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An Empirical Analysis of Vertical Integration Determinants among Peasant Farmers in Northern Algeria

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Abstract

This study aims to analyze the determinants of vertical integration (ownership and contract-ing) among peasant farmers in Northern Algeria. The choice of asset control is between ownership and a simple contracting. Thus, the integration of vertical stages of agricultural produc-tion leads to higher gross margins, influences the choice of marketing and supply channels, and improves market participation of farmers. Three different regression models were used to determine the likelihood of a peasant household to integrate vertically (and horizontally) in its enterprise. Data were collected from 635 smallholder farmers in Northern Algeria. Farm structure, farm size, farmers' age, farmers' level of education, seasonality, and geographical location were assumed to be the key factors in accounting for a household's likelihood to ver-tically integrate in its farming enterprise. These key factors affect the household's likelihood of horizontal integration. The study, then, carries the implication that policy-makers should develop increased awareness of farm structure, its scale, seasonal and spatial nature of agricultural production, as well as of some farmers' social characteristics in order to be able to improve the agricultural productivity.

Keywords:
asset ownership; contract-ing; farming; vertical integration; Algeria

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INTRODUCTION

This study draws upon the relevant lessons from some evidence on the institutional structure of the agricultural production in developing countries. Its contribution is largely empirical. Indeed, it is based on the quasi-absence of studies on the agricultural organization in Algeria. For this reason, the Algerian agriculture is taken as a case study, leading us to generate verifi-able hypotheses about the determinants of vertical and horizontal integration in Algerian agri-culture. In this study, by identifying the conditions in which forces shaping farm efficiency vary, testable hypotheses about the determinants of farm vertical and horizontal integration. As such, the choice of asset control forms is between ownership and a simple contracting, that is, a complete acquisition or a contractual arrangement on specific assets. To test our hypotheses, modern conceptual advances were employed to explain how farming systems perform in developing countries. Likewise, the nature of the relationship between vertical and horizontal integration and socioeconomic factors in the agricultural production will be investigated. The paper is organized as follows: Section 2 gives an overview of farm organization; section 3 talks about the research hypotheses; section 4 explores the modeling methodology; section 5 presents the empirical results and discussions, and finally, section 6 provides a synopsis of the study findings.

The purpose of this research is to study the farm organization (the ownership and the contracting) in Northern Algeria. More specifically, the Algerian case seems to be interesting regarding the importance of the agricultural sector in the national economy and for food security issues. The following question is considered: What explains the different patterns of contractual choices for asset control and risk management in agriculture? This question has been largely treated in advanced countries, and our essay is to generate testable hypotheses in the context of emergent developing countries, particularly, in Algeria.

Overview of farm organization

Despite the multitude of theoretical frameworks recently elaborated for the analysis of the farm extent, the new institutional economics [1] provides helpful analytical tools to examine the farmers' behavior and choices in different institutional environments. Therefore, the Transaction Costs' Theory (TCT) was considered. This approach has been largely applied in economic organization of agricultural practices in the last three decades. The TCT offers an advanced conceptual framework to explain different features of contractual arrangements in agriculture (Allen and Lueck, 1993, 2004, 2008; Chavas, 2008; Cook et al., 2008; Roumasset, 1995). It suggests that the organization of farm production is largely determined by the efforts made to economize on transaction costs. In addition, the TCT focuses essentially on the different is-sues of asset specificity such as site, physical, and human ones. As stated by Allen and Lueck (2004), farming can hardly be characterized as a production process laced with specific assets. Accordingly, the vertical integration in agriculture is a strategy used by farmers to gain control over production stages in order to increase its power in the marketplace, reduce costs, and earn higher income. As such, the empirical evidence places a great emphasis on the fact that farmer contractual choice is relevant for understanding the economic organization.

In the modern era, (Algeria after the independence, 1962[2]), there was three farm organizational dominant forms: relatively small individual family farms, collective state farms, and farm leasing systems. In theory, the emergence and evolution of these farm organizational forms is largely determined by political and socioeconomic considerations. Furthermore, it has been shown that the evolution of a farm structure is a part of a complex evolution of the agriculture sector and its role in the global economy (Chavas, 2001).

