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## **Farmland Rental Rate and Marginal Return to Land: A French FADN Perspective**

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## **Abstract**

The paper examines the relationship between the cash rent and the shadow value of farmland to understand the French farmland market. The empirical analysis is restricted to French main grain crops, namely wheat, oil crops and other grain crops. The sample is an unbalanced panel of 35,089 observations, that includes 6,089 crop farms which are observed about 5 years each, during the period 1990 -2007. The shadow values of all quasi-fixed assets have been derived from a restricted variable profit function. The profit function was successively estimated and tested by three estimation strategies: pooled OLS, one-way fixed effect and random panel model. However, concluding remarks are based on the results of the fixed effect model because of its statistical significance. The result indicates that the shadow prices of land and labour were persistently diverging from there observed price. The average shadow value of farmland was estimated about 550€/ha/year which is five times higher than the average rental price of 112€/ha/year over the studied period. Implication for the behaviours of French farmland market has been drawn from this analysis.

**Keywords**     Shadow values, cash rent, farmland price, NPV, restricted profit, fixed effect

**JEL code**     Q12, Q15

## 1. Back ground and Introduction

Historically, the trend of French farmland price was very responsive to gross marginal profitability. For example, Bonion and Cavailhès (1988) observed that farmers were the major buyers to reap the profit of agriculture during the period 1850-1940. During 1940-1980, the farmers who had acquired land before offered more than three-fourth of their land for sale due to the decrease in gross farm income and off-farm employment opportunities (Bonion and Cavailhès 1988; Fachini 1995). In those periods, the decline in farmland price was explained by the decrease in the gross margin of agriculture and the tightened credit policy that was conducted from 1971 (Bonion and Cavailhès 1988; Facchini 1995). This decline continued until 1990. Since 1997 onwards, the non-farmland demand and the regulation have prevailed over the still declining trend of agricultural returns to explain the increase of French farmland price (Latruffe et al. 2008; Cavailhès et al. 2003). The real price of farmland (crop land and grazing land) has been growing by 15 %, 35% in nominal values, since 1997 (Agreste, 2011). This shows that the price of farmland depends on many interrelated factors. The question is whether the farmland price follows its agricultural return or whether other factors remain prevailing for farmland price analysis. Both the theoretical and empirical data knows to a few in France.

Considering the context of the French farmland market, characterized by several regulations, we explore the following question “What is the profitability of farmland or its shadow value for pure agricultural land against its cash rent?” What does it implies for being owner-operator buyer or seller and for non-operator owner or seller? What are implications of the divergence of shadow value of farmland against cash rent in terms of French farmland market policies? A recent study of the French Ministry of Agriculture reports that farmers offered 34% of the total farmland sold in 2005, while they bought 71% of the total farmland area purchased in the same year. The report also indicates a systematic price difference between free farmland, meaning land without tenant, and land with tenant: 5, 230€ per ha for the average land without tenant and 3,620 € per ha for the average land with a tenant in place at the time of sale (Agreste, 2011).

In this paper we stick to the agricultural determinants of the farmland sale price. We compare the cash rent which is paid by tenants and the shadow value of farmland in agricultural production. Insights are drawn for understanding the behaviour of the farmland market by using the Net Present Value (NPV) model of farmland price formulation. Empirical results enable to understand why owner-operators are inclined to buy more land and to sell less land than non-operators. Estimating the shadow price of farmland from a multi-product farm production model and conducting a comparison to the cash rent is the main contribution of this paper.

The analysis has been carried out from the French Farm Accountancy Data Network (FADN) on 6,089 farms specialized in grain and field crops. There are almost six year observations per farm on average. So, a total of 35,089 observations over years 1990 to 2007 were utilized for this study. We formulated a restricted dual quadratic profit function with a short-term

production horizon to model the annual farm gross profit. The gross profit was calculated as the annual sale revenue minus the annual intermediate costs. The intermediate costs are the costs of variable inputs such as fertilizer, energy, seed and miscellaneous expenses. Our short term farm production model assumes that land, labor and capital are fixed factors which might be adjusted in the long run, but are exogenous in the short run. The other assumed exogenous variables are the prices of output, a contract service price index, subsidies and technology. Consequently, the shadow price of land is a linear function of these fixed factors and exogenous variables.

The cash rent per hectare paid by each tenant farmer is directly obtained from farm accountancy report, by dividing the annual payment for renting land by the rented area. The dual profit function was estimated using pooled OLS, fixed effect and random effect econometric methods for unbalanced panel data. The statistical tests favor the fixed effect model. Throughout the period, the cash rent per ha is stable while the shadow value of land decreases steadily before rising by soaring grain prices in 2006 and 2007. The shadow prices of other fixed inputs have also been derived with similar methodology. Implication for farmland market is discussed. Following this introduction, section two briefly explain the French farmland market characteristics and present some literature relevant to the present study, section three presents the theoretical approaches of the shadow price of farmland with a basic micro economic farm production model, section four discusses the econometric approaches and the studied data, section five provides the result and discussion, and section six concludes.

## **2. Literature Review**

### **2.1 Characteristics of French Farmland Market**

In this section the basic characteristics of French farmland market is discussed in order to examine the relationship between its cash rent and its shadow value. Contextually, the French farmland market is regulated in one or another. In France, this regulation is nationally defined and implemented at the NUTS3 regional level.<sup>1</sup> Two wings are involved in the decision of farmland sales regulations together with the local prefecture that represent the national government at this regional level. ‘SAFER’ (Sociétés d’Aménagement Foncier et Etablissement Rural Agricole) is a public farmland agency and ‘CDOA’ (Commission Départementale d’Orientation Agricole) is a regional committee made of representatives of various public bodies and agricultural professional organizations where farm transmissions and enlargements are presented and debated before any decision from the prefecture. Especially SAFER has a full responsibility and right for implementing the farmland market regulation.

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<sup>1</sup> In France, excluding overseas territories, there are 22 NUTS2 regions, sub-divided into a total of 96 NUT3 regions.

