Farmland rental values in GM soybean areas of Argentina: do contractual arrangements matter?

Abstract

We study the determinants of rental prices of farmland in the Argentinean Pampas. In particular, we examine the value of lease contract characteristics within a hedonic price framework, while controlling for other potential sources of variation. Using first-hand data for 255 parcels, our results indicate that both short-term contracts and contracts with sowing pools push rental prices upwards. We also find that soybean yields have a significant impact on land rental rates. These results suggest that if Argentina intends to protect the enormous natural advantage it has for agricultural production, it should consider strictly regulating land rental contracts.

Keywords: Argentina, hedonic price, lease, contracts, soybean

JEL codes: Q13, Q15, R11

1. Introduction

Argentinian land markets have experienced great changes in the past decades, notably with the expansion of biotech genetically modified (GM) crops. Since the introduction of GM soybeans to Argentina in 1996, there has been a dramatic rise in production. As a result, all production of soybeans in Argentina is genetically modified and is mainly concentrated in the Pampas region. Today, Argentina is the third largest exporting country, after the USA and Brazil (Filomeno, 2013; Leguizamón, 2013; Urcola et al., 2015).

Within this context, the rental price of farmland has increased dramatically. In the Pampas, the central agricultural producing area of Argentina, land rental prices have doubled since 2001 (Bert et al., 2010). This upward movement was driven by a dramatic increase in land demand, brought about by record profits in GM soybean cultivation. Strong cost savings associated with high yields, high prices in international markets and economic reforms during the 1990s, contributed to increasing soybean producers' incomes.

Technical changes in GM soybean production have encouraged economies of scale in farming, leading to increased farm sizes. Because of the high cost of land, the race for land to produce the very profitable GM soybean has been dominated by the acquisition of user's rights, rather than ownership of land. As a result, the total area of land farmed under tenancy contracts has increased sharply, compared to land farmed by landowners. Today, in the soybean growing regions of Argentina more than 60% of cultivated land is under some sort of tenancy contract. Fixed rental contracts account for 90% of total leased land, whereas share contracts represent only 10%. Among fixed rental arrangements, contracts for a single agricultural season are expanding at a high rate as well.[i]

The growing disconnect between land ownership and land cultivation, compounded by the shortening of lease contracts, has important implications for land use sustainability. A large number of studies suggests that rented land is managed differently according to the type of lease contract, which may affect the selection of crops, the choice of technological packages, and the use of conservation practices such as crop rotation (Abdulai et al., 2011; Fraser, 2004; Myyrä et al., 2007; Soule et al., 2000). Indeed, the increased number of short-term cash lease contracts in Argentina has been correlated with a land allocation strategy favouring soybean monoculture and the massive use of agrochemicals. Bert et al. (2011) have shown that, given the level of the rental prices, tenanted land must be allocated to soybean if producers want to be sufficiently profitable. How to promote rational use of the land in order to guarantee the preservation of the environment has thus become a central issue in Argentina.

Some of the literature attempts to explain agricultural land rents with hedonic models. The impact of farmland characteristics (such as quality of soils, localization of parcels, surface, and productive potential) on land-lease rates was highlighted, as well as the impact of public intervention, and more recently, environmental considerations. However, the extent to which lease contract properties are correlated to land rent prices is an intriguing question which has not been explored, but deserves attention. Obviously, contract design must affect the land-lease price because it determines the duration of payments, the level of risk taken, and sometimes the allocation of land to different uses.

The objective of this paper is to shed light on the effects of contract characteristics on farmland rental rates, while controlling for other potential sources of variation, such as land characteristics and expected returns. We assume that the contractual conditions are capitalized into land rents, as suggested by Palmquist (1989). The great variety of contractual land arrangements in Argentina offers a good opportunity to evaluate the preferences of landowners and producers associated with specific contracts. Our results, based on a first-hand survey among producers, lead to a better understanding of the determinants of land rental prices.

To reach our research objectives, we use a hedonic price model. The structure of this paper is as follows. Section 2 discusses the functioning of land rental markets in the Pampas region of Argentina and provides details about land lease contracts. Section 3 presents the hedonic literature on farmland rental prices. Section 4 contains the empirical analysis, followed by the conclusion.

2. Lease transactions in a GM soybean area of Argentina

2.1. Land rental market functioning in the Pampas

We start with a simple model of the dynamics of rental markets. We assume that the short term lease rent reflects the annual spot market which, in turn, results from interactions of competitive, profit-maximizing landlords and tenants. Given that the physical supply of land is fixed in the Pampa region and that all land is already cultivated, land available for renting (supply) only comes from farmers who release their land.

Following the literature examining the determinants of land lease (Deininger et al., 2003; Swinnen et al., 2006), we postulate that farmers' decision to enter the land market as a landlord depends on the comparison between the marginal return to the land cultivated and the market rental rate. If we assume a standard framework for the production function, i.e. a Cobb-Douglas functional form, the marginal return to land cultivated depends on the quality of land, the amount of capital (inputs) and agricultural ability. It follows that farmers who lack both farm capital assets and agricultural ability are more likely to rent out their land and earn a fixed income instead of taking the risk to engage in an uncertain activity.