The current prevalence of the family farm as

[1] *For the foundations of the new institutional economics, see Williamson (2000, 2010). For the empirical foundations, see Sykuta (2008), and Allen and Lueck (2008).*

[2] *The historical report about the agricultural organization in Algeria of the 18's century is provided from Saidouni (2001), where he investigates on the Algerian rural life. For more details on the evolution of land ownership in French colonization era, see Henni (1996).*

a socioeconomic unit of agricultural production (where it is often difficult to distinguish between production unit and household consumption unit) is particularly noteworthy (Chavas, 2001). As stated by Deininger and Feder (2001), the cost of supervision is particularly large in agricultural production due to spatial dispersion of the production process and the need of constant adjustments to microvariations of the natural environment. Family members are residual claimants of profits; accordingly, they have higher incentives to sustain efforts compared to hired laborers. They share farm risks and can be employed without incurring hiring or searching costs. These attributes enhance the general supe-riority of family farming over large-scale wage operations, manifested empirically in an inverse relationship between farm size and productivity.

When considering the efficiency of the farm organization, more attention should be devoted to two main aspects: assets control and risk management. By asset control, it is recognized that the choice of asset control forms is between ownership and a simple contracting. Accordingly, the water-well irrigation asset and machinery asset control are employed as proxies. This choice is explained by the fact that irrigation and machinery assets are, in many cases, transaction-specific assets involved in a farmland contract. The modern theoretical framework, and more specifically, the TCT, suggests that the firm's technology adoption is influenced by some kinds of asset specificity such as site specificity and physical asset specificity (Williamson, 1988). As a result, larger farms may also be located in areas with better information sources or with growing conditions which are more favorable for new varieties. Feder (1980) showed that larger farms might thwart less credit or capital limitations on adopting technologies.

The researchers hypothesize that farm structure and farm characteristics have an influence on the vertical extent of the farm. Moreover, the seasonality and spatial nature of agricultural production seem to have a strong influence on farm organization as whole (Allen & Lueck, 1993, 1998, 2004). The on-farm diversification was used as a proxy for the horizontal integration in farming activities. In fact, farm enterprise diversification can be an efficient risk management mechanism by stabilizing expected returns in an uncertain environment (McNamara & Weiss, 2005). More specifically, enterprise diversification is a method deployed for reducing income variability (Mishra et al., 2004).

Based on some theoretical considerations, it seems that farm structure has an impact on on-farm diversification (Pope & Prescott, 1980), which means that family farms are more specialized than other farms. This evidence assumes that the individual family farm is less constrained mainly in specific institutional environments. In contrast, if the farmer operates in a more constrained institutional environment, he will face higher production risks. As a result, he will devise some risk management mechanisms. In Algerian context, the researchers hypothesize that the individual family farm is less specialized, and its risk management device is related to the diversification of on- and off-farm activities. Small farms are also more likely to be diversified. Accordingly, it will be so evident that smaller farms are more diversified than larger ones.

However, on-farm diversification requires an improved education level. In other words, greater experience may change risk preferences. Therefore, learning by doing may lead to incentives for specialization. In terms of age, some empirical and theoretical assumptions suggest that older farmer tend to be less motivated to engage in on-farm diversification, as age and wealth are positively correlated (McNamara & Weiss, 2005). The researchers hypothesize that more experienced farmers are more diversified than inexperienced ones. Generally, the farmer use his family members as labor input in order to economize on shirking costs and hold up problems. Likewise, the researchers argue that farmers will be more reluctant to pursue an on-farm diversification as a method of reducing financial risks associated with farming activities[3].

The spatial dimension of agricultural production requires that the farming activities cover numerous

areas that differ from one another with respect to soil fertility, microclimate, and other factors that influence production process. However, regional location constraints (climatic, soil productivity, infrastructures, etc.) compel the potential farm business strategies and impose limitations on human capital development opportunities. The researchers argue that farm location influences the choice of enterprise options and the development of alternative methods for the supply and marketing of the agricultural products.

