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RTG 1666 GlobalFood

Transformation of Global Agri-Food Systems:
Trends, Driving Forces, and Implications for Developing Countries

Georg-August-University of Göttingen

GlobalFood Discussion Papers

No. 50

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October 2014

RTG 1666 GlobalFood · Heinrich Düker Weg 12 · 37073 Göttingen · Germany
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Supplier dynamics in horticultural export chains - evidence from Ecuador

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ABSTRACT

In this paper we study the dynamics of smallholder participation in export value chains focusing on the example of small-scale broccoli producers in the highlands of Ecuador. A double hurdle model and a multi-spell cox duration model are used to explain the extent of participation and the hazards of dropping out of the export chain. The empirical results suggest that small farmers´ withdrawal from the export sector is in fact accelerated by hold-ups experienced in the past and that family ties play an important role in farmers' marketing decisions. Negative external shocks – such as the bankruptcy of the main buyer in our case study – represent a major threat towards the sustainability of smallholder farmer inclusion in high-value chains, because farmer organizations often possess low resilience towards such events.

Keywords: Horticultural export chains, small farmers, duration model, double hurdle model, transaction risks

JEL classification: D23, D81, Q12

Acknowledgement: The financial support of the German Research Foundation (DFG) is gratefully acknowledged.

1. Introduction

During the past three decades the agri-food industry has undergone rapid structural changes. In response to the growing demand for innocuous and high quality food, procurement systems have been modernized, including the implementation of private standards and a shift from spot market transactions to vertical coordination (Reardon et al. 2009). These structural supply and demand side changes have opened up remunerative opportunities for small-scale farmers in developing countries. Farmers´ inclusion in global markets as food suppliers is perceived as a way to increase farm incomes and thus to foster rural development (Braun, Hotchkiss, and Immink 1989; Kydd et al. 2004; R. Hernández, Reardon, and Berdegué 2007; Maertens and Swinnen 2009)Maertens and Swinnen 2009). Based on the argument that participation in high value markets can provide an avenue out of poverty, promoting and linking small farmers to these markets has become a main focus of donors and NGOs in recent years (Altenburg 2006).

While the export of fresh products from developing to high-income countries has increased over the past decades, smallholders often face serious limitations in their access to international high value markets due to stringent public and private safety and quality regulations set by importing countries (Dolan and Humphrey 2000; Henson, Masakure, and Boselie 2005; Schuster and Maertens 2013). Besides limited access to information and technology, small farmers often face missing credit, insurance, and factor markets hindering their compliance with new market demands (Key and Runsten 1999). Nevertheless, these market failures[1] can be overcome through contract farming, which has evolved as an institutional innovation that can help farmers adjust to the current market requirements (Kersting and Wollni 2012). Through contract farming, firms purchase the harvest of independent producers acquiring certain control over the production process and producers gain access to modern global markets (Miyata, Minot, and Hu 2009).

An extensive set of literature deals with the inclusion or exclusion of small-scale farmers in contract farming schemes and in modern food markets. In accordance with economic theory, firms prefer to source from larger and better-endowed farms to reduce transaction costs. But for labor-intensive products small-scale producers are attractive due to their access to cheap family labor[2] and their greater willingness to follow the firm´s advice. Berdegué et al. (2005); Carter and Mesbah (1993); Dolan and Humphrey (2000); Reardon, Henson, and Berdegué (2007); Schuster and Maertens (2013); and Rao and Qaim (2011) show evidence for the exclusion of small-scale farmers from high-value markets and reveal that export companies or local supermarkets source only a small percentage of their produce from smallholders. On the other hand, Bellemare (2010); Henson, Masakure, and Boselie (2005); Maertens and Swinnen (2009); Minten, Randrianarison, and Swinnen (2009); Reardon et al. (2009); and Schipmann and Qaim (2010) describe successful cases of inclusion that rely on institutional innovations, where positive welfare effects could be achieved. According to Barrett et al. (2012), farmers who overcome existing constraints and supply modern value chains typically improve their productivity and profitability. Nevertheless, Chemnitz (2007) points out the dangers and high dependency that joining high value chains can bring in the long run to small-scale producers. Small farmers´ participation in contract farming can, for example, increase tensions within the household or community and lock producers in an unbalanced relationship, where they have low bargaining power vis-à-vis their buyer (Key and Runsten 1999; Swinnen and Maertens 2007).

Another set of literature deals with the dynamics of innovation adoption in the agricultural sector. Most of these studies describe the adoption/disadoption of agricultural practices and technologies (Feder, Just, and Zilberman 1985; Läpple 2010; Neill and Lee 2001; Moser and Barrett 2006), and a

[1] For a detailed discussion of market imperfections faced by small-scale farmers refer to Key and Runsten, 1999
[2] No monitoring is needed when family labor is used, therefore reducing costs.

few more recent studies use duration models to explain the timing of adoption and disadoption of non-traditional crops and related technologies (Carletto et al. 2010, Schipmann and Qaim 2010, Wollni et al. 2013). In these studies, time affects the decision and diffusion of non-traditional crop adoption negatively, meaning that the products become unpopular with time and non-adopters are less likely to adopt at a later point in time. When analyzing the disadoption of non-traditional crops, Carletto et al. (2010) find that a higher land quality, the ownership of agricultural assets and higher prices for non-traditional products extend the length of the production spell, while non-agricultural assets are linked to a faster disadoption of the crop. Even when governmental and non-governmental organizations facilitate participation in high-value chains, market forces may prevent small-scale farmers from taking full advantage of or benefiting from these opportunities (Carletto et al. 2010). Access to international high-value markets can only contribute to poverty reduction, if the gains indeed reach poor producers. This hinges for example on the type of contractual arrangement used to link farmers to high-value chains and whether these arrangements are honored in practice. Actors will engage in and honor a contract as long as the perceived benefits derived from the arrangement are greater than the perceived costs, but the parties involved in the contract can suddenly demand a contract renegotiation or shirk when there is a better, more profitable option in the market. In the long run, problems may arise in marketing relationships, which, if not solved properly by efficient public and/or private mechanisms, may lead to the break-down of the agreement (Guo and Jolly 2008). Farmers, for example, may fail to deliver the agreed volumes and quality on time because there is a better price in the spot market, or the firm may choose to reject the product without a valid cause, lower the price ex post, or default on the payment (Cungu et al. 2008; Klein 1996; Barrett et al. 2012).

Some of the existing market arrangements involving small-scale farmers have been reported to lack sustainability over time. Barrett et al. (2012) mention that contract farming schemes regularly lose participants or collapse completely indicating some failures of the system. Hamilton and Fischer (2003) point out that small-scale vegetable production for the export sector has been replaced by large-scale plantations, indicating a decline of the participation of small-scale farmers, at least in some areas. Similarly, Berdegué (2001) mentions the bankruptcy of farmers´ cooperatives in Chile and Carletto et al. (2010) describe the diversification and retirement of Guatemalan snow pea producers from the export sector. Given these examples, promoting linkages to high-value markets as a strategy for poverty alleviation should be handled with care until further studies show new paths to ensure its long-term effectiveness. To date, there is little research on the sustainability of smallholder participation in high-value markets (Barrett et al. 2012). Studies so far have focused on the adoption of high-value crops or on the participation in contract farming schemes, but the dynamics of participation in high-value chains has not been analyzed in detail. To the best of our knowledge, Carletto et al. (2010) is the only study explaining the withdrawal of farmers from nontraditional crop production and Cungu et al. (2008) explain the effects of payment delay on investment decisions in a similar context. The difficulty of obtaining consistent data for several years, especially concerning detailed information on delivered quantities and transaction risks, has been a holdback to this matter. Cross-sectional or recall data are usually not precise enough so as to reveal the timing of withdrawal from a high-value marketing channel, the relative importance of transaction risks, or the effect of learning from past contract performance on present contract status (Barrett et al. 2012; Gow and Swinnen 1998). Our data, which covers 11 years from 2002 to 2012, shows that a large percentage of small-scale farmers do not participate continuously in the high-value marketing channel, even when there is a previous verbal agreement, but instead decide to abandon it temporally or completely and return to the local market.

