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Analysis of the Determinants of Agricultural Investment Decisions in Burkina Faso

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Abstract

Agricultural investment contributes to increased productivity and production. This research analyzes the determinants of agricultural investment decisions in Burkina Faso. A double hurdle model is used to analyze the factors that explain agricultural investment and intensification decisions based on data collected in 2017 by the Laboratory of Quantitative Analysis of Development in Sahel (LAQAD-S). The results show that off-farm income and level of education positively affect household agricultural investment. Economic policy measures to develop income-generating activities and improve household education levels are crucial to raising the level of agricultural investment by rural households in Burkina Faso.

Keywords: agricultural investment, off-farm income, double hurdle model, Burkina Faso

1. Introduction

Agriculture in Sub-Saharan Africa (SSA) is characterized by low use of agricultural inputs (Teno et al., 2018; Duflo et al., 2011; Udry, 2010). According to the World Bank (WB) (2019), fertilizer consumption as a percentage of total production is 140.2% in Latin America and the Caribbean; 127.2% in North America; 94.8% in the Middle East, and only 16.2% in SSA. As a result, some households are likely to lose part of their production due to the low use of agricultural inputs. Indeed, while agricultural production worldwide is estimated at 2.98 billion tonnes, SSA records around 162 million tonnes, compared with 251 million tonnes in Latin America and the Caribbean, and 944 million tonnes in East Asia and the Pacific (WB, 2020). However, the use of modern technology improved seeds and fertilizers has helped to increase agricultural yields in Asia (Morris et al., 2007). The adoption of new technologies in SSA could help to increase production and thus guarantee food security, reduce poverty, and improve the well-being of rural households (De Janvry and Sadoulet, 2009).

In this part of the world, agriculture remains the most important productive sector in terms of its contribution to Gross Domestic Product (GDP) and the number of people it employs. Indeed, the sector employs more than half of the working population and contributes more than 15% to the formation of GDP (World Bank (WB), 2019). In Burkina Faso, agriculture employs 73% of the working population and accounts for around 20.4% of GDP (WB, 2021). As farmer is the sector that pulls the economy along, it is necessary to use the necessary quantities of inputs so that this contributes to raising the level of agricultural production, and this is possible by changing agricultural practices (Duflo et al., 2008). In this situation, agriculture can contribute to economic transformation, drive economic growth, and play a key role in poverty reduction. Faced with this situation, it is therefore important to identify the factors that explain the adoption of agricultural investments to increase farmers' agricultural production.

To increase agricultural production, farmers face some technology adoption choices. According to the expected utility theory, the choice of technological adoption is based on expected utility. For authors such as Dorward and Chirwa (2011), investment adoption decisions are guided by reasons of profitability and market accessibility. Indeed, households decide to invest if the expected gain is greater than that of not investing. Moreover, other authors have shown that the presence of a market positively influences households' investment decisions (Raut et al., 2011; Mathenge and Tchirley, 2008; Barrett, 2008). Farmers' wealth also proves to be an important determinant in the adoption of agricultural investments due to risk aversion. Indeed, when a farmer is wealthy, he is more likely to take risks compared to a poor farmer. This indicator generally has a positive effect on the adoption of agricultural investments. In the literature, wealth is understood either in terms of income (Rodríguez-Entrena and Arriaza, 2013), social capital (Baffoe-Asare et al., 2013), or off-farm income (Chirwa, 2005). However, a farmer can be wealthy without this influencing the adoption of agricultural investments.

Human capital, approximated by the level of education of the head of household, has a positive influence on households' decision to adopt agricultural investments. When farmers have a high level of education, they are more likely to adopt technologies than farmers with a lower level of education (Chirwa, 2005), as well as in agricultural intensification (Croppenstedt et al, 2003).