MATERIALS AND METHODS

In this study, the researchers used farm-level data to test the hypotheses. The data came from the Regional Sample Survey provided by the National Research Program on Farming and Agricultural Cooperatives over the period of 2012-2014. The survey is realized on a random sample of local farm operators, through detailed interviews conducted with 635 farmers. The researchers aimed to develop a questionnaire, which was well adapted to the farmers. The data were collected through direct interviews in order to capture several peasant farmers' characteristics. Table 1 provides the definitions and summary statistics for the variables used in this study.

In order to examine the determinants of contractual choice on assets, we used the Logit model to generate maximum likelihood estimates. This is viewed as an econometric advantage with respect to the nature of variables [4]. The following empirical specification was used, where for any farm i, the complete model is:

$$Y_i = X_i \beta_i + \varepsilon_i$$

where Y_i is the observed dichotomous choice of the asset control form; X_i is a row vector of exogenous variables, β_i is a column vector of unknown coefficients, and ε_i is a farm-specific error term.

The independent variable Y_i reflects the contractual choice on assets control forms. Subsequently, we have two Logit estimation models: The first model concerns a dummy of water-well irrigation asset control *(IRRIG)*. It takes the value of 1 if the farmer is an owner of water-well irrigation asset and 0 otherwise. The second model is related to a dummy of machinery (combines) asset control *(MACHIN)*. It takes the value of 1 if the farmer is an owner of machinery asset and 0 otherwise.

One another model is computed by a censored dependent variable used for the farm output diversification *(DIVERS)*, where :

$$DIVERS = \Sigma\, p_k \log(1/p_k)$$

as the entropy index, where p_k represents the income proportion of farm i from crop k. The entropy index approaches to zero when there is a complete specialization. Accordingly, we use the Tobit model to generate maximum likelihood estimates

These three models are shown in Table 2. Yet, the focus will be on the row vector of inde-pendent variables X_i.

In order to capture different farm structures, we use three design variables: A dummy of fami-ly farm *(FAMILY)*, it takes the value of 1 if the farm is owneroperator family farm and 0 oth-erwise. As a dummy of a farm leasing *(RENT)*, it takes the value of 1 if lease farm operator and 0 otherwise. Moreover, a dummy of a State-owned farm *(COLLECT)*, it takes the value of 1 if this choice is related to a collective farm and 0 otherwise. In order to reflect the farm size, we used the total landholding (FSIZE). The farmers' age (AGE) in the number of years, a dummy of the farmers' education *(EDUCAT)* taking the value of 1 if the farmer has a formal education level and 0 otherwise. Another variable was also employed to represent the farmers' household size *(HOUSIZE)* captured by the farmer's family members.

On the other hand, another block of variables is implemented and corresponds to the number of cycles of the principal activity per year. The first

[3] *See Chavas and Di Falco (2012) for the role of risk and economies of scope in farm diversification, and Duffy (2009) for the role of economies of scale in farm production.*

[4] *The use and the interpretation of econometric models are based on the guidebooks of Hosmer and Lemeshow (2000) and Greene (2003).*

one was for a unique cycle per year (*CY-CLE_1)*, taking the value of 1 if the main farm output has a cycle per year and 0 otherwise. The second variable is related to two cycles per year *(CY-CLE_2)*, taking the value of 1 if the main farm output has two cycles per year and 0 otherwise. Finally, the third variable is convenient to three or more than three cycles per year *(CYCLE> 3)*. It takes the value of 1 if the main farm output has 3 (or more) cycles per year and 0 otherwise. In our set of explanatory variables, the regional dummies were captured by three design variables for the north of the country (*EAST, WEST*, and *CENTRE*).

RESULTS AND DISCUSSION

The Table 1 presents a summary of descriptive statistics of farm data from the Regional Sample Survey. The mean of the ownership of irrigation asset is 56%, and the ownership of machinery is 47%. Notwithstanding, they represent high variances. The diversification index has a mean of 0.25 with low variance. It means that the representative farmer of our sample is relatively diversified.

