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Rental and sale prices of agricultural lands under spatial competition*

Marten Graubner† and Silke Hüttel‡

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Abstract

Much of the land economics literature has largely ignored the spatial nature of competition and related differences between farmland rental and sales markets. In this note we propose a model for price formation in both markets under a spatial competition framework. We demonstrate that price formation differs, particularly under policy-induced output price shocks. We suggest that using rent-price ratio as an approximation for expectations in the net returns of farming, based on the net present value model, may produce biased results. We conclude that estimates for the capitalization of agricultural, environmental and energy policy into farmland prices can be biased.

Keywords: Land Markets, Rent-price Ratio, Spatial Competition
JEL codes: L13, Q12, Q18

1 Introduction

The spatial aspects of competition and associated distinctions between the rental and sales markets for agricultural lands are as important as location specific characteristics and spatial dependencies (cf. Nickerson et al., 2012). For instance, rents may be the results of less competitive market settings compared sales markets, since local farms compete primarily

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in the rental market, while non-local agricultural and non-agricultural investors compete primarily in the sales market. Ignoring the spatial nature of competition may challenge the results given by the net present value model of farmland prices (cf. Deaton and Lawley, 2022), i.e., relying on the land-price ratio to approximate the returns from farming (e.g., Borchers et al., 2014; Plogmann et al., 2020; Schaak and Mußhoff, 2022). This may for instance explain the noted divergence in policy capitalization rates in rental and sales markets (e.g., Salhofer and Feichtinger, 2020; Ciaian et al., 2021). Assessments of climate change on agriculture which use Ricardian approaches based on rental rates or land values ignoring spatial aspects of the markets may also give biased results (e.g. Ortiz-Bobea, 2020).

To demonstrate how changes in marginal revenues may affect equilibrium rental and sales prices, we develop a model for price formation in farmland markets under a spatial competition framework. Unlike existing models of spatial competition under farm policies (Graubner, 2018) and approaches attempting to explain the behavioural differences of agricultural and non-agricultural bidders in farmland markets (Curtiss et al., 2021; Seifert et al., 2021; Balmann et al., 2021; Deininger et al., 2023), our model is better able to account for previous empirical findings of the differences in policy capitalization rates on land prices and rental rates, respectively, and the bidding behaviours of owners, buyers and renters. This leads us to propose the following hypothesis: given the spatial nature of competition in rental and sales markets for agricultural lands, compounded rents differ systematically from sales prices, but particularly under an output price shock and alternative future use of land.

This note is organized as follows. Section 2 describes our theoretical framework, introduces the graphical models of spatial competition in the rental and sales farmland markets as well as our hypothesis. In Sections 3 and 4 we demonstrate the effects of shocks in downstream markets and alternative uses of the lands on land rentals and sales prices, respectively. Section 5 discusses the results, and section 6 concludes with suggestions for future research.

2 A spatial competition framework of land markets

2.1 Land rental market

Following (Graubner, 2018), we assume two farms, A and B, located at the endpoints of a line market with unit length and uniformly distributed land along this segment. Both operate under distance cost t reflecting their decreasing willingness to pay (WTP) for land with increasing distance to the farmstead. Under perfect competition in the agricultural output market, they receive a net marginal revenue from land p, i.e., the marginal revenue for land net of production costs but the rental price for land.

At each location $x = [0,1]$, a landowner can supply one unit of land to the farmland rental market, given the price $r(x)$ exceeds the landowner's reservation price v. Farms can set the rental price for land at each location, i.e. for each individual plot. This decision is influenced by their linear distance costs t and gives: $WTP_A(x) = p_A - tx$ and $WTP_B = p_B - t(1-x)$. Depending on their cost and production structure, their net marginal revenue might differ, i.e. $p_A \neq p_B$. We find the location $\hat{x}$ where A and B have the same willingness to pay for land in the rental market by:

$$\hat{x} = \frac{p_A - p_B + t}{2t}. \tag{1}$$

With sufficiently low v, the market is covered and A and B can profitably rent land neighbouring the farmstead of their competitor with $v + t \leq p$ as shown in Figure 1.

