Entrepreneurship and Farm Profit in Rural Niger

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Abstract:

With numerous challenges hindering farm households' entrepreneurship decision, it is often argued that entrepreneurship can play an essential role in improving farm productivity. Yet assessment of the impact of entrepreneurship on farm productivity is scarce. We address this issue by analyzing the effect of non-agricultural entrepreneurship on farm profit. Using the World Bank's Living Standards Measurement Study-Integrated Survey on Agriculture datasets for 2011 and 2014 of Niger and applying endogenous switching regression, we find that non-agricultural entrepreneurship significantly increases farm profit. Farm profit increased by 908,504.4 CFA F for the farm households that developed non-agricultural enterprises thanks to their entrepreneurship behavior. The total value of farm profit for the farm households without non-agricultural enterprises would have increased by 808,789.2 CFA F relative to the current level with the development of non-agricultural enterprises. The findings support increasing arguments on the need to promote entrepreneurship in rural areas to improve farm profit and to transform structurally the economy

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Abstract

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Key words: Entrepreneurship, endogenous switching, farm profit, non-agricultural enterprises

1. Introduction

Sub-Sahara African (SSA) countries are characterized by a high level of poverty, and the poor are mainly located in rural areas of these countries. Poverty reduction can pass through the rural transformation of these countries. It is established that the process of rural transformation is intrinsically linked with the structural transformation which takes place within a given country (Proctor, 2014). The structural transformation is expected to occur in every sector of the economy to boost growth and economic development. Through the structural transformation of the agricultural sector, the share of agriculture in terms of economic output and employment will fall to the benefit of the share of industrial activities and services. Thus, supporting farm-household income diversification through complementary and new efforts appears crucial in the transformation process, and enormous pressures are put on rural societies in terms of adjustments and modernization in SSA countries characterized by incomplete demographic transition (Proctor, 2014). The structural transformation is considered to be also beneficial in mitigating the negatives impacts of climate change and to take opportunities from the positive impacts (Cunguara *et al.*, 2011), through many channels such as transforming rain-fed agriculture to irrigated one and using modern equipment in the production process. It is worth noting that structural change may be already taken place, but the evidence may be missed by macro level analyses (Fox and Pimhidzai, 2011). Indeed, Fox and Pimhidzai (2011) argued that, in Uganda the process began at the household level with diversification into the non-farm sector, largely through productive informality.

In rural areas, income diversification refers to the expansion of the range of income sources away from own farm labor (Bryceson, 1999; Davis *et al.*, 2010). Diversification of income sources by generating income from activities off the farm is found by the National Bureau of Statistics of Tanzania (NBS, 2012) to have the potential to increase farm productivity and help to reduce farmers' vulnerability to exogenous weather and price shocks, pointing out its importance in the transformation of the agriculture, and this finding may hold in other SSA countries. It should be noted that SSA countries are characterized by low agricultural productivity compared with non-agricultural sectors, and allocate a larger fraction of employment to agricultural activities (Adamopoulos and Restuccia, 2014). Income diversification is also considered by some analysts as a trend that weakens rather than strengthens rural productivity (Bryceson, 1999). Income diversification has the potential to relax cash constraint to farmers. Actually, farmers may invest more in agricultural activities based on their earnings from off-farm activities or may devote these earnings to more consumption. When farmers invest more in agricultural activities based on these earnings, they will be able to apply more fertilizers and pesticides, to rely more on improved seeds and modern equipment, yielding to high productivity and hence to high levels of farm profit.

Two types of factors (push and pull factors) are identified in the literature to explain the share of non-farm employment/income in SSA countries including trying to understand what is behind household decision taking to enter a sector, that means the factors which determine the engagement of the farmers in nonfarm activities including entrepreneurship decisions (Nagler and Naudé, 2014). Factors related to risk minimizing behavior, in particular risk associated with a high dependency on agriculture, managing the aftermath of shocks or use of surplus family labor, in particular during the farm calendar off season constitute the push factors. Pull factors relate to individual and household level capabilities, including educational attainment and assets, as well as institutional and regional features, such as access to credit and infrastructure.