Observed behaviour of Argentinian farmers since the introduction of GM soybean cultivars fits well these predictions and is largely documented (Gras, 2009; Murmis and Murmis, 2012; Urcola et al., 2015). Landlords in Argentina tend to be retired farmers or farmers that are no longer involved in farming activities.[ii] They describe themselves as too small to handle the technical changes or the risk of farming, or they feel technically outdated and unable to compete with younger farmers for additional land (Gras, 2009; Urcola et al., 2015). Other reasons are a lack of capital and ability to finance the purchase of inputs (seeds, agrochemicals, labour, agricultural services, and so forth). Their objective is to obtain the highest quasi riskless short-term return on land capital, and indeed, the level of rental prices is high enough to provide a comfortable standard of living (Urcola et al., 2015). Other suppliers of land are medium-size farmers who rent out part of their farm as a risk management strategy or as a specialization strategy. In both cases farmers manage their plots as an asset portfolio, renting out some plots in order to secure a fixed income or renting out the plots that appear unsuitable for the activities they want to specialize in (for instance cattle breeding). Since there are no barriers to entry and that arable land can be put in use quickly, we assume that suppliers of land (landowners) enter the market instantaneously. Thus any increase in land supply is expected to translate into the lease rate.

Potential tenants (demand) are those who are inadequately endowed with land compared to other non-land assets and seek to expand production by renting in additional land in order to achieve economies of scale in their operations. The likelihood of renting in land is expected to be higher for those poorly endowed with land but with higher levels of farm capital assets (in particular farm machinery) and better ability to produce, including good access to technical information and knowhow and numerous contacts with production networks. The demand for farmland is thus a function of the producers' marginal product and evolves with the price of the output relatively to the price of all inputs.

Information about the cost of rent for any given type of soil is usually known by most farmers. The Argentinian "*modelo sojero*" is characterized by intensive social interactions taking place through producers associations (Goulet and Hernández, 2011). Information is easily obtained from other farmers or landlords, making the land market fairly transparent, and quite open. Under such circumstances, we can reasonably assume that the short term lease price moves in order to clear the market.

However, rental arrangements are often multiyear. In this case, the rent level must reflect market participants' expectations about future rental conditions as is usually hypothesized in the real estate markets (Grenadier, 1995; Gunnelin and Söderberg, 2003; Stanton and Wallace, 2002). According to economic theory, and borrowing from the theoretical framework provided by Grenadier (1995) on real estate markets, we assume that the term structure of the rental rates reflects market participants' expectations about the future tightness of the market and thus future rents. We are therefore able to derive hypothesis regarding the relationship between contract term and land rental levels. According to Grenadier (1995) when the market is tight, the price of the longer term lease falls below the spot rent. When the spot rent is high, new suppliers are likely to enter the market so that future rents are expected to decrease. Tenants will accept to enter longer term lease contracts only if the rent takes into account their expectations. Otherwise, they would prefer rolling over short term contracts. We thus expect the rent for longer fixed leases contracts to be lower than the spot fixed contract lease. Another reason why short-term contracts should exhibit higher prices than longer-term ones is that the latter include lower transactions costs because all conditions are agreed upon at the start of the lease period, and usually not re-negotiated or adjusted.

We also assume the level of the rent to be tied to the intensity of the asset's use, as Grenadier (1995) does it. It is now largely recognized that fixed-rent contracts create incentives for tenants to use land unsustainably in order to increase income, for instance by planting soybean crop after soybean crop, or by applying huge volumes of herbicides, practices that deplete the soil over time. They are chosen by landlords for whom natural resource conservation is not a major concern. Conversely, a common practice of landlords who have long-term interests in farming activities and concerns about degradation and exhaustion of the soil is to offer share contracts that allow them to control tenants' agronomic practices, in particular a good crop rotational cycle. Keeping in mind that soybean is the most profitable crop, better agronomic practices result in a lower flow of income. In order to provide incentives to encourage tenants to enter share contracts, landlords must offer attractive rents. We thus expect the rent for share contracts to be lower than for fixed rent contracts.

Finally, even in a competitive market, land transactions rarely occur without frictions. These frictions result into transaction costs, which in turn, must be reflected in land rents. Landlord and tenant's transaction costs include common negotiating costs associated to contract renewal.

Landlords incur specific information costs in searching "good" tenants, and in monitoring and enforcing the conditions of the contract whereas tenants bear the information costs in searching good quality of land. The level of these costs depends, among other things, on landlord-tenants relationships. Since transaction costs depress land rents, rental prices are expected to be inversely correlated to the tightness of landlord-tenant relationship.

