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Impact of the modern marketing channel on the gross income of milk producers in Linguere

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ABSTRACT

In Senegal, marketing channel importance in the participation of breeders in value chains remains poorly documented. This study aimed to evaluate the impact of the modern marketing channel on the dairy farmers gross income at Linguère. The snowball method was used to collect data from 104 breeders. Then, the impact was evaluated using the instrumental variables method. The results reveal that the modern marketing channel has a positive and significant effect of 1.38 FCFA / cow / day on farmers' gross income. Thus, to interest the latter and secure their supply, the local processing units should implement a policy of stabilizing the purchase price of milk and a collection mechanism that reduces transaction costs. In addition, an improvement of the food supplements accessibility by lowering the purchase price would, ceteris paribus, increase the milk productivity, a factor determining the gross income of the milk producers.

Keywords: Milk ; Marketing channel ; Instrumental variable ; Probit ; Senegal

RESUME

Au Sénégal, l'importance des circuits de commercialisation dans la participation des éleveurs aux chaînes de valeur reste peu documentée. Cette étude avait pour objectif d'évaluer l'impact du circuit moderne de commercialisation sur le revenu brut des producteurs laitiers à Linguère. La méthode « boule de neige » a permis de collecter les données auprès de 104 éleveurs. Ensuite, l'impact a été évalué par la méthode des variables instrumentales. Les résultats révèlent que le circuit moderne de commercialisation a un effet positif et significatif de 1,38 Fcfa/Vache/Jour sur le revenu brut des éleveurs. Ainsi, pour intéresser ces derniers et sécuriser leur approvisionnement, les unités de transformation locales devraient mettre en place une

politique de stabilisation du prix d'achat du lait et un mécanisme de collecte qui réduit les coûts de transaction. De plus, une amélioration de l'accessibilité des compléments alimentaires par la baisse du prix d'achat permettrait, ceteris paribus, une augmentation de la productivité laitière, facteur déterminant le revenu brut des producteurs de lait.

Mots clés : Lait ; Circuit de commercialisation ; Variables instrumentales ; Probit ; Sénégal

INTRODUCTION

Animal husbandry occupy a prominent place in the search for food self-sufficiency, especially in products of animal origin in Senegal. With a contribution of 28.8 % to primary sector GDP and 4.2 % national GDP, livestock ranks second among primary sector activities (MEF 2013). Among the various livestock products, milk, the second most important commodity after poultry products, accounts for 9.7 % of primary sector turnover (DPEE 2011). Over the period from 2010 to 2016, milk production decreased by 20.65 %, with year-to-year variations rising from 155 823 tons in 2010 to 123 640 tons in 2016 (FAOSTAT 2016).

However, consumption levels of milk and dairy products is relatively low: 40 equivalent liters per capita in 2009, of which 77 % in the form of milk powder, while the recommended standard is 91 liters / inhabitant / year (Duteurtre 2006). Moreover, despite a decline in imports, the dairy bill is still high with more than 42 million US dollars in 2013 for the sole imports of whole milk powdered cow (FAOSTAT 2013).

Faced with strong demand and low and seasonal production, local processing units have a crucial role to play as they link producers to an increasingly demanding market. In fact, the determinants of milk and dairy product consumption are related to the characteristics of consumers and in particular to their level of education (Broutin *et al.* 2002). Thus, affluent and educated consumers place an emphasis on the safety and hygiene of dairy products.

Packaging is then perceived as a source of quality differentiation which is considered better compared to that of bulk dairy products (Broutin *et al.* 2002). These authors show that 80 % of consumers prefer curd wrapped in sachets or jars.

In addition, fresh milk is very vulnerable to several microorganisms, with the consequent, product degradation and risks of contamination / infection in consumers (Murinda *et al.* 2004 ; Olivier *et al.* 2005). Given this situation, producers alone cannot ensure an adequate supply of dairy products to consumers (especially urban).