In our context, several farm structures have relative proportional distributions. The family farms represent 64% as a dominant form. The state-owned farms have also a significant proportion with 32%. The farm leasing is the less present form, with a proportion of 4%.

The farming systems of our sample represent a mean of the farm size of 7.52 hectares of the owned landholdings (with a variance of 89.17). The mean age of a farmer is around 52 years old, which reflects the fact that the representative farmer is an old man (the minimum value is 23 years old but the mode and the median are 57 and 60 years old, respectively). It seems that young entrepreneurship in farming is less present in the Algerian agriculture. Figure 1 shows some illustrations on the farmers' age variations.

From the left figure, the age variations factorized by the farm structure can be deduced, showing that the farm leasing has less variance –related to the farmers' age– than the two other forms. In terms of regions, in the right figure, a more significant variance of age demonstrates that the central regions show younger farmers than the Eastern ones. However, in the Western regions, the representative farmer is typically an old man.

The human capital dummy, represented by the formal education, contains 72% of non-qualified farmers. In detailed term, the education level's distributions demonstrate that: 23% of the qualified (with formal education) farmers are subsisting in family farms; 33% of them are operating in collective farms, and 47% of them are working in leasing farms. Indeed, it seems that leased farms present higher levels of human capital. For the regional location, it seems that the farmers are relatively equal proportional distributions (roughly one third for each region). The farm distributions in the East, West and Center represent respectively 37%, 32%, and 31%.

Now, we test some of the implications derived from the modeling of asset control and risk management determinants. The costs of contracting and ownership are determined by specific factors like farm structure, farm size, human capital, location, and the seasonality. Conse-

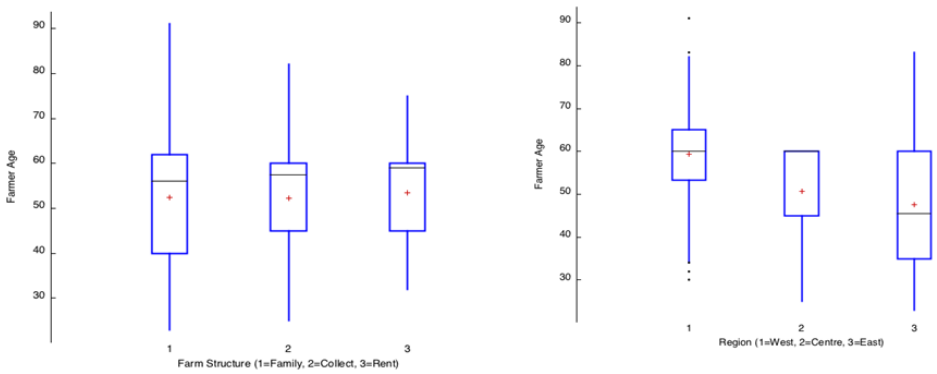

Figure 1. The Boxplots of Farmers Age Variations Factorized By Farm Structure and By Regional Locations

Table 1
Summary of Farm Data from Regional Sample Survey in Algerian Agriculture

Variables	Definition	Mean	SD
Dependent variables			
IRRIG	1 if the farmer owns well irrigation asset; 0 otherwise	0.56	0.39
MACHIN	1 if the farmer owns machinery; 0 if he lease it	0.47	0.25
DIVERS	The entropy index (censored from 0 to 1)	0.25	0.07
Explanatory variables			
Farm Structure			
FAMILY	1 if the farmer operates on family ownership; 0 otherwise	0.64	0.23
RENT	1 if the farmer operates by renting land; 0 otherwise	0.04	0.03
COLLECT	1 if the farmer operates in a State-owned; 0 otherwise	0.32	0.22
Farm Characteristics			
FSIZE	Farm total landholding (in hectares)	7.52	89.17
AGE	The age of the farmer in years	52.40	174.50
EDUCAT	1 if the farmer has a formal education level; 0 if not	0.28	0.20
HOUSIZE	Size of farmer family members	0.19	0.15
Production Cycles			
CYCLE_1	1 if the farm output has 1 cycle per year; 0 otherwise	0.35	0.20
CYCLE_2	1 if the farm output has 2 cycle per year; 0 otherwise	0.12	0.11
CYCLE>3	1 if the farm output has more than 3 cycles; 0 otherwise	0.53	0.26
Regional Location			
EAST	1 if the farm is located in Northeast; 0 otherwise	0.37	0.23
WEST	1 if the farm is located in Northwest; 0 otherwise	0.32	0.22
CENTRE	1 if the farm is located in Centre; 0 otherwise	0.31	0.21