On the other hand, some authors believe that when farmers have a high level of education, they leave the agricultural sector for the non-agricultural sector. Thus, the agricultural sector is mostly occupied by farmers with a low level of education. According to Chirwa (2005), farm size is crucial to the adoption of agricultural investments by households. Just and Zilberman (1983) support this idea, showing that farmers with large farms are willing to allocate more land to new technologies than those with small farms. Indeed, farmers with small farms would be more vulnerable to the risks associated with new technology. The low use of agricultural inputs is based on the existence of market imperfections (Barrett, 2008). This situation limits farmers' ability to cope with the capital and investment intensification of this sector. As a result, credit constraints explain the low use of agricultural inputs. Authors point out that credit constraints significantly limit the adoption of good technology packages (Abdallah, 2016; Raut et al., 2011; Croppenstedt et al., 2003).

In Burkina Faso, low agricultural productivity is partly due to low levels of investment (Combary, 2016). Burkina Faso uses 22 kilograms per hectare of agricultural inputs in contrast to China, where this is estimated at 503.3 kilograms per hectare (Food Organization of the United Nations Statistics (FAOSTAT, 2019). As a result, agricultural production remains low compared with other countries. Burkina Faso recorded 4.991 million tons of cereals compared with 25.191 million tons in Ethiopia; 10.388 million tons in Morocco; 10.159 million tons in Mali; 6.099 million tons in Niger in 2018 (World Bank, 2020).

This analysis aims to identify the factors that explain the adoption of agricultural investment decisions by farmers in Burkina Faso. To achieve this objective, the Double Hurdle Model (DHM) is used. Unlike the Heckman method and the Tobit model, the DHM is more flexible in that it admits the possibility of zeros in the second stage (Wodjao, 2008). This model has the advantage of enabling the probability of adoption and intensification to be determined in two simultaneous stages, using a Probit model and a truncated model.

The rest of the article is organized into four sections. Section 1 presents a literature review of the factors that explain farmers' adoption of agricultural investment decisions. Section 2 justified the choice of empirical model. Section 3 describes the data and descriptive statistics. Section 4 presents and discusses the econometric results. The article ends with a conclusion and policy implications.

2. Literature Review

Agricultural investment depends on many factors. These factors generally represent farm characteristics, farmers' characteristics, technology characteristics, and institutional factors (Waithaka et al., 2007).

The farm size is one of the first factors on which the empirical literature on adoption focuses (Feder et al., 1985). Chirwa (2005) finds that the farm size positively affects adoption. In addition, high rainfall can lead households to invest more in agriculture. Mathenge and Tchirley (2008) find that this variable positively affects agricultural intensification. Education is considered that the most important form of human capital. It boosts agricultural productivity

by influencing decision-making, technology adoption, and information acquisition (Huffman, 2001). Akpan et al, (2012) and Chirwa (2005) have shown that education positively affects agricultural investment. In SSA in general, when the level of education of the head of household increases, he or she moves away from agricultural activities towards non-agricultural activities. To better develop agricultural activities, access to credit is a determining factor. According to Feder et al, (1985), access to credit positively affects technological adoption, since it enables households to access the inputs needed to increase productivity. Authors such as Abdallah, (2016), Raut et al., (2011), and Karugia, 2003) have shown that access to credit positively affects agricultural investment.

Social capital enables producers to acquire the resources they need for production. Membership in a farmers' organization facilitates access to credit. Membership of a producer group is positively correlated with agricultural investment. In this sense, Abate et al, (2013), and Mathenge and Tchirley (2008) find that this variable positively affects agricultural investment. Off-farm income plays a key role in the adoption of agricultural technology. In the event of a shock, the physical capital endowment of farmers can positively affect the adoption of agricultural investment. Indeed, poultry is easily sold on the market and gives the household a certain capacity to cover its investment expenses (Pender et al., 2002). Access to information is crucial to agricultural investment decisions. In the present analysis, access to information is used as a proxy for market access. Raut et al, (2011), Mathenge and Tchirley (2008), and Karugia (2003) have shown that the presence of a market positively influences households' agricultural investment decisions.