The main objective of SAFER is to regulate farmland market in general and its price in particular. It has a role for insuring the transfer of farmland to young farmers' and facilitates farmland consolidation between adjacent areas for ensuring the renewal of profitable family farms in France. These regulations are exercised in both farmland sale market and rental market. Every proposed sale must be notified to SAFER which may preempt the parcel. Both the tenancy duration and the rental price are regulated by the NUTS3 level of administration. A French tenancy law goes back to the 1940s. The basic principle of this tenancy code is either to limit the power of the landlord over their tenant farmer and to limit the unearned income of the landlord from land holding. This is exercised by limiting the minimum duration of the contract to nine years as well as designing medium term contracts (18 years) and long term contracts (25 years) including career-long contracts. The tenant has an automatic right to renew the lease for the next nine years for himself, his spouse or his legal descendants. If the tenant dies, the rental contract will continue in the name of his legal descendant or other relatives as far as they were working in the farm during the five years prior to tenant's death. The law also provides 'a tenant's pre-emption right' which gives the tenant the priority to buy the farmland from the owners as soon as he has been working on the farmland for three years and commit himself to continue.

In addition to the regulation of tenancy contract duration and transfer rights, the minimum and maximum rental price of farmland is administratively set for each type of land of each appropriately designated zone. Contracting out of this interval is not allowed by law. Each NUTS3 region endowed with SAFER sets the index of rents ("indices des fermages" in French) according to national directives. The index calculation is based on the weighted five year average gross margin of the NUTS3 region, the national average income of farmland and the average gross farm income in the corresponding specific production.

The share of rented farmland in the total Utilized Agricultural Area (UAA) is still 60% according to the 2000 agricultural census. This is significant as compared to other European countries. According to the FADN data base, the share of rented farmland reached 59.9% in 1990 and 75.8% in 2006 (Latruffe et al. 2008). Most land owners are former farmers and former farmers' heirs as the number of farmers has steadily declined for 60 years to about one tenth of the initial five millions. The average rental price of crop and grazing land was increasing up to 1999 and stable since then. For example average cash rent of farmland (cropland and grazing land all together) was only about 122.3 € per hectare while its sales price reached 4,790 € per hectare (Latruffe et al. 2008). This means that the capitalization rate (farmland rental price over the sales price) is less than 2.5%. Hence, the capitalization of cash rent to the farmland price is not lowest as compared to other European countries (for Germany, Netherland, 2.49%; Finland, 3.19% according to Strelecek et al., 2010). Indeed, the farmland price became very responsive not only to agriculture profitability but also to non-agricultural development opportunities. Recent evidences shows that farm policies and peri-urban pressure are key factors that determine farmland prices (Cavaillès et al. 1996; Cavaillès et al., 2003; Latruffe et al. 2008; Geniaux et al. 2011). Until 1990, the farmland market was dominated by non-farmers who were both major suppliers and major demanders. Since, farmers have become the dominant buyers of farmland, especially in pure agricultural

zones areas (Agreste, 2011). If the price of French farmland does not only account for its gross farm income but also for other anticipated income, why did the farmers recently become the major buyers of farmland? Why does the price gap between the farmland with and without tenant persist?

In summary, both the farmland sale market regulation and the rental market price regulation favour the tenant over the land owners. Considering these French specificities, we compare the marginal return to farmed land with the observed cash rent in France. The next section give a brief review of literature on net farmland return measures, cash rent versus other 'imputed' values', and its implication for farmland price formation.

## **2.2 Literatures on farmland rerun and farmland price**

It is clear that conceptually relation between land rent and the farm-based return was a subject of research since the time of Ricardo (1815) and Von Thünen's location theory (1826). Ricardo provided a solution for classical economics with his theory of differential rent and Von Thünen with his theory of spatial differential rent theory. In both theories, the farmland return can be measured by the residual value of sales minus production costs. This is called the imputed residual farmland return or the imputed value of farmland. On the other hand, the neo-classical economists solve the problem by incorporating the land factor into their capital theory for valuing the net farmland return and its rental price. This is the Marginal Value of farmland (MVL) or, in other words, the shadow price of farmland. Considering a perfect market assumption, all approaches provide the same result. These market conditions have been important questions for researchers who look for the best measures of farmland return, ending in formulating various Net Present Value (NPV) models of farmland price (Mishara, Moss and Erickson, 2004). Net farmland return and its discount rate are the two main components of the NPV models of farmland price. NPV Models of farmland price are considered as theoretically sound and are the most cited model in farmland price literature (Alston 1986, Burt 1986, Featherstone et al.1987, Campbell and Schiller 1987 and Clark 1993). However, the empirical findings have had inconclusive findings in order to explain the relation between farm-based return and farmland price (Clark et al.1993; Falk 1991; Campel and Sheiller 1987, Guiterrez et al. 2007).

In empirical studies, two lines of measures of farmland return have been considered. These are the cash rental price of farmland and the Ricardo imputed farmland return. The cash rent refers to the market price outcome between the land owners and their tenants. Given a competition for farmland, the cash rent will be determined by the determinants of agricultural profitability, such as input prices, output prices and the rate of technological change. Although the cash rent approach is conceptually sound, it has been questioned as a good measure of the net farmland return. In particular, how really the 'renter value' the farmland during the time of rental contract negotiation is unobservable (Mishara, Moss and Erickson, 2004).

When the quasi-fixed inputs are wrongly considered as a variable input and when the quasi-fixed inputs are not at their equilibrium level, the shadow value of farm land and the cash rent value will not give the same measure of the net farmland return. Hence to measure the farmland return one need to identify and classify which factors of production are variable inputs and which are quasi fixed inputs in the sphere of production (Mishara, Moss and Erickson, 2004).

As a conclusion, there is no ideal measure of farmland return. We follow a different approach to measures the shadow values of farmland from a dual profit function and specification. Deriving the shadow values of the quasi-fixed inputs from the farm production model is therefore the theoretical basis of the paper.