The aim of this research is to analyze the factors influencing smallholder decisions to allocate their non-traditional crop production to a specific marketing channel and to drop out partially or entirely

from an export chain. Special attention is placed on the effects that transaction risks (payment delay and product rejection) and social networks have on these decisions. This paper takes into account the period a farmer is an active supplier of the export chain and analyzes how her specific characteristics and past experiences influence the extent of participation measured as quantity delivered. For this we propose to apply a double hurdle model and a discrete failure time model to a unique panel data set containing detailed information on the deliveries of Ecuadorian broccoli producers supplying the export market through a farmers´ organization.

The article is organized as follows. The next section gives background information on the broccoli sector in Ecuador. The third section discusses the theoretical foundations and the conceptual framework for the empirical analysis. Section four provides information on data collection and develops the econometric models. Finally, section 5 presents the results and section 6 concludes.

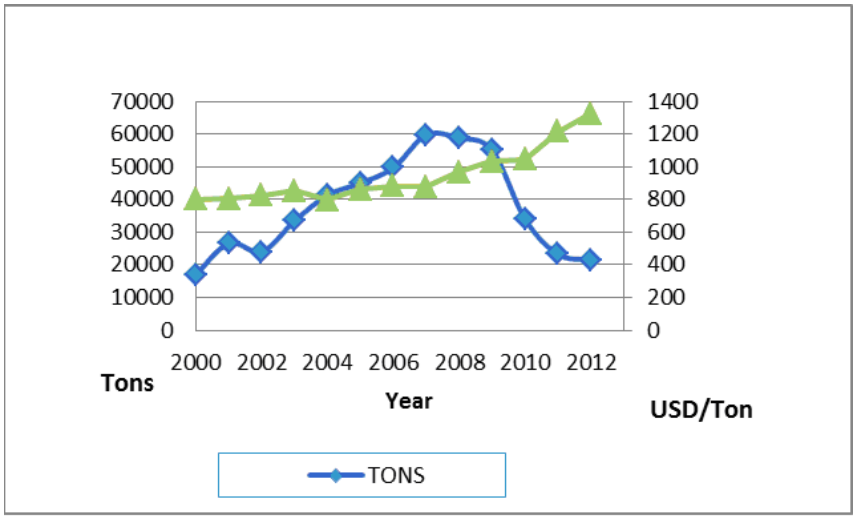
2. The broccoli market in Ecuador

The history of broccoli cultivation in Ecuador dates back to the 90's, when a private investor introduced the crop to the highlands to produce high-quality broccoli for the export market. The geographical location allows for year-round production and the climate and altitude reduce pest pressure and produce broccoli of a particular color and compactness, which is appreciated in international markets. Additionally, the availability of rural labor allows for processes such as hand-cut chopping to take place at affordable costs, which adds value to the vegetable in the international market (Hernández et al. 2010). In 2003, the broccoli sector employed around 11,500 workers and provided a source of income to approximately 4000 families (Gall 2009). While three decades ago the vegetable was hardly known at all in the country and local consumption was very low, nowadays it is popular among local consumers.

From the 90's onwards, a period of diffusion started until broccoli became the second most important non-traditional export product. In 2008, Ecuador became the 6th largest exporting country of broccoli and cauliflower (5th in value exported) with around 60 thousand tons sent to North American and European markets representing around 57 million dollars (FAOSTAT, 2013). However, in the following years exports started to decrease, and by 2010 Ecuador was relegated to the 11th place (34 thousand tons and 35.5 million dollars). Figure 1 presents prices and quantities of broccoli and cauliflower[3] exported since 1992, showing a constant and significant increase in quantity until 2009 and after that a constant drop until present times (National Central Bank, 2013)[4].

[3] Figures for broccoli alone are not available.
[4] The price/ton depicted in the graph was obtained from national statistics dividing total broccoli and cauliflower exported per year by total income received. Therefore, it is the average of the price obtained in the international market, which increased over the years, but it does not necessarily represent the price paid by exporting firms to local producers.

Fig. 1: Prices and quantities exported by Ecuador during the past decade. (Source: National Central Bank, 2013)



Initially, broccoli was only cultivated on large plantations and exported by a few processors, but since the year 2001 small-scale farmers from the Chimborazo province[5] were linked to the export market. A few years later small-scale farmers represented 93% of the suppliers, but their land area added up to only one-third of the total broccoli area planted for the international market. The remaining two-thirds were cultivated by medium and large-scale farmers as well as by the same exporting firms in vertically integrated production units[6].

The inclusion of smallholders started in the year 2000, when a local NGO helped a group of 108 indigenous farmers to organize as an association and provided them with training in broccoli production, business development and management capacities[7]. After one year, the members adopted broccoli as a cash crop for the export market and installed a collection center in the village in order to gather the product and send it to a private processing-exporting firm (from here on referred to as exporter). This firm cut the broccoli into small pieces, froze it and exported it to international markets. The first eight months only members of the association supplied the export sector through the collection center. Over the following years, the number of members of the association remained constant and no new members were admitted. However, hundreds of producers from neighboring villages joined the project as suppliers and growing broccoli came to be a profitable business for small-scale farmers in the region[8].

The exporter contracted with the smallholders using the model firm-intermediary-smallholder, where the farmers´ group acted as the intermediary. A written contract was signed between the exporter and the farmers´ group where the volume, a fixed price, quality and payment conditions were specified, and verbal agreements were used between the association and the smallholders. A typical production

[5] The province of Chimborazo was chosen as the location to promote small-scale broccoli production for three reasons: the good quality of the land for agriculture and the availability of water made it suitable for the production of high quality vegetables, the area was densely populated with vegetable farmers and there was high availability of experienced labor, and the community where the farmers group and the collection center were established, already had a high degree of social organization.

[6] Large and medium scale plantations are located in the province of Cotopaxi and were not included in our analysis.

[7] The farmers´ group has received support from four different organizations (NGO´s working with international funds and governmental organizations) at different points in time.

[8] For more insights on the advantages of working with smallholders in this specific case refer to (Gall 2009)

contract system was put into operation with the exporter providing the plants through the collecting center and facilitating access to inputs, credit, market and technical information. The farmers on the other hand were in charge of growing broccoli on their land under the firm's technical direction and had to deliver the product to the collection center in order to pay for the services received.

Once the product is ready for harvest it undergoes the following chain: i) prior to the harvest, the farmer has to determine where to sell his product according to its quality, which is assessed by a collection center´s worker, ii) the broccoli going to the export sector is delivered to the collection center, where it undergoes a first grading process in the presence of the farmer, iii) the broccoli meeting the quality criteria at the collection center is further sent to the exporter, where a second grading process takes place, this time in the absence of the farmer[9]. Until 2010, the broccoli from different farmers was sent to the exporter in separate bins. As the overall quantity delivered by smallholders has decreased, the broccoli from different producers is nowadays mixed in the same container and sent to the firm. Therefore, since 2010 the quantity rejected by the exporter is divided equally among the farmers who sent their product with that specific shipment. Finally, iv) the product meeting the exporting firm´s quality requirements is accepted and the payment is made two weeks later according to the terms of the contract. Due to the fact that broccoli for the export market is harvested differently than that for the local market and due to its high perishability, the broccoli rejected at the exporter level can no longer be sold in the local market and thus represents a monetary loss to the farmer[10].

Nowadays, twelve years after the whole inclusion process started, a large percentage of previous suppliers have abandoned the scheme and the collection center faces a shortage of broccoli supplies. The export broccoli chain underwent a major crisis in 2009, when the exporting firm sourcing from the collection center went bankrupt and left the scene without paying for the delivered product. As a consequence, the collection center faced a liquidity crisis, and payments to farmers were delayed for extended time periods. Formal legal institutions have not solved the problem so far and the farmers´ association still has a large debt to recover from the exporter. After their original buyer went out of business, the farmers' association established a new marketing contact with one of the remaining broccoli processors-exporters in the country. This exporter agreed to source from the collection center to supplement its own estate production, given that they have a functioning internal quality control system in place and several years of experience in the export market.

