Market Power in Agricultural Land Markets: Concepts and Empirical Challenges

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1 Introduction

In recent years, demands for stricter regulations of agricultural land markets have been articulated in many EU countries. Aside from rising land prices, a particular concern is land concentration. As a result, in April 2017 the European Parliament adopted a resolution pointing out that the concentration of land in the hands of a small number of producers is distorting production and market processes, and is liable to have a counterproductive effect on farming in the Member States and the EU as a whole. The resolution also stated that the concentration of farmland would have an adverse effect on the development of rural communities and the socio-economic viability of rural areas. Land concentration may result in the loss of agricultural jobs and thus decrease the standard of living for the agricultural community, lower the availability of food supplies, and create imbalances in the territorial development and the social sphere (EUROPEAN PARLIAMENT, 2017). In Germany, the Federal Ministry and State Ministries of Agriculture established a joint workgroup "Bodenmarktpolitik" (land market policy) to assess needs and opportunities for tighter land market regulations. As an outcome, this group suggested to take measures that ensure a broad distribution of land ownership, the prevention of dominant land market positions on the supply and demand side, and the attenuation of increases in land rental and sales prices (BUND-LÄNDER-ARBEITSGRUPPE "BODENMARKTPOLITIK", 2015).

From an economic perspective, land market regulations that extend beyond a general institutional framework and ensure the functioning of markets are usually justified by the existence of market failures. One argument in favor of land market regulations postulates the existence of "excessive" speculation by land market investors (GEMEDA et al., 2019). If land prices deviate from their fundamental value, they send the wrong signals to market participants. Land markets are then not able to allocate scarce land resources efficiently. Such inefficiencies affect also the allocation and efficient use of other inputs. A second major concern, which we focus on in this article, addresses land concentration and imperfect competition in land markets. For instance, non-farming landowners may be able to extract excessive rents from farmers who need land, causing farm incomes to suffer despite of governmental income support (NICKERSON et al., 2012; CIAIAN et al., 2012). Large farms may also be able to exercise market power over (small) landowners or act as price leaders to the disadvantage of potential new entrants or smaller farms (CIAIAN and SWINNEN, 2006; GRAUBNER et al., 2021). In general, imperfect competition constitutes market failure that entails allocative inefficiency. POSNER and WEYL (2016) even argue: "Property is just another name for monopoly."

Due to the immobility of land, it is widely acknowledged that market power may affect agricultural land markets (e.g. KIRWAN and ROBERTS, 2016; O'NEILL and HANRAHAN, 2016). This is particularly true in the case of a dual farm structure, i.e., the co-existence of small and large farms (e.g. CIAIAN and SWINNEN, 2006; CURTISS et al., 2013) or if land ownership is more fragmented than farm sizes and their plots (CIAIAN and SWINNEN, 2006). Thus, it is surprising that apart from a few studies providing evidence that market power in land markets exists and has relevance, broader knowledge on causes,

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impact channels, and mechanisms, as well as the consequences of market power on price formation in agricultural land market is missing. This paper aims to close this gap and pursues three purposes. First, we review theoretical models and concepts that are able to capture market power taking into account specific characteristics of agricultural land, such as immobility and heterogeneity with regard to land qualities, location, and potential users. Second, we explore challenges that come along with an empirical estimation of market power in land markets, e.g. the definition of the relevant market and implications of market thinness. We review standard and non-standard hedonic models that have been applied in land and real estate markets. Third, we illustrate how land concentration as a potential source of market power may be measured and how land market power may be capitalized in land prices using the empirical example of the federal state of Brandenburg in Germany. Sections 2 and 3, which address the first and second objective, respectively, are designed as a review article, while section 4 contains an empirical illustration of some of the aforementioned concepts and modeling approaches. The paper ends with conclusions that identify research gaps and directions for further research on measuring market power on land markets.

2 Definition and Concepts of Market Power and Bargaining Power

In general, market power describes the ability of a market participant to impact economic decisions of other market participants through his/her market behavior (e.g., SAMUELSON and NORDHAUS, 2010: 170; PINDYCK and RUBINFELD, 2012: 19). In empirical applications, market power is commonly identified either by market structure, market outcome, or observing certain types of market behavior, such as collusion or cartel formation (BONANNO et al., 2018; MCCORRISTON, 2002). From the viewpoint of market structures, a firm is in command of market power if it has no or only a few competitors. This definition suggests the use of concentration indices based on market shares as an indicator of market power (e.g., BARLA, 2000). The interpretation of concentration indices in terms of market power is hampered at least by three issues. First, the calculation of concentration rates requires the definition of a relevant market and the degree of concentration is not invariant against changes in this definition. Second, determining critical thresholds for concentration indices that signal significant market power is arbitrary. The EUROPEAN COMMISSION (2004), for example, considers a Herfindahl-Hirschman-Index (HHI) below 1,000 as uncritical in the context of merger and acquisition control. It is, however, questionable whether this figure can be adopted in the context of land markets. A third concern is the ambiguity of concentration measures. The Structure-Conduct-Performance (SPC) paradigm in the tradition of BAIN (1951) postulates a clear link between market structure and firms' profits and predicts a higher degree of market power with a decreasing number of competitors. This view is challenged by the efficient market hypothesis according to which firms have heterogeneous cost structures (DEMSETZ, 1974). Due to competition, firms producing with low costs grow and expand their market shares and profits, while firms with higher costs are pushed out of the market. According to that, higher profits are not the result of exerting market power, but of superior efficiency. Note, however, that these two views, which provide alternative explanations for a positive correlation between market concentration and firms' profits are not mutually exclusive. In fact, efficient firms may exercise market power once they gained a large market share.

Because land capacity, i.e., maximum land supply, is fixed and typically exhausted in western economies, any increase in land use by one farm requires a release of land by another farm. The use of the fixed production factor land generates an economic rent for its owner, i.e., a payment in excess of the costs required to keep the land in production. In a competitive farm market, landowners earn a land rent that amounts to the excess payment. However, if market power prevails on both market sides, the factor price and thus the allocation of land rents is not uniquely determined and depends on the relative bargaining power of landowners and tenants (e.g. GERVAIS and DEVADOSS, 2006). This relates market power to the concept of bargaining power (NASH, 1950)[2]. When evaluating the outcome of bargaining processes, aspects of fairness and distributional justice may come into play. For example, it is often stated that land rental prices equal or even exceed the marginal value of land, which causes insufficient income capacities of farmers. At the same time, speculative returns of financial investors from land market transactions are blamed (e.g. KAY et al., 2015). This view rests on normative assumptions on how land returns should be distributed among landowners and active farmers and go beyond classical considerations of efficient factor allocation.

Land markets are characterized by several peculiarities that challenge the investigation of market power based on classical concepts outlined above. Land is immobile and, due to transport costs that emerge by cultivating land and traveling between the farmstead and the plot, farmers (*ceteris paribus*) prefer land in close proximity to the farmstead compared to land further away. Hence, land is a spatially differentiated production factor. Additionally, land characteristics (e.g., soil quality and plot size) can vastly differ within a region or even at the farm-level, which brings the concept of vertical differentiation of the production factor into play. Both, vertical and horizontal (spatial) differentiation causes market power and can generate rents, as has already been shown in the pioneering works of RICARDO (1891) and THÜNEN (1826). To investigate the allocation of rents between tenants and landlords or between sellers and buyers, spatial competition as well as search and matching models appear useful to cope with the unique features of land markets.