Recent studies have investigated the patterns and determinants of income diversification as well as of nonfarm entrepreneurship in SSA (e.g., Beyene, 2008; Demeke and Zeller, 2012; Sarah, 2012; Senadza, 2012; Nagler and Naudé, 2014; Agyeman *et al.*, 2014; Dedehouanou *et al.*, 2016). Some studies captures diversification and nonfarm entrepreneurship through the use of indices such as the Herfindahl index, and the Simpsons index (e.g., Sarah, 2012; Agyeman *et al.*, 2014), while others rely on binary variables (e.g., Beyene, 2008; Demeke and Zeller, 2012; Nagler and Naudé, 2014; Dedehouanou *et al.*, 2016). Factors such as education, agricultural potential, market access, household size, wealth, non-labor income, existence of finance institution, passage of common transport through the village, existence of a cereal bank in the community, household distance to Capital of department of residence, price shock, climate factors, and weather shocks are found to affect income diversification. Therefore, both of the push and pull factors are found empirically to have the potential to influence income diversification. Moreover, Nagler and Naudé (2014) categorized the factors that affect significantly the likelihood of operating an off-farm enterprise into individual capabilities, household characteristics, and institutional factors. In summary, most of the existing literature is relative to the determinants of the likelihood of diversification, and little is known about its role in improving agricultural productivity and profit. So, there is a need to investigate the benefits of such strategy. It is worth nothing that authors such as Reardon *et al.* (1992), Phimister and Roberts (2006), Kilic *et al.* (2009), Oseni and Winters (2009), Anriquez and Daidone (2010), Owusu *et al.* (2011), Atamanov and Van den Berg (2012) investigated the effects of income diversification. However, most of them investigated the effect of nonfarm activities on the intensity of input use in the agricultural sector.

With the background of the aforementioned studies, this paper aims at investigating the farm profit impact of income diversification in Niger, using the World Bank's Living Standards Measurement Study – Integrated Survey on Agriculture (LSMS-ISA) datasets for 2011 and 2014. We restrict our analysis on non-agricultural enterprises to capture diversification beyond farm activities. The value added of this paper is the fact that it aims at estimating the extent to which non-agricultural entrepreneurship can enable farm households to earn more profit from farm activities.

Niger is selected for this study because it is one of the poorest countries in the World. In 2014, the Human Development Index of Niger amounted to 0.348, positioning the country at 188 out of 188 countries and territories ranked (UNDP, 2015). This low level of human development reflects the food insecurity and poverty issues in the country. Moreover, the choice is motivated by the availability of LSMS-ISA dataset. Niger is located in the Sahel, and is a landlocked country of West Africa. The total land size of the country amounts to 1,267,000 km^2, which is divided as follows: (i) desert zone: 65%; (ii) agro-pastoral zone: 20%; and (iii) agricultural zone: 15%. The country is one of the most vulnerable countries of the world. This high vulnerability of the country is due to its climatic, institutional, livelihood, economic and environmental context (World Bank, 2013). Indeed, the country is prone to droughts, floods and locusts which affect agricultural production (both crop and livestock production). Agriculture contributes to 40% to the gross domestic product (GDP) in Niger and over 80% of the country's population are employed in the sector (World Bank, 2013). Therefore, there is a productivity issue in the agricultural sector. Actually, agriculture is done mainly through small household exploitations with low use of mechanization, but sometimes with use of animal traction. Livestock rearing is done in the arid and semi-arid regions of the country. The country is endowed with important natural resources

such as uranium, oil, phosphate, coal, pewter, iron, salt, and copper, but most of them are not yet exploited.

The remainder of the paper is organized as follows. Section 2 presents the material and methods. Section 3 presents the results and discussion, while section 5 concludes the paper.