In personal interviews, the exporters have emphasized the existing demand for Ecuadorian broccoli in the international market and the constant need for new and efficient suppliers given land constraints that hinder the expansion of their own plantations. Yet, they have also pointed out their reluctance to work with smallholders because of the associated coordination problems, especially since there is a shortage of suppliers. When the collection center was booming with suppliers, trucks were filled faster and dispatched to the processing plant immediately. In addition, traceability was easier to implement since the broccoli from different farmers could be kept in separate bins. Nowadays, it takes longer for the truck to fill and the waiting time affects the quality of the product. Moreover, planning is difficult, because the exporter cannot rely on certain volumes being delivered by the collection center.

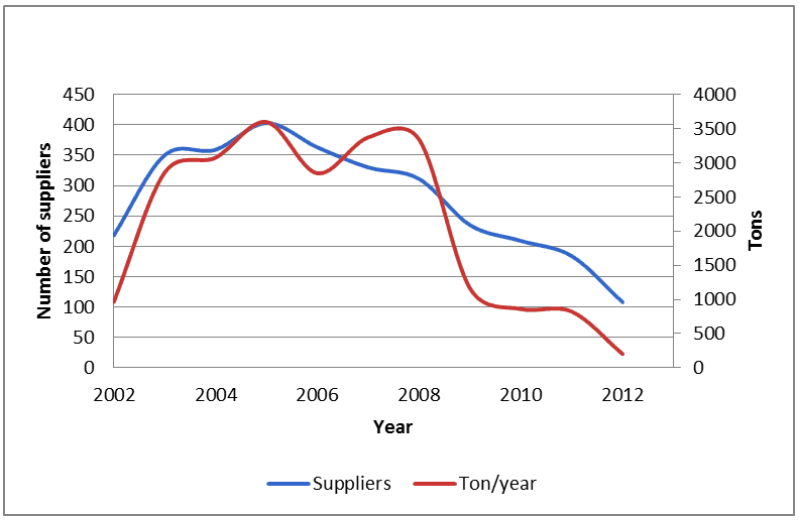
Fig. 2 shows the dynamics of broccoli supplies to the collection center during the last decade. The amount of broccoli delivered to the export sector drastically declined in 2009 and since then has been further decreasing. Suppliers have joined and abandoned the supply chain at different points in time.

[9] The rejection data in our data set refer to the rejections at the exporter level, and do not take into account rejections at the collection center level, where the farmer can assist and verify the process.

[10] When harvested for the export market only the head of the broccoli is cut and the rest of the plant is left in the field, while for the intermediaries and local market the head has to be covered by several plant leafs.

The total number of farmers who have ever participated in the export sector is around 630 from 8 different villages located in the province of Chimborazo. The largest number of suppliers (403 smallholder farmers) was registered in 2005. Nowadays, there is only 108 active suppliers of which only 47 are members of the association.

Fig. 2: Number of suppliers and quantity delivered per year to the collection center



3. Conceptual framework

Broccoli producers in Ecuador can choose between two alternative marketing channels to sell their produce: 1.) The spot market: coordinated by price and characterized by nonrecurring transactions with no prior arrangements and no promise of repeating the transaction in the future. It takes place at the local market or at small market points close to each community. There are multiple buyers and multiple sellers and payment is usually made at the moment of the transaction. 2.) The export market: characterized by verbal or written agreements between the parties to supply a fixed quantity of broccoli with certain characteristics, during a certain time period and at a constant price. The payment is usually made 15 days after delivery and the closer relationship between the parties facilitates the flow of information. While large-scale farmers are offered individual contracts directly with the exporting firm, small-scale farmers can only access the export market through verbal agreements with the collection center managed by the farmers´ association.

In order to participate in the export marketing channel, farmers have to fulfill stringent requirements related to the quality, quantity and timing of deliveries. The farmer's ability to meet these conditions determines the probability and extent of participation. In principle, we assume that farmers decide to participate in the export market if their utility derived from participation is higher than their utility derived from non-participation. We hypothesize that the utility associated with participation in a particular marketing channel is influenced by three factors: income, costs (including transaction costs) and social acceptance within the community. Thus, utility is defined by the following equation:

$$U_t = f(I_b, C_b, TC_b, SA)$$

where I_b represents the income from broccoli, C_b the costs of production, TC_b the transaction costs associated with selling broccoli in a specific marketing channel, and SA is social acceptance. Based on the framework proposed by Hobbs and Young (2000), Table 1 summarizes the transaction costs associated with the commercialization of broccoli in the two alternative marketing channels.

Table 1: Transaction costs associated with different marketing channels

	Export market	Local market
Transaction costs	Low uncertainty due to fixed price and secure buyer	High uncertainty due to variable price and buyer
	High uncertainty due to possible rejections related to quality	Low uncertainty due to quality
	High uncertainty due to payment (related to timing)	Medium uncertainty due to payment
	Asset specificity: medium	Asset specificity: low

According to transaction costs economics, the characteristics of the transaction affect its costs and therefore define the way in which the transaction is coordinated (spot market, partial or complete vertical integration). The characteristics of a transaction according to Williamson (1979) and Hobbs and Young (2000) are described by its uncertainty, frequency, asset specificity and complexity, which in turn determine the risks faced by the actors. These transaction characteristics change over time due to changes in the environment (natural events, changes in demand or human behavior). As information regarding these changes is imperfect, the variation in risks cannot be perfectly anticipated by farmers. Hence, they may trigger changes in utility and thus affect the marketing channel choice. In a food chain, uncertainty increases when: i) the product is perishable, ii) there are unobservable quality attributes that partly determine the price, iii) payment is not immediate, iv) the product is differentiated (thus increasing asset specificity), and v) traceability is required (Hobbs and Young 2000).

When entering a formal or informal agreement, the uncertainty of finding a buyer at the moment of harvest decreases; however uncertainty regarding the price (even when a fixed price is agreed on ex ante) still remains. As the payment is not immediate, farmers will only know their final payment once their product has been delivered, graded and the money has been transferred. In high-value chains the price depends to a large extent on the quality of the product and the timing of payment, giving rise to three possible risks: a) a risk derived from asymmetric information during the grading process, where the farmer might believe he is being cheated if a high rate of rejection is experienced; b) a risk related to possible exporter´s opportunistic behavior, who may reject high quality produce due to a lack of processing capacity; and c) a risk linked to the payment time, where the final real price decreases if the transfer of money is delayed by the exporter[11]. These transaction risks threaten the sustainability of the

[11] When a payment is not made on time, the contracting firm is extracting rent from its suppliers by getting access to interest free loans. Suppliers on the other hand experience economic losses and can face cash-flow shortages that threaten their survival capacity, especially in the case of smallholders.

chain by reducing the farmers' willingness to invest, and thus the quality and/or quantity of produce delivered and – if the transaction risks are too high – they can even induce a farmer to drop out of the export market entirely.

4. Empirical Analysis

4.1. Data collection

In order to disentangle the dynamics of small-scale farmers supplying the export market we collected quantitative as well as qualitative data on the marketing decisions of broccoli producers in Ecuador. Qualitative methods were used to collect general information on broccoli production and on the organization of the broccoli sector in the province of Cotopaxi – where the processing firms and large-scale farms are located – and in the province of Chimborazo. In a first step, we conducted semi-structured interviews with members of the farmers´ group, exporting firms and government entities supporting inclusive business[12] in order to understand the structure of the sector, its development since the 90's and the current state of the value chain. Subsequently, quantitative research was carried out in the province of Chimborazo, where the small-scale farmers are located. The farmers´ association under study is the only organized group of smallholders producing broccoli for the export sector in the country. It has supplied exporting firms through contract farming for over a decade[13]. A household survey was carried out from November 2012 to February 2013 in nine villages of the province of Chimborazo. We covered all eight villages where former and active suppliers of the collection center live. In addition, we interviewed farmers who never participated in the export market living in the same eight villages and from a ninth village located in the same province (with same geographical, infrastructure and weather characteristics).

