Export vegetable supply chains, household labour allocation and poverty effects among small producers – Evidence from Northern Tanzania

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Summary

Throughout the past years, global agri-food systems have been deeply evolving with the rise and consolidation of modern supply chains. The emergence and increasing role played by these modern supply chains have been prompted by, among others, the growth and increasing domination of supermarkets and retailers as well as an increase of the demand in the developed countries for fresh and healthy products such as fruits and vegetables. This has in turn favoured the expansion of global trade of these high-value agricultural products and in particular their exports from developing countries to developed countries. These modern export supply chains are different than the traditional supply chains in the sense that they are more concentrated, follow a strong vertical coordination pattern with a domination of the aforementioned retailers and are regulated by more stringent quality standards and requirements. A comparable process has also taken place with the emergence of domestic modern supply chains and the rise of supermarkets in developing countries.

These changes have important consequences in terms of agricultural and rural development for developing countries. Indeed, some of the small producers who are not able to comply with these supply chains requirements may no longer be able to participate in the latter and thus be excluded, which could affect their livelihoods. However, in many cases small producers have eventually not systematically been excluded from these modern supply chains and have managed to participate in the latter as suppliers, including through contract farming schemes and other types of supplying arrangements. The implications and development effects for these small producers supplying their produce to modern supply chains have been of interest and analysed by the literature, in particular in terms of labour and employment generation as well as poverty reduction. Yet, some related research areas remain unaddressed.

First, with regard to the labour market effects, evidence from the literature shows that small producer participation in modern supply chains, in particular when it comes to horticultural products, can generate employment opportunities, *via* an increased on-farm casual labour demand, benefitting in particular women. Building on the literature on rural household labour allocation decision process and the concept of non-separability, one could expect that participation in modern export supply chains may potentially affect the labour allocation of participating households, *i.e.* both their on-farm hired labour demand and off-farm labour supply decisions. This specific aspect has not yet been entirely covered by research in this area since little is known about whether and how this labour allocation process in its entirety can be affected by entering modern supply chains as product suppliers. Furthermore, it would

also be interesting to find out more about how these supply chains' labour effects can also affect rural youth (aged 15-34). This is particularly important considering the challenges youth face in rural areas in developing countries, especially *vis-à-vis* their access to farming and rural non-farm activities and employment.

Second, there is a large body of evidence that participation in modern supply chains can have a positive effect on income and contribute to poverty reduction. Yet, much of this evidence builds on the comparison of the effects of participation in modern supply chains with respect to non-participation at all in these supply chains, thus not taking into account the potential heterogeneity of modern supply chains and participation modalities. Indeed, there is evidence that these modern supply chains can differ from each other in terms of their structure, supply arrangements and conditions. Some non-negligible exit rates from producers have also been noted. One could thus assume that participation in these supply chains may convey different effects for participating producers, depending on the characteristics of the supply chains as well as these producers' individual circumstances.

Thus, this dissertation contributes to fill these research gaps and consists of two main chapters. The first chapter aims to analyse the effects of small producer participation in modern export supply chains on household labour allocation, *via* the effects on household on-farm hired labour demand and off-farm labour supply. We also adopt an age-disaggregated approach to analyse whether and how these effects benefit particularly rural youth. The second chapter focuses on the effects of small producer participation in two types of modern export supply chains on poverty. Both chapters are implemented within the context of export vegetable supply chains in Tanzania and rely on data collected in 2015 from 349 vegetable producers.

For the first chapter, the application of a Generalized Separability Test fails to reject the separability hypothesis in our research context. We thus consider on-farm and off-farm labour supply decisions as separable and assess them separately through log-normal double-hurdle models. Using a control function approach, we fail to reject the exogeneity of participation in modern export supply chains. Our main results show that participation in modern export supply chains increases a households' likelihood to hire on-farm labour by about 10 percentage points and their unconditional hired labour demand by 83 percent. The age-disaggregated results show that participation in modern export supply chains increases a households' likelihood to hire young labourers and older labourers (aged 35 and over) by 12 and 13 percentage points, respectively. We also find that it has an effect on the unconditional

hired labour demand for the youth cohort only, which it increases by about 62 percent. The effect on the unconditional hired labour demand for the older age cohort is not statistically significant. On the other hand, we find no evidence of an effect on neither household's decision to enter off-farm labour markets, nor on their total off-farm labour supply.

In the second chapter, we estimate endogenous switching regressions models to assess the effect of participation in modern export supply chains on household per capita income. We differentiate between two types of modern export supply chains: high-value export supply chains and regular export supply chains. We find that overall participation in modern export supply chains has a positive effect on household income per capita, which is increased by 77 percent. However, we find that this effect is mostly driven by the high-value export supply chains, in which participation increases household income per capita by 45 or 99 percent, depending on the comparison group used. On the other hand, we find that participation in regular export supply chains has overall a negative effect on participating producers' household income per capita. Through a disaggregation of the average treatment effects, we also find that larger and richer producers benefit the most from participating in the high-value export supply chains while some of the poorer producers can actually benefit from supplying the regular export supply chains as it would increase their household income per capita by 14 percent.

A few lessons and conclusions can be drawn from these two chapters. In general, they confirm that small producer participation in modern export supply chains has positive effects on rural development, either through labour market effects or directly through product market effects. By generating casual agricultural wage labour employment opportunities, in particular for youth, it creates livelihoods options for the poor. Furthermore, our results confirm that small producers can benefit from participating in the export modern supply chains, although in our research context, this effect seems to be limited to what we have defined as high-value export supply chains. Participation in modern export supply chains *per se* may thus not translate directly into poverty reduction effects. Participation dynamics and modalities of different types of modern export supply chains can affect participating producers' livelihoods differently. These conclusions, as well as policy recommendations and the limitations of the study, are discussed in the last section of this dissertation.

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List of acronyms

ATE	Average Treatment Effect
ATT	Average Treatment Effect on the Treated
ATU	Average Treatment Effect on the Untreated
BH	Base Heterogeneity
CDF	Cumulative Density Function
DHM	Double-Hurdle Model
ESC	Export Supply Chain
FAO	Food and Agriculture Organization of the United Nations
FIML	Full-Information Maximum Likelihood
HODECT	Horticultural Development Council of Tanzania
HVESC	High-Value Vegetable Export Supply Chain
ILO	International Labour Office
IV	Instrumental Variable
LDH	Lognormal Double-Hurdle Model
MSSM	Multivariate Sample-Selection Model
NGO	Non-Governmental Organization
PDF	Probability Density Function
OLS	Ordinary Least Squares
RESC	Regular Vegetable Export Supply Chain
SACCO	Savings and Credit Cooperative Organization
SSM	Sample-Selection Model
TDH	Truncated Normal Double-Hurdle Model
TH	Transitional Heterogeneity
TM	Traditional Market
TZS	Tanzanian Shillings
USD	United States Dollars

À Bassidi

1 General introduction

1.1 Background: the rise and implications of modern supply chains

Agricultural food systems and supply chains have been ongoing through significant changes and an important transformation and globalization process which has spanned over the last few decades (Reardon et al., 2009; Maertens et al., 2012). In a context strongly marked by the liberalization processes affecting developing countries (Swinnen et al., 2011), foreign direct investments and global agricultural trade have strongly increased and contributed to the modernization of the agricultural supply chains, in particular the related food processing and retail sectors (Reardon et al., 2009; Maertens et al., 2012; Swinnen et al., 2015). In parallel, this transformation has also been marked by a shift to high-value agricultural products, in particular fresh fruits and vegetables due to changes in dietary habits in both developed and developing countries (Humphrey et al., 2004; Weinberger and Lumpkin, 2007; Mergenthaler et al., 2009; Qaim, 2017) as well as an increasingly important role played by food requirements and standards covering different aspects related to agricultural production such as environmental, social, health and food safety concerns (Maertens et al., 2012; Chiputwa et al., 2015; Swinnen et al., 2015).

As a result, modern supply chains, comprised of both export supply chains and domestic supermarket supply chains, have emerged in developing countries (Maertens et al., 2012). They present different organizational and institutional characteristics and configurations than the traditional supply chains (Reardon et al., 2009; Maertens et al., 2012). Indeed, they are to a larger extent more vertically coordinated (Reardon and Barrett, 2000) and much more concentrated with a reduced number of retailers (Dolan and Humphrey, 2004). The structure and functioning of these modern supply chains, in particular the high level of the production and quality requirements, have generated some concerns regarding the potential exclusion of small producers as some of the retailers may prefer to further rely on larger commercial farms and estates (Reardon and Barrett, 2000; Reardon et al., 2003; Humphrey et al., 2004; Minten et al., 2009; Schuster and Maertens, 2013). In some cases, rural households have managed to keep participating in these modern supply chains through the labour markets. Indeed, these modern supply chains have generated off-farm employment opportunities, in particular in the horticultural agro-processing sector, which rural households have been taking up (Damiani, 2003; Weinberger and Lumpkin, 2007; Maertens, 2009; Maertens and Swinnen, 2009). Ultimately, in different country and commodity settings, small producers have managed to remain and actively participate as suppliers in these modern supply chains, in many cases

through contract farming schemes (Minten, 2008; Minten et al., 2009; Maertens et al., 2012; Ōtsuka et al., 2016).

The effects of these modern supply chains on the poverty and livelihoods of small producers and rural households through both the product and labour markets (Maertens et al., 2012) have been extensively analysed by the scientific literature. First, *via* the labour markets, a gendered effect should be noted as the aforementioned off-farm employment opportunities are often taken up by women (Barrientos et al., 2003; Maertens et al., 2012). Since a large share of these off-farm labour opportunities are to be found in rural areas (Maertens et al., 2012), their implications for rural development are non-negligible and some research has stressed their effects on household's welfare and overall rural development through various pathways (Maertens, 2009; Maertens and Swinnen, 2009; Maertens and Verhofstadt, 2013).

Second, literature has also shown that small producer participation in these modern supply chains *via* the product markets could also convey important welfare effects. These welfare effects can target participating households directly, for instance by increasing their income (see for example Maertens, 2009; Miyata et al., 2009; Miyata et al., 2009; Rao and Qaim, 2011; Bellemare, 2012), as well as rural households beyond the participating households, through the labour markets and an increased labour demand (Neven et al., 2009; Rao and Qaim, 2013). This dissertation contributes to this literature stream since it exclusively focuses on the effects of small producer participation in modern supply chains through the product markets.

As mentioned above, participation of producers in modern supply chains can positively affect rural labour markets through an increased hired labour demand on their farms (Weinberger and Lumpkin, 2007; Neven et al., 2009; Rao and Qaim, 2013). This increased labour demand is mostly due to the higher labour intensity of the horticultural products and quality requirements at stake in modern supply chains which increase *de facto* the labour needs of the production units, be them small or larger commercial farms (Neven et al., 2009; Rao and Qaim, 2013). These on-farm labour opportunities convey important implications for poverty in rural areas as they usually benefit the poorer segments of rural populations, including landless labourers or households (Weinberger and Lumpkin, 2007; Rao and Qaim, 2013). Similarly to the off-farm employment opportunities in the post-production and processing stages of the supply chains, these labour opportunities are usually important for rural women, who benefit the most from this generated labour demand (Weinberger and Lumpkin, 2007; Rao and Qaim, 2013).

Furthermore, participating producers and their households' welfare and livelihoods can also directly benefit from supplying these supply chains. A few studies have for instance showed that participation in modern supply chains could increase participating producers' farm productivity as well as technical efficiency (Hernández et al., 2007; Minten et al., 2007; Rao et al., 2012). This is an important consideration for poverty reduction in rural areas (Jayne et al., 2010; Rao et al., 2012; Benin, 2016). A larger body of the literature has also analysed the effects of small producer participation in modern supply chains on welfare *via* economic indicators such as profits and returns on investments as well as household income, using econometric methods to take into account and address a potential selection bias. Many of these studies suggest that participation in modern supply chains can increase small producer profitability, income and welfare, whether they participate in export supply chains (Roy and Thorat, 2008; Maertens and Swinnen, 2009; Minten et al., 2009; Bellemare, 2012; Narayanan, 2014; Briones, 2015; Muriithi and Matz, 2015) or domestic modern supply chains such as supermarkets (Miyata et al., 2009; Rao and Qaim, 2011; Wang et al., 2014a). A literature review performed by Ōtsuka et al. (2016) in the case of a participation via contract farming schemes, shows that the household income or income from the contracted crop(s) can be increased by 32 to 183 percent, depending on the case and crop assessed. This is a non-negligible effect in terms of poverty alleviation. A few recent papers using panel data have also confirmed this welfare effect for producers participating in the supermarkets supply chains (Michelson, 2013; Andersson et al., 2015).

Considering these benefits, the determinants of small producer participation in these modern supply chains have been analysed by this literature stream. First of all, geographical characteristics, such as, among others, the availability and quality of road infrastructure and easiness of access to the market outlets, access to water (or lack thereof) or broader agro-ecological factors can constraint or favour small producer participation in these supply chains (Barrett et al., 2012; Michelson, 2013). Upfront investments, or the capacity to fulfil them, are certainly an important determinant of small producer participation in these supply chains (Barrett et al., 2012). In this perspective, physical capital is an important factor to be taken into account (Hernández et al., 2007; Rao and Qaim, 2011; Andersson et al., 2015). Human and social capital play also an important role, in particular producers and households' education (Rao and Qaim, 2011; Escobal and Cavero, 2012), or social networks, either through established platforms such as producer organizations and access to non-governmental organizations (NGOs) (Blandon et al., 2009; Narrod et al., 2009; Rao and Qaim, 2011; Barrett

et al., 2012; Bellemare, 2012; Escobal and Cavero, 2012) or more informal exchanges with neighbours and relatives (Andersson et al., 2015).

These resource and capital-intensive determinants underline the potential challenges faced to participate sustainably in these supply chains. As a matter of fact, some of the participating producers may face difficulties to remain in the latter and eventually drop out (Narayanan, 2014; Andersson et al., 2015). This can be due to their difficulties to sustainably supply these market outlets because of time and labour constraints (Andersson et al., 2015) and potential economic losses, low prices received as well as a low profitability recorded by some of them (Hernández et al., 2007; Michelson et al., 2012; Narayanan, 2014). Thus, while participation in modern supply chains can provide a relevant avenue for poverty reduction for participating producers, this may not necessarily apply to all participating producers and households.

1.2 Research gaps

There is thus an important body of literature exploring the effects of small producer participation in modern supply chains on livelihoods, in particular on poverty and on the labour markets. Yet, some research gaps inherent to this literature still exist and relevant uncovered aspects of this research topic, in particular in a rural development and poverty perspective, remain to explore.

1.2.1 Modern supply chains and household labour allocation

As aforementioned and with respect to the specific effects on labour markets, literature has mostly focused on the effects of small producer participation on participating households' on-farm labour demand (Neven et al., 2009; Rao and Qaim, 2013). However, in the specific case of rural households, a potential situation of non-separability may need to be taken into account, in particular in cases where markets are missing or failing (Lopez, 1986; Taylor and Adelman, 2003). This dimension of non-separability affects rural households' labour allocation process, in which on-farm labour demand and off-farm labour supply becomes interdependent and should thus be considered as a joint decision process (Wang et al., 2007). To the best of our knowledge, no study analysing the effects of small producer participation in modern supply chains has neither taken this consideration into account or looked into the direct effects on overall labour allocation, nor assessed the effects on household off-farm labour supply.

Participating in modern supply chains may affect the whole household labour allocation decisions, in particular in a non-separable context. Indeed, if a hired on-farm labour demand is

generated at the household level to respond to the labour needs of crop production for the modern supply chains, one could hypothesize that households may seek to substitute their family labour with cheaper hired labour and allocate a larger amount of their household labour endowments to more lucrative off-farm employment activities. This would make sense considering that commercial agriculture can be seen as a vector of diversification of activities for rural households (Barrett et al., 2001). An effect on the opposite direction could also take place as this more profitable farm and agricultural production may provide a higher incentive for the household to diversify less its activities and portfolios (Ellis, 2000).

These considerations are important from a rural development perspective, in particular in Sub-Saharan Africa. The significance of off-farm labour and activities for rural households, in particular as an income accumulation or diversification strategy (Reardon, 1997; Barrett et al., 2001) as well as a source of income for poorer households (van den Broeck and Maertens, 2017), has been highlighted in literature. Among these, agricultural wage labour is important for the poorer segments of rural areas (Rao and Qaim, 2013; Davis et al., 2017). Overall, the agricultural/farm and non-agricultural/non-farm sector and their mutual linkages have also been shown to be both important and complementary for rural development (Maertens, 2009; Dorosh and Thurlow, 2014; van den Broeck and Maertens, 2017), so the effects on both on-farm labour demand and off-farm labour supply are important and should be taken into account in this analysis.

Furthermore, while the literature on modern supply chains has stressed the gendered aspect of these labour effects (Rao and Qaim, 2013), the effects affecting specifically rural youth, have, to the best of our knowledge, not been explored. Youth[1] are an important and vulnerable population group in rural areas in developing countries, in particular in Sub-Saharan Africa (African Development Bank et al., 2012; Losch et al., 2012), where they are often characterized by high levels of unemployment (African Development Bank et al., 2012; Filmer and Fox, 2014). A large portion of this group is often looking to leave agriculture, driven by their difficulties to make a livelihood in the sector or the perspective of better jobs off the farm (Sumberg et al., 2012; White, 2012; Bezu and Holden, 2014). They also face challenges accessing off-farm labour opportunities, in particular household enterprises (Filmer and Fox, 2014). As a result of the youth bulge the continent is facing, 375 million of rural young individuals will reach a working age by 2030 (Losch, 2016). Addressing these

[1] In this dissertation, we consider as youth individuals aged 15 to 34, following the definition from the African Union (2006).

concerns, and more broadly investing in youth employment and development, is thus important for growth and poverty reduction (The World Bank, 2007; Filmer and Fox, 2014). Yet, there seems to be a missing link and research gap on how modern supply chains can contribute to these efforts with respect to rural youth.

It would thus be interesting to explore to which extent small producer participation in modern supply chains can generate on-farm labour demand and employment opportunities that can specifically attract rural youth and absorb their labour supply. In the context of a possible intra-household labour substitution process, youth from the participating households could also be the ones benefiting the most from the released time inputs to build up the necessary capital and take up off-farm activities, in particular as they may further rely on their innovative and entrepreneurial skills than older cohort to do so.

1.2.2 Heterogeneity of modern supply chains and implications for household poverty

As mentioned above, most studies have overall showed that supplying exporters or supermarkets could have important positive welfare effects for rural households (Maertens and Swinnen, 2009; Miyata et al., 2009; Rao and Qaim, 2011; Bellemare, 2012; Andersson et al., 2015), although in some instances non-significant or negative effects were observed (Hernández et al., 2007; Michelson et al., 2012; Narayanan, 2014).

This specific literature, including in particular some research reviewing and drawing lessons from various empirical case studies from this field and the related contract farming schemes – see for example Reardon et al. (2009), Barrett et al. (2012), Maertens et al. (2012), Wang et al. (2014b) or Ōtsuka et al. (2016) – may also allow to stress an interesting aspect of these modern supply chains, namely that these can be quite heterogeneous and vary from each other (Narayanan, 2014).

Indeed, the related modalities and schemes for small producer participation in modern supply chains may differ from a type of modern supply chain to the other, depending on the crop produced, the supply arrangements or the local context. With respect to the supply arrangements or agreements, context-specific transaction costs influence the optimal choice and organization of a contract and eventual involvement of small producers (Key and Runsten, 1999). Some variation and heterogeneity in terms of these contracts' conditions and organization can thus be observed (Porter and Phillips-Howard, 1997).

This is also the case for small producer participation in modern supply chains, where the heterogeneity of contracts was concretely stressed by Barrett et al. (2012) in their comparative

study. In the same vein, Ōtsuka et al. (2016) have observed in their research review on contract farming that in some cases small producers were participating in modern supply chains *via* production contracts, while other were doing so through marketing contracts. There may also be differences in a single modern supply chain depending on the firm or organization supplied (Narayanan, 2014). As an example, it can be observed in the analysis of the case of high-value green onion and apple supply chains in China performed by Miyata et al. (2009) that the producers supplying the four packers in this context were not receiving the same amount of inputs from the latter and that the price determination mechanisms were different. This heterogeneity should not be ignored as these diverging types of contract might have different characteristics and hence may convey non-similar effects on participating producers.

Furthermore, as mentioned by Narayanan (2014) and further stressed by Andersson et al. (2015) in their research focusing on the dynamics of participation in supermarket channels in Kenya, small producers participating in similar modern supply chains may, due to their own individual circumstances, not all go through the same experience in these markets and some of them eventually face various challenges. These producers may as a result leave these supply chains due to the difficulties herein encountered (Andersson et al., 2015).

This heterogeneity of modern supply chains and their modalities for small producer participation combined with the varying experiences lived by participating producers may lead one to assume that the effects of participation in modern supply chains can vary from a type of supply chain to the other and be heterogeneous for participating producers (Narayanan, 2014). However, apart from the study by Narayanan (2014) in the context of contract farming schemes for high-value agricultural supply chains in India, we found no other research taking this aspect into account in a single or similar supply chain context. This study also assesses the effects of participation in different contract farming schemes on the net profit gained for the relevant crops. It could be interesting to actually look beyond the net profit and analyse the effect on broader economic indicators, such as household income. Looking at the effects on household income would allow accounting for further related household dynamics affecting poverty and livelihoods, such as the labour and land committed to crop productions for the modern supply chains and which can no longer be allocated to other occupations and activities (Miyata et al., 2009).

Taking into account the potential heterogeneity of the different types of modern export supply chains and its implications for household income in a single context is relevant for poverty

reduction. With the increasingly high number of supply schemes and contract farming agreements used to connect small producers in developing countries to modern supply chains (Wang et al., 2014b; Briones, 2015; Ōtsuka et al., 2016), it is important to separately assess in a single context the effects of participation in different types of modern supply chains on household poverty and assess which of these actually has a relevant impact for poverty reduction.

1.3 Research objectives and outline

The main objective of this dissertation is to analyse the effects of small producer participation in modern supply chains on household welfare and livelihoods, in particular to address the aforementioned research gaps. It thus focuses on the effects on labour markets on the one hand, and the heterogeneous poverty effects of different participation schemes on the other hand. The dissertation is comprised of two main chapters, each of them representing one paper focusing on one of these research gaps.

Export vegetable supply chains in Northern Tanzania were chosen as a case study for this dissertation, which is based on household data collected from a sample 349 vegetable producers from this area. Among these, some of the producers were supplying French beans and snap peas to vegetable exporters through contract farming agreements, while the other were supplying and selling their vegetables to traditional markets. The export vegetable supply chains in Tanzania provide an interesting case study for this analysis as the Tanzanian government has been pushing for the development of the horticultural export sector as poverty reduction strategy in the agricultural sector, which is dominated by small producers (HODECT, 2010). Also, at the time of our survey, four exporters were active in the area and getting their produce from small producer and their producer organizations *via* contract farming schemes, hence allowing us to consider the potential heterogeneous effects of the different participating arrangements in the export vegetable supply chains.

The first paper focuses on the effects of small producer participation in export vegetable supply chains on household labour allocation, in particular their on-farm hired labour demand and off-farm labour supply. We also disaggregate the results by age cohorts (15-34 and 35 and over age cohorts, respectively) to assess whether these labour effects are more marked for rural youth. We hypothesize that participation in export vegetable supply chains could affect positively household hired labour demand as a response to the high labour requirements and intensity of this line of production. Off-farm labour supply could also be affected through a potential labour substitution process at the household level. We also conduct a separability

test, namely Le's Generalized Separability Test (Le, 2010) to confirm whether on-farm and off-farm labour decisions should be assessed jointly or separately. We further use various econometric models and techniques, mostly following Matshe and Young (2004), Ricker-Gilbert et al. (2011), Rao and Qaim (2013) and Salmon and Tanguy (2016), taking into account both the specificities of labour demand and supply data as well as the potential endogeneity of participation in modern supply chains. For this first chapter, we rely on a sample of 344 households[2], of which only 87 households are included in the treatment group as these were the only ones supplying the exporters for the recall period of reference for the labour data.

In the second chapter, we analyse the effects of small producer participation in export vegetable supply chains on household per capita income, and compare the effects of different contract farming and supply schemes agreements. We rank the four exporters active in the research area into two categories, namely high-value export supply chains and regular export supply chains. This categorization is based on the differences of their supply scheme agreements, in particular in terms of the inputs provided and price offered for the produce. We assume that the important differences between these types of exporters and the related participation modalities would be reflected in the welfare and livelihoods effects for participating producers. We use endogenous switching regression techniques (Maddala, 1983) to address the potential self-selection bias and followed the empirical applications of Di Falco et al. (2011), Rao and Qaim (2011), Asfaw et al. (2012) and Narayanan (2014). We also disaggregate the effects by farm size and poverty level to assess which producers benefit the most from each type of supply scheme and export supply chains. For this second chapter, we rely on a sample of 320 households[3] of which 74 supplied the high-value export supply chains and 62 supplied the regular export supply chains.

Overall, the remainder of this dissertation is structured as follows: **Chapter 2** presents the first paper, focusing on the effects of small producer participation in export vegetable supply chains on household labour allocation. **Chapter 3** consists of the second paper, analysing the effects of small producer participation in export vegetable supply chains on household income, considering the potential differentiated effects of the two types of export supply chains. In **Chapter 4**, we summarize the key findings of the two aforementioned chapters and

[2] After removing a few outliers with non-realistic values in key dependent variables.
[3] We only kept the households who had actually supplied and drawn income from the vegetable exporters during the survey reference period and removed a few outliers with non-realistic values.

reflect on some of their limitations. We also draw and discuss in this chapter the main conclusions and policy implications of this research's findings, as well as the remaining areas for research to be explored in this specific literature stream.