2. Material and methods

2.1 Empirical approach

This section is relative to the empirical strategy to estimate the effects of non-agricultural enterprises on farm profit. Thus, the aim of the econometric analysis is to assess the extent to which farm profit differs significantly between farm households that had non-agricultural enterprises and those that did not have. The econometric model can be expressed as:

$$t_i = l_i'\tau + \gamma y_i + \sigma_i \quad (1)$$

where t_i is farm profit of the farm household i, y_i denotes a dummy variable representing the uptake of non-agricultural enterprises, l_i is a vector of other regressors, τ and γ are coefficients to be estimated, and σ_i is the error term. In this framework, γ measures the effect of non-agricultural enterprises on farm profit. Non-agricultural entrepreneurship decision is not random leading to endogeneity issues. Indeed, farm households that diversified their income sources through non-agricultural entrepreneurship may be systematically different from those that did not, and not accounting for that may bias the true effects on farm profit. Precisely, two issues need to be accounting for in the econometric analysis, which are related to the presence of sample selection and unobserved heterogeneity. Unobserved factors such as innate abilities, skills and motivation, and preferences may affect the likelihood to diversify through non-agricultural entrepreneurship. Therefore, the estimation of Equation (1) by ordinary least squares (OLS) may yield biased estimates. The endogeneity of the non-agricultural entrepreneurship decision is taken into account by estimating a simultaneous equations model using endogenous switching regression (ESR) technique (Di Falco *et al.*, 2011; Tambo and Wunscher, 2016; Mukasa *et al.*, 2017). The ESR model can be written as follows:

$$y_i = x_i'\beta + \varepsilon_i \quad (2)$$

$$t_{i1} = l_i'\tau_1 + \theta_{i1} \;\; if \; y_1 = 1 \quad (3)$$

$$t_{i0} = l_i'\tau_0 + \theta_{i0} \;\; if \; y_1 = 0 \quad (4)$$

where t_{i1} and t_{i0} refer to the farm profit for the farm households with non-agricultural enterprises and those without those enterprises, respectively. τ_1 and τ_0 represent the parameters to be estimated for the entrepreneurs and non-entrepreneurs regimes, respectively. The error terms ε_i, θ_{i1}, and θ_{i0} are assumed to have a trivariate normal distribution with mean vector zero and covariance matrix

$$Cov(\varepsilon, \theta_1, \theta_0) = \begin{bmatrix} \sigma_\varepsilon^2 & \sigma_{\varepsilon\theta_1} & \sigma_{\varepsilon\theta_0} \\ \sigma_{\varepsilon\theta_1} & \sigma_{\theta_1}^2 & \sigma_{\theta_1\theta_0} \\ \sigma_{\varepsilon\theta_0} & \sigma_{\theta_1\theta_0} & \sigma_{\theta_0}^2 \end{bmatrix}. \quad (5)$$

This papers adopts estimating simultaneously the ESR model by Full Information Maximum Likelihood (FIML) method (Lokshin and Sajaia, 2004; Greene, 2012). Following Lokshin and

Sajaia (2004) and subject to the assumption with respect to the distribution of the error terms, the log-likelihood function of the ESR model is expressed as:

$$LnL = \sum_i \left[I_i w_i \left(ln\{F(\eta_{1i})\} + ln\left\{ f\left({}^{\theta_{i1}}/_{\sigma_{\theta_1}} \right) / \sigma_{\theta_1} \right\} \right) + (1 - I_i) w_i \left(ln\{1 - F(\eta_{2i})\} + ln\left\{ f\left({}^{\theta_{i0}}/_{\sigma_{\theta_0}} \right) / \sigma_{\theta_0} \right\} \right) \right] \quad (6)$$

where $F(.)$ is a cumulative normal distribution function, $f(.)$ is a normal density distribution function, w_i is an optional weight for observation i, and

$$\eta_{ji} = \frac{\beta Z_i + \rho_j \theta_{ji} / \sigma_{\theta_j}}{\sqrt{1 - \rho_j^2}} \qquad j = 0,1 \quad (7)$$

where $\rho_1 = \sigma_{\varepsilon\theta_1}^2 / \sigma_\varepsilon \sigma_{\theta_1}$ is the correlation coefficient between θ_{i1} and ε_i and $\rho_2 = \sigma_{\varepsilon\theta_2}^2 / \sigma_\varepsilon \sigma_{\theta_2}$ is the correlation coefficient between θ_{i0} and ε_i. Although the model is identified by construction through nonlinearities, for its better identification, it is important to use an exclusion restriction. Thus, at least one variable is necessary that affects farm household adoption of non-agricultural entrepreneurship but does not affect farm profit. Following Di Falco *et al.* (2011) and Tambo and Wunscher (2016), the admissibility of the variables identified as valid instruments is established through a falsification test. Thus, a variable is considered as an appropriate selection instrument, if it affects adoption of non-agricultural entrepreneurship decision but does not affect farm profit of non-adopters. After estimating the model, the estimated coefficients are used to derive the conditional expected values of farm profit, which are then used in estimating the unbiased average treatment effect on the treated (ATT), and the average treatment effect on untreated (ATU):