The basic foundation of **spatial competition models** is the geographical distribution of supply and demand in combination with positive transport costs. The latter, for instance, cause a decline in a farmer's willingness to pay for land with increasing distance. Particularly, the substitutability of a given land plot close to the farmstead by an alternative plot decreases with increasing distance of the latter. Vice versa, all farmers located in a "reasonable" economic distance from a land plot can be considered as competitors on the demand side, but (*ceteris paribus*) exhibit distance-specific willingness to pay for every plot. A central feature of spatial competition models is that market competitiveness in input markets is expressed in terms of the relationship of economic distances (among competitors) and marginal revenue (ZHANG and SEXTON, 2001) and that this relationship crucially determines market outcomes. While THÜNEN (1826) rationalized land use patterns (due to transport costs and a central market), HOTELLING (1929) provides with his "Main Street" model the canonical framework of spatial/horizontal product differentiation. Hotelling's focus is on the location decision of sellers that rely on consumers who need to travel from their location to the firm, i.e., consumers bear transport costs, which decreases their utility of consumption. This is typically termed non-discriminatory pricing (GREENHUT et al., 1987). In the context of land markets, however, the location of farms can typically be assumed to be fixed and farms bear transport costs, e.g., by driving to the plot of land to cultivate it (and back to the farmstead). In this setting, spatial price discrimination is feasible because land is

[2] Market power and bargaining power are related but different concepts. Market power manifests itself as bargaining power if market prices and quantities are determined through a negotiation process among a buyer and a seller. However, market power may also exist without explicit negotiations, e.g. in an auction setting or in a monopoly with numerous consumers. On the other hand, bargaining power also applies to non-market situations.

immobile and farmers may pay even for homogenous soil qualities local land (rental) prices that do not fully reflect transport cost differences between two locations, from the perspective of one farm (PHLIPS, 1983).

The choice of the spatial price policy by farms, i.e., whether or not to pay different prices to different landowners depending on their land's proximity to the farmstead, has important consequences for (farm) profit, income (of the landowners), and total welfare (GRAUBNER, 2020). On the one hand, the use of price discrimination itself is an indicator of market power (HOOVER, 1937). On the other hand, different price policies might be beneficial for the farm depending on the competitiveness of the (local land) market, which influences the welfare distribution (ZHANG and SEXTON, 2001). For instance, GRAUBNER et al. (2011) show that price discrimination is prevalent in settings comparable to land markets. GRAUBNER (2018) highlights that the distribution of policy rents is quite different under spatial competition in land markets compared to non-spatial (imperfect) competition.

While models of spatial competition can provide relevant insights in pricing and competition behavior of farms in land markets, two main limitations prevail: Beyond location, land is assumed to be homogeneous and transaction costs are assumed to be equal to zero. A second class of models deals with these issues. **Search and matching models** assume that buyers and sellers have to find each other via a costly search (cf. HAN and STRANGE, 2015; RUBINSTEIN and WOLINSKY, 1985; WOLINSKY, 1987). Once a potential buyer and seller have met, a bargaining process about the land price begins. One of the negotiating partners makes an offer and the other partner has the choice between accepting and rejecting the offer. This decision hinges on their value of no agreement, i.e., the reservation utility, which is partly private information, as well as on the costs of continuing the search process. The reservation utility of the seller captures the value of her/his own land use and alternative price offers, weighted against the offer made in the bargaining process. The buyer's outside options include alternative land acquisition, which may be of different quality and distance characteristics. Another typical feature of search models with market frictions is that they do not only clear via the price, but also via time. Thus, patience is a further important determinant of bargaining power in land price negotiations (MUTHOO, 1999). Indeed, the urgency of transactions can differ considerably. For example, a farmer or investor, who intends to acquire land to avoid tax payments, such as due to the disclosure of hidden reserves, is most likely willing to pay a premium beyond an average location value. Farmers or investors without financial distress and other time limitations can wait and invest time in searching for alternative offers.

As rental and sales markets differ with respect to number and composition of market participants, distinguishing between these markets when analyzing market power seems useful. While the demand side in the rental market for agricultural land is dominated by (local) farmers, potential buyers in the sales market are diverse and are comprised of, among others, local and non-local farmers, agro-holdings, non-agricultural investors, churches, and public institutions. At the same time, interrelations between both markets exist. For instance, non-local farmers or other actors may compete with local farmers in the sales market with the intention to invest (rather than to operate the land themselves). These buyers, however, act as future suppliers in the rental market. The prevailing understanding is that farmland prices and land rental prices are linked through asset pricing theory. Thus, economic rents attached to the production factor land are capitalized into farmland values, (LATRUFFE and LE MOUËL, 2009; FEICHTINGER and SALHOFER, 2013). Moreover, renting land constitutes an alternative to immediately selling or buying land, at least temporarily, which has implications for the bargaining position of landowners.

Summarizing, the respective market structure described by the number of (potential) buyers and sellers, which is in farmland markets typically low with limited outside options, determines whether market power and thus bargaining emerges. However, the degree of bargaining power will be affected by personal and/or firm characteristics of sellers and buyers as well. These determine the willingness to invest in further market search, acquiring information, competencies, and negotiation abilities. The bargaining position will also be determined by available information about the uncertain land value and characteristics of the opposed negotiating party, e.g., professionalism and experience with land trading.

3 Empirical Analyses of Market Power in Real Estate and Land Markets: Challenges and State of the Art

Spatial competition as well as search and matching models can be used to predict the relative bargaining power and the sharing of land rents among market participants. However, it is not straightforward, how predictions from these models can be empirically estimated. In this section we discuss some challenges and econometric approaches for the empirical estimation of bargaining power on land markets.

3.1 Challenges

Outcomes of immobile and largely heterogenous goods markets, such as land and real estate, are governed by local specificity and the underlying market microstructure, including, *inter alia,* transaction mechanisms (e.g., negotiations and auctions), (potential) market participants, liquidity, and agents' search processes. Land markets are thus local and must be treated as decentralized. While financial investors and capital are rather mobile, agricultural production is usually tied to farmsteads and transport costs hinder the substitutability of land parcels at different locations. That is, even if investors are willing to buy agricultural land irrespective of its location, they are forced to find local farmers in the rental market. Immobility and heterogeneity of land imply that local land markets are typically thin in the sense that only a few potential sellers and buyers interact. A challenge for the empirical investigation of market power is thus the delineation of the relevant market (BAILEY et al., 1995). This comprises finding the relevant land market as the factor market regarding substitutability among lands and the respective regional market. Negotiated price advantages will not be sustainable if, for instance, buyers can fall back on land with similar properties offered by other sellers (relevant for the bargaining position). Hence, lands with substitutability regarding quality of soils and lot size are considered as a bundle belonging to the same market. Given the immobility and its pedologic soil constitution, farmland quality and productivity vary considerably even at small regional scales. While substitutability of land can be presumed under such conditions, the degree and cost of substitutability depends on quality, size, and other lot characteristics, as well as on the intended use of the respective buyer. For cases where the intention to buy is using the land for operation, substitutability requires the determination of an acceptable distance (in kilometers or travelling time) between a farmstead and a land plot to determine the relevant markets. COTTELEER et al. (2008) derive the size of the local land market from the empirical distribution of distances between the location of the buyer and plot. They find that, for the Netherlands, 90 percent of agricultural buyers are located within a 6.7-kilometer radius of the parcel they buy. For the German state of Brandenburg, PLOGMANN et al. (2022) find that 90 percent of newly acquired operated land is within a radius of 11.8 kilometers around the farmstead. Interest for land in terms of the willingness to pay, however, will not be constant within this radius and will instead depend on transport cost and relative distances (BAKKER et al., 2018).

