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Supplier dynamics in horticultural export chains – Evidence from Ecuador. Revised version.

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Supplier dynamics in horticultural export chains

- Evidence from Ecuador - Revised version.

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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. We analyze the extent of participation over an 11-year time period using correlated random effects and diff-GMM models and explain the hazards of dropping out of the export chain based on a multi-spell cox duration model. The empirical results suggest that small-scale farmers' exit from the export sector is 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 global financial crisis starting in 2007 that was associated with the bankruptcy of the main buyer in our case study – represent a major threat towards the sustainability of smallholder inclusion in high-value chains.

Keywords: high-value supply chains, market participation, panel data, duration model, transaction costs

JEL classification: D23, D81, Q12

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1. Introduction

During the past three decades the agri-food industry has undergone rapid structural changes. The growing demand for innocuous and high quality food has led to the modernization of procurement systems inducing a shift from spot market transactions to vertical coordination (Reardon et al. 2009). These structural supply and demand side changes have opened up new marketing opportunities for small-scale farmers in developing countries. Farmers' inclusion in global agri-food markets through producer groups and contract farming schemes is often considered a promising way to increase farm incomes and thus foster rural development (Braun, Hotchkiss, and Immink 1989; Kydd et al. 2004; Hernández, Reardon, and Berdegué 2007; Maertens and Swinnen 2009). Based on the argument that participation in high-value markets can provide an avenue out of poverty in rural areas, 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 major barriers in their access to high-value markets (Dolan and Humphrey 2000; Henson et al. 2005; Schuster and Maertens 2013). An extensive set of literature dealing with the determinants of smallholder participation in modern food markets offers mixed results. Berdegué et al. (2005), Dolan and Humphrey (2000), Reardon et al. (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. In contrast, Bellemare (2012), Henson et al. (2005), Maertens and Swinnen (2009), Minten et al. (2009), Reardon et al. (2009), and Schipmann and Qaim (2010) describe successful cases of smallholder inclusion that rely on institutional innovations, such as contract farming schemes.

While these studies provide some evidence on the determinants of participation at a particular point in time, little research has been done on the sustainability of smallholder inclusion in high-value chains over time. This is of particular relevance as some studies suggests that contract farming schemes regularly lose participants or collapse entirely (Barrett et al. 2012). Therefore, the dynamics of participation may be much more complex than suggested by cross-sectional studies and may also explain to some extent seemingly contradictory results. A few recent studies have investigated the dynamics of market participation focusing on domestic supermarkets in Kenya (Andersson et al. 2015), export-related standard adoption in Thailand (Holzapfel and Wollni 2014), and the disadoption of horticultural export crops in Guatemala (Carletto et al. 2010). However, due to the difficulty of obtaining consistent data on farmers' marketing choices over several years, these studies rely on two-year panel or recall data. These data are usually too short or not precise enough to reveal the complex dynamics of (multiple) entries and exits from a high-value chain and the relative importance of transaction risks for contract performance.

The aim of this study is to address this research gap by analyzing the factors influencing smallholders' decision to deliver their produce to the export market as well as the decision to remain a supplier or to drop out temporarily or permanently from the export chain. We place particular emphasis on the role of transaction risks (i.e. payment delays and product

rejections) that may influence and shape the farmers' marketing decisions. We thus investigate the effects of household characteristics and past experiences in the supply chain on the extent of participation (measured in terms of the quantity delivered to the export chain). Furthermore, we analyze the determinants of withdrawal from the export chain, taking into consideration that farmers may enter and exit the chain multiple times.

Our analyses are based on a unique data set consisting of original household survey data collected in 2012 and the records of a collection center to which the broccoli from small-scale farmers destined for the export market is delivered. The records of the collection center contain transaction level information for every transaction of all the suppliers during the past eleven years (i.e. since it was established). Our data shows that a large percentage of small-scale farmers do not participate continuously in the high-value export market channel, but instead decide to abandon it temporarily or completely and return to the local market. Using panel data we can investigate the dynamic relationships within the supply chain while controlling for unobserved heterogeneity of farmers and for yearly shocks that may affect production levels (e.g. weather shocks, price shocks, etc.).

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

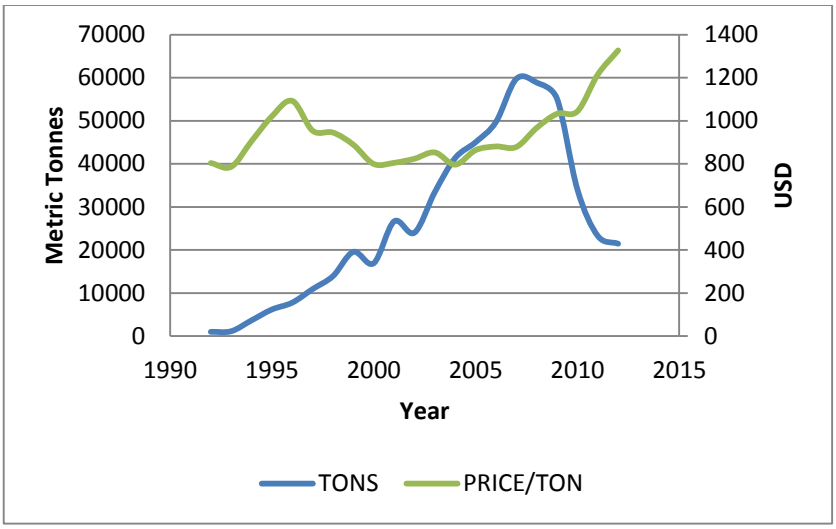
2. The broccoli market in Ecuador

Broccoli was introduced as an export crop in Ecuador in the 1990's and since then its cultivation has spread rapidly until it became the country's 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 export prices and quantities of broccoli and cauliflower[1] 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)[2]. During the same time, export prices have been relatively stable spiking in 1996 and then again since 2007 showing an increasing tendency.

[1] Data for broccoli alone are not available.

[2] The price/ton depicted in the graph was obtained dividing total broccoli and cauliflower exported per year by total income received obtained from national statistics. 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[3] were linked to the export market. A few years later, small-scale farms[4] represented one-third of the total broccoli area planted for the international market and the remaining two-thirds were cultivated by medium and large-scale farms as well as by the same exporting firms in vertically integrated production units[5] (Gall 2009).

Small-scale farmers were linked to the export market through a producer organization that served as an intermediary between farmers and the export firm. The producer organization established a collection center in the village in order to assemble the broccoli 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 chain as suppliers[6].

Between the exporter and the producer organization a written contract was signed, in which the volume, a fixed price, quality and payment conditions were specified. The producer organization relied on verbal agreements with smallholder farmers regarding the quantity and quality specifications of broccoli deliveries and the time to payment. A typical production contract system was put into operation with the exporter providing the plants through the collection center and facilitating access to the market and technical information. The collection center at the same time offered access to inputs and credit to its suppliers. The farmers on the other hand were in charge of growing broccoli on their land under the firm's

[3]Small-scale farmers were supported by a local NGO to form a producer group and produce broccoli for the export market.
[4] Defined as farmers owning less than 20 ha (Gall, 2009).
[5] Large and medium scale plantations are located in the province of Cotopaxi and were not included in our analysis.
[6] For more insights on the advantages of working with smallholders in this specific case refer to Gall (2009).

technical direction and had to deliver the product to the collection center in order to pay for the services received.

In summary, the broccoli harvest and post-harvest process consists of the following stages: i) prior to the harvest, the farmer has to decide 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[7]. 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 (on average one truck is dispatched every working day from the collection center to the firm). Finally, iv) the product meeting the exporting firm's quality requirements is accepted and the payment should be 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[8].