$$ATT = E(t_{i1} | y_i = 1) - E(t_{i0} | y_i = 1) \quad (8)$$

$$ATU = E(t_{i1} | y_i = 0) - E(t_{i0} | y_i = 0) \quad (9)$$

Farm profit is computed as the value of total crop production less variable inputs and fixed costs[1]. Specifically, the costs that are accounted for are animal and equipment costs, hired labor expenditures, the costs of buying fertilizers, pesticides and seeds. We do not include family labor costs in the computation of farm profit because one cannot value this labor using the wage of hired labor; one needs the shadow wages. The vector of explanatory variables includes land use, household size, hired labor use, plow use, access to extension services, droughts, floods, input prices shocks, output prices shocks, mobile phone, age of household head, education of the household head, agro-ecological settings (Table 1).

Table 1. Definition of variables

Variables	Description	Unit
Farm profit	Farm profit	Local currency (CFA F)[a]
Non-agricultural enterprises	Presence of non-agricultural enterprises in the household	1=yes and 0=no
Land use	Land use	Ha
Household size	Number of individuals in the household	Number of persons
Hired labor use	Use of hired labor by the household	1=yes and 0=no
Plow use	Use of plow	1=yes and 0=no

[1] We also try to use land productivity (farm profit per hectare), but the model does not converge.

Extension services	Access to extension services	1=yes and 0=no
Droughts	The household has been negatively affected by droughts during the last 12 months	1=yes and 0=no
Floods	The household has been negatively affected by floods during the last 12 months	1=yes and 0=no
Input prices shocks	The household has been negatively affected by input prices shocks during the last 12 months	1=yes and 0=no
Output prices shocks	The household has been negatively affected by output prices shocks during the last 12 months	1=yes and 0=no
Mobile phone	Ownership of a mobile phone	1=yes and 0=no
Age	Age of household head	Years
Education	The household head can read a short text in any language	1=yes and 0=no
Agro-ecological zones		
Agricultural	The household lives in an agricultural agro-ecological zone	1=yes and 0=no
Agricultural-pastoral	The household lives in an agricultural-pastoral AEZ	1=yes and 0=no
Pastoral	The household lives in a pastoral AEZ	1=yes and 0=no

Note: 1 CFA F is equal to 471.87 and 494.41 in 2011 and 2014, respectively.

2.2 Data

This paper makes use of the rural sample of the LSMS-ISA datasets of 2011 and 2014 for Niger (Enquête Nationale sur les Conditions de Vie des Ménages et l'Agriculture – ECVM/A[2]).[3] The 2011 survey included 3,968 households from 270 Zones de Dénombrement (ZD), and is representative of the country, as well as of the three ecological zones (agricultural, agro-pastoral, and pastoral). In 2014, the households surveyed in 2011 were revisited, and the 2014 survey has tracked households who moved after the 2011 survey. Thus, those that have moved within the country were found and re-interviewed in 2014. As for individuals from the households that moved, one of them was selected to be tracked. Three sets of questionnaires were used for the surveys, namely household questionnaire, agricultural questionnaire, and community questionnaire and the surveys cover the post-planting visits as well as the post-harvest visits. The geographic positing system (GPS) coordinates of each farm household were collected to help extracting geographic information system (GIS) data relative to factors such as soil type, elevation, slope, and climate conditions. However, climate parameters were not in the 2014 dataset. After merging the two data sets, we keep only the farm households that are in rural areas and those that said an agricultural questionnaire is required for them. We also delete farm households with extension values equal to 1 and 2. We replace land use missing values by farm size and we drop observations with missing values and for which we do not have values for farm size and also observations with zero values of land use. After cleaning, the dataset is on the form of unbalanced panel data with 3489 farm households (1710 and 1779 farm households in 2011 and 2014, respectively).

