

Determinants of participation in cavy marketing: Evidence from the Democratic Republic of Congo

Franklin Simtowe^{a,*}, Birthe K. Paul^b, Benjamin M. M. Wimba^c,
Samy B. Bacigale^{d,**}, Wanjiku L. Chiuri^{e,***}, Brigitte L. Maass^{b,****}

^aInternational Maize and Wheat Improvement Center (CIMMYT), Nairobi, Kenya

^bInternational Center for Tropical Agriculture (CIAT), Nairobi, Kenya

^cInstitut National pour l'Etude et la Recherche Agronomiques (INERA)-Mulungu, Bukavu, Democratic Republic of Congo

^dUniversité Evangélique en Afrique (UEA), Bukavu, Democratic Republic of Congo

^eInternational Center for Tropical Agriculture (CIAT), Kigali, Rwanda

Abstract

Smallholder supply chain participation remains low despite the potential welfare gains that would result from choosing a market-oriented production. Yet, studies on determinants of market participation for commodities with under-developed value chains are scanty. Employing a double-hurdle model, this paper examines factors determining households' participation in cavy marketing among cavy farmers from Sud-Kivu province in the Democratic Republic of Congo. We find that wealthier households participated less in cavy marketing while those producing more cavies were more likely to participate in their marketing. Moreover, smaller households tended to sell more cavies, while households with other livestock sold fewer cavies. The findings underscore the significance of increasing the participation in the cavy supply chains by farmers through the promotion of appropriate husbandry practices that enhance cavy productivity and production and that enable farmers to participate in markets as sellers.

Keywords: domestic cavy, marketing, double-hurdle, supply chain participation, guinea pig, *Cavia porcellus*

1 Introduction

The participation of small-scale producers in commodity supply chains is widely acknowledged in development literature as a basis for economic growth and poverty reduction. Yet, current smallholder supply chain participation remains low despite the potential

welfare gains that would result from choosing a market-oriented production (Barret, 2008). Cross-country and multiple year studies consistently show that typically less than one-quarter of the smallholder farmers in Africa sell some of their cereals produced (Levinsohn *et al.*, 2007). Literature on causes of low market participation in the developing world is exhaustive, attributing it to a mix of institutional, infrastructural and policy failures, price risk and uncertainty, difficulties of contract enforcement, insufficient numbers of middlemen, cost of putting small dispersed quantities of produce together and the inability to meet standards. Indeed, in the absence of institutional arrangements that can link producers to markets, Alene *et al.* (2008) demonstrate that high transport and transaction costs undermine the process of exchange and result in limited markets with

* Corresponding author

International Maize and Wheat Improvement Center (CIMMYT)
ICRAF House, United Nations Avenue – Gigiri,
P.O. Box 1041-00621, Nairobi, Kenya; Email: f.simtowe@cgiar.org

** Current affiliation: International Institute of Tropical Agriculture (IITA), Bukavu, Democratic Republic of Congo

*** Current affiliation: Current affiliation: University of Laikipia, Nyahururu, Kenya

**** Current affiliation: Georg-August University of Göttingen, Göttingen, Germany

little rural-urban market linkages. Poor infrastructure and supply chain problems, compounded by weak contracting environments, make it more costly for farmers to access input and output markets as well as the benefits from technology adoption.

Yet, empirical studies to understand the market participation behaviour by small producers have concentrated on commodities with long¹ and well-developed supply chains and among producers accessing spatially differentiated markets. Such studies are based on the assumptions that market access is not uniform because households may face different transactions costs for market participation (Key *et al.*, 2000; Renkow *et al.*, 2004). In this paper we analyse the participation of farmers in cavy supply chains in the eastern region of the Democratic Republic of Congo (DRC).

Domestic cavy, also widely known as Guinea pig (*Cavia porcellus*) is considered one of the small livestock species with potential for commercialisation by smallholders or resource-poor farmers, due to its low requirements for capital, equipment, space and labour (Lammers *et al.*, 2009). Moreover, covies provide high quality white meat (Kouakou *et al.*, 2013) and can be a good source of income and manure (Lammers *et al.*, 2009; Yiva *et al.*, 2014). Like for most small livestock, the information on the importance of covies in the livelihoods of rural communities remains scanty. Covies do not specifically appear in national or regional livestock census, which further reduces the likelihood of their inclusion in research and development initiatives, creating a vicious circle of neglect (Maass *et al.*, 2014).