Nowadays, twelve years after the inclusion process started, a large percentage of small-scale suppliers have abandoned the scheme and the collection center faces a shortage of broccoli supplies. In consequence of the global financial crisis starting in 2007, 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 product delivered over several months. 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' collection center still has a large debt to recover from the exporter. After their original buyer went out of business, the farmers' collection center 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. The contract scheme outlined above still applies in this new marketing relationship, and is re-negotiated on an annual basis.

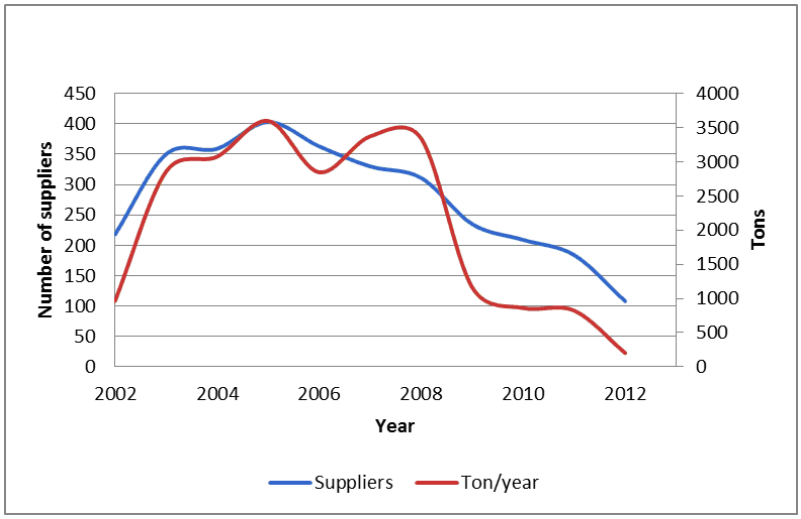
In personal interviews, the exporters have emphasized the existing demand for Ecuadorian broccoli in the international market due to its high quality and the constant need for new and efficient suppliers given land constraints that hinder the expansion of their own plantations. Yet, they have also pointed 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

[7] 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 where the farmer can assist and verify the process.
[8] 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.

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

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



Source: Farmers' collection center records

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 where there are multiple buyers and multiple sellers and payment is usually made at the moment of the transaction. 2.) The export market: characterized by vertical coordination 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 should be made 15 days after delivery and the closer relationship between the parties can facilitate 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' group under study.

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, or in other words, higher than their opportunity costs of participation (Barrett et al. 2012). The farmer's utility associated with participation in the export chain is influenced by several factors including revenues and production costs as well as the transaction risks associated with selling broccoli in the export sector. Based on the framework proposed by Williamson (1979) and extended by Hobbs and Young (2000), Table 1 summarizes the transaction risks associated with the commercialization of broccoli in the export chain compared to the alternative, i.e., the local market.

Table 1: Transaction risks associated with export market participation

Transaction risks related to:	**Exposure in export market (compared to local market)**
Price uncertainty	Lower (annually fixed price)
Timing of payment uncertainty	Higher (frequent delays)
Buyer uncertainty	Lower (secure buyer)
Quality uncertainty	Higher (frequent product rejections)
Relationship-specific investments (and related exposure to opportunistic behavior)	Higher (in particular after harvest)

While certain types of risks are typically reduced through contract farming arrangements that link smallholders to export markets similar to the one studied here, other types of risks can be exacerbated (Barrett et al. 2012). Uncertainty related to the price and to finding a suitable buyer is usually lower compared to transactions in the local market, given that a purchase agreement exists with a secure buyer and the price is negotiated ex-ante, thus allowing farmers to plan production costs accordingly. However, new uncertainties may be introduced, e.g., related to the farmer's ability to meet strict quality requirements. Furthermore, even though an ex-ante agreement exists, the exporter may renege on the agreement[9], e.g. by rejecting produce inappropriately or by delaying or defaulting on the final payment[10] (Barrett et al. 2012). When high quality requirements are defined, as in the export market, uncertainty surrounding the compliance with these quality criteria increases (in particular when criteria are difficult to determine objectively and depend on subjective assessment). As a result, the

[9] This refers to both situations in which the exporter is experiencing a negative shock and is therefore unable to fulfill his contract obligations as well as situations in which the exporter is behaving opportunistically.
[10] When payments are delayed, the contracting firm is effectively extracting rents from its suppliers by getting access to interest-free loans. Suppliers on the other hand experience economic losses and can face cash-flow shortages, especially if they are credit-constrained.

grading process, often performed in the absence of the farmer, is characterized by asymmetric information and can be susceptible to opportunistic behavior (as reported by Saenger et al. 2014). Furthermore, uncertainties are exacerbated by relationship-specific investments incurred by farmers producing for the export market. In the broccoli sector, these become especially relevant after harvest, due to distinct harvesting technologies between the two markets. Thus, once the product has been harvested for the export market, the farmer is locked into the marketing relationship with the exporter, given that his second best option of marketing the broccoli elsewhere now tends towards zero[11]. We expect that the realization of these transaction risks, i.e., to what extent the exporter takes advantage of holdup opportunities, determines the gains accruing to farmers, and thus, in the long term the dynamics of smallholder participation in the export market. In particular, past holdups experienced by the farmer threaten the sustainability of the chain by reducing the farmer's willingness to invest, and thus the quantity and quality of produce delivered, and – if transaction risks become too high – 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 the same infrastructure and climatic 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

[11] In the local market, asset specificity is lower, because multiple buyers exist. Accordingly, even if one buyer turns down the produce, other equally good marketing options exist in the spot market.
[12] The main purpose of inclusive business is to link small/poor producers to the market in a sustainable way.
[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.

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 on 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. Information on farm size and on family members who have worked in the collection center was obtained for the past eleven years using recall data. The respondent's attitude towards risk was measured using an experimental risk lottery designed by Binswanger (1980), where real payoffs were offered. 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 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

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 specifying the following model:

$$Q_{it} = \alpha Q_{i(t-1)} + \beta TR_{i(t-1)} + \theta \boldsymbol{X}_{it} + \pi \boldsymbol{Z}_i + c_i + \mu_{it}$$

The extent of participation is measured as the quantity Q that farmer i delivers to the export market in year t. Q_{it} is specified as a function of previous deliveries $Q_{i(t-1)}$, the transaction risks experienced by the household in the previous period $TR_{i(t-1)}$, a vector of other time variant covariates X_{it}, and a vector of time invariant covariates Z_i potentially influencing the marketing decision. The error term is composed of a time constant unobserved heterogeneity term (c_i) reflecting the unobserved characteristics of each individual (e.g. management ability, motivation, cognitive ability, etc.), and a time varying error term (μ_{it}), which reflects external shocks that are non-systematic. If the farmer does not deliver any broccoli to the export market during a specific year, Q_{it} is set to zero, i.e. the observation enters the analysis. However, transaction risks are not observed during years in which the farmer does not

participate in the export market, resulting in missing values in the subsequent year, and thus giving our panel an unbalanced structure.

There are three potential sources of endogeneity in our estimation: i) The decision to participate each year may be correlated with the constant unobserved characteristics of each individual (c_i) (e.g. loyal individuals may participate more consistently, while others decide to participate only sporadically). ii) c_i may be correlated with the independent variables (e.g. the motivation of a farmer can influence the quantity delivered to the export sector, but also the quality of the broccoli and thus the quantity rejected). iii) Controlling for persistence in supplying behavior may cause endogeneity, because the lag term of the dependent variable $Q_{i(t-1)}$ is likely to be correlated with the error term (due to c_i) (Bond 2002). Even though we are not interested in the effect of $Q_{i(t-1)}$, Bond (2002) states the necessity to control for possible autoregressive dynamics in order to obtain consistent estimates of the remaining parameters. We propose two estimation techniques to address these problems: a) a Correlated Random Effects model for unbalanced panel data to control for unobserved heterogeneity (c_i), and b) a First-Differenced General Method of Moments model, which eliminates c_i and controls for the endogeneity of $Q_{i(t-1)}$.