3. Results and discussion

Table 2 reports the extent of non-agricultural entrepreneurship during the two survey years. Nine types of non-agricultural enterprises were identified. Overall, at least one non-agricultural enterprise was present in 63.10% of the farm households in 2011 against 53.46% in 2014. This

[2] The National Household Living Conditions and Agriculture Survey

[3] Survey instruments are available here: http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTLSMS/0,,contentMDK:23635520~pagePK:64168445~piPK:64168309~theSitePK:3358997,00.html

situation depicts a decline in non-agricultural enterprises among farm households in rural Niger between 2011 and 2014. Specifically, the percentages of farm households decreased from 2011 to 2014 for (i) the transformation of agricultural product or meat for resale, (ii) ownership of a small enterprise to make clothing, to make sandals, or other shoes, (iii) ownership of an enterprise in the housing construction or in field of carpentry in wood or in metal like iron or aluminum, (iv) ownership of a business enterprise, and (v) ownership of any other non-agricultural enterprise. For the remaining four non-agricultural enterprises, the percentage of farm households increased from 2011 to 2014. The findings suggest that farm households in rural Niger do not draw income from farm activities only, they are to a certain extend entrepreneurs.

Table 2. Extent of non-agricultural entrepreneurship by survey year

	Pooled sample		**2011**		**2014**	
	Number	Relative frequency	Number	Relative frequency	Number	Relative frequency
Transformation of agricultural product or meat for resale	539	15.45	305	17.84	234	13.15
Ownership of a small enterprise to make clothing (tailor), to make sandals, or other shoes	84	2.41	49	2.87	35	1.97
Ownership of an enterprise in the housing construction or in field of carpentry in wood or in metal like iron or aluminum	122	3.50	68	3.98	54	3.04
Ownership of a business enterprise	838	24.02	473	27.66	365	20.52
Practice of a liberal profession or practice of traditional medicine	129	3.70	58	3.39	71	3.99
Ownership of an enterprise providing all other services; services for the repairs and maintenance, washing car, polishing shoes, etc.	168	4.82	76	4.44	92	5.17
Ownership of a taxi, transport bus, or other transport method for a commercial activity	49	1.40	18	1.05	31	1.74
Ownership of a restaurant or bar	40	1.15	12	0.70	28	1.57
Ownership of any other non-agricultural enterprise	623	17.86	367	21.46	256	14.39
Presence of non-agricultural enterprises	2,030	58.18	1,079	63.10	951	53.46
Observations	3,489	100	1,710	100	1,779	100

The dynamics of non-agricultural enterprises from 2011 to 2014 are also investigated by looking at their evolvement between the two survey years (Table 3). Thus, Table 3 helps to appreciate the patterns of the development of each non-agricultural enterprise between the two periods. The analyses are done only for the households tracked between the two survey years (1,634 households). Regardless to the type of non-agricultural enterprises, 39.66% of the households have at least a non-agricultural enterprise in 2011 and 2014. Therefore, those households maintained the presence of non-agricultural enterprises over years. Nevertheless, about a fourth (23.44%) developed non-agricultural enterprises in 2011 and gave up them in 2014. The statistics show that 14.38% of the households were not entrepreneurs in 2011 and became in 2014. More than the fifth of them (22.52%) were not entrepreneurs either in 2011 or in 2014.