It is estimated that more than two million covies are kept in DRC, contributing significantly to nutrition security as well as income generation and empowerment of women and youth; the two Kivu (Nord and Sud) provinces of the DRC are said to be the largest cavy producing regions (Maass *et al.*, 2014). According to Cox (2012), aside from their comparatively low capital requirements, covies are relatively secure to keep in times of unrest as large livestock have been depleted through looting by armed groups in the Kivu provinces. In a survey in Sud-Kivu, Maass *et al.* (2012) found that about 50% of livestock keepers had covies, while Mètre (2011) even suggested eight out of ten rural households in Sud-Kivu have covies. Since the mid-1990s, covies have become an integral part of people's diets in the region (Maass *et al.*, 2014). Farmers in the

study region largely keep covies for food, while a few keep them as an important source of income. However, unlike markets for conventional livestock, cavy markets are highly informal and underdeveloped, and little is known about the characteristics of suppliers in the cavy market as well as the demand for covies in the region.

We use farm-level data collected from 250 cavy farmers from Sud-Kivu province of the DRC to assess determinants of household participation and the extent of participation in cavy supply chains. Literature on market participation models tends to describe marketing decisions as occurring in two steps: (1) whether to participate in the market and (2) what volume to be sold (Goetz, 1992; Key *et al.*, 2000; Bellemare *et al.*, 2006). We adopt the two-step framework and apply a double-hurdle market participation model proposed by Cragg (1971).

2 Theoretical and empirical framework

2.1 Theory of market participation

To explain market participation, we start with the standard economic choice problem of the agricultural household, making its production and consumption choices to maximize the utility of consumption, subject to some constraints (on available resources and technologies). We follow Key *et al.* (2000) to explore the role of transaction costs on cavy marketing. We adopt a static model that ignores a number of components of household decision making to reduce its complexity but also to more specifically capture the impact of transaction costs, liquidity, productivity and other wealth-related factors on the marketing of covies. Market participation is specified as a choice variable. That is, in addition to deciding how much of each of the good i to consume c_i , produce q_i and use as an input x_i , the households also decide how much of each good to 'market' m_i (where m is positive when it is a sale and negative when it is a purchase). In the absence of transaction costs, the households' problems could be to maximize the utility function (1) subject to equations (2) through (5):

$$u(c; z_u) \quad (1)$$

$$\sum_{i=0}^n p_i^m m_i + T \geq 0 \quad (2)$$

$$q_i - x_i + A_i - m_i - c_i = 0, i = 1, \dots, N \quad (3)$$

$$G(q, x; z_q) = 0 \quad (4)$$

$$c_i, q_i, x_i \geq 0 \quad (5)$$

¹ More in general, a food supply chain can be defined as "short" when it is characterized by short distance or few intermediaries between producers and consumers.

where p_i^m is the market price of good i , A_i is an endowment in good i , T is exogenous transfers and other incomes, z_u and z_q are exogenous shifters in utility and production, respectively, while G represents the production technology. The cash constraint (Eq. 2) states that expenditures on all purchases must not exceed revenues from all sales and transfers. The resource balance (Eq. 3) states that, for each of the N goods, the amount consumed, used as inputs and sold is equal to what is produced and bought plus the endowment of the good. The production technology (Eq. 4) relates inputs to outputs. The empirical analysis focuses on how different socioeconomic and geospatial characteristics affect the participation of households in cavy marketing.

Following Stephens *et al.* (2011), we also test the extent to which liquidity constraints may affect household participation in commodity markets. Liquidity-constrained households may be forced to sell their cavies in order to meet their current income needs based on the intuition that wealthy households may have a wide range of alternatives through which to participate in commodity markets. Other aspects explored by Stephens *et al.* (2011), which we do not investigate in this paper but that are equally important in explaining market participation behaviour include seasonality of commodity prices and how credit access can affect household's commodity market participation decisions.

2.2 Empirical estimation strategy

The theoretical model discussed above leads us to some testable hypotheses regarding household liquidity and other socio-economic factors on cavy marketing. We expect households facing liquidity constraints to have a higher likelihood using cavies as an entry into commodity markets. A complete understanding of market participation decisions would require that we also explore determinants of household level purchases of cavies but we lack data on household purchases, hence, the focus on cavy market supplies. We are interested in understanding factors affecting two types of decisions: cavy market entry and quantity of cavy sales. We thus follow Holloway *et al.* (2002) and Cragg (1971) to address the empirical problem above by applying the double-hurdle framework.

The underlying assumption in the double-hurdle approach is that individuals make two decisions with regard to their participation in the marketing of a commodity. The first decision is whether they will sell some amount of the commodity at all. The second decision is about the quantity of that will be sold conditional on the first decision. In this study the two decisions are,

therefore, whether to sell cavies and how many cavies to sell. The importance of treating the two decisions independently lies in the fact that factors that affect one's decision to sell may be different from those that affect the decision on how much to sell. The double-hurdle model allows for the possibility that these two decisions are affected by a different set of variables. The advantage with this approach is that it allows us to understand characteristics of a class of households that would never participate in cavy markets. Originally proposed by Cragg (1971), the double-hurdle model has been recently applied in a variety of areas.