2 Small producer participation in export vegetable supply chains and household labour allocation in Northern Tanzania: an age-disaggregated approach

Abstract:

Modern agricultural supply chains have been playing an increasingly important role in developing countries and have had significant effects on the rural labour markets. This paper analyses the effects of small producer participation in these supply chains on both household hired labour demand and off-farm labour supply, using an age-disaggregated approach. Failing to reject the separability hypothesis as well as the exogeneity of small producer participation in export supply chains, we apply lognormal double-hurdle models and find that participation in export vegetable supply chains in Tanzania affects positively a household's decision to hire labour from all age groups. We also find that it increases the unconditional overall level of hired labour demand, while the age-disaggregated analysis shows that these effects benefit mostly rural youth. However, no evidence of an effect on household off-farm labour supply is found.

Key words *– export supply chains; hired labour; off-farm labour; small producers; rural youth*

JEL Codes **–** I31, J43, O12, Q12

An improved and shorter version of this chapter has been accepted for publication in *Agricultural Economics*: https://doi.org/10.1111/agec.12441. This chapter is co-authored by Bernhard Brümmer (BB) and Victor Afari-Sefa (VAS). The contributions of each author are as follows: Marwan Benali (MB), BB and VAS conceptualized and designed the research. MB implemented the survey and collected the data with support from VAS. MB analysed and interpreted the data. BB and VAS assisted in the analysis and interpretation of the results. MB wrote the paper. BB and VAS also provided valuable feedback and comments at various stages of the research and drafting of the paper.

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2.1 Introduction

Through the past years, global agri-food systems have witnessed the emergence and consolidation of modern domestic and export supply chains, in particular in developing countries, such as African countries who have been supplying an increasing share of high-value agricultural products, in particular fresh horticultural commodities, to developed countries (Maertens et al., 2012). Among others, this process has been pushed by the increased demand for higher quality and more diverse products in the latter (Humphrey et al., 2004). As a result, these supply chains have had important effects in terms of rural development through various pathways. Indeed, while the exclusion of small producers can potentially be a consequence of the above-mentioned process (Reardon and Barrett, 2000; Weatherspoon and Reardon, 2003; Humphrey et al., 2004), positive effects through both the product and labour markets have been noted (Maertens et al., 2012). For instance and through the former, positive income and price effects for participating producers have been found (Maertens and Swinnen, 2009; Neven et al., 2009; Rao and Qaim, 2011).

Modern supply chains can also have direct and indirect effects on and through the labour markets, respectively (Maertens et al., 2012). For participating farms, higher levels of on-farm hired labour use were noted (Neven et al., 2009; Maertens et al., 2012) and a direct positive effect of these supply chains on their hired labour demand was recorded (Rao and Qaim, 2013). On the other hand, export supply chains may also generate off-farm employment opportunities for poor rural households in developing countries, mostly as employed workers in the associated agro-processing sector (Humphrey et al., 2004; Maertens and Swinnen, 2009; Maertens et al., 2012). Participation in these supply chains *via* the off-farm labour markets has positive effects on income, agricultural production and poverty reduction (Maertens, 2009; Maertens and Swinnen, 2009; Maertens et al., 2012). These labour effects, through both the on-farm and off-farm labour markets have also been particularly important for women labourers (Maertens et al., 2012; Rao and Qaim, 2013).

Such positive effects on labour and employment generation are relevant when one considers the importance of rural employment for development and poverty reduction in developing countries. In Sub-Saharan Africa, non-farm and off-farm income and activities have been increasingly important for the livelihoods of rural households and their welfare (Barrett et al., 2001; Davis et al., 2017). Among others, they allow them to diversity their income, reduce their income risk or present an opportunity to take-up more profitable opportunities (Reardon, 1997; Barrett et al., 2001). While wealthier rural households may have higher opportunities to

access lucrative off-farm activities as a strategy to increase their wealth and income, poorer households usually enter low-return off-farm activities to respond to the challenges they face in agriculture, such as land constraints, low returns on agriculture or the seasonality of production (Barrett et al., 2001; Lanjouw and Lanjouw, 2001; Reardon et al., 2007; Jayne et al., 2014). Among these low-return off-farm activities and income sources, hired and agricultural wage labour is important for the poorer households (Ellis and Mdoe, 2003; Rao and Qaim, 2013; Davis et al., 2017), since most of the hired labourers are usually small producers and landless labourers (Weinberger and Lumpkin, 2007).

Rural labour and employment is an important and relevant issue for the rural youth[4] in Sub-Saharan Africa as 375 million of them will enter the working age in the next fifteen years (Losch, 2016). Rural youth face higher levels of poverty (AfDB et al., 2012) as well as challenges in reaching sustainable livelihoods and employment (Filmer and Fox, 2014; FAO et al., 2014). Their difficulties are particularly pronounced in rural areas. With respect to agriculture, they face various constraints, such as a reduced access to land and farming activities, which prevents them from building sustainable livelihoods and may eventually push them away from the sector (White, 2012; Bezu and Holden, 2014). They also struggle to access profitable employment opportunities in the non-farm economy in rural areas, in particular due to their lack of or reduced access to the needed capital (Filmer and Fox, 2014). As a result of these reduced windows of opportunities, rural youth may opt for distress migration, which can have negative implications for them as well as for broader rural development (Deotti and Estruch, 2016).

Promoting rural youth employment in both the agricultural sector and the rural non-farm economy hence appears important, especially considering the potential these two sectors represent for growth and poverty reduction in Africa (Christiaensen and Todo, 2014). Small producer participation in modern supply chains could contribute to this. Rao and Qaim (2013) have shown that small producer participation in supermarket supply chains in Kenya has led to an increased hired labour demand on these producers' farms, benefitting mostly rural women labourers. A similar process could potentially take place for rural youth, considering their aforementioned difficulties. Furthermore, through labour substitution and/or a sustained capital accumulation process, participation in these supply chains could provide young

[4] In this paper, we follow the African Union (2006), which defines youth with age limits of 15 and 35. We implement this as the young cohort being aged between 15 and 34, and the older age cohort for 35 years and over.

individuals from the participating households with both the higher time endowments and potential capital necessary to enter into off-farm activities.

Through the case of export vegetable supply chains in Tanzania, we contribute to this literature in two different ways. First, we analyse the effects of small producer participation in modern supply chains on hired on-farm labour demand. We are aware of the aforementioned study by Rao and Qaim (2013) which directly analysed this type of effect and which we follow in various aspects. Neven et al. (2009), Maertens and Swinnen (2012) and Maertens et al. (2012) have also pointed in their research to the increased levels of hired labour noted on farms supplying the export or supermarket supply chains. We add to this literature stream by studying whether and to which extent the expected increased hired labour demand and generated agricultural wage employment benefit rural youth. This is also important from a rural development perspective.

Second, we extend the analysis further into the household labour allocation process by taking into account the potential interdependence and non-separability of the household labour decisions. We thus consider the effects on participating households' off-farm labour supply. To the best of our knowledge, this would be the first study estimating the effect of participating in these supply chains as a supplier on a household's off-farm labour market participation and related decisions. We also disaggregate the analysis by age to identify potentially stronger effect for the younger members of these households.

2.2 Conceptual framework

2.2.1 Theoretical foundations

When considering the different mechanisms through which participation in modern supply chains could affect households' labour allocation decisions, the specificity of agricultural households in developing countries should be accounted for. Following the seminal work of Singh et al. (1986), agricultural household models have been used to analyse the microeconomic behaviour of farm families and households. In the context of small producers and rural households, the allocation of available labour between farming and household activities is subject to a common decision and not fixed by institutional arrangements. An important assumption of these models is related to the separability of the production and consumption sides of the agricultural households (Lopez, 1986; Singh et al., 1986) which allows among others for a distinct analysis of the off-farm, family on-farm and hired labour decisions (Wang et al., 2007). In many developing countries, factor markets fail, which questions this assumption and may lead to a situation of non-separability (Lopez, 1986;

Taylor and Adelman, 2003) in which households' production and consumption decisions are both affected by the household's preferences (Le, 2010), and should then be considered simultaneously (Sadoulet and de Janvry, 1995). This is relevant to the analysis of the effects of modern supply chains on participating producers' hired labour demand and off-farm labour supply.

2.2.2 Impact pathways

With respect to the effect on on-farm hired labour demand, a first impact pathway is directly related to the labour intensity of these lines of production. Indeed, as mentioned in the introduction, these supply chains have mostly been focusing on high-value commodities, in particular horticultural products (Maertens et al., 2012). These commodities are more labour intensive than other crops (Weinberger and Lumpkin, 2007). To this has to be added the role of quality requirements and standards since the cultivation of high-standards products would require producers to invest in agricultural inputs, including labour (Swinnen et al., 2015). Thus, we can expect that, with higher quality requirements, household needs in labour will be higher and hired labour demand would increase, should the household's family labour endowments not be sufficient to respond to this labour intensity.

Moreover, if large profits and gains are recorded by these households, they may decide to allocate higher shares of their land and agricultural production to this specific line of production. This has for instance been observed in the case of producers supplying vegetables to supermarkets in Kenya (Rao and Qaim, 2011; 2013). This would potentially reflect a farm specialization and lead to a self-reinforcing hired labour demand over the production seasons. Higher farm profits and generated commercial surplus could also help households overcome the liquidity and credit constraints which may hamper investments in their farming activities (Reardon et al., 1994; Oseni and Winters, 2009). In this respect, it is also noteworthy that buyers in these supply chains (*e.g.* exporters, supermarkets, agro-processors) can help their suppliers overcome these constraints by facilitating their access to credit (Minten et al., 2009; Miyata et al., 2009). Releasing some of these financial and liquidity constraints could affect positively hired labour demand for both the very crops produced for these supply chains as well as for broader farm activities.

Modern supply chains can also potentially affect these households' participation in off-farm labour markets through various pathways. First, literature has stressed that various factors could motivate rural households to diversity their income and enter the rural non-farm and off-farm economy, and which could be differentiated on the basis of "pull" and "push" factors

(Barrett et al., 2001; Reardon et al., 2007; Davis et al., 2009). These two types of factors, as this was well posited by Reardon et al. (2007), obey to different logics. The former is generally linked to "accumulation objectives" and the latter to the necessity to "manage risk, cope with shock, or escape from agriculture in stagnation" (Reardon et al., 2007). We hypothesize that participation in modern supply chains could serve as a "pull" factor for the households' entry or strengthened involvement in the off-farm labour markets. Indeed, commercial agriculture and increased farm incomes can be seen as a potential "pull" factor favouring households' participation in the non-farm economy (Barrett et al., 2001; Haggblade et al., 2010). This makes sense as they may help overcome some of the entry barriers impeding their access to non-farm activities (Reardon, 1997). As mentioned by Haggblade et al. (2010), higher farm incomes could provide the capital available for investment in off-farm activities. Participation in modern supply chains could thus help producers and their households building up and accumulating their capital and investment capacity to enter more profitable self-employment enterprises and other off-farm activities. At a broader scale, Maertens and Swinnen (2009) have stressed that, in their research setting, the restructuration of the French beans export supply chains in Senegal was accompanied by a shift of various producers from contract farming to working as an employee in this sector. One could thus contemplate that participation in export supply chains as supplier could also lead some of the members from contracted households to enter in parallel these supply chains as agro-processing employees, besides the other potential activities generated along the supply chain.

Reflecting on the aforementioned potential non-separability of their labour choices, the interdependence of on-farm and off-farm labour decisions may play a role in these impact pathways. On one hand, a higher price of farm output may reduce the producers and households' incentives to diversify (Ellis, 2000). This could lead them to focus on this specific farming activity, hence reducing their level of off-farm activities. On the other hand, if households decide to further diversify into non-farm activities, this may potentially lead to a substitution of family labour by cheaper hired labour (Rao and Qaim, 2013). From the perspective of the age-specific effects, this could benefit rural youth since they may be a cheaper labour force. Thus, should these effects be interdependent, their direction remains unclear.

2.2.3 The rationale for an age-disaggregated approach

These households should be perceived as collective households, with an intra-household allocation and decision-making process for their individual members' resources (Doss, 1996;

Vermeulen, 2002). Household members may thus allocate their time and labour endowment to different labour markets, depending on their skills (Ellis, 2000). This consideration is important as the individuals from the different age cohorts and their labour choices may thus be affected differently by the participation in modern supply chains. They could also adjust their choice as a reaction to the latter in diverse ways. This is important when one focuses on the age of the individual household members. While youth are in general more inclined towards taking-up non-farm and off-farm activities (Huang et al., 2009; African Development Bank et al., 2012), the marked needs for social, human and financial capital to enter these may restrain them in doing so and rather favour access to these occupations by older household members.

Thus, in the remaining of the paper, we will analyse these various impact pathways, including for the different age cohorts. We will also consider the potential non-separability of household decisions to properly account for any existing interdependence between on-farm and off-farm labour decisions.

2.3 Context and data collection

2.3.1 Export and traditional vegetable supply chains in Tanzania

This paper focuses on the case of export vegetable supply chains in Tanzania, in particular in the Arumeru and Arusha districts, in the Northern Highlands region, where most of the country's horticultural exporters are located due to the adequate climate and infrastructures as well as the existing markets and supporting institutions (HODECT, 2010). These exporters source a large share of their produce, mostly French beans and snap peas, which are the crops of focus of this paper, from small producers. These agro-exporters mostly work with small producers through producer organizations[5] to which they are linked *via* contract farming agreements, of which main terms can vary from an exporter to the other. A common feature of these contracts is the collection of the produce by the exporters *via* producer collection centres managed by the producer organizations, before the produce is processed in agro-processing centres.

[5] In other words, producer organizations constitute the main link between export companies and small producers, being the main interface for the latter's access and inclusion in the export supply chains. While some of these producer organizations already existed before the implementation of these contracts, others were constituted in an *ad hoc* fashion by small producers, with the objective to enter these export markets.

On the other hand, traditional vegetable supply chains in the area are less concentrated and rely more on spot transactions through vegetable middlemen[6] who either collect the vegetable produce directly from the producers' vegetable plots and harvest themselves or buy directly from the producers after they have harvested. Exotic and traditional vegetable crops (*e.g.* tomatoes, carrots, onions, African nightshade, eggplant etc.), of supposedly lower quality than those sold in the export supply chains constitute the bulk of the produce exchanged and sold in these traditional supply chains. These mostly rely on the wholesale and retail markets in the Kilombero outlet, located in the city of Arusha as well as some minor retail markets in the surroundings.

2.3.2 Data collection and survey

The data for our analysis were collected between July and September 2015. The sampling strategy involved an initial identification of all the producer groups involved in these export supply chains *via* key informant interviews with the export companies. In total, there were eleven producer groups located in ten different villages. For all these organizations, we obtained the complete population lists of their members supplying the export supply chains as well as those of the other vegetable producers in the same villages.

Based on these lists and using a stratified sampling approach, we interviewed 349 small producers from these ten villages[7]. For this paper, we use the data from 344 producers[8] including 157 producers supplying French beans and snap peas to the exporters and 187 producers supplying vegetables exclusively to the traditional markets. We exploit labour data from these households for the preceding agricultural year (March 2014 - February 2015), when only 87 of these households supplied French beans and snap peas to export vegetable supply chains while 257 supplied their produce exclusively to traditional markets. This modified sample is due to the fact that the data on labour allocation accounted for the abovementioned preceding agricultural year[9]. For these specific data, we collected total on-farm hired labor use (for all crops) and total off-farm labor supply (for all activities) through

[6] Usually referred to as "collectors" in the area.
[7] The questionnaires from one of these villages were incomplete due to technical errors. We thus could not include this village in the final sample.
[8] We dropped a few observations with non-realistic values for important variables.
[9] We assume that the labour allocation for these producers initially in the treatment group should not have been affected by their participation in export supply chains as it was recorded for the period prior to the latter. As a robustness check, we checked that this change did not affect drastically the final results.

the full aforementioned year, measured in person-days and disaggregated by age cohorts (15-34 and 35 and over)[10].

2.3.3 Descriptive statistics

Descriptive statistics on the socio-economic and farm characteristics of the two respective groups in our sample are provided in Table 2.1. With regard to their socio-demographic characteristics, households from both groups seem to be relatively similar. However, they differ significantly with respect to their access to physical and socio-economic infrastructures. Indeed, households involved in the export vegetable supply chains benefit from a higher access to electricity and use more credit (which could be explained by the credit facilities provided by the producer organizations).

Moving to the farm characteristics, producers in our sample have relatively small farms (2.7 acres/1.09 ha in average) but producers in export markets allocate almost twice the share of their farmland to vegetable production than those from the control group, which indicates a potential specialization, in line with the descriptive differentiation highlighted in Rao and Qaim (2011). Moreover, producers supplying the export markets irrigate a larger portion of their farm size than the producers in the traditional markets, which could be related to the higher product quality (Humphrey et al., 2004) and irrigation requirements in these supply chains. They also benefit from a higher access to extension services and are located closer to the agro-input markets, which could be linked to their participation in export markets, as they often obtain a large share of their inputs from the exporters.

[10] Labour days are defined on the basis of eight-hour labour days.

Table 2.1. Household and farm characteristics, by market channel

	Traditional markets (N=257)	Export markets (N=87)	Complete sample (N=344)
Household characteristics			
Household size	4.296	4.494	4.346
	(1.425)	(1.320)	(1.400)
Household head age (in years)	47.327	47.942	47.482
	(11.431)	(11.528)	(11.442)
Household head male (dummy)	0.934	0.920	0.930
	(0.249)	(0.274)	(0.255)
Household head education (in years)	7.424	7.690	7.491
	(2.233)	(1.826)	(2.138)
Household head farming experience (in years)	22.428	22.724	22.503
	(10.928)	(11.372)	(11.026)
Household members mean education (in years)	6.659	6.825	6.701
	(1.982)	(1.875)	(1.954)
Access to electricity (dummy)	0.412	0.713	0.488***
	(0.493)	(0.455)	(0.501)
Distance to tarmac road (in kilometres)	11.270	10.693	11.125***
	(10.236)	(8.596)	(9.842)
Distance to public transportation system (in kilometres)	1.744	1.298	1.631
	(2.407)	(2.930)	(2.553)
Use of credit (dummy)	0.226	0.391	0.267
	(0.419)	(0.491)	(0.443)
Share of off-farm income (in percent)	17.562	16.435	17.277
	(28.257)	(26.208)	(27.720)
Farm characteristics			
Farm cultivated area (in acres)	2.863	2.282	2.716
	(2.674)	(2.168)	(2.565)
Share of vegetable area (in percent)	38.644	64.258	45.122***
	(26.342)	(25.889)	(28.466)
Access to irrigation (dummy)	0.946	0.989	0.956*
	(0.227)	(0.107)	(0.205)
Share of irrigated area (in percent)	79.097	87.650	81.266**
	(35.216)	(26.749)	(33.444)
Use modern irrigation techniques (dummy)	0.062	0.011	0.049*
	(0.242)	(0.107)	(0.217)
Distance to agricultural input markets (in kilometres)	4.535	2.959	4.133***
	(6.519)	(6.173)	(6.461)
Access to agricultural extension services (dummy)	0.553	0.690	0.587**
	(0.498)	(0.465)	(0.493)
Livestock ownership (dummy)	0.922	0.931	0.924
	(0.268)	(0.255)	(0.265)

Notes: Mean values are shown with standard deviations in parentheses. The statistical significance of the differences between the mean values of the two groups is presented as follows: *significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.

Descriptive information on our main variables of interest, namely hired labour use at the farm level and off-farm labour supply at the household level, both in person-days[11] are provided in Tables 2.2 and 2.3, respectively. With regard to overall hired labour use, producers involved in the export markets use a larger amount (almost twice) of hired labour on their farms, similar to the findings of Rao and Qaim (2013). Furthermore, producers involved in the

[11] On the basis of an eight-hour labour day.

export markets hire more labour from casual labourers aged 15-34 and 35 and over, respectively, than the producers supplying the traditional markets, although the difference is statistically significant for the former only. In terms of within-groups differences, both groups use almost three times more labour from the youth cohort, implying that the overall horticultural sector is dominated by young labourers.

Table 2.2. On-farm hired labour demand, by market channel

	Traditional markets (N=257)	Export markets (N=87)	Complete sample (N=344)
Total hired labour use – All hired labourers	55.569	96.960	66.037**
(in person-days)	(99.231)	(192.888)	(130.393)
Hired labour use – 15-34 age cohort	41.482	71.227	49.005**
(in person-days)	(82.613)	(159.642)	(107.942)
Hired labour use – 35 and over age cohort	14.087	25.733	17.032
(in person-days)	(47.662)	(80.843)	(57.967)

Notes: Mean values are shown with standard deviations in parentheses. The statistical significance of the differences between the mean values of the two groups is presented as follows: *significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.

Finally, with regard to the participation in off-farm labour markets (Table 2.3), households supplying the export markets sell out significantly more labour off their farm than the other households. For both household groups, individuals belonging to the older age cohort rent out a larger quantity of their labour inputs off the farm than the younger members. While it was mentioned in the introduction that youth may be more likely to undertake off-farm activities (Huang et al., 2009; African Development Bank et al., 2012), this could imply that most of these activities are taken up by the household head and their spouse, rather than younger members of a household. Most of the off-farm activities undertaken by the individuals and households in our sample are wage jobs outside of agriculture and self-employment activities, in particular the holding of personal and family shops, running a public transportation motorbike or working as construction worker.

Table 2.3. Off-farm labour supply, by market channel

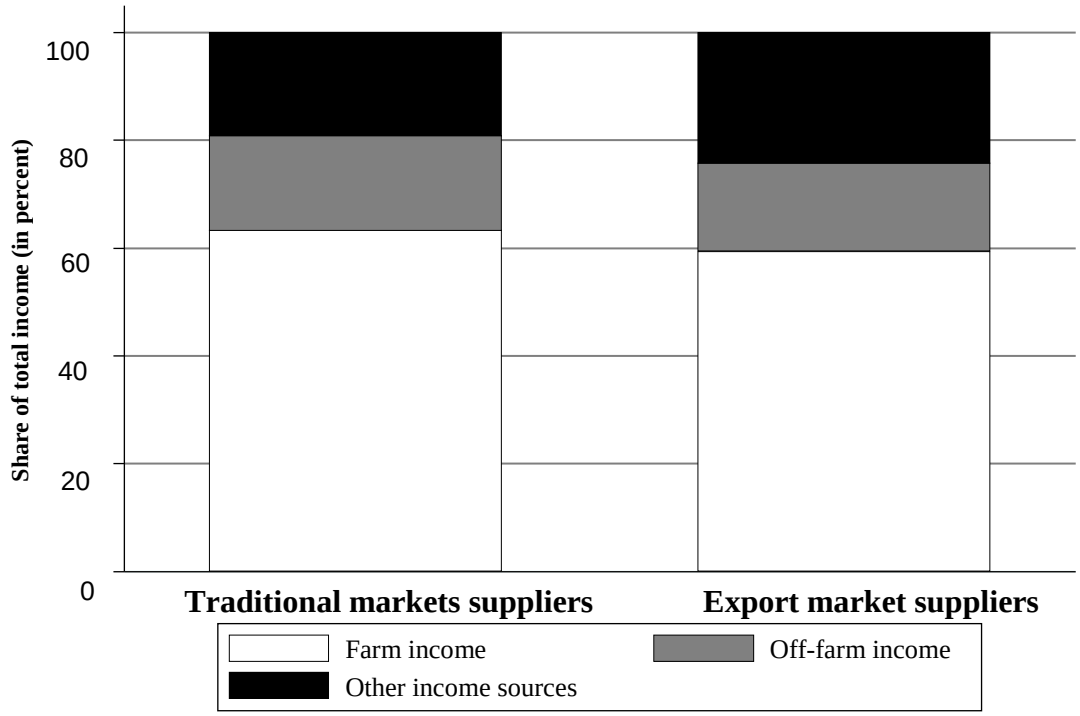
	Traditional markets (N=257)	Export markets (N=87)	Complete sample (N=344)
Total off-farm labour supply	52.294	85.155	60.604**
(in person-days)	(104.439)	(144.262)	(116.462)
Off-farm labour supply – 15-34 age cohort	17.036	29.552	20.201
(in person-days)	(54.603)	(83.566)	(63.521)
Off-farm labour supply – 35 and over age cohort (in person-days)	35.258	55.603	40.403*
	(92.138)	(115.844)	(98.904)

Notes: Mean values are shown with standard deviations in parentheses. The statistical significance of the differences between the mean values of the two groups is presented as follows: *significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.

Even though households from the two groups seem to have overall different labour demand and supply levels, the distribution of their income is relatively close, as can be seen in Figure 2.1. Overall more than half of their income comes from farming activities. It is however

noteworthy that producers supplying the traditional markets rely slightly more on off-farm income while other income sources (*e.g.* pensions, remittances, equipment rental) play a more important role in export market suppliers' portfolios.

Figure 2.1. Income sources of the households, by market channel



Finally, the distribution of the different households based on their specific labour regime is displayed in Table 2.4, following the most commonly used regime classification (Sadoulet et al., 1998; Henning and Henningsen, 2007; Wang et al., 2007). A third of the households in the total sample (111 households) participate in both labour markets, which further stresses the stated need to consider in our analysis both sides of the labour markets. Furthermore, a larger number of households participate in one of the two labour markets (196 households), while only a minority behave in an autarkic way (37 households).