Besides transportation issues and land characteristics, the value of agricultural land is determined by local market characteristics, regional amenities and policy (HÜTTEL et al., 2013; NICKERSON and ZHANG, 2014; FEICHTINGER and SALHOFER, 2013), all of which determining the "relevant" market and thus the potential to exercise market power. In this regard, policies impacting the local number of competitors, agents' risk and investment behavior, as well as information access and thus market transparency have been discussed (e.g., GRAUBNER, 2018). For instance, HENNIG and LATACZ-LOHMANN (2017) discuss effects of biogas feed-in tariffs on land rental prices. The effects they find are constrained to the local land and feedstock market structure and occur only "*in combination with the local competitive situation and agglomeration economies*" (HENNIG and LATACZ-LOHMANN, 2017: 2248).

As empirical analyses typically target prices as the main market outcome, analyzing the role of market power thus requires the acknowledgement of the roles of the market microstructure—including respective agents and the potential to exercise market and bargaining power—and typical market thinness (cf. NICKERSON and ZHANG, 2014: 121; HAN and STRANGE, 2015: 834). In Germany, for instance, land valuation committees (*Obere Gutachterausschüsse für Grundstückswerte*) provide estimates for location values for agricultural land, namely prices for normalized lots in designated zones (HELBING et al., 2017). Actual transactions, however, can vary considerably around these values, even if core land characteristics are acknowledged. Such observed farmland price dispersion for the same fundamental value that could be attributed to typical farmland market thinness has recently gained attention (e.g., BIGELOW et al., 2020); (KIONKA et al., 2021) in contrast to real estate market analyses, where market illiquidity has longer been noted to explain such price dispersion. For instance the required time for a sale has been shown as a potential source of bias in the valuation of real estate that often presumes an immediate transaction (e.g., LIN and VANDELL, 2007).

3.2 Models

Given the before ascribed features of land markets, investigating market power via the outcome of a search and bargaining process for a specific land plot seems to be more appropriate than considering the land market as an abstract market that is characterized by supply and demand functions. Thus, ROSEN's hedonic pricing model denotes a typical starting point for farmland (and real estate) price analysis (NICKERSON and ZHANG, 2014).

In **standard hedonic models**, the presence and price impact of market and bargaining power is inferred from an advantage in the search, information gathering, and bargaining process of a specific agent or agent type. This advantage can be observed as specific price markups or markdowns of sellers or buyers, respectively. The higher the respective advantages are, the larger are the effects. To identify such markups or markdowns with observational data in hedonic models, advantages are attributed to observable seller and buyer characteristics. Adding variables ascribing seller and buyer types to the hedonic price function allows the testing of buyers' or sellers' relative advantage in the bargaining process by testing for systematic price impacts of those variables (HARDING et al., 2003a; HARDING et al., 2003b). For the housing market, HARDING et al. (2003b) find seasonal bargaining power from the presence of school-aged children, offering sellers to take the greater share of the bargaining surplus if the families, for instance, are pressured to get into a valuable school district. Other examples from the real estate and housing market include less experienced first-time buyers (e.g., WILHELMSSON, 2008) and first-time sellers (e.g., LARSEN and COLEMAN, 2014). Based on the idea that opposing agents with equal characteristics face a balanced bargaining process, COLWELL and MUNNEKE (2006) and HAYUNGA and MUNNEKE (2019) rely on differences in seller and buyer characteristics to analyze house price effects from asymmetries in information and bargaining power.

The role of the search and bargaining process and thereby the potential price impact of bargaining power in farmland (rental and purchase) price formation has rarely been investigated. KING and SINDEN (1994) offers a framework that conceptualizes the bargaining process and explicitly notes the search process and related cost. The authors rely on a hedonic pricing framework but differentiate initial bid and offer prices in their empirical models and relate seller and buyer characteristics to price formation. In their empirical analysis, the authors consider variables describing local microstructural market conditions, such as the number of buyers, and search related variables, such as actors' time in the market. Based on the hedonic approach by HARDING et al. (2003a) and refinements by COTTELEER et al. (2008), some recent studies investigate the influence of bargaining power on rental price formation (KUETHE and BIGELOW, 2018; TEMESGEN and DUPRAZ, 2014; LOUGHREY and HENNESSY, 2019; GEBREHIWOT and HOLDEN, 2020). To summarize, these studies have in common an adjustment of the standard hedonic model to the peculiarity of thin (land) markets in order to model agent-types' price influence rooted in type-specific search and bargaining costs; this is typically operationalized by adding variables describing or reflecting agents' characteristics under the assumption that search and bargaining costs vary with these characteristics.

The relevance of different market agent types for price formation has also been extensively examined in the literature without explicitly acknowledging the bargaining process and asymmetric power relations. For instance, different prices paid by different buyer types can be explained by different information levels and related costs (DEVANEY and SCOFIELD, 2017) or different expectations about future land use (BRORSEN et al., 2015). The latter has been shown to be strongly related to urbanization, with future urban land use offering speculative gains through urban sprawl. Such (uncertain) development options of land are highly price relevant (CAVAILHÈS and THOMAS, 2013; DELBECQ et al., 2014). Relating non-farmer buyers to the group of investors, VYN and SHANG (2020) find that in urban areas, investors pay higher prices compared to farmers as a result of speculation about future land development. Urbanization, however, may not only affect the willingness to pay, but may increase the number of potential buyers (thickness effect) and, in turn, influence the local market structure and thus the potential to exercise market power (e.g., COTTELEER et al., 2008).

When describing the local market structure as it asserts the potential to exercise market power, few studies rely on concentration measures entering the hedonic function as additional variables. These encompass for instance, the number and size of farms in administrative units from which the presence of market power in farmland markets could be inferred (BACK et al., 2019; MARGARIAN, 2010). CURTISS et al. (2013), for instance, use the number of farms in a region to reflect potential local market competition.

Competition for plots can depend on plot size given that the number of potential competitors might differ. This effect may be amplified in urban proximity (BRORSEN et al., 2015; RITTER et al., 2020). Thus, identifying market and bargaining power effects requires accounting for the intention to use (an investor with the intention to lease out and a farmer buyer with the intention lease out or operate). Respective response coefficients in hedonic models related to variables describing the buyer characteristic would then denote potential markups or markdowns induced by market and bargaining power beyond transportation cost advantages, or price markups due to increased competition from a high number of potential buyers, for instance in urban proximity. Some studies infer from buyer types the intended land use, such as by presuming that non-agricultural buyers intend to buy and lease out, or proximity to the lot. For instance, SEIFERT et al. (2020) argue that tenant buyers are more likely to be located in close proximity to the lot as local buyers. Thus, tenant buyers are presumed to buy the land for operation. Following the idea that local buyers have better information about the market, they have a better bargaining position. As SEIFERT et al. (2020) show, this group can achieve price markdowns when buying medium-sized plots. For smaller plots, more potential buyers may exist and could create market thickness effects.

Neglecting local market microstructure and consequences from informational asymmetries on the search and bargaining process could lead to biased estimates in the hedonic model due to omitted variables bias (CARRIAZO et al., 2013). Recently, GRAUBNER et al. (2021) illustrated theoretically and empirically that rental prices in Ukraine increase with increasing spatial competition. The authors also show that the competition strategy of farms in land markets matters. For instance, large farm enterprises (agroholdings) may act as price leaders in local land markets. This explains why their subsidiary farms manage more land while paying higher rental rates than independently operating competitors. Also APPEL et al. (2016) argues that local land competition impacts prices: they show that land competition can be accelerated by biogas investments with price-increasing effects in local land rental markets with high investments.