2.2. Data on land-lease in the Pampas

Because data on land-lease transactions are not available in Argentina, we focus on a sub land-rental market in two provinces within the Pampas region, Buenos Aires and Santa Fé, where we collected information. Within these two provinces, a portion of territory of 110 thousand hectares was randomly selected and each plot of land pertaining to this selected area had been listed. Information about the owner or the producer, the type of productive activities, and the tenure modes were collected.[iii] This rich database allowed us to select a simple random sample comprising of 186 farmers cultivating 542 parcels, of which 321 were leased. The survey was undertaken during July and August of 2011, collecting information about each plot's size, type of land, cropping pattern, productive assets, type of lease contract, and method of payment.[iv] Information was also collected on the identity of contracting parties and some of the landlords' characteristics such as relationship to the tenant and status with respect to agricultural activity (active farmer or non-producer landlord). We analyse data for 255 of the parcels, after removing those without a complete set of information.[v]

In the two provinces under study, we find three main types of lease contract: a regular, or multi-year, fixed-lease contract, with a term of at least three years; a one-cultivation-cycle fixed contract, where land is leased for a single growing season and sometimes for a single crop; and a multi-year share contract. The primary contractual arrangement remains the fixed lease, at 94% of plots, while share contracts still occur, though to a much lesser extent, at 6% of plots. Among our sample, 28% are short term fixed-rent contracts. This share is rapidly increasing, driven by its high flexibility.

The actors of the Argentinian land market are of two types: physical persons and societies; they can be lessors or lessees. Landowners are usually physical persons. Tenants are farmers who already own land but seek to extend their production. They represent the most important group, both in terms of number and area sown. Tenants can also be societies. Indeed, GM soybean cultivation has been accompanied with deep changes in the organization of the production. New forms of associations between farmers emerged, namely "*pooles de siembra"*, to manage and finance soybean production (Hernandez, 2009). These sowing pools lease tracts of land as well as services for the main farming operations (planting, spraying and harvesting) and sometimes for transport.

As far as rent payment is concerned, a specific system is working according to the "use and customs." The survey data indicate that the dominant form of landlord-tenant contracts is a lease wherein the tenant pays the landlord a fixed amount, expressed in quintals of soybean per hectare rented (instead of its monetary equivalent), no matter the length of the contract. Since soybean prices exhibit high intra-seasonal fluctuations, payment in kind enables the landlord to reap the best possible price from his "rent" payment, either by storing the output to sell at a future higher price or by transporting it to distant markets that offer a better price. With a share lease, the landlord receives a stipulated percentage of the production.[vi]

3. Capturing the effects of lease contract using a hedonic pricing framework

The rental price of an agricultural parcel represents the equilibrium relationship between supply and demand for land. Rents differ because parcels do not have the same characteristics and they are localized in different places. The hedonic price method connects the rental value of the plots to their characteristics. It allows for calculating the weight of each feature in the rent paid to landowners.

While Rosen (1974) is the seminal article on hedonic pricing for housing, we refer to Palmquist (1989) for a hedonic price model of the rental prices of farmland.[vii][viii] In his model, which is a standard hedonic equation, rents are explained by characteristics of farmlands such as:

$$R = R(z_1, \dots, z_k),$$

where R is the rental price of each parcel and z is a vector of n characteristics of parcels.

There are many empirical contributions, mostly from OECD countries (Donoso and Vicente, 2001; Herriges et al., 1992; Huttel et al., 2015; März et al., 2014). Herriges et al. (1992) analyze the capitalization of a U.S. commodity program into farmland rents using Iowa rental survey data. Huttel et al. (2015) investigate, among other variables, the impact of the length of contracts (in years) on farmland rental values in Germany. More directly related to our study, Donoso and Vicente (2001) investigate rental rates in the Pampas Region in Argentina using survey data for 86 parcels and focusing on soil erosion.

To the best of our knowledge, no hedonic study has connected farmland rental values and contractual arrangements, with the exception of Huttel et al. (2015). To a broader extent, literature on any correlation between these variables is scant. There are, however, some exceptions. In the Netherlands, based on a survey asking land agents and landowners to rank the value of tenanted land, Slangen and Polman (2008) show that the value of land under tenancy depends on the type of contractual arrangement, with the shortest contract having the highest value. Moss and Barry (2002) study the bidding behaviour of a panel of Illinois producers regarding different lease types. In an experimental approach, farmers were asked to make bids using the three different contractual arrangements (share, cash, and hybrid). The results indicate that the potential return to management drives more aggressive bidding behaviour for cash leases, compared to hybrid or share leases.

4. Empirical analysis

4.1. Sample characteristics

There are major differences between analysing farmland values and rental prices, and these shall motivate the choice of variables in the hedonic model. Quoting Palmquist and Danielson (1989, p. 55) "When people rent land, their only interest will be in the current productive capabilities of the land, although the lease may require them to protect the interests of the landowner. The value of land as an asset depends on the present value of future rents. The land may be used for different purposes in the future, so different characteristics may be relevant. These characteristics would then influence asset value but not rental value. For example, proximity of farmland to a major population center might increase land values even though it did not increase agricultural productivity. In the same vein, a characteristic that is of value in agricultural use, such as soil productivity, may be discounted in the asset price if that characteristic is not as highly valued in some alternative use (for example, commercial use) that is anticipated in the near future." The variables used in our model are presented in Tables

Table 1 and their summary statistics in Table 2.