However, Sall (2015) considers supply as one of the main problems of Local Processing Units (LPU) in the sylvo-pastoral area including our study area (Linguère). The same problem was observed in Kolda where Dièye *et al.* (2008) indicate that local processing units only operates between 15 to 33 % of their total capacity. In fact, the traditional milk marketing channel (sales to the markets) strongly competes with the modern milk marketing channel (sale to the LPU). The immediate consequence is the reduction of fresh milk delivered by farmers to local processing units; which leads to an under-utilization of their production capacities. In order to limit supply problems and preserve their market, some LPU use milk powder. This is the case, particularly, in the dry season when the supply of milk powder can constitute up to 100 % of processed milk flows (Cissé 2004; Gaulier 2005; Corniaux *et al.* 2005). This threatens the viability of these local processing units, but also the access of small-scale milk producers to markets and sustainable value chains.

According to Paterson (1997), the choice of a producer's milk marketing channel depends on factors such as market availability, market potential, price offered and distance from market. Poor information or lack of market information can lead the producer to choose an unprofitable marketing channel (Nkosi & Kirsten 1994). Although some studies have addressed aspects of milk marketing in Senegal (Dièye *et al.* 2002; Duteurtre 2006; Dièye *et al.* 2008; Dia 2013), there have been no studies known to the author that have examined the link between milk marketing channel choice and milk producer's gross income . This study therefore attempts to fill this gap by analyzing empirically the modern marketing channel choice on milk producer's gross income in the department of Linguère, Senegal. The research questions are:

- What are the determinants of the choice of the modern milk marketing channel circuit by producers?
- What are the determinants of milk producer's gross income?
- What is the impact of the modern marketing channel on milk producer's gross income?

MATERIALS AND METHODS

Study area

With Latitude 15 ° 21'32 North and Longitude 15 ° 9'29 West, Linguère is a department of Louga region in Senegal, part of the silvopastoral zone (Diallo 1996). The department has a Sahelian continental, semi-arid, monomodal climate with a dry season from October to June and a rainy season (ARD 2013). From 2012 to 2014, the average precipitation was

approximately 419.59 mm with an interannual variation (Ndione *et al.* 2014). populate this department (Diallo 1996). Also, 90 % of the area is occupied by livestock, this could be explained by the importance of the activity (ARD 2013).

Data collection

The data was collected during the dry and rainy seasons in various areas using a structured questionnaire schedule from the selected milk producers, in order to better understand the milk production and valorization systems. Not having a sampling frame, the first action has consisted in targeting the department which had processing units that could put us in contact with their suppliers. In department where these units do not exist, veterinary agents have played the role of facilitators by directing us to the farmers who actually produce milk.

The "snowball" sampling method was used for this study. It relied on the social network of a first contact who guided the team to its next contact (Goodman 1961).

The minimum sample size (n) was determined by the following formula (Dagnelie 1998):

$$n = \frac{Z^2 P(1-P)}{d^2} \quad \text{Where:}$$

Z is the standard value of the normal law at a confidence level of 5 % ($Z = 1.96$),

P is the estimated proportion of the population of milk producers with the characteristic of interest for the study, that is, the use of the modern marketing channel for the sale of milk. Since P is not known, it has been set at 0.5.

d is the marginal error set at 10 % so $d = 0.1$.

Thus, the minimum size of the breeders to be surveyed is 96. In total, 112 producers participated in the survey. After the count, 104 observations were selected for the analyzes.

Theoretical framework

According to rational choice theory, agricultural producers choose a technology based on the expected maximum utility given their socio-economic characteristics, institutional environment and relevant resource constraints (Norris & Sandra 1987; Pryanishnikov & Katarina 2003). Indeed, it is assumed in the theory that economic agents will choose a technology only if the

perceived or actual utility of the use of such a technology is significantly higher than that of other alternative technologies. Since utility is not directly observable, it will be deduced from the behavior of economic agents through their choice. As part of this study, the technology is assimilated to different cow's milk marketing channels.

Consider a breeder i in a population of N breeders to choose a marketing channel from among j alternative channels, with $j = 0$ for the use of the traditional channel (final consumers at the market) and, $j = 1$ for the use of the modern channel (local processing units). Let U_j be the utility level that the technology j provides to the producer i . The producer will opt for the modern channel, when these provide him more utility than the traditional circuit, in other words when $U_{i1} > U_{i0} = U_{i1} - U_{i0} > 0$. Assuming the usefulness of technology j as a linear function of its determinants, we obtain the following equation (Greene 2003):

$$U_{ij} = \beta_i X_i + \varepsilon_i \quad (1)$$

Where X_i is the producer's socio-economic characteristics, institutional factors and technology factors; β_i the parameters to be estimated associated with the explanatory variables and ε_i , the error term.