Various kinds of **spatial and spatio-temporal econometric models** have been used to acknowledge the regionality and potential interdependencies of the decentralized land markets (e.g., HUANG et al., 2006; MADDISON, 2009). Implicitly, these approaches ca be seen as another strategy to mitigate a omitted variables bias in hedonic models. However, applying such spatial empirical models to the land market is *"far from problem-free"* (NICKERSON and ZHANG, 2014: 124), especially when assessing the role of market microstructure with respect to market power. Typically estimated by maximum likelihood that relies on the true (known) model structure, it seems ironic that these models are used in cases where the structure is unknown. Relying on exogenously specified weight matrices based on administrative units and straight-line distances (rather than distances to the farmstead or based on transportation costs), however, bears the danger that the relevant local market structure may not be reflected, resulting in biased estimates. Moreover, the size of administrative units can largely differ, which could hamper comparing concentration measures across regions. Thus, controlling for spatial effects implicitly and explicitly at different layers has been proposed to help mitigating omitted variables bias that may arise through inappropriate reflection of the complex capitalization gradients of local (dis-)amenities (ABBOTT and KLAIBER, 2011).

Standard hedonic models, irrespective of the empirical spatial modelling framework, however, rest in fact on a thick markets' assumption. Adjusted to the context of thin markets and assuming land as a largely heterogeneous good, the core idea is that in thin markets, the respective surplus over which agents can bargain will be extracted by the party with more efficient search processes, informational advantages, and bargaining strength (DOBSON et al., 2001). To mitigate biases from neglecting consequences from informational asymmetries in thinly traded and decentralized markets, adjustments of the estimation framework and therefore **non-standard hedonic models** have been proposed. This type of model offers exploiting the surplus distribution between sellers and buyers, under which structural conditions and plot characteristics markups or markdowns prevail. Two-tier approaches (KUMBHAKAR and PARMETER, 2010, 2009) have been proposed, rationalized by information deficiencies and bargaining (dis-)advantages that cause price dispersion around the equilibrium price. SEIFERT et al. (2020) first applied this model to the farmland market and find price markups for professionally organized sellers, but markdowns for tenant-farmer buyers limited to medium-sized lots. This result could not have been identified with standard hedonic models. In highly dynamic markets, however, where strong power relations distort price formation, the assumption that the majority of transactions are close to the competitive price and the surplus to be extracted by one agent is with a high chance low or close to zero, cannot be justified. Hedonic models are still useful in this context. Their estimates can serve as upper or lower boundaries of the marginal willingness to pay (NICKERSON and ZHANG, 2014). To infer the direction of the distortion and role of the market microstructure, CURTISS et al. (2020) rely on stochastic frontier approaches with one-sided deviations from buyer type hedonic price functions to analyze buyer power in the Czech farmland market. They find considerably lower prices paid by farmer buyers due to their strong market position, but divergence of farmer and non-farmer buyer frontiers to diminish over time with increasing market transparency.

4 Empirical Challenges: Illustrations for the German Farmland Market

We rely on three databases: First, the Integrated Administration and Control System (IACS), which contains information about the amount and type of land operated by each farm, including cultivars at the field level and field size; second, the cadastral land register (ALKIS), which offers information about land ownership allowing the estimation of ownership concentration; third, sales transaction data from local committees of land valuation experts, which has information about land prices, lot-specific and seller/buyer characteristics. A comparable data set for rental prices is, to the best of our knowledge, not available. Thus, we focus on land sales markets.

The IACS serves as the basis for the allocation of agricultural subsidies by the EU (LETEINTURIER et al., 2006). Since 2005, the IACS is stored in the Land Parcel Identification System (LPIS), a geographic information system that identifies all plots within the EU on the cut-off date of May 31 each year (EUROPEAN COMMISSION, 2020). We can rely on data from 2007 to 2018 (preprocessed following LAKES et al. (2020)). Based on a unique farm identifier, the data permit to identify plots operated by one farm, from which we can calculate regional concentration measures for land use. Agricultural holdings that own different farms, however, possess several farm identifiers and cannot be identified as a holding.

The official information system of the cadastral land register (*Amtliches Liegenschaftskatasterinformationssystem*, ALKIS) combines real estate information in a uniform cadaster based on international standards. For each parcel of agricultural land, the ALKIS stores personal information of private owners, the name of the company, or of the institutional owner. Ownership information is attached to a spatial data layer that contains all properties with high topological accuracy and is continuously updated. These data enable to quantify ownership patterns through aggregating identical owner entries, which allows us to approximate ownership structures (MÜLLER et al., 2021). ALKIS has previously been used to characterize ownership structures of agricultural land for

59 municipalities (Gemeinden) across Germany (TIETZ et al., 2021). However, ALKIS data do not permit us to extract corporate ownership arrangements, such as when an agent owns several subsidiary companies. Illustrating corporate ownership requires linking ALKIS to additional databases such as commercial registers, which allow to reveal company structures and subsidiaries companies (TIETZ et al., 2021). The ALKIS data on ownership refer to the cut-off date of February 15, 2019 and were available to us for the county (*Landkreis*) of Märkisch-Oderland, located in eastern Brandenburg. Agriculture constitutes the backbone of Märkisch-Oderland and is dominated by large farms, including a vivid land market with a sizable number of transactions compared to other regions in Brandenburg.

All sales transactions in Germany, including farmland, forests, building land, and developed real estate, are traced by regional committees of land valuation experts (*Gutachterausschüsse für Grundstückswerte*). For Brandenburg, we can rely on transaction specific data for agricultural land covering the years 2007 to 2018. The data comprise the transaction price, lot size, soil quality, type of land use (arable land or grassland), anonymized information about the buyer type (farmer or non-farmer, former tenant or non-tenant) and seller (public, professional, or private sellers). The location of a transacted lot is recorded using the coordinates of the transaction, which allows us to match the transactions with IACS and ALKIS data.

4.1 Land Use and Ownership Concentration

To calculate land use concentration with the IACS dataset, we rely on the farm identifier, derive the area operated by each farm, and compute the concentration of land use for the one (CR_1), two (CR_2), and three (CR_3) largest farms at the municipal level in Brandenburg PLOGMANN et al. (2022). Figure 2 portrays the concentration rate in Brandenburg as the percentage of land operated by the two largest farms (CR_2) per municipality in 2007 and 2018. The figure suggests large heterogeneity between municipalities and over time, but no clear spatial pattern or trend appear visible.

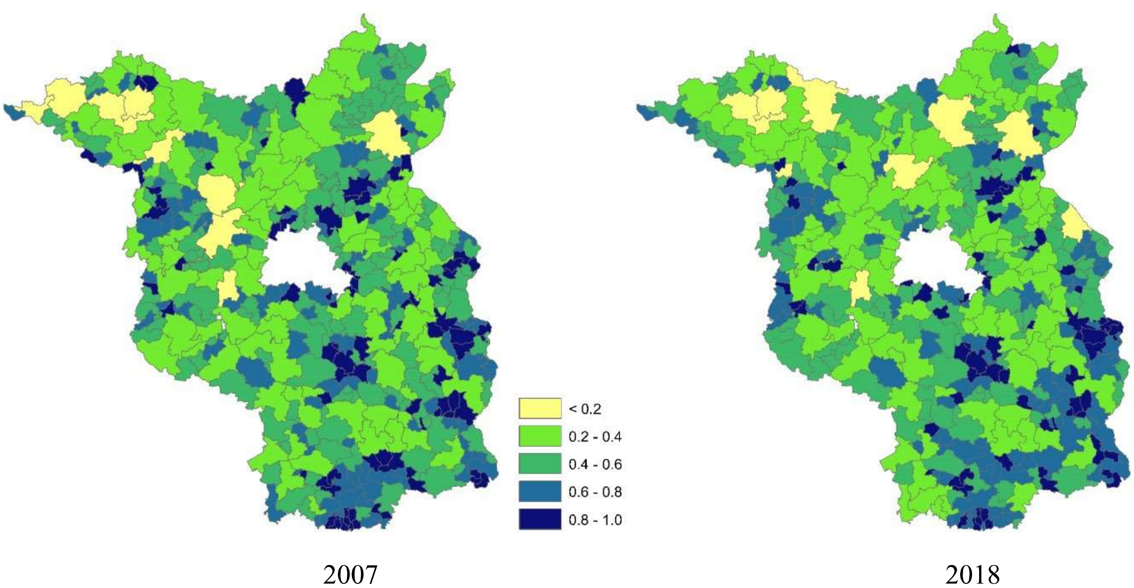

Figure 2: Land use concentration of the two largest farms at the municipal level in 2007 and 2018; data source: IACS

To quantify ownership concentration, we calculated the Gini-coefficient from the ALKIS data for Märkisch-Oderland. The Gini coefficients, as illustrated in Figure 3, reveal a moderately high concentration of agricultural land.