The average rental price per hectare of land is $1,239, ranging from $160 to $2,571. The average surface of plots is 119 hectare. In our study, 42% of the plots are located in the province of Buenos Aires and 58% in the Province of Santa Fé. Although these two provinces are quite representative of Pampas agriculture, the former is more urbanized. Indeed, its capital city Junín is closer to the city of Buenos Aires than San Justo (Santa Fé). In the latter, livestock is more developed. As noted by Choumert and Phélinas (2015), farmland parcels in the province of Buenos Aires are more valued than those situated in Santa Fé, notably because the province benefits from better infrastructure (such as roads), greater commercial and residential development, and better accessibility to major markets.

As far as agricultural potential is concerned, the two districts differ more in the quality of their soils than in their climate. The territorial scan carried out by the project CLARIS LPB[ix] showed that 80% of Junin's soils are suitable for agriculture and have a very high productive potential whereas the proportion of land for agricultural use is only 44% in San Justo, among which, only 29% have a high productive capacity (Hernandez et al., 2015). Nonetheless, both provinces share the same climatic environment with mean length of dry spells as well as mean length of wet spells being nearly the same (Hernandez et al., 2015). These results are consistent with previous studies conducted in the Pampas region (Magrin et al., 2005; van Dam et al., 2009).

The sample of plots contains various land types (arable land, grassland), which are rented at different prices. However, most contracted land is used for grain or soybean production. In a majority of plots, farmers grow soybeans (73%). Wheat is grown on 20% of plots and corn on 23%. Only 15% of plots have been rented for cattle ranching or dairy production.[x] We introduce measures of yields for the three crops and a binary variable for livestock activity. The measure of soybean yields allows us to take the expected return of land cultivation into account.

In our sample, family, neighbours, and local tenants dominate the land rental market, whereas sowing pools, which are agricultural trusts seeking to lease tracts of land temporarily, appear to be a minor actor. This is in line with Urcola et al. (2015), where they analyse the land leasing market in Balcarce (province of Buenos Aires).

4.2.Empirical analysis

In line with the literature on hedonic models, we apply a logarithmic transformation of rental prices.[xi][xii] The base model is MODEL 1 in Table 3 (log-linear specification). Plots are heterogeneous goods. This heterogeneity can create heteroscedasticity in the residuals of the estimation of the hedonic price function. We actually detect heteroscedasticity in our model (the calculated value of the Breusch-Pagan test (25.43) is superior to its theoretical value

($\chi^2_{\alpha=5\%}(1) = 3.84$)); hence, we estimate models with robust standard errors. Given that multicollinearity is a frequent concern in hedonic studies, we verify variance inflation factors (VIF) to detect potential collinearity of the regressors, and find none, as the maximum VIF is 16.

4.3. Results

The results are shown in Table 3 (Model 1). Our hedonic analysis explains around 60% of rental price variations. Marginal effects[xiii] of our base model, Model 1, are presented in Table 4. As expected, rental prices are higher in the Buenos Aires province. Renting a plot in this province is substantially more expensive than renting one in Santa Fé. This result is in line with the literature on land rental prices which demonstrates that the productive potential of the land is one of the main factor that affect land rents. Indeed previous studies, such as Hernandez et al. (2015), have highlighted the productive and soil quality differentials between those provinces. This result also supports that localization is an important factor explaining land prices and corroborates the idea that better access to infrastructure and proximity to major markets are capitalized in rental prices.

Farmland rental values fluctuate according to the profitability of what is being produced on a rented plot, which in turn, determines the income that can be generated from the parcel. As expected, we observe a variation in rental prices as a function of soybean yield, which is a good proxy for the expected market return of the plot, with soybeans being the most profitable crop. Similarly, allocating land to cattle production exerts a negative influence on farmland rents. Lower output prices and/or lower profitability explain this result.

The rental price per hectare tends to be negatively correlated with the surface of parcels (Model 2). This is a standard result in hedonic studies. It also supports the inverse farm size-productivity relationship and its land market expression (Barrett, 1996; Carter, 1984).

The identity of contracting parties matters. The level of the rent is significantly affected by the nature of the relationships between the parties (familial or vicinity) and the geographical distance between landlords and tenants. Rental rates are much lower when the lease contract is concluded between family members or within the local network of neighbours and acquaintances, than they are when the lease contract is concluded with societies, such as sowing pools. The latter are charged the highest rental price. These results suggest the presence of significant transaction costs associated with the lease of land. They are in line with most previous studies on farmland transactions showing that transactions with family members are discounted because they are easier to enforce and the probability of morally hazardous behaviour is lower. The informational advantage of the local network, driven by long-term relationships, also plays a significant role (Kostov, 2010; Otsuka and Hayami, 1988; Rainey et al., 2005). However, Bryan et al. (2015) do not find any impact of family relations on the magnitude of cash rental rates.