Table 2.4. Distribution of the households based on their labour regime and market channel

	Traditional markets (N=257)	Export markets (N =87)	Complete Sample (N =344)
Autarkic household	32	5	37
Hiring-in labour only	125	45	170
Hiring-in and selling out labour	79	32	111
Selling-out labour only	21	5	26

2.4 Econometric approach

2.4.1 Separability test

Given the empirical evidence of factor market failures in Tanzania (Dillon and Barrett, 2017), a test of the separability hypothesis is important in our case. Early separability tests were developed by Benjamin (1992) and Jacoby (1993). In the Benjamin test, the null hypothesis of separability is rejected if farm labor demand is affected by the household labor endowments (Benjamin, 1992; Dillon and Barrett, 2017). In the Jacoby test, separability is rejected if market and shadow wages differ significantly. Le (2010) has stressed that each of these tests uses only partial information on the relationship between production decisions and preferences or on differences between shadow and market wages, potentially leading to contradictory results. He proposes a generalized separability test, which combines both Benjamin and Jacoby tests, leading to the following model:

$$Log(pQ/L) = -\log(\gamma_L) + \beta Log(w) + \alpha A + \varepsilon \quad (2.1)$$

where pQ is the total value of the farm output, L is the total labour allocated to the farm by the household, w is the market wage, A are the preference shifters, in this case the number of dependents and non-dependents in the household and γ_L is a vector of dummy differences, in our case dummies for the administrative divisions[12] and the main crop produced (Le, 2010).

The test consists in jointly testing whether the β coefficient on wage is significantly different from one and the α coefficients on the preference shifters are significantly different from zero. The results of this test are presented in the Table 2.5. Using an instrumental variable approach to address the potential measurement error in the wage variable (Le, 2010), this test fails to reject the null hypothesis of separability. It thus seems that in our research setting, at least from a conceptual point of view, on-farm and off-farm labour decisions are not interdependent. We thus treat on-farm labour hiring and off-farm labour supply as two independent decision processes.

[12] Divisions in Tanzania are the third lowest level of administrative layer, below the districts and above the wards and the villages (in the case of rural wards).

Table 2.5. Results of Le´s Generalized Separability Test following Le (2010)

	Log(pQ/L) [a]		
	OLS	LAD	IV [d]
	(1)	(2)	(3)
Off-farm hour labour wage (log)	-0.119	0.103	2.305*
	(0.230)	(0.203)	(1.348)
Number of male non-dependents	-0.263	-0.293	-0.0916
	(0.237)	(0.215)	(0.345)
Number of female non-dependents	-0.290	0.0911	-0.694
	(0.292)	(0.251)	(0.464)
Number of dependents	0.0742	-0.0251	0.0413
	(0.189)	(0.171)	(0.266)
Export vegetables as main crops [b]	-0.886	0.0969	-0.684
	(0.561)	(0.504)	(0.796)
Local vegetables as main crops [b]	-0.500	-0.523	-0.390
	(0.517)	(0.456)	(0.728)
Division Kingo´ri [c]	-1.676*	-1.049	-2.525*
	(0.848)	(0.752)	(1.276)
Division Mbuguni [c]	0.753	0.559	-0.468
	(0.803)	(0.702)	(1.306)
Division Moshono [c]	-0.240	-0.423	-0.645
	(0.721)	(0.623)	(1.035)
Constant	9.418***	7.113***	-8.307
	(1.965)	(1.705)	(9.955)
F-Test: Coefficients of household characteristics are simultaneously zero and coefficient of wage is equal to one F(4,114)	6.86***	5.18***	0.72
Observations	124	124	124
R^2	0.130		

Notes: Coefficient estimates shown with standard errors in parentheses.
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] Following Le (2010), *pQ* represents the value of the household farm output while *L* is the household farm labour.
[b] Reference crops are the non-vegetable crops.
[c] Reference division is Poli.
[d] Off-farm wage is instrumented with the household head education and the commune wage (Le, 2010).

2.4.2 Econometric framework

The econometric approach adopted in this paper follows closely the one used by Rao and Qaim (2013) as the structure of their data and main econometric challenges resemble ours, as well as those implemented by Matshe and Young (2004), Ricker-Gilbert et al. (2011) and Salmon and Tanguy (2016), who used somehow similar approaches.

Labour demand and supply data are usually characterized by a large number of zero observations, for which linear regression models might produce biased estimates (Matshe and Young, 2004; Rao and Qaim, 2013; Salmon and Tanguy, 2016). This corresponds in theory to a corner solution configuration, *i.e.* the zeros are actually observed outcomes (Dow and Norton, 2003; Madden, 2008), as the result of a household's actual choice not to participate in a labour market, based on its preferences or potential disability to do so (Matshe and Young, 2004; Rao and Qaim, 2013; Salmon and Tanguy, 2016).

A two-part or double-hurdle model (Cragg, 1971; Blundell et al., 1987; Wooldridge, 2002) appears in this case more adequate than a Tobit estimator as it allows the decision to participate in a given labour market and the decision on the quantity of labour allocated to the latter to be thought as two different processes (Matshe and Young, 2004; Yen, 2005; Rao and Qaim, 2013; Salmon and Tanguy, 2016). The selection and quantity of labour equations for both on-farm hired labour demand *h* and off-farm labour supply *o* of a household *i* can thus be expressed as follows (Wooldridge, 2002; Matshe and Young, 2004; Rao and Qaim, 2013; Salmon and Tanguy, 2016):

$$d_{ij}^{*} = \alpha z_{ij} + \mu_{ij} \qquad \mu_{ij} \sim \mathrm{N}(0,1), \tag{2.2}$$

$$y_{ij}^{*} = \beta x_{ij} + \varepsilon_{ij} \qquad \varepsilon_{ij} \sim \mathrm{N}(0, \sigma^2), \qquad j=\mathrm{h,o}\ , \tag{2.3}$$

where d_{ij}^{*} is the decision to hire on-farm labour or supply labour off the farm ($d_{ij}^{*} = 1$) or not ($d_{ij}^{*} = 0$), y_{ij}^{*} is the related quantity of labour hired or supplied, z_{ij} and x_{ij} are vectors of variables for the selection and level equations, respectively, including our main (binary) explanatory variable, reflecting the participation in export markets, as well as control variables. ε_{ij} and μ_{ij} are random error terms.

2.4.3 A lognormal double-hurdle model specification

We use the lognormal hurdle specification (Wooldridge, 2002) since, considering the structure of our data, transforming the dependent variables can be used to accommodate their positive values (Yen, 2005) and help better address the non-normality of the error terms (Yen and Rosinski, 2008). As a robustness check for the separability test results, we also estimate a Multivariate Sample-Selection Model (MSSM) developed by Yen (2005)[13], which takes into account the potential correlations between on-farm and off-farm labour decisions and allows controlling for the potential sample selection of labour market participation[14]. The coefficients from this model are presented in Tables A2.1 to A2.3 in the Appendix.

We use likelihood ratio tests to determine the best model between the MSSM and the nested sample selection and double-hurdle models (Yen, 2005; Zampelli and Yen, 2017). The results from these tests (in Table A2.4 in Appendix) show that we fail to reject the double-hurdle model for all age cohorts, which confirms our choice for the latter.

[13] The Heckman´s bivariate sample-selection model (SSM) and the double-hurdle model (DHM), which assumes independence between the selection equations and the corresponding level equations (Cragg, 1971; Yen, 2005; Madden, 2008), are nested in the MSSM (Yen, 2005).
[14] It is in any instance interesting to control for sample selection considering that, as underlined by Mathenge and Tschirley (2015) for the case of off-farm employment, participation in labour markets may result from individuals´ self-selection into the latter.

We also statistically test our choice of lognormal double-hurdle (LDH) specification against the Tobit model for a single mechanism as well as against the normal truncated double-hurdle (TDH) specification. As the Tobit model is nested in the TDH model, we proceed with a likelihood ratio test to decide between the two models as previously done by Ricker-Gilbert et al. (2011) or Rao and Qaim (2013). For the specification of the LDH model against the Tobit and TDH models, we use Vuong's likelihood ratio test (Vuong, 1989). A similar approach was used by Olwande et al. (2015). We implement these tests for both overall hired labour demand and off-farm labour supply decisions. The results are displayed in the Table A2.5 in Appendix[15]. We can observe from this table that the two-step mechanism is preferred as both the LDH and TDH models are preferred to the Tobit model. From a statistical point of view, both the LDH and TDH models would fit equally well the data. We thus opt for the use of the LDH for the aforementioned reasons and its specific fitness for the structure of our age-disaggregated data.

2.4.4 Maximum Likelihood Estimation and marginal effects of the LDH model

The lognormal double-hurdle model consists in applying to the whole sample a probit model for the participation in a given labour market *j* and an ordinary least squares (OLS) estimation of the level equations of log-person-days for those with positive labour observations (Wooldridge, 2002; Madden, 2008). This model can be estimated by maximum likelihood method, with the following likelihood function for a household *i* (Wooldridge, 2002):

$$L = 1[y_{ij}=0]log[1-\Phi(z_{ij}\alpha)] + 1[y_{ij}>0]\left\{log\Phi(z_{ij}\alpha) - \log(y_{ij}) - \frac{1}{2}\log(\sigma^2) - \frac{1}{2}\log(2\pi) - \frac{1}{2}[\log(y_{ij}) - x_{ij}\beta]^2 / \sigma^2\right\} \quad j=\text{h,o} \ , \tag{2.4}$$

where the coefficients α are the results of the probit estimation on the decision on whether to hire or supply labour or not. The β coefficients result from the OLS regression of $\log(y_{ij})$ for the observations clearing the first hurdle, while σ is the standard error from this second-part regression (Wooldridge, 2002). Φ (.) represents the normal cumulative distribution function.

[15] We could not run these tests for the hired labour demand for labourers aged 35 and over since the related truncated regression encountered convergence problems. All the other models for all age cohorts were consistent with the results presented in the table A2.5. We assume that the selection mechanism does not change for the hired labour demand for labourers age 35 and over.

To estimate the average marginal effects, we rely on the probability of a household *i* to participate in on-farm hired labour or the off-farm labour supply markets, which is expressed as:

$$P(y_{ij} > 0 \,|z_{ij}) = \Phi\,(z_{ij}\alpha) \tag{2.5}$$

The log-transformed dependent variables and non-normality of the level equation residuals require the use of the Duan's smearing estimate for the conditional and unconditional means (Duan et al., 1983; Duan, 1983; Mullahy, 1998). As a result, the conditional means are represented as follows (Duan et al., 1983; Duan, 1983; Belotti et al., 2015):

$$E\big(y_{ij}\big|y_{ij} > 0, x_{ij}\big) = \exp\big(x_{ij}\beta\big) * \ \delta_{ij} \tag{2.6}$$

Where δ_{ij} is the Duan's smearing estimate defined as (Duan, 1983):

$$\delta_{ij} = \frac{1}{N}\sum_{i=1}^{N} \exp(\varepsilon_{ij}) \tag{2.7}$$

The unconditional means are represented as follows (Duan, 1983; Mullahy, 1998; Wooldridge, 2002):

$$E\big(y_{ij}\big|z_{ij}, x_{ij}\big) = \Phi\,\big(z_{ij}\alpha\big) * \exp\big(x_{ij}\beta\big) * \ \delta_{ij} \tag{2.8}$$

We derive for each model and age cohort the average marginal effects for the decision to participate in a labour market. We also derive the conditional and unconditional average marginal effects for the quantity of labour allocated, using the Duan smearing estimate and bootstrapping the standard errors, following the guidelines provided by Belotti et al. (2015)[16].

2.4.5 Endogeneity of the main explanatory variable

Literature has underlined that participation in modern supply chains may be endogenous, in particular due to the potential self-selection of producers and the role of non-observable factors (Maertens and Swinnen, 2009; Rao and Qaim, 2011; Barrett et al., 2012; Bellemare, 2012; Rao and Qaim, 2013). We address this issue by using a control function or two-stage residual inclusion approach (Smith and Blundell, 1986; Rivers and Vuong, 1988; Terza et al., 2008), which has already been successfully used in the related literature with a potential endogeneity challenge (Ricker-Gilbert et al., 2011; Rao and Qaim, 2013; Salmon and Tanguy,

[16] For this purpose, we use the *twopm* Stata command developed by Belotti et al. (2015). The code developed by Deb et al. (2013) and retrievable online also served as inspiration to compute the Duan smearing estimate and conditional marginal effects for the second part of the lognormal double-hurdle models.

2016). It consists of estimating a first stage regression of the endogenous variable on the control variables and the potential instrument(s). In the second stage, the generated residuals are included in the double-hurdle model as a control variable: if they are significant, exogeneity is rejected and their inclusion corrects for endogeneity.

We use the individual distance to the closest produce collection centre as an instrument. We believe this is a valid instrument since the closer a producer is located from these produce collection centres, the more likely they will be to participate in export supply chains. For instance, the distance to paved road and the availability of transportation means can influence a producer's likelihood to participate in modern supply chains (Hernández et al., 2007; Rao and Qaim, 2011). We can thus assume that producers living closer to the market outlet, the produce collection centre in this setting, are more likely to participate in these supply chains. Furthermore and as underlined by Andersson et al.(2015), social capital may play an important role in a producer's decision to participate in a specific market. One could thus infer that producers living closer to these collection centres, and *a fortiori* the producer organization's centre of activities, may rely on this social capital to get exposed to and enter these specific supply chains.

2.4.6 Dependent and control variables

We use as dependent variables the total hired labour use on the farm and the total labour supplied off the farm by the households through one full year, measured in person-days and disaggregated by age cohort (15-34 and 35 and over). We first adapted a format used by Chege (2015) to collect information on hired labour use at the farm level. Regarding the data on off-farm labour supply, we adapted a procedure used by the World Bank (The World Bank, 2008) to collect and aggregate at the household level data on the total time spent by the different household members on off-farm activities.

With regard to the control variables, we include the socio-economic characteristics of the household through the household head personal characteristics which can affect labour allocation to farm and off-farm labour (Reardon, 1997; Jolliffe, 2004; Kimhi and Rapaport, 2004; Mduma and Wobst, 2005; Mathenge and Tschirley, 2015). We also control for the household age composition (Kimhi and Rapaport, 2004; Wang et al., 2007) and overall education with the share of school graduates within the household (Wang et al., 2007). We include farm characteristics at the time of the survey, such as the size of the farm land (Mduma and Wobst, 2005; Huang et al., 2009) and the total irrigated area as proxy for access to technology (Rao and Qaim, 2013). Access to extension services may reduce the supervision

and research costs for hired labour (Lovo, 2012) and is thus also included. We also include the hired and off-farm labour wages (Wang et al., 2007; Rao and Qaim, 2013) and used the corresponding average wages in the respective village for households not participating in the labour market(s), following Rosenzweig (1980) and Rao and Qaim (2013).

We also take into consideration access to credit (Reardon, 1997; Mduma and Wobst, 2005; Lovo, 2012), the distance to the closest public transportation means (Mduma and Wobst, 2005; Huang et al., 2009; Mathenge and Tschirley, 2015) and division dummies to account for potential geographical and regional disparities, following for instance Rao and Qaim (2013). Finally, we also include a variable on electric power availability as a proxy for the access to public assets for off-farm labour supply (Mduma and Wobst, 2005; Mathenge and Tschirley, 2015) and which can also represent the level of development of the area and labour markets, thus affecting the probability to enter on-farm hired or off-farm supply labour markets (Mduma and Wobst, 2005; Lovo, 2012). We assume this variable would only affect the probability of entering these specific labour markets without directly affecting the quantity of labour inputs allocated to these markets and thus include it only in the participation equations[17].

2.5 Results and discussion

2.5.1 Endogeneity test: quality of the instrument and significance of the residuals

The results from the first-stage probit regression, presented in Table 2.6, show that the distance to the collection centre affects as expected the likelihood of participation in export supply chains, validating this choice of instrument[18].

In the second step of the control function approach, the derived residuals are not significant in any of the selection and level equations, as showed in Table 2.7. Thus, this test fails to reject the exogeneity of participation in export supply chains, which is also in line in some evidence in the literature (Rao and Qaim, 2013). We thus do not include these residuals in the selection and level equations of the lognormal double-hurdle models, following Ricker-Gilbert et al. (2011) or Rao and Qaim (2013).

[17] When including this variable in the two-part models, it did not have any significant effect on the quantities of labour allocated.
[18] Furthermore, this instrument is neither statistically correlated with our variables of interest (quantity of labour hired on-farm and supplied off the farm), nor with any of the residuals from both the selection and level equations of the lognormal double-hurdle for each age-cohort.

Table 2.6. First stage probit of the control function approach

	Participation in export markets	
	Hired labour	Off-farm labour
Distance to the closest collection centre	-0.137**	-0.136*
	(0.065)	(0.070)
Household head age	-0.047	-0.033
	(0.056)	(0.057)
Household head age (square)	0.000	0.000
	(0.001)	(0.001)
Household head education	0.052	0.042
	(0.068)	(0.065)
Household head male	-0.082	-0.131
	(0.392)	(0.402)
Numbers of individuals aged under 15	0.049	0.084
	(0.126)	(0.128)
Number of individuals aged 15-34	0.254**	0.254*
	(0.128)	(0.133)
Number of individuals aged 35 and over	0.221	0.202
	(0.227)	(0.219)
Share of primary school graduates	0.008	0.008
	(0.007)	(0.007)
Share of lower secondary school graduates	-0.002	-0.002
	(0.008)	(0.009)
Share of upper secondary school graduates	-0.038**	-0.033**
	(0.015)	(0.015)
Farm cultivated area	-0.096	-0.093
	(0.066)	(0.068)
Irrigated area	0.045	0.050
	(0.069)	(0.069)
Access to credit	0.537**	0.499**
	(0.215)	(0.224)
Hired labour wage	0.208	
	(0.151)	
Off-farm wage		0.029
		(0.055)
Access to extension services	0.249	
	(0.168)	
Access to electricity	0.672***	0.694***
	(0.240)	(0.215)
Distance to public transportation system	-0.027	-0.027
	(0.062)	(0.058)
Division Kingo'ri [a]	-1.012*	-1.259**
	(0.537)	(0.527)
Division Mbuguni [a]	-0.026	-0.153
	(0.583)	(0.588)
Division Moshono [a]	0.025	-0.082
	(0.452)	(0.447)
Constant	-1.321	-1.227
	(1.632)	(1.587)
Log-likelihood	-157.633	-159.148
Observations	338	338

Notes: Coefficient estimates shown with bootstrapped standard errors in parentheses.
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] Reference division is Poli.

Table 2.7. P-values of the residuals and exogeneity tests

	All age cohorts	15-34 age cohort	35+ age cohort
Hired labour demand		*p-value*	
Selection equation	0.265	0.940	0.193
Level equation	0.142	0.410	0.960
Off-farm labour supply		*p-value*	
Selection equation	0.469	0.230	0.177
Level equation	0.423	0.419	0.952

2.5.2 Household labour allocation decision for all age cohorts

The discussion of the results specifically focuses on the average marginal effects for the lognormal double-hurdle models estimated for all age cohorts, which are displayed in Tables 2.8 and 2.9[19].

Starting with the effects on on-farm hired labour demand (Table 2.8), participation in export vegetable supply chains increases a household's probability to hire labour by about 10 percentage points. The results of the conditional average marginal effects also show that, conditioning on having decided to hire labour, households' hired labour demand is increased by the participation in export supply chains by about 44 person-days over a year. The unconditional average marginal effects show that participation in export supply chains increases a household's on-farm labour demand by about 46 person-days over a year, confirming the on-farm labour and employment creation potential of modern supply chains (Rao and Qaim, 2013). Inspired by Rao and Qaim (2013), we calculate the increase in hired labour demand participation in export vegetable supply chains would proportionally generate with respect to the hired labour demand of non-participating producers[20]. Since the producers in our control group have used in average around 55.6 person-days of hired labour (Table 2.2), participation in export supply chain would potentially increase hired labour demand by about 83 percent, which is non-negligible in terms of employment generation and rural development.

[19] The coefficients from the Maximum Likelihood Estimations of the lognormal double-hurdle models for both on-farm hired labour demand and off-farm labour supply are displayed in Tables A2.6 and A2.7 in the Appendix.

[20] In a similar vein and still following Rao and Qaim (2013), we also generated from this model the unconditional expected hired labour demand for the traditional market suppliers, following the guidelines provided by Belotti et al. (2015). These were quite close to the actual mean hired labour demand for this very group (79.755 person-days) and generated similar percentage changes (80 percent increase). These results are not included here for brevity but are available upon request.

Table 2.8. Conditional and unconditional average marginal effects on hired labour demand (lognormal double-hurdle model)

	All age cohorts			15-34 age cohort			35+ age cohort		
	Conditional		Unconditional	Conditional		Unconditional	Conditional		Unconditional
	Decision	Labor days	Both stages	Decision	Labor days	Both stages	Decision	Labor days	Both stages
Participation in export markets	0.103**	44.187**	46.045***	0.121**	24.169	25.639*	0.133**	85.606	43.058
	(0.041)	(20.264)	(17.390)	(0.054)	(15.471)	(15.389)	(0.061)	(80.581)	(31.001)
Household head age	-0.003	0.267	0.023	-0.005	0.211	-0.151	0.003	0.473	0.323
	(0.003)	(1.006)	(0.811)	(0.003)	(0.924)	(0.744)	(0.003)	(2.072)	(0.665)
Household head education	-0.009	4.936	3.493	0.002	4.853	3.547	-0.009	0.285	-0.563
	(0.011)	(3.281)	(2.624)	(0.013)	(3.499)	(2.422)	(0.012)	(6.479)	(2.768)
Household head male	0.229**	20.699	27.899	0.154	23.789	23.282	-0.060	38.546	9.870
	(0.099)	(25.273)	(19.287)	(0.104)	(26.298)	(15.101)	(0.097)	(41.385)	(21.276)
Numbers of individuals aged under 15	0.001	-18.185*	-13.527*	0.029	-12.488*	-7.090	-0.003	-26.389	-8.571
	(0.024)	(9.301)	(7.278)	(0.029)	(6.953)	(5.730)	(0.028)	(19.802)	(11.338)
Numbers of individuals aged 15-34	-0.026	-12.947	-13.170	-0.032	-10.675	-9.468	-0.009	-8.903	-3.473
	(0.022)	(9.733)	(8.016)	(0.027)	(8.288)	(6.303)	(0.026)	(16.752)	(6.938)
Numbers of individuals aged 35 and over	-0.013	-24.165*	-21.055*	-0.018	-16.668	-12.830	-0.045	-4.249	-4.582
	(0.040)	(14.646)	(12.719)	(0.050)	(12.203)	(9.741)	(0.049)	(31.915)	(13.211)
Share of primary school graduates	-0.001	-0.433	-0.324	-0.001	-0.157	-0.148	0.001	-1.477	-0.403
	(0.001)	(0.465)	(0.386)	(0.001)	(0.414)	(0.337)	(0.001)	(1.037)	(0.540)
Share of lower secondary school graduates	0.002	-0.907	-0.496	0.001	-0.973*	-0.650	0.005**	-1.278	-0.074
	(0.002)	(0.588)	(0.497)	(0.002)	(0.582)	(0.413)	(0.002)	(1.122)	(0.505)
Share of upper secondary school graduates	-0.000	0.197	0.246	0.004	-0.355	0.007	0.003	1.123	0.582
	(0.004)	(0.902)	(0.965)	(0.005)	(1.021)	(0.968)	(0.004)	(2.213)	(1.235)
Farm cultivated area	0.023	1.798	2.986	0.010	-0.511	0.229	0.019	2.269	2.098
	(0.015)	(4.774)	(4.090)	(0.015)	(6.123)	(4.226)	(0.013)	(8.329)	(4.005)
Irrigated area	0.037*	7.732	8.632*	0.042**	6.535	7.090	0.018	-1.216	0.882
	(0.020)	(5.735)	(4.864)	(0.020)	(6.606)	(5.108)	(0.016)	(9.950)	(3.841)
Access to credit	0.069	-2.440	3.172	0.089	-5.246	1.410	-0.061	-1.414	-4.846
	(0.044)	(13.944)	(10.879)	(0.055)	(11.326)	(8.482)	(0.052)	(42.615)	(12.589)
Hired labour wage	0.008	-24.217*	-20.173*	0.066	-20.396	-10.458	-0.050	-19.928	-9.853
	(0.042)	(13.026)	(11.399)	(0.050)	(13.260)	(10.405)	(0.046)	(25.232)	(11.422)
Access to extension services	0.091**	22.193	25.697**	0.055	20.455*	17.533*	0.098**	-55.651	-8.343
	(0.043)	(14.353)	(11.699)	(0.051)	(12.304)	(10.214)	(0.048)	(50.552)	(13.169)
Access to electricity	-0.026		-1.598	0.006		0.354	-0.011		-0.774
	(0.043)		(3.170)	(0.052)		(3.686)	(0.051)		(4.448)
Distance to public transportation system	-0.010	4.751	3.448	-0.005	4.288	2.742	-0.015	2.102	-0.375
	(0.008)	(3.884)	(3.224)	(0.009)	(3.659)	(2.626)	(0.012)	(10.416)	(4.338)
Division Kingo´ri [a]	0.055	-19.842	-13.587	0.025	-23.278	-15.240	0.235*	29.345	32.616
	(0.077)	(41.355)	(34.120)	(0.112)	(31.865)	(23.670)	(0.129)	(118.679)	(98.361)

Table 2.8. Continued

	All age cohorts			15-34 age cohort			Over 35 age cohort		
	Conditional		Unconditional	Conditional		Unconditional	Conditional		Unconditional
	Decision	Labour days	Both stages	Decision	Labour days	Both stages	Decision	Labour days	Both stages
Division Mbuguni [a]	0.137**	3.184	11.213	0.051	-9.779	-3.970	0.033	91.295	30.160
	(0.058)	(39.461)	(33.807)	(0.100)	(37.422)	(25.456)	(0.100)	(146.166)	(99.495)
Division Moshono [a]	0.079	-54.287	-40.836	0.068	-55.741	-34.433	-0.096	15.029	-2.320
	(0.075)	(37.372)	(32.581)	(0.095)	(47.209)	(28.840)	(0.094)	(96.913)	(40.344)
Observations	341	279	341	341	240	341	341	97	341

Notes: Coefficient estimates shown with Delta-Method standard errors in parentheses for the marginal effects of the first stage. Bootstrapped standard errors (150 replications) are shown in parentheses for the conditional marginal effects for the second stage and unconditional marginal effects.

*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.