Correlated random effects (CRE) model for unbalanced panels

With panel data, one way of controlling for time constant unobserved heterogeneity (c_i) is to use Fixed Effects estimators. This removes, however, all time constant explanatory variables (Z_i) from the analysis, which are often of interest for understanding the drivers and barriers to participation. This disadvantage can be overcome using the Mundlak-Chamberlain approach, which controls for fixed effects by including a correlated random effects (CRE) estimator. Wooldridge (2010) show that this method is also valid for obtaining unbiased estimators with unbalanced panels, as long as we can assume that selection is not correlated with the time varying error term (μ_{it}).

The CRE model allows for linear correlation between the unobserved heterogeneity term c_i and the observed explanatory variables by including a vector of variables containing the means of all time-varying covariates for each household as indicated in the following equation:

$$Q_{it} = \alpha Q_{i(t-1)} + \beta \boldsymbol{X}_{it} + \pi \boldsymbol{Z}_i + \xi \overline{X}_t + a_i + \mu_{it}$$

where $\boldsymbol{X}_{it}$ contains all time-varying covariates including $TR_{i(t-1)}$, and $\overline{X}_t$ is a vector of variables containing the means of the time-varying covariates including the time dummies (Wooldridge 2010) . In unbalanced panels, the calculation of means is based only on the selected observations that enter the estimation in the specific year (Wooldridge 2010). With this approach we eliminate the problem of self-selection based on c_i and the endogeneity caused by possible correlation between covariates and c_i. The model is estimated using Random Effects and standard errors are clustered at the household level to obtain estimates robust to heteroskedasticity and correlation among the disturbances as recommended by Wooldridge (2010).

Generalized Method of Moments

The second estimation strategy is First-Diff GMM developed by Arellano and Bond (1991). It uses first differences to eliminate the unobserved heterogeneity term (c_i) and an instrumental variable approach to eliminate the endogeneity of the lagged dependent variable ($Q_{i(t-1)}$). For this purpose, further lags of $Q_{i(t-1)}$ in levels are used as instruments. The final model to be estimated is specified in the following equation:

$$\Delta Q_{it} = \alpha \Delta Q_{i(t-1)} + \beta \Delta \boldsymbol{X}_{it} + \Delta \mu_{it} \; |\alpha| < 1$$

where $\Delta \boldsymbol{X}_{it}$ contains all differences of the time-variant covariates including $TR_{i(t-1)}$. First difference GMM is expected to perform poorly if the series used in the estimation are random walks or highly persistent (Bond 2002). A necessary assumption for the model is that the time-varying errors are not serially correlated. This implies that $Q_{i(t-2)}$ and past lagged levels are not correlated with $\Delta \mu_{it}$ and therefore can be used as instruments for $\Delta Q_{i(t-1)}$. The assumption of no serial correlation is fulfilled if there is no second-order serial correlation in the first-differenced residuals[14]. The validity of the instruments can be tested using the Sargan test of over-identifying restrictions.

An indication of the consistency of α can be obtained by comparing the first-differenced GMM results with those obtained with OLS and Fixed Effects. Since $Q_{i(t-1)}$ is correlated with the individual effects (c_i), the OLS estimate is expected to be biased upwards. On the other end, the Fixed Effects estimate will be biased downwards, because of the negative correlation introduced between the transformed lagged dependent variable and the transformed error term. Therefore, a consistent estimator of α is expected to lie between the ones obtained with OLS and FE (Bond, Hoeffler, and Temple 2001; Bond 2002).

4.2.2. Dropping out of a high-value chain

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). 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 he stops 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

[14] First order serial correlation is expected in the first-differenced residuals even if the disturbances are serially uncorrelated. When using System GMM, second order correlation is present, therefore we limit our model to using only Difference-GMM.

variant covariates (X_{it}) is included, which is fixed within the interval *t* and speeds up or delays the failure time of the individual. A vector of time invariant covariates ($\boldsymbol{Z}_t$) is also observed, which is constant over the whole period under study.

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:

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

Where $T_i = t$ denotes failure within interval *t*, $T_i \geq t$ denotes survival up to time *t* for individual *i*, X_{it} is a vector of time varying covariates including $TR_{i(t-1)}$, and Z_i is a vector of time invariant covariates.

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:

$$\alpha_{ij}(t) = \alpha_0(t)exp(\beta X_{ij} + \gamma Z_i + v_j)$$

Where $\alpha_0(t)$ is the unspecified baseline hazard, v_j corresponds to the error term (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 times for each farmer are not independent from each other and thus the standard errors should be adjusted to account for this possible correlation. The option of shared frailty 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). As we consider time discrete (yearly data), 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. Potential determinants

Among the 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

[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).

captured by the variables: a) *days to payment*$_{(t-1)}$ which is the average number of days the farmer had to wait for payment from the exporter in the previous year, and b) *log_kg rejected*$_{(t-1)}$ which represents the total kilograms rejected by the exporting firm in the previous year in logs[16]. We consider these variables strictly exogenous, which means that feedback from current or past external unobserved shocks has been ruled out.

Regarding other transaction characteristics, the price per kilogram paid by the exporter to the collection center at time *t* is included in the model (p*rice export market*). This value represents a fixed price that is negotiated between the farmers' group and the exporter on an annual basis. In addition, we include a dummy that equals one if during 2012 the average price obtained by the farmer in the local market was below the fixed export market price of 2012. We use this variable as a proxy for *low bargaining power in the local market*. As we only have farmer-specific local market prices for 2012 and not for the full study period, we implicitly assume that individual bargaining power remained invariable throughout the analyzed time period.

Furthermore, we consider three distinct proxies for social networks and information access. First, we include a dummy variable that equals one if the farmer has *family ties with workers of the collection center*. Given that family ties play an important role in Latin American rural societies (Carlos and Sellers 1972), farmers may feel more obliged to meet their commitment and deliver their produce to the collection center, if a family member is working there. 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. Second, we follow Moser and Barrett (2006) using the aggregate quantity delivered per village (*aggregate village supplies*$_{(t-1)}$) 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. Therefore, if many village members are active suppliers of the export market and village leaders encourage participation, individual farmers might associate higher social acceptance with that particular marketing channel. In addition, higher levels of aggregate village supplies can also result in better access to information and lower costs of transportation for individual farmers. In the econometric estimation we consider this variable as pre-determined (it may be influenced by past external shocks) and use lagged aggregate village supplies to minimize endogeneity problems resulting from reverse causality. Third, *membership in the farmers' group* operating the collection center can facilitate access to information, e.g. regarding the conditions of export market participation, and to the services provided by the organization such as access to technical support and credit. In addition, members made monetary contributions to the initial investments of the organization and therefore have a stake in the business, which also makes them more likely to patronize the collection center. It is important to note that farmers became members of the farmers' group when it was founded in 2001, and in the following years no new members were admitted.

[16] In the duration model, we do not control for the total amount of broccoli delivered in the previous time period, and therefore, instead of the absolute quantity rejected we include the percentage of produce rejected in the previous time period.

While often unobserved in empirical studies due to the difficulty of measurement, we also include the farmer's attitude towards risk as a potential determinant. This is particularly important in the context of our study, given that the farmer's risk attitude is likely to influence his subjective perception and evaluation of transaction risks. We played an experimental game with real payoffs proposed by 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) and normalized to a scale from 0 (low risk aversion) to 1 (high risk aversion). We expect that more risk-averse farmers prefer the market channel associated with lower risk. Accordingly, risk-averse farmers may be more likely to participate in the export chain offering them a secure market and a secure price. On the other hand, if there is mounting evidence of increasing transaction risks, such as payment delays or product rejections, risk-averse farmers may be the first to drop out of the chain.