The channels through which leasing opportunities are found differ according to the physical distance separating the contracting parties. Informal local networks allow local landlords to exploit informational advantages to learn about their tenants' skill, effort, reputation and trustworthiness. Usually, landlords and tenants who live in the same area already know each other before they enter into a contractual agreement. There is, accordingly, a tendency for the resulting rent to be lower, compared to the rent agreed between contracting parties living in a different district or department. Societies, which often operate in a more dispersed geographic area, including foreign countries, call upon the services of brokers to find leasing opportunities (Urcola et al., 2015). This might result in a higher cost for the whole process. They also might be less informed about land rental rates in an area.

As far as the length of the contract is concerned, we find evidence that rental prices of short-term contracts lay well above rental prices for multi-year contracts of same nature (fixed rent), whereas prices for share contracts appear to be the lowest.

Following the earlier discussion, that longer fixed leases are less valued than short fixed leases (although not by much) can be taken as an evidence of downward expectations in the rental market. Such expectations induce the tenant to accept a longer term contract only if the landlord accepts to receive a lower rent. This result is corroborated by the observed evolution of the rent level in subsequent years. In 2011, the year our field survey was conducted, rental values had been on rise for years but began to decline during the agricultural campaign 2012/2013 (Arbolave, 2014). They are currently still moving down, driven by a weak demand for agricultural products from the principal trade partner (China) and a dramatic fall in international agricultural prices.

Also, a longer contractual period might indicate mutual trust between the landlord and the tenant. The resulting lower rent can be considered as a market translation of lower enforcement costs. This argument is supported by the theory of incentive contracting (Huffmann and Just, 2004; Allen and Lueck, 1992a).

Unfortunately, insofar as the rent level is tied to the intensity of the land use, short-term contracts create disincentives to good agricultural practices or investment in soil conservation measures. Long-term productivity can be seriously diminished because of overplanting soybeans, since the benefits of chemical application have a short duration. An increase in the current year's income therefore comes at the expense of future income.

Share contracts exhibit the lowest rent, a fact that is consistent with the existing theoretical literature on land-lease contracts. This result largely reflects differences in crop mix according to the type of contractual arrangement and strongly supports the hypothesis that landlords who enter share contracts have requirements regarding land management, herbicide application, and rotation of soybeans with cereals, at the cost of a lower lease price. There is a large body of empirical evidence showing that share tenancy is preferred when landlords have the ability to monitor tenants, in order to avoid potential degradation of the land asset, among other things. Immediate income is clearly sacrificed for soil conservation. Another explanation for this result might come from differences in tenants' entrepreneurial abilities, which are not easily observable. Those endowed with higher skills may seek fixed-rent contracts that allow them to perceive a higher return on their effort. As a result, less skilled tenants might be self-selected for share contracts.

4.4.Robustness checks

We carry out robustness checks to Model 1 (log-lin model). In Model 2, we remove the variable *Livestock* which is correlated with *surface_plot* (correlation = 0.25). This correlation suggests that more land is necessary for livestock activities. As expected, the variable *surface_plot* becomes significant. In Model 3, instead of having soybean, corn and wheat yields (*soybean_yield*, *corn_yield*, *wheat_yield*), we introduce binary variables *soybean*, *corn* and *wheat* indicating whether these crops are grown on the plot. They are less precise than yields but do corroborate the results of Model 1. Model 4 is the same as Model 3 but without the *livestock* variable, to take into account the correlation between the plot surface and livestock activities. Model 5 is a log-log specification, with a logarithmic transformation of both rental prices and surface of the plots. All models corroborate our results.

As previously explained, in the current study we cannot apply spatial econometric techniques to control for spatial autocorrelation. To face this, we suggest a multilevel hedonic analysis as robustness check, while allowing to address spatial variation of rental prices. See Jones (1991), Jones and Bullen (1994) and Orford (2000) for a detailed presentation of multilevel hedonic models (also called Variance Components Models). The model is composed of "compositional effects" (structural attributes) and of "contextual effects" (locational attributes). There are therefore two levels of analysis in our case, provinces of the Argentinian Pampas, and individual plots. The model can be written as follows

$$R_{ij} = \beta_{0j} + \sum_{k=1}^{K} \beta_k Z_{ki} \ + \ \varepsilon_i$$

With $\beta_{0j} = \beta_0 + u_j$ and $u_j \sim N(0, \sigma_u^2)$ the same random effect for all the plots in the same province, it can capture the effect of context related to membership in a province. The error term is composed of two parts (i) the unobserved heterogeneity $u_j \sim N(0, \sigma_u^2)$, which is specific to each province and constant between plots in the same province; (ii) the second component $\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$ is the usual error term which varies between plots and between provinces. The justification is that the province of Buenos Aires benefits from better infrastructure (such as roads), more commercial and residential development, and better accessibility to major markets, than the province Santa Fé. Rental prices will therefore vary at two levels, the individual one (at the plot level) and at the province one. The model to be estimated can be written in the following reduced form:

$$R_{ij} = \beta_0 + \sum_{k=1}^{K} \beta_k Z_{ki} + \varepsilon_i + u_j$$

The first steps consists in the estimation of the empty model, i.e. without explanatory variables (using the maximum likelihood estimator) (See Appendix 1), to determine the contribution of each level to the total variance of rental prices. In order to calculate the intraclass correlation, we use the following formula:

$$\rho = \frac{\sigma^2{}_u}{\sigma^2{}_\varepsilon + \sigma^2{}_u}$$

We find that rental prices are correlated within provinces. 47 % of the total variance is explained by membership to a province. This correlation corroborates the idea that within the Pampas, farmland rental prices are correlated with Buenos Aires and Santa Fé provinces. We then estimate the full model with all explanatory variables (See Appendix 2). The results of the multilevel hedonic model further corroborate our results.

5. Conclusion

High international prices combined with technological advances raised returns on Argentinian agricultural production, thereby increasing the demand for farmland. As a result, land rentals increased sharply during the last decades.

In this paper we have studied the rental farmland market in the Argentinian Pampas. In particular, we question the importance of contractual arrangements in the context of rapid GM soybean development. We used a hedonic pricing model, which includes three main types of leasing contracts and controls for other characteristics of the plots leased. We provide empirical evidence that contractual arrangements are capitalized in land rental values, all things being equal.

The one-cultivation-cycle contract has the highest rental value, and the land area under this type of contract is expected to increase. Unfortunately, there is a tendency for soybeans to be grown continuously in areas under short-term contract instead of the technically recommended crop rotation. Declining ecological conditions could be a serious consequence of the expansion of this type of contract. In particular, long-term negative effects on land productive capacity are expected, due to excessive planting of soybeans.

Since a growing share of farmland in Argentina is cultivated by tenants, our results suggest that a protective land policy to minimize the adverse environmental impacts of changes in land tenure is needed. If Argentina intends to protect its enormous natural advantage for agricultural production, a strict regulation of land rental contracts, with respect to length of term and land management, should be considered. Another alternative would be to support the relative profitability of other crops through export taxes and/or input cost reduction.

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Tables

Table 1. Description of variables

VARIABLES	DESCRIPTION	EXPECTED SIGN
RENT	Rental price (US dollar per hectare)	Dependent variable
LN_RENT	Logarithmic transformation of the rental price	Dependent variable
BUENOSAIRES	= 1 if the plot is in Buenos Aires province, 0 otherwise	+
SANTAFE	= 1 if the plot is in Santa Fé province, 0 otherwise	-
SURFACE_PLOT	Surface of the plot (hectares)	-
LN_SURFACE_PLOT	Logarithmic transformation of the surface of the plot	-
SOYBEAN_YIELD	Tons per hectare of land where soy is cultivated	+
SOYBEAN	= 1 if soybean is grown on the plot, 0 otherwise	+
WHEAT_YIELD	Tons per hectare of land where wheat is cultivated	+
WHEAT	= 1 if wheat is grown on the plot, 0 otherwise	+
CORN_YIELD	Tons per hectare of land where corn is cultivated	+
CORN	= 1 if corn is grown on the plot, 0 otherwise	+
LIVESTOCK	= 1 if there is livestock activity on the plot, 0 otherwise	-
FIXED RENT LONG	= 1 if the contract is long fixed rent, 0 otherwise	-

SHARECROPPING	= 1 if sharecropping, 0 otherwise	-
FIXED RENT SHORT	= 1 if the contract is short fixed rent , 0 otherwise	+
RELATION_PARENT	= 1 if contractual arrangement between relatives, 0 otherwise	-
RELATION_NEIGHBOR	= 1 if contractual arrangement between neighbours, 0 otherwise	-
RELATION_IN_DEP	= 1 if contractual arrangement between persons in the department, 0 otherwise	+
RELATION_OUT_DEP	= 1 if contractual arrangement between persons outside the department, 0 otherwise	+
RELATION_SOCIETY	= 1 if contractual arrangement with sowing pools, 0 otherwise	+

Table 2. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Rent	1238.89	499.65	160	2571
Ln_rent	7.03	0.45	5.08	7.85
Buenosaires	0.42	0.49	0	1
Santafe	0.58	0.49	0	1
Surface_plot	118.93	131.74	7	998
Ln_surface_plot	4.34	0.92	1.95	6.91
Wheat_yield	0.83	1.83	0	10
Wheat	0.20	0.40	0	1
Corn_yield	1.50	3.20	0	13.33
Corn	0.23	0.42	0	1
Soybean_yield	1.97	1.42	0	4.83
Soybean	0.73	0.45	0	1
Livestock	0.15	0.36	0	1
Fixed rent long	0.66	0.47	0	1
Sharecropping	0.06	0.24	0	1
Fixed rent short	0.28	0.45	0	1
Relation_parent	0.22	0.41	0	1
Relation_neighbor	0.29	0.46	0	1