### 3. Theoretical Model and Approaches

The main objective of this paper is to compute the shadow value against the observed cash rent with land being one of the quasi-fixed inputs in the short run. This leads us to specify a dual profit function in order to measure the shadow value of farmland.

Consider a farmer who faces different fixed constraints in the short run and maximizes the revenue over the variables cost.

$$\pi(p, w, z) = \underset{y, x}{Max} \left\{ \sum_{i=1}^m y_i p_i - \sum_{j=1}^n x_j w_j = py - wx; F(y, x, Z = 0) \right\} \dots\dots\dots 1$$

In equation 1,  $\pi$  is a multiple output, multiple input short-run profit function,  $y$  represents the vector of  $m$  outputs  $y$  ( $y_1, y_2, \dots, y_m$ ) using of  $x$  variable inputs  $x$  ( $x_1, x_2, \dots, x_n$ );  $p$  is the vector of  $m$  output prices  $p$  ( $p_1, p_2, \dots, p_m$ );  $w$  is the vector of  $n$  input prices  $w$  ( $w_1, w_2, \dots, w_n$ ) and  $Z$  is also vector of refers to  $k$  quasi-fixed inputs and other exogenous factors ( $z_1, z_2, \dots, z_k$ ). With competitive behaviour and a regular technology represented by the production transformation function  $F(x, y, Z)$ ; the maximization programme gives a dual transformation which is called variable profit function (Lau 1976; Shumay 1983). From this dual formulation it is possible to compute the supply of outputs and the demand for variable inputs. The dual approach has been preferred over its primal for econometrics application as the nature of the specification clearly identifies and distinctly put the endogenous variables in one hand and exogenous variables on the other side of the equation. Because of its application merits, the dual approach was taken over here to compute the shadow value of farmland.

Applying the Hotelling Lemma from equation (1) the profit maximizing level of output supply can be derived from the first order derivatives of the profit with respect to output price:

$$y_m(p, w, z) = \partial \pi(p, w, Z) / \partial p_m \dots\dots\dots 2$$

In equation 2,  $y_m$  represents the output supply of the  $m^{\text{th}}$  output. Analogously, the shadow value of the quasi-fixed input  $k$  can be derived by taking the first order derivative of the short run profit function with respect to the quasi-fixed input quantity  $Z_k$  (Diewert 1974; Huffman 1987). This can be represented as:

$$\varpi_k(p, w, Z) = \partial \pi(p, w, Z) / \partial Z_k \dots\dots\dots 3$$

Equation (3) is our interest and it is our objective. It represents the shadow price of quasi-fixed input k from the optimum dual profit function. This can be interpreted as how the optimum profit changes according to the change in each quasi-fixed input ( $Z_k$ ) (Diewert 1987; Lau 1976). Within this framework, we compute the shadow value of farmland from one of the flexible functional form, the *quadratic restricted profit function*.

#### 4. The Empirical Model

The quadratic function is one of the flexible functional forms, which was formulated according to a second-order Taylor's expansion theory to approximate the short-run production function. A particular characteristic of this function is that ensuring the local convexity ensures the global convexity and the second-order derivatives are the linear function of the parameters of the profit function (Lau 1976)). The function can be written as:

$$\begin{aligned} \pi = & \partial_0 + \sum_{i=1}^3 \partial_i P_i + \sum_{k=1}^5 \varpi_k Z_k + \frac{1}{2} \sum_{i=1}^3 \sum_{j=1}^3 \beta_{ij} P_i P_j + \frac{1}{2} \sum_{k=1}^5 \sum_{l=1}^5 \psi_{kl} Z_k Z_l + \dots \dots \dots 4 \\ & \sum_{m=1}^{29} \sum_k r_{ki} Z_k P_i + \frac{1}{2} \delta_1 w^2 + \theta_1 w + \sum_{i=1}^3 \mu_{mn} P_m w_n + \sum_{k=1}^5 \phi_{kn} Z_k w_n \end{aligned}$$

In equation 4,  $\pi$  refers to the short run restricted profit (measured by the farm gross margin); P is the price vector of the three main crops (wheat, oil crops and major grain crops); w refers to the contracted service price index as a proxy for variable input price; Z is the vector of quasi-fixed inputs including (land, labour, capital, subsidy, and the technology change proxied by the time trend) and respective parameters coefficient ( $\partial, \beta, \psi, \gamma, \delta, \theta, \phi$  and  $\mu_i$ ) to be estimated. A well behaved profit function should exhibit the following properties: linear homogeneity in price, meaning that the profit should increase in the same proportion as the increase in all prices; symmetry implies the second order partial derivatives of the profit function must be the same irrespective of the order of differentials ( $r_{ij} = r_{ji}$ ) and the monotonicity conditions requires that all estimated values for output supply must positive and the convexity condition requires that the Hessian matrix of price derivatives ( $A = \partial_i$ ) to be positive semi-definite .

Using Hotelling's Lemma , the first-order derivative of equation with respect to the profit function gives a series of output supply as follow:

$$y_m = \partial_i + \sum_{i=1, i \neq j}^3 \beta_{ij} P_j + \sum_{k=1, i=1..3}^5 r_{ik} Z_k + \mu_{in} w_n \dots \dots \dots 5$$

In equation 5,  $Y_i$  represents the optimal supply of one of the three crops namely wheat, oil crops and other grain crops. Other variables and parameters are as defined above. The shadow price of farmland can be derived from the profit function of equation (4). It is a linear function of prices, other quasi-fixed inputs and technology parameters (Diewert 1987). This can be defined for every component of Z. If we assume that k =land, the shadow value of land can be expressed as:

$$\text{Shadow price of Land} = \varpi_{land} + \psi_{land} Z_{land} + \sum_{k=1, k \neq land}^4 r_{land} Z_k + \sum_{i=1}^3 r_{land} P_i + \sum_n^5 \phi_{land} w_n \dots\dots\dots 6$$

The derived shadow value of land can be interpreted as the marginal change in profit for an additional unit of farmland. Similarly, from equation (4) the shadow values of capital, labour and subsidies can be also derived. Therefore equation (4) and (5) are the basis of our econometric models and equation (6) is a straight forward calculation of the expected marginal value of land, based on the estimated parameters and the explanatory variables. The next section briefly explains the econometric method of estimation.