Few studies have been done on the impact of choosing the marketing channel. Ng'eno (2016) assessed the impact of marketing choice on the income of Kenyan milk producers using propensity score matching. According to the author, this approach does not require any hypothesis on the functional form by specifying the relation between the results and its predictors. However, it has the disadvantage of the conditional independence assumption, that is, for a set of covariates, the choice of marketing channel is independent of potential outcomes (Smith & Todd 2005). In addition, producers using the modern marketing channel and those the traditional one should have the same observable characteristics, which is difficult to achieve in practice. Also, the method of matching propensity scores is criticized because it is based solely on observable characteristics, ignoring the unobservable factors that may affect the choice of a particular marketing channel considered in this study as a technology (Boudot *et al.* 2013). Therefore, this approach will not be used in this study because of its inability to treat unobservable characteristics.

The instrumental variable method is one of the suitable methods in eliminating observable and unobservable bias (Heckman & Vytlačii 2005; Abadie 2003). This method was used and assumes the existence of at least one variable called "instrument" that directly affects the choice

of marketing channel (traditional or modern) but indirectly the result “y” (in this case the milk producer’s gross income) provided that the independent variables “x” are controlled. It allows to estimate the marginal effect of the modern milk marketing channel choice on the producers gross income in the population of the users of the modern marketing channel (MTT).

Consider Y_i as the income of a milk producer i , who uses or does not use the modern marketing channel. Let A_i be the decision to use in such a way that $A_i = 1$ if the producer use the modern marketing circuit and $A_i = 0$ if not. Assuming that income is a function of observed and unobserved factors, and using conventional regression notation, income Y_i can be written as follows:

$$Y_i = \lambda + \gamma x_i + \beta A_i + \varepsilon_i \quad E(\varepsilon_i | \lambda, \gamma, \beta, x_i, A_i) = 0 \quad (2)$$

Where λ , γ and β are unknown parameters to estimate, x_i are explanatory variables and ε_i is the error term. β is the average causal impact of A_i on Y_i in all observation units.

If observable and unobservable variables are not controlled, the estimate of the impact of the choice of marketing channel on income is likely to be biased. Thus, the use of an appropriate instrument for the choice of marketing channel is necessary to explicitly control the selection of unobservable factors. The correct estimation of equation (2) requires the use of instrument (z).

Specification of the models

A two-step approach was used to evaluate the impact of the choice of modern marketing channel on dairy farmer’s gross income. The first step was to model the marketing channel choice and the second estimate the impact of using the modern marketing channel on the milk producer’s daily gross income per cow.

Preferably, the dependent variable should be daily net income per cow. However, data on the value of some inputs has been difficult to obtain, especially inputs such as labor, feed and fodder. Also, data on fixed costs are missing from several producers. Therefore, like Sharma (2015) and Ng'eno (2016), daily gross income per cow was used as the dependent variable in the impact model.

In addition, the instrumental variable is the knowledge of the existence of modern marketing channel (z) with $z = 1$ for producers who know the existence of the modern channel and $z = 0$ if not. The choice of this instrument is justified by the fact that knowledge of the existence of modern marketing channel can influence the choice of marketing channel by the producer. However, knowing about the existence of the modern marketing circuit does not directly influence the producer's income. In fact, a producer who is aware of the existence of the modern

marketing channel may not choose it. In summary, knowledge of the existence of the modern marketing channel can influence its use but does not directly influence the income. Thus, this variable meets the definition of the instrument as presented by Abadie (2003).

According to the literature, the following variables were introduced into the models.

- **Age**

It's a continuous variable. It has been introduced in both the modern marketing channel choice model and the impact model on gross income.