The double-hurdle model assumes the decision to participate in a market and the intensity of participation are determined by two separate stochastic processes and, therefore, two equations. The first equation in the double-hurdle (Eq. 6) relates to the decision to participate in cavy markets, expressed as follows:

$$d_i^* = \alpha x_i + \varepsilon; \varepsilon \sim N(0, 1), \tag{6}$$

$$\text{where } d_i = \begin{cases} 1 & \text{if } d_i^* > 0 \\ 0 & \text{otherwise} \end{cases}, \tag{7}$$

while the decision on how many cavies to sell can be described as

$$y^* = \beta z_i + \mu_i; \mu \sim N(0, \sigma^2), \tag{8}$$

$$\text{where } y_i = \begin{cases} y^* & \text{if } y^* > 0 \text{ and } d_i = 1 \\ 0 & \text{otherwise} \end{cases}. \tag{9}$$

d_i is a discrete variable measuring whether or not a household sold some cavies, while d_i^* is the latent variable for d_i . y_i refers to the observed number of cavies marketed, while y^* is the latent variable for y_i . x_i and z_i are vectors of characteristics, allowed to overlap (household, market, regional) that influence market entry as well as the quantities of cavies to be marketed. β and α are vectors of parameters, while ε_i and μ_i are error terms. Given the expression in Eq. (9), the number of cavies sold is only observed when $d_i = 1$ and $y^* > 0$.

The model has an advantage over the standard univariate Tobit model in that it provides a more flexible framework to model the observed consumer's behaviour as a joint choice of two decisions.

2.3 Data collection

The data used in this analysis draws from a survey of cavy-keeping households conducted by the International Center for Tropical Agriculture (CIAT) in collaboration with Université Evangélique en Afrique (UEA), Bukavu and Institut National pour l'Etude et la Recherche Ag-

Table 1: Household characteristics of cavy farmers in eastern DR Congo (2011–2012).

Variable	Territoire			Overall mean (n=250)
	Kalehe (n=90)	Kabare (n=80)	Walungu (n=80)	
Family size	5.75 (2.6)	5.75 (2.6)	5.86 (2.5)	5.79 (2.7)
Age of household head (years)	39.2 (10.9)	46.3 (15.0)	44.2 (15.6)	43.1 (14.1)
Farming experience (years)	20.3 (10.7)	26.2 (16.3)	25.7 (15.2)	23.9 (14.4)
Cavy farming experience (years)	9.9 (8.6)	11.7 (10.3)	9.0 (8.3)	10.2 (9.1)
Main motivation for keeping cavies (%)				
Consumption	71.1	57.5	63.7	64.4
Cash income	22.2	20.0	18.8	20.4
Manure	1.1	15.0	10.0	8.4
Second motivation for keeping cavies (%)				
Cash income	30.0	18.7	40.0	29.6
Consumption	21.1	30.0	23.7	28.8
Manure	17.7	42.5	20.0	26.4
Others	11.1	6.25	12.5	10.0
Female-household (%)	33.3	46.3	47.5	42.0
Average land holding (ha)	2.16 (3.6)	1.46 (2.4)	1.84 (2.0)	1.83 (2.8)
Can read and write (%)	66.7	50.0	58.8	58.8
Amount of off-farm income (CDF/year)*	192,897 (973,361)	63,241 (110,402)	67,618 (152,930)	111,318 (594,717)
Distance to market (km)	3.1	3.7	2.5	3.1
Cavies reared throughout the year (no./year)	31.2 (18.3)	28.8 (17.2)	34.8 (27.2)	31.6 (21.3)
Other livestock kept (no.)				
Chicken	2.2	2.2	2.4	2.2
Goats	1.3	1.5	1.7	1.5
Pigs	0.2	0.1	0.9	0.4
Cattle	0.5	0.2	0.3	0.3

Standard deviation in brackets.

* During the time of the survey in 2012, 1 USD was equivalent to about 900 Congolese Francs (CDF).

ronomiques (INERA). The data were collected from three *territoires* Kabare (81 households), Kalehe (90) and Walungu (79) by 10 trained enumerators between 26 June and 9 July 2012 in Sud-Kivu province in eastern DRC. These *territoires* and the 13 sampled villages were chosen after reconnaissance surveys and key informant interviews to represent different production systems and agro-ecologies, and if they were known to have high cavy concentrations. The survey data contains various aspects of cavy production, breeding, feeding, husbandry practices, marketing and consumption.