Marginal conditional effects for the second stage and unconditional marginal effects were transformed using Duan´s smearing estimate (Duan, 1983).

[a] Reference division is Poli.

Table 2.9. Conditional and unconditional average marginal effects on off-farm labour supply (lognormal double-hurdle model)

	All age cohorts			15-34 age cohort			35+ age cohort		
	Conditional		Unconditional	Conditional		Unconditional	Conditional		Unconditional
	Decision	Labor days	Both stages	Decision	Labor days	Both stages	Decision	Labor days	Both stages
Participation in export markets	0.010	47.317	20.294	0.023	50.917	13.267	0.033	30.784	13.986
	(0.060)	(38.281)	(18.859)	(0.048)	(137.016)	(155.924)	(0.054)	(48.787)	(273.755)
Household head age	-0.011***	-1.656	-2.260*	-0.003	-0.949	-0.505	-0.009***	1.354	-1.089
	(0.004)	(2.708)	(1.361)	(0.003)	(6.397)	(5.838)	(0.003)	(2.993)	(35.445)
Household head education	0.029**	9.650	8.195	-0.008	4.699	-0.140	0.026**	10.070	6.999
	(0.013)	(6.284)	(11.147)	(0.010)	(16.156)	(15.571)	(0.011)	(9.341)	(96.674)
Household head male	-0.009	84.282*	32.479	-0.059	37.966	1.623	0.109	103.743	36.152
	(0.100)	(48.564)	(35.743)	(0.089)	(101.443)	(144.941)	(0.080)	(185.021)	(48.600)
Numbers of individuals aged under 15	-0.046	-23.181	-16.169	0.000	-18.562	-3.479	-0.028	0.304	-4.514
	(0.030)	(19.663)	(16.326)	(0.024)	(44.102)	(43.580)	(0.025)	(19.150)	(110.267)
Numbers of individuals aged under 15-34	0.116***	19.107	25.260	0.071***	47.596	18.331	0.052**	17.596	13.297
	(0.028)	(16.257)	(27.694)	(0.021)	(39.567)	(140.010)	(0.024)	(19.811)	(275.542)
Numbers of individuals aged 35 and over	0.161***	42.664	41.515*	-0.045	31.901	0.146	0.224***	43.106	48.496
	(0.052)	(36.743)	(24.200)	(0.042)	(75.931)	(90.559)	(0.043)	(42.967)	(1,495.089)
Share of primary school graduates	-0.004***	-1.834*	-1.332	-0.000	-3.087	-0.625	-0.003**	-0.011	-0.557
	(0.002)	(1.041)	(0.964)	(0.001)	(2.332)	(4.968)	(0.001)	(1.273)	(17.888)
Share of lower secondary school graduates	-0.002	-1.451	-0.852	0.002	-2.534	-0.178	-0.004**	-0.601	-0.786
	(0.002)	(1.112)	(0.871)	(0.002)	(2.969)	(4.554)	(0.002)	(1.596)	(14.788)
Share of upper secondary school graduates	-0.002	0.632	-0.032	0.000	-1.674	-0.275	-0.001	6.018	1.382
	(0.005)	(2.852)	(1.974)	(0.004)	(5.849)	(4.558)	(0.004)	(5.036)	(5.474)
Farm cultivated area	-0.008	7.174	1.522	-0.014	-9.179	-3.555	-0.002	21.187	5.299
	(0.016)	(19.050)	(13.713)	(0.017)	(53.845)	(35.994)	(0.014)	(24.104)	(322.116)
Irrigated area	0.007	-6.350	-1.398	0.022	21.265	6.911	-0.007	-36.420	-10.925
	(0.019)	(19.858)	(13.814)	(0.018)	(54.218)	(34.019)	(0.017)	(28.393)	(412.700)
Access to credit	-0.031	56.980	16.957	-0.047	-9.548	-7.806	0.059	67.626	29.644
	(0.058)	(42.090)	(26.607)	(0.043)	(113.426)	(74.525)	(0.054)	(51.674)	(717.489)
Off-farm wage	0.043**	-17.347***	-0.207	0.003	-16.402	-2.725	0.019**	-16.679***	-1.253
	(0.017)	(5.542)	(5.028)	(0.007)	(13.763)	(14.753)	(0.009)	(6.354)	(25.001)
Access to electricity	-0.002		-0.328	0.024		3.147	-0.016		-2.576
	(0.055)		(12.735)	(0.043)		(26.583)	(0.048)		(345.225)
Distance to public transportation system	-0.020*	-11.099	-7.442	-0.007	2.258	-0.473	-0.016	-20.341	-8.015
	(0.011)	(13.102)	(8.105)	(0.009)	(16.314)	(83.384)	(0.011)	(16.399)	(433.539)

Table 2.9. Continued

	All age cohorts			15-34 age cohort			Over 35 age cohort		
	Conditional		Unconditional	Conditional		Unconditional	Conditional		Unconditional
	Decision	Labour days	Both stages	Decision	Labour days	Both stages	Decision	Labour days	Both stages
Division Kingo´ri [a]	-0.037	20.971	1.917	-0.045	97.560	8.872	0.124	-105.897	-17.376
	(0.117)	(118.692)	(57.792)	(0.072)	(307.715)	(404.160)	(0.121)	(74.181)	(1,713.337)
Division Mbuguni [a]	-0.184**	23.631	-21.591	-0.167***	20.929	-18.504	0.051	-55.960	-7.816
	(0.090)	(86.232)	(41.005)	(0.048)	(491.168)	(82.927)	(0.103)	(110.976)	(671.404)
Division Moshono [a]	-0.112	107.300	25.150	-0.156**	134.572	6.203	0.079	-42.205	2.396
	(0.098)	(99.348)	(37.144)	(0.071)	(145.922)	(136.017)	(0.084)	(102.522)	(264.935)
Observations	341	134	341	341	60	341	341	86	341

Notes: Coefficient estimates shown with Delta-Method standard errors in parentheses for the marginal effects of the first stage. Bootstrapped standard errors (150 replications) are shown in parentheses for the conditional marginal effects for the second stage and unconditional marginal effects. For the conditional marginal effects for the 15-34 age cohort, only 135 replications out of 150 converged successfully.

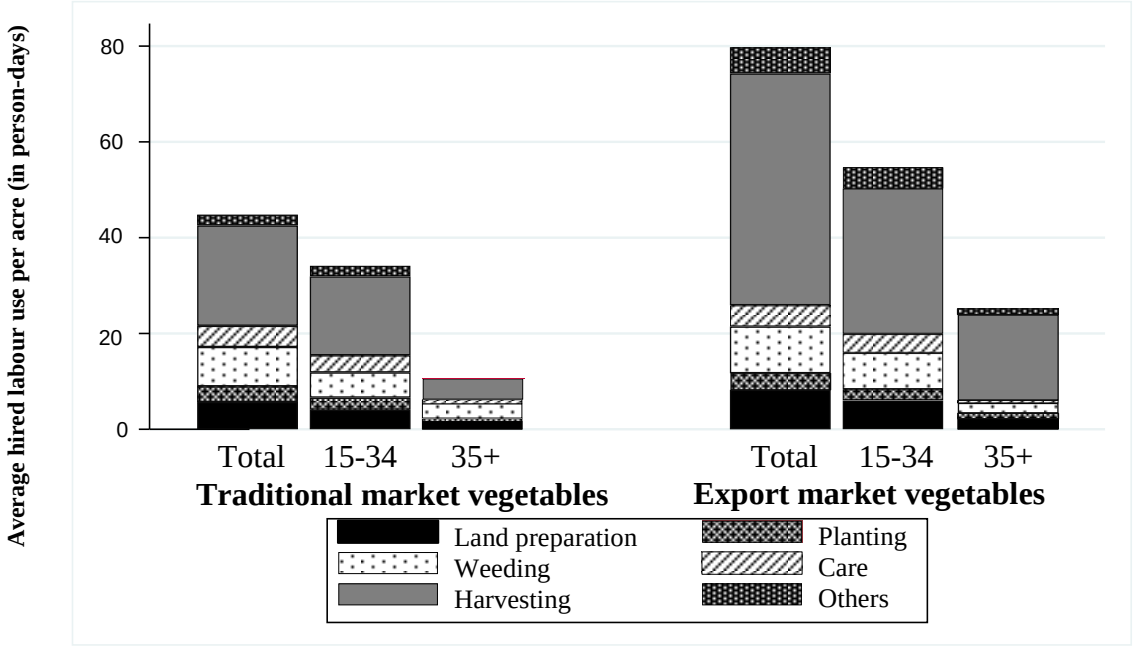
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.

Marginal conditional effects for the second stage and unconditional marginal effects were transformed using Duan´s smearing estimate (Duan, 1983).

[a] Reference division is Poli.

This positive effect may be tied to the higher labour intensity of the cultivated export crops as well as the more stringent standards and quality requirements in these supply chains, leading producers to hire more labour on their farm. As shown in Figure 2.2, export producers hire more labour to produce the export crops, in comparison to the quantity of labour hired by both export and traditional market suppliers for vegetable crops sold in traditional markets. Harvesting (to a large extent) and weeding are the most labour-intensive production steps for which casual labourers are hired. The higher prices proposed in these channels may also serve as an incentive to specialize in these vegetables' production (Rao and Qaim, 2011; 2013), directly moving upwards the overall hired labour demand through a higher vegetable area.

Figure 2.2. Hired labour use for vegetables for export and traditional markets, by type of vegetable



Notes: Data collected at the plot level for traditional vegetable crops produced by both export and traditional market suppliers. Only the export market suppliers in the agricultural year preceding the survey implementation (March 2014 - February 2015) are considered for the export vegetable crops. The category "Care" includes activities such as irrigation, fertilizers and pesticides application. The category "Others" includes activities such as gap filling, stacking and roping and postharvest activities (transportation and packaging).

The unconditional average marginal effects associated to some of the control variables also provide some interesting insights on the overall determinants of households' labour demand and the labour allocation decision process. Indeed, it seems that the total number of household members from the 15 and younger and 35 and over age cohorts reduces overall hired labour demand. This makes sense if we consider that these household members´ labour inputs would be used on the family farm for this higher price and profitable line of production and thus reduce the need to hire more labour to perform their tasks, although this could to a certain extent be in contradiction with some of the intuitions of the separability hypothesis.

Moving to the effects on overall off-farm labour supply (Table 2.9), we do not find a statistically significant effect, albeit with non-negligible coefficients, of participation in export vegetable supply chains on neither households' decision to supply labour off the farm, nor the quantity of labour inputs allocated to these labour markets. Reflecting on the conceptual framework elicited in Section 2.2, we can potentially connect this result to two of the main envisioned pathways. First, we described how the producers supplying the export markets could use the higher income generated to build their financial and/or physical capital which could help them enter the off-farm labour markets, in particular through self-employment and household enterprises. This is relevant in the context of Tanzania where about 39 percent of rural households operate or own a non-farm enterprise and that wealth is an important determinant to do so (Nagler and Naudé, 2017). In our sample, about 29 percent of the participating producers had been involved by the time of the survey for a year or less in the export markets. This may have been a too short timeframe for them to set up their household enterprise and actively spend time on it[21].

Furthermore, and as mentioned earlier, considering that commercial agriculture and broader growth can stimulate the non-farm economy (Haggblade et al., 2010), it could also be expected that the horticultural export sector also contributes to the growth and consolidation of such non-farm activities along the supply chains (*e.g.* marketing of inputs, transportation and processing of the produce, other types of service provision). The agro-processing facilities could also provide off-farm opportunities with the generation of low entry rural wage labour employment for some of these household members as what happened in the French beans sector in Senegal (Maertens and Swinnen, 2009). In our research setting though, these agro-processing facilities are located too far away from the supplying villages, precluding these households from accessing these wage labour opportunities. The exporters also concentrate most of the related services such as the transportation of the produce or sales/provision of inputs. This potentially reduces the potential of these supply chains to generate direct off-farm opportunities and support the local non-farm economy in the villages in our research setting.

Finally, producers do not produce vegetables for these supply chains constantly throughout the year, but rather during specific production seasons spanning two-three months in a year,

[21] Especially if one considers that we used recall data for the participation in off-farm labour markets, which may reduce this timeframe even more by a few months.

hence giving them the possibility to allocate their household labour inputs throughout the year, potentially allowing on-farm and off-farm labour to be complement rather than substitute. This could potentially limit the direct influence on off-farm labour supply decisions.

The effects associated to the other control variables show interesting insights regarding the decision for a household to enter off-farm labour markets. Interestingly, the number of household members from the older age cohort increases off-farm labour supply by 41.5 person-days, confirming the trend, also noted in the descriptive statistics, that older household members in our sample tend to work more off the farm.

2.5.3 Household labour allocation decision disaggregated by age cohort

Regarding the age-disaggregated effects on hired labour (Table 2.8), participation in export vegetable supply chains increases farms' likelihood to hire labourers belonging to the 15-34 age cohort by 12 percentage points and labourers aged 35 and over by 13 percentage points, thus affecting the probability to hire labourers from each of these age cohorts in a similar fashion. However, no specific statistically significant effect is found on the conditional quantities of hired labour demand for both age cohorts. On the other hand, while the unconditional average marginal effect on the hired labour demand for the older age cohort is statistically insignificant[22], the effect of participation in export vegetable supply chains on labour demand for young labourers conveys a statistically significant increase of about 25.6 person-days over a year. This represents an increase of about 62 percent in comparison to the control group's mean hired labour demand for this age cohort, which amounts to 41.5 person-days (Table 2.2). Considering the abovementioned non-significant conditional average marginal effect, we assume that this effect is mostly driven by the higher number of export-vegetable producers who decide to hire young labourers (79 percent of this group) rather than an increase of the labour demand from the producers already hiring young casual labourers.

We can thus infer from the latter that export vegetable supply chains seem to generate new casual on-farm employment and labour opportunities, in particular for younger labourers. This is a relevant finding considering the youth unemployment rate of 37.2 percent (ILO, 2017)[23] and the importance of wage labour for the poor in rural areas in Tanzania (Ellis and Mdoe,

[22] Although with a non-negligible increase magnitude of 43 person-days of labour demand.

[23] This unemployment rate refers to extended definition of unemployment, that is "all persons of working age who were: a) without work during the reference period, *i.e.* were not in paid employment or self-employment; b) currently available for work, i.e. were available for paid employment or self-employment during the reference period, as a percentage of the labour force" applied to the 15-29 age cohort in 2013 (International Labour Organization (ILO) (2017).

2003; Mduma and Wobst, 2005). As observed in Figure 2.2, this effect could be linked to the specific labour intensity of land preparation, weeding and harvesting of French beans and snap peas within the context of export horticulture, which may require specific specialized skills in compliance to standards, triggering producers to hire younger labourers. Furthermore, young labourers may be more available in rural areas to take up this specific range of casual labour in the area due to their reduced access to land or other activities, as mentioned in the introduction, and benefit in priority from this labour demand created.

With respect to off-farm labour supply (Table 2.9), results from the age-disaggregated models are in line with the aforementioned results on household overall off-farm labour supply since, for both age cohorts, no evidence of an effect of participation in export vegetable supply chains is found. Besides the aforementioned argument that the agro-processing wage jobs are located too far away from the villages in our sample, the lack of attractive off-farm opportunities created along the value chains could also affect rural youth decision to enter the labour markets (D. Schwebel, personal communication, 2017).

While we do not find any effect on the off-farm labour supply at the household level, we do not exclude the potential existence of heterogeneous individual effects within the different household members, which may not be reflected in the effects at the household level. Indeed, some individual members within the participating households may have seen their individual participation in off-farm activities affected differently than the other household members, including through the various pathways detailed in Section 2.

2.5.4 Robustness checks and study limitations

As stressed by Rao and Qaim (2013), even though the instrument used seems valid, unobserved heterogeneity may still be of concern and not perfectly addressed. We thus follow their approach and proceed with a robustness check consisting in adding to the model different variables potentially correlated with the unobservable characteristics of producers that may influence both their decision to participate in export markets and their labour decisions (Rao and Qaim, 2013). We use in our case similar variables, such as farming experience of the household head, access to NGOs as well as motorbike and phone ownership. The results presented in the Table A2.8 show that introducing these variables in the model does not change significantly the magnitude and significance levels of the coefficients in any of the six estimated models. We can thus assume that the instrument used has allowed us to correctly address unobserved heterogeneity (Rao and Qaim, 2013).

Our study may still present some limitations, in particular with respect to the research context. Indeed, the results in this paper are found in a context where the separability assumption holds, with a theoretically reasonable functioning of the labour markets. Evidence from the literature has showed potentially different settings and regular rural market failures in Sub-Saharan Africa (Dillon and Barrett, 2017). It would thus be interesting to analyse whether similar results would hold in a context of labour market failures. Also, the cross-sectional structure of the dataset used in this study may present some further limitations. Linked to the aforementioned point on the potential capital needed to access to off-farm activities, some effects on off-farm labour supply may indeed need more time be triggered. Thus, additional survey rounds and an equivalent panel dataset may help better account for this aspect in assessing the effects on off-farm labour supply. With respect to these effects, the relatively small sample size may also preclude the identification of statistically significant effects.

2.6 Conclusion

The application of a double-hurdle model indicates for the case of export vegetable markets in Tanzania that participation in agricultural export supply chains increases the likelihood for a household to hire labour as well as their overall hired labour demand. This is in line with the previous findings of the literature (Rao and Qaim, 2013) and confirms that modern supply chains can contribute to poverty reduction through on-farm labour market effects. Furthermore, the age-disaggregated models show that it also specifically increases the unconditional hired labour demand for the younger labourers, highlighting an employment generation effect particularly marked for the rural youth. This is a relevant result considering that this type of on-farm wage labour is important for the poor (Ellis and Mdoe, 2003; Mduma and Wobst, 2005; Rao and Qaim, 2013).

On the other hand, we have found so far no evidence of a significant effect of participation in export supply chains neither on households' decision to enter off-farm labour markets, nor on the total quantity of labour supplied on the latter. As explained in Section 5, this could be tied to the fact that no major labour substitution is taking place in our research context. Furthermore, the potential shift from involvement *via* product markets to participation through labour markets (Maertens and Swinnen, 2009; Maertens et al., 2012) as well as the establishment of additional off-farm labour opportunities along the supply chain did not materialize.

This research contributes to the current debate on prospects in agriculture for youth, who may eventually also remain active in the agricultural and farming sector, should employment

opportunities be offered to them. It is however important to note, based on our on-site observations, that these labour opportunities are concentrated in narrow time periods, mostly for land preparation and harvesting seasons, and thus not necessarily regular or stable wage labour opportunities. Furthermore, as displayed in the Table A2.9 in the Appendix, the hourly wages received by casual labourers hired by participating small producers are somehow similar to the ones received by casual labourers working on farms not supplying the export supply chains. This positive effect on labour demand may thus not translate into higher wages for labourers and rural youth, but rather only into a higher number of economic and employment opportunities. Yet, more decent working conditions are also an important pathway towards rural poverty reduction and livelihoods development (Ayenew et al., 2017). Thus, besides this aforementioned positive generation of labour opportunities for rural youth, broader welfare effects of modern supply chains *via* casual on-farm labour demand generation, better working conditions, employment stability and higher wages for rural youth in comparison to wage labour and other labour opportunities may also be an interesting topic to assess in future research, in a rural development and poverty reduction perspective, in particular targeting rural youth.

2.7 Appendix A2

Table A2.1. Maximum Likelihood Estimates of the Multivariate Sample-Selection Model (All age cohorts)

	Decision to hire labour (1)		Quantity of hired labour (log) (2)		Decision to supply labour off-farm (3)		Quantity of labour supplied off-farm (log) (4)	
Participation in export markets	0.528**	(0.248)	0.502**	(0.196)	-0.002	(0.183)	0.286	(0.214)
Household head age	0.039	(0.067)	0.054	(0.059)	-0.132**	(0.061)	-0.039	(0.076)
Household head age (square)	-0.001	(0.001)	-0.001	(0.001)	0.001*	(0.001)	0.000	(0.001)
Household head education	-0.041	(0.050)	0.060	(0.037)	0.089**	(0.041)	0.084**	(0.038)
Household head male	0.870**	(0.342)	0.247	(0.369)	0.001	(0.306)	0.683*	(0.386)
Numbers of individuals aged under 15	0.003	(0.114)	-0.198**	(0.088)	-0.147	(0.094)	-0.176*	(0.104)
Number of individuals aged 15-34	-0.120	(0.106)	-0.172*	(0.094)	0.358***	(0.092)	0.191	(0.124)
Number of individuals aged 35 and over	-0.075	(0.193)	-0.288*	(0.158)	0.472***	(0.164)	0.388*	(0.201)
Share of primary school graduates	-0.005	(0.006)	-0.004	(0.005)	-0.012**	(0.005)	-0.015**	(0.006)
Share of lower secondary school graduates	0.010	(0.008)	-0.009	(0.006)	-0.006	(0.006)	-0.011	(0.007)
Share of upper secondary school graduates	-0.002	(0.018)	0.004	(0.014)	-0.008	(0.015)	0.001	(0.014)
Farm cultivated area	0.106	(0.072)	0.023	(0.048)	-0.028	(0.050)	0.037	(0.088)
Irrigated area	0.174*	(0.098)	0.094*	(0.054)	0.022	(0.059)	-0.032	(0.093)
Access to credit	0.341	(0.242)	-0.024	(0.184)	-0.107	(0.180)	0.265	(0.218)
Hired labour wage	0.044	(0.195)	-0.304**	(0.130)				
Off-farm wage					0.157***	(0.054)	-0.088***	(0.026)
Access to extension services	0.410**	(0.193)	0.305*	(0.173)				
Access to electricity	-0.114	(0.221)			-0.008	(0.163)		
Distance to public transportation system	-0.048	(0.036)	0.061*	(0.036)	-0.061*	(0.035)	-0.108**	(0.053)
Division Kingo´ri [a]	0.274	(0.426)	-0.233	(0.381)	-0.220	(0.385)	0.141	(0.351)
Division Mbuguni [a]	0.754*	(0.414)	0.062	(0.369)	-0.692**	(0.352)	-0.045	(0.350)
Division Moshono [a]	0.349	(0.339)	-0.679**	(0.326)	-0.409	(0.311)	0.579*	(0.301)
Constant	-0.887	(1.705)	2.940*	(1.584)	2.678*	(1.522)	4.362**	(1.764)
Ln Sigma2	0.192***	(0.042)						
Ln Sigma4	-0.004	(0.107)						
ρ_12	-0.021	(0.508)						
ρ_13	-0.027	(0.115)						
ρ_14	0.079	(0.124)						
ρ_23	-0.007	(0.087)						
ρ_24	0.161	(0.100)						
ρ_34	0.455	(0.353)						
Log Likelihood	-959.184***							
Chi-Squared	239.70							
Observations	341		341		341		341	

Notes: Coefficient estimates shown with standard errors in parentheses. *Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] Reference division is Poli.

Table A2.2. Maximum Likelihood Estimates of the Multivariate Sample-Selection Model (15-34 age cohort)

	Decision to hire labour (1)		Quantity of hired labour (log) (2)		Decision to supply labour off-farm (3)		Quantity of labour supplied off-farm (log) (4)	
Participation in export markets	0.404**	(0.200)	0.423**	(0.211)	0.073	(0.219)	0.259	(0.354)
Household head age	-0.046	(0.061)	0.044	(0.063)	-0.114	(0.070)	-0.063	(0.140)
Household head age (square)	0.000	(0.001)	-0.001	(0.001)	0.001	(0.001)	0.001	(0.001)
Household head education	0.012	(0.043)	0.075*	(0.040)	-0.036	(0.048)	0.069	(0.069)
Household head male	0.489	(0.306)	0.525	(0.374)	-0.245	(0.354)	0.621	(0.556)
Numbers of individuals aged under 15	0.088	(0.097)	-0.167*	(0.101)	-0.002	(0.112)	-0.253	(0.210)
Number of individuals aged 15-34	-0.132	(0.092)	-0.170	(0.107)	0.331***	(0.104)	0.331	(0.256)
Number of individuals aged 35 and over	-0.034	(0.166)	-0.241	(0.177)	-0.213	(0.197)	0.180	(0.358)
Share of primary school graduates	-0.003	(0.005)	-0.002	(0.005)	-0.001	(0.006)	-0.027***	(0.010)
Share of lower secondary school graduates	0.001	(0.007)	-0.014**	(0.007)	0.011	(0.008)	-0.020	(0.014)
Share of upper secondary school graduates	0.011	(0.018)	-0.002	(0.016)	0.001	(0.017)	-0.008	(0.022)
Farm cultivated area	0.031	(0.051)	-0.003	(0.052)	-0.067	(0.078)	-0.111	(0.192)
Irrigated area	0.136**	(0.065)	0.123**	(0.062)	0.105	(0.083)	0.202	(0.193)
Access to credit	0.334*	(0.194)	0.001	(0.202)	-0.234	(0.220)	-0.137	(0.360)
Hired labour wage	0.253	(0.169)	-0.227	(0.149)				
Off-farm wage					0.016	(0.034)	-0.119**	(0.050)
Access to extension services	0.205	(0.165)	0.404**	(0.182)				
Access to electricity	0.023	(0.165)			0.157	(0.215)		
Distance to public transportation system	-0.013	(0.030)	0.061	(0.038)	-0.033	(0.041)	-0.057	(0.072)
Division Kingo´ri [a]	0.096	(0.389)	-0.330	(0.431)	-0.232	(0.391)	0.603	(0.479)
Division Mbuguni [a]	0.167	(0.353)	-0.071	(0.370)	-0.993***	(0.369)	0.087	(0.633)
Division Moshono [a]	0.230	(0.318)	-0.720**	(0.344)	-0.700**	(0.308)	0.918*	(0.482)
Constant	0.675	(1.530)	2.292	(1.594)	2.644	(1.775)	5.096	(3.452)
Ln Sigma2	0.254***	(0.074)						
Ln Sigma4	-0.028	(0.188)						
ρ_12	0.450	(0.343)						
ρ_13	0.073	(0.119)						
ρ_14	0.396*	(0.205)						
ρ_23	0.012	(0.107)						
ρ_24	0.367*	(0.211)						
ρ_34	0.350	(0.663)						
Log Likelihood	-782.989***							
Chi-Squared	179.51							
Observations	341		341		341		341	

Notes: Coefficient estimates shown with standard errors in parentheses. *Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] Reference division is Poli.