According to Akpan et al, (2012), older household heads invest less than younger ones. Indeed, younger heads of households may have more knowledge about the use of new technologies than older heads of households. Conversely, older heads of households may be more willing to adopt new technologies, since they have a comparative advantage in terms of capital accumulation, credit availability, and experience (Waithaka et al., 2007). In African countries, women's adoption of technology is lower than men's, due to heavy customary law (Mathenge and Tchirley, 2008). Household size has a positive impact on technology adoption, especially in contexts where the labor market is imperfect. On the other hand, when household size is high and the number of working people low, this can hurt the household's ability to invest, since the high number of inactive people generates huge expenditure. In this sense, Akpan et al, (2012) find that household size negatively affects fertilizer adoption.

3. Empirical Model

Heckman (1979) two-stage method can be used to identify the factors that explain agricultural investment. This method corrects for selection bias by first estimating a participation model, the Probit model, and then predicting the Inverse Mills Ratio to be included in the estimation of the outcome equation. This approach is better suited to accidental truncation, where zeros represent unobserved values (Heckman, 1979). However, observing zeros may be an optimal choice for farm households, and a corner solution model would be more appropriate than a selection model, the Tobit model. However, the Tobit model has a limitation. The Tobit model

postulates that the decision to use an input and the quantity used are defined by a single mechanism (Wooldridge, 2002). Another model used for analysis is DHM (Akpan et al., 2012). This model is increasingly used in empirical analyses in developing countries. This analysis uses the DHM following the example of Akpan et al, (2012), and Mathenge and Tchirley (2008) who used this model to explain fertilizer use in southern Nigeria and Kenya respectively.

The equations of the double hurdle model are defined as follows:

$$Z_{ij} = \begin{cases} Z_{ij*} \text{ si } X_{ij}\beta + \varepsilon_{ij} > 0 \\ 0 \text{ si } Xij\beta + \varepsilon ij \leq 0 \end{cases} \quad (1)$$

$$Z_{ij} = X_{ij}\beta + \varepsilon_{ij} \qquad avec \quad \varepsilon \sim (0, \sigma^2). \quad (2)$$

Z_{ij} refers to the type of investment j $(j = 1, \dots, k)$ adopted by the household i $(i = 1, \dots, N)$. X_{ij} is the vector of investment explanatory variables, β is the vector of parameters associated respectively with the terms X_{ij} and ε_{ij} is the error term. Z_{ij}^* is a latent variable for the adoption of the type of investment j by the household i .

To observe positive investments, the model postulates that two distinct hurdles must be overcome. Firstly, the household must decide to invest, and secondly, subject to the first hurdle, the household allocates resources to purchase agricultural inputs. To estimate this model, maximum likelihood estimation method is used. This involves a pooled regression of the two equations, producing consistent and asymptotically efficient estimates for all parameters (Manning et al., 1987).

4. Data and Descriptive Statistics

The empirical model developed is estimated from rural household data collected in Burkina Faso as part of the evaluation of the National Land Management Program, phase 3. Data collection was carried out by the Laboratory of Quantitative Analysis of Development in Sahel (LAQAD-S) of Thomas SANKARA University in 2017.

Table 1 presents the descriptive statistics. This table shows that 79.18% of households use chemical fertilizers, and 59.09% use organic manure. If households decide to invest, they allocate resources to each of the two types of investment. The data show that to acquire chemical fertilizers, households spend an average of 26,183 FCFA annually. On the other hand, they spend 6,893 FCFA on organic manure. Household heads are adults, with an average age of 47. The average household size is 8. This household size is the same as the average size of rural households in Burkina Faso, estimated at 8 members in 2014 (INSD, 2014), thus reflecting the good quality of the data. In terms of level of education, 15.26% of household heads have a primary education. Households own an average of 15 livestock units and 25 poultry units respectively. The average of off-farm income is 354,142 FCFA. The proportion of household heads with social capital, approximated by membership in a peasant organization, is 17%. The rural areas covered by the analysis receive an average of 1043.01 millimeters of water per year. Some 63.18% of households have formal access to information via radio and

television. The average farm size is 3.98 hectares. The average annual total credit received by households is 74,660 F CFA.

