, at least if they are pronounced. For example, after the German reunification, many farmers from West Germany or other Western European countries bought or rented land (or even entire farms) in

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East Germany at prices that were considerably lower than in the western parts of the country (Koester, 2000). Moreover, despite legal barriers, non-agricultural investors participate in agricultural land markets (e.g., Fiske et al., 1986). That is, though land is immobile, the mobility of capital and/or farm managers will likely induce arbitrage processes on land markets towards a spatial equilibrium. This view is supported by Waights (2014), who proves that the law of one price holds for hedonic prices in urban land markets under specific assumptions. However, compared with other markets, transaction costs are high (Shiha and Chavas, 1995). As a result, the convergence of land prices will take place much more slowly, if at all, and markets may appear separated though they are spatially integrated.

While the concept of spatial market integration has been extensively applied to agricultural product markets (e.g., Barrett and Li, 2002) and agricultural labour markets (Richards and Patterson, 1998), applications to land markets are rare. An exception is the study by Carmona and Rosés (2012) that investigates spatial integration of Spanish land markets between 1904 and 1934. They find that land prices converged across provinces and that their variations were driven by market fundamentals.The contribution of our paper to the existing literature is twofold. First, this is one of the first attempts to examine the spatial market integration of agricultural land markets empirically. By investigating the spatio-temporal behaviour of land prices, we enhance the scope of spatial econometric models that are commonly used for hedonic land price studies. Second, we test the applicability of statistical tools that have been developed for commodity markets in the context of land markets. In contrast to Carmona and Rosés (2012) we take into account heterogeneity of land characteristics in the price series. This is important as Spreen et al. (2007) have shown that the non-homogeneity of goods can lead to a false rejection of the LOP.

The rest of the paper is structured as follows: Section 2 provides a brief overview of the econometric methodologies used in this study, particularly how to test for the (local) validity of the LOP with stationarity tests; Section 3 describes the study area and available dataset, as well as the necessary price adjustments and choice of a benchmark region; Section 4 presents and interprets the results of the empirical application; Section 5 provides final conclusions and a discussion of the limitations of the study.

2. Methodology

According to the (relative) LOP, land prices in two regions should differ only by transaction costs and quality differences in the long-run, i.e.,

$$q_{ijt} = p_{it} - p_{jt} = \tau_t + \xi_t \tag{1}$$

where p_{it} and p_{jt} are the log prices of land in region i and j at time t, respectively. τ_t and ξ_t denote transaction costs and product quality differences, respectively. The absolute version of the LOP requires the price differential to be zero, but in the short-run, stochastic deviations from this relationship may occur. However, if quality adjusted price differences exceed transaction costs, arbitrage processes will be triggered and pull back relative land prices to their long-run equilibrium relationship. This implies that the difference of (log) prices is stationary under the LOP given that transaction costs are stationary. Thus, the long-run equilibrium (1) can be tested by the following empirical model with a first-order autoregressive component:

$$q_{ijt} = \alpha_i + \rho_i q_{ij,t-1} + \varepsilon_{ijt} \tag{2}$$

where ρ_i is the long-run equilibrium relationship and α_i is the region-specific constant that accounts for initial price differences as well as quality differences and transaction costs from Eq. (1).

To test whether the process in Eq. (2) is stationary, unit root tests can be conducted.[1] The low power of univariate unit root tests has been improved by the development of panel unit root tests (e.g., Levin et al., 2002; Im et al., 2003). Whereas the Levin-Lin-Chu (LLC) test assumes a common convergence rate for all regions, the Im-Pesaran-Shin (IPS) test allows for region-specific convergence rates. The IPS test is based on the following augmented Dickey-Fuller (ADF) regression:

$$\Delta q_{ijt} = \alpha_i + \beta_i q_{ij,t-1} + \sum_{k=1}^{p} b_{ik} \Delta q_{ij,t-k} + \varepsilon_{ijt} \tag{3}$$

The speed of convergence is reflected by the size of $\beta_i = \rho_i - 1$. If the coefficient β_i is smaller than zero, relative land prices follow a stationary process. In that case, shocks are temporary and Δq_{ijt} converges to a constant value so that the LOP holds. If Eq. (3) has a unit root, i.e., $\beta_i = 0$, then Δq_{ijt} is non-stationary and the two land markets are separated. In the context of commodity markets, this finding is usually interpreted as evidence of market inefficiency.

Another important criterion for the selection of the appropriate test is the composition of the error term ε_{ijt}. If the individual time series in the panel are cross-sectionally independent, the IPS test is adequate. In the presence of cross-sectional dependence, however, the IPS test results will be biased. To cope with cross-sectional dependence, Pesaran (2007) suggests a cross-sectionally augmented IPS (CIPS) test that makes use of an cross-sectionally augmented ADF (CADF) regression:

$$\Delta q_{ijt} = \alpha_i + \beta_i q_{ij,t-1} + \gamma_i \bar{q}_{t-1} + \sum_{l=0}^{p} c_{il} \Delta \bar{q}_{t-l} + \sum_{k=1}^{p} d_{ik} \Delta q_{ij,t-\mathrm{k}} + \varepsilon_{ijt} \tag{4}$$

Eq. (4) augments the individual regressions in Eq. (3) by the cross-sectional average $\bar{q}_t = N^{-1} \sum_{n=1}^{N} q_{nt}$ and the lagged differences, $\Delta \bar{q}_t, \Delta \bar{q}_{t-1}, \ldots, \Delta \bar{q}_{t-p}$. Since in the case of cross-sectional independence the CIPS test has lower power than the IPS test, we apply the cross-sectional dependence (CD) test of Pesaran (2004) to test for the presence of cross-sectional dependence and hence to choose the most appropriate panel unit root test.[2]

Though panel unit root tests increase the statistical power of univariate unit root tests, they are still not very powerful with respect to the alternative hypothesis of stationarity, i.e., the null hypothesis of non-stationarity may not be rejected even if prices are slowly converging. To increase the reliability of our testing procedure, we combine the (C)IPS test with a stationarity test, the Hadri Lagrange Multiplier (LM) test (Hadri, 2000), which is an extension of the univariate stationarity test by Kwiatkowski et al. (1992) (KPSS test) to panel data. The data generating process that underlies the Hadri test is given by:

$$\Delta q_{ijt} = r_{ijt} + \varphi_i t + \varepsilon_{ijt} \tag{5}$$

where r_{ijt} is a random walk, $r_{ijt} = r_{ij,t-1} + \mu_{ijt}$; $\varphi_i t$ denotes fixed effects and individual trends, and μ_{ijt} and ε_{ijt} are zero-mean i.i.d. normal errors over time t. The null hypothesis is given by H_0: $\lambda = \sigma_\mu^2 / \sigma_\varepsilon^2 = 0$ with σ_μ^2 and σ_ε^2 being the variances of μ_{ijt} and ε_{ijt}, respectively. The null hypothesis corresponds to Δq_{ijt} being stationary because in the

[1] Besides unit root tests, co-integration and error-correction models have also been used in the LOP literature. Since some of our price series are not integrated of order one, we do not consider a co-integration analysis in this case.

[2] Note that more general error structures have been suggested in the literatures. For instance, Pesaran et al. (2013) extend Eq. (4) to a multifactor error structure model by incorporating unobserved factors into the error term.