To capture poverty, we use a dummy variable that equals one if the household received a governmental cash transfer (*cash transfer*), which is targeted to the poorest households in the country. Other variables capturing household and farm characteristics are included as controls, such as age, gender and education of the household head, number of household members, lagged farm size, and distance to the collection center in kilometers. In most specifications, we include 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 negative external shock caused by 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. Year and village dummies are also included to control for year-specific macroeconomic effects and shocks as well as village-specific characteristics.

5. Descriptive results

Descriptive statistics for the covariates included in the models are presented in Table 2 as well as in Table A1 in the Appendix. Table 2 compares the characteristics for the year 2012 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 results indicate that while most of the household characteristics do not differ significantly between the three groups, 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. 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 (*cash transfer*), however, we do find evidence that current participants are significantly poorer than non-participants. Finally, we find significant differences between the groups with respect to social networks. A significantly larger share of current participants is member of the farmers' group and has 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.

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, because some of their produce was destined to the export sector.

Table 2: Household, farm and transaction characteristics in 2012, by participation status [a]

Variable	**a. Current part.**	**b. Former part.**	**c. Non-part.**	**Sig. differences**		
(no. obs)	*88*	*195*	*118*	*ab*	*bc*	*ac*
Household characteristics						
Risk aversion	0.247	0.211	0.267			
HH members	4.17	4.18	4.32			
HH head age	48.35	47.23	46.58			
HH member has off-farm job	0.72	0.64	0.74		*	
HH head secondary education	0.19	0.23	0.35	**	**	**
Farming experience	10.23	9.59	8.14		**	**
Farm characteristics						
Distance to collection center (km)	1.37	4.51	10.02	***	***	***
Distance to local market (km)	13.25	12.05	9.91	***	***	***
Total area (solar)[b]	4.21	5.13	6.50			*
Own area (solar)	3.73	4.3	5.07			
Broccoli area (solar)	2.61	1.95	2.07	**	**	***
Wealth related variables						
Cash transfer	0.70	0.6	0.52	*		***
Total income (USD)	6412.09	7766.7	8576.87			**
Total farm income (USD)	2740.10	2777.32	3214.68			
Social Networks						
Membership farmers' group	0.48	0.24	0.00	***	***	***
Family ties	0.34	0.10	0.01	***	***	***
Relatives in local market	5.17	5.42	4.02		***	**
Relatives in export market	4.0	1.64	0.43	***	***	***

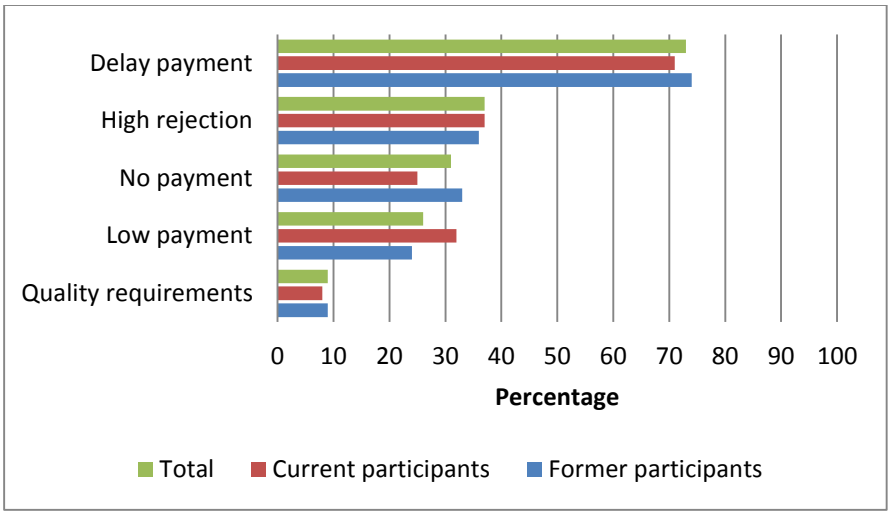
Characteristics of the transaction						
Broccoli income total	1117.91	1014.33	1101.99			
Broccoli income local market	635.12	904.72	1067.05			**
Delivers only to collection center	0.22	0	0	***		**
Days to payment (local market)	4.2	2.65	1.81	***	*	***
Days to payment (export market)	38.54	-	-			
% rejection (in export market)	11.5	-	-			

[a] Mean values calculated from survey data. An explanation of each variable can be found in Table A1 in the appendix.
[b] Area is measured in *solar*. 1 solar = 1700m^2 (approximately)
*Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level

With respect to the transaction risks, we can observe stark differences between the two marketing channels. In the export market farmers had to wait on average 38 days for their payment in 2012, whereas in the local market payment was made on average within two to four days after delivery. Similarly, stringent quality requirements result in relatively high rejection rates in the export sector. On the average, 11.5% of produce delivered by current participants was rejected in the high-value chain, while in the local market produce rejections are not an issue. In the export market, farmers received a fixed price of 0.25 US$/kg throughout the whole year, whereas in the local market farmers faced extremely volatile prices ranging from 0.04 US$/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 as an important problem. This reflects the high levels of uncertainty to which farmers in the export sector are exposed. 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.

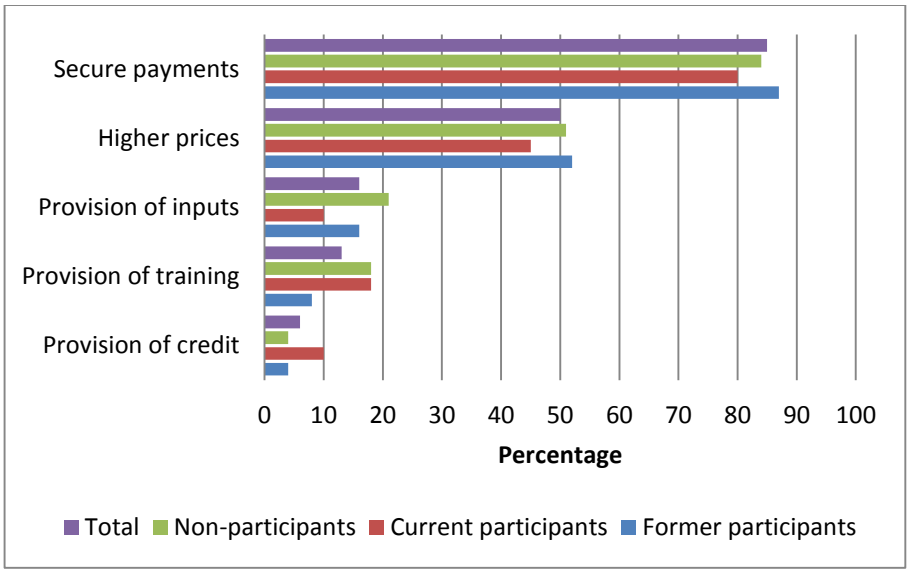
Fig. 3: Problems experienced by farmers in the export sector [a]



[a]*Sub-sample of 283 surveyed farmers who ever delivered broccoli to the export sector.*

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 was supported by a legal document[17] (Figure 4). The conditions that are critical for them to sign an agreement include secure payment (85%) and higher prices (50%). Less than 16% 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 functioning factor markets in the area.