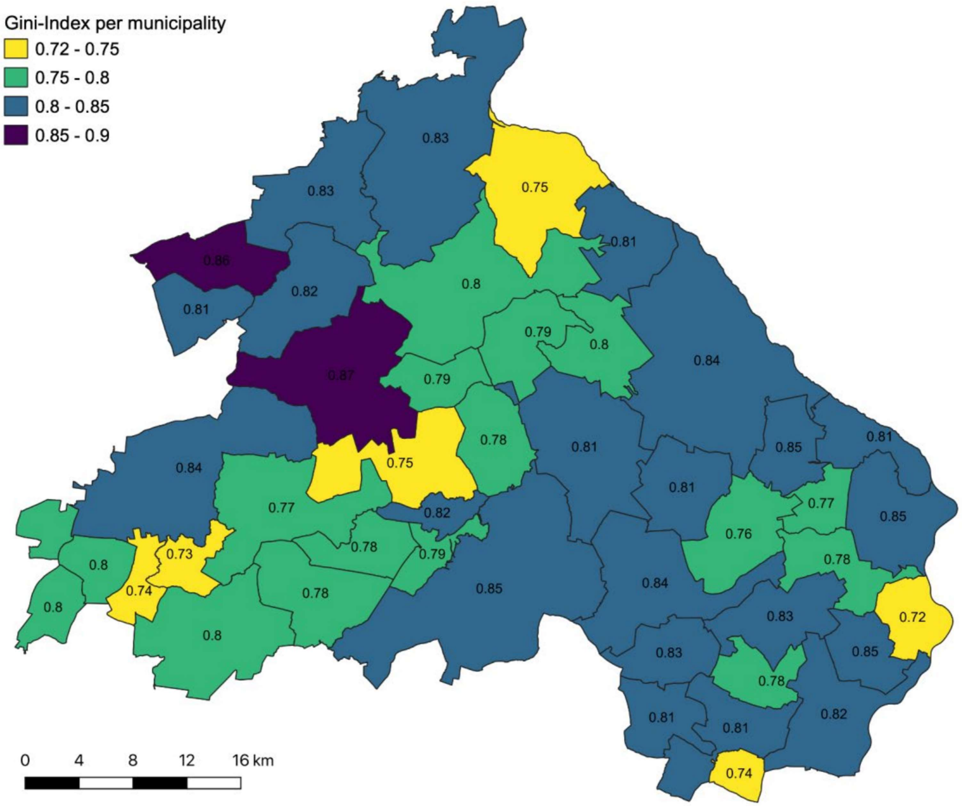

Figure 3: Gini coefficients of land ownership at the municipal level (*Gemeinde*) in Märkisch-Oderland (adapted from MÜLLER et al. (2021))

4.2 Market Microstructure and Seller Concentration

We measure the market microstructure (thinness) with the number of transactions and potential seller concentration based on farmland sale transactions data. Figure 4 a) depicts the density of land sales transactions between 2007 and 2018 in Brandenburg. It shows higher land market activity in eastern counties (e.g., in Märkisch-Oderland) and west of Berlin (Havelland), and lower activity in the north. However, the available data do not allow to identify whether a single seller or buyer contributed a large share to the observed transactions. The required detailed information on buyers or sellers is not available.

Sales by the *Bodenverwertungs- und -verwaltungs GmbH* (BVVG), the federal agency assigned the task to privatize land expropriated and collectivized during the socialist phase in eastern Germany, can be identified. The BVVG is an actor specific to the land market in eastern Germany and relies on first price sealed bid auctions with public tenders, special tenders for young and organic farmers, and direct sales to former owners and tenants (cf. CROONENBROECK et al. (2020) or WOLZ (2013) for details). Transaction data show that between 2007 and 2018, 35% of the total transacted land was sold by the BVVG, indicating a potential seller concentration. Figure 4 b) shows the regional share of area sold by the BVVG, which seems higher in the north. Although the BVVG is the largest professional seller in Brandenburg, we only find a few clusters with a high share of area sold by the BVVG and thus where the BVVG could act as a monopolist over the study period. Nevertheless, the BVVG could have exercised market power differently, e.g., because of its flexibility regarding the timing of land sales and hidden reservation prices which may have led to repeated auctions.

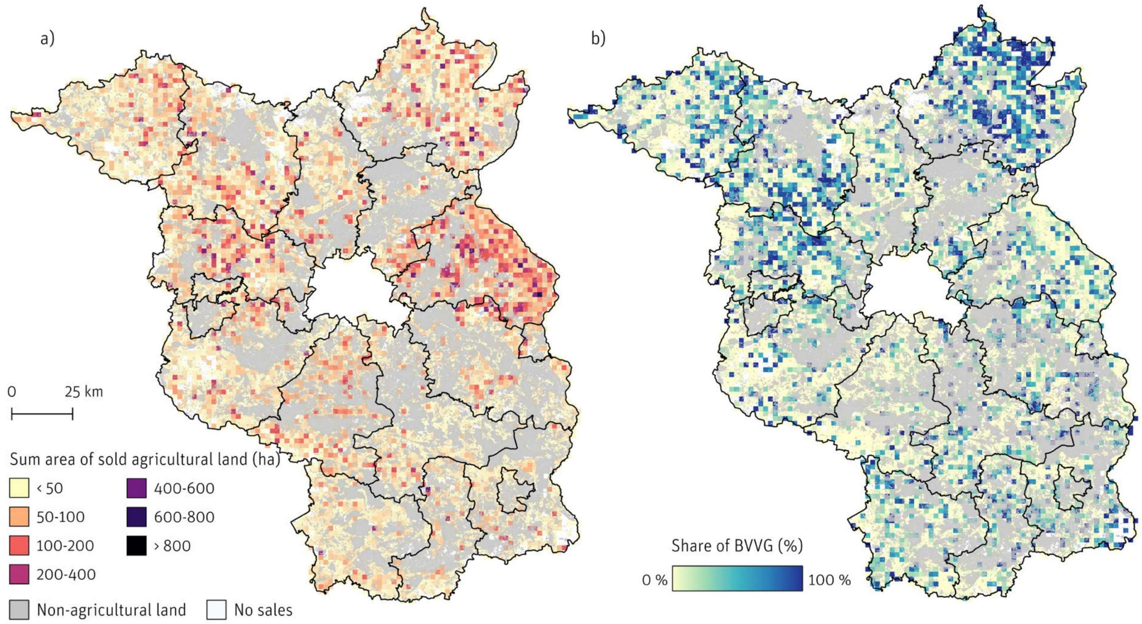

Figure 4: a) Sum and b) share of agricultural land sold by the BVVG in Brandenburg between 2007 and 2018 (both maps summarize the sales area on a 2 km x 2 km grid)

4.3 Investigating the Price-Concentration Relation

To demonstrate how currently available data can be applied to infer potential price impacts of market power on the buyer side, we analyze the relationship between land purchase prices, land concentration, and variables describing the local market structure for the German federal state of Brandenburg.