3 Results

3.1 Household characteristics

Summary statistics for selected key household characteristics appear in Table 1. Sampled households were relatively large, averaging 6 persons per household. The average age of heads of households was 43 years with an average land holding size of 1.8 ha; about 42 % of them

were from female-headed households. Cavy farming is not new in the area as the surveyed farmers have been keeping cavies for at least a decade. Farmers reared an average of 32 cavies per household in a year. The majority of farmers (64 %) reported the first reason for rearing cavies as consumption. About 20 % and 8 %, reported cash income and manure as the first reasons for rearing cavies, respectively. The findings underscore the significance of cavy farming as a food security commodity. Aside from rearing cavies, they also reared other livestock such as chicken, goats, pigs and cattle. There was significant variation in household off-farm incomes and in the ease of access to output markets across territories.

The distribution of cavies reared by land holding size category (Table 2) reveals that the farmers in the smaller land holding size category (0–0.5 ha) kept relatively less cavies (about 30) than farmers with larger land holdings (more than 2 hectares) who had an average of 35 to >41 cavies, a finding suggesting that smaller land holdings did not necessarily drive farmers into cavy intensification.

Table 2: Scale of cavy production (% of cavy farmers) by landholding size in eastern DR Congo (2011–2012).

Number of cavies held (July 2011–July 2012)	Landholding size category					Overall mean (n=250)
	0–0.5 ha (n=72)	0.51–1 ha (n=52)	1.1–2 ha (n=78)	2.1–5 ha (n=32)	>5 ha (n=16)	
Average no. of cavies	29.7	29.3	31.4	34.5	40.5	31.6
Proportion of household by cavy and land holding categories (%)						
1–10 cavies	38.9	34.6	29.5	15.6	31.3	31.6
11–15 cavies	26.4	32.7	24.4	25.0	25.0	26.8
16–20 cavies	20.8	9.6	21.8	25.0	18.8	19.2
21–25 cavies	5.6	15.4	12.8	18.8	18.8	12.4
>25 cavies	8.3	7.7	11.5	15.6	6.3	10.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Table 3: Characteristics of cavy keepers according to their market positions.

Variable	Autarky (n=107)	Sellers only (n=64)	Buyers only (n=52)	Buyer and seller (n=27)	Overall mean (n=250)
Family size (no. of HH members)	5.7	6.2	5.2	6.2	5.7
Age of household head (years)	42.8	46.4	40.1	42.2	43.1
Male-hh (%)	57.8	61.6	58.6	50.0	58.0
Farming experience of HH head (years)	23.8	25.9	21.3	24.4	23.8
Average land holding (ha)	1.67	2.30	1.60	1.70	1.83
Cavies reared throughout the year (no./year)	29.2	41.6	24.3	32.3	31.5
Cavy farming experience (years)	9.5	10.8	9.2	13.3	10.2
Cavies at the time of survey (no.)	16.2	17.8	13.0	13.7	15.6
Cavies sold (no.)*	0	11.7	0	6.6	10.7
Proportion of cavies sold (%)	n.a.	26	n.a.	22	25
Selling price of cavies (CDF)†	n.a.	1323	n.a.	1559	n.a.
Amount of off-farm income (CDF)	176,338 (896,148)	67,184 (132,590)	69,034 (134,674)	39,693 (62,310)	111,318 (594,717)
Distance to the market (km)	2.9	3.4	2.9	3.7	3.1
Cavies consumed (no. per year)	13.1	12.2	11.3	12.0	12.4

n.a.: not available; Standard deviation in brackets

* These figures are highly likely an underestimation considering the long recall period, and they do not include cavies that died due to diseases or other causes. † During the time of the survey in 2012, 1 USD was equivalent to about 900 Congolese Francs (CDF).

3.2 Marketing participation

3.2.1 Market positions and characteristics of cavy producers

There are four categories of market positions of cavy producers (Table 3); the cavy buyers only that buy for both consumption and breeding, cavy sellers only, those that buy and sell, and the autarkic household (those that did not sell or buy). Subsistence production is common with 44 % of the cavy farmers being autarkic implying that they did not buy or sell any cavies in the year 2011–2012. A quarter of them participated as sellers only, while 20 % participated as buyers only. The category involving cavy producers that participated in the market as both buyers and sellers comprised of 11 % of the

farmers. Our interest in this paper is on a category of farmers that had some marketed surplus; thus, a combination of those that only sold plus those that sold and purchased. The two groups accounted for about 35 % of the total farmers.

Characteristics of cavy producers by the category of their market positions are presented in Table 3. Sellers of cavies tended to have older heads of households (46 years) than those in autarky (43 years) and buyers only (40 years). Sellers only also tended to have more years of experience in farming (26 years) than buyers only (21 years). The sellers only also had larger land holdings (2.3 ha) than the rest of the categories whose land holdings were less than 2 hectares. Cavy sellers had larger flocks of cavies (42) than those in autarky (29),

buyers only (24) and those that bought and sold (32). Cavy buyers only had fewer (1.7) chicken than all the other categories. Autarkic households had substantially higher off-farm incomes than the rest of the household categories. Those that participated in both selling and buying tended to be a bit further away from the markets (3.7 km) than the remainder.