Three categories of farmers were identified for the analysis: Active suppliers of the export market (*current participants, n=108*), former participants who stopped supplying the export market channel (*former participants, n=522*) and farmers who have always supplied the local market (*non-participants, n= approx. 1500*). A stratified random sample was used to select farmers for the interviews. Given their comparatively small number, we decided to over-sample current suppliers in order to ensure sufficient observations for analysis. Current and former participants were randomly chosen from a complete list of active and former producers provided by the association. If producers were not available or did not agree to participate in the interviews, they were replaced with the next person in the list. Non-participants were selected using a random walk sampling approach. In order to obtain a comparable control group, households were chosen only if they have been producing broccoli during the last 12 months.

The final sample is composed of 401 farmers: 88 farmers who still participate in the export chain, 195 farmers who have dropped out of the scheme, and 118 farmers who have always grown broccoli exclusively for the local market. A structured questionnaire was used to collect information on socio-economic and farm characteristics, agricultural production and marketing, group memberships, family ties and household assets. The respondent´s attitude towards risk was measured using an experimental risk lottery designed by Binswagner where real payoffs were offered (Binswanger 1980). Enumerators visited each household and conducted a face-to-face interview of approximately 1.5 hours with a household member involved in the cultivation and commercialization of broccoli. The data collected for the current and former suppliers of the export chain was merged with records provided by the

[12]The main purpose of inclusive business is to link small/poor producers in a sustainable way to the markets.
[13] Nowadays, smallholders can only access the export chain through a farmers´ group given that firms do not sign individual contracts with small-scale producers. Sporadic participation in the export chain of non-organized small-scale suppliers was possible during the 90s and early 2000s.

farmers´ association containing data on the quantity of broccoli delivered from 2002 to 2012, the days to payment, and the quantity rejected by the exporter per delivery.

4.2. Model specification

4.2.1. Extent of participation: Double hurdle model with independent error terms

Each year farmers have to decide how much of their broccoli they allocate to the export sector and how much they sell in the local market. We model this marketing decision by analyzing the factors influencing the extent of participation in the export chain. The extent of participation is measured as the quantity *Q* that farmer *i* delivers to the export market in year *t*, and takes the value of 0 or is strictly positive. Q_{it} is specified as a function of the transaction risks experienced by the household in the previous period ($TR_{i(t-1)}$), which reflect the costs associated with the transaction, the social acceptance (*SA*) of the marketing decision composed of the acceptance within the village and within the family, and a vector of other explanatory variables potentially influencing the marketing decision.

$$Q_{it} = \alpha TR_{i(t-1)} + \beta SA_{it} + \gamma X_{it} + \varepsilon_{it}$$

$$\varepsilon_{it} = c_i + \mu_{it}$$

In our sample, Q_{it} takes the value of zero many times because some farmers never allocate any produce to the export market, whereas others decide not to deliver anything to the export chain in certain years. In order to accommodate the structure of our data we use a corner solution model proposed by Cragg (1971) and implemented by Burke (2009). This craggit model is a double hurdle model with independence of errors, where the first equation predicts the probability of a positive value and the second equation predicts the actual value. While the tobit model requires both decisions to be estimated by the same covariates, the advantage of the craggit model is that it allows different covariates to have different effects on each of the two decisions. The craggit model can also be applied to panel data using a pooled estimator and clustering at the household level in order to control for possible autocorrelation of the error within households (Burke 2009). We assume independence of errors because the zeros we deal with are real values rather than unobserved[14].

To obtain consistent estimates in panel data models, the explanatory variables must not be correlated with the time-constant unobserved term (c_i). This can be solved using a fixed effects panel estimator, but when using a pooled estimator the easiest way to control for it is to include a correlated random effects (CRE) estimator named the Mundlak-Chamberlain approach (Ricker-Gilbert, Jayne, and Chirwa 2011). The CRE consists of including a vector of variables containing the means of all time-varying covariates for each household (Burke and Jayne 2014; Ricker-Gilbert, Jayne, and Chirwa 2011). These additional control variables have the same value for each household during the period under study but vary across households. Their coefficients account for the differences between households over the entire period (due to unobservable time-constants), while the coefficients of the time varying covariates explain the within household effects, i.e., the effect of a deviation from the household average over time (Burke and Jayne, 2014).

[14] Ever since its establishment, the farmers' collection center has been reaching out to small-scale farmers in the Chimborazo area to increase its supplier base. While production costs, agricultural practices and labor requirements are similar for both markets, the collection center has provided incentives and technical advice to farmers to help them overcome potential market failures. Therefore, all small-scale farmers in our sample have the real chance to participate in the export sector, but some of them choose not to do so because of their real preferences. Thus, the zeroes in our data represent real decisions.

4.2.2. Duration model with binary dependent variables

Time duration models estimate the probability that an individual switches from one stage to another given that he has not done so in the previous period (Dadi, Burton, and Ozanne 2004). In the present study, we model the farmer´s decision to withdraw from the export marketing channel, by estimating the probability that the farmer changes his position from participation to non-participation at the beginning of time period *t*, given that he has not done so before *t*. We organize our data in a discrete time fashion, where each farmer has eleven observations, one for each year of the time period under study (2002 – 2012). Given that the withdrawal from the export sector is conditional on previous participation, we exclude those farmers who never participated in the export sector from the analysis. The event of withdrawal is called failure, and we denote the discrete time to failure with *T*. The dependent variable is a dummy variable that equals zero in every year that the farmer supplies the export sector and one in the year they stop supplying (failure). Multiple spells are allowed, which means that farmers can decide to participate a second or third time after withdrawing. The spell or time of duration starts when the farmer starts supplying the export market and finishes when he decides to withdraw. A vector of time dependent variables $\mathbf{X}_{it}$ is also observed, which is fixed within the interval *t* and speeds up or delays the failure time of the individual. This set of variables can be constant over the whole period of time under study (time invariant variables such as gender, education, distance to market and to the collection center) or vary from year to year (time varying variables such as the area of the farm, % of rejection, number of days to payment, and price). We hypothesize that past hold-ups experienced by the farmer in the export value chain increase the perceived transaction risks and therefore speed up withdrawal.

The hazard function (α_i) which characterizes *T* is given by the conditional probability for the risk of failure in interval *t* (Fahrmeir 1997) given that the individual has not failed before *t* and is expressed by:

$$\alpha_i(t|X_{it}) = Pr(T_i = t|T_i \geq t, X_{it}), t = 1, \ldots, q$$

Where $T_i = t$ denotes failure within interval *t*, $T_i \geq t$ denotes survival up to time *t* for individual *i*, and $X_{it}= (x_{i1}, \ldots x_{it})$ is the vector of explanatory variables for individual *i* up to time *t*.

The hazard function can also be expressed as a function of time (baseline hazard) combined with a vector of covariates acting multiplicatively on the baseline hazard and shifting it proportionally (Burton, Rigby, and Young 2003). Semi-parametric approaches in duration analysis, such as the Cox model, do not require any assumption on the distribution of the errors, and thus of the baseline hazard. Instead they rank the occurrence of failures and conduct a binary analysis on each observation, exclusively using the ranking of survival times (Cleves et al., 2008). The proportional hazard model, which we will estimate using the Cox model approach, is specified as:

$$\alpha_{tj}(t) = \alpha_0(t)\exp(\beta X_{tj} + v_j)$$

Where $\alpha_0(t)$ is the unspecified baseline hazard, v_j corresponds to the frailty of the model, i.e., a latent random effect within groups that enters multiplicatively on the hazard function. Given that in our data we have multiple observations per individual (multiple spells), we can expect that the failing time for each farmer is not independent and thus the standard errors should be adjusted to account for this possible correlation. The shared frailty (v_j) is used to account for this potential correlation, which is measured by θ and is assumed to have a gamma distribution (Cleves et al., 2008). In our data set, time

is not recorded as a continuous variable but is rather discrete (yearly data). Therefore it is likely that more than one observation fails at the same time (tied failures) and as a result the order of failures within this year cannot be established as required for the simple Cox model. Cleves et al. (2008) mention three ways of handling such tied failures, of which we use the Efron´s method[15].