We use a *standard* hedonic price regression framework (see Section 3.2), where observed transaction prices P are expressed as a function of lot characteristics x, such that $P = h(x) + \varepsilon$. Therein, $h(\cdot)$ denotes the hedonic pricing function and ε collects measurement error and noise. We merge a sample of farmland transactions in Brandenburg with the other data sources specified in Section 4.2. and 4.3. Thereby we can account for the market structure explicitly by additional variables capturing land use and seller concentration, the market microstructure and seller and buyer types besides x. To control for spatio-temporal variation, a time trend and spatial dummy variables are included as control variables.[3] The hedonic pricing function thus consists of four parts: lot characteristics, concentration measures, variables describing the local market structure, buyer and seller types, and spatio-temporal control variables.

Lot characteristics include the lot size x_s, soil quality x_q, and a dummy variable G that equals one for grassland and zero for arable land. To account for concentration with respect to land use, we consider concentration rates of either the largest (CR_1), the two largest (CR_2), or the three largest (CR_3) farms at the municipal level. Following Section 2.1, concentration rates serve as a proxy for market power. Because we have access to ALKIS data only for one county, we refrain from including ownership concentration in the subsequent regression analysis. To quantify the impact of the concentration in land operation, we estimate three models, M1, M2, and M3, that consider CR_1, CR_2, and CR_3, respectively.

[3] As shown by ANSELIN and ARRIBAS-BEL (2013), spatial fixed effects do not necessarily remove spatial autocorrelation but can mitigate omitted variable bias.

We further include other variables that may capture competition effects and the potential presence of market power on the buyer side. We use the number of bidders in BVVG auctions as an indicator for potential demand and consider the 75% quantile of the observed number of bidders submitting buy bids (bb_{Q75}) and lease bids (lb_{Q75}) in auctions in the year prior to a transaction in the respective county. Using the 75% quantiles instead of the maximum will mitigate the effect of single auctions with a very high number of bidders, e.g., for lots with alternative land use. Likewise, using the lagged variable will dampen the risk of potential endogeneity regarding observed prices.

We use several variables to reflect the local market microstructure: for each transaction we add the local share of transactions (at the municipal level) by the BVVG in the two years prior to the transaction (m_{BVVG}). To account for the availability of farmland, we use the municipality's share of utilized agricultural area (UAA, m_{UAA}). To analyze potential effects related to market liquidity, we add the total number of transactions (TA) in the respective year in the municipality.

Seller and buyer types can differ, such as in their level of professionalism, and thus differ in their search and bargaining costs. To account for such potential price impacts indicated by different seller and buyer types (cf. SEIFERT et al., 2020), we add dummy variables differentiating lots sold by BVVG (s_{BVVG}), professional sellers (s_{Prof}, e.g., real estate agents), and public sellers (s_{Pub}, e.g., municipalities). On the buyer-side, we include dummy variables that equal one if buyers are farmers (b_F) and if the buyer was the former tenant of the lot (b_T). To capture potential buyer type-specific effects of the concentration measures, concentration rates enter the model in linear terms and as interactions with the dummy variables for farmer buyers (b_F) and tenant buyers (b_T).

We acknowledge the potential impacts of subsidized renewable energy on future returns to land use (cf. SEIFERT et al., 2020; HAAN and SIMMLER, 2018; TOWE and TRA, 2013) and include the installed biogas capacity in kW per hectare at the municipal-level (m_{BG}). An additional dummy variable m_B equals one for transactions that took place in municipalities in the Berlin metropolitan area (BBSR, 2019). This is to capture potential effects of urbanization due to urban sprawl and potential demand effects for alternative land use.

The sample covers transactions beginning in 2007, when the BVVG began offering lots using first-price sealed bid auctions. Due to the inclusion of the lagged number of bids in land auctions, we drop the first year of observations and the finally used sample covers 2008 to 2018. The initial sample consists of 40,408 transactions. Following standards of the *Oberer Gutachterausschuss für Grundstückswerte*, we remove 7,847 observations of less than 0.25 hectares. Further, 65 observations with soil qualities below ten index points and two observations with unobserved prices are removed. To identify other outliers, we implement the minimum covariance determinant estimator (MCD) (ROUSSEEUW and VAN DRIESSEN, 1999) separately for grassland and arable land, which eliminates 1,096 observations. Removing an additional 51 observations with missing values in the considered variables results in a final sample of 31,287 transactions, of which 21,407 are arable land and 9,880 are grassland.

The average observed transaction price is 0.58 €/m² (see Table 1), with average prices of 0.65 €/m² and 0.44 €/m² for arable land and grassland, respectively. The average lot has a size of 3.37 ha and a soil quality of 33 index points. While grassland and arable land have, on average, similar soil qualities, lots of arable land in the sample are considerably larger with 4.1 ha, on average, compared to 1.8 ha for grassland. The concentration measures indicate that at the municipal level, the largest farm operates, on average, 29% of the total available farmland, the two largest 44%, and the three largest around 54%; however, the 99% quantiles suggest a much stronger concentration and, in some municipalities, nearly all farmland is operated by two farms. The number of bids in buy and lease auctions by the BVVG indicate considerable variation between counties in the demand for land. The total number of transactions also suggests a strong variation in market activity. This variation is more pronounced in the spatial dimension, while the annual number of transactions within each municipality remains rather stable.

While the three models differ regarding the concentration measures, the functional form specification is identical: The dependent variable is the log of the transaction price in Euro per m². For the hedonic function, we use a flexible Box-Cox functional form, which has been shown to mitigate omitted variable bias (KUMINOFF et al., 2010). Lot size and lot quality enter as logs. We also model their interaction in linear terms, that is, a flexible relationship between lot characteristics and transaction prices (cf. RITTER et al., 2020). The impact of size and quality is further differentiated by lot type (grassland and arable land) through interactions with the dummy variable for grassland. Buyer and seller variables ($s_{\mathrm{BVVG}}, s_{\mathrm{Prof}}, s_{\mathrm{Pub}}, b_F, b_T$) and regional control variables (m_{B}, $m_{\mathrm{BG}}, m_{\mathrm{BVVG}}, m_{\mathrm{UAA}}$) enter the model without transformations. To mitigate omitted variable bias due to unobserved regional effects and to capture such spatial heterogeneity, we add spatial dummy variables, that is, for each of the k =18 counties of Brandenburg a county dummy variable enters the model (county_k). Finally, we include a quarterly trend variable in linear and squared terms (τ, τ^2) to control for temporal effects.

For transaction i, the regression equation is:

$$\begin{aligned} \log P = {} & \alpha + \beta_1 \log x_s + \beta_2 \log x_q + \beta_3 (x_s * x_q) + \beta_4 (G * \log x_s) + \beta_5 (G * \log x_q) \\ & + \beta_6 (G * x_s * x_q) + \beta_7 s_{\mathrm{BVVG}} + \beta_8 s_{\mathrm{Prof}} + \beta_9 s_{\mathrm{Pub}} + \beta_{10} b_F + \beta_{11} b_T \\ & + \gamma_1 m_{\mathrm{BVVG}} + \gamma_2 m_{\mathrm{UAA}} + \gamma_3 m_{\mathrm{BG}} + \gamma_4 m_{\mathrm{B}} + \gamma_5 \tau + \gamma_6 \tau^2 + \sum_{k=1}^{18} \gamma_{7,k} \mathrm{county}_k \\ & + \delta_1 TA + \delta_2 bb_{Q75} + \delta_3 lb_{Q75} + \delta_4 CR + \delta_5 CR \times b_F + \delta_6 CR \times b_T + \varepsilon, \end{aligned} \tag{2}$$

where CR corresponds to the considered concentration rate; β and γ are coefficients of lot-specific hedonic variables and regional controls, respectively; δ's are parameters of competition and market power-related variables; and ε is the error term. The models are estimated with pooled ordinary least squares. Inference is based on heteroscedasticity-consistent standard errors (WHITE, 1980).