Table A2.3. Maximum Likelihood Estimates of the Multivariate Sample-Selection Model (Over 35 age cohort)

	Decision to hire labour (1)		Quantity of hired labour (log) (2)		Decision to supply labour off-farm (3)		Quantity of labour supplied off-farm (log) (4)	
Participation in export markets	0.410**	(0.198)	0.670	(0.539)	0.136	(0.199)	0.206	(0.239)
Household head age	0.087	(0.065)	0.074	(0.162)	-0.053	(0.068)	0.158	(0.099)
Household head age (square)	-0.001	(0.001)	-0.001	(0.002)	0.000	(0.001)	-0.001	(0.001)
Household head education	-0.030	(0.042)	-0.007	(0.075)	0.104**	(0.045)	0.044	(0.050)
Household head male	-0.202	(0.309)	0.857	(0.608)	0.456	(0.415)	0.895	(0.668)
Numbers of individuals aged under 15	-0.014	(0.095)	-0.360*	(0.208)	-0.097	(0.097)	0.039	(0.121)
Number of individuals aged 15-34	-0.030	(0.088)	-0.082	(0.167)	0.196**	(0.095)	0.055	(0.129)
Number of individuals aged 35 and over	-0.156	(0.168)	0.066	(0.389)	0.888***	(0.187)	0.089	(0.327)
Share of primary school graduates	0.003	(0.005)	-0.020*	(0.011)	-0.013**	(0.005)	0.003	(0.007)
Share of lower secondary school graduates	0.016**	(0.006)	-0.022	(0.019)	-0.015**	(0.007)	0.000	(0.009)
Share of upper secondary school graduates	0.010	(0.016)	0.023	(0.030)	-0.004	(0.015)	0.039**	(0.018)
Farm cultivated area	0.065	(0.045)	0.027	(0.099)	-0.009	(0.054)	0.137	(0.090)
Irrigated area	0.060	(0.056)	-0.106	(0.104)	-0.021	(0.064)	-0.216**	(0.097)
Access to credit	-0.214	(0.194)	0.206	(0.407)	0.205	(0.194)	0.342	(0.235)
Hired labour wage	-0.166	(0.158)	-0.204	(0.318)				
Off-farm wage					0.066*	(0.035)	-0.119***	(0.031)
Access to extension services	0.338**	(0.171)	-0.813*	(0.459)				
Access to electricity	-0.003	(0.188)			-0.031	(0.183)		
Distance to public transportation system	-0.051	(0.040)	0.022	(0.118)	-0.061	(0.041)	-0.104	(0.064)
Division Kingo´ri [a]	0.789**	(0.393)	0.529	(0.928)	0.437	(0.406)	-0.939**	(0.462)
Division Mbuguni [a]	0.181	(0.344)	1.449**	(0.617)	0.165	(0.380)	-0.352	(0.443)
Division Moshono [a]	-0.258	(0.314)	0.785	(0.630)	0.283	(0.346)	-0.288	(0.402)
Constant	-2.827*	(1.668)	3.072	(4.795)	-0.915	(1.668)	-0.192	(2.620)
Ln Sigma2	0.275	(0.302)						
Ln Sigma4	-0.156	(0.199)						
ρ_12	-0.449	(1.087)						
ρ_13	0.025	(0.112)						
ρ_14	-0.106	(0.166)						
ρ_23	0.006	(0.161)						
ρ_24	0.203	(0.249)						
ρ_34	-0.429	(0.706)						
Log Likelihood	-595.394***							
Chi-Squared	200.28							
Observations	340		340		340		340	

Notes: Coefficient estimates shown with standard errors in parentheses. *Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] Reference division is Poli.

Table A2.4. Likelihood ratio tests for the MSSM and nested SSM and DHM

	All age cohorts			15-34 age cohort			35+ age cohort		
	Likelihood Ratio Tests								
	χ2	*p-value*	*Interpretation*	*χ2*	*p-value*	*Interpretation*	*χ2*	*p-value*	*Interpretation*
DHM nested in SSM (df=2)	1.240	0.538	DHM preferred	2.440	0.295	DHM preferred	0.770	0.679	DHM preferred
SSM nested in MSSM (df =4)	3.880	0.422	SSM preferred	6.120	0.190	SSM preferred	0.900	0.924	SSM preferred
DHM nested in MSSM (df =6)	5.120	0.529	DHM preferred	8.570	0.199	DHM preferred	1.680	0.947	DHM preferred

Notes: DHM: Double-hurdle model; SSM: Sample selection model; MSSM: Multivariate Sample Selection Model

Table A2.5. Specification tests for the choice between the Tobit, LDH and TDH models

	Hired Labour		
Likelihood Ratio test			
	χ^2	*Minimum value* ($\chi^2_{0.01, 21}$)	*Interpretation*
Tobit model vs. TDH model	455.080	46.800	TDH preferred
Vuong test			
	Coefficient	*p-value*	*Interpretation*
Tobit model vs. TDH model	0.667	0.000	TDH preferred
Tobit model vs. LDH model	0.701	0.000	LDH preferred
LDH model vs. TDH model	0.037	0.185	Indifferent
	Off-farm labour supply		
Likelihood Ratio test			
	χ^2	*Minimum value* ($\chi^2_{0.01, 20}$)	*Interpretation*
Tobit model vs. TDH model	70.072	45.315	TDH preferred
Vuong test			
	Coefficient	*p-value*	*Interpretation*
Tobit model vs. LDH model	0.093	0.002	LDH preferred
Tobit model vs. TDH model	0.106	0.000	TDH preferred
LDH model vs. TDH model	-0.012	0.429	Indifferent

Notes: TDH: Truncated normal double-hurdle model; LDH: Lognormal double-hurdle model.

Table A2.6. Maximum Likelihood Estimates for the hired labour demand (lognormal double-hurdle model)

	All age cohorts				15-34 age cohort				Over 35 age cohort			
	Selection		Log outcome		Selection		Log outcome		Selection		Log outcome	
Participation in export markets	0.530**	(0.224)	0.503***	(0.170)	0.418**	(0.192)	0.336*	(0.192)	0.435**	(0.187)	1.046**	(0.454)
Household head age	0.036	(0.064)	0.056	(0.051)	-0.042	(0.060)	0.055	(0.059)	0.088	(0.058)	0.152	(0.151)
Household head age (square)	-0.000	(0.001)	-0.001	(0.000)	0.000	(0.001)	-0.001	(0.001)	-0.001	(0.001)	-0.001	(0.001)
Household head education	-0.043	(0.041)	0.060*	(0.033)	0.007	(0.038)	0.072*	(0.042)	-0.031	(0.039)	0.004	(0.081)
Household head male	0.866**	(0.366)	0.272	(0.334)	0.474	(0.312)	0.427	(0.429)	-0.197	(0.313)	0.814*	(0.490)
Numbers of individuals aged under 15	0.004	(0.098)	-0.201**	(0.087)	0.095	(0.086)	-0.186**	(0.092)	-0.011	(0.090)	-0.405*	(0.232)
Number of individuals aged 15-34	-0.119	(0.104)	-0.172*	(0.102)	-0.107	(0.085)	-0.159	(0.108)	-0.032	(0.089)	-0.137	(0.189)
Number of individuals aged 35 and over	-0.063	(0.177)	-0.300**	(0.153)	-0.059	(0.157)	-0.249	(0.165)	-0.156	(0.161)	-0.065	(0.340)
Share of primary school graduates	-0.005	(0.005)	-0.004	(0.005)	-0.002	(0.005)	-0.002	(0.005)	0.003	(0.005)	-0.023**	(0.011)
Share of lower secondary school graduates	0.010	(0.007)	-0.009	(0.006)	0.002	(0.006)	-0.015**	(0.007)	0.016**	(0.007)	-0.020	(0.013)
Share of upper secondary school graduates	-0.002	(0.015)	0.004	(0.009)	0.014	(0.014)	-0.005	(0.012)	0.011	(0.014)	0.017	(0.022)
Farm cultivated area	0.105*	(0.058)	0.024	(0.044)	0.033	(0.046)	-0.008	(0.053)	0.066	(0.063)	0.035	(0.091)
Irrigated area	0.171**	(0.084)	0.095*	(0.054)	0.137**	(0.060)	0.098	(0.066)	0.061	(0.070)	-0.019	(0.108)
Access to credit	0.343	(0.212)	-0.015	(0.163)	0.302	(0.189)	-0.079	(0.182)	-0.217	(0.190)	-0.022	(0.421)
Hired labour wage	0.036	(0.117)	-0.306**	(0.140)	0.218	(0.136)	-0.304*	(0.169)	-0.171	(0.158)	-0.306	(0.304)
Access to extension services	0.413**	(0.190)	0.316*	(0.165)	0.180	(0.161)	0.320*	(0.183)	0.340**	(0.171)	-0.730**	(0.345)
Access to electricity	-0.122	(0.192)			0.020	(0.167)			-0.037	(0.175)		
Distance to public transportation system	-0.048	(0.031)	0.060	(0.042)	-0.016	(0.031)	0.064	(0.046)	-0.050	(0.034)	0.032	(0.110)
Division Kingo´ri [a]	0.278	(0.400)	-0.272	(0.453)	0.085	(0.361)	-0.403	(0.482)	0.720*	(0.402)	0.395	(0.747)
Division Mbuguni [a]	0.767*	(0.404)	0.032	(0.389)	0.173	(0.319)	-0.149	(0.432)	0.109	(0.346)	1.058	(0.692)
Division Moshono [a]	0.357	(0.327)	-0.699*	(0.379)	0.223	(0.280)	-0.802*	(0.418)	-0.319	(0.310)	0.221	(0.670)
Constant	-0.767	(1.634)	2.909**	(1.327)	0.620	(1.513)	2.631	(1.601)	-2.734*	(1.488)	0.979	(3.636)
Log pseudolikelihood	-582.982				-574.342				-338.247			
Observations	341		280		341		240		341		97	

Notes: Coefficient estimates shown with robust standard errors in parentheses.
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] Reference division is Poli.

Table A2.7. Maximum Likelihood Estimates for the off-farm labour supply (lognormal double-hurdle model)

	All age cohorts				15-34 age cohort				Over 35 age cohort			
	Selection		Log outcome		Selection		Log outcome		Selection		Log outcome	
Participation in export markets	0.030	(0.184)	0.279	(0.220)	0.104	(0.215)	0.389	(0.419)	0.123	(0.198)	0.180	(0.259)
Household head age	-0.146***	(0.056)	0.001	(0.070)	-0.116*	(0.060)	-0.060	(0.132)	-0.047	(0.068)	0.150	(0.111)
Household head age (square)	0.001**	(0.001)	-0.000	(0.001)	0.001**	(0.001)	0.001	(0.001)	0.000	(0.001)	-0.001	(0.001)
Household head education	0.088**	(0.040)	0.059*	(0.032)	-0.037	(0.044)	0.038	(0.089)	0.099**	(0.044)	0.060	(0.042)
Household head male	-0.028	(0.347)	0.702**	(0.353)	-0.251	(0.370)	0.356	(0.457)	0.478	(0.414)	0.955	(0.716)
Numbers of individuals aged under 15	-0.141	(0.087)	-0.143	(0.099)	0.002	(0.097)	-0.151	(0.213)	-0.106	(0.098)	0.002	(0.119)
Number of individuals aged 15-34	0.353***	(0.086)	0.118	(0.092)	0.332***	(0.091)	0.387*	(0.202)	0.199**	(0.095)	0.106	(0.114)
Number of individuals aged 35 and over	0.493***	(0.154)	0.263	(0.179)	-0.212	(0.177)	0.259	(0.397)	0.854***	(0.180)	0.259	(0.213)
Share of primary school graduates	-0.012***	(0.005)	-0.011**	(0.006)	-0.001	(0.005)	-0.025**	(0.011)	-0.013**	(0.005)	-0.000	(0.006)
Share of lower secondary school graduates	-0.006	(0.006)	-0.009	(0.006)	0.011*	(0.006)	-0.021	(0.013)	-0.014**	(0.007)	-0.004	(0.008)
Share of upper secondary school graduates	-0.006	(0.014)	0.004	(0.016)	0.002	(0.014)	-0.014	(0.027)	-0.005	(0.015)	0.036*	(0.019)
Farm cultivated area	-0.025	(0.048)	0.044	(0.096)	-0.065	(0.058)	-0.075	(0.296)	-0.008	(0.054)	0.127	(0.100)
Irrigated area	0.022	(0.056)	-0.039	(0.108)	0.102	(0.065)	0.173	(0.307)	-0.028	(0.064)	-0.219**	(0.108)
Access to credit	-0.096	(0.178)	0.335	(0.213)	-0.230	(0.220)	-0.079	(0.389)	0.219	(0.192)	0.392	(0.251)
Off-farm wage	0.130***	(0.044)	-0.107***	(0.024)	0.014	(0.029)	-0.133**	(0.066)	0.074**	(0.036)	-0.100***	(0.022)
Access to electricity	-0.007	(0.166)			0.113	(0.192)			-0.059	(0.182)		
Distance to public transportation system	-0.062**	(0.029)	-0.068	(0.071)	-0.032	(0.035)	0.018	(0.086)	-0.060	(0.041)	-0.122*	(0.068)
Division Kingo´ri [a]	-0.114	(0.365)	0.123	(0.505)	-0.223	(0.369)	0.612	(0.759)	0.437	(0.401)	-0.864*	(0.486)
Division Mbuguni [a]	-0.607*	(0.336)	0.139	(0.415)	-0.981***	(0.356)	0.159	(0.600)	0.190	(0.371)	-0.359	(0.486)
Division Moshono [a]	-0.338	(0.303)	0.657	(0.466)	-0.687**	(0.308)	1.052	(0.696)	0.307	(0.340)	-0.247	(0.440)
Constant	3.033**	(1.417)	3.703**	(1.768)	2.700*	(1.539)	5.265	(3.641)	-1.023	(1.671)	-0.572	(2.799)
Log pseudolikelihood	-378.825				-211.925				-263.297			
Observations	341		134		341		60		341		86	

Notes: Coefficient estimates shown with robust standard errors in parentheses.
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] Reference division is Poli.

Table A2.8. Robustness checks for the control function approach and selected instrument following Rao and Qaim (2013)

	All age cohorts		15-34 age cohort		35+ age cohort	
	Hired labour demand					
	Selection	Log outcome	Selection	Log outcome	Selection	Log outcome
Original model	0.530**	0.503***	0.418**	0.336*	0.435**	1.046**
	(0.224)	(0.170)	(0.192)	(0.192)	(0.187)	(0.454)
Farm experience	0.529**	0.519***	0.416**	0.342*	0.435**	1.044**
	(0.224)	(0.169)	(0.192)	(0.189)	(0.186)	(0.453)
Access to NGO	0.535**	0.560***	0.440**	0.394**	0.386**	1.103**
	(0.225)	(0.172)	(0.195)	(0.193)	(0.188)	(0.449)
Motorbike ownership	0.527**	0.528***	0.433**	0.358**	0.427**	1.054**
	(0.227)	(0.172)	(0.197)	(0.194)	(0.186)	(0.460)
Mobile phone ownership	0.525**	0.510***	0.411**	0.345*	0.429**	1.047**
	(0.224)	(0.173)	(0.193)	(0.196)	(0.188)	(0.461)
	Off-farm labour supply					
	Selection	Log outcome	Selection	Log outcome	Selection	Log outcome
Original model	0.030	0.279	0.104	0.389	0.123	0.180
	(0.184)	(0.220)	(0.215)	(0.419)	(0.198)	(0.259)
Farm experience	0.025	0.281	0.108	0.417	0.126	0.205
	(0.184)	(0.223)	(0.216)	(0.443)	(0.201)	(0.275)
Access to NGO	0.026	0.259	0.133	0.421	0.101	0.134
	(0.185)	(0.259)	(0.214)	(0.449)	(0.203)	(0.262)
Motorbike ownership	0.039	0.248	0.106	0.398	0.168	0.142
	(0.185)	(0.211)	(0.215)	(0.434)	(0.202)	(0.238)
Mobile phone ownership	0.011	0.238	0.065	0.491	0.133	0.037
	(0.184)	(0.219)	(0.217)	(0.428)	(0.203)	(0.258)

Notes: Coefficient estimates shown with robust standard errors in parentheses.
*Significant at the 10 percent level, **significant at the 5 percent level.
The original model refers to the Maximum Likelihood Estimates for the dependent variable "Participation in export markets" presented in the Table A2.6. The other models represent the estimates for the same dependent variable when the control variables "Farm experience", "Access to NGO", "Motorbike ownership" and "Mobile phone ownership" are added to the model.

Table A2.9. Hourly wages received by hired labourers

	Traditional markets (N=257)	Export markets (N=87)	Complete Sample (N=344)
Wage received by hired labourers (in TZS per hour)	1103.1 (533.2)	1210.4 (587.4)	1130.3 (548.5)
Wage received by hired labourers –15-34 age cohort (in TZS per hour)	1169.3 (646.2)	1242.2 (670.7)	1191.5 (653.1)
Wage received by hired labourers – 35 and over age cohort (in TZS per hour)	1042.3 (477.7)	1108.0 (455.2)	1064.4 (468.6)

Notes: Mean values are shown with standard deviations in parentheses.
The statistical significance of the differences between the mean values of the two groups is presented as follows: *significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
TZS: Tanzanian Shillings. At the time of the survey, the average quarterly exchange rate was USD 1 = TZS 2,088.82.

3 Small producer participation in export vegetable supply chains and poverty: evidence from different export schemes in Tanzania

Abstract:

With the rise and consolidation of modern supply chains, literature has put emphasis on the welfare effects for participating small producers but has often considered these effects through the comparison of participating producers with those not participating at all. Using endogenous switching regression models, we assess in this paper the effects of small producer participation in export vegetable supply chains in Tanzania on household income and compare the effects of supplying two different types of French beans and snap peas export supply chains, defined as high-value (HVESC) and regular export supply chains (RESC), respectively. We find that participation in export supply chains increases producers' household per capita income. We also find evidence that these effects may vary from one type of export supply chains to the other and are mainly driven by HVESC, which confirms that participation in export supply chains may have varying effects depending on individual circumstances and participation conditions. We also disaggregate the analysis with respect to the producers' farm size and income level and find evidence that richer and larger producers benefit from supplying the HVESC while supplying the RESC can increase the household per capita income of some poorer producers.

Key words *– small producers, export supply chains, horticulture, endogenous switching regression, household income, Tanzania*

JEL Codes **–** C24, O12, O13, Q12, Q13

This chapter is co-authored by Bernhard Brümmer (BB) and Victor Afari-Sefa (VAS). The contributions of each author are as follows: Marwan Benali (MB), BB and VAS conceptualized and designed the research. MB implemented the survey and collected the data with support from VAS. MB analysed and interpreted the data. BB and VAS assisted in the analysis and interpretation of the results. MB wrote the paper. BB and VAS also provided valuable feedback and comments at various stages of the research and drafting of the paper.

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3.1 Introduction

As part of the transformation process of the global agri-food systems, modern export supply chains have been expanding in Sub-Saharan Africa, in a context particularly marked by, among others, a shift towards high-value products, an increase in trade volumes of food commodities from the continent and the consolidation of food quality standards (Reardon and Barrett, 2000; Maertens and Swinnen, 2009; Maertens et al., 2012; Chiputwa et al., 2015). These changes have had diverse implications for small producer participation in these supply chains as different levels and shares of sourcing from small producers can be found, depending on the commodity sector and country case examined (Maertens et al., 2012). In cases where small producers remain suppliers of these export supply chains (ESC) and keep participating in the latter *via* product markets, contract farming schemes have in many cases been used to link small producers to these export markets (Maertens and Swinnen, 2009; Minten et al., 2009; Schipmann and Qaim, 2011; Barrett et al., 2012; Bellemare, 2012; Maertens et al., 2012).

Literature has given significant attention to the potential livelihoods and poverty effects of these supply chains, showing that participation in the latter can have positive income and poverty reduction effects (Maertens and Swinnen, 2009; Miyata et al., 2009; Bellemare, 2012; Maertens et al., 2012). Similar positive effects on poverty were found in domestic high-value supply chains (Rao and Qaim, 2011; Michelson, 2013; Andersson et al., 2015), which have similar characteristics than the abovementioned ESC (Rao and Qaim, 2011). Broader welfare effects have also been noted as participation in these supply chains can positively affect, among others, farm productivity and efficiency (Minten et al., 2007; Rao et al., 2012) as well as hired labour demand (Rao and Qaim, 2013).

Yet, building on the abovementioned literature, these modern supply chains and the related participation schemes may be heterogeneous and have different characteristics (Narayanan, 2014; Wang et al., 2014b). First of all, as can be seen from examples from the literature, the very conditions of small producer participation and contract farming/supply schemes can take different forms from a country to the other and from a supply chain/commodity to the other (Barrett et al., 2012; Bellemare, 2012; Wang et al., 2014b) as well as from a firm to the other within a single commodity supply chain (Narayanan, 2014). Likewise, the supply scheme agreements in a specific sector or provided by a same firm may evolve over time (Ochieng et al., 2017), which could also bear a potential change in terms of the effects on participating producers. In general, one could assume that these differences and heterogeneity of the

different supply schemes could also convey a difference in terms of their potential welfare effects.

Furthermore and as highlighted by Narayanan (2014), producers participating in these supply chains may also face different experiences and not all benefit in the same way. As a matter of fact, some producers face challenges and difficulties to remain in these supply chains and high exit rates in the latter can be noted (Narayanan, 2014; Andersson et al., 2015). In the case of Nicaragua, small producers supplying Walmart supermarkets were receiving lower price than their counterparts in the traditional markets (Michelson et al., 2012). In the context of Guatemala, producers supplying tomatoes to supermarkets also incurred high expenditures for inputs, hence reducing their profitability (Hernández et al., 2007). There may thus be some heterogeneity of the effects and a potential absence of direct positive effects and benefits for some participating producers, who in turn leave the supply chains for alternative livelihoods.

Reflecting on the heterogeneity of these supply chains and modalities for small producer inclusion in the latter as well as the potentially different experiences faced by small producers, one could assume that the effects of participation in ESC can vary from a supply chain or supply agreement to the other (Narayanan, 2014). Some studies have so far compared the welfare effects of participation as employee with participation as a contract farmer (Maertens and Swinnen, 2009) or the effects of selling vegetables to supermarkets or wholesalers through contracts against the option of selling them through direct marketing (Wang et al., 2014a). Related to the broader literature on modern supply chains, other research compared the effects of different types of product certification schemes (Ruben and Zuniga, 2011; Chiputwa et al., 2015). However, to the best of our knowledge, besides the paper by Narayanan (2014) in the context of India, we are not aware of any other study that compares different participation schemes in modern supply chains and their welfare effects for participating producers in a similar context.

This paper, through the case of French beans and snap peas export supply chains in Tanzania, will thus contribute to this literature by assessing the effects of small producer participation in ESC on household welfare, in particular through the comparison of the effects on producers supplying different types of exporters. These exporters differ in terms of the type of crop produce exported, their contract arrangements with producers, as well as the final shape and processing stage of the produce they export. This would allow us to better understand which type of export supply schemes (and their characteristics) may benefit supplying producers the most. In this regard, our research question and approach is similar to and follows Narayanan

(2014), although we concentrate on one group of commodities and look into a broader welfare outcome than net profits through the effects on household per capita income[24] . Focusing on the effects on per capita income allows us to consider the various aspects and pathways through which participation in modern supply chains can affect household poverty, in particular with considerations to the labour and land allocated to the crop production for these supply chains (Miyata et al., 2009). For instance, participation in modern supply chains may lead to a potentially reduced household time endowment available for off-farm activities, which would also affect household income. Furthermore, we also disaggregate the results based on producers' farm size and income level as there is some evidence that the extent to which participation in modern supply chains or adoption of food standards can affect them may differ based on these characteristics (Rao and Qaim, 2011; Hansen and Trifković, 2014). This is useful to understand which households and producers can benefit the most from these different types of export schemes. Finally, a Gini decomposition analysis is also carried out in order to identify the potential of these respective types of supply chains to reduce inequalities among small producers.

Thus, the remainder of the paper is organized as follows: Section 2 will briefly present the export vegetable supply chains in Tanzania and present some descriptive statistics for our sample as well as the contracts and supply agreements in our research study context; Section 3 will elaborate on the econometric framework and approach used while the Section 4 will present the main results of the econometric analysis. Finally, Section 5 will discuss these results and Section 6 will conclude the paper.

3.2 Context, data and descriptive statistics

3.2.1 The export vegetable supply chains in Tanzania

The horticultural sector has been growing extensively in the recent years and identified as a priority sector in the national development strategies in Tanzania (HODECT, 2010). Among the different products in this commodity group, French beans and green peas[25] constitute a non-negligible share of the export value amounting to USD 7.97 million and USD 1.07 million in 2013, respectively (FAOSTAT, 2017), with the former being the highest-valued exported vegetable from the country and the latter being the third after onions in that same year.

[24] Due to some technical issues related to the data, production costs could however not be subtracted from farm income.
[25] Similar data for snap peas only were not available.

Most of the currently active horticultural exporters in the country are located in the region of the Northern Highlands, where the most suitable environment for horticulture, in terms of climate, infrastructures and markets can be found (HODECT, 2010). At the time of conducting our survey in 2015, four exporters were active in the area. While the list of commodities they process and export may vary from an exporter to the other, all of them export vegetables such as French beans and a majority export snap peas, mainly to Europe (Belgium, France, Germany, Netherlands, United Kingdom) and South Africa.