Some authors have shown that young people are not adverse to risks and consequently are more favorable to the adoption of innovations (Zegeye *et al.* 2001; Glèlè *et al.* 2008). Others, on the other hand, consider that young producers adopt less innovations than older ones (Moturi *et al.* 2015; Mutura *et al.* 2015). Age can therefore have a negative and positive influence on the adoption of the modern marketing channels considered in the case of this study as technology or innovation (Sharma 2015; Moturi *et al.* 2015; Mutura *et al.* 2015). In the context of this study, the effect of the milk producer's age on the choice of marketing channel cannot be predetermined (model 1).

Sharma (2015) observed a negative influence of the producer's age on his income. A negative sign is expected for age in the impact model of the modern milk marketing channel on gross income. This variable is in logarithmic form ($\ln\text{Age}$) in the impact model (model 2).

- **Veterinary follow-up**

Veterinary follow-up refers to the contact of the producer with an extension agent. This discrete variable which takes the value 1 if the producer receives the visit of extension agents and 0 if not. Producers are more willing to adopt a new technology when they have the information and hope for a gain after adoption (Jevons 1875; Menger 1892). It is through contact with extension agents or veterinarians that the producer accesses information about the existence of new technology and its benefits. Access to information positively and significantly influences the choice of cooperatives (modern channel) for milk sale (Mutura *et al.* 2015). In addition, Sharma (2015) and Ng'eno (2016) found that veterinary services positively influence the use of modern milk marketing channel. It is expected in this study that this variable positively influences the choice of the modern milk marketing channel (model 1).

The greater the use of agricultural extension services or veterinarians, the higher the likelihood of using dietary supplements and sanitary products (Jamison & Lau 1982). Sharma (2015)

measured a positive influence of veterinary follow-up on the milk producers income. This variable is expected to have a positive influence on the producer's gross income (model 2).

- **Number of females in the herd**

It is a continuous variable that has been used as a proxy for the size of the flock. Babadakpodji *et al.* (2015) showed that the area planted with rice positively influences the choice of paddy rice processing units as a marketing channel. In addition, the livestock size has a positive influence on the choice of the modern milk marketing channel (Moturi *et al.* 2015). However, Mburu *et al.* (2007), Mutura *et al.* (2015) and Sharma (2015) noted a negative relationship between herd size and the choice of modern marketing channel. The sign of this variable cannot be assumed in advance (model 1).

- **Selling price variation coefficient**

It is a continuous variable that measures the risk of a variation in the selling price incurred by milk producers in the different markets or marketing channel. According to Sharma (2015), the greater the risk of a change in selling price in the traditional marketing channel, the more producers turn to modern marketing channels. According to the latter, producers are attracted by transparency and price stability in this market. In the same order of ideas, Kumar & Staal (2010); Moturi *et al.* (2015) and Ng'eno (2016); have observed a negative influence of the selling price variation coefficient on the choice of modern marketing channels. Moreover, Sharma (2015) has obtained a negative influence of this variable on the producer's income. In this study, a negative sign for this variable is expected in both models.

- **Distance from farm to the nearest processing unit**

It is a continuous variable that measures the distance between the farm and the nearest modern marketing channel (local processing unit). The work of Sharma (2015) and Ng'eno (2016) has shown that the greater the distance to local processing units, the more producers move to traditional marketing channels (spot market). Thus, a negative sign for this variable is expected in the choice model of the modern marketing channel (model 1).

In addition, Sharma (2015) in India, has shown that distance to the milk local processing units is inversely related to income. Thus, the proximity of the farm to the local processing units (modern marketing channel) will facilitate the flow of milk and consequently increase income. Several authors like Bravo-Ureta *et al.* (2005); Tomoyo *et al.* (2006); Ahouandjinou *et al.*

(2010) used this variable as a determinant of income. A negative sign is expected in the impact model (model 2). This variable was used in its logarithmic form.

• **Daily milk production per cow**

It is a continuous variable that measures daily milk production per cow. The choice of modern marketing channels is positively influenced by daily milk production per cow (Tsougiannis *et al.* 2008; Mutura *et al.* 2015). Based on the fact that daily production per cow contributes to the estimate of daily gross income per cow, the increase in production will have a positive influence on gross income. A positive sign is expected for this variable in both models. Note that it is the logarithmic form of this variable that has been used.