Table 1: Descriptive statistics of arable and grassland transactions in Brandenburg from 2008 to 2018

$N = 31{,}287$	Variable	Unit	Mean	Med.	SD	Q01	Q99
Price	P	€/m²	0.58	0.45	0.44	0.095	2.11
Lot size	x_s	ha	3.37	1.53	4.47	0.26	22.94
Soil quality	x_q	Index	32.58	32.00	8.89	15.00	59.00
Grassland	G	Dummy	0.32	0	0.46	0	1
Seller: BVVG	s_{BVVG}	Dummy	0.16	0	0.36	0	1
Seller: Professional	s_{Prof}	Dummy	0.02	0	0.13	0	1
Seller: Public	s_{Pub}	Dummy	0.02	0	0.14	0	1
Buyer: Farmer	b_F	Dummy	0.38	0	0.49	0	1
Buyer: Tenant	b_T	Dummy	0.14	0	0.34	0	1
BVVG transaction share	m_{BVVG}	[0,1]	0.17	0.13	0.16	0	0.75
Share UAA	m_{UAA}	[0,1]	0.53	0.53	0.19	0.15	0.90
Biogas capacities	m_{BG}	kW/ha	0.09	0	0.23	0	1.07
Berlin agglomeration	m_{B}	Dummy	0.08	0	0.27	0	1
Q75 BVVG buy bids (lag 1)	bb_{Q75}	Count	3.39	3.25	1.33	0	8
Q75 BVVG lease bids (lag 1)	lb_{Q75}	Count	2.24	2	2.05	0	8.25
CR1	CR_1	[0,1]	0.28	0.23	0.17	0.08	0.87
CR2	CR_2	[0,1]	0.44	0.39	0.20	0.15	0.94
CR3	CR_3	[0,1]	0.54	0.50	0.20	0.21	0.98
Number of transactions	TA	Count	21.21	18.00	17.83	1.00	81.00

Note: For data security restrictions, minima and maxima cannot be reported. Instead, we refer to the 1% and the 99% quantiles, Q1 and Q99.

Table 2 reports the estimation results for the three model specifications. All models show a satisfactory goodness of fit with R^2 equal to 0.558 in all cases. Parameter estimates are nearly identical in all three models and generally show the expected signs. We note, however, an unexpected positive coefficient of the grassland dummy variable. Nonetheless, predicted prices for grassland are substantially lower due to the non-linear relationship between lot size, lot quality, and prices. For both grassland and arable land, prices increase with soil quality, but the effect is substantially larger for the latter. While the parameter estimate for lot size is negative, a positive parameter estimate is found for the interaction of lot size and soil quality. In line with RITTER et al. (2020), the overall effect of lot size on price is positive for arable lots larger than 1 hectare and for grassland lots larger than 2.5 hectares, while a price premium is present for small lots.

Table 2: Parameter estimates of hedonic and regional control variables, buyer and seller characteristics, and competition indicators

	Dependent variable: Log (Price) in €/m²					
	M1		M2		M3	
Intercept	-2.611***	(0.044)	-2.597***	(0.044)	-2.599***	(0.045)
Hedonic characteristics						
log(Size)	-0.016***	(0.004)	-0.016***	(0.004)	-0.016***	(0.004)
log(Size) × Grassland	-0.050***	(0.012)	-0.050***	(0.012)	-0.050***	(0.012)
log(Quality)	0.312***	(0.012)	0.311***	(0.012)	0.311***	(0.012)
log(Quality) × Grassland	-0.253***	(0.030)	-0.252***	(0.030)	-0.252***	(0.030)
Size × Quality × 10^{-2}	0.040***	(0.003)	0.040***	(0.003)	0.004***	(0.003)
Size × Quality × Grassland × 10^{-2}	0.033**	(0.015)	0.034**	(0.015)	0.034**	(0.015)
Grassland	0.545***	(0.103)	0.542***	(0.103)	0.542***	(0.103)
Seller / buyer characteristics						
Seller: BVVG	0.454***	(0.007)	0.454***	(0.007)	0.454***	(0.007)
Seller: Professional	0.149***	(0.023)	0.149***	(0.023)	0.149***	(0.023)
Seller: Public	0.134***	(0.025)	0.134***	(0.025)	0.134***	(0.025)
Buyer: Farmer	-0.009	(0.011)	-0.012	(0.014)	-0.015	(0.016)
Buyer: Tenant	0.068***	(0.013)	0.083***	(0.016)	0.095***	(0.019)
Regional control variables						
BVVG transaction share	0.057***	(0.019)	0.059***	(0.019)	0.060***	(0.019)
Share UAA	0.186***	(0.018)	0.184***	(0.019)	0.185***	(0.019)
Biogas capacities (kW/ha)	0.055***	(0.012)	0.053***	(0.012)	0.052***	(0.012)
Berlin agglomeration	0.239***	(0.012)	0.237***	(0.012)	0.238***	(0.013)
Competition indicators						
Number of transactions	-0.0003*	(0.0002)	-0.0003**	(0.0002)	-0.0002	(0.0002)
Q75 BVVG buy bids (lag 1)	0.009***	(0.002)	0.009***	(0.002)	0.009***	(0.002)
Q75 BVVG lease bids (lag 1)	0.004**	(0.002)	0.004**	(0.002)	0.004**	(0.002)
CR1	-0.089***	(0.024)				
CR1 × Buyer Tenant	-0.235***	(0.037)				
CR1 × Buyer Farmer	0.061*	(0.032)				
CR2			-0.079***	(0.022)		
CR2 × Buyer Tenant			-0.188***	(0.033)		
CR2 × Buyer Farmer			0.046	(0.029)		
CR3					-0.062***	(0.022)
CR3 × Buyer Tenant					-0.175***	(0.032)
CR3 × Buyer Farmer					0.042	(0.028)
R^2		0.558		0.558		0.558
Observations		31,287		31,287		31,287
County dummy variables		Yes		Yes		Yes

Note: Heteroscedasticity-consistent standard errors in parentheses. Asterisks *, **, and *** denote statistical significance at the 10%, 5%, or 1% based on t-tests, respectively.

The results indicate substantial price differences between different seller types. In line with SEIFERT et al. (2020), professional sellers achieve higher prices than private sellers. This effect is particularly pronounced for BVVG transactions, for which the parameter estimate corresponds to a price markup of 57%. This result is in line with previous studies that also find price-markups in auctions compared to other sales mechanisms, such as bargaining (e.g., HÜTTEL et al., 2016). The positive impact of the share of transactions by the BVVG in a municipality further suggest a positive price impact on transactions by other sellers. This result may be due to BVVG's strategy to publish auction results at a fine regional scale. This, in turn, provides the opportunity for rather uninformed sellers to enter negotiations better informed and thus strengthens their position, particularly for small sellers (see CURTISS et al. (2020) for a discussion).

The results for the competition indicators show a positive relationship between lot prices and the number of buy and lease bids in BVVG auctions. This suggests a positive effect of demand for land on land prices. Further, a larger number of bidders suggests a higher number of competitors on the buyer side also in other transactions, which may reduce market power on the buyer side resulting in a price-increasing effect.[4] Statistically significant negative effects of the total number of transactions on prices in M1 and M2 suggest a price decreasing effect of market liquidity; however, this effect is insignificant in M3. In contrast, all three models indicate statistically significant and negative effects of concentration rates, i.e., decreasing land prices with increasing concentration of land use. The direct effects of concentration rates thereby decrease in magnitude with the number of farms considered.