Fig. 4: Farmer's conditions for signing a new contract [a]



[a]*Subsample of 254 farmers willing to sign a new contract.*

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

6. Econometric results

When investigating the determinants of the quantities delivered to the export market or the factors influencing the withdrawal from the export chain, those farmers who never participated in the export chain (*non-participants*) are not considered in the analyses, given that participation is a pre-requisite for the subsequent decision of product allocation and withdrawal from the chain[18]. Nonetheless, we are interested to know whether there are systematic differences between those farmers who at some stage supplied the export market and those farmers who have never done so. To test for potential selection bias, we estimate a Heckman selection model based on the full sample (non-participants, former and current participants). In the first stage, a probit model is used to predict the probability of ever participating in the export market. In the second stage, for those farmers who have ever supplied the export sector the quantity delivered during their first year of participation is predicted. Estimation results are reported in Table A3 in the appendix. Rho is not statistically significant, indicating that sample selection is not an issue and farmers who ever participated in the export sector are not systematically different from those who supply only the local market. In the following sections, those farmers who have never entered the export sector are not further regarded in the analyses.

6.1. Extent of participation

Table 3 presents the estimates from the Correlated Random Effects and First-Differenced GMM models on the determinants of the extent of participation. Models (1) and (2) include interaction terms of various potential explanatory variables with the time dummy 2009-2012 to control for the possibility of a structural break induced by the external financial shock. For comparison, columns (3) to (5) report additional model specifications and alternative estimators. Column (3) provides CRE estimates without interaction effects. Comparing results in columns (2) and (3) illustrates the importance of controlling for the structural break that is associated not only with changes in the magnitude but even in the sign of several coefficients before and after the external shock. Accordingly, the data provides strong evidence that supply patterns were adjusted in response to the crisis. Finally, OLS and Fixed Effects estimates are reported in columns (4) and (5).

[18] In the model on the extent of participation, non-participants could enter the analysis by setting their amount delivered equal to zero. However, if they never participated in the export chain, they never experienced any transaction risks and accordingly drop out of the analysis due to missing values. Setting their transaction risk values equal zero would be misleading, because it suggests that they experienced no problems, when in reality they simply did not perform any transactions in the export sector.

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

VARIABLES	(1) Diff-GMM	(2) CRE	(3) CRE	(4) OLS	(5) FE
Kg delivered$_{(t-1)}$	0.504**	0.378***	0.406***	0.554***	0.224***
	(0.225)	*(0.0408)*	*(0.0409)*	*(0.0432)*	*(0.0507)*
Transaction characteristics					
Days to payment delay$_{(t-1)}$	-9.749*	-9.781*	-3.267	-8.742**	-8.868*
	(5.880)	*(5.221)*	*(2.621)*	*(3.548)*	*(4.884)*
Log kg rejected$_{(t-1)}$	-2,330***	-460.3*	-1,099***	109.2	221.0
	(822.2)	*(262.5)*	*(178.2)*	*(244.6)*	*(275.4)*
Price export market	88.38	2,349	3,263**	452.4	-170.4
	(518.0)	*(1,665)*	*(1,502)*	*(514.2)*	*(411.5)*
Low bargaining local market		213.8	147.3		
		(425.9)	*(243.5)*		
Social networks					
Family ties	651.5	-648.2	-1,309	1,032	228.7
	(1,283)	*(1,225)*	*(846.8)*	*(947.6)*	*(1,313)*
Aggregate village supplies$_{(t-1)}$	2.439	0.111	1.517***	0.565	1.723***
	(2.127)	*(0.709)*	*(0.579)*	*(0.463)*	*(0.647)*
Membership farmers'group		1,758***	454.7		
		(586.5)	*(360.2)*		
Other control variables					
Risk aversion		643.3	-142.1		
		(551.2)	*(301.3)*		
HH members	225.2	-1,664**	-1,348*	-3.644	-1,855**
	(1,046)	*(776.5)*	*(765.7)*	*(90.56)*	*(780.7)*
HH head female		-16.97	204.0		
		(482.7)	*(359.5)*		
HH head age	-786.6***	-895.6	-407.7	14.24	137.8
	(286.7)	*(1,365)*	*(1,273)*	*(12.08)*	*(223.8)*
HH head secondary education		-185.3	-222.8		
		(325.2)	*(319.9)*		
Distance to collection center		7.124	-19.47		
		(66.69)	*(69.01)*		
Own area$_{(t-1)}$	731.2**	696.9**	528.0*	166.4**	665.0**
	(361.2)	*(277.5)*	*(289.0)*	*(65.33)*	*(321.0)*
Cash transfer		-777.0**	-295.1		
		(386.6)	*(223.9)*		
Total years of participation		615.7***	539.3***		
		(85.04)	*(84.81)*		
Period 2009 – 2012					
2009-2012 x days to payment$_{(t-1)}$	4.400	7.495		7.922*	5.370
	(6.492)	*(5.875)*		*(4.148)*	*(5.253)*
2009-2012 x log kg rejected$_{(t-1)}$	-935.8**	-1,296***		-1,042***	-1,352***
	(430.3)	*(311.0)*		*(258.0)*	*(310.8)*
2009-2012 x Low bargaining local market		-282.2			
		(610.7)			
2009-2012 x family ties	-1,323	-553.9		-1,036	-2,427*
	(1,750)	*(1,307)*		*(1,080)*	*(1,462)*
2009-20012 x aggregate village supplies$_{(t-1)}$	-1.717	0.873		-0.827*	-0.0818
	(1.108)	*(0.587)*		*(0.489)*	*(0.463)*

2009-2012 x membership farmers' group		-3,227***			
		(798.1)			
2009-2012 x risk aversion		-1,780**			
		(784.5)			
2009-2012 x HH head female		732.8			
		(615.3)			
2009-2012 x own area$_{(t-1)}$	-43.39	-204.6***		-61.37	-229.2***
	(142.4)	*(71.51)*		*(82.99)*	*(86.69)*
2009-2012 x cash transfer		914.1*			
		(542.7)			
Constant		-65,257	-77,014*	-7,480	9,519
		(49,953)	*(46,588)*	*(10,307)*	*(14,358)*
Observations	1,108	1,480	1,480	1,483	1,483
R-squared		0.5939	0.5717	0.498	0.430

Robust standard errors in parenthesis; *** p<0.01, ** p<0.05, * p<0.1

Dummies for years and villages included in both models.

Means for the time-variant covariates included in the CRE model.

Probability weights are used to correct for sampling stratification in models 1, 4, 5.

In the Diff-GMM model (column (1)) we address the endogeneity of the lagged dependent variable *kg delivered$_{(t-1)}$* by using lags two to five as instruments. A Fisher-type unit root test for panel data rules out the existence of random walks in the series used in the model confirming its validity (results are reported in Table A4 in the appendix). The Sargan and Hansen tests also show that the instruments used are exogenous to the lagged dependent variable and therefore valid for the estimation (results are reported in Table A5 in the appendix). Additionally, we find no autocorrelation of second order in the model using the Arellano-Bond test for autocorrelation[19]. Autocorrelation of first order is expected in first differences because $\Delta\mu_t$ and $\Delta\mu_{t-1}$ share a common term (results are reported in Table A6 in the appendix). Controlling for potential endogeneity, the Diff-GMM estimates show that the amount of broccoli delivered in the previous period has a significantly positive effect on the amount of broccoli delivered in the current period. The coefficient estimate obtained from the Diff-GMM model lies between the OLS and Fixed Effects estimates, which confirms its consistency. The path dependency or persistence of deliveries reflected in this coefficient is in line with other studies that have reported a strong positive correlation between lagged and current horticultural export volumes (e.g. Schuster and Maertens (2015) for the Peruvian asparagus sector).