• **Self-consumption**

It is a qualitative categorical variable that represents the share of production that is self-consumed by the household. This variable takes the value 1 if the rate of self-consumption of milk is less than or equal to 70 % and 0 if not. It is estimated that commercially oriented producers are more willing to adopt the technologies/innovations. Thus, self-consumption would negatively influence the choice of modern marketing channels (Babadankpodji *et al.* 2015). A negative sign is then expected for this variable in the choice of modern marketing channel (model 1).

• **Number of agricultural assets**

It is a continuous variable that measures the number of people working permanently with the household head, including himself. Babadankpodji *et al.* (2015) found that this variable negatively influences the sale of paddy rice (raw material) to processing units. As milk is a raw material for local processing units, it is assumed that this variable would negatively influence the choice of the modern marketing channel (model 1).

• **Interaction variables**

To test the heterogeneity of the impact of marketing channel choice on the daily gross income per producer's cow, the variable "choice of the marketing channel" was crossed with other variables and introduced into the impact model. The variables thus obtained are called "interaction variables" and their coefficients measure the impact variation of a modern channel user to another. It is:

- "choice of marketing channel" * Number of years of experience in milk production

- "choice of the marketing channel" * Number of agricultural assets
- "choice of the marketing channel" * Number of females in the herd
- "choice of the marketing channel" * Literacy

Table 1 presents all the variables introduced in the models and their expected signs.

Table 1 : Expected signs of the variables included in the choice model of the marketing circuit.

Variables	Description of variable	Nature	Signs	
			Model 1	Model 2
Age	Household head's Age	Continuous	+/-	-
Veterinary follow-up	Contact with extension agent or veterinarian	Binary (1=Yes and 0=No)	+	+
Eff_F_Tr	Number of females in the herd	Continuous	+/-	
Coeff_Vari	Selling price variation coefficient	Continuous	+	-
DistancetoUTL	Distance between farm and the nearest local processing unit	Continuous	-	-
ProdTot_Vache	Daily production of milk per cow	Continuous	+	+
AUTOCON	Self-consumption of milk	Binary (1= if the consumption rate \geq 70 % et 0= if no)	-	
NA	Number of agricultural assets	Continuous	-	

Model 1: Model of the choice of the modern milk marketing circuit.

Model 2: Impact model of the choice of the modern marketing circuit on the producer's gross income.

Diagnostic test of the models

In this section, the potential multicollinearity of the probit model of marketing choice was tested for continuous variables using the variance inflation factor (VIF) and the pairwise correlation. In fact, multicollinearity becomes a serious problem if the pairwise correlation between the independent variables is greater than 0.5 (Gujarati 2004) or when the variance inflation factor (VIF) is greater than 8 (Greene 2003). Furthermore, the contingency coefficient was used to analyze the relationship between the discrete independent variables and the dependent variables. Finally, the Wald test was used to evaluate the nullity of the interaction terms.

RESULTS AND DISCUSSION

The diagnostic test carried out indicates that the variance inflation factor does not exceed the threshold value (8). Also, the highest pairwise correlation was 0.47; which is below the threshold value of 0.5. Multicollinearity was not a problem for the specifications.

In addition, the contingency coefficient revealed that only self-consumption of milk is significantly related to the dependent variable (choice of marketing circuit). However, the two (02) other categorical variables (veterinary follow-up and formal education) are known in the

literature as variables influencing the choice of marketing channel (Walter *et al.* 2015; Sharma 2015; Mutura *et al.* 2015). They have been maintained in the model.

Determinants of the modern marketing channel choice

Table 2 presents the factors influencing the choice of cow milk modern marketing channel in the department of Linguère. The results in Table 2 indicate that the model is globally significant at the 1 % level. The main variable influencing the choice of the milk modern marketing channel is the distance between the production farm and the nearest Local Processing Unit (LPU). This variable has a negative and significant influence on the choice of milk modern marketing channel at the 1 % threshold. Thus, the greater the distance between the farm and the local processing unit, the lower the probability that a farmer will sell milk through the modern marketing channel. In fact, the increase in distance results in an increase in transaction costs and sometimes makes negative, especially in the dry season, the utility derived from the choice of this modern marketing channel. These results confirm the characterization work of Dassou *et al.* (2017) who observed that breeders dwelling near LPU prefer to sell fresh milk to them. These results are also corroborated by the work of Sharma (2015) in India which concludes that milk producers tend to sell their productions through the traditional marketing channel as the distance to LPU increases. In addition, Mutura *et al.* (2015) and Otieno *et al.* (2009) found similar results using transaction costs as proxy for the distance between the farm and the sales cooperative. They report that high transaction costs reduce producers' profit margins and thus discourage them from using channel with high transaction costs.