3.2.2 Scale of cavy marketing

About a third (35 %) of households reported selling cavies (Table 4) for several reasons. Distress selling to cover emergency expenditures was reported by 29 % of the cavy sellers. Moreover, payment of school fees ranked highly, as major reason for selling cavies and was reported by 36 % of the cavy farmers, while 26 % sold cavies to cover planned expenditures. There was considerable variation in cavy marketing across the territories. The highest proportion of cavy producers that participated in cavy markets as sellers were from Kabare (40 %), followed by Kalehe (36 %) and Walungu (30 %). Cavy producers stated to sell about 25 % of their annual production. There was no variation in the proportions of cavies sold across the *territoires*. They sold an average of 10 cavies per household and at an average price of 1400 CDF per cavy (min. 900 CDF, max. 2000 CDF), which is equivalent to 1.6 USD per cavy. About 47 % of cavy-selling households reported that marketing decisions were made by female members of the household, while 24 % were made by men, and 21 % jointly by women and men.

From the foregoing, the cavy supply chain is quite short with most of the sales involving the interaction of producers and final consumers/buyers. The short supply chain has several advantages to both buyers and sellers, as it helps in establishing and strengthening closer ties between producers and consumers. Moreover, it is also expected to facilitate fair pricing and value addition for the cavies being sold in a way that addresses consumer preference. Consistent with the preceding explanation, farmers expressed great preference for individual consumers for a number of preferred traits (Table 5).

Over 75 % of the sellers highly ranked individual consumers for the good price they offered, while 63 % of them also expressed preference for individual customers for their timely delivery of payment.

3.3 Econometric results on determinants of cavy marketing

The econometric analysis was used to assess the factors that influence participation in cavy marketing. The factors tested included, transaction costs, household

wealth and liquidity as well as other household socio-economic characteristics. The existence of transaction costs raises effective prices for buyers, while lowering effective prices for sellers, creating a price band within which some households find it unprofitable to either sell or buy. For lack of data on the actual proportional transaction costs (e.g. transport costs), we use distance from the homestead to output markets as a proxy for the proportional transaction costs while the ownership of transport facilities such as bicycle and information tools such as radio and mobile phone, were used as proxies of the magnitude of fixed costs. We expect households that own bicycles and radio to have a higher likelihood to participate in marketing, although being fixed costs; they should not affect the quantity traded, while we expect households close to the markets to face lower transaction costs and to sell larger numbers of cavies than those far from the market.

Regarding variables reflecting household liquidity and wealth such as the amount of household off-farm income, ownership of other livestock, we expect that household liquidity constraints will increase the propensity of cavy sales and the quantity of sales. This would imply a lesser likelihood of participation in cavy selling for households with access to liquidity through alternative income sources and wealth. This follows an expansive literature on market participation in developing countries (de Janvry *et al.*, 1991; Goetz, 1992; Key *et al.*, 2000) showing that, if people have no other means of addressing liquidity constraints, they might find it optimal to convert non-cash wealth in the form of grains or livestock products into cash by selling them. Thus, cavies should be seen as an emerging farm commodity in eastern DRC whose importance in the household economy is likely to increase as better markets develop and are accessed by producers. Other variables tested for their effect on market participation, but without any theoretically justifiable *a priori* expectations in terms of their impact on market participation included; age of the household-head, household size, gender of the farmer, education levels as well as variables that have a bearing on cavy demand such as land size and years of experience in farming.

Estimates of the market entry (decision to participate) and quantity (intensity of participation) equations, respectively, are displayed in Table 6. The coefficient for bicycle ownership was insignificant in the market entry equation but was negative and significant in the quantity equation suggesting that bicycle ownership did not influence the decision to sell cavies, but that bicycle owners significantly sold fewer cavies whenever they decided to sell some.

Table 4: Scale of cavy marketing by region ('Territoire') in eastern DR Congo.

Variable	Territoire			Overall mean (n=250)
	Kalehe (n=90)	Kabare (n=80)	Walungu (n=80)	
Proportion of cavy-farmers selling cavies (%)	35.5	40	30	35.2
Proportion of households selling cavies through different channels (%)				
Individual customers	71.4	80.0	75.0	75.6
Relatives	39.3	70.0	50.0	53.5
Cavy traders	14.3	10.0	32.1	18.6
Others	25.0	3.3	7.1	11.6
Butcher/slaughter	10.7	10.0	10.7	10.5
Cavies sold last year (average no.)	9.5	9.5	11.6	10.1
Proportion of cavies sold (%)	24	24	28	25
Average price received per cavy (CDF)*	1488	1492	1137	1397
Place of the market relative to the household				
Within village	92.6	96.9	96.4	95.4
Within <i>territoire</i>	7.4	3.1	3.6	4.6
Who decides on market participation (%)				
Women	42.9	52.9	44.8	47.3
Men	21.4	26.5	24.1	24.2
Jointly made	35.7	11.8	17.2	20.9
Children	0	5.9	13.8	6.6
Non-household members	0	2.9	0	1.1
Major motivation for selling cavies (%)				
Paying school fees	37.5	29.0	44.0	36.3
Cover emergency household expenses	20.8	38.7	24.0	28.8
Cover planned household expenses	37.5	19.4	24.0	26.3
Unwanted behaviour	0	3.2	4.0	2.5
Culling due to disease	0	0	4.0	1.3
Culling due to performance	0	3.2	0	1.3
Reduce stock size	0	3.2	0	1.3
Other	4.2	3.3	0	2.2
Cavies consumed last year (no.)	12.4	10.4	14.3	12.4