While some of these exporters obtain some of their supply from alternative sources such as their own farms and production units or medium-scale and large-scale commercial farms, all these exporters obtain an important share of their supply from small producers *via* contract farming arrangements in the districts of Arusha and Arumeru in the Arusha region, in the district of Moshi in the Kilimanjaro region and in the district of Lushoto in the Tanga region for one of these exporters. This is also consistent with the fact that small producers still dominate the horticultural sector in Tanzania (HODECT, 2010) and as such constitute the major source of supply in the area. Most of these producers are organized in groups which serve as the main platform for interactions and the contract engagements between the exporters and the supplying producers.

However, behind the labels "exported produce" and "exporters", one can find different finished shapes of the produce as well as different processing schemes and modalities of participation in ESC. A major distinction to be stressed between the different exporters relate to the processing of the produce. While three of the abovementioned exporters process the produce on-site and ship it directly to the final destination countries in a cold-packed form, the other exporter sends the produce to Kenya to be processed there, mostly into cans and jars, before being shipped to its final destination. For the remainder of this paper, we will refer to the former type of exporters and supply chains as high-value vegetable export supply chains (HVESC) and the second one as regular export vegetable supply chains (RESC), respectively.

3.2.2 Data collection and survey

The data for this study were collected between July and September 2015 in the abovementioned districts of Arumeru and Arusha in the region of Arusha of Tanzania. We selected these two districts since all the four exporters active in the area during the data collection period were located and sourced at least a substantial part of their supply from small producers in these two districts. We first conducted key informant interviews with staff from the four exporters, who provided us with the contact details of the producer groups

supplying them at the time. We thus identified and selected all the ten villages where these producer groups were located. These villages were located in four divisions, namely Kingo'ri, Mbuguni, Moshono and Poli. We obtained from these groups the list of their members supplying French beans and snap peas to the exporters. In parallel, we obtained from the local village authorities the list of vegetable producers in the same ten villages supplying the traditional markets (TM) only.

Based on these two lists, we proceeded with a stratified random sampling approach and distinguished between the producers supplying French beans and snap peas to the exporters from those selling their vegetables in the traditional markets only. We interviewed in total 349 producers[26], among which 159 were participating in the export supply chains and 190 were supplying the traditional markets. In order to consistently assess the actual effect of small producer participation in ESC, we only consider in this analysis the farmers who actually sold some of their vegetable produce and drawn income from the exporters or the local traditional markets in the recall period prior to our data collection. This leaves us with a final sample of 320 observations/producers[27], among which 136 producers participate in ESC and 184 supply the TM exclusively.

More detailed information regarding the distribution of these producers in the different types of ESC and market channels, *i.e.* high-value, regular export supply chains and traditional markets, can be found in Table 3.1 below. Among the 136 export producers, 74 supplied the HVESC while 62 supplied the RESC. None of the producers supplying the HVESC were located in the Kingo'ri division, which could be consistent with evidence from the literature regarding the role played by agro-ecologic conditions and infrastructures in the choice of an area for procurement by the exporters (Barrett et al., 2012). Three of these producers supplied both types of ESC during the same period and are considered as HVESC suppliers for this analysis since we assume the effects of participation in HVESC would overcome those of participation in RESC.

[26] The questionnaires from one of these villages were incomplete due to technical errors. We thus could not include this village in the final sample.
[27] Some observations with missing data or non-realistic values for important variables were also excluded from the analysis.

Table 3.1. Distribution of the households, by type of ESC and market channel

TOTAL SAMPLE	
320 households	
Export supply chains	**Traditional markets**
136 households	184 households
High-value export supply chains	***Regular export supply chains***
74 households	62 households

We used a structured questionnaire to interview these producers and elicited data on their farm and household socio-characteristics as well as their vegetable and non-vegetable production and marketing, including the contract farming arrangements for participating producers.

3.2.3 Characteristics of the contract farming arrangements and transactions

Most of the contracts are signed between the different exporters and the producer organizations supplying the crop produce to them. All the exporters provide at least some inputs (seeds or fertilizers) and ensure the transportation of the produce from the village produce collection centre to their processing facilities. However, reflecting on the key informant interviews performed in our research area with the different exporters and the producers supplying them, the contract arrangements differ from an exporter to the other as well as from the HVESC to the RESC type of exporter. To assess in more details these differences and similar to Bellemare (2012), Table 3.2 displays detailed information on the production and marketing arrangements for producers participating in both types of ESC, using as a basis the numerous transactions through which these producers cultivated and sold French beans and snap peas for the two types of exporters throughout the survey recall period. These represent a total amount of 203 transactions of vegetables with the exporters, of which 131 in the HVESC and 72 in the RESC.

An important aspect to consider is the slightly higher diversification of the high-value exporters in terms of the types of vegetables outsourced, considering that 54 percent of the transactions were on French beans while 46 percent were for snap peas. On the other hand, the regular exporter focuses its activities on French beans only.

Interestingly, producers participating in the RESC receive more inputs from the exporter, in particular fertilizer, with respect to their counterparts supplying the HVESC. They also receive more monthly visits by the extension officers. This could be linked to the fact that many of these RESC producers are new entrants and as such may need more technical support from the exporter in order to meet export standards.

Most importantly, the price per kilogram received is twice larger for the produce sold to high-value exporters, amounting to TZS 1,430[28] against TZS 750 for the regular exporter[29], hence reflecting a major difference between the two types of exporters and supply chains. All transactions in the RESC obey to a fixed price policy while some of the transactions with the HVESC are subject to a floating price.

Table 3.2. Characteristics of the contract schemes, by type of ESC

	All transactions (N=203)	RESC transactions (N=72)	HVESC transactions (N=131)
Crops grown and sold			
French beans	0.699*** (0.460)	1.000 (0.000)	0.534 (0.501)
Snap peas	0.295*** (0.457)	0.000 (0.000)	0.458 (0.500)
Inputs and services received			
Seeds (dummy)	0.946*** (0.227)	1.000 (0.000)	0.916 (0.278)
Fertilizers (dummy)	0.517*** (0.501)	0.972 (0.165)	0.267 (0.444)
Pesticides (dummy)	0.029 (0.170)	0.028 (0.165)	0.030 (0.173)
Visits by the extension officer (monthly)	1.733*** (1.663)	2.121 (1.877)	1.528 (1.506)
Transaction			
Quantity supplied (kilograms)	1565.485 (2510.013)	1499.743 (1182.107)	1601.618 (3003.764)
Price received (TZS per kilogram)	1187.336*** (496.612)	750.000 (0.000)	1429.552 (467.331)
Fixed price (dummy)	0.788*** (0.410)	1.000 (0.000)	0.672 (0.471)
Floating price (dummy)	0.211*** (0.409)	0.000 (0.000)	0.328 (0.471)
Timing of payment (weeks after delivery)	3.310*** (2.307)	2.667 (1.592)	3.664 (2.556)

Notes: Mean values are shown with standard deviations in parentheses. RESC: Regular export supply chains; HVESC: High-value export supply chains. The statistical significance of the differences between the mean values of the two groups is presented as follows: *significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.

3.2.4 Household socioeconomic and farm characteristics

Descriptive information on the farm and household characteristics of the sample households can be found in Table 3.3. While these groups of producers do not differ much in terms of their household characteristics, the producers participating in the ESC are different from the producers supplying the TM with respect to their access to socio-economic amenities. For instance, they have a higher access to electricity but lower access to piped water and live further away from tarmac roads. They also have a higher access to credit, which could also be facilitated by their participation in ESC as part of the services provided by the exporters or the producer organizations through which they participate in these markets. They also receive more services from non-governmental organizations (NGOs). With respect to their farm

[28] At the time of the survey, the average quarterly exchange rate was USD 1 = TZS 2,088.82.

[29] French beans were bought by the HVESC at a price of TZS 1,100 per kilogram (average over 70 transactions) while the snap peas were bought at a price of TZS 1,834 per kilogram (average over 59 transactions). While these prices would lead us to assume that supplying snap peas might affect to a higher extent household per capita income, prices for both crops remain higher than the prices for the French beans supplied to the RESC.

characteristics, producers in the ESC allocate a higher share of their farm land to vegetable production, which could stress a potential specialization of ESC producers in vegetable production, a situation similar than the one found by Rao and Qaim (2011) for producers supplying the supermarkets in Kenya.

Table 3.3. Socioeconomic and farm characteristics, by type of ESC and market channel

	Total sample (N=320)	TM suppliers (N=184)	ESC suppliers (N=136)	RESC suppliers (N=62)	HVESC suppliers (N=74)
Household characteristics					
Household size	4.338** (1.425)	4.190† (1.438)	4.537 (1.387)	4.532 (1.501)	4.541 (1.295)
Household head age (years)	47.187 (11.300)	47.081 (11.465)	47.331 (11.115)	46.581 (10.479)	47.959 (11.654)
Household head male (dummy)	0.931 (0.253)	0.940 (0.238)	0.919 (0.274)	0.903 (0.298)	0.932 (0.253)
Household head education (years)	7.528 (2.190)	7.391† (2.048)	7.713 (2.363)	7.500 (2.281)	7.892 (2.430)
Dependency ratio (in percent)	58.344 (58.021)	59.891 (55.832)	56.252 (61.004)	57.289 (75.465)	55.383 (46.062)
Member of a non-producer organization (dummy)	0.181* (0.386)	0.212†† (0.410)	0.140 (0.348)	0.210 (0.410)	0.081§§ (0.275)
Access to credit (dummy)	0.269*** (0.444)	0.185††† (0.389)	0.382 (0.488)	0.323$^{\#\#}$ (0.471)	0.432 (0.499)
Off-farm employment (dummy)	0.419 (0.494)	0.380††† (0.487)	0.471 (0.501)	0.403 (0.495)	0.527 (0.503)
Share of off-farm income (percent)	17.886 (27.894)	18.825 (29.896)	16.614 (24.982)	16.276 (25.940)	16.897 (24.325)
Access to NGO services (dummy)	0.294*** (0.456)	0.196††† (0.398)	0.426 (0.496)	0.387$^{\#\#\#}$ (0.491)	0.459 (0.502)
Mobile phone ownership (dummy)	0.830** (0.376)	0.786††† (0.411)	0.890 (0.314)	0.839 (0.371)	0.932§ (0.253)
Motorbike ownership (dummy)	0.263 (0.441)	0.228 (0.421)	0.309 (0.464)	0.290 (0.458)	0.324 (0.471)
Access to piped water (dummy)	0.738*** (0.441)	0.826††† (0.380)	0.618 (0.488)	0.548$^{\#\#\#}$ (0.502)	0.676 (0.471)
Access to electricity (dummy)	0.48*** (0.500)	0.413††† (0.494)	0.574 (0.496)	0.419 (0.497)	0.703 §§§ (0.460)
Distance to tarmac road (kilometres)	10.90** (9.781)	9.949 (10.09)	12.195 (9.219)	13.345$^{\#\#}$ (8.780)	11.205 (9.530)
Distance to public transportation (kilometres)	1.561 (2.459)	1.611 (2.096)	1.496 (2.881)	1.560 (2.182)	1.442 (3.371)
Farm characteristics					
Farm size (acres)	2.761 (2.602)	2.603 (2.377)	2.974 (2.874)	3.875$^{\#\#\#}$ (3.427)	2.220§§§ (2.048)
Share of vegetable area (percent)	44.189*** (28.482)	37.920††† (26.458)	52.671 (29.016)	38.617 (26.705)	64.446§§§ (25.549)
Share of irrigated area (percent)	80.337 (34.170)	77.664 †† (35.941)	83.933 (31.402)	78.879 (35.424)	88.167§ (27.114)
Use of modern irrigation (dummy)	0.056 (0.231)	0.071† (0.257)	0.037 (0.189)	0.064 (0.248)	0.013 (0.116)
Distance to the collection centre (kilometres)	1.222 (1.061)	1.240†† (0.848)	1.198 (1.297)	1.526$^{\#}$ (1.411)	0.919§§§ (1.127)
Access to extension services (dummy)	0.581** (0.494)	0.527 † (0.501)	0.654 (0.477)	0.661$^{\#}$ (0.477)	0.649 (0.481)
Livestock units [a]	2.485 (2.252)	2.498 (2.348)	2.467 (2.122)	2.790 (2.576)	2.193 (1.609)
Altitude (meters)	1242.744 (279.602)	1256.181†† (266.965)	1224.630 (295.829)	1076.774$^{\#\#\#}$ (189.348)	1350.205§§§ (312.548)

Notes: Mean values are shown with standard deviations in parentheses. TM: Traditional markets; ESC: Export supply chains; RESC: Regular export supply chains; HVESC: High-value export supply chains. The statistical significance of the differences between the mean values of the different groups is presented as follows: *Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level for the differences between ESC suppliers and TM suppliers; †significant at the 10 percent level, ††significant at the 5 percent level, †††significant at the 1 percent level for the differences between HVESC suppliers and TM suppliers; $^{\#}$significant at the 10 percent level, $^{\#\#}$significant at the 5 percent level, $^{\#\#\#}$significant at the 1 percent level for the differences between RESC suppliers and TM suppliers; §significant at the 10 percent level, §§significant at the 5 percent level, §§§significant at the 1 percent level for the differences between HVESC suppliers and RESC suppliers.

[a] The livestock units were calculated using the following weights: cattle=0.70; pigs=0.20; goat, sheep and donkey= 0.1; and poultry=0.01 (Jahnke et al., 1988).

The two groups of producers participating in the ESC also present differences between each other (Columns 4 and 5 of Table 3.3). In terms of their household and socio-economic characteristics, producers in the HVESC have a higher access to electricity and mobile phone ownership, which could be a sign of higher welfare level. With respect to their farm characteristics, producers supplying the RESC have larger farms but are less specialized in vegetable cultivation than their counterparts in the HVESC. The farms of producers supplying the HVESC are located at a higher altitude than those of producers supplying the TM and RESC, the latter being also located at a lower altitude than the former.

Table 3.4 provides information on different poverty indicators for the different groups in our sample. Overall, producers in the ESC have higher levels of household income and per capita income (although the difference is statistically significant for the former only). We also computed the poverty headcount ratio and gap for our sample, using as reference the official national basic needs poverty line, which amounts to TZS 36,482 per adult per month (The World Bank, 2015). The basic needs poverty rate of our complete sample is 16 percent, about half lower than the national rural basic needs poverty rate of 33 percent in the country (The World Bank, 2015). The producers supplying the ESC are less poor than their counterparts supplying the TM exclusively, with basic needs poverty rates of about 9.5 percent against 21 percent, respectively. The basic needs poverty gap is also larger in the group of producers in TM. With respect to the differences between the producers supplying the HVESC and those in the RESC, no major statistically significant differences can be found in terms of income as well as basic needs poverty rates.

Table 3.4. Poverty indicators, by type of ESC and market channels

	Total sample (N=320)	TM suppliers (N=184)	ESC suppliers (N=136)	RESC suppliers (N=62)	HVESC suppliers (N=74)
Household per capita yearly income	1326.907	1190.125††	1511.965	1293.549	1694.961
(in '000 TZS)	(1782.611)	(1742.277)	(1825.914)	(1636.323)	(1963.078)
Household yearly income	5203.162**	4452.28††	6219.052	5416.117	6891.782
(in '000 TZS)	(7034.363)	(6136.391)	(8004.546)	(7400.177)	(8469.994)
Head count index [a]	0.163***	0.212††	0.095	0.113$^{\#}$	0.081
	(0.369)	(0.410)	(0.295)	(0.319)	(0.275)
Poverty gap [a]	0.057***	0.077††	0.030	0.042	0.020
	(0.161)	(0.186)	(0.113)	(0.139)	(0.084)

Notes: Mean values are shown with standard deviations in parentheses. TM: Traditional markets; ESC: Export supply chains; RESC: Regular export supply chains; HVESC: High-value export supply chains. The statistical significance of the differences between the mean values of the different groups is presented as follows: *Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level for the differences between ESC suppliers and TM suppliers; †significant at the 10 percent level, ††significant at the 5 percent level, †††significant at the 1 percent level for the differences between HVESC suppliers and TM suppliers; $^{\#}$significant at the 10 percent level, $^{\#\#}$significant at the 5 percent level, $^{\#\#\#}$significant at the 1 percent level for the differences between RESC suppliers and TM suppliers; §significant at the 10 percent level, §§significant at the 5 percent level, §§§significant at the 1 percent level for the differences between HVESC suppliers and RESC suppliers.

[a] Based on Tanzania's national basic needs poverty line.

3.3 Econometric approach

3.3.1 Modelling participation in export supply chains

Considering the focus of this paper on the effects of producer participation in vegetable ESC on household income, we follow the approaches used by Rao and Qaim (2011) and Narayanan (2014) with respect to the perspective of supplying modern supply chains as well as the approaches used by Di Falco et al. (2011), Asfaw et al. (2012), Kleemann et al. (2014) and Chiputwa et al. (2015), for the decision and effects related to the participation in certification schemes or technology adoption and which follow a similar logic. Based on this literature, the decision from a household/producer *i* to supply a specific export supply chain *j* can be thought as a binary decision modelled as follows:

$$P_{ij}^{*} = \alpha_j Z_i + \varepsilon_{ij} \quad \text{with} \quad P_{ij} = \begin{cases} 1 \; if \; P_{ij}^{*} > 0 \\ 0 \; \text{otherwise} \end{cases} \tag{3.1}$$

where P_{ij} is a binary variable taking the value of 1 if a producer i decides to participate in a type of export supply chain j and the value of 0 otherwise, Z_i is a vector of observable variables determining this decision by the producer i, and ε_{ij} is an error term.

Producers will participate in a specific export supply chain j or accept the related supply arrangement based on their subjective perception of the latter and the related expected utility, in particular in comparison with the expected utility from supplying alternative traditional markets m (Rao and Qaim, 2011; Barrett et al., 2012; Chiputwa et al., 2015). In other words, the producers would participate in the export supply chain j if $U_{ij} > U_{im}$ (Rao and Qaim, 2011; Chiputwa et al., 2015). Considering the evidence from the literature, the likelihood of a producer's decision to participate in ESC can be influenced by a myriad of factors, related to both farm and socio-economic characteristics of the households, such as the size of the farmland, access to social amenities and infrastructures, membership in producer organizations, social capital of the household head (Hernández et al., 2007; Roy and Thorat, 2008; Blandon et al., 2009; Neven et al., 2009; Rao and Qaim, 2011; Barrett et al., 2012) as well as the configuration of the participation scheme offered to the producers and their perception of the latter, for instance with regard to their trust *vis-à-vis* the buyer or the risks associated to the transactions (Blandon et al., 2009; Barrett et al., 2012).

3.3.2 Effects of participation in export supply chains on household income

Considering the above and the fact that producers will perceive and expect participation in modern supply chains to increase their welfare (Minten et al., 2009; Rao and Qaim, 2011;

Barrett et al., 2012), as well as the evidence on its direct effect on agricultural profits (Roy and Thorat, 2008; Narayanan, 2014) and household income (Maertens and Swinnen, 2009; Miyata et al., 2009; Rao and Qaim, 2011; Bellemare, 2012; Andersson et al., 2015), the effects of participation in an export supply chain j on household per capita income can be modelled as follows (Rao and Qaim, 2011; Bellemare, 2012) :

$$Y_{ij} = \beta P_{ij} + \gamma X_i + \mu_{ij} \quad (3.2)$$

where Y_{ij} is the household per capita, P_{ij} is a binary variable representing participation of a producer i in an export supply chain j, X_i is a vector of observable variables and μ_{ij} is an error term.

Estimation of the effects of participation in ESC with an Ordinary Least Square (OLS) approach based on this model may lead to biased results due to a potential self-selection into these supply chains by the producers and unobservable characteristics that can affect both their income levels and decision to participate in these supply chains, potentially leading to endogeneity (Maertens and Swinnen, 2009; Rao and Qaim, 2011; Barrett et al., 2012; Bellemare, 2012; Rao and Qaim, 2013). To address these specific econometric issues, literature in this specific research stream has successfully used endogenous switching regression models (Rao and Qaim, 2011; Kleemann et al., 2014; Narayanan, 2014), which we also apply in this paper.

3.3.3 An endogenous switching regression model

Our methodological approach is based on Maddala (1983; 1986) as well as Lokshin and Sajaia (2004). We also carefully follow and get inspirations from the empirical applications of Di Falco et al. (2011), Rao and Qaim (2011), Asfaw et al. (2012), Kleemann et al. (2014) and Narayanan (2014).

Following the abovementioned literature and framework for participation in ESC, household per capita income can be modelled for two regimes, namely for producers participating in a given type of ESC on the one hand, and on the other hand for producers not participating in the latter. This model can be presented as follows (Maddala, 1983; Maddala, 1986; Di Falco et al., 2011; Rao and Qaim, 2011; Asfaw et al., 2012; Kleemann et al., 2014):

$$P_{ij}^{*} = \alpha_j Z_i + \varepsilon_{ij} \quad (3.3)$$

$$\text{Regime 1: } Y_{1i} = \gamma_1 X_{1i} + \mu_{1i} \text{ if } P_{ij}=1 \quad (3.4)$$

$$\text{Regime 2: } Y_{2i} = \gamma_2 X_{2i} + \mu_{2i} \text{ if } P_{ij}=0 \quad (3.5)$$

where Y_{1i} and Y_{2i} are the household per capita income in the two regimes, X_{1i} and X_{2i} the vectors of observable variables determining the household per capita income in each regime while the vector Z_i includes the observable variables determining the selection into a specific regime, in this case the participation in a given ESC.

Following Maddala (1983; 1986) and Lokshin and Sajaia (2004), the residuals μ_{1i}, μ_{2i} and ε_i are normally distributed, with a mean 0 and covariance matrix Σ defined as follows:

$$\Sigma=\begin{bmatrix} \sigma_{\varepsilon}^2 & \sigma_{1\varepsilon} & \sigma_{2\varepsilon} \\ \sigma_{1\varepsilon} & \sigma_1^2 & . \\ \sigma_{2\varepsilon} & . & \sigma_2^2 \end{bmatrix} \tag{3.6}$$

Where σ_ε^2 is the variance of the error term from the selection equation and is equal to one (Maddala, 1983), while σ_1^2 and σ_2^2 are the variances of the income equations. σ_{12}, $\sigma_{\varepsilon 1}$ and $\sigma_{\varepsilon 2}$ are the covariance between μ_{1i} and μ_{2i}, μ_{1i} and ε_i, and μ_{2i} and ε_i, respectively. σ_{12} is not defined since Y_{1i} and Y_{2i} are never observed simultaneously (Maddala, 1983; Lokshin and Sajaia, 2004).

The correlations between μ_{1i} and ε_i as well as between μ_{2i} and ε_i can be used to test for potential endogeneity and self-selection: following Maddala (1983), if $\sigma_{\varepsilon 1}=\sigma_{\varepsilon 2}=0$, then we are facing a switching regression model with exogenous switching; if one of these correlations is statistically different from zero, then we have a switching regression model with endogenous switching, in particular influenced by the role of unobservable factors (Rao and Qaim, 2011; Kleemann et al., 2014). Concretely, the expected values of μ_{1i} and μ_{2i} conditioning on the sample selection can be modelled as follows, respectively (Maddala, 1983; Di Falco et al., 2011; Rao and Qaim, 2011; Asfaw et al., 2012):

$$E\left[\mu_{1i}|P_i=1\right]=\sigma_{1\epsilon}\frac{\phi(\alpha Z_i)}{\Phi(\alpha Z_i)}=\sigma_{1\epsilon}\lambda_{1i} \tag{3.7}$$

and

$$E\left[\mu_{2i}|P_i=0\right]=-\sigma_{2\epsilon}\frac{\phi(\alpha Z_i)}{1-\Phi(\alpha Z_i)}=\sigma_{2\epsilon}\lambda_{2i} \tag{3.8}$$

where $\phi(.)$ is the standard normal probability density function (PDF) and $\Phi(.)$ the standard normal cumulative density function (CDF). λ_{1i} and λ_{2i} are thus the Invert Mills Ratio at αZ_i (Lokshin and Sajaia, 2004; Greene, 2008; Rao and Qaim, 2011).

Endogenous switching regression models can be estimated with the Full Information Maximum Likelihood (FIML) method, which is the most efficient method, and for which the log-likelihood function can be expressed as follows (Lokshin and Sajaia, 2004; Di Falco et al., 2011; Asfaw et al., 2012):

$$Ln\ L_i = \sum_{i=1}^{N} P_i \left[\ln \emptyset \left(\frac{\mu_{1i}}{\sigma_1}\right) - ln\sigma_1 + ln\Phi(\partial_{1i})\right] + (1 - P_i)\left[\ln \emptyset \left(\frac{\mu_{2i}}{\sigma_2}\right) - ln\sigma_2 + \ln(1 - \Phi(\partial_{2i}))\right] \quad (3.9)$$

where $\partial_{ki} = \frac{(\alpha Z_i + \rho_j \mu_{ji}/\sigma_j)}{\sqrt{1-\rho_j^2}}$, j=1,2, and ρ_j is the correlation coefficient between the residuals of the selection equation and those of the income equations for the two regimes (Di Falco et al., 2011; Asfaw et al., 2012).

With respect to the configuration and pairwise comparisons of the regimes or treatments applied in our paper, we mainly follow the approach used by Narayanan (2014). Based on the latter, we thus apply the endogenous switching regression model to different sub-samples, with a disaggregation in terms of treatment group/regime and related counterfactual group/regime, defined as follows: (1) ESC suppliers vs. TM suppliers; (2) HVESC suppliers vs. TM suppliers; (3) RESC suppliers vs. TM suppliers; and (4) HVESC suppliers vs. all the other producers (RESC and TM suppliers). This will allow assessing the effects of overall participation in ESC as well as well as comparing the effects of the participation in different types of ESC, first with respect to the producers supplying the TM exclusively and second, with each other.