Regarding transaction risks, we find – consistently across both models (columns (1) and (2)) – a strongly negative effect of past produce rejections on the extent of participation. According to the CRE model estimates, a one percent increase in the amount rejected in the previous year leads to a decrease in current deliveries of 4.6 kg. This effect is even further exacerbated by the crisis, after which a one percent increase in rejection rate is associated with a decrease in the delivered quantity by 17.6 kg. Once we adequately control for the endogeneity of lagged product deliveries, the Diff-GMM model predicts an even stronger effect of product rejections ranging from a reduction in deliveries of 23.3 kg before the crisis to 32.7 kg after the crisis. Regarding days of payment, results are also consistent across both models,

[19] The existence of autocorrelation of second order would invalidate the use of lags as instruments.

indicating a negative effect that is statistically significant at the 10% level. Accordingly, each additional day of payment in the previous period decreases current product deliveries by 9.8 kg. The effect of days of payment on product deliveries remains unaltered after the external shock.

The CRE model further allows us to investigate the relationship between potential time-invariant determinants and the extent of participation. First of all, a strong and significantly positive correlation is identified for membership in the farmers' group. On the average, membership increases deliveries by as much as 1758 kg compared to non-members. This positive effect, however, reverses with the event of the negative external shock to the supply chain. After the crisis, members on the average deliver 1469 kg less to the collection center than non-members. This may be due to members having better access to information regarding the performance of the organization and thus being more aware of the difficult situation faced by the supply chain and reacting accordingly by reducing their produce allocated to the export market. Besides membership in the farmers' group, the other social network variables (aggregate village supplies[20] and family ties) do not seem to play an important role in farmers' product allocation decisions among alternative market outlets.

Finally, we observe that the quantity delivered increases with farm size, and that poor farmers deliver significantly less compared to non-poor households. These relationships are affected, however, by the negative external shock. After the supply chain is struck by the crisis in 2009, farmers with larger farm sizes reduce their produce allocation to the export market, even though the overall effect of farm size remains positive. On the other hand, the difference between poor and non-poor farmers becomes insignificant in the post-crisis period (joint significance of the coefficients on *cash transfer* and the interaction term: p= 0.1327). Finally, farmers with higher risk aversion respond to the crisis delivering significantly less compared to farmers with low risk aversion in the post-crisis period.

6.2. Dropping out of a high-value chain

Table 4 shows estimation results from the Cox model of proportional hazards analyzing the decision of current and former participants to exit the export market. The coefficients represent the change in the log odds of the outcome variable 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 the outcome variable, which means a decrease in the hazards of dropping out of the export sector (hazard ratio < 1). On the contrary, a positive coefficient reflects an increase in the log odds of the outcome variable, meaning an increase in the hazards of dropping out (hazard ratio > 1). The empirical hazard function is visualized in Figure A1 (in the appendix). It represents the conditional probability of dropping out in each time period, given that the farmer did not drop out in the previous time period, but without taking potential multiplicative effects of covariates into account. Figure A1 suggests that the baseline hazard of dropping out increases during the early years of

[20] In the Diff-GMM model we instrument for the pre-determined variable *Aggregate village supply(t-1)* using the lags seven to ten as instruments. Sargan and Hansen test results are reported in the appendix and confirm the validity of the instruments.

participation, stays relatively constant between years five to seven, and then increases sharply after year eight.

Table 4: Results on the hazard of dropping out of the export sector

VARIABLES	(1)		(2)	
	Coefficient	Hazard ratio	Coefficient	Hazard ratio
Transaction characteristics				
Days to payment $_{(t-1)}$	0.0042**	1.0042**	0.0032***	1.0033***
	(0.0021)	*(0.0024)*	*(0.0011)*	*(0.0012)*
% rejection$_{(t-1)}$	0.0608**	1.0627**	0.0164	1.0165
	(0.0285)	*(0.033)*	*(0.0164)*	*(0.016)*
Price export market	-0.507	0.6021	-0.449	0.6384
	(0.400)	*(0.236)*	*(0.385)*	*(0.246)*
Low bargaining local market	-1.401**	0.2462**	-0.599**	0.5490**
	(0.706)	*(0.179)*	*(0.293)*	*(0.133)*
Social networks				
Family ties	1.173**	3.2319**	-0.0512	0.9501
	(0.494)	*(1.680)*	*(0.255)*	*(0.22)*
Aggregate village supplies$_{(t-1)}$	-0.0001	0.9999	-0.0003	0.9997
	(0.0003)	*(0.0003)*	*(0.0002)*	*(0.0003)*
Membership farmers' group	-2.452***	0.0861***	-1.153***	0.3155***
	(0.438)	*(0.038)*	*(0.232)*	*(0.069)*
Other control variables				
Risk aversion	-0.307	0.7356	-0.207	0.8132
	(0.331)	*(0.275)*	*(0.203)*	*(0.175)*
HH members	0.0178	1.0180	0.0195	1.0197
	(0.0466)	*(0.047)*	*(0.0488)*	*(0.047)*
HH head age	-0.0066	0.9934	-0.0043	0.9956
	(0.0065)	*(0.0066)*	*(0.0064)*	*(0.0066)*
HH head secondary education	-0.0929	0.9113	-0.0442	0.9568
	(0.177)	*(0.174)*	*(0.174)*	*(0.181)*
HH head female	0.692**	1.9985**	0.315	1.3708
	(0.288)	*(0.564)*	*(0.239)*	*(0.291)*
Distance to collection center	-0.00439	0.9956	-0.00691	0.9931
	(0.0282)	*(0.052)*	*(0.0322)*	*(0.053)*
Own area$_{(t-1)}$	-0.00687	0.9932	-0.0141	0.986
	(0.0132)	*(0.02)*	*(0.0126)*	*(0.016)*
Cash transfer	0.403*	1.4969*	0.168	1.1831
	(0.208)	*(0.337)*	*(0.131)*	*(0.174)*
Period 2009 - 2012				
d2009-2012 x days to payment$_{(t-1)}$	-0.00156	0.9984		
	(0.0024)	*(0.0027)*		
d2009-2012 x % rejection$_{(t-1)}$	-0.0554	0.9461		
	(0.0362)	*(0.034)*		
d2009-2012 x Low bargaining local market	1.018	2.7673		
	(0.744)	*(2.1358)*		
d2009-2012 x family ties	-1.501***	0.2228***		
	(0.528)	*(0.129)*		
d2009-2012 x aggregate village supplies$_{(t-1)}$	-0.0001	0.9998		
	(0.0002)	*(0.0003)*		
d2009-2012 x membership farmers' group	1.787***	5.9721***		
	(0.495)	*(3.019)*		

d2009-2012 x Risk aversion	0.111	1.1176	
	(0.411)	*(0.5069)*	
d2009-2012 x HH head female	-0.822**	0.4395**	
	(0.419)	*(0.191)*	
d2009-2012 x own area$_{(t-1)}$	-0.0181	0.9821	
	(0.0259)	*(0.031)*	
d2009-2012 x Cash transfer	-0.392	0.6756	
	(0.262)	*(0.185)*	
Θ	1.03 e-7		1.03 e-7
Observations	1538		1538
Number of groups	278		278
Log-likelihood	-1174.67		-1188.75

Standard errors in parenthesis: *** p<0.01, ** p<0.05, * p<0.1
Dummies for years and villages included.
Likelihood-ratio test of θ: p=0.498 for both models.

Column (1) in Table 4 provides full results from the Cox model of proportional hazards, including interaction effects and thus allowing for changes in magnitude and size of the coefficients after the structural break induced by the financial crisis. For comparison, we also report results without interaction terms in column (2). As in the extent of participation model, for several variables we observe substantial changes in the effects, both in terms of effect size and direction, after the structural break.

The results of the full model (column (1)) show that the coefficients of the transaction risks variables regarding days to payment and rejections 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 0.42 percentage points. This can become an important risk factor considering that for the period 2004 - 2009 farmers had to wait for more than 60 days on the average for their payment (see Table A2 in the appendix). Moreover, for each additional percentage point of rejection (in relation to the quantity delivered), the hazard rate of withdrawal increases by 6.27 percentage points. These effects remain unchanged after the supply chain shock. Finally, we find that, everything else held constant, farmers with low bargaining power in the local market tend to drop out of the export market more slowly, which is intuitive given that they have less attractive outside options. On the average, low bargaining power in the local market decreases the hazard rate of withdrawal by 75 percentage points.