* During the time of the survey in 2012, 1 USD was equivalent to about 900 Congolese Francs (CDF).

Table 5: Ranking by preferred traits of individual cavy consumers/buyers in eastern DR Congo (% of cavy farmers).

Proportion (%) of cavy farmers ranking buyers by preferred buyer traits (n=250)	Individual buyer characteristic					
	Best prices	Buys large quantities	Reliability (buys throughout)	Timely payment	Road accessibility	Easy transport access
Most preferred	59.0	10.0	13.3	23.3	12.5	11.3
Preferred	26.2	33.3	31.7	40.0	28.6	15.1
Neutral	4.9	21.7	21.7	20.0	33.9	34.0
Not preferred	4.9	11.7	25.0	8.3	17.9	22.6
Never preferred	4.9	23.3	8.3	8.3	7.1	17.0

Table 6: Double hurdle estimates of determinants of participation in cavy supply chains in eastern DR Congo.

Variables	Market entry equation		Quantity sold equation	
	Coefficient	SE	Coefficient	SE
Latent Demand				
Age of household head (years)	1.221**	0.558	0.198	0.165
Gender of household head (1=M, 0=F)	-0.259	0.354	0.121	0.098
Household size (no.)	0.411	0.290	-0.273***	0.072
Can read and write (1=yes, 0=otherwise)	0.224	0.366	0.106	0.098
Latent supply				
Cavies produced annually (no./year)	1.156***	0.291	1.238***	0.081
Cavy farming experience (years)	0.106	0.152	0.025	0.047
Land holding size (ha)	0.024	0.121	0.030	0.036
Wealth related variables				
Chicken (no.)	-0.022	0.039	-0.030***	0.010
Goats (no.)	-0.071	0.076	0.009	0.020
Pigs (no.)	0.115	0.155	-0.132*	0.069
Cows (no.)	0.083	0.060	-0.025	0.016
Liquidity measures				
Amount of off-farm income (CDF) [†]	-0.025	0.018	-0.004	0.004
Hiring farm labour (1=yes, 0=otherwise)	-0.313	0.341	-0.213**	0.086
Transaction cost variables				
Distance to the nearest market (proportional)	-0.059	0.059	-0.018	0.014
Ownership of radio (1=yes, 0=otherwise) (fixed)	0.089	0.343	0.100	0.095
Ownership of bicycle (1=yes, 0=otherwise) (fixed)	0.037	0.671	-0.519***	0.173
Ownership of mobile (1=yes, 0=otherwise) (fixed)	0.114	0.159	0.043	0.041
Others				
<i>Ex-ante</i> decision not sell cavies (1=yes, 0=others)	-0.739**	0.322	-0.184**	0.087
Protestant (1=yes, 0=otherwise)	-0.036	0.659	0.423**	0.184
Catholic (1=yes, 0=otherwise)	-0.156	0.632	0.368*	0.191
Teritoire level fixed effects				
Kabare (1=yes, 0=otherwise)	0.792*	0.412	-0.158	0.108
Kalehe (1=yes, 0=otherwise)	0.827*	0.430	-0.075	0.129
Constant	-9.363***	2.570	-3.093***	0.774
Observations	250		250	
<i>P</i>	0.0434		0.0434	
χ^2	34.53		34.53	
Ll	-408.5		-408.5	

***, **, *: Significance at 1 %, 5 %, and 10 % level.
[†] During the time of the survey in 2012, 1 USD was equivalent to about 900 Congolese Francs (CDF).

The point estimates for other proxies of transactions costs (distance to the market, ownership of radio and mobile phones) were neither significant in the market entry decisions nor in the quantity sold.

The coefficient estimates for variable capturing liquidity constraints (amount of off-farm income) had an expected negative coefficient, but it was not significant

in explaining neither market participation nor the intensity of participation. However, households with capacities to hire agricultural labourers tended to sell fewer cavies. The ownership of livestock is an indicator of the household's wealth status (Maass *et al.*, 2013) as well as a measure of the household's flexibility to enter the commodity market. Households with a diversified livestock

portfolio may enter commodity markets using livestock other than cavies, hence, reducing the likelihood as well as quantities of cavies to sell. Results indicate that the ownership of chicken and pigs did not affect cavy market entry, but conditional on cavy market entry, household owning chicken and pigs tended to sell fewer cavies than those with fewer or no chicken and pigs.