For the identification of the model, we use a combination of two instruments – one at the village level and one at the individual level. With respect to the former, we follow Maertens and Verhofstadt (2013) who instrumented female wage employment in the export agro-industry with the share of households in the village with females working in the export agro-industry. We thus use in each village the share of households in our sample participating in the ESC, HVESC and RESC, depending on the type of ESC considered as treatment. We consider that this instrument would reflect the intensity of each type of exporters' supply activity in a village, as well as the suitability of the given area for contracting producers (Barrett et al., 2012). If this is the case it would then be correlated with producers' probability to supply these exporters. As an individual-level instrument, we use the number of neighbours (out of the five closest in our sample) who are aware of or informed about the ESC. In this respect, we find inspiration in the procedure used by Hansen and Trifković (2014) who instrumented the adoption of food standards with the individual producers' knowledge of these standards as well as a binary variable taking the value of one if at least one producer in

the village applies food standards. We were also inspired by Andersson et al. (2015) who used the number of neighbours involved in the supermarket supply chains to instrument the participation in the latter. This is consistent with the evidence from the literature that neighbourhood effects can play a role in a household's decision to participate in a given market (Holloway and Lapar, 2007).

We thus assume that producers with more neighbours informed about the ESC[30] would, in part due to social network effects, have a higher exposure to the latter and increase their likelihood to participate in them. We also assume that both these instruments do not affect household income directly and checked their validity by following the falsification test used by Di Falco et al. (2011): first, as can be seen in Table A3.1 in the Appendix, these instruments affect positively a producers' likelihood to participate in the different ESC, in all the pairwise comparisons implemented[31]. Furthermore, we assessed whether these instruments directly affect the household per capita income of non-participating households (*i.e.* the households in regime 2 in each pairwise comparison), which would lead us to reject their validity. As can be seen in Table A3.2 in Appendix, none of these instruments affect directly the household per capita income levels of non-participating producers and we thus fail to reject their validity[32].

3.3.4 Conditional expectations of household income and treatment effects

Following Di Falco et al. (2011) and Asfaw et al. (2012), we can use the estimates and predictions from the endogenous switching regression models to compare the expected levels of household per capita income for producers participating in the different vegetable ESC and those in the respective counterfactual group. Furthermore, this model also allows the computation of the expected household per capita income for participating producers in the hypothetical case where they had not participated as well as for the non-participating producers in the hypothetical case where they had participated (Di Falco et al., 2011). Concretely, the expectations in each of these cases could be presented as follows (Lokshin and Sajaia, 2004; Di Falco et al., 2011; Asfaw et al., 2012):

[30] In our sample, a large number of producers are informed/aware of the export markets but do not participate in the latter, so there should be no distributional concern regarding this variable with respect to the participation in ESC (Hansen and Trifković, 2014).

[31] This is also confirmed by the Wald Tests performed on the combined statistical significance on the coefficients of the instruments in all the models estimated (χ^2=49.030; χ^2=40.660;χ^2=36.810;χ^2=37.090, respectively and significant at the one percent level in all cases). Furthermore, we could reject at the five percent level the hypothesis that these instruments were weak following the critical values for the weak instrument test based on Limited Information Maximum Likelihood (LIML) estimator size as provided in Stock and Yogo (2005).

[32] The F-Statistic on these instruments also confirms that they have no effect on non-supplying producers' household per capita income.

$$E(Y_{1i}|P_i = 1) = \gamma_1 X_{1i} + \sigma_{1\epsilon}\lambda_{1i} \quad (3.10a)$$

$$E(Y_{2i}|P_i = 0) = \gamma_2 X_{2i} + \sigma_{2\epsilon}\lambda_{2i} \quad (3.10b)$$

$$E(Y_{2i}|P_i = 1) = \gamma_2 X_{1i} + \sigma_{2\epsilon}\lambda_{1i} \quad (3.10c)$$

$$E(Y_{1i}|P_i = 0) = \gamma_1 X_{2i} + \sigma_{1\epsilon}\lambda_{2i} \quad (3.10d)$$

Following Heckman et al. (2001), Di Falco et al. (2011) and Asfaw et al. (2012), the Treatment Effect on the Treated (TT), which represents the effect of participation in the different ESC for producers who have actually supplied the exporters, can be computed from the difference between the expectations (3.10a) and (3.10c):

$$TT = E(Y_{1i}|P_i = 1) - E(Y_{2i}|P_i = 1) = X_{1i}(\gamma_1 - \gamma_2) + (\sigma_{1\epsilon} - \sigma_{2\epsilon})\,\lambda_{1i} \quad (3.11)$$

The Treatment Effect on the Untreated (TU), which corresponds to the effect of participation in the different ESC on non-participating producers, can then be calculated from the difference between the expectations (3.10d) and (3.10b) as follows:

$$TU = E(Y_{1i}|P_i = 0) - E(Y_{2i}|P_i = 0) = (X_{1i} - X_{2i})\gamma_{1i} + \sigma_{1\epsilon}(\lambda_{1i} - \lambda_{2i}) \quad (3.12)$$

Finally, following Carter and Milon (2005), Di Falco et al. (2011) and Asfaw et al. (2012), we consider the heterogeneity effects to examine the differences due to the unobserved factors (Di Falco et al., 2011). First, the "effect of base heterogeneity" for producers who decide to supply ESC can be expressed as (Carter and Milon, 2005; Di Falco et al., 2011; Asfaw et al., 2012) :

$$BH_1 = E(Y_{1i}|P_i = 1) - E(Y_{1i}|P_i = 0) = (X_{1i} - X_{2i})\gamma_{1i} + \sigma_{1\epsilon}(\lambda_{1i} - \lambda_{2i}) \quad (3.13)$$

Similarly, the "effect of base heterogeneity" for producers deciding not to supply ESC can be expressed as:

$$BH_2 = E(Y_{2i}|P_i = 1) - E(Y_{2i}|P_i = 0) = (X_{1i} - X_{2i})\gamma_{2i} + \sigma_{2\epsilon}(\lambda_{1i} - \lambda_{2i}) \quad (3.14)$$

The difference between the TT and the TU provides the "transitional heterogeneity effect" (TH), which allows assessing whether the effect of supplying ESC is larger or smaller for producers who actually supplied the ESC, with respect to the effect on non-supplying producers in the counterfactual case where they would have supplied the ESC (Carter and Milon, 2005; Di Falco et al., 2011; Asfaw et al., 2012).

3.4 Results of the econometric analysis

Tables 3.5 to 3.8 present the results of the endogenous switching regression models estimated with the FIML method[33] and applied to the different abovementioned pairwise comparisons, namely (1) ESC suppliers vs. TM suppliers; (2) HVESC suppliers vs. TM suppliers; (3) RESC suppliers vs. TM suppliers; and (4) HVESC suppliers vs. all the other producers (RESC and TM suppliers)[34], respectively. In each of these tables, the first column shows the estimated coefficients for the selection equation into a specific type of ESC/regime while the second and third columns show the estimated coefficients for the income regressions for non-participating and participating producers, respectively[35].

3.4.1 Determinants of participation in export supply chains

As can be observed in the first column of Table 3.5, both household demographic characteristics and access to socio-economic infrastructures affect a producer's likelihood to participate in ESC. With respect to the former, larger households are more likely to enter ESC, which could be linked to the larger labour endowments from which these households can benefit. Furthermore, access to credit[36] affects positively the probability to supply vegetable exporters. This may be related to the important initial capital investments needed to participate in modern supply chains (Rao and Qaim, 2011; Andersson et al., 2015). On the other hand, membership in non-producer groups affects negatively the probability to enter these markets, which could be due to the fact that producer organizations are actually a major factor of participation in ESC in this research context, thus counterbalancing the effect of social capital *via* other groups. Access to electricity has also a positive effect on participation, as exporters may tend to look in priority for improved social amenities and infrastructural development when prospecting for areas where to concentrate their supply from small producers (Barrett et al., 2012). Finally, access to NGO services also tends to increase small producer participation in ESC. This is consistent with our qualitative assessment of this research context as many producers in the latter have been connected to exporters *via* this kind of institutional projects and actors. This is also consistent with previous empirical evidence from the literature (Rao and Qaim, 2011; Barrett et al., 2012; Ōtsuka et al., 2016).

[33] We used the Stata command *movestay* (Lokshin and Sajaia, 2004) to estimate these endogenous switching regression models with the FIML estimator.
[34] Since no HVESC suppliers were found in the Kingo'ri division, we replicated as a robustness check the estimations with the sub-samples (2) HVESC suppliers vs. TM suppliers and (4) HVESC suppliers vs. all the other producers (RESC and TM suppliers) without all the observations from this division. The results were not found to change drastically and we thus proceeded with the estimations with all observations from the respective sub-samples.
[35] In all these equations, the dependent variable is the log of household per capita income in thousands TZS.
[36] Since many producers were obtaining credit from the producer organizations through which they participate in export markets, we considered here all other sources of credit exclusively, in order to properly disentangle the effects of this variable.

Table 3.5. FIML Endogenous Switching Regression (ESC suppliers vs. TM suppliers)

		TM suppliers	ESC Suppliers
	Participation in ESC	Log per capita income	Log per capita income
Household head age	-0.010 (0.008)	-0.011* (0.007)	-0.007 (0.006)
Household head education	-0.030 (0.036)	0.099*** (0.028)	0.101*** (0.026)
Household head male	-0.880** (0.361)	0.088 (0.309)	0.360 (0.273)
Household size	0.162** (0.070)	-0.240*** (0.052)	-0.331*** (0.066)
Dependency ratio	-0.001 (0.002)	-0.000 (0.001)	0.001 (0.001)
Farm size	0.020 (0.037)	0.153*** (0.032)	0.041 (0.027)
Off-farm employment	0.166 (0.184)	0.319** (0.135)	0.480*** (0.125)
Access to credit	0.578** (0.262)	-0.118 (0.333)	0.213 (0.155)
Membership in a non-producer organization	-0.997*** (0.290)	-0.177 (0.223)	-0.372 (0.236)
Access to electricity	0.421** (0.187)	0.204 (0.128)	-0.066 (0.164)
Access to piped water	-0.555** (0.245)	0.466** (0.190)	0.399** (0.186)
Distance to public transportation	-0.005 (0.031)	0.037 (0.024)	-0.020 (0.025)
Distance to the produce collection centre	-0.004 (0.096)	0.057 (0.071)	0.060 (0.066)
Access to extension services	0.077 (0.198)	-0.210 (0.168)	-0.103 (0.149)
Access to NGO services	0.873*** (0.211)	-0.344* (0.189)	0.141 (0.171)
Mobile phone ownership	0.021 (0.283)	-0.129 (0.167)	-0.282 (0.287)
Motorbike ownership	0.090 (0.208)	0.237 (0.151)	-0.015 (0.151)
Livestock units	-0.029 (0.043)	0.084*** (0.030)	0.036 (0.029)
Altitude in meters	-0.001** (0.001)	0.000 (0.000)	-0.001 (0.000)
Division Kingo´ri [a]	0.309 (0.413)	-0.221 (0.265)	-0.349 (0.379)
Division Mbuguni [a]	-0.984** (0.485)	0.443 (0.302)	0.077 (0.373)
Division Moshono [a]	0.151 (0.307)	-0.095 (0.232)	0.235 (0.330)
Share of export producers in the village	3.039*** (0.771)		
Neighbours aware of the export markets	0.409*** (0.080)		
ln σ_j		-0.225*** (0.079)	-0.356*** (0.070)
ρ_{ij}		-0.214 (0.273)	-0.231 (0.237)
Constant	-0.879 (0.999)	5.598*** (0.798)	7.776*** (0.625)
Observations	311	311	311
Log-Likelihood		-493.820	
Wald χ^2		196.870***	
Wald Test of independent equations		1.561	
(p-value)		(0.458)	

Notes: Coefficient estimates shown with robust standard errors in parentheses. The dependent variables are participation in ESC and log household per capita income in thousands TZS. TM: Traditional markets; ESC: Export supply chains. ρ_{ij} are the correlation coefficients between the error term ε_i (equation 3.3) and the error terms μ_{ji} (equations 3.4 and 3.5).
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] The reference division is Poli.

We can also draw insights on the determinants of participation in both HVESC and RESC from the coefficients in the first columns of Tables 3.6 to 3.8. While various factors bear similar effects for both types of ESC (*e.g.* access to electricity and NGO services), some determinants vary from a type of ESC to the other. Indeed, access to credit positively influences participation in HVESC (Tables 3.6 and 3.7) but does not have any statistically significant effect on the participation in RESC (Table 3.8). This could underline higher investment and capital requirements for the former in comparison to the latter. Similarly,

mobile phone ownership increases the probability of supplying high-value exporters (Table 3.6), which could reflect that more innovative, business-oriented or better off producers tend to supply these exporters.

Table 3.6. FIML Endogenous Switching Regression (HVESC suppliers vs. TM suppliers)

		TM suppliers	HVESC suppliers
	Participation in HVESC	Log per capita income	Log per capita income
Household head age	0.004 (0.016)	-0.011* (0.007)	-0.016 (0.012)
Household head education	0.111 (0.069)	0.099*** (0.029)	0.167*** (0.044)
Household head male	-1.280** (0.621)	0.065 (0.312)	0.106 (0.339)
Household size	0.182 (0.136)	-0.237*** (0.050)	-0.335*** (0.096)
Dependency ratio	0.000 (0.004)	-0.000 (0.001)	-0.001 (0.002)
Farm size	-0.012 (0.089)	0.156*** (0.031)	0.085* (0.047)
Off-farm employment	0.428 (0.376)	0.327** (0.135)	0.196 (0.155)
Access to credit	0.787** (0.386)	-0.116 (0.330)	0.027 (0.231)
Membership in a non-producer organization	-3.276*** (0.574)	-0.187 (0.217)	-0.466 (0.525)
Access to electricity	0.950** (0.401)	0.214 (0.130)	-0.187 (0.188)
Access to piped water	-0.475 (0.401)	0.419** (0.175)	0.243 (0.269)
Distance to public transportation	0.099 (0.075)	0.034 (0.024)	-0.017 (0.015)
Distance to the produce collection centre	0.184 (0.198)	0.056 (0.071)	0.071 (0.088)
Access to extension services	0.122 (0.366)	-0.196 (0.161)	-0.246 (0.153)
Access to NGO services	1.085*** (0.321)	-0.298* (0.174)	0.215 (0.264)
Mobile phone ownership	1.125** (0.531)	-0.131 (0.167)	-0.892* (0.460)
Motorbike ownership	0.145 (0.368)	0.227 (0.151)	-0.051 (0.187)
Livestock units	0.045 (0.074)	0.082*** (0.029)	0.032 (0.042)
Altitude in meters	-0.007*** (0.002)	0.000 (0.000)	-0.001 (0.001)
Division Kingo´ri [a]	-1.250 (1.664)	-0.195 (0.263)	
Division Mbuguni [a]	-3.800*** (1.151)	0.447 (0.308)	-0.161 (0.437)
Division Moshono [a]	1.030 (0.935)	-0.071 (0.233)	0.493 (0.481)
Share of high-value export producers in the village	14.137*** (3.054)		
Neighbours aware of the export markets	0.627*** (0.140)		
ln σ_j		-0.230*** (0.073)	-0.595*** (0.069)
ρ_{ij}		-0.223 (0.356)	0.086 (0.924)
Constant	-1.587 (2.636)	5.740*** (0.807)	9.789*** (0.965)
Observations	249	249	
Log-Likelihood		-323.906	
Wald χ^2		195.100***	
Wald Test of independent equations (p-value)		0.424 (0.809)	

Notes: Coefficient estimates shown with robust standard errors in parentheses. The dependent variables are participation in HVESC and log household per capita income in thousands TZS. TM: Traditional markets; HVESC: High-value export supply chains. ρ_{ij} are the correlation coefficients between the error term ε_i (equation 3.3) and the error terms μ_{ji} (equations 3.4 and 3.5).
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] The reference division is Poli.

Table 3.7. FIML Endogenous Switching Regression (HVESC vs. All other producers)

		Non-HVESC suppliers	HVESC suppliers
	Participation in HVESC	Log per capita income	Log per capita income
Household head age	0.004 (0.012)	-0.008 (0.006)	-0.016 (0.013)
Household head education	0.054 0.087)	0.061*** (0.021)	0.168*** (0.046)
Household head male	-1.091 (0.718)	0.241 (0.247)	0.068 (0.574)
Household size	0.055 (0.151)	-0.253*** (0.051)	-0.332*** (0.109)
Dependency ratio	0.000 (0.003)	0.000 (0.001)	-0.001 (0.002)
Farm size	-0.076 (0.116)	0.100*** (0.035)	0.082 (0.054)
Off-farm employment	0.384 (0.454)	0.503*** (0.124)	0.212 (0.249)
Access to credit	0.862** (0.342)	0.157 (0.359)	0.051 (0.403)
Membership in a non-producer organization	-2.330*** (0.458)	-0.244 (0.376)	-0.519 (0.880)
Access to electricity	0.723 (0.562)	0.188 (0.173)	-0.165 (0.327)
Access to piped water	-0.123 (0.568)	0.277* (0.152)	0.242 (0.262)
Distance to public transportation	0.110 (0.099)	-0.003 (0.029)	-0.015 (0.021)
Distance to the produce collection centre	0.118 (0.173)	0.062 (0.079)	0.060 (0.160)
Access to extension services	0.257 (0.420)	-0.067 (0.159)	-0.239 (0.192)
Access to NGO services	0.791*** (0.262)	-0.058 (0.192)	0.247 (0.504)
Mobile phone ownership	0.700 (0.601)	-0.219 (0.169)	-0.869 (0.549)
Motorbike ownership	0.077 (0.291)	0.107 (0.209)	-0.045 (0.208)
Livestock units	0.070 (0.072)	0.069*** (0.024)	0.032 (0.043)
Altitude in meters	-0.005 (0.004)	-0.000 (0.001)	-0.001 (0.001)
Division Kingo´ri [a]	-3.026 (2.202)	-0.029 (0.348)	
Division Mbuguni [a]	-2.940* (1.699)	0.495 (0.358)	-0.179 (0.468)
Division Moshono [a]	0.797 (1.469)	0.306 (0.199)	0.459 (0.623)
Share of high-value export producers in the village	10.659** (4.559)		
Neighbours aware of the export markets	0.450*** (0.113)		
ln σ_j		-0.213*** (0.058)	-0.589*** (0.143)
ρ_{ij}		0.160 (1.821)	0.195 (1.794)
Constant	-1.881 (4.469)	6.422*** (0.977)	9.700*** (1.502)
Observations	311	311	
Log-Likelihood		-425.612	
Wald χ^2		173.610***	
Wald Test of independent equations (p-value)		0.013 (0.994)	

Notes: Coefficient estimates shown with robust standard errors in parentheses. The dependent variables are participation in HVESC and log household per capita income in thousands TZS. HVESC: High-value export supply chains. ρ_{ij} are the correlation coefficients between the error term ε_i (equation 3.3) and the error terms μ_{ji} (equations 3.4 and 3.5).
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] The reference division is Poli.

Table 3.8. FIML Endogenous Switching Regression (RESC suppliers vs. TM suppliers)

		TM suppliers	RESC suppliers
	Participation in RESC	Log per capita income	Log per capita income
Household head age	-0.019* (0.010)	-0.012* (0.007)	-0.017 (0.011)
Household head education	-0.071 (0.048)	0.091*** (0.029)	0.021 (0.029)
Household head male	-0.970** (0.380)	-0.016 (0.325)	1.108*** (0.374)
Household size	0.193*** (0.073)	-0.224*** (0.050)	-0.307*** (0.079)
Dependency ratio	-0.003 (0.002)	-0.000 (0.001)	0.001 (0.001)
Farm size	0.013 (0.041)	0.171*** (0.034)	0.049** (0.025)
Off-farm employment	0.226 (0.227)	0.361** (0.144)	0.858*** (0.162)
Access to credit	0.084 (0.345)	-0.089 (0.303)	0.748*** (0.267)
Membership in a non-producer organization	-0.202 (0.281)	-0.271 (0.190)	-0.226 (0.240)
Access to electricity	0.440* (0.230)	0.309** (0.142)	-0.261 (0.203)
Access to piped water	-0.571** (0.283)	0.218 (0.219)	0.499* (0.302)
Distance to public transportation	-0.037 (0.048)	0.022 (0.029)	-0.135** (0.064)
Distance to the produce collection centre	0.126 (0.089)	0.059 (0.069)	0.096 (0.071)
Access to extension services	0.269 (0.235)	-0.120 (0.148)	0.357* (0.210)
Access to NGO services	0.588** (0.249)	-0.151 (0.189)	0.224 (0.196)
Mobile phone ownership	-0.135 (0.309)	-0.106 (0.176)	-0.175 (0.299)
Motorbike ownership	-0.107 (0.282)	0.239 (0.157)	-0.023 (0.202)
Livestock units	-0.032 (0.042)	0.065** (0.029)	0.038 (0.034)
Altitude in meters	-0.001* (0.001)	0.000 (0.000)	-0.002** (0.001)
Division Kingo´ri [a]	0.507 (0.501)	-0.158 (0.273)	0.003 (0.372)
Division Mbuguni [a]	-0.312 (0.611)	0.502 (0.322)	0.130 (0.500)
Division Moshono [a]	0.148 (0.449)	-0.028 (0.248)	0.668* (0.342)
Share of regular export producers in the village	2.492*** (0.939)		
Neighbours aware of the export markets	0.324*** (0.125)		
ln σ_j		-0.161 (0.121)	-0.514*** (0.143)
ρ_{ij}		0.891 (0.605)	-0.451 (0.337)
Constant	0.387 (1.320)	6.424*** (1.029)	8.280*** (1.153)
Observations	240	240	
Log-Likelihood		-356.313	
Wald χ^2		184.390***	
Wald Test of independent equations		4.169	
(p-value)		(0.124)	

Notes: Coefficient estimates shown with robust standard errors in parentheses. The dependent variables are participation in RESC and log household per capita income in thousands TZS. TM: Traditional markets; RESC: Regular export supply chains. ρ_{ij} are the correlation coefficients between the error term ε_i (equation 3.3) and the error terms μ_{ji} (equations 3.4 and 3.5).
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
[a] The reference division is Poli.

The estimated coefficients for the correlation terms ρ_{ij} are not statistically significant in any of the models (lower rows of Tables 3.5 to 3.8). We thus fail to reject the absence of sample selection hypothesis in this analysis and assume that unobservable factors would not play a role in the behaviour of the producers in our sample, should the export market opportunities not exist (Rao and Qaim, 2011).

3.4.2 Determinants of household per capita income

The estimated coefficients from the regime equations in the ESC vs. TM pairwise comparison (Columns 2 and 3 of Table 3.5) show that some heterogeneity and differences between the two groups of producers exist with respect to their income determinants. Indeed, TM suppliers' household per capita income increases with higher land and farm size. This could be linked to the fact that the income levels for these producers rely more on the quantity of crop cultivated and marketed. On the other hand, the income level for producers in the ESC regime is not affected by their farm size, pointing towards the fact that they would focus more on productivity and the quality of the produce (Rao and Qaim, 2011). Similarly, the fact that livestock ownership increases income for producers in the TM regime could be a sign that the latter is used as a diversification strategy and income complement for these specific producers, in comparison to their counterparts in the ESC regime, who may thus be more specialized in vegetable production (Rao and Qaim, 2011).

In the HVESC vs. TM pairwise comparison (Columns 2 and 3 of Table 3.6), a similar income diversification strategy can be assumed from the fact that off-farm employment influences non-participating producers' income but not for those supplying HVESC. Thus, TM suppliers rely to a larger extent on off-farm income, which is consistent with the results from the descriptive analysis (Table 3.3) and can make sense considering that their revenues from vegetables and other cash crops may be lower. A higher magnitude of the coefficient on farm size as well as a significant coefficient on livestock units are also noted for TM producers in this comparison. Overall, similar differences are also noted when comparing HVESC suppliers with the pooled sample gathering RESC and TM suppliers (Columns 2 and 3 of Table 3.7).

In the RESC vs. TM pairwise comparison (Columns 2 and 3 of Table 3.8), human capital *via* the household head education seems to have a larger influence on RESC producers' household income, as well as access to off-farm employment, credit and extension services. There thus seems to be a non-negligible heterogeneity with respect to these two groups' income determinants, as producers in the RESC may rely more extensively on institutional and non-farm sources of income.

3.4.3 Treatment effects of participation in export supply chains

Table 3.9 shows the treatment effects of participation in ESC on both the treated and the untreated as well as the heterogeneity effects, for all the aforementioned pairwise comparisons. In the ESC vs. TM comparison, participation in ESC has a positive effect on

participating producers' household per capita income since it increases it by 77 percent. Non-participating households would also be better off, had they participated in these ESC as we find a positive treatment effect on the untreated.

Table 3.9. Average expected household per capita income (log-transformed), treatment and heterogeneity effects

	Obs.	Regime		Treatment effect	% change
		Treatment	Control		
ESC vs. TM					
Export producers (ATT)	133	6.88 (0.05)	6.31 (0.06)	0.57*** (0.05)	77
Non-export producers (ATU)	178	7.09 (0.05)	6.53 (0.05)	0.56 *** (0.03)	75
Heterogeneity effects (TH)	311	-0.21 (0.07)	-0.22*** (0.08)	0.01 (0.06)	
HVESC vs. TM					
High-value export producers (ATT)	71	7.05 (0.08)	6.36 (0.09)	0.69*** (0.06)	99
Non-export producers (ATU)	178	7.35 (0.08)	6.53 (0.05)	0.82*** (0.05)	127
Heterogeneity effects (TH)	249	-0.30** (0.13)	-0.17* (0.10)	-0.13 (0.09)	
HVESC vs. All					
High-value export producers (ATT)	71	7.05 (0.08)	6.68 (0.07)	0.37*** (0.05)	45
Non-high-value export producers (ATU)	240	7.26 (0.06)	6.57 (0.04)	0.69 *** (0.04)	99
Heterogeneity effects (TH)	311	-0.21 (0.13)	0.11 (0.08)	-0.32*** (0.08)	
RESC vs. TM					
Regular export producers (ATT)	62	6.69 (0.09)	7.46 (0.11)	-0.77*** (0.10)	-116
Non-regular export producers (ATU)	178	6.85 (0.07)	6.53 (0.05)	0.32*** (0.06)	38
Heterogeneity effects (TH)	240	-0.17 (0.13)	0.92*** (0.11)	-1.09*** (0.12)	

Notes: Standard errors are shown in parentheses. The treatment effects of the log-transformed dependent variable are computed in percentage change as $100(e^{ATT}-1)$ (Asfaw et al., 2012) ESC: Export supply chains; TM: Traditional markets; RESC: Regular export supply chains; HVESC: High-value export supply chains.
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.