#### 4.1 Econometric approach

As mentioned in the introduction, our objective to estimate the profit function that was defined in equation (4) and then derive theoretically consistent shadow values of land. Therefore the econometric methodology is to estimate the profit function with best of statistical performance in line with our data structures. Our analysis is farm level French FADN. The data structure is unbalanced panel with average number of observation per farm is only 6 times out of the maximum 18 observed years. We follow the normal balanced panel estimation method as Wooldridge (2010) suggests that the mechanics of estimation between balanced panel and unbalanced follow similar procedures. The detail data descriptions are discussed in section 4.2. Thus, the econometric methods presented here are the method which we have followed to handle this data set so to meet our objective. Equation (4) was estimated successively with the pooling OLS regression, the fixed effect and the random effect specifications for panel data. The shadow land value function and the other quasi-fixed asset values (such as labour, subsidies, and capital) have been derived and computed directly from the result of the estimation. The econometric models of equation of the profit function have the following structure:

$$\pi_{it} = X_{it} \Theta + c_i + u_{it} \dots\dots\dots 7$$

In equation 7,  $\pi_{it}$  is the profit variable of each farm  $i$  at year  $t$ ,  $X$  is the set of explanatory variables of the profit function that are identified in equation 4 (output prices, land, labour, capital and contract service price index and technology) and  $\Theta = [\partial_i, \varpi_j, \psi_{ij}, r_{ij}, \delta_1, \theta_1, \mu_i, \phi]$  are vectors of parameters to be estimated.  $c_i$  is the fixed effect of farm  $i$  to account for unobservable heterogeneity, and  $u_{it}$  is the error term. We assume that  $E(u_{it}) = 0$  and that  $u_{it}$  is independent from the other explanatory variables ( $cov(X_{it}, u_{it}) = 0$ ).

We prefer to follow a step by step estimation strategy. We started with the pooled OLS specification, continued with the fixed effect and ended with the random effect. Pooled OLS makes a strong assumption about the fixed effect ( $c_i$ ) of equation (7). It assumes that the fixed effect can be explained by in the error term ( $u_{it}$ ). If we define  $V_{it} = c_i + u_{it}$  where  $V_{it}$  represents a composite error term between white noise error term ( $u_{it}$ ) and the fixed effect ( $c_i$ ), this model assumes that  $E(X', V_{it}) = 0$  and hence the  $E(X_{it}, c_i) = 0$ . Under this strong assumption, the pooled OLS would give unbiased and efficient estimator according to Wooldridge (2010). In our case, we have carried out the F-statistics based on Baltagi (2005) to test the pooled against the fixed effect model. The F-statistics are constructed as a set of

linear restriction which assumed a ‘constant term’ across all observations against the specification where the individual fixed effect varies across farms. The results reject the null hypothesis of pooled OLS and support for panel specification. We then further carried out another test whether  $(c_i)$  should be treated as a random effect or as a fixed effect. The null hypothesis of the Hausman test was also rejected in favor of the fixed effect model. We concluded that due to the heterogeneity of farm characteristics, the fixed effect model performs better than the other two types of specifications. The results of the fixed effect model are presented below and, for comparison, the results of pooled OLS and random effect specifications are presented in Appendix A-1 of this paper.

## 4.2 Description of the data

All the relevant data of the study was taken from the French Accountancy Data Network (FADN) for 18 years from 1990 to 2007. The total number of observations is 35,089 across 6,089 crops farms of wheat crops, oil crops and other cereal crops. The data structure is unbalanced panel data in which the average farm was observed 6 times on average, over the 18 year period, while 25 % of farms were observed 8 times or more. Less than 2% of the total observations had been observed only one year. These one year farms were lost in the fixed effect estimation but were kept for Pooled OLS and random panel. The output prices of each of crops are defined in (€/per quintal) and are available for each observation. The mean quantity of wheat crop is 3,183 quintals per farm which is higher than other grain crops with 2,117 quintals per farm and oil crops with 772 quintals per farm per year. The cost of intermediate inputs by type such as fertilizer, fuel, seeds etc are not available in the data base but we have the aggregate cost of production. We took it to calculate our variable profit as the annual farm gross margin. In addition, we have complemented our model by considering the contracted service price index as an indicator of variables costs. It is only available at a regional basis. In addition, both the quantity of labour and the expenditure of labour are available from the data base. The total labour unit was converted in man-year equivalent. Similarly, the quantity of cultivated farmland area is classified as rented area and owned cultivated area. Over all, in the data, about 31% of the total cultivated area of land was owned by the operators while a large share of 69% of the land is under tenancy contracts. The quantity of total capital and all allocated subsidies are also available in the data set. We took the average of all kinds of subsidies per farm per year. The subsidy rate was also calculated as the ratio of total annual subsidy payment over the total cultivated area per year.

The gross margin of the farm has been calculated as total annual crops sales plus the total subsidies of all categories minus the total intermediate cost of production. The average gross profit of the farm was 81,363 € per farm all over observation. The average cash rental payment per total cultivated area of land (owned cultivated + rented land) was about 89 € per hectare while when we calculate the ratio of total cash rent to total rented area, the rent goes up by 112 € per ha. Monetary variables were deflated by the 1990 based national GDP deflator. Thus all estimation results are based on real values. The descriptions and definition of variables are provided in Table 1.