Relation_in_dep	0.36	0.48	0	1
Relation_out_dep	0.11	0.32	0	1
Relation_society	0.02	0.12	0	1
N = 255				

Table 3. Results of the hedonic analysis

VARIABLES	Model 1 (log-lin) Ln_rent	Model 2 (Model 1 without livestock) Ln_rent	Model 3 (Model 1 without yields) Ln_rent	Model 4 (Model 1 without yields and livestock) Ln_rent	Model 5 (log-log version of Model 1) Ln_rent
Buenosaires	0.607***	0.616***	0.633***	0.649***	0.607***
	(0.0405)	(0.0417)	(0.0388)	(0.0398)	(0.0404)
Surface_plot	-0.000251	-0.000435**	-0.000253	-0.000445**	
	(0.000172)	(0.000182)	(0.000175)	(0.000184)	
Ln_surface_plot					-0.0247
					(0.0243)
Wheat_yield	0.0130	0.0163			0.0120
	(0.00975)	(0.0103)			(0.00986)
Corn_yield	0.00219	0.00132			0.00196
	(0.00729)	(0.00763)			(0.00725)
Soybean_yield	0.0308**	0.0419**			0.0300**
	(0.0149)	(0.0165)			(0.0149)
Livestock	-0.247***		-0.249***		-0.258***
	(0.0825)		(0.0835)		(0.0818)
Fixed rent long	-0.0544*	-0.0881**	-0.0459	-0.0758**	-0.0542*
	(0.0324)	(0.0346)	(0.0319)	(0.0333)	(0.0325)
Sharecropping	-0.217*	-0.219*	-0.216*	-0.215*	-0.218*
	(0.125)	(0.123)	(0.125)	(0.124)	(0.125)
Fixed rent short	-	-	-	-	-
Relation_parent	-0.579***	-0.525***	-0.585***	-0.537***	-0.574***
	(0.120)	(0.0913)	(0.127)	(0.102)	(0.121)
Relation_neighbor	-0.399***	-0.328***	-0.406***	-0.342***	-0.396***
	(0.0969)	(0.0530)	(0.102)	(0.0635)	(0.0988)
Relation_in_dep	-0.496***	-0.442***	-0.497***	-0.447***	-0.491***
	(0.103)	(0.0649)	(0.108)	(0.0737)	(0.105)
Relation_out_dep	-0.441***	-0.358***	-0.448***	-0.371***	-0.444***
	(0.107)	(0.0637)	(0.112)	(0.0731)	(0.110)
Relation_society	-	-	-	-	
Soybean			0.0756	0.109*	
			(0.0536)	(0.0583)	
Wheat			0.0602	0.0840*	
			(0.0450)	(0.0466)	
Corn			0.0184	0.0115	
			(0.0459)	(0.0475)	
Constant	7.294***	7.212***	7.286***	7.200***	7.372***
	(0.0906)	(0.0381)	(0.0907)	(0.0366)	(0.110)
Observations	255	255	255	255	255
R-squared	0.588	0.555	0.584	0.552	0.585

Table 4. Marginal prices for Model 1

Significant variables	Variation of the rental price per hectare due for having the characteristic (dummy) or to a one unit increase (continuous variable)	Variation for the average rental price per hectare
	%	USD per hectare
Buenosaires	83.49	1034.37
Soybean_yield	3.08	38.16
Livestock	-21.89	-271.14
Fixed rent long	-5.29	-65.60
Sharecropping	-19.51	-241.67
Relation_parent	-43.95	-544.54
Relation_neighbor	-32.90	-407.61
Relation_in_dep	-39.10	-484.45
Relation_out_dep	-35.66	-441.80

Footnotes

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[i] It is difficult to assess land under tenancy since 2002 because, for different reasons, the results of the last Rural National Census conducted in 2008 are not published. The figure we mention comes from estimates given by different authors (Delvenne et al., 2013; Manciana, 2009). They are consistent with the share of land under different tenancy arrangements we found in our survey.

[ii] In our sample, 82% of landlords are non-producers. The database does not indicate whether they are economically active or retired.

[iii] This preliminary work was conducted within the context of two research programs implemented earlier. The first one is a European program on climate, named CLARIS LPB, and the second one is a project financed by the French Agency for Research (ANR), named INTERRA.

[iv] Since tenants sometimes contract with more than one landlord, and landlords with more than one tenant, the sample unit is a contract, not an individual tenant or landlord.

[v] On the 321 leased parcels for which we collected information, we had to remove 20% for which we did not have a complete set of variables (leaving 255 plots). For instance we miss the information on surface for 2, on the relationship between contracting parties for 7, and on the rental price for 41 plots. Regarding the latter, 19 plots are in fact divided in two or more parts and combine share and fixed contract. Under these circumstances it was impossible to calculate an average lease price. 6 plots are under non-monetary lease arrangements between family members. 12 plots are under sharecropping and the information about lease rent is missing. The remaining 22 are plots under fixed-rent contracts. There are no reasons to suspect that our subsample of observed leases is biased. Mean comparison tests for main variables for plots for which we have the information on the rental price and those for which we do not have the information indicate no significant differences.