The entry coefficient for the number of cavies kept has a significant expected positive sign in both the participation as well as the quantity equation, suggesting that households with more cavies are more likely to sell some, as well as transact in larger quantities of cavies.

Larger family size did not influence the decision to participate in cavy marketing, but once households decided to participate in markets, those with larger family sizes sold significantly fewer cavies than those with smaller family size.

Moreover, we found that *ex-ante* motivations of keeping cavies tended to influence the way cavies were utilised by the producers. Cavy farmers who indicated that their motivation to keep cavies was just for food were less likely to sell cavies and that, even when they decided to sell some cavies, they did so on a smaller scale than those whose principle motivation for keeping cavies was to sell. Older farmers with more years of farming experience tended to have a large propensity to enter cavy markets, but their age did not influence the quantities of cavies they sold. Interestingly, both Protestant and Catholic religious affiliation had a positive effect on market intensity, but not on market entry as opposed to other religions (i.e., Moslem, traditional African religion, Seventh day Adventists and Jehova Witnesses).

The fixed effects location variables are significant in explaining the variability in market participation. Results reveal that households in Kabare and Kalehe *territoires* were more likely to participate in cavy marketing compared to Walungu (reference *territoire*). The location dummy variables did not seem to influence the intensity of market participation as the coefficients were insignificant. These location dummy variables are probably capturing systematic differences in transaction costs and/or unobserved household characteristics, reflecting geographic concentration of market participants in *territoires* with better marketing infrastructure despite longer distance. The lack of differentiation might also be caused by high intra-*territoire* variability of infrastructure and market access. Point estimates for a few of the other variables were not significant. Such variables include literacy levels, land holding size and the gender of the head of household.

4 Discussion

The results show that cavy farmers are confronted by a limited and small size market, with most producers having direct contacts with the final consumers and selling within their villages. The combination of a limited market with the poor road infrastructure in the study area (Ulimwengu *et al.*, 2009), discourages traders from reaching some of the remote villages where cavies are produced. This in turn impacts negatively on the prices that farmers receive. To reduce the risk of market failure, a multi-stakeholder approach has been employed by the project in applying an integrated agricultural research for development (IAR4D) approach comparable to that by Chiuri *et al.* (2013), setting up of Innovation Platforms to encourage investments in marketing and infrastructure around the cavy producing region as to enhance access to markets, especially for women.

Currently cavies are sold as live animals without any value addition. There will be need to train producers and traders in making potential value-added products that can be created from cavies such as smoked cavies, making dumplings, minced meat, or mixing cavy meat with other meats that are all currently under investigation in Cameroon (F. Meutchieye, pers.comm.) and whose market acceptability is tested, for example, in southern Colombia (Argote *et al.*, 2009). A problem of acceptability of cavy meat by some consumers in some restaurants calls for concerted efforts to sensitize communities about the nutritional advantage of cavy and the delicacy of its meat.

Overall the findings from the econometric analysis show that some factors affecting the decision to participate in cavy marketing are different from those determining the intensity or extent of participation in cavy marketing. The significant negative effect of the ownership of bicycle on the intensity of market participation is inconsistent with *a priori* expectation that, if farmers owned bicycles and if they used them for transportations, they would pay less for transport and then sell more cavies. Hence the apparent negative effect could be suggestive of the fact that the ownership of a bicycle is rather an indicator of wealth; to the extent that wealthier households reared cavies for consumption and not for sale.

The lack of significance of distance to market, ownership of radio and mobile is consistent with expectation in that the short cavy supply chains with no or few intermediaries (middle men) have lower transaction costs as well as increase the share of value added that goes to the farmer. In this study, nearly all cavy sales were done within the village and around homesteads or road sides