Table 1: Descriptive Statistics of variable

Variables	Mean	Std. Dev.	Minimum	Maximum	Number of Obs.
Gross Margina (€ per farm)	81,363	60,340	-41521	930.7	N = 35,089
Rental rate price (€/ha )	113	89	0	5 .60	N = 34 ,419
q. wheat crops (in quintal)	3,183	2,675	1	41.	N = 30,202
q. oil Crops(in quintal)	772	779	1	10.46	N = 23,425
q. other Cereal Crops(in quintal )	2,177	2,567	1	68.52	N = 30,304
land in (ha)	118	77	1	774	N = 35,089
labour in man year equivalent	2	1	1	41	N = 35,089
Average Price of wheat (€ per quintal )	11	4	5	80	N = 35,089
Average price of Oil Crops(€ per quintal )	29	14	6	100	N = 35,089
Average Price of other cereal Crops(€/quintal)	19	12	5	100	N = 35,089
Total Subsidies (€ per farm)	30,957	25,18	0	259,978	N = 35,089
Subsidy rate per ha (€ per ha)	250.19	154.68	0	16460.43	35089

Source: Owned Calculation

## 5 The Result and Discussion

### 5.1 Estimation Results for the Profit Function

The estimates of the parameters of the variable profit function of equation (4) are presented in Table 2. The adjusted R-square shows that a fixed effect model perform better than the pooled OLS and the random effect models. Most of the relevant variables are significant. The symmetry conditions are imposed. Based on our estimates, the desired rules of homogeneity and convexity in respect of the output prices are not fulfilled. Indeed, the estimated profit function exhibits good statistical performance but failed to comply with the economic theory. So the interpretations and implications are in caution. With a quadratic function, first order and second order effects of all the variables are estimated. Hence the interpretations of the coefficients are more adequate at the average values of the sample than at its margins.

**Table 2 Parameter estimate of the profit function with- Fixed-effects (within) regression**

Variables	Dependent Variable:* Gross Margin							
Gross Margin	Coefficients	t- value	Variables	Coefficients	t- value	Variables	Coefficients	t- Value
land	312	8.4***	landp <sub>1</sub>	14.6	17.2***	P <sub>1</sub> trend	106.2	7.2***
labour	4251.7	3.0**	landp <sub>2</sub>	0.6	3.4***	P <sub>2</sub> P <sub>3</sub>	0.1	0.2
P <sub>1</sub> - wheat crop(P1)	-260.5	-0.5	landp <sub>3</sub>	0.6	2.6***	subratp <sub>2</sub>	-0.5	-4.6***
P <sub>2</sub> - Oil crop(P2)	-107.7	-0.9	subratland	0.3	14.7***	P <sub>2</sub> capita	0.0	1.3
P <sub>3</sub> .cereal crop(P3)	181.7	1.4	landcapita	0.0001	5.7***	P <sub>2</sub> inprice	0.1	0.1
Sub rate	69.6	5.4***	landinprice	0.1	0.5	P <sub>2</sub> trend	21.7	6.2***
Capital	-0.01	-0.7	landtrend	-5.3	-5.3***	subratep <sub>3</sub>	-0.1	-1.1
C. service costs	-360	-1.9**	labop <sub>1</sub>	-306.1	-7.5***	P <sub>3</sub> capita	0.0	0.9
Trend	-4369.8	-8.6***	labop <sub>2</sub>	18.6	1.4	P <sub>3</sub> inprice	-3.0	-2.8***
landsqua.	-0.26	-3.1**	labop <sub>3</sub>	20.6	2.0*	P <sub>3</sub> trend	25.6	6.2***
labosqu.	468.7	6.5***	subratlabo	0.4	0.6	subratcapi	0.0	-3.8***
subrsqu.	-0.004	-1.2	labocapita	0.01	7.9***	subratinput	-0.1	-1.7
capitalsqu.	-0.001	-9.1***	laboinprice	54.5	4.2***	subrattrend	-0.1	-0.2
inputprsqu.	3.03	1.3	labotrend	-359.6	-7.3***	capitalinput	0.0	0.1
P <sub>1</sub> squa.	-56.8	-7.3***	P <sub>1</sub> P <sub>2</sub>	14.1	3.7***	capitatrend	0.0	3.3***
P <sub>2</sub> squa.	-3.8	-4.3***	P <sub>1</sub> P <sub>3</sub>	4.4	1.0	inpricetrend	4.6	0.8
P <sub>3</sub> squa.	-3.05	-3.4***	subratP <sub>1</sub>	-2.4	-4.3***	Constant	40091.6	4.0***
trendsqu.	145.1	5.6***	P <sub>1</sub> capita	0.0	5.6***			
landlabo	-6.5	-2.4	P <sub>1</sub> inprice	-2.0	-0.5			

Notes that the number of obs =35089 (Number of farms = 6089) with number of bs. per farm: (min.1 ave. =5.8, max. = 18) ; F(54,28946) = 225,34 (Prob > F =0) ; corr(u<sub>i</sub>, X<sub>b</sub>) = 0.0144 and the t-values of (\*) indicates significant at 10 percent ; (\*\*) significant 5 percent ; (\*\*\*) significant at 1% .

**Source: Own Computations**

Qualifying this condition, we can understand that the first order effect of two major inputs of production, labour and land, are positive and significant at one- percent level. However, the marginal profit of land decreases with land (the coefficient of landsqu=-0.26)<sup>2</sup>. From the overall formulation, relaxing the land constrain will increase the gross profit up to 89 hectares (118 ha being our sample average) and then the profit will decrease. This is in line with the marginality conditions and the economies of scale work to this limit.

The effect of labour on farm profit increases at increasing rate as its square coefficient is highly positive and significant (labosqu=468.79). The subsidies have also shown a decreasing trend on farm profit with its negative second order effect. The capital has a negative effect on the farm profit as both its first order linear effects and second order degree are zero and less than zero.

<sup>2</sup> As the profit function is a quadratic its optimum can be computed as  $(ax^2+bx+c=-b/2a)$ , for case of farmland  $[312/(-0.26-6.58+14.6+0.6298+0.6318-0.357-0.0001615+0.183-5.37)]=89]$

To summarize, the statistical performance of the fixed effect model is powerful in all methods of estimation (the regression result of pooled OLS and random effect model are presented in Appendix-B for comparison purpose), most of the relevant variables are significant and in line with the expected signs except the price of outputs which is inconsistent with the economic theory and violates the curvature conditions.