We further 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 223 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 strong punishment when diverting their product entirely to the local market. 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 overall hazard rate of withdrawal by 28 percentage

points[21]. 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 may be a rational strategy, 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 farmers' group has a negative effect on the log odds of dropping out of the export chain, decreasing the hazard rate of withdrawal by almost 91 percentage points, when compared to non-members in normal times. 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 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 49 percentage points. This provides evidence of how the event of a negative external shock, in this case resulting in 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 dropping out of the export sector is correlated with household-specific characteristics. We find that poor and female-headed households drop out faster from the export chain. For poor households, the hazard rate of withdrawal is 50 percentage points higher compared to non-poor households. Similarly, for female-headed households the hazard rate is 100 percentage points higher compared to male-headed households. Interestingly, after the crisis the effect reverses for female-headed households, who now tend to remain longer in the export chain compared to their male counterparts. Compared to male-headed households, the hazard rate of withdrawal is 12 percentage points lower for female-headed households in the period 2009-2012. This marked difference between the two periods is likely to be related to the different transaction costs associated with the two market channels and the perceptions thereof of vulnerable population groups, such as female-headed households. For example, the bankruptcy of the main buyer led to large outstanding debts of the collection center towards farmers. More vulnerable households may be more inclined to stay in the export chain hoping to recover at least some of their payments.

7. 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 controlling for unobserved heterogeneity of the farmers. Given that

[21] To calculate the effect of a variable in the period 2009-2012 the coefficients before and after this period are added and then exponentiated.

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 increase the risk of dropping out entirely. 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. Our results further show that family ties play an important role in the farmers' decision to participate in or drop out of the export chain, however, the relationship is complex. On the one hand, if farmers have family members working at the collection center, they appear to be less loyal and take advantage of short-term benefits when these can be realized in the local market. On the other hand, after the collection center was affected by the bankruptcy of its main buyer, farmers with family ties proved to be more committed staying with the collection center during difficult economic times. This behavior could be explained, if farmers maximize household welfare, rather than the returns from broccoli sales.

Association membership can increase the extent of participation and slow down withdrawal, 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 case study, members holding a share in the collection center are unlikely to be expelled from the farmers' group even when they decide to market their produce elsewhere. Furthermore, members may still derive other benefits from the organization besides having a market outlet for their produce, such as preferential access to credit, training and external support even when they reduce the quantity delivered to their association.

While we find no particular evidence for the exclusion of small-scale farmers from the export sector, we do find that poorer households and female-headed households tend to drop out faster, especially as long as the sector is still prospering. After the sector is struck by the crisis, female-headed households drop out more slowly and larger-scale farmers reduce their supplies to the export sector more drastically than small-scale farmers. This suggests that those farmers, who have better outside options, retire from a crisis-struck sector more immediately, while disadvantaged households may get trapped more easily in less profitable market arrangements.

Based on our results, we derive some policy recommendations aiming to improve the long-term sustainability in high-value chains. As high rejection rates in the export sector have strong economic implications for farmers and thus negatively influence their participation, it is important to increase the transparency regarding the reasons for rejections. Saenger, Torero, and Qaim (2014) e.g. propose the implementation of a third-party control mechanism to increase transparency in the grading process. This could also be useful in the Ecuadorian

broccoli sector, where non-transparent product rejections provoke farmers' mistrust in downward actors of the value chain.

Furthermore, it should be a priority to reduce the risk of external shocks caused by the sudden retirement of an export firm and the consequent default in payment borne by farmers. There is an urgent necessity for a stronger legal framework regulating the finances in contract farming and the participation of small farmers' businesses in such schemes. In particular, adequate safeguards could be demanded from export firms to reduce opportunistic behavior and protect small-scale farmers from bearing the consequences of downstream actors' financial problems.

Finally, farmers' businesses and organizations should be placed in a real network environment. Policy attention needs to shift from supporting and regulating particular organizations towards a whole value chain perspective. The debate about smallholder participation in high-value markets needs to graduate from the initial focus on facilitating access to a focus on how to make these business relationships viable and beneficial in the long term. For donors and practitioners this means for example that it is not sufficient to provide incentives for participation, but that more long-term business assistance is needed, for example improving bargaining skills and providing support to conduct legal actions when farmer association are affected by the opportunistic behavior of downstream actors of the value chain.

8. References

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9. APPENDIX

Table A1. Explanation of variables

Variable	Specification
% rejection	Percentage of produce rejected by the exporter; calculated as kg rejected/kg delivered*100
Aggregate village supplies	Total sum of broccoli supplies delivered to the collection center by village members; measured in metric tons
Broccoli area	Total land area cultivated with broccoli in 2012, in solar
Broccoli income local market	Income from broccoli sold in the local market in USD for 2012
Broccoli income total	Total income from broccoli in USD for 2012 (calculated based on survey data)
Cash transfer	1 if household is eligible for government cash transfer program targeting poor households
Collection center only	1 if farmer sold broccoli exclusively to the collection center in 2012
Distance to collection center	Distance to the collection center in km
Distance to local market	Distance to the nearest local market in km
Family ties	1 if family member works at the collection center
Farming experience	Number of years the household has grown broccoli
HH head age	Age of the household head in years
HH head female	1 if household head is female
HH head secondary education	1 if household head has obtained secondary education
HH member off-farm	1 if household head has off-farm employment
HH members	Number of household members
Kg delivered	Quantity of broccoli delivered to the export market in kg
Kg rejected	Quantity rejected by the exporter in kg
Low bargaining local market	1 if average price obtained in the local market is lower than export market price in 2012
Membership farmers' group	1 if household is a member of the farmers' group
Own area	Total land area owned by the household in 2012, in solar
Days to payment	Number of days after delivery until payment was received (in 2012)
Price export market	Price per kilogram paid by the exporter to the collection center in USD
Relatives in export market	Number of relatives delivering broccoli to the export market
Relatives in local market	Number of relatives delivering broccoli to the local market
Risk aversion	Partial risk aversion coefficient calculated according to Binswanger (1980); normalized to a scale from 0 (low risk aversion) to 1 (high risk aversion)
Total area	Total land area cultivated by the household in 2012 (owned, rented, and under sharecropping), in solar
Total farm income	Total farm income in 2012 in USD

Total income	Total household income in 2012 in USD (incl. farm income, off-farm income, remittances, cash transfers, rents)
Total years of participation	Number of years household has participated in the export market

Note: Land area is measured in *solar*: 1 solar = approx. 1700m^2

Table A2. Descriptive statistics for export market transaction variables per year