4.2.3. Explanatory variables

Among the vector of variables potentially explaining the extent of participation as well as the decision to drop out of the export sector, we are particularly interested in the effect of transaction risks. In particular, hold-ups experienced in previous periods might increase the perceived risk of the transaction and thus have a strong negative effect on participation. Transaction risks are captured by the variables: a) *days to payment (t-1)* which is the average number of days the farmer had to wait to get his payment in the previous year, and b) *percentage of rejection (t-1)* which is the average percentage rejected by the exporting firm in the previous year.

We furthermore consider two proxies for social acceptance in our model: *family ties with workers at the collection center* and *aggregate village supplies*. Having a family member working at the collection center might influence the farmer's marketing decision positively given that family ties play an important role in Latin American rural societies (Carlos and Sellers 1972). On the other hand, for the case of Madagascar, Fafchamps and Minten (2001) show that contracts are handled more flexibly among kin and thus deviations from the original agreement are observed more frequently. Regarding our second proxy for social acceptance, we follow Moser and Barrett (2006) using the lagged aggregate quantity delivered per village as a proxy for community behavior and expectations. Moser and Barrett (2006) describe how the pressure to conform to behavioral norms established within a community can affect individual decisions. In addition, higher levels of aggregate village supplies can also result in better access to information and lower costs of transportation for individual farmers.

While often unobserved in other empirical studies due to the difficulty of measurement, we also include the farmer's attitude towards risk as a potential determinant. We played an experimental game with real payoffs proposed by Hans Binswanger (Binswanger 1980) to obtain a measure of risk attitude. Six different gambling options were presented to each farmer at the end of the interview, each option with a different partial risk aversion coefficient ranging from extreme risk-averse (if option 1 was preferred) to neutral or negative risk-averse (if option 6 was preferred). Given that many of the interviewed farmers were illiterate, for each of the six options we presented them a picture of the sum of money they could win. The *partial risk aversion coefficient* was then calculated according to the farmer's choice as explained in Binswanger (1980). We expect more risk-averse farmers (those with a higher risk aversion coefficient) to be less likely to abandon a contracting scheme with exporters, which provides them with a secure market and a secure price.

To capture poverty, we use a dummy variable that equals one if the household received a government subsidy (*Bono*), which is targeted to the poorest households in the country. Other variables capturing household and farm characteristics are included as controls, such as gender and education of the household head, number of household members, area of the farm, and distance to the collection center and to the local market. Regarding marketing characteristics, the *real price* paid by the exporter is included. Variables indicating the period when the farmer joined the export sector are used in the

[15] Efron´s method is an approximation to the exact marginal calculation method for tied failures, where all the possible orders of failures within a group failing at the same *t* are taken into account for the final probability of failure at that specific time *t*. In Efron's method the risk set used as denominator contains all the observations failing at time *t*, but is corrected using probability weights (Cleves et al, 2002).

duration model. Three periods are identified: *Joined_Period1* indicates that the farmer started supplying the collection center during the first year (innovators). *Joined_Period2* indicates that the farmer started supplying the collection center after it was well established (followers). Last but not least, *Joined_Period3* covers the years 2009 to 2012 and indicates that the famer joined the export sector after the collection center experienced a crisis in 2009 induced by the bankruptcy of its main buyer (late comers). Both models contain interaction terms between a dummy variable for the *period 2009 – 2012* and our main variables of interest in order to control for the time span after the bankruptcy of the buyer. Long payment delays and payment defaults during this time may have jeopardized the trust of smallholder suppliers, negatively affecting their participation in the value chain. Descriptive statistics for the covariates included in the models are presented in Table 2 in the following chapter as well as in Table A1 in the annex.

4.3. Descriptive statistics

Table 2 compares the characteristics of farmers currently supplying the export market (*current participants*), farmers who dropped out of the export market (*former participants*) and farmers who have never supplied the export market (*non-participants*). Descriptive statistics indicate that farmers in all three categories have similar levels of risk aversion. Similarly, there are no significant differences regarding the number of household members or the percentage of households with at least one member working off-farm. Current participants have less education but more farming experience than former participants and in particular than non-participants. Geographically, current participants are located closer to the collection center and further away from the local market, compared to both former and non-participants. We find no significant difference in the size of owned land (in 2012) between the three categories of farmers; only when taking into account rented and shared plots the total land size of non-participants is slightly bigger than that of current participants (significant at the 10% level). Yet, current participants are more specialized in terms of the area dedicated to broccoli production. Nevertheless, when looking at the income derived from broccoli production, we find no significant difference between the three groups. Furthermore, income differences, even though slightly lower for current participants, are not significantly different between the groups. According to our proxy for wealth (Bono), however, we do find evidence that current participants are significantly poorer than non-participants. A significantly larger share of current participants qualifies to receive the government subsidy for poor households (*Bono*). Finally, we find significant differences between the groups with respect to social networks.

A significantly larger share of current participants are members of the farmers' association and have family ties with workers at the collection center. Compared to non-participants, both current and former participants have a larger number of relatives producing broccoli for the local market and in particular for the export market.

Table 2: Household, farm and transaction characteristics by participation status

Variable	a. Current part.	b. Former part.	c. Non-part.	Sig. Differences		
(no. obs)	*88*	*195*	*118*	*ab*	*bc*	*ac*
Partial risk aversion coefficient	2.08	1.77	2.24			
Household characteristics						
HH members (no.)	4.17	4.18	4.32			
HH head age (years)	48.32	47.23	46.96			
HH member has off-farm job (d)	0.72	0.64	0.74			
HH head secondary education (d)	0.19	0.23	0.35	**	***	***
Farming experience (years)	10.23	9.59	8.14		***	***
Farm characteristics						
Distance to collection center (km)	1.61	4.65	9.95	***	***	***
Distance to nearest local market (km)	13	12.04	9.94	**	***	***
Total area, 2012 (solar)[a]	4.21	5.13	6.5			*
Total own area, 2012 (solar)	3.73	4.3	5.07			
Total broccoli area, 2012 (solar)	0.89	0.63	0.41	**	**	***
Livestock (number of cows)	0.64	0.83	1.32			
Wealth related variables						
Bono (d)	0.7	0.6	0.52	***		***
Total income (USD	6412.1	7766.7	8530.29			
Total farm income (USD)	3097.07	3429.85	4076.91			
Social Networks						
Member in association (d)	0.48	0.24	0.01	***	***	***
Family ties to collecting center (d)	0.34	0.1	0.02	***	***	***
No. relatives delivering broccoli to local market	5.17	5.42	4.02		***	**
No. relatives delivering broccoli to export market	4	1.64	0.43	***	***	***
Characteristics of the transaction						
Income from broccoli	1068.6	976.03	975.75			
Income from broccoli local market	626.15	976.03	975.03	**		**
Sells broccoli to collection center only, 2012 (d)	0.22	0	0	***		**
Days to payment in local market	4.2	2.65	1.81	***	*	***
Days to payment in export chain	38.1	-	-			
% Rejection in export chain	0.11	-	-			

[a] Area is measured in *solares.* 1 solar = 1700m^2 (approximately)
*Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level
(d) dummy variable