### 5.1 Shadow Values of Land and the cash rent

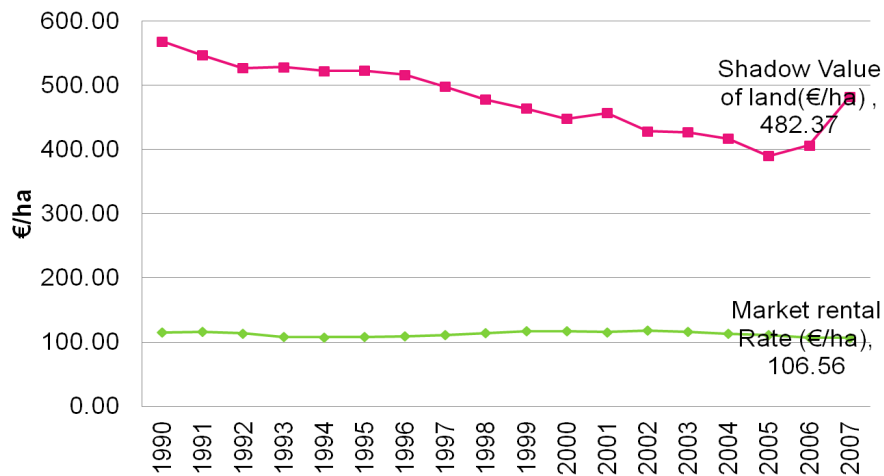
Using the parameters of Table 2, the shadow value of land can be defined as:

$$S.Land = 312.04 - 0.26land - 6.57labour + 14.6P1 + 0.62P2 + 0.63P3 + 0.35subrat + 0.00016capita + 0.18service\ cost - 5.37trend \dots\dots\dots 8$$

The estimates of the farmland shadow price equation are represented in equation 8. All parameters including the squared land are significant with expected signs, except the price of contracted service. Having a constant positive value (312.04) and negative coefficients (-0.26), the shadow price of farmland decreases with the area of the farmland. This is in line with the marginal theories of fixed inputs or concavity conditions for fixed inputs. A negative sign of labour in the farmland price equation shows that the price of farmland decreases with labour. This means that the demand for labour will decrease with increases in farm size. A positive coefficient of capital indicates the complementarity between land and capital. At the same time, the shadow price of farmland increases output prices ( $P_1$ ,  $P_2$  and  $P_3$ ) and policy parameters (subsidy), as expected. However, the shadow value of crop farmland decreases over time by 5.37 per year.

Using this equation, we calculated the shadow price of each farm per each observation (each farm-year). The results shows that the shadow value of farmland was 632 € per ha in 1990, very slowly decreases until 2005, and then rebuilds again in the end of our observation period (See Graph 1). Similarly, we have calculated the observed cash rent farm by farm basis. We then computed the average annual cash rent. We compare this observed rate to the derived shadow values of farmland over the observation period. The change of the cash rent over the period is less than one percent from year to year for the whole 18 years. The real cash rent remains between 105 € per ha to 120€ per ha. According to this result the cash rent is five times less than the shadow value of land.

Graph 1: Trend of shadow value of farmland versus the observed cash Rent



In the same manner, we have calculated the shadow value of labour, capital and subsidy. We have found that the average shadow value of labour is 6,236€ per person per year. The observed wage rate is 11,725 € per person per year. The growth rate of both the market wage rate and the computed value follow the same trend. The shadow price of capital also is between 4% and 6%. The average value of capital is 4.30%. The shadow value of subsidy begins at a very low level at the beginning of the 1990s and then reached a peak level in 1993 and 1998 immediately after the CAP policy shifts. The observed subsidy rate also follows the same trend but at higher magnitude level. Details of the shadow values compared to the market values are provided in AnnexI-B of this report.

## 6 Summary and Conclusion

The basic motivation and research problem of this paper is to identify the agricultural-return / shadow values/ of the farmland against its cash rent from the basic farm production model in context of France. This is because we hypothesizes that even in the pure agricultural zones areas where the urban pressure is minimal, the price of farm land is not representing its net farmland value. This is due to either the behaviour of French farmland market or competition among farmers. We have had recent new evidences there is a shift in the demand and supply sides of the farmland market from farmers to non-farmers. The report showed that farmers are net buyer while non-farmers are net sellers. In line with this, there is a systematic price difference between a farmland with tenant and a farmland without tenant. Qualifying the context of French farmland market in general and the rental regulation in particular, we proposed that examining the relationship between the observed cash rent and the shadow price of farmed land gives an insight to understand the farmland sale market and the Net Present Value model of farmland prices. The analysis was conducted on French FADN large data set with more 35089 observations from 1990 to 2007. We derived the shadow value of farmland and of other quasi-fixed inputs (labour, capital and subsidies) from a restricted variable profit function. We calculated the observed cash rent on a farm by farm basis for 18 years period. We have found that the shadow value of farmland is more than 5

times higher than the observed cash rental price in France. Over all in the period of study, both the shadow value and the cash rent were increasing by less than 1% over the studied period. A consistent divergence between shadow price of farmland and its cash rent directly implies that land is relatively scarce according to the constrained quasi-fixed asset theory. The more you relax the constraint, the higher the profitability of agriculture. In other words farmland has been allocated below its optimal level.

Similarly, the cash rent is one of the most stable and well predictable variables among the micro-variable factors that affect the profitability of agriculture in the French crop farm context. This is probably because of the rental rate regulation. Similarly our result for labour is on the opposite, the observed wage rate of farm labour was higher by more than 50% than its estimated shadow value. However, similar to land, both the observed wage rate and our calculated shadow wage rate exhibit the same growth pattern over the studied period (less than 1%). The estimated shadow price of subsidies is also much lower than the observed subsidy rate over the studied period. We have found that the average shadow value of capital in the range of 4.3%.