[vi] In both cases, the level of the rent has been given in quintals of soybean by respondents, so that the rent for share and fixed contracts is expressed in the same unit. To obtain a value, we assumed that producers face the same price for output and used the mean of soybean prices for 2011 calculated from the time series given by the professional trade magazine "*Margenes Agropecuarios.*"

vii See Palmquist and Danielson (1989), for a model on farmland values. For an overview of the empirical literature, see Choumert and Phélinas (2015) and Maddison (2000).

viii Another strand of the literature is focused on farmland rental market in the Pampas and use agent based modelling. This literature goes beyond the scope of our analysis. For further reading see Bert et al. (2010, 2014, 2011).

ix Cf. note iii

x Note that farmers can grow several types of crops on a plot within an agricultural cycle.

xi A linear functional form would imply constant implicit marginal prices, which is independent of the level of characteristics.

xii Spatial econometric techniques are increasingly used in hedonic analysis of farmland values (Huang et al., 2006; Maddison, 2009; Ma and Swinton, 2012; Nivens et al., 2002). Theoretically one could argue the existence of several spatial effects : (i) the spatial autocorrelation could be caused by the existence of a relationship between the observed rental price of a plot and the rental prices of other plots located in the neighborhood, referring to the "adjacency effect" following Can (1992) (ii) Omitted variables presenting a spatial configuration with the error structure (Gallo, 2002). However, during data collection it has not been possible to collect GPS coordinates of the plots. There are several reasons to explain why we couldn't collect such data: (i) Some respondents provided answers for several plots and were interviewed in their house. Therefore enumerators could not take GPS coordinates of the plots; (ii) with some plots being very large, using the survey localization to approximate the localization of the plot may have led to bias; to cope with this, it could have been possible to approximate the localization of a plot using its centroid. But this implies taking more than 1 GPS point to then calculate the centroid. (iii) As a consequence of practical field constraints and resources available for this survey, taking relevant GPS coordinates has not been possible.

xiii For a continuous variable, a unit increase of any variable leads to a variation of 100*coefficient % of the plot rental price. For binary variables, the impact in % is measured by $(e^{\beta} - 1)*100$.

*Appendix **Erreur ! Document principal seulement.**. Multilevel hedonic model without explanatory variables*

VARIABLES	ln_rent	σ_u	σ_ε
Constant	7.084***	0.312**	0.326***
	(0.221)	(0.157)	(0.0145)
Observations	255	255	255
Number of provinces	2	2	2

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix ***Erreur ! Document principal seulement.****. Multilevel hedonic model with all explanatory variables*

VARIABLES	Model 1 Ln_rent	Model 2 Ln_rent	Model 3 Ln_rent	Model 4 Ln_rent
Surface_plot	-0.000254*	-0.000438***	-0.000254*	-0.000447***
	(0.000151)	(0.000151)	(0.000152)	(0.000152)
Wheat_yield	0.0132	0.0166		
	(0.0111)	(0.0115)		
Corn_yield	0.00245	0.00160		
	(0.00635)	(0.00659)		
Soybean_yield	0.0312**	0.0423***		
	(0.0143)	(0.0147)		
Livestock	-0.247***		-0.249***	
	(0.0553)		(0.0558)	
Fixed rent long	-0.0540	-0.0878*	-0.0455	-0.0755
	(0.0457)	(0.0468)	(0.0464)	(0.0476)
Sharecropping	-0.216***	-0.218**	-0.215**	-0.214**
	(0.0835)	(0.0867)	(0.0844)	(0.0876)
Fixed rent short	-	-	-	-
Relation_parent	-0.577***	-0.523***	-0.583***	-0.535***
	(0.154)	(0.160)	(0.156)	(0.162)
Relation_neighbor	-0.398***	-0.327**	-0.405***	-0.340**
	(0.152)	(0.157)	(0.154)	(0.159)
Relation_in_dep	-0.495***	-0.441***	-0.495***	-0.445***
	(0.152)	(0.158)	(0.154)	(0.159)
Relation_out_dep	-0.440***	-0.357**	-0.446***	-0.369**
	(0.160)	(0.165)	(0.162)	(0.167)
Relation_society	-	-	-	-
Soybean			0.0756*	0.109**
			(0.0448)	(0.0458)
Wheat			0.0611	0.0850
			(0.0506)	(0.0522)
Corn			0.0195	0.0127
			(0.0465)	(0.0483)
σ_u	0.301**	0.306**	0.315**	0.323**
	(0.152)	(0.155)	(0.159)	(0.163)
σ_ε	0.289***	0.300***	0.290***	0.301***
	(0.0128)	(0.0133)	(0.0129)	(0.0134)
ρ	.521	.509	.541	.534
Log-likelihood	-50.174	-59.795	-51.292	-60.884
Constant	7.594***	7.517***	7.600***	7.522***
	(0.263)	(0.268)	(0.271)	(0.278)
Observations	255	255	255	255
Number of provinces	2	2	2	2