Large differences also exist between the three groups of farmers regarding the characteristics of the market transactions. First of all, we observe that only 22% of the current participants exclusively sell their broccoli to the export market. The majority of current participants, besides delivering to the export market, also deliver some of their produce to the local market. Yet, when compared to former and non-participants their income obtained from local market sales is significantly lower, due to the fact that some of their produce is destined to the export sector. With respect to the transaction risks, we can observe stark differences between the two marketing channels. In the export market farmers had to wait 38 days for their payment, whereas in the local market payment was made within two to four days after delivery. Similarly, stringent quality requirements and possibly opportunistic behavior of exporters result in relatively high rejection rates in the export sector. On the average, 11% of produce delivered by current participants was rejected. In the local market, produce rejections are not an issue, because farmers always find a trader buying their produce, but potentially at a lower price. While in the export market farmers received a fixed price of 0.25 US$/kg throughout the whole year (of which the collection center kept 0.02 US$/kg to cover their costs), in the local market farmers faced extremely volatile prices ranging from 0.04 US$/kg to 1.43 US$/kg (mean: 0.40 USD/kg, standard deviation: 0.24). When current and former participants were asked about the problems experienced in the export sector, over 70% reported payment delays and 30% mentioned that they were not paid at all, because the exporter defaulted on the payment (see Figure 3). Furthermore, around 35% experienced produce rejections. This reflects the high levels of uncertainty that farmers in the export sector are exposed to. Both delayed/lack of payment as well as produce rejections negatively affect the cash flow and/or income of smallholder farmers, which often do not possess the means and liquidity to compensate such losses. Finally, low prices and high quality requirements were considered a problem by 25% and 10% of the current and former participants, respectively. It is thus worth noting that the vast majority of current and former participants feel that with the experience acquired so far they are able to produce broccoli according to the quality criteria set by the exporter.

In spite of the perceived problems, over 60% of the entire sample (including non-participants) would be willing to produce broccoli for the export market and join a contract scheme, if it is supported by a legal document[16] (Figure 4). The conditions that are critical for them to sign an agreement include secure payment (85%) and higher prices (50%). Less than 15% of the farmers mentioned the provision of inputs, training or credit as a condition to participate in the export market, thus providing some evidence for the existence of well-functioning factor markets in the area.

[16] No particular buyer was specified in the question.

Fig. 3: Problems experienced by farmers in the export sector

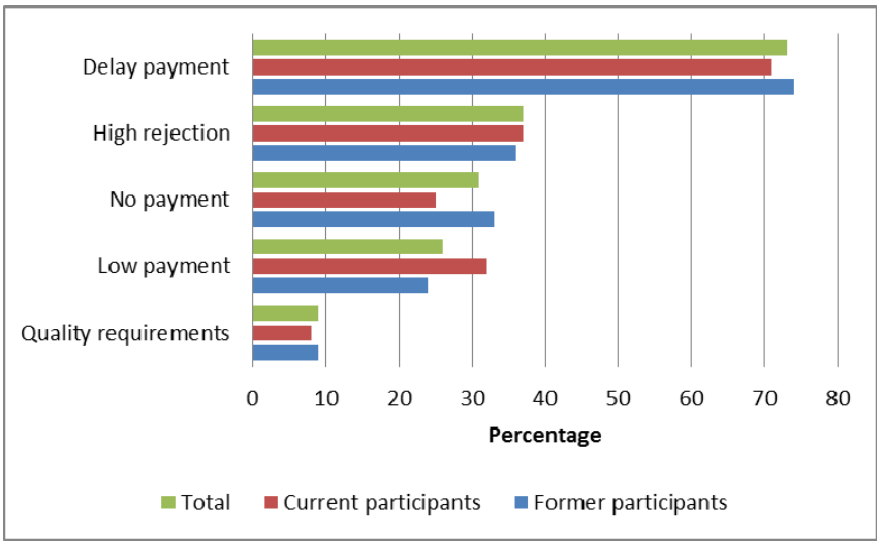
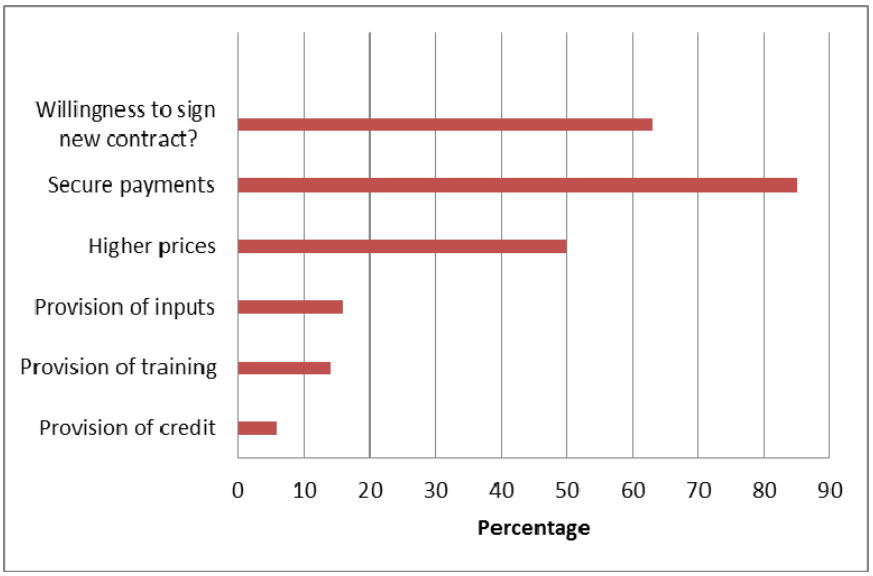


Fig. 4: Farmer´s conditions for signing a new contract with the collection center



5. Results

5.1. Extent of participation

Table 3 shows results from the double hurdle model on the quantity delivered to the export market. The coefficients of hurdles one and two are the conditional average partial effects (APEs) obtained for each hurdle separately.

Table 3: Results on the extent of participation in the export sector

Variable	Hurdle 1 **Probability of participating in export market**	Hurdle 2 **Quantity delivered to export market (kg)**
Transaction risks		
Days to payment (t-1)	-	-36.60**
		(14.65)
% Rejection (t-1)	-	-135.42**
		(63.60)
Social acceptance		
Family working collect center (t-1)	-0.1093	307.69
	(0.1001)	*(1550.68)*
Tons/ village (t-1)	0.0001**	2.48**
	(0.0001)	*(1.07)*
Other control variables		
Kg delivered (t-1)	-	0.08***
		(0.03)
Partial risk aversion coefficient	0.0045	69.46
	(0.0054)	*(61.02)*
HH members	0.0834***	-1599.72*
	(0.0276)	*(883.06)*
HH head secondary education (d)	-0.0076	1242.29**
	(0.0346)	*514.35*
HH head gender	-0.0385	-135.78
	(0.0437)	*(766.08)*
Distance to collection center	0.0006	-6.70
	(0.0054)	*(126.32)*
Distance to nearest local market	-0.0106	241.58
	(0.0069)	*(149.93)*
Own area (t-1)	0.0007	631.42
	0.0049	*(508.80)*
Bono	-0.0241	-271.54
	(0.0269)	*(402.84)*
Member in association	0.5701***	1978.90*
	(0.0543)	*(1069.41)*
Price	0.0967**	18223.34**
	(0.0247)	*(2339.25)*
Interactions period 2009-2012		
d2009-2012xDays payment (t-1)		30.65*
		(16.47)
d2009-2012x% rejection (t-1)		-175.09
		(190.26)
d2009-2012xFamily working collection center	0.1723	-4248.27
	(0.1096)	*(4264.01)*
d2009-2012xTons/village (t-1)	0.0001**	-0.44
	(0.00003)	*(1.53)*
d2009-2012xMember Asoc	-0.2701***	-4446.81**
	(0.0542)	*(2044.88)*
Observations	4000	1375
Pseudo R^2	0.2981	

*** p<0.01, ** p<0.05, * p<0.1
(d): dummy variable
Dummies for years and villages included in the model
Averages for time varying covariates are included in both hurdles
Unconditional APEs obtained via bootstrapping

The first column (Hurdle 1) shows the determinants of farmers' participation in the export sector, and the second column (Hurdle 2) shows the influence of the covariates on the quantity delivered to the export market conditional on participation. The transaction risks variables are included only in the second equation because non-participating farmers have not been exposed to rejection or delay on payment, which is specific to transactions in the export chain.