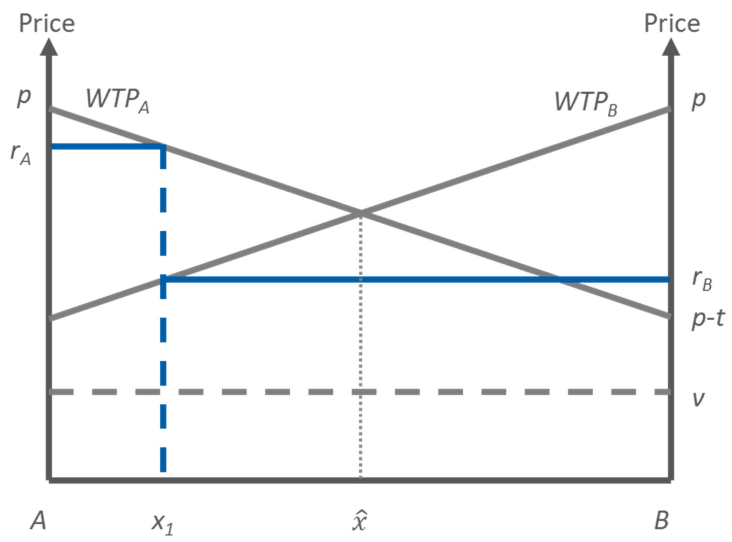

Figure 1: A spatial model of the land rental market

Given the distance cost, farm A (B) on the left (right) of $\hat{x}$ has a higher willingness to pay, e.g. if $p_A = p_B$, $\hat{x} = 1/2$ and the maximum willingness to pay for land is $r_A = WTP_A(x_1)$ at location x_1 for farm A, but B is only able to pay $r_B = WTP_B(x_1)$ and the landowners' willingness to accept (WTA) at x_1 is v (see Figure 1).

Because of the (perfectly) price-inelastic local land supply, uniform pricing is the profit maximizing price strategy for farms (Espinosa, 1992; Graubner et al., 2011a). Under uniform pricing, a farmer offers the landowner an identical rental price irrespective of the distance from the landowner's plot to the farmstead as long as it generates (local) surplus to the farm. In a non-cooperative setting, no Nash equilibrium under uniform pricing exists (Schuler and Hobbs, 1982; Zhang and Sexton, 2001).

If farms A and B decide their rental prices according to an average of the prices of neighbouring farms (Balmann et al., 2021), a spatially-cooperative price matching competition emerges (Gronberg and Meyer, 1981; Graubner et al., 2011b). In equilibrium, farms set rental prices at the landowners reservation price (Graubner, 2018) to capture all of the suppliers' (landowners') surplus (Zhang and Sexton, 2001). For instance, at location x_1 the owner's surplus is zero because $r_u = v$, but both farms could yield non-zero profits if they offer r_u and rent that land (see Figure 1). The potential surplus of farm A is $p - tx_1 - v$ and larger compared to farm B: $p - t + tx_1 - v$. Tie-breaking rules determine which farm rents land at location x_1 (Gronberg and Meyer, 1981; Iozzi, 2004). Since both farms offer the same price r_u, one could assume that landowners randomly select the tenant, but farmers in Eastern Germany often exchange rented land to round off their farmland area (Margarian, 2008). The practice corresponds to the efficient tie-breaking rule (Iozzi, 2004), i.e. the farm with the lowest distance costs rents the plot. Hence, farm A obtains the surplus from the plot at x_1.

If all land in the market is rented so that no farm owns (at least part of) its operated land, the equilibrium rental price $r_u = v$ yields landowners surplus in the market of

$$\int_0^1 r(x) - v dx = 0 \tag{2}$$

while the surplus of the farmers is

$$\int_0^1 p - t|x - x_i| - v dx = p - \frac{t}{4} - v \tag{3}$$

with $x_i = [0, 1]$.

2.2 Land sales market

Instead of renting land, farmers may prefer buying it due to the transaction costs of negotiating rental contracts, the search costs associated with losing contracts and related risks. Seeking hedges against inflation, storing wealth, stabilizing portfolios, etc., may motivate non-farmer buyers to acquire farmland. Liquidity reasons or other investment options are incentives for landowners to sell land.

The common approach to model land values R is the net present value (NPV) model, which discounts a stream of expected returns over an infinite time horizon (Goodwin et al., 2003); cash rents are an observable option for such returns (Borchers et al., 2014). Accordingly, any rental price $r(x)$ in Figure 1 represents the potential annual returns from owning land. Using the NPV model yields a local sales price:

$$R(x) = \sum_{n=1}^{\infty} \frac{r(x)}{(1+d)^n} \tag{4}$$

where d is a constant discount factor.