In addition to distance, the coefficient of variation of the selling price is negatively correlated with the choice of the modern milk marketing channel and significant at the 5 % threshold. As a result, the higher the coefficient of variation of selling price, the more the farmers are turning away from the modern marketing channel. In fact, farmers tend to prefer marketing channels where the variability of selling price is low. The modern marketing channel represented by local processing units provides this stable sales price that breeders are looking for. On the other hand, the traditional marketing channel represented by weekly markets and traveler, there is an inter and intra seasonal variation in selling prices. These results are corroborated by those obtained by Sharma (2015) and Moturi *et al.* (2015) respectively in India and Kenya.

Finally, the decision to sell its production following the modern milk marketing channel is negatively linked to the self-consumption of milk. This variable is significant at the 5 % threshold. According to this variable, non-market producers are those who deliver low

quantities of milk to the market (less than 30 % of production). For these producers, "milk is considered as a livestock co-product that is an end in itself" (Corniaux *et al.* 2012). Thus, it is the surplus of milk after self-consumption that is sold in the various marketing channels. They are therefore not in a logic of maximizing the profit from this activity. On the basis of this principle, these producers choose marketing channels that are less demanding on quantity and quality of the product. Therefore, they opt for the traditional milk marketing channel. These results are in agreement with those obtained by Babadankpodji *et al.* (2015) in the sale of paddy rice to processing units.

In total, the cow's milk modern marketing channel choice by Linguère breeders is determined by the distance separating the farm from the nearest LPU, the coefficient of variation of selling price and the milk self-consumption (Table 2).

Table 2 : Variables determining the milk modern marketing channel choice

Variables	Coefficients
Age	1,33 (0,96)
Veterinary follow-up	1,99 (1,39)
Number of females in the herd	0,27 (0,31)
Coefficient of variation of selling price	-0,05 (0,02) **
Distance between the farm and the nearest local processing unit	-0,46 (0,16) ***
Milk Self-consumption	-1,45 (0,65) **
Daily production of milk per cow	0,79 (0,53)
Number agricultural assets	-0,13 (0,48)
Constant	-4,72 (3,64)
Number of observations	84
Wald-LR chi2 (8)	71,14***
Pseudo R2	0,63
Log likelihood	-21,12

* Significant at 10 %; ** Significant at 5 % and *** Significant at 1 %

Impact of the modern marketing channel choice on gross income of the dairy production system

The results of the impact model on the marketing channel choice on milk producers gross income are presented in Table 3. The analysis of this table indicates that the model is globally significant at 1 % threshold. Variables introduced in the model account for 90 % of gross income variability. This indicates that the inclusion of these variables in the model was essential to explain the variation in the milk producers gross income. The model is therefore generally satisfactory. In addition, the probability density function is positive and significant at 1 %

threshold. This result means that producers have anticipated a possible improvement in gross income by choosing the modern marketing channel. Finally, a value of 8.89 and significant at 1 % threshold was obtained with the Wald test for the interaction variables. The null hypothesis that all interaction terms are null cannot therefore be accepted. As a result, the impact on daily gross income per cow varies from one user of the modern channel to another.

The difference in gross income observed between users of the modern and traditional channels is 934 CFA / cow / day and significant at 1 % threshold. Thus, cow milk production is more profitable for users of the modern marketing channel than for users of the traditional channel. The impact model reveals that the modern marketing channel has a positive and significant effect of 1.38 F CFA / cow / day on the milk producers gross income, using the modern channel. This result, though weak, is consistent with the one obtained by Ng'eno (2016) in Kenya. According to the latter, the producers who sell their production to the processing cooperatives increase their gross income by 18.24 Kenyan shillings, or 5.14 F CFA on average per cow.