quently, our empirical analysis of integration trends has three parts: First, using Logit regression, we estimate the factors that influence the choice of irrigation asset control. Second, by the same regression method, we estimate the factors that influence the choice of machinery asset control. Third, using Tobit regression, we estimate the factors that influence the on-farm diversification. The Table 2 shows the three econometric modeling estimates for integration trends from regional sample survey.

In many cases, irrigation and machinery assets are transaction-specific assets involved in a farmland contract (Allen & Lueck, 2001). The appropriate model implies that the farm size has a negative effect on the assets ownership. In other words, an increase in farm size will decrease the probability of contracting for assets ownership. Likewise, the farm structure has a significant effect on asset control forms.

In terms of assets acquisition[5] in different farming systems, according to the estimates from the Table 2, it seems that the age as proxy of farmer's experience has negative effects on asset control forms. In contrast, the education level and the household size have strong positive effects. Furthermore, it seems that the seasonality and geographical location have statistically significant effects on the two assets control forms.

The modeling of the farm output diversification determinants shows the following results: among the farm structures, it seems that the family farm has an effect on the farm output di-versification[6]. Farm size has a strong negative effect on the farm output diversification in contrast to household size and formal education. Nevertheless, the geographical location and seasonality present statistically significant effects on the farm output diversification. In addition, it seems to be helpful to represent the used diversification index factorized by farm structure and by region as shown in Figure 2.

From the left figure, we found the diversification index factorized by the farm structure, showing that the stateowned farm has less variance than

[5] *See Negri and Books (1990) and Panin (1995) for the determinants of the technology adoption.*
[6] *Torane et al. (2011) provides empirical evidences on the farm organization nature and the diversification in different institutional environment.*

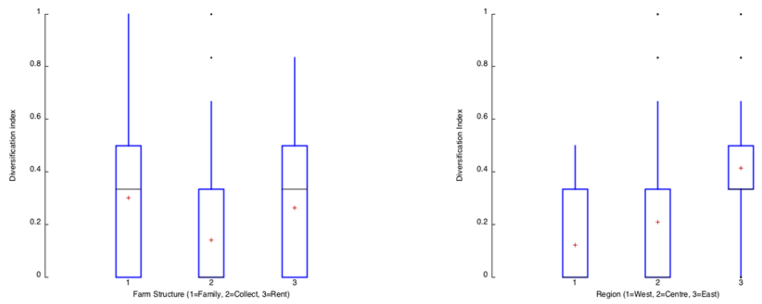

Figure 2. The Boxplots of Diversification Index Factorized By Farm Structure and By Regional Locations

the two other forms. In contrast, the family farms present more levels of diversification index. In terms of regions, in the right figure, a more significant variance of diversification index demonstrates that the central and Eastern regions show more diversified farming activities than the Western ones. These findings of the current study show that smaller farms are more

Table 2
Three Econometric Modeling Estimates for Integration Trends from Regional Sample Survey in the Algerian Agriculture