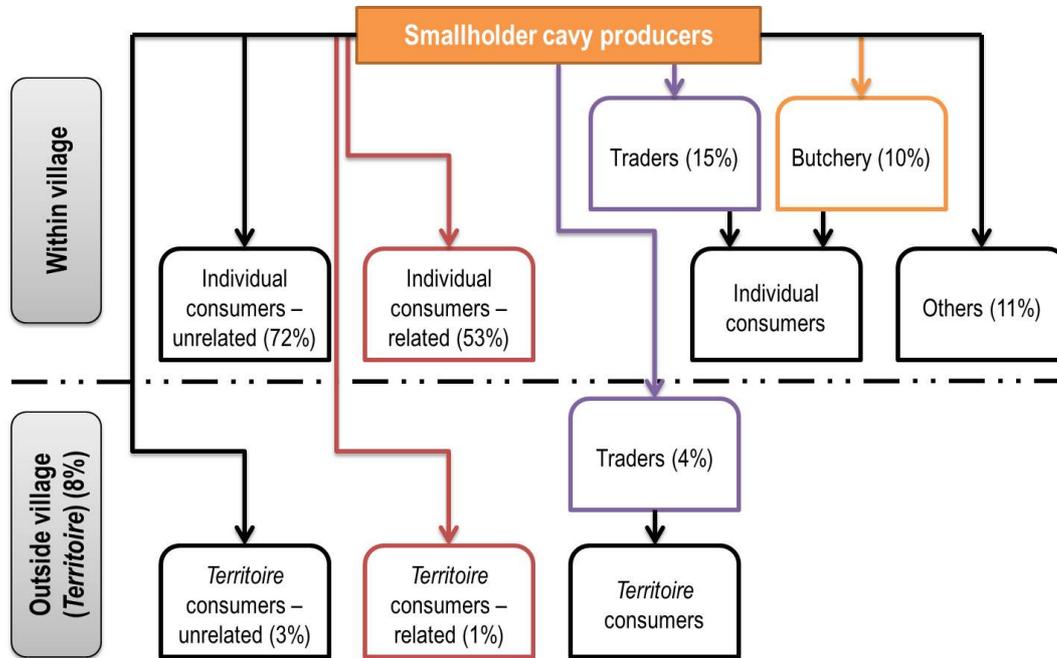
where transaction costs were low. The fact that most transactions were between relatives or people that knew each other also reduced information and search costs, hence, reducing transaction costs. Moreover, this finding is also consistent with those by Renkow *et al.* (2004) who found little relationship between the distance to the market and other related transaction costs for villagers in Kenya without access to motorized transport. The positive and significant coefficient of household with the capacity to hire labour makes intuitive sense if such households have enough liquidity from other sources to the extent that they do not have to rely on cavies to enter commodity markets. The positive effect of the ownership of pigs and chicken on cavy marketing is consistent with expectation especially if chicken and pig markets are more lucrative than cavy markets, such that chicken and pork income substitute income from cavy sales. Moreover, these farmers may already have climbed up some steps on the “livestock ladder” (Maass *et al.*, 2013) and, thus, they kept cavies as a “normal” livestock commodity that serves home consumption, while chicken and pig sales reflect a higher business orientation. The negative effect of family size on cavy marketing seems to suggest that larger families consume more of what is produced and have less for the market, a finding that is consistent with those reported by Benfica *et al.* (2006) for tobacco contract farmers in Mozambique and Key *et al.* (2000) for maize farmers in Mexico. The positive effect of the age of the farmer on market entry is plausible and might be explained by the fact that older and more experienced farmers have greater contacts, which might enhance mutual trust and allow trading opportunities to be undertaken at lower costs.

5 Conclusions

This paper investigates the determinants of smallholder cavy farmers’ participation in cavy marketing. Our analysis shows that about a third of households participated in cavy selling. Households facing liquidity constraints tended to sell more cavies. Although

older farmers and those with larger numbers of cavies were more likely to participate in cavy marketing, it was smaller households and those with less chicken and pigs that tended to sell more cavies, as they were probably still at the lower end of the “livestock ladder” (Maass *et al.*, 2013) and, consequently, they were still more dependent on micro livestock to generate income. Moreover, we found that *ex-ante* motivations of keeping cavies tended to influence the way cavies were utilised. Cavy farmers who indicated that they decided to keep cavies just for food were less likely to sell them and that, even when they decided to sell some cavies, they did so on a smaller scale than those whose principle motivation for keeping cavies was to sell. The findings suggest that there is potential for scaling out participation in cavy supply chains if cavy productivity is improved as this will impact strongly on how and in what way the cavy supply chain evolves. Nevertheless, there are costs involved in improving cavy husbandry for increased production, which has to be seen in relation to their contribution to the overall household income. On the other hand, common sales and purchases through the Innovation Platforms implemented within the integrated agricultural research for development (IAR4D) approach of the project (Chiuri *et al.*, 2013) has already helped to take advantage of economies of scale, resulting in sales increases in all three research locations. Improved road infrastructure would immediately provide cavy farmers with better access to markets, a necessary pull for the supply chain to meet the potential high demand in an environment that is currently facing agricultural growth. In general and for sustainability and increased welfare gain, it is also important to sensitize households about the nutritional value, delicacy of the meat and the convenience in raising cavies as they require less capital to raise relative to larger livestock. The promotion of appropriate husbandry practices that enhance cavy productivity and production should be encouraged as they can go a long way in enabling farmers participate in markets as sellers.

Appendix: The cavy supply chain in Sud-Kivu Province, eastern DR Congo.



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