The results of this estimation have several implications in terms of farmland market in general and farmland price in particular in the context of France. Considering the motivation of our study and the result of our estimation, we propose that controlling the non-farm components of the farmland price, examining the difference between cash rent and shadow value of the farmland gives an insight on the operation and the performance of farmland sale market in France. Let's consider the two recent phenomenon of the French farmland market: i) the farmers want to be the owner of the farmland and ii) the price gap between a farm with tenant (ongoing contract) and without tenant. In the first case, the farmers buy more land than they were before. This can be explained as an effect of the regulation of the rental market. If the farmers' current financial position is much better than before as the result of better profitability of agriculture, it implies that the shadow values of land is higher than its cash rent in our case, therefore the farmers want to bid for more farmland. Thus, a farmer is tending to keep their holding or they want to increase the size of his farm (if he is existing farmer). This is particularly true when the rental market is not functioning well to fulfil the demand for farmland of farmers. Indeed, the farmers want to be the owner of the farm and bid intensively in the sale price. Thus the farmland price of the pure agricultural land diverges from its basic NPV price, *ceteris paribus*.

The observed price gap between a free farmland (without tenant) and with tenant can be explained as owner operator buyer or seller vis-à-vis non-operator owner or non-farmer buyer of farmland. For example in our illustration the willingness to pay of farmers (owner operators) will be higher than the willingness pay of non-farmers because only the former is able to capitalize the farmland shadow value. The maximum willingness to pay (remember  $NPV = \text{return of farmland} / \text{capitalization rate}$ ) for owner operator reaches as high as 12,548 € according to our estimated shadow value of the farmland (550€) and our estimated capitalization rate of 4.30%. In contrast, for non-operators, return for farmland is based on the market cash rent, the capitalization price of farmland would remain as low as 2,458€ per ha

*ceteris paribus*<sup>3</sup>. The same is true on the supply side of the land market. The acceptance price level of owner-operator would be higher than the non-operator owner of farmland.

What does this implies for the farmland market and equilibrium farmland price in French context?<sup>4</sup> If potential purchases are composed of a group of farmers and non-farmers, the equilibrium farmland price in between these two values, usually what has been observed between (3620 € to 5,230€ per ha) and in the corner case, price will reach on the two points. Assuming that the demand side determines the equilibrium price of the farmland, the lower bound was rarely observed. Various studies confirmed that the urban pressure and developments are drivers of farmland price in peri-urban areas. Our message is different. In pure agricultural areas where the urban pressure is minimal, the price of farmland wing from its NPV price because the cash rent is not following the net farmland return (its shadow values).

Another implication of the paper is methodological issues for explaining a farmland price in the farm income capitalization model or NPV model. Which measures of farmland income (Cash rent, the residual return or the shadow values) should be taken for NPV modeling and for explaining the relationship between farmland return and farmland price in France? Within the context of multi-quasi-fixed factors of farm production and rental regulation environment, our result shows that the commonly measure of farmland returns (cash rent or the residual return) may not represent the production value of farmland and lead to wrong conclusion. Therefore one should consider how really the cash rent represents the shadow value of farmland based on the basic notion of the NPV farmland model and draw an implication.

Finally, due to the unfulfilled curvature conditions of our profit function, we have been trying to estimate the parameters of the profit function by using the simultaneous estimation of the supply equations of the three crops and by imposing the adequate cross equation restrictions. We estimated the profit function with a pooled seemingly unrelated cross equation model (pooled SUR) without considering panel data effect, the statistical performance of the estimated parameters are not as efficient as the fixed effects and we did not get the curvature regularities. We have a plan to run seemingly unrelated fixed effect model and examine whether the parameters estimates are improving in terms of statically significance and its curvature properties.

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<sup>3</sup> There are several factors that affect the farmland market which are difficult to precisely measure their separate effects on farmland rent or prices.

<sup>4</sup> According to French land regulation agricultural area are dedicated only for farming activities, and any new building restricted for farming activities(Latruffe et al. 2008; Geniux et al.2011). However, the market explicitly or implicitly is active between apure agricultural and urban land market

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## Annex I-A Regression Result and Shadow values