However, some features of the production system have direct effects on the producer's gross income. This suggests that the observed impact of the modern marketing channel choice may be wrongly attributed to the characteristics of the production system. Thus, the relationship between the modern marketing channel and the gross income of the dairy system will only be causal if these characteristics are controlled. It is essentially the coefficient of variation of selling price and the daily production of milk per cow.

The modern marketing channel choice has a positive influence on the gross income of the milk producer. Its coefficient is significant at 1 % level. The significance of this variable reflects the utility of a decision made by a rational producer. Indeed, the rational producer will always choose a marketing channel that maximizes its utility (here gross income) (Pryanishnikov & Katarina 2003).

The results indicate also that the coefficient of variation of selling price negatively and significantly influences the milk producers gross income at 1 % level. Thus, a 1 % increase in the coefficient of variation of selling price results a 1 % decrease in the milk producer gross income. Indeed, inter-seasonal variation in the milk selling price results in a real loss of earnings for users of the traditional milk marketing channel. On the other hand, a low selling price coefficient of variation is observed among the users of the modern marketing channel. Specifically, local processing units generally have a selling price stability policy to build customer loyalty. Sharma (2015) in India found similar results among dairy farmers.

In addition, daily milk production per cow is also significant at 1 % level and positively influences the producer's gross income. As a result, a 1 % increase in the daily amount of milk produced by a cow results in a 2.72 % increase in the producer's gross income. Thus, increasing the productivity of lactating cows will result in an increase in producers' gross income. Nevertheless, it would be necessary for breeders to become more rational by making milk production a production goal as much as meat production. Specifically, producers need to look for the best inputs and combinations of inputs for optimal milk production by cows. In other words, the producers must be technically efficient in the production of cow's milk.

Table 3 : Results of the impact model of milk modern marketing channel on gross income.

Variables	Paramètres
Choice of marketing channel	2,20 (1,27) ***
Age	-1,02 (1,07)
Coefficient of variation of selling price	-1 (1) ***
Daily production of milk per cow	2,72 (1,04) ***
Veterinary follow-up	1,09 (1,09)
Distance between the farm and the nearest local processing unit	-1,03 (1,02)
Choice of marketing channel * Number of years of experience in milk production	-1,21 (1,05) ***
Choice of marketing channel * Number agricultural assets	-1,08 (1,06)
Choice of marketing channel * Number of females in the herd	-1,08 (1,04) *
Choice of marketing channel * Literacy	-1,13 (1,07)
Constant	6,55 (0,26) ***
Number of observations	104
F	90,08 ***
Adj R-squared	0,90
Wald test for variables without interaction	258,19***
Wald test for variables with interaction	8,89***
Gross income of producers using the traditional circuit	1103
Gross income of producers using the modern circuit	2037
Difference of gross income	934***
Impact on modern marketing channel user	1,38*

* Significant at 10 %; ** Significant at 5 % and *** Significant at 1 %

CONCLUSION

The present study contributes to the literature on dairy sector by estimating the added value of using cow milk modern marketing channel and by identifying the factors that should be taken into account in order to make farmers use more of this milk channel. In total, the use of the

modern marketing channel (sale to local processing units) has substantially improved farmers gross income (milk producers). Its impact is small but positive (1.38 FCFA/Cow/Day). Thus, this marketing channel must be promoted by the agencies in charge of dairy sector development in Senegal because, despite its impact on farmers gross income (milk producers), it would contribute to the conservation of milk and a supply of a range of quality dairy products to consumers (especially urban). However, for the sustainability of this marketing channel and therefore the supply of local processing units (LPU), the latter must ensure that a policy of stabilizing milk purchase price is maintained throughout the period year for a regular supply. Also, should they implement a more efficient collection mechanism by reducing the transaction costs of producers who want to use this marketing channel. The payment of delivery expenses to producers by LPU managers or the multiplication of collection points could be a solution for the transaction costs reduction. In addition, a major effort must also be made by the state to reduce the price of food supplements to allow producers to better feed lactating cows for better productivity. As for LPU, their actions must also be part of the supply of input credit to help producers during wet periods in order to increase the productivity of cows and ensure a regular supply of local processing units.

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