Lands immobility, local specificity, spatial distribution and low market liquidity (Bigelow et al., 2020; Kionka et al., 2022) characterize farmland sales markets as a static, one-shot game. In this setting, farms have less incentives for collaboration (Espinosa, 1992). In terms of local returns, the lowest WTP at any location determines the non-cooperative, Nash-equilibrium sales price $R^*(x)$(Graubner et al., 2021; Lederer and Hurter, 1986; Thisse and Vives, 1988).

For $p_A = p_B$, the red lines in Figure 2 show the resulting local land price schedule.

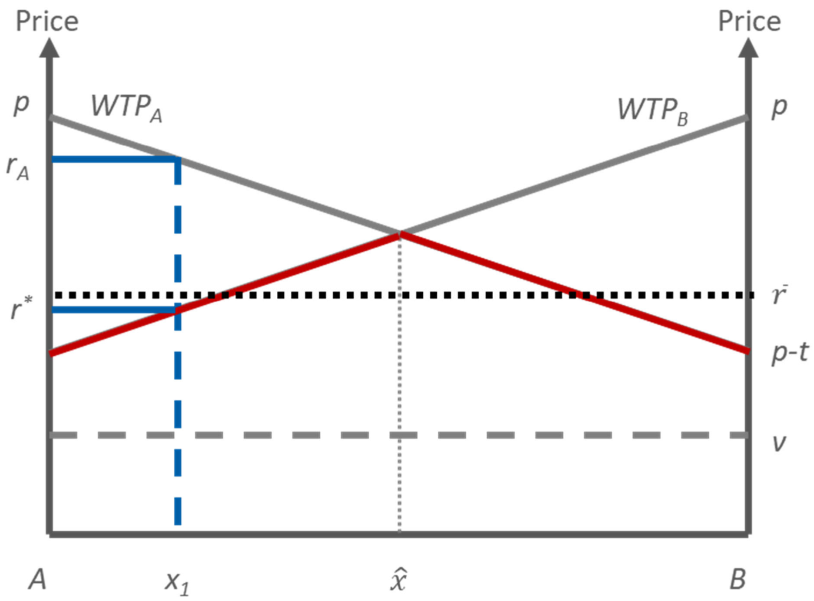

Figure 2: A spatial model of the land sales market

Farm A (B) can profitably purchase land left (right) of $\hat{x}$. At location x_1 the surplus of farm A, pricing marginally above $WTP_B(x_1)$, is $WTP_A(x_1) - r^*(x_1)$ and the landowner's surplus is $r^*(x_1) - v$. Under perfect information, all landowners and potential buyers can observe the local prices. The cost of search and information gathering, however, may be asymmetrically distributed among market participants; sellers and buyers might not be able to acquire all the information about market conditions and specific attributes of the respective land plot (Meissner and Musshoff, 2022). For instance, local farmers can be better informed than non-local farmers and other buyers (Seifert et al., 2021). Accordingly, these groups only observe the average sales price $\hat{R}$ in a region. The dotted line in Figure 2 shows the corresponding average return $\bar{r}$, given by:

$$\bar{r} = \frac{p(0) + p(\hat{x})}{2}\hat{x} + \frac{p(\hat{x}) + p(1)}{2}(1 - \hat{x}) = p - \frac{3}{4}t. \tag{5}$$

Using the average return via (4), we obtain the average sales price $\hat{R}$. We observe that $\bar{r}$ increases with increasing marginal revenue from the land but decreases with distance costs. We can make qualitatively similar observations for the farmer's WTP and thus the equilibrium sales prices, but not for the equilibrium rental prices that are independent of p or t (2). The landowner surplus in the sales market is

$$\int_0^1 r(x) - v dx = \frac{1}{4}(4p - 3t - 4v) > 0, \tag{6}$$

where $r(x) = \min\{WTP_A(x), WTP_B(x)\}$. The surplus of the farmers is

$$\int_0^1 |WTP_A - WTP_B| dx = \frac{t}{2}, \tag{7}$$

which is always smaller compared to the surplus of farms in the rental market (3). In other words, renting is preferable to buying in an atomistic landownership structure and under the assumption that the rental market is less competitive than the sales market.