Year	Variable	Obs	Mean	Std. Dev.	Min	Max
2002	Kg delivered	112	5996.5	6056.514	127	30543
	Kg rejected	112	514.4375	471.3525	4	2511
	% rejection	112	0.095804	0.037142	0.02	0.2
	Days to payment	111	47.04505	13.62577	17	96
2003	Kg delivered	166	8587.723	7437.829	280	34066
	Kg rejected	166	594.5964	497.4679	11	2587
	% rejection	166	0.073133	0.02071	0.03	0.14
	Days to payment	166	27.21687	14.34345	6	101
2004	Kg delivered	164	9057.701	8087.636	160	34672
	Kg rejected	164	334.3841	328.599	2	1454
	% rejection	164	0.037744	0.028096	0.01	0.28
	Days to payment	164	68.52439	14.35759	23	153
2005	Kg delivered	168	9607.327	8490.575	203	34500
	Kg rejected	167	409.6048	376.4703	8	1724
	% rejection	168	0.042619	0.013939	0	0.14
	Days to payment	168	74.79762	12.74323	21	148
2006	Kg delivered	150	9049.487	7728.636	284	34109
	Kg rejected	150	638.5467	608.9711	15	3064
	% rejection	150	0.064867	0.024184	0.03	0.18
	Days to payment	148	68.53378	11.45082	37	115
2007	Kg delivered	171	10736.37	7757.177	432	34947
	Kg rejected	171	801.0058	1601.17	11	20261
	% rejection	171	0.070175	0.043811	0.03	0.43
	Days to payment	168	80.32143	34.4238	34	489
2008	Kg delivered	176	10588.84	8275.709	478	35275
	Kg rejected	176	1773.614	1932.781	21	11507
	% rejection	176	0.06125	0.021478	0.02	0.17
	Days to payment	176	144.8636	24.67396	66	236
2009	Kg delivered	154	6019.455	5909.05	191	28781
	Kg rejected	152	406.9934	430.0803	11	2673
	% rejection	153	0.066994	0.032969	0.03	0.22
	Days to payment	120	200.575	94.74634	0	388
2010	Kg delivered	146	4495.548	3892.135	111	19194
	Kg rejected	146	389.2877	358.2424	10	1797

	% rejection	146	0.089795	0.044029	0.03	0.42
	Days to payment	145	49.62069	41.68184	0	367
2011	Kg delivered	132	4799.97	4512.431	152	23891
	Kg rejected	132	592.7121	539.3078	27	2794
	% rejection	132	0.133182	0.062362	0.05	0.55
	Days to payment	132	52.34848	35.7472	0	217
2012	Kg delivered	88	1999.545	1881.352	119	10232
	Kg rejected	88	229.8636	230.6466	6	1223
	% rejection	88	0.115	0.046312	0.01	0.23
	Days to payment	85	38.54118	26.77354	0	155

Note: Calculations based on data obtained from the collection center's records. Only the households included in the household survey were used for calculating these values.

Table A3. Heckman model estimates of initial export market participation and extent of participation

Variable	Probability of ever supplying export market	Quantity delivered to export market in first year (kg)
Distance to collection center	-0.110***	
	(0.0132)	
Family ties	-0.0379	954.7
	(0.813)	*(1,748)*
Aggregate village supplies	-0.000141	0.650
	(0.0002)	*(0.700)*
Risk aversion	-0.0261	291.7
	(0.307)	*(948.6)*
HH members	-0.183**	97.55
	(0.0724)	*(163.0)*
HH head secondary education	-0.182	306.5
	(0.272)	*(807.1)*
HH head female	-0.574*	-1,802**
	(0.347)	*(771.6)*
Own area	0.0162**	163.3**
	(0.00744)	*(79.12)*
Cash transfer	0.106	-643.8
	(0.256)	*(623.3)*
Membership farmers' group	7.260***	2,655***
	(0.837)	*(819.0)*
Price export market	2.281***	163.4***
	(0.292)	*(43.56)*
Rho		-0.0151
		(0.071)
Constant	-41.15***	
	(5.341)	

Observations	401	401

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Wald test for rho: p=0.1816

In the first stage probit model on the decision to ever participate in the export sector, we use the distance to the collection center as exclusion restriction. The coefficient is statistically significant, indicating that farmers located further away from the collection center are less likely to participate in the export chain. Furthermore, female-headed households and larger households (family size) have a lower probability to enter the export sector. On the other hand, land size (owned area), membership in farmers' group and export market price positively influence the decision to participate in the export market. The parameter ρ is not statistically significant indicating that there is no systematic unobserved differences between export sector participants and non-participants.

Table A4. Fisher-type unit root test for panel data

Ho: All panels contain unit roots	Number of panels =	283
Ha: At least one panel is stationary	Avg. number of periods =	5.75
AR parameter: Panel-specific	Asymptotics: T -> Infinity	

	Statistic	**p-value**
Kg delivered		
Inverse chi-squared(128)	205.3834	0
Inverse normal	-5.3951	0
Inverse logit t(324)	-5.1144	0
Modified inv. chi-squared	4.8365	0
Kg rejected		
Inverse chi-squared(126)	261.311	0
Inverse normal	-8.0771	0
Inverse logit t(319)	-7.7579	0
Modified inv. chi-squared	8.5238	0
Payment delay		
Inverse chi-squared(128)	182.1162	0.0012
Inverse normal	-4.1785	0
Inverse logit t(324)	-3.8992	0.0001
Modified inv. chi-squared	3.3823	0.0004

Table A5. Sargan/Hansen test

Sargan test of overid. restrictions (Not robust, but not weakened by many instruments)	Prob> chi2	= 0.415

Hansen test of overid. restrictions (Robust, but weakened by many instruments.)	Prob> chi2	= 0.164

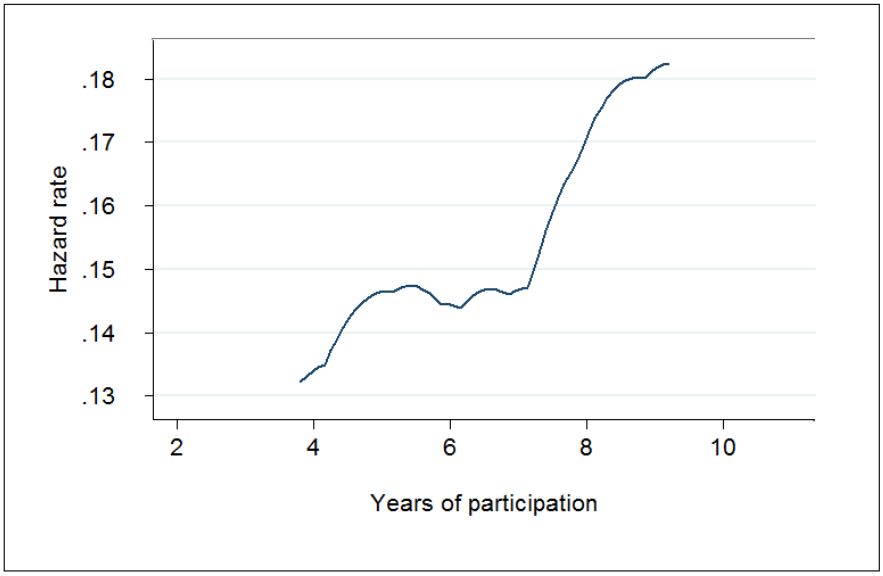
Difference in Hansen tests of exogeneity of instruments subsets

gmm(kg delivered$_{(t-1)}$, collapse lag(2 7))	
Hansen test excluding group:	Prob > chi2 = 0.444
Difference (null H = exogenous):	Prob > chi2 = 0.130
gmm(aggregate village supplies$_{(t-1)}$, collapse lag(7 10))	
Hansen test excluding group:	Prob > chi2 = 0.695
Difference (null H = exogenous):	Prob > chi2 = 0.041

Table A6. Arellano-Bond test for Autocorrelation

Arellano-Bond test for AR(1) in first differences	Prob > z	= 0.004
Arellano-Bond test for AR(2) in first differences	Prob > z	= 0.446

Figure A1. Smoothed hazard estimate for farmer's withdrawal from the export chain



Note: The hazard function is the derivative of the Nelson-Aalen cumulative hazard, which is the number of expected failures in the period (0, t) for a subject, if failure is a repeatable event. As the cumulative hazard can not be directly diffentiated, the hazard is estimated by smoothing the steps of the cumulative hazard with a kernel smoother. This requires averaging values over a moving window of data. Near the endpoints, these windows contain insufficient data for accurate estimation, so the estimators contain boundary bias and are not plotted in the graph (Cleves et al. 2002).