Regarding the concentration and tenant buyers' interaction, we find statistically significant negative effects in all three models. The dummy variable for tenant buyers is positive and significant in all three models. In contrast, the effect of the farmer buyer dummy variable is insignificant in the three models and its interaction with the concentration rates is statistically significant and positive in M1.

To summarize, the results suggest a negative price effect of land use concentration that can be further reinforced by the buyer type. In particular, for tenants – who are presumably in the buyer group with the highest likelihood regarding the intention to operate the land rather than invest and lease it out – results suggest a negative price effect of land use concentration on land prices.

To illustrate the size of the effects, Figure 5 presents the relationship between land use concentration and buyer types based on predicted prices for M1, M2, and M3 for a lot with mean lot and transaction characteristics (see Table 1) in Märkisch-Oderland in 2018. All three models indicate a negative effect of land use concentration on land prices. However, the effect varies by buyer type. For non-tenant farmers, price differentials between concentration rates close to zero and one are of moderate magnitude with around –0.05 €/m² and are slightly higher for non-farmers (–0.08 €/m²). In contrast to SEIFERT et al. (2020), who analyze the land market in the German federal state of Saxony-Anhalt, the results indicate lower prices for non-farmers compared to farmers. We note, however, that the corresponding parameter estimates are statistically insignificant. Compared to non-tenant buyers, results show a price markup for tenant buyers if land use concentration is low and a markdown for high concentration rates in all models. The magnitude of the effect is substantial, and prices differ by 0.20 €/m² (M3) to 0.25 €/m² (M1, M2) between concentration rates close to zero and one. Further, the level of the concentration rates at which predicted prices of the different buyer types intersect, increases from M1 to M3 but is in all cases close to the average observed concentration rates in the sample. That is, at average levels of land use concentration, price effects are small between the different buyer groups. Overall, our results show a price decreasing effect of land use concentration that is particularly pronounced for buyers that were former tenants; the similarity of these effects across different concentration rates (CR1 to CR3) may suggest the presence of oligopsony market power. However, a causal interpretation of the effect that tenants exercise market power is invalid. The role of single buyers with the potential to exercise market power remains uncovered, and the estimated effects correspond to average effects for all tenant buyers irrespective of their individual market position. Identification of buyer-specific price effects would require further information to directly link buyers and market power potential, which is unobserved in our data set.

[4] We thank an anonymous reviewer for pointing out this interpretation.

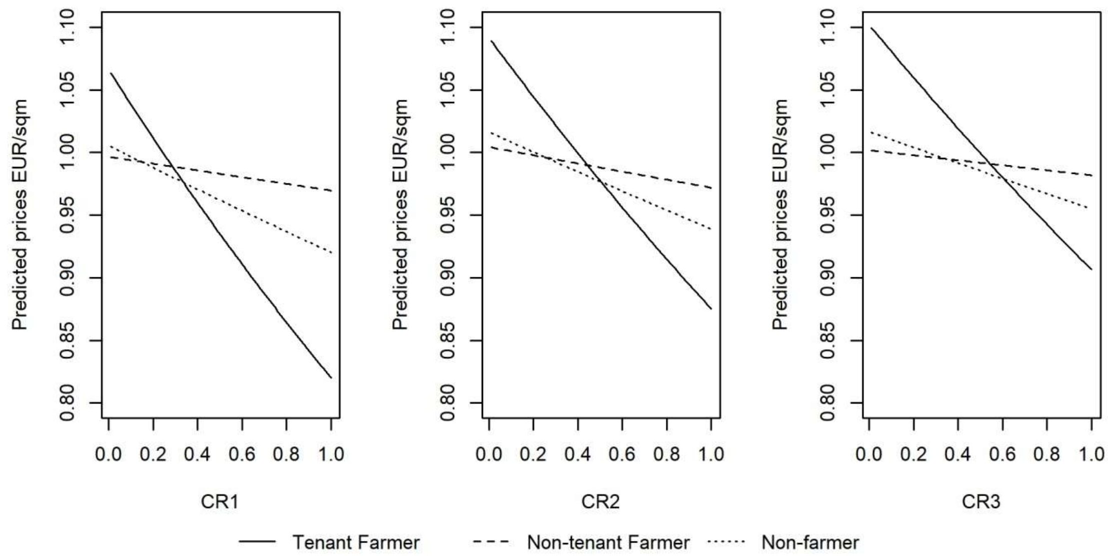

Figure 5: Predicted prices for different buyer types and concentration rates for M1 (left), M2 (center), and M3 (right)

5 Concluding Remarks

The objective of this paper was to demonstrate that the assessment and quantification of market power in agricultural land markets is challenging because of the characteristics of the production factor land. These characteristics hinder a direct application of familiar concepts from commodity markets. In particular, immobility, fixed supply, and large heterogeneity of land render traditional demand and supply analysis for a fictitious point market inapt. Land markets, instead, break down into a multitude of local markets with a varying composition of market participants. The fixed amount of land at any location implies economic rents, which are often negotiated among buyers (tenants) and sellers (landlords) in a bargaining process. Depending on the microstructure of these markets, bargaining power may or may not exist. Theoretical models, which address the peculiarities of land markets, shed light on the determinants of bargaining power, encompassing search and matching models, as well as spatial competition models.

As for homogeneous good markets, concentration measures may convey information about the prevalence of market power in land markets. The analysis of concentration indicators, however, is hampered by two problems. First, defining the relevant regional size of the market is challenging and concentration indicators are not robust with regard to this definition. Second, concentration of land ownership or land operations are (often) the result of structural change in agriculture, which can be accompanied with increasing efficiency due to economies of scale. If concentration is “sufficiently” high, adverse effects of market power can outweigh these socially beneficial efficiency gains. Only in this latter case, i.e., market power causes severe deviations from a socially optimal resource allocation, high concentration measures call for competition policy and market regulation, whereas concentration as a result of structural change and sectoral adjustment processes typically does not. In other words, land market policies that target the reduction of land concentration may be accompanied with high welfare costs if they hinder structural change and limit the functions of the land market. Additionally, strategic behavior of market participants needs to be considered. On the one hand, high concentration and repeated interactions of a small group of actors (i.e., high market concentration) can foster collusive behavior and thus welfare loss in a market. On the other hand, non-cooperative price competition (e.g., "price wars") can yield the same market allocation as perfect competition even in highly concentrated markets. Thus, it is not sufficient to focus on concentration indicators when assessing market power. Instead, it is necessary to verify whether deviations from a "competitive" price exist. The identification of price markups or markdowns, however, is demanding. Standard hedonic land price models must be extended to account for information asymmetries in thin and decentralized markets. Recently, two-tier stochastic frontier models have been applied as a promising approach to disentangle bargaining advantages from other price determinants.

The aforementioned challenges have been illustrated with a case study for the federal state of Brandenburg in Germany. We conclude that the quantification of market power is hampered by the availability of data, particularly for ownership and land rental prices. Land ownership data exist in Germany but is costly and difficult to acquire. Information about land rental transactions is scarce because these transactions are not regularly reported to public authorities and are surveyed at the municipal level only once per decade. Using available data for land sales, a regression analysis revealed a negative relationship between land use concentration and farmland prices. With all due caution, this result can be interpreted as an indication of market power on the buyer side in agricultural land markets. Nevertheless, it is hardly possible to translate this finding into recommendations for land market regulations that are valid for legal purposes because a proof of misuse of a dominant position in local land markets should be case-specific and cannot be founded by mean effects from a regression analysis. It is quite possible that market power on the demand and supply side coexist and that both effects offset each other. We conclude that providing evidence for the exploitation of market power in land markets deserves further attention from research and politics alike.

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