3 Shocks in farm output markets

Many empirical studies identify substantial capitalization of price shocks in farm output markets caused by farming policies or other factors on land rentals. However, capitalization is lower than theoretically expected (Ciaian et al., 2021; Latruffe and Le Mouël, 2009). This has been attributed to imperfect competition in local land rental markets (Kirwan and Roberts, 2016): if the marginal revenue for land p changes due to external price shocks, farms' WTP changes as well. But if the landowners' reservation price v is independent of a plot's marginal revenue, the equilibrium rental price does not change, and no price transmission from the farm output market shock to the rental market occurs (Graubner, 2018). A shock or policy does change the reservation price if landowners believe that an external shock may affect a plot's future use and its return.[1]

The resulting effects on the land sales prices will depend on whether all or only a part of the farm population benefits or loses by the external shock. [2] Figure 3 shows that when farm B benefits by a higher net marginal revenue of land, farm B's WTP shifts by s for each location.

Not receiving a higher return, farm A's WTP does not change, but does alter the local price it has to pay to obtain land (for $x = [\hat{x}', \hat{x}]$) and also increases the area where farm B has a cost advantage over farm A to $1 - \hat{x}'$. The (new) Nash-equilibrium sales prices $r'(x)$ also causes the average observed sales price $\bar{r}'$ to increase but the difference $\bar{r}' - \bar{r} < s$ due to the asymmetric effect on local prices, i.e., in Figure 3, left of $\hat{x}'$ the price effect is s but right of $\hat{x}$ it is zero.

4 Location specific effects of alternative uses of land

In specific area x_R, we assume landowners expect it will be used for urban or infrastructural purposes, renewable energy production, etc., and that future returns will exceed agricultural returns, i.e., the WTP of potential buyers and the landowners' opportunity cost (WTA) increase. Figure **??** shows the locations of alternative uses and the respective sales prices in specific area x_R; the prices typically do not depend on the distance to either farm.

More profitable alternative use increases the average observable sales price in the region, but the level of increase depends on the difference in

[1]The reservation price reflects alternative uses (opportunity costs) of agricultural land, e.g. forestation, subsistence or hobby agriculture, building land or renewable energy production. In the short run and depending on a plot's location, some alternative uses may be limited, and the reservation price may not account for changes in external conditions of farming (Graubner, 2018). In the long run, however, landowners may adjust their reservation price by incorporating government payments, potential alternative land designations, and the like, in expectations of future earnings (Hendricks et al., 2012; Kirwan and Roberts, 2016; Hüttel et al., 2016).

[2]For instance, price shocks in certain markets may affect farms differently depending on their production portfolio. Under farming policies, benefits might unevenly be distributed among farms given their willingness to participate in such programs or if the policy supports specific location characteristics, e.g. peatlands for carbon sequestration. Another example poses renewable energy subsidies, where farms investing in biogas receive subsidies for their energy crops.

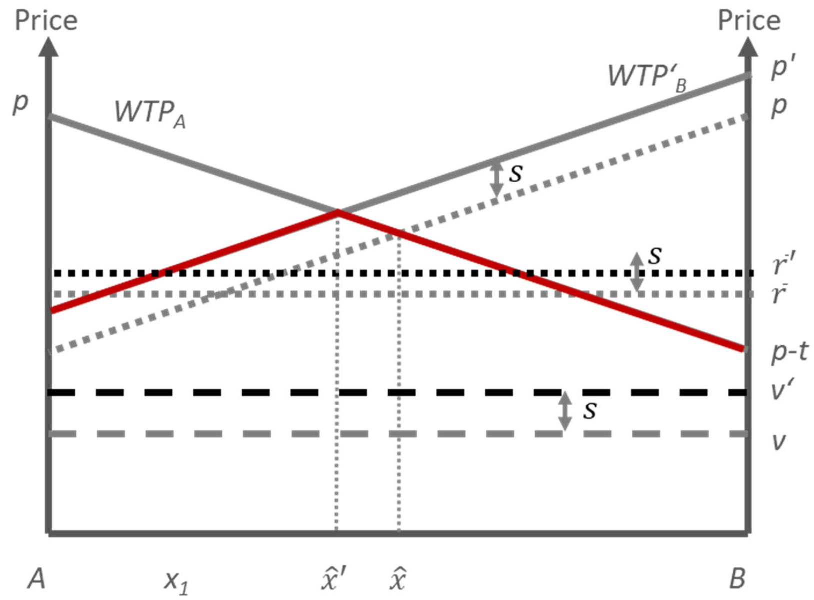

Figure 3: Effect of shocks in the output market on rental and sales prices.

returns and the size of x_R relative to the size of the region. Similarly, the rental price increases in x_R to v_R according to equation 4 but remains at v everywhere else. The effect on the average rental price in the region then depends on the difference of $v_R - v$ and, again, the size of x_R relative to the size of the region.