Table 3. Dynamics of non-agricultural enterprises from 2011 to 2014

	Yes in 2011 and in Yes 2014		Yes in 2011 and No in 2014		No in 2011 and Yes in 2014		No in 2011 and No in 2014			
	Number	Relative frequency	Number	Relative frequency	Number	Relative frequency	Number	Relative frequency	Total	%
Transformation of agricultural product or meat for resale	118	7.23	180	11.02	104	6.37	1,231	75.38	1,633	100
Ownership of a small enterprise to make clothing (tailor), to make sandals, or other shoes	18	1.11	26	1.59	15	0.92	1,572	96.38	1,631	100
Ownership of an enterprise in the housing construction or in field of carpentry in wood or in metal like iron or aluminum	14	0.86	53	3.25	36	2.20	1,530	93.69	1,633	100
Ownership of a business enterprise	149	9.12	307	18.79	193	11.81	985	60.28	1,634	100
Practice of a liberal profession or practice of traditional medicine	17	1.04	39	2.39	54	3.30	1,524	93.27	1,634	100
Ownership of an enterprise providing all other services; services for the repairs and maintenance, washing car, polishing shoes, etc.	18	1.10	54	3.30	68	4.16	1,494	91.43	1,634	100
Ownership of a taxi, transport bus, or other transport method for a commercial activity	6	0.37	11	0.67	24	1.47	1,593	97.49	1,634	100
Ownership of a restaurant or bar	0	0	10	0.61	25	1.53	1,594	97.85	1,629	100
Ownership of any other non-agricultural enterprise	84	5.15	260	15.93	149	9.13	1,139	69.79	1,632	100
Presence of non-agricultural enterprises	648	39.66	383	23.44	235	14.38	368	22.52	1,634	100

Note: Yes in 2011 and Yes in 2014, Yes in 2011 and No in 2014, No in 2011 and Yes in 2014, and No in 2011 and No in 2014 denotes the presence of the non-agricultural enterprises in 2011 and 2014, the presence in 2011 and the absence in 2014, the absence in 2011 and presence in 2014, and the absence in 2011 and 2014.

Table 4 reports the descriptive statistics of the variable used in the econometric analyses. Tests on the differences between the subgroups of farm households that developed non-agricultural enterprises and those that did not have been also carried out. In most cases, these tests indicate significant differences between the two subgroups. However, farm profit does not differ significantly between the two subgroups according to these tests. But as we do not control for confounders, the results of these tests should be taken with caution.

Table 4. Descriptive statistics

Variable name	**Total sample**		**Farm households that diversified**		**Farm households that did not diversify**	
	Mean or proportion	Std. Dev.	Mean or proportion	Std. Dev.	Mean or proportion	Std. Dev.
Farm profit	170,527.15	7,902.85	173,464.04	10,317.51	166,440.87	12,294.79
Land use	5.83	0.16	6.02	0.21	5.57	0.23
Household size	7.27***	0.06	7.54	0.09	6.91	0.09
Hired labor use	0.27***	0.01	0.29	0.01	0.25	0.01
Plow use	0.10***	0.01	0.12	0.01	0.08	0.01
Extension services	0.18	0.01	0.19	0.01	0.18	0.01
Droughts	0.33***	0.01	0.31	0.01	0.36	0.01
Floods	0.06	0.00	0.07	0.01	0.06	0.01
Input prices shocks	0.06	0.00	0.06	0.01	0.06	0.01
Output prices shocks	0.30***	0.01	0.31	0.01	0.27	0.01
Mobile phone	0.44***	0.01	0.47	0.01	0.39	0.01
Age	45.70	0.25	45.76	0.31	45.63	0.40
Education	0.26***	0.01	0.29	0.01	0.21	0.01
Agro-ecological zones						
Agricultural	0.45***	0.01	0.47	0.01	0.41	0.01
Agricultural-pastoral	0.42	0.01	0.42	0.01	0.44	0.01
Livestock	0.13***	0.01	0.11	0.01	0.15	0.01

Note: *, **, and *** indicate statistically significant differences at the 10%, 5%, and 1%, respectively between the subgroups of farm households that diversified and that not diversified using a simple t-test with unequal variances and test of proportions

The results of the estimation are reported in Table 5. The excluded instrument used which is the ownership of a mobile phone is significant in the selection equation but does not affect significantly the farm profit of those that did not have non-agricultural enterprises, indicating the validity of the selection instrument. The correlation coefficients are both significant at the 1% level of significance but are positive between the presence of non-agricultural enterprises equation and the farm profit of farm-household with non-agricultural enterprises equation and negative for the second outcome equation. These findings suggests that there is self-selection in the decision of developing non-agricultural enterprises. The test for independence of the equations suggests the joint dependence between the selection equation and the farm profit equations.