Variables	Logit Estimation of Water-Well Irrigation (IRRIG)		Logit Estimation of Machinery Acquisition (MACHIN)		Tobit Estimation of Output Diversification (DIVERS)	
FAMILLY	0.198		-0.097		0.301	
	(3.035)	***	(-0.212)		(1.493)	
COLLECT	0.624		1.228		-1.026	
	(3.979)	***	(4.017)	***	(-6.142)	***
RENT	1.199		-0.630		-1.163	
	(1.204)		(-0.980)		(-4.888)	***
FSIZE	0,434		0,009		-0,194	
	(3,368)	***	(0,064)		(-8,301)	***
AGE	-0,001		-0,014		0,002	
	(-0,064)		(-2,811)	***	(0,029)	
EDUCAT	0,523		0,451		0,004	
	(0,831)		(3,245)	***	(0,206)	
HOUSIZE	1,597		0,283	*	0,908	
	(2,403)	**	(1,893)	***	(4,397)	***
EAST	-1,399		-1,834		-0,138	
	(-1,484)		(-8,769)	***	(-3,347)	***
WEST	-1,265		-1,989		-0,271	
	(-2,167)	**	(-8,300)	***	(-5,468)	***
CENTRE	1,261		-1,700		-0,183	
	(2,678)	***	(-8,228)	***	(-4,313)	***
CYCLE_1	0,307		1,606		0,192	
	(6,097)	***	(9,510)		(8,440)	***
CYCLE_2	0,628		1,444		0,570	
	(1,009)		(9,550)	***	(28,742)	***
CYCLE_3	-0,924		-0,277		0,409	
	(-3,497)	***	(-1,402)		(17,428)	***
Correctly Predicted	66,1%		65,7%		/	
McFadden (R^2)	0,263		0,115		0,267	
Log-Likelihood	-972,27		-965,73		-469,27	
Likelihood Ratio Test:$\chi^2(9)$	254,04 [0,0000]		253,28 [0,0000]		49,59 [0,0000]	

Note: The value of the (asymptotic for Logit equation) z-statistics is in parentheses.
* p<0.1, ** p<0.05, *** p<0.01

diversified than larger ones. The results indicate that the educational level of the farmer negatively influences on-farm diversification. This means that an additional level in school decreases the likelihood for farm output diversification, that is, enhancement in risk management skills. These results corroborate the findings of some recent studies (Benmehaia & Brabez, 2016; Chavas & Di Falco, 2012; Mu-tura et al., 2016; Omrane & Benmehaia, 2016; Torane et al., 2011).

The present study should also illustrate some implications and limitations, which appeal for further research. We retain from the analysis presented above two main empirical pieces of evidence: The first one is that the farmer contractual choice in contemporary farming systems in Algeria is determined by various socioeconomic factors. The second one is that the farm extent in Algerian settings is affected by some institutional constraints in respect of efficiency considerations.

In our context, it is obvious that individual family farmers are less efficient then the two other forms. They adapt to the risky and constrained environment by making certain production decisions and employing same risk mitigating strategy regarding their financial liability. The diversification is a mechanism for individual family farmers for avoiding risks and reducing income variability, while the diversification strategy in turn is affected by the technological and financial constraints. On the other hand, the gains from specialization are stimulated by economies of scale and human capital considerations.

Based on the proposed empirical evidence, some recommendations are given to promote fur-ther reflection on the farmers' behavior and choices in our context. Based on the findings of this study, it could be argued that the farm organizational forms should do matter for the policy making to include the main institutional constraints that enhance efficiency in agriculture sector. The farm structure, the scale, the human capital, household characteristics, geographical differences, as well as the seasonality can recapitulate these main institutional constraints. The farmers' human capital needs to be considered, because entrepreneurship plays an important role in the agricultural sector, especially in terms of knowledge transfer process and technological improvements. Attention should be given also to the regional differences regarding the agricultural vocation and potentialities of the regions. More scrutiny of the common forms of farm structure is assumed to highlight the farmers' behavior according to the geographical location and the risk management devices.

CONCLUSION

The foregoing results affirm the need for integration and policy interventions to streamline supply chain and marketing channels. Farm structure and scale, farmer age, his household size and his schooling level are key to improved production and marketing. Indeed, provision of education and services to the farmers on supply channels and technology adoption will be key to accessing the best production efficiency. Along the same line, the seasonality and geographical location were hypothesized to be the major determinants of vertical integration that can have an important policy implication. The study focused on the determinants of vertical integration among the peasant farmers. Further research should be carried out on the extent to which large-scale farmers who have vertically integrated can create horizontal integration with smallholder farmers. This study used the peasant farmer as the point of analysis. Researchers can carry out further studies on what choice attributes could influence farmers' choice of other assets control forms.

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