5 Discussion

The results of our proposed model outweigh those from models assuming that the rent-price ratio reflects average returns from farming, and that land values sufficiently capitalize current policies and future expectations. Our results suggest another potential for bias in Ricardian estimates based on average regional rental rates or sales prices presumed to be the outcome of perfect competition (cf. Ortiz-Bobea, 2020).

We find that while landowners' reservation prices do not change due to external shocks in farm output markets, the shocks do alter sales prices but not rental prices. We believe that rental rates are poor predictors for (changing) sales prices, and vice versa land-price ratios are poor estimates of farming returns. Should a farmland market become more competitive,

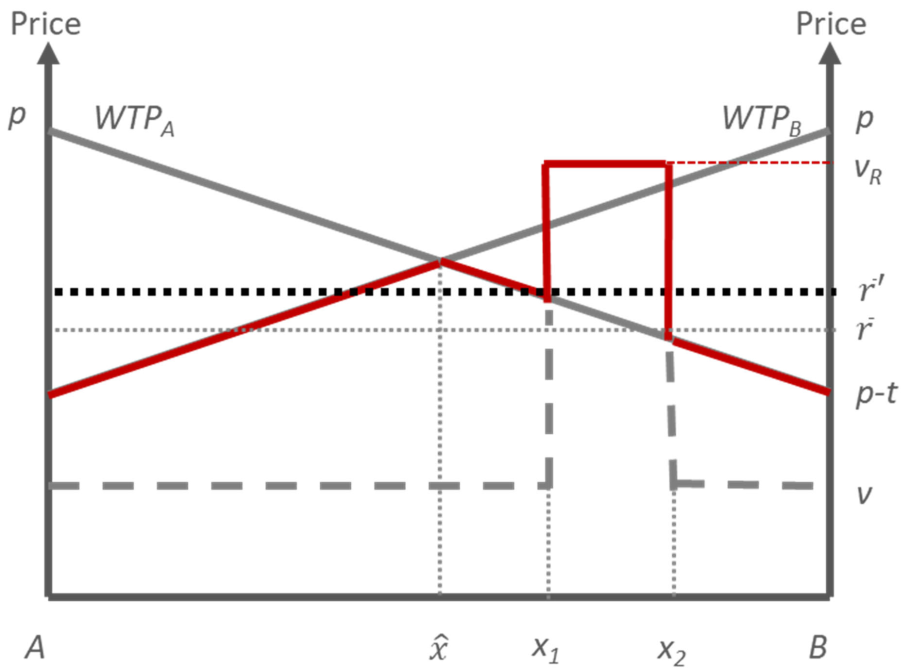

Figure 4: Location specific effects.

e.g., more competitors in the specific region, and/or a decrease in the region's distance costs – both signs of competition flatten the WTP-curves as shown in Figure 1 – rental rates are not affected when farmers behave cooperatively. Cooperative behaviour increases the discrepancies between rental and sales prices because the latter price increases according to equation (5). When there is non-cooperative behaviour in the rental market, an increase in rental rates will reflect a portion of the output price shock or policy, and the price transmission will increase as more farms compete (Graubner, 2018).

Finding that the observable (average) sales price $\hat{r}$ in a region increases with increasing market competition, i.e., by decreasing distance costs or to neighbouring farms and increasing number of competitors, suggests the need to control for the number of (potential) competitors and other liquidity measures in empirical farmland rental and sales price analyses (Balmann et al., 2021; Kionka et al., 2022), particularly when analysing the capitalisation of public farm support policies (Ciaian et al., 2021; Salhofer and Feichtinger, 2020). Our proposed model explains the wide range and the discrepancy of estimated capitalisation rates for agricultural subsidies by rentals and land prices (Ciaian et al., 2021), and why expectations of changing (non-farm) land uses increase capitalisation in land sales prices compared to rental rates (Ortiz-Bobea, 2020).

6 Conclusions

This note provided additional explanations for the variations in previous studies investigating the capitalisation of agricultural subsidies, energy policies, urbanisation, and zoning regulations. The proposed model identified distinct price formations based on the behavioural differences and expectations, between buyer and seller types, e.g., non-agricultural buyers seeking to hedge, or farmers seeking to expand their business, etc.

We believe that future empirical research continues to identify different outcomes and effects in farmland rental and sales markets under imperfect competition and we recommend controlling for local farming, policies, and land market structures. The effects of global heating on farm and agricultural lands and their rental and sales require additional research. The public demands that governments use the most accurate, timely climate change impact assessments on agriculture, to prepare for the future.

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