The likelihood to develop non-agricultural enterprises is significantly related to household size, hired labor use, mobile phone ownership, and time. Household size is found to be positively associated with non-agricultural entrepreneurship. Thus, large farm households have enough labor to be shared between farm activities and non-agricultural enterprises. Moreover, in rural Niger

there is abundance of labor and large farm households perceive the need to venture in off-farm activities instead of wasting all this labor in only farming activities. Therefore, surplus family labor push the farm households into entrepreneurship. This finding is in line with the economic theory and that of Eshetu and Mekonnen (2016). Farm households that used hired labor are found to be more likely to go for non-agricultural enterprises compared with their counterparts that did not rely on this kind of labor. Actually, hired labor use is associated with being commercial farmers. Commercial farmers produce for the market and are always looking for more profit, so they have the ability to detect the activities in which they can invest to increase their wealth. Ownership of mobile phone is beneficial for the development of non-agricultural enterprises among farm households. Indeed, farm households that own mobile phones are able to have access to information on the activities to be undertaken to maximize the total earnings of the households from their relatives living other villages or that are in towns. Mobile phones can also help them in continuing with the non-agricultural enterprises; they can contact easily their suppliers and even can be contacted by customers. Actually mobile phone helps farmers to overcome information asymmetry (Mittal and Mehar, 2012). The findings suggest that the presence of non-agricultural enterprises in the farm households in rural Niger decreased from 2011 to 2014, suggesting the degradation of business environment in rural Niger between 2011 and 2014.

The estimates presented in the last two columns of Table 5 reveal differences in the coefficients of the farm profit equation between the farm households with non-agricultural enterprises and those without those enterprises. These differences illustrate the presence of heterogeneity in the sample. Household size is significantly associated with an increase in the farm profit of the farm households that have non-agricultural enterprises. However, household size has a negative and significant effect on the farm profit of those without non-agricultural enterprises.

Although hired labor use, and plow use have a positive and significant effect on the farm profit of the farm households that developed non-agricultural enterprises, they do not influence that of the remaining households. Access to extension services is related positively and significantly to the farm profit of the two categories of farm households. Nevertheless, the magnitude of its coefficients is greater for farm households which are entrepreneurs (60,805.59 CFA F against 33,531.46 CFA F). Another difference between the two categories of farm households concerns the effect of floods on the farm profit. We find that while floods do not affect the farm profit of farm households which are entrepreneurs, these extreme events are significantly associated with a decrease in the farm profit of the farm households without non-agricultural enterprises. Thus, farm households with non-agricultural enterprises have the capacities to counter the negative effects of floods on their agricultural activities. The findings also suggest that the farm profit of the households with non-agricultural enterprises decreased between 2011 and 2014, while that of the remaining farm households has increased.

Table 5. Endogenous switching regression model estimation results

	Non-agricultural enterprises	**Farm profit**	
		Non-agricultural enterprises=1	Non-agricultural enterprises=0
Land use		-145.7045	319.052
		(383.3402)	(612.737)
Household size	0.027***	13757.54***	-8253.672***
	(0.005)	(2444.639)	(3103.208)
Hired labor use	0.172***	97264.34***	-36132.71

	(0.053)	(29941.57)	(31418.23)
Plow use		38572.78**	24618.77
		(15725.72)	(16129.67)
Extension services		60805.59***	33531.46*
		(13119.14)	(18067.33)
Droughts	-0.033	-23515.42	4030.803
	(0.045)	(22698.68)	(24194.3)
Floods	0.078	18438.29	-74578.02**
	(0.059)	(30292.44)	(36437.12)
Input prices shocks	0.011	30977.88	5664.407
	(0.069)	(31283.9)	(41233.73)
Output prices shocks	-0.065	-19507.15	39929.43
	0.058	(28109.76)	(39003.02)
Mobile phone	0.038**		
	(0.019)		
Age	-0.0004		
	(0.0004)		
Education	0.026		
	(0.020)		
	Agro-ecological zones (Reference: Agricultural)		
Agricultural-pastoral		-13656.83	-22633.62
		(16553.21)	(28228.53)
Pastoral		26119.89	46416.84
		(24234.25)	(32510.76)
Survey wave 2	-0.200***	-38018.77*	126616.5***
	(0.053)	(21261.92)	(32272.39)
Constant	-0.013	-175045.9***	-198685.4***
	(0.063)	(33035.34)	42561.92
$ln s_j$		13.168***	13.230***
		(0.035)	(0.004)
σ_j		523429	556878.9
		(18352.02)	(2129.716)
$/r_j$		2.660***	-2.593***
		(0.107)	(0.150)
Wald test of indep. eqns		2687.42***	
Observations		3489	

Note: Clustered-robust standard errors are reported into brackets. *, **, *** indicate statistically significance at the 10%, 5%, and 1%, respectively.