**Table 3: Regression result comparison pooled OLS, Fixed effect and Random Panel**

Variables	Pooled OLS		One way Fixed Effect		Radom effect model		Variables	Pooled OLS		One way Fixed Effect		Radom effect model	
Gross Margin	Estimated Coefficients	t- Value	Coefficients	t- Value	Estimated Coefficients	Z- Value	Gross Margin	Estimated Coefficients	t- Value	Coefficients	t-Value	Estimated Coefficients	Z- Value
land	337.91	14.01***	312.05	8.46***	333.6	11.95***	labop3	-58.10	-5.35***	20.67	2.06*	-8.8	-0.93
labour	25832.40	26.39***	4251.79	3.02**	14640.8	13.6***	subratlabo	-5.04	-7.8***	0.40	0.65	-1.5	-2.85***
Price of wheat crop(P1)	1996.78	3.48***	-260.51	-0.59	-67.1	-0.15	labocapita	0.02	23.78***	0.01	7.99***	0.0	15.31***
Price of Oil crop(P2)	562.45	4.11***	-107.71	-0.96	-57.0	-0.52	laboinprice	84.11	10.25***	54.59	4.22***	77.3	7.53***
Price of other ceral crop(P3)	17.65	0.13	181.77	1.42	180.4	1.48	labotrend	-227.13	-5.32***	-359.65	-7.31***	-319.5	-7.54***
Sub rate	46.54	3.12***	69.68	5.45***	59.7	4.97***	p1p2	23.61	4.68***	14.18	3.74***	17.1	4.52***
Capital	0.06	4.64***	-0.01	-0.74	0.0	-0.93	p1p3	-6.46	-1.14	4.45	1.02	-0.3	-0.08
Contact service costs	-289.88	-1.35	-360.04	-1.98**	-202.5	-1.15	subratp1	-0.45	-0.63	-2.45	-4.3***	-2.0	-3.65***
Trend	-3577.30	-6.43***	-4369.88	-8.64***	-4861.8	-10.15***	p1capita	0.00	5.04***	0.00	5.68***	0.0	7.87***
land squa.	-0.26	-6.13***	-0.26	-3.16**	0.0	0.12	P1inprice	-17.90	-3.56***	-2.03	-0.52	-4.3	-1.12
labosqua.	-604.93	-12.17***	468.79	6.58***	12.6	0.25	P1trend	160.55	8.56***	106.23	7.21***	124.3	8.55***
subrsqua.	0.02	13.44***	0.00	-1.27	0.0	4.09***	p2p3	5.37	5.25***	0.16	0.2	1.6	2.1**
capitalsqua.	0.00	-21.15***	0.00	-9.13***	0.0	-12.44***	subratp2	-0.63	-4.56***	-0.50	-4.68***	-0.4	-3.94***
inputprsqua.	3.94	1.55	3.03	1.36	0.8	0.38	p2capita	0.00	-5.5***	0.00	1.3	0.0	0.06
p1 squa.	-94.55	-8.43***	-56.83	-7.31***	-65.1	-8.22***	P2inprice	-5.68	-5.25***	0.14	0.15	-0.7	-0.81
p2squa.	-8.92	-7.58***	-3.86	-4.34***	-4.4	-5.03***	P2trend	42.15	9.81***	21.74	6.22***	24.6	7.15***
p3squa.	4.01	3.83***	-3.05	-3.49***	-1.0	-1.14	subratep3	0.27	1.97***	-0.12	-1.13	-0.1	-0.56
trendsqua.	-149.08	-4.83***	145.11	5.68***	76.9	3.08***	p3capita	0.00	-4.72***	0.00	0.97	0.0	-0.4
landlabo	-15.29	-9.1***	-6.58	-2.42	-24.2	-11.61***	P3inprice	-2.60	-2.62***	-3.01	-2.87***	-3.2	-3.22***
landp1	17.76	17.25***	14.60	17.21***	15.3	18.47***	P3trend	19.81	4.38***	25.66	6.25***	26.2	6.68***
landp2	1.24	5.98***	0.63	3.46***	0.9	4.94***	subratcapi	0.00	-9.23***	0.00	-3.81***	0.0	-2.07**
landp3	-0.37	-1.47	0.63	2.64***	0.5	2.07**	subratinput	-0.50	-4.18***	-0.18	-1.74	-0.3	-2.66***
subratland	0.19	7.99***	0.36	14.79***	0.3	14.96***	subratrend	2.67	4.69***	-0.10	-0.22	0.5	1.13
landcapita	0.00	8.45***	0.00	5.79***	0.0	6.32***	capitalinp~e	0.00	1.46	0.00	0.14	0.0	1.69
landinprice	-0.98	-5.42***	0.18	0.56	-0.8	-3.22***	capitatrend	0.00	2.21**	0.00	3.36***	0.0	1.35
landtrend	-1.40	-1.7	-5.37	-5.39***	-2.9	-3.43***	inpricetrend	13.76	2.24**	4.63	0.82	14.0	2.61***
labop1	-639.71	-13.58***	-306.11	-7.58***	-393.9	-10.21***	_cons	-6504.40	-0.56	40091.62	4.01***	25018.5	2.62***
labop2	-158.03	-11.47***	18.62	1.49	-40.2	-3.41***							

Number of obs. = 35089, No. farms = 6089

- ❖ pooled OLS: R-squared = 0.7656, Adj. R-squared = 0.7652, Root MSE = 29236;
- ❖ Fixed-effects: R-sq: within = 0.2960, overall = 0.6484, corr (u<sub>i</sub>, X<sub>b</sub>) = 0.0144;
- ❖ Random Effect: R-sq: within= 0.2763, over all = 0.7435, Random effects u<sub>i</sub> ~ Gaussian Wald

Note that: the t-values of (\*) indicates significant at 10 percent ; (\*\*) significant 5 percent ; (\*\*\*) significant at 1% .

Source: Own computation

## Appendix A-2 Shadow values of different Inputs

Table 5: Shadow prices of quasi-fixed inputs with Market Prices

	<b>Land(€/ha)</b>		<b>Labour(€/Year/pp)</b>		<b>Subsidy(€ /ha)</b>		<b>Shad. Capital(%)</b>
<b>Year</b>	<b>Cash rent</b>	<b>Shadow</b>	<b>wage rate</b>	<b>Sh. Val.</b>	<b>Rate</b>	<b>Shadow</b>	
1990	115	632	11759	7098	27	2	5,05
1991	116	613	11644	6909	30	8	5,02
1992	114	599	11575	6395	89	23	4,55
1993	108	605	11504	6773	233	31	3,57
1994	108	598	11903	6928	281	34	3,32
1995	108	600	12114	6823	314	36	3,31
1996	109	591	12045	6557	309	38	3,51
1997	111	568	11857	6597	296	39	3,71
1998	114	548	12297	6608	293	42	3,69
1999	117	535	12505	6441	298	46	3,69
2000	117	519	12737	6347	290	48	3,86
2001	116	528	13033	6117	305	44	4,10
2002	118	501	10682	6177	291	47	4,29
2003	116	500	10666	5848	291	47	4,55
2004	113	489	11142	5637	293	48	4,57
2005	111	462	11063	5670	274	51	4,65
2006	107	478	11244	5274	280	46	5,10
2007	107	550	11287	4040	272	28	6,61
Average	<b>112</b>	<b>550</b>	<b>11725</b>	<b>6236</b>	<b>248</b>	<b>36</b>	<b>4.30</b>
Growth Rate	<b>0,02</b>	<b>0,022</b>	<b>0,004</b>	<b>0,068</b>	<b>-0,410</b>	<b>-0,792</b>	<b>-0,14</b>

**Source:** Own Computation