With respect to participation, we find that lagged village behavior has a statistically significant, albeit small effect on farmers' participation decision. For each additional ton of aggregate village deliveries during the past period, the farmer's likelihood to participate in the export market increases by 0,01%. In the period 2009-2012 after the crisis, the effect slightly increases. These results suggest that farmers' marketing decision is not independent of their community members' decisions, which could be due to different reasons including better access to information as well as social conformity. Furthermore, we find that members of the farmers' association are more likely to participate in the export chain. In particular, membership in the association increases the likelihood to participate in the export market by 57%. However, after the crisis the effect of membership on participation drops by 27 percentage points, suggesting that an external shock can have a substantial effect on supply chain relationships. Finally, concerning the price, each additional cent offered per kilogram of broccoli increases the probability of participation by 10%.

Results from the second hurdle show that farmers' marketing decision is affected by the hold-ups experienced in the previous period. Conditional on participation in the export market, farmers reduce the delivered quantity by 36 kg for each additional day they had to wait for their payment in the previous year. Similarly, each additional percentage point of rejection experienced in the previous year leads to a decrease in the delivered quantity by 135 kg. Surprisingly, after the crisis (2009-2012) the effect of payment delays became smaller, with each additional day to payment reducing the delivered quantity by only 6 kg. This can be explained by the fact that after the crisis long payment delays were common, but many farmers still continued to supply the collection center to claim their outstanding payments. We furthermore find that price is an important factor driving farmers' delivery decision, which confirms results of other studies (e.g. Carletto et al. 2010) revealing that small-scale farmers are very responsive to price incentives. Conditional on participation, a price increase of one cent per kilogram of broccoli, leads to an increase in the quantity delivered by 18223 kg on the average.

Regarding our proxies for social acceptance, we find that previous village behavior significantly influences farmers' delivery decision. For each additional ton that was delivered by village members in the past year, an individual famer in the same village will increase delivered quantity by 2.48 kilograms. The other proxy for social acceptance, whether a family member works at the collection center, neither increases the probability of participation, nor the quantity delivered to the export market. Conditional on participation in the export chain, membership in the association has a positive and significant effect on the quantity delivered, on the average increasing deliveries by 1978 kilograms compared to non-members. This positive effect, however, only persists as long as there is no negative external shock. After a negative shock, such as the one experienced by the collection center in our study, members deliver on the average 2468 kilograms less than non-members. This may be due to members having better access to information and thus being more aware of the difficult situation faced by the supply chain.

Table 4: Unconditional average partial effects of selected covariates

Variable	Unconditional APEs
Transaction Risks	
Days to payment (t-1)	-14.21**
% Rejection (t-1)	-56.56**
Social acceptance	
Tons/village (t-1)	0.964**
Price	929.28***
Interactions period 2009-2012	
d2009-2012 x Days to payment (t-1)	11.89*

*** p<0.01, ** p<0.05, * p<0.1
The unconditional APEs were calculated only for the covariates of interest that were significant in the double hurdle model (Table 3).

In Table 4 we report unconditional average partial effects for selected covariates, which provide the marginal effects on the extent of participation calculated based on the entire sample, i.e., irrespective of the participation decision. When taking the whole sample into account, the transaction risks variables are still significant and negative, but the effect on the extent of participation is smaller, given that now non-participants, who do not deliver any broccoli to the export sector, are also considered. Results indicate that for each additional day the farmer had to wait for payment and for each additional percent of broccoli rejected during the previous year, the delivered quantity decreases by 14.21 kg and 52.56 kg, respectively. The effect of payment delays is less pronounced after the crisis, but still negative and significant, with farmers delivering 2.32 kg less on the average for each additional day they had to wait for payment in the previous period. Similarly, the total effects of the broccoli price and of past aggregate village deliveries remain positive and significant, but the magnitude of the effect decreases. A one-cent increase in the price of broccoli, leads to an increase of 928.28 kg in the delivered quantity, on the average. In response to a one-ton increase in the aggregate quantity delivered by the village in the previous year, a farmer living in the same village delivers an additional 0.96 kg in the current year.

5.2. Dropping out of a high-value chain

Table 5 shows estimation results from the Cox model of proportional hazards analyzing the withdrawal decision of current and former participants of the export market. The model is statistically significant at a *p-value* of 0.000. The coefficients represent the change in the log odds of the outcome variable ("failure" or withdrawing from the export market) for a one unit increase in the independent covariate holding all other covariates constant. For easier interpretation, the hazard ratios are also provided, which were calculated by exponentiating the coefficients. A negative coefficient implies a negative change in the log odds of dropping out, which means a decrease in the hazards of withdrawal from the export sector (hazard ratio < 1). On the contrary, a positive coefficient reflects an increase in the log odds of the outcome variable, that means an increase in the hazards of failure (hazard ratio > 1).

Table 5: Results on the hazard of dropping out of the export sector

VARIABLES	coefficient	Hazard ratio
Transaction risks		
Days to payment (t-1)	0.0008*	1.001*
	(0.004)	*(0.0004)*
% Rejection (t-1)	0.07**	1.0725**
	(0.0291)	*(0.0311)*
Social acceptance		
Family working collect center (t-1)	1.476**	4.4289**
	(0.615)	*(2.665)*
Tons/ village (t-1)	-0.0002	0.9998
	(0.000268)	*(0.0003)*
Other control variables		
Risk aversion coefficient (s1)	-0.0318	0.9686
	(0.0239)	*(0.0232)*
HH members	0.0379	1.0386
	(0.0452)	*(0.0469)*
HH head secondary education (d)	-0.1026	0.9024
	(0.179)	*(0.1630)*
HH head gender	0.845***	2.3282***
	(0.306)	*(0.7133)*
Distance to collection center	-0.0007	0.9992
	(0.0385)	*(0.0384)*
Distance to local market	0.0521	1.0534
	(0.0357)	*(0.0376)*
Own area (t-1)	-0.0197	0.9804
	(0.0135)	*(0.0132)*
Bono	0.0851	1.0887
	-0.137	*(0.1493)*
Member in asociation	-2.308***	0.0994***
	(0.147)	*(0.0414)*
Price	-0.403	0.6681
	(0.384)	*(0.2564)*
Start Period 2 (Followers)	0.383	1.4673
	(0.239)	*(0.3508)*
Start Period 3 (Late comers)	0.516	1.6757
	(0.653)	*(1.0945)*
Interactions period 2009-2012		
d2009-2012xDays payment (t-1)	-0.0004	1.0003
	(0.0005)	*(0.0005)*
d2009-2012x% rejection (t-1)	-0.0620*	0.9399*
	(0.0339)	*(0.0318)*
d2009-2012xFamily working collection center	-1.950***	0.1423***
	(0.620)	*(0.0882)*
d2009-2012xTons/village (t-1)	-0001	0.9999
	(0.0005)	*(0.0002)*
d2009-2012 x HH head gender	-0.916**	0.4001**
	(0.441)	*(0.1765)*
d2009-2012 x Membership Asociation	1.640***	5.1548***
	(0.463)	*(2.3877)*
Θ	1.02 e-7	

The coefficients of the transaction risks variables are positive and significant. Both a larger number of days to payment and a higher percentage of rejection in the previous period increase the speed of withdrawal from the export chain. Specifically, for each additional day the farmer had to wait for

payment, the individual hazard rate increases by 0.1 percentage points. This can become an important risk factor considering that during 2009 farmers had to wait for more than 3 months on the average for their payment (see Table A1 in the annex). Moreover, for each additional percentage point of rejection, the hazard rate of withdrawal increases by 7.25 percentage points. After the crisis, the effect of rejection slightly decreases (statistically significant at the 10% level), but given that this change is so small, the overall effect for the period 2009–2012[17] remains negative. Thus, farmers seem to be more sensitive to product rejections than to payment delays. Product rejections represent a major monetary loss to the farmer, given that once the broccoli is harvested and sent to the exporter, it can no longer be sold in the local market.