Table 6 presents the predicted farm profit from the ESR model which are used to compute the treatment effects of diversifying through non-agricultural enterprises on farm profit. The ATT measures the mean difference between the actual farm profit of entrepreneurs and what they would have earned if they did not have non-agricultural enterprises. The results show that the presence of non-agricultural enterprises has a positive and statistically significant effect on farm profit of entrepreneurs. Farm profit increases by 908,504.4 CFA F for farm households thanks to the non-agricultural entrepreneurship. As the difference in terms of land use between the two groups of farm households is not significant, this finding suggests that farm households with non-agricultural enterprises have land productivity levels higher than the remaining farm households. This finding is in line with that of Owusu *et al.* (2011) that found a positive association between participation in non-farm work and farm income. The paper also computes the ATU which measures the mean difference between what the farm households that are not entrepreneurs would have earned if they had gone for entrepreneurship and their actual farm profit. The findings indicate that there would

be a significant increase in farm profit if those farm households developed non-agricultural enterprises. Farm profit would have increased by 808,789.2 CFA F for these farm households if they have developed non-agricultural enterprises. Overall, non-agricultural enterprises play a paramount importance in increasing farm profit. Thus, non-agricultural enterprises allow farm households to make important investments in agriculture (e.g. in fertilizers, pesticides, improved seeds and modern equipment) from what they earn from entrepreneurship that can support farm profit. These findings point out the importance of non-agricultural entrepreneurship in the transformation of the agriculture.

Table 6. Treatment effects of non-agricultural enterprises

	With non-agricultural enterprises (A)	**Without non-agricultural enterprises (B)**	**C=A-B**
Farm households with non-agricultural enterprises	315,199	-593,305.4	ATT=908,504.4***
Farm households without non-agricultural enterprises	290,581.7	-518,207.5	ATU= 808,789.2***

Note: *, **, and *** indicate statistically significance at the 10%, 5%, and 1%, respectively.

4. Conclusion and policy implications

In this paper, we provide empirical evidence on the farm profit impact of income diversification with rural Niger as research area. Nine types of non-agricultural enterprises were identified in rural Niger. In 2011, 63.10% of the farm households had at least one non-agricultural enterprise, against 53.46% in 2014. The endogeneity of the entrepreneurship decision is taken into account in the econometric analyses. Thus, the paper estimate an endogenous switching regression model. The findings indicate that the main factors that drive the entrepreneurship decision are household size, hired labor use and mobile phone. They also suggest significant differences in the estimated coefficients of the farm profit equation between the farm households with non-agricultural enterprises and those without those enterprises. Farm profit increased by 908, 504.4 CFA F for the farm households that developed non-agricultural enterprises thanks to their entrepreneurship behavior. The value of farm profit for the farm households without non-agricultural enterprises could be increased by 808,789.2 CFA F relative to the current level with the development of non-agricultural enterprises.

The findings imply that non-agricultural enterprises have the potential of improving farm productivity. Thus, it is necessary to strengthen the entrepreneurial capacities of the farm households and also support farm households' entrepreneurship decision taking. In this paper, all the households with non-agricultural enterprises were lumped together irrespective to their enterprises, and separate analyses were not performed for the different enterprises, and this is due to low relative frequency for most of them. However, it will be interesting to assess how specific type of non-agricultural enterprises contribute to farm productivity. Future research could carry out such analysis.

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Table 7. Falsification test

	Coefficients	Robust Std. Err.
Mobile phone	40079.69	35928.54
Constant	-73864.83**	36791.32
F-Stat	5.02***	
Observations	1459	

Note: Clustered-robust standard errors are reported. *, **, *** indicate statistically significance at the 10%, 5%, and 1%, respectively.

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