Table 1. Descriptive Statistics for Variables

Variables	Averages
Chemical fertilizer users (in %)	79,18
Adopters of organic manure (%)	59,09
Expenditure on chemical fertilizers (in F CFA)	26 183
Expenditure on organic fertilizer (in F CFA)	6 893
Age of head of household (in completed years)	47
Sex (% of male heads of household)	94,21
Household size (number of people)	8
Primary level (%)	15,26
Livestock (number of heads)	15
Poultry (number of heads)	25
Non-farm income (in FCFA)	354 142
Share capital (%)	17,00
Annual rainfall (in Millimeters)	1 043,01
Access to information (%)	63,18
Farm size (in hectares)	3,98
Total credit (in F CFA)	74660

Source: National Land Management Program data, 2017

5. Results and Discussion

The results of the Wald test show that the coefficients of the variables are on the whole significantly different from zero, as the Wald statistic calculated for the different types of investment is greater than the value read from the chi2 distribution table at the 1% threshold. On the whole, the variables used in the different models globally explain household agricultural investment. Table 2 presents the maximum likelihood estimates of the Double hurdle Model that can be used for interpretation and economic analysis.

The estimated effect of off-farm income is positive and significant on the decision to invest in chemical fertilizers and organic manure. This result is in line with expectations. One explanation for this result is that in rural Burkina Faso, households are subject to climatic hazards that negatively affect production and farm income. This leads them to engage in off-farm activities and use these resources to finance the acquisition of production factors. As far as agricultural intensification is concerned, its effect is positive and significant in terms of organic manure. Indeed, income from off-farm activities gives households more opportunities to purchase the inputs needed for their agricultural production. In this way, off-farm income is a form of insurance for more intensive agricultural production.

The results show that household heads with access to credit are likely to invest in fertilizers and organic manure and to intensify the purchase of chemical fertilizers. According to Feder et al (1985), this result meets theoretical expectations. One explanation for this result is that access to credit provides households with the resources to choose a technological package to increase productivity. Household heads with primary education intensify their use of chemical fertilizers. Indeed, according to human capital theory, producers with a higher level of education are better informed about the conditions of use, the benefits of technology, and the conduct of agricultural innovations. As a result, they are motivated to invest in the technology change to increase their productivity.

Age has a positive and significant effect on the decision to invest in organic manure. This result can be explained by the fact that older farmers have a comparative advantage in terms of experience in the use of organic manure. As a result, they are less inclined to venture into new technology, the use of which they often have no control over. However, age has a negative and significant effect on chemical fertilizer intensification. This result can be explained by the fact that younger heads of households are more enlightened and receptive in relation to agricultural modernization such as the use of chemical fertilizers.

Male heads of household invest in organic manure and use chemical fertilizers intensively. The explanation for this result is that in rural, men have greater access to land and make production decisions within the household. Household size affects household agricultural investment. When household size is high, households make the decision to invest in organic manure and to intensify both types of agricultural investment. This result can be explained by the fact that the use of organic manure requires a substantial workforce, and if the household size presents a high number of assets this will lead the household to adopt and intensify in both types of investment. Size, on the other hand, negatively affects the decision to invest in chemical fertilizers. This result can be explained by the fact that the high number of inactive members in the household generates enormous expenditure on food, health, education and clothing. In this situation, the household prefers to provide for its inactive members rather than invest in chemical fertilizers.

Households that own livestock adopt organic manure and intensify both types of agricultural investment. This can be explained by the fact that livestock can help to produce organic manure and accentuate the purchase of chemical fertilizers. Household heads who also own poultry invest more in organic manure. One explanation for this result is that poultry is easily sold on the market, the income from which can be used to purchase agricultural inputs. Household heads who are members of a farmers' organization invest in fertilizers and intensify their use of fertilizers and organic fertilizers. In the context of Burkina Faso, credit for the purchase of chemical fertilizers is generally given concerning the household head's membership in an organization that guarantees repayment of this credit. Annual rainfall positively and significantly affects household agricultural investment. This result can be explained by the fact that crops require good rainfall conditions. When the producer is located in an area that satisfies these conditions, he will have a stronger incentive to adopt, invest, and intensify in agriculture.