With respect to the proxies for social acceptance, we find that having a family member who works at the collection center speeds up the process of withdrawal from the export chain, increasing the hazard rate by 344 percentage points. While this is unlike expected, it is likely that the enforcement of the existing agreement is hampered by family ties to the extent that farmers do not fear a strong punishment when diverting their product to the local market, as suggested by Berdegué (2001). Our results also confirm the findings of Fafchamps and Minten (2001), who explain that agreements are handled more flexibly, when actors are related through kinship. However, after the crisis (2009-2012) the effect of family ties reverses, decreasing the hazard rate of withdrawal by almost 40 percentage points. Thus, farmers with family ties, while often pursuing short-term benefits in the period before the crisis, tended to support the collection center during difficult times. This is rationale if farmers maximize family level (rather than individual level) utility and therefore seek to prevent the collection center from going bankrupt and loosing income from wage employment at the center.

Membership in the association has a negative effect on the log odds of dropping out of the export chain, decreasing the hazard rate of withdrawal by more than 90 percentage points, when compared to non-members. This result can be explained by the fact that members are also the owners of the collection center and thus hold shares of the enterprise. Nonetheless, the negative external shock in 2009 also significantly affected the members of the association. Overall, after the crisis (2009-2012) the effect of being a member on the speed of withdrawal is still negative, but to a lesser extent. In this period, membership decreases the hazard rate by only 50 percentage points, as opposed to 90 percentage points before the crisis. This provides evidence of how the event of a negative external shock, in this case the bankruptcy of the main buyer, increases uncertainty in the supply chain and affects the loyalty of small-scale suppliers in the upstream segment of the chain.

Furthermore, the speed of withdrawal from the export sector is significantly influenced by the gender of the household head. For female-headed households the hazard rate of withdrawal is 132 percentage points higher, indicating that compared to male-headed households they tend to drop out of the export sector more quickly. However, interestingly after the crisis the effect reverses, indicating that female-headed households now tend to remain as long or slightly longer in the export chain compared to their male counterparts (the hazard rate of withdrawal is 7 percentage points lower for female-headed households in the period 2009-2012). This marked difference between the two periods is likely to be associated with the different conditions in the value chain and the respective response of vulnerable population groups, such as female-headed households. Anecdotal evidence from the field visit suggests that after the crisis the collection center had outstanding debts with the farmers, and that in particular poorer and more disadvantaged households preferred to stay in the export chain hoping to recover their outstanding payments.

[17] The hazard ratio is obtained by exponentiating the coefficient, which results from adding the coefficients of *% Rejection* $_{(t-1)}$ and of the interaction term *d2009-2012* x *% rejection* $_{(t-1)}$.

Finally, the price, while being an important determinant of the decision to join the export sector and of the quantity delivered to the high-value chain, does not have a significant effect on the decision to remain in or drop out of the export chain. This indicates that once the farmer has joined the scheme, other factors besides the price, such as the transaction risks associated with the marketing relationship, gain in importance for the marketing decision.

6. Conclusions

This study combines cross-sectional and panel data to analyze the determinants of smallholder participation in the broccoli export market. We focus on the effects of transaction risks on the extent of participation and on the timing of withdrawal from a high-value chain. While previous studies have investigated the factors influencing participation in high-value markets and contract schemes, we add to the current literature by using longitudinal data, which allows us to identify the threats to the long-term sustainability of smallholder inclusion in high-value export chains. Given that linking smallholder farmers to high-value markets is considered a promising tool for lifting rural households out of poverty, the identification of such threats is of paramount importance for designing and promoting sustainable value chains for rural development.

Results of our analyses reveal that hold-ups experienced in the export chain substantially increase the uncertainty associated with market transactions in the chain and thus have a negative influence on farmers' participation. In particular, we find that farmers are especially sensitive to product rejections, which reduce the amount delivered to the export market in the following year and speed up the process of dropping out of the chain completely. Delay in payments, although having a smaller effect, can also become an important source of uncertainty, in particular, when farmers are exposed to long payment delays, e.g. in the aftermath of a negative external shock, such as the bankruptcy of the main buyer experienced by the producers in our case study.

Our results further show that social networks play an important role in farmers' marketing decisions. Lagged aggregate village supplies positively influence farmers' participation and quantity supplied to the export market. This may be related to better access to information about marketing opportunities, transportation (if e.g. several village members send their produce together in one truck to the collection center), or social acceptance of participation in the export market channel. Family ties play an ambiguous role: on the one hand, fostering the perception of agreements as being flexible and thus decreasing farmers' loyalty to the collection center when short-term benefits can be realized in the local market, on the other hand, increasing farmers' commitment to stay with the association during difficult economic times.

Association membership can increase farmers' likelihood and extent of participation, but is no guarantee for farmers' loyalty during difficult economic times. In our analysis we find that farmers who are members of the association deliver significantly less in the aftermath of the crisis, possibly because they have better access to information and are more aware of the difficult situation faced by the enterprise. In our study we are dealing with a special case because the association has a closed membership policy implying that after the founding phase no new members were accepted into the organization. Founding members holding a share in the association are unlikely to leave the organization even when they decide to market their produce elsewhere. Furthermore, members may derive other benefits from the organization besides having a market outlet for their produce, such as preferential access to credit, training and external support, and therefore remain in the organization.

It is important to note that we find no evidence for the exclusion – neither initial exclusion from participation, nor faster dropping out of the value chain – of smaller or poorer farmers. In our case study, farmer-level organizations have been effective in solving market failures particularly faced by disadvantaged farmers and including them in the broccoli export chain. Nevertheless, an important point that remains to be addressed is the gender issue. We find in our analysis that female-headed households drop out of the chain faster before the crisis, but more slowly after the crisis. This may point to female-headed households having less access to information or having less bargaining power in the market. Future work should investigate and address the particular challenges faced by female-headed farm households producing for high-value chains to improve the sustainability of their participation.

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8. ANNEX

Table A1. *Descriptive statistics for export market transaction variables by year.*

Year	Variable	Observ[a]	Mean	Stnd. Dev	Min	Max
2002	Kg delivered/household	113	6342.77	7064.24	127	45126
	% Rejection	113	9.57	3.69	2	20
	Days to payment	112	47.12	13.59	17	96
2003	Kg delivered/household	179	11540.18	13048.54	280	69912
	% Rejection	179	7.16	2.08	3	14
	Days to payment	179	26.32	14.24	6	101
2004	Kg delivered/household	178	12027.82	13852.43	160	98384
	% Rejection	178	3.75	2.7	1	28
	Days to payment	178	68.41	13.88	23	153
2005	Kg delivered/household	187	13267.61	15258.45	203	101702
	% Rejection	187	4.24	1.34	0	14
	Days to payment	187	74.66	12.22	21	148
2006	Kg delivered/household	164	12628.48	15046.73	284	101922
	% Rejection	164	6.5	2.39	3	18
	Days to payment	162	68.42	11.03	37	115
2007	Kg delivered/household	184	13067.79	12195.53	432	72208
	% Rejection	184	7.13	4.44	3	43
	Days to payment	181	79.87	33.23	34	489
2008	Kg delivered/household	191	13581.23	13973.1	478	97943
	% Rejection	191	6.13	2.11	2	17
	Days to payment	191	145.08	24.35	66	236
2009	Kg delivered/household	155	6001.8	5893.93	191	28781
	% Rejection	154	6.71	3.29	3	22
	Days to payment	121	201.38	94.77	0	388
2010	Kg delivered/household	148	4530.79	3877.62	111	19194
	% Rejection	148	8.95	4.38	3	42
	Days to payment	147	49.42	41.42	0	367
2011	Kg delivered/household	133	4784.71	4498.74	152	23891
	% Rejection	133	13.24	6.26	4	55
	Days to payment	133	52.27	35.62	0	217
2012	Kg delivered/household	88	1999.54	1881.35	119	10232
	% Rejection	88	11.5	4.63	1	23
	Days to payment	85	38.54	26.77	0	155

[a]: Only the households included in our survey were used for calculating these values.