Table 2: Estimation results for the Double-Hurdle-Model

	Chemical fertilizers		Organic Manure	
Variables	Hurdle1	Hurdle 2	Hurdle 1	Hurdle 2
Age	-0,002	-0,071***	0,006**	0,007
	(0,002)	(0,023)	(0,002)	(0,049)
Gender	-0,056	12,106***	0,428**	8,625
	(0,147)	(3,664)	(0,143)	(5,334)
Size	-0,025**	0,155**	0,069***	0,819***
	(0,011)	(0,066)	(0,010)	(0,131)
Primary level	0,159	1,682***	0,100	-2,070
	(0,114)	(0,632)	(0,087)	(1,824)
Livestock	-0,001	0,028**	0,007***	0,077***
	(0,002)	(0,013)	(0,002)	(0,027)
Poultry	-0,000	0,003	0,003**	-0,004
	(0,001)	(0,007)	(0,001)	(0,018)
Off-farm income	0,001***	-0,007**	0,001***	0,015***
	(0,000)	(0,002)	(0,000)	(0,004)
Share capital	0,944***	4,862***	-0,124	6,551***
	(0,202)	(0,850)	(0,107)	(2,014)
Precipitation	0,001***	0,018***	-0,000	-0,001
	(0,000)	(0,002)	(0,000)	(0,004)
Access to information	0,345***	0,421	0,114*	0,519
	(0,078)	(0,620)	(0,067)	(1,491)
Farm size	0,142***	1,140***	0,022*	0,881***
	(0,020)	(0,070)	(0,012)	(0,129)
Total credit	0,018**	0,226***	0,015**	-1,588
	(0,008)	(0,069)	(0,007)	(0,158)
Constant	-1,367***	-47,860***	-1,410***	-33,343***
_	(0,298)	(6,025)	(0,271)	(7,282)
Comments	1782		1782	
Log-likelihood	-2218,724		-5942,75	
Wald chi2 (12)	195,07		226,83	
Prob>chi2	0,0000		0,0000	
Sigma	3,409***		8,046***	
	(0,181)		(0,294)	

Notes: Standard are errors in parentheses ***p < 0.01, **p < 0.05 and *p < 0.1.

Source: National Land Management Program data, 2017.

Access to information used as a proxy for the presence of a market positively and significantly affects the investment decisions of households. This result can be explained by the fact that when a household is open to the market, it has easier access to inputs and becomes more productive. Indeed, information received formally can guide households to invest in the agricultural sector. When farm size is large, household heads decide to invest and intensify both types of investment. This result is explained by the fact that holding large farm size gives households a comparative advantage. As a result, households are more likely to invest in agriculture than in other activities.

6. Conclusion and Policy Implications

This research aimed to analyze the determinants of agricultural investment in rural Burkina Faso. To carry out this analysis, it is necessary to use an appropriate model. Thus, the Double Hurdle Model developed by Cragg (1971), considered the most robust was used based on data from a sample of 1782 households, surveyed during the survey conducted by PNGT2 in 2017 as part of a study on the living conditions of rural households in Burkina Faso. The results show that off-farm income, level of education, livestock, poultry, social capital, access to information, and access to credit act positively on agricultural investment and intensification decisions. It is therefore necessary to develop income-generating activities to increase agricultural productivity. The level of education is also a determining factor in agricultural investment. A policy of supporting education enables household heads to make more informed choices to achieve their production objectives. Access to credit encourages agricultural investment. The poorest households must therefore be given access to credit through farmers' organizations. To take capital investment into account, future analyses will require panel data.

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