This effect is mostly driven by participation in HVESC, which – with both comparison groups used – has positive income effects for participating producers (income increases by 99 and 45 percent, respectively). It would also have stronger effects for non-participating producers, with effects on the untreated corresponding to an income increase of 127 and 99 percent respectively. There would thus be a larger room for income effect for producers supplying the TM, if these were to participate in HVESC. On the other hand, participation in RESC has a negative effect on household per capita income for participating producers, while it would benefit TM suppliers in the counterfactual case where they would have participated in the latter, although in a reduced magnitude (38 percent increase in household per capita income) compared to the effect on the untreated conveyed by HVESC. This shows that the producers supplying the RESC are not better off doing so and would possibly benefit more from supplying TM. The diverging nature of the effects of the different types of ESC stresses the importance of disaggregating the analysis and considering the intra-group specificities and differences.

Furthermore, in both the comparison between ESC suppliers vs. TM suppliers and the comparison between HVESC suppliers vs. TM suppliers, the negative signs of the base heterogeneity effects show that, had they been in a similar situation and both groups of producers not participating in ESC, the TM suppliers would have higher per capita income levels and be better off than those supplying the (HV)ESC. This also stresses the potential development and importance of participating in the export supply chains for HVESC suppliers, who would have, without the latter, possibly not been better off than the TM suppliers. On the contrary, in the RESC vs. TM suppliers comparison, the positive sign of the base heterogeneity effects in the non-export context shows that producers supplying the RESC would have, in the counterfactual case where they would have kept supplying the TM, a higher household per capita income than TM suppliers. This is consistent with the aforementioned negative TT effect for the RESC suppliers and the fact that they would be better off supplying the TM. One can thus assume that these producers were or would be among the better off and wealthier vegetable producers supplying the TM.

Finally, the TH effects have negative signs and are statistically significant in the comparisons HVESC suppliers vs. All other producers as well as RESC suppliers vs. TM suppliers. This shows that the effects of supplying these types of exporters on household per capita income would be larger for TM suppliers in the counterfactual case where they would have supplied these supply chains than for the producers who actually did so.

As mentioned in the introduction, we also follow Rao and Qaim (2011), Asfaw et al. (2012) and Hansen and Trifković (2014) and check for potential heterogeneous effects among producers based on their farm size and income level[37]. These results are showed in Tables 3.10 and 3.11, respectively. Regarding the disaggregation by farm size, the results from the overall comparison ESC vs. TM suppliers suggest that overall participation in ESC is more beneficial to producers with lower farm acreage, which is consistent with the results from Rao and Qaim (2011). However, participation in HVESC chains seems to have larger income effects for larger producers, regardless of the comparison group used. On the other hand, participation in RESC affects positively the income of the producers belonging to the third farm size quartile only, although the magnitude of the effect is smaller.

[37] In this specific part of the analysis, we follow Asfaw et al. (2012) and consider the Average Treatment Effects (ATE) only.

Table 3.10. Average treatment effects on household per capita income (log-transformed) disaggregated by farm size

	Obs.	Farm size (acres)	Treatment effect	% change
ESC vs. TM				
Quartile 1	110	< 1	0.70*** (0.03)	101
Quartile 2	55	1 – 2	0.63*** (0.06)	88
Quartile 3	69	2 – 3.5	0.59***,d (0.06)	80
Quartile 4	78	> 3.5	0.30***,c,g,h (0.07)	35
HVESC vs. TM				
Quartile 1	97	< 1	0.73*** (0.05)	107
Quartile 2	50	1 – 2	0.82*** (0.09)	127
Quartile 3	46	2 – 3.5	0.82*** (0.12)	127
Quartile 4	57	> 3.5	0.82*** (0.10)	127
HVESC vs. All				
Quartile 1	110	< 1	0.49*** (0.04)	63
Quartile 2	55	1 – 2	0.66***,a (0.08)	93
Quartile 3	69	2 – 3.5	0.70***,e (0.09)	101
Quartile 4	78	> 3.5	0.68***,f (0.08)	97
RESC vs. TM				
Quartile 1	79	< 1	0.06 (0.06)	6
Quartile 2	40	1 – 2	0.15 (0.10)	16
Quartile 3	57	2 – 3.5	0.15* (0.09)	16
Quartile 4	64	> 3.5	-0.14b (0.13)	-15

Notes: Standard errors are shown in parentheses. The treatment effects of the log-transformed dependent variable are computed in percentage change as $100(e^{ATE}-1)$ (Asfaw et al., 2012). ESC: Export supply chains; TM: Traditional markets; RESC: Regular export supply chains; HVESC: High-value export supply chains.

*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level for the ATEs.

The statistical significance of the differences between the mean values of the different quartiles is presented as follows: [a] significant at the 5 percent level for the difference between the first and second quartiles; [b] significant at the 10 percent level, [c] significant at the 1 percent level for the ATE differences between the third and fourth quartiles; [d] significant at the 10 percent level, [e] significant at the 5 percent level for the ATE differences between the first and third quartiles; [f] significant at the 5 percent level, [g] significant at the 1 percent level for the ATE differences between the first and fourth quartiles; [h] significant at the 1 percent level for the ATE differences between the second and fourth quartiles.

Likewise, in the pairwise comparison HVESC vs. All other producers, producers from the highest income quartiles benefit substantially from participating in HVESC, in comparison to poorer producers[38] (Table 3.11). Interestingly, participation in RESC benefits only producers belonging to the second income quartile, which potentially signals an effect targeting specifically some of the poorer farmers for this supply chain.

[38] Although it is noteworthy that producers in the lowest income quartile benefit significantly from participating in HVESC when compared to producers supplying the TM

Table 3.11. Average treatment effects on household per capita income (log-transformed) disaggregated by household per capita income level

	Obs.	Income ('000 TZS)	Treatment effect	% change
ESC vs. TM				
Quartile 1	72	< 390	0.56*** (0.06)	75
Quartile 2	78	390 – 732	0.60*** (0.05)	82
Quartile 3	79	732 – 1333	0.55*** (0.06)	73
Quartile 4	83	>1333	0.55*** (0.06)	73
HVESC vs. TM				
Quartile 1	59	< 390	0.75*** (0.08)	111
Quartile 2	60	390 – 732	0.68*** (0.08)	97
Quartile 3	63	732 – 1333	0.87*** (0.09)	139
Quartile 4	68	>1333	0.82*** (0.08)	127
HVESC vs. All				
Quartile 1	72	< 390	0.53*** (0.07)	70
Quartile 2	78	390 – 732	0.52*** (0.06)	68
Quartile 3	79	732 – 1333	0.65*** (0.08)	91
Quartile 4	83	>1333	0.74***,a,b (0.06)	110
RESC vs. TM				
Quartile 1	66	< 390	0.01 (0.10)	0
Quartile 2	61	390 – 726	0.13** (0.06)	14
Quartile 3	58	726 – 1333	0.03 (0.09)	3
Quartile 4	55	>1333	0.00 (0.12)	0

Notes: Standard errors are shown in parentheses. The treatment effects of the log-transformed dependent variable are computed in percentage change as $100(e^{ATE}-1)$ (Asfaw et al., 2012) ESC: Export supply chains; TM: Traditional markets; RESC: Regular export supply chains; HVESC: High-value export supply chains.
*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.
The statistical significance of the differences between the mean values of the different quartiles is presented as follows: [a] significant at the 5 percent level for the ATE differences between the first and fourth quartiles; [b] significant at the 5 percent level for the ATE differences between the second and fourth quartiles.

3.5 Discussion of the results

3.5.1 A gross margin analysis

Overall, participation in ESC seems to have a positive effect on producers' household per capita income, in particular participation in HVESC. On the contrary, participation in RESC seems to have overall negative effects on income for participating producers, except for some of the poorer households. To further interpret and understand these results beyond the argument of the lower price received producers supplying the RESC (Table 3.2), we performed a cost and gross margin analysis for the producers in our sample. This analysis is displayed in Table 3.12 and is performed at the plot level[39].

[39] For this part of the analysis, we use the data for one plot per farm, in which the most commercialized vegetable crop was produced during the reference survey period. For the non-export producers, we performed this gross margin analysis with the most commercialized vegetable crop produced for TM.

Table 3.12. Costs and gross margin analysis of vegetable production

	Total sample (N=318)	TM suppliers (N=184)	ESC suppliers (N=134)	RESC suppliers (N=62)	HVESC suppliers (N=72)
Costs (in '000 TZS/acre)					
Purchased manure	1.235	2.135	0.000	0.000	0.000
	(14.336)	(18.817)	(0.000)	(0.000)	(0.000)
Chemical fertilizers	106.692	110.059	102.069	105.279	99.304
	(142.475)	(151.543)	(129.406)	(162.343)	(93.323)
Organic fertilizers	0.126	0.217	0.000	0.000	0.000
	(2.242)	(2.948)	(0.000)	(0.000)	(0.000)
Chemicals	94.007	97.562	89.124	73.469	102.605
	(151.356)	(141.998)	(163.757)	(72.250)	(212.956)
Seeds	86.822***	51.677†††	135.080	121.327$^{\#\#\#}$	146.923
	(106.238)	(103.374)	(90.235)	(94.484)	(85.294)
Hired labour	234.033***	170.717†††	320.975	320.056$^{\#\#\#}$	321.766
	(246.629)	(199.897)	(277.187)	(263.136)	(290.579)
Other costs	44.829***	27.324†††	68.867	16.892	113.623§§§
	(139.743)	(95.816)	(181.401)	(29.678)	(237.686)
Revenue (in '000 TZS/acre)					
Gross revenue	1821.544	1750.525	1919.064	1507.070	2273.836§§§
	(2160.120)	(2447.921)	(1691.118)	(968.543)	(2067.710)
Gross margin	1253.800	1290.833	1202.948	870.047	1489.613§§
	(2002.583)	(2250.195)	(1608.438)	(901.530)	(1991.937)

Notes: Mean values are shown with standard deviations in parentheses. TM: Traditional markets; ESC: Export supply chains; RESC: Regular export supply chains; HVESC: High-value export supply chains. The statistical significance of the differences between the mean values of the different groups is presented as follows: *Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level for the differences between ESC suppliers and TM suppliers; †significant at the 10 percent level, ††significant at the 5 percent level, †††significant at the 1 percent level for the differences between HVESC suppliers and TM suppliers; $^{\#}$significant at the 10 percent level, $^{\#\#}$significant at the 5 percent level, $^{\#\#\#}$significant at the 1 percent level for the differences between RESC suppliers and TM suppliers; §significant at the 10 percent level, §§significant at the 5 percent level, §§§significant at the 1 percent level for the differences between HVESC suppliers and RESC suppliers.

First of all, the gross revenue and margin per acre (0.40 ha) are significantly larger for HVESC producers in comparison to RESC producers. While the producers supplying the RESC receive a much lower price (gross revenue), their production costs are relatively similar to those from their counterparts in HVESC, in particular in terms of hired labour, chemical fertilizers and seeds costs, hence lowering their gross margin.

These high production costs seem to play a role in the comparison with TM suppliers, since producers in RESC spend about twice more than the latter in seeds and hired labour inputs. Yet, this production intensity of French beans in RESC does not translate into higher gross revenue and margin than the ones received by producers in TM. Actually, some other vegetables (*e.g.* tomato, nightshade, cucumber, sweet pepper) can be sold at a higher price per kilogram and provide higher gross revenues per acre, as can be seen in Table 3.13. Producers marketing these more profitable vegetables are thus in theory better off supplying TM than if they would participate in RESC.

Table 3.13. Gross revenue per acre and price per kilo of vegetables sold in the traditional markets

	Gross revenue (in '000 TZS/acre)	Price (in TZS/kilogram)	Observations
Tomato	1792.773 (1289.360)	798.369 (1916.298)	60
Nightshade	1107.101 (1073.715)	1282.085 (4804.600)	43
Cabbage	1788.782 (2320.086)	375.749 (510.998)	41
African eggplant	2068.986 (2179.480)	348.417 (273.961)	31
Okra	1139.608 (757.674)	542.698 (304.543)	17
Cucumber	2588.961 (2404.127)	1244.729 (2975.544)	14
Sweet Pepper	4002.627 (6733.186)	1138.654 (754.537)	11
Eggplant	979.067 (739.198)	601.829 (455.128)	8
Broccoli	2143.458 (1232.314)	1074.127 (816.978)	8
Ethiopian Mustard	415.429 (338.486)	571.667 (364.368)	7
Chinese Cabbage	4620.600 (4884.821)	1250.000 (606.218)	5
French beans	857.200 (551.342)	1275.000 (618.466)	4

Notes: Mean values are shown with standard deviations in parentheses. Analysis based on all the vegetables sold in the traditional markets by at least four of the producers in our sample.

These gross margins can also be helpful in further interpreting some of the heterogeneous effects presented in Tables 3.10 and 3.11. First, hired labour is the costliest input for producers supplying ESC, which is consistent with the high labour intensity of these lines of production (Weinberger and Lumpkin, 2007; Neven et al., 2009; Rao and Qaim, 2013). Small producers in Sub-Saharan Africa have a lower labour productivity than larger-scale producers (Wiggins, 2009). It can thus be expected that larger producers have higher returns on labour and thus receive greater benefits from supplying HVESC. On the other hand, participation in HVESC is more beneficial to richer producers in our computed quantile distribution, as these may be more able than poorer producers to absorb these high upstream costs and generate higher returns to investment (Hansen and Trifković, 2014). There may also be a process of wealth accumulation (Chiputwa et al., 2015) and productivity effects (Minten et al., 2007; Rao et al., 2012) taking place over time and which may also contribute to the higher benefit perceived by better off producers. Furthermore, we saw that poorer producers could benefit from participating in RESC. We may consider that these specific producers' main or "best alternative" (Narayanan, 2014) to supplying these RESC could be to cultivate and market some of the vegetables sold in the TM at a lower price (Table 3.13) and potentially less profitable than the cultivation of French beans for the RESC. They would thus be better off supplying produce to RESC rather than staying in the TM.

3.5.2 A Gini-coefficient decomposition analysis

To complement these results, we performed an analysis of the Gini-coefficient decomposition by income source for the three groups of producers in our sample, following the approach used by Lerman and Yitzhaki (1985). According to the latter, the Gini coefficient of

household per capita income inequality can be represented as follows (Lerman and Yitzhaki, 1985; López-Feldman, 2006):

$$G = \sum_{k=1}^{K} S_k G_k R_k \tag{3.15}$$

where S_k represents the share of income source k in total household per capita income, G_k is the Source Gini corresponding to the income source k and R_k is the Gini correlation of income source k with the distribution of total household per capita income.

The effect of a percentage change e in an income source k on the total household per capita income Gini coefficient and inequality can thus be expressed as (Lerman and Yitzhaki, 1985; López-Feldman, 2006):

$$\frac{\partial G / \partial_e}{\partial G} = \frac{S_k G_k R_k}{G} - S_k \tag{3.16}$$

Table 3.14 displays the results of the household per capita income Gini-coefficient decomposition by income source as well as the marginal effects on inequality for each of these income sources[40]. For brevity, we focus the discussion only on the contribution of the income from vegetables sold to ESC to total household per capita income inequality and related marginal effects. The results of the Gini-coefficient decomposition analysis seem to be in line with the aforementioned treatment effects disaggregated by income quartile. In particular, we observe that the income derived from the participation in HVESC contributes to 47.3 percent of the inequality in terms of household per capita income. Also, a ten-percent increase in the income from supplying the HVESC would result in a 0.43 percent increase in the Gini coefficient on total household per capita income, which would translate into an increase in inequality. This is consistent with the fact that larger and richer producers would benefit the most from supplying the HVESC, which would thus increase inequality between the HVESC suppliers, albeit at a rather low magnitude.

On the other hand, the income derived from supplying the RESC contributes to a lesser extent to household per capita inequality (about 23.2 percent) and has a negative effect on the Gini coefficient as a ten-percent increase in this income source results in a 0.44 percent decrease in the Gini coefficient, hence reducing the overall inequality in this specific sub-group. Although these marginal effects remain low in terms of their absolute magnitude, they are non-

[40] We used the Stata command *descogini* (López-Feldman, 2006) to perform this analysis and generate the related marginal effects.

negligible with respect to the other income sources and their computed marginal effects on the overall inequality in terms of household per capita income.

Table 3.14. Gini-coefficient decomposition analysis

Income sources [a]	Share total income (percent)	Gini coefficient	Correlation with total income	Contribution to total inequality (percent)	Percent change
TM suppliers					
Vegetables supplied to ESC	0.000				
Vegetables supplied to TM	0.398	0.693	0.818	0.408	0.010
Non-vegetable crops	0.237	0.784	0.760	0.256	0.019
Off-farm activities	0.195	0.837	0.645	0.190	-0.004
Others [b]	0.170	0.765	0.612	0.145	-0.024
Total household per capita income		0.553			
HVESC suppliers					
Vegetables supplied to HVESC	0.430	0.670	0.858	0.473	0.043
Vegetables supplied to TM	0.141	0.823	0.654	0.145	0.004
Non-vegetable crops	0.080	0.761	0.560	0.065	-0.015
Off-farm activities	0. 206	0.794	0.755	0.237	0.030
Others [b]	0.138	0.647	0.453	0.077	-0.061
Total household per capita income		0.523			
RESC suppliers					
Vegetables supplied to RESC	0.276	0.596	0.736	0.232	-0.044
Vegetables supplied to TM	0.139	0.759	0.592	0.120	-0.019
Non-vegetable crops	0.281	0.807	0.837	0.364	0.083
Off-farm activities	0.183	0.822	0.699	0.202	0.018
Others [b]	0.120	0.729	0.492	0.083	-0.038
Total household per capita income		0.522			

Notes: TM: Traditional markets; HVESC: High-value export supply chains; RESC: Regular export supply chains.
[a] All the income sources are computed in per capita income in thousands TZS.
[b] The other income sources include agricultural and non-agricultural rental, remittances, pensions and income from NGOs and governmental actors.

3.5.3 Study limitations

Besides the usual caveats of cross-section analysis, some limitations of this paper should also be acknowledged at this point. First, our sample may lack variation in terms of exporters, in particular for the RESC, consisting in this case of only one exporter. This could be seen as a drawback and it could be interesting to include more exporters in this treatment group, which was unfortunately not possible in our case as all the exporters in the research area were already included in the sample. Also, at the time of the survey, this exporter had recently started to outsource their supply from this area, including the sampled producers. As some adjustment time might be needed for both parties and a typical learning curve still to develop, this leads us to consider some of these results with caution.

Also, a difficulty in this type of analysis often lies in the disentanglement of the effects between those linked to the cultivation of a new/different crop and those linked to the

participation in modern supply chains and their characteristics (Barrett et al., 2012; Narayanan, 2014). This is also the case in this paper as this disentanglement could not be done; although since French beans and snap peas are barely sold and consumed at the local level in Tanzania, we assume that those effects can be assessed together in this context. Furthermore, since we compared the effects of two different types of ESC for almost similar crops, we can assume that this somehow helps in disentangling these effects and interpret them under the supply chain perspective[41].

Finally, as can be observed in Table 3.12, while the differences in terms of gross revenue between the three groups of producers are quite important, the differences in terms of gross margin are less significant due to the higher inputs costs inherent to production for the producers in ESC. Some of these coefficients and treatment effects on household per capita income may thus seem quite high in comparison to the differences in terms of gross margin. However, they are grossly in line with the literature on the effects of contract farming on farm and household income in developing countries and some of the coefficients and magnitude gathered and presented in the review performed by Ōtsuka et al. (2016).

3.6 Conclusion

Using endogenous switching regression models, we analysed the effects of small producer participation in export vegetable supply chains on household per capita income, and compared the effects of participation in high-value supply chains with those of participation in what we define in this paper as regular supply chains. We find that small producer participation in export supply chains (ESC) has overall a positive effect on household per capita income. We also find that this effect is mostly driven by small producer participation in high-value export supply chains (HVESC) which has large effects on their household per capita income, in particular through a higher price received than the average prices received for the main vegetables marketed in the local traditional markets (TM). However, participation in regular export supply chains (RESC) has a negative effect on participating producers' household per capita income, suggesting that such producers would be better off selling vegetable produce in traditional markets. This could be the consequence of the low price they receive in comparison to the high production costs incurred. Yet, the disaggregated average treatment effects show that some of the poorer farmers benefit from the participation in regular export

[41] Although we can assume that part of the effect is also driven by the higher price received for snap peas with comparison to the price received for French beans, even when considering the transactions with the HVESC only.

supply chains while richer producers would be the ones benefiting most from a higher effect of high-value export supply chains.

As mentioned in the previous section, our sample relies on only one starting/new exporter for the regular export supply chains; and these results would thus need to be considered cautiously as they strongly depend on the specificities of this research context. It could thus be interesting to further extend this research with panel data and/or in a context with a higher number of well-established exporters, so that the analysis would rely on more information and potentially include a higher level of variation for both groups of exporters. The analysis from such a context may thus provide results for which external validity may be easier to assert.

Our results and considerations are still important as they confirm that different situations can be experienced by small producer participating in export supply chains, including depending on the type of exporter they supply. Thus, a variety of realities and welfare effects may lie behind the concept of export supply chains and this paper can provide some insights on which kind of export supply schemes can better affect positively participating producers' welfare. By relating the characteristics of the contract and supply arrangements of the different exporters in our sample (Table 3.2) with the corresponding welfare effects, these results can also help in better informing and crafting policies on the different requirements and characteristics these export supply schemes should feature to better ensure or increase the probability that small producers benefit from participation in export and modern supply chains.

3.7 Appendix A3

Table A3.1. Validity of the instruments - Determinants of participation in export supply chains

	ESC vs. TM (1)	HVESC vs. TM (2)	HVESC vs. All (3)	RESC vs. TM (4)
Household head age	-0.010 (0.008)	0.006 (0.015)	0.004 (0.011)	-0.017 (0.011)
Household head education	-0.030 (0.037)	0.127** (0.061)	0.047 (0.055)	-0.078* (0.044)
Household head male	-0.899** (0.356)	-1.380** (0.569)	-1.033** (0.455)	-1.010** (0.397)
Household size	0.171** (0.070)	0.189 (0.131)	0.044 (0.096)	0.167** (0.080)
Dependency ratio	-0.001 (0.002)	0.000 (0.003)	0.001 (0.002)	-0.003 (0.002)
Farm size	0.018 (0.037)	-0.016 (0.074)	-0.067 (0.068)	0.014 (0.042)
Off-farm employment	0.158 (0.184)	0.429 (0.334)	0.421 (0.261)	0.197 (0.235)
Access to credit	0.527** (0.253)	0.731* (0.392)	0.873*** (0.297)	0.289 (0.313)
Membership in a non-producer organization	-0.964*** (0.284)	-3.335*** (0.543)	-2.308*** (0.423)	-0.314 (0.301)
Access to electricity	0.429** (0.187)	1.037*** (0.341)	0.678** (0.275)	0.516** (0.236)
Access to piped water	-0.558** (0.248)	-0.520 (0.393)	-0.082 (0.328)	-0.644** (0.298)
Distance to public transportation	-0.005 (0.032)	0.109 (0.073)	0.102* (0.055)	-0.034 (0.051)
Distance to the collection centre	-0.006 (0.095)	0.176 (0.192)	0.117 (0.179)	0.110 (0.103)
Access to extension services	0.069 (0.194)	0.165 (0.329)	0.242 (0.269)	0.228 (0.232)
Access to NGO services	0.867*** (0.210)	1.106*** (0.309)	0.795*** (0.245)	0.649** (0.260)
Mobile phone ownership	-0.018 (0.275)	1.143** (0.533)	0.648 (0.447)	-0.164 (0.284)
Motorbike ownership	0.074 (0.213)	0.172 (0.357)	0.085 (0.281)	0.038 (0.258)
Livestock units	-0.028 (0.043)	0.049 (0.075)	0.072 (0.065)	-0.038 (0.045)
Altitude in meters	-0.001** (0.001)	-0.007*** (0.002)	-0.005*** (0.002)	-0.001* (0.001)
Division Kongo´ri [a]	0.361 (0.399)			0.279 (0.487)
Division Mbuguni [a]	-0.943* (0.483)	-3.641*** (1.082)	-3.066*** (0.905)	-0.631 (0.582)
Division Moshono [a]	0.177 (0.306)	0.985 (0.744)	0.930 (0.678)	0.003 (0.469)
Share of export producers in the village	3.086*** (0.757)			
Neighbours aware of the export markets	0.402*** (0.080)	0.627*** (0.138)	0.448*** (0.112)	0.359*** (0.111)
Share of high-value export producers in the village		14.039*** (2.720)	11.017*** (2.516)	
Share of regular export producers in the village				2.784*** (0.912)
Constant	-0.865 (0.988)	-2.125 (2.360)	-1.502 (1.853)	0.594 (1.416)
Observations	311	214	265	240
Wald Test on the instruments (χ^2)	49.030***	40.660***	36.810***	37.090***
χ^2	99.710***	90.680***	86.520***	79.44***
Log-likelihood	-143.409***	-54.592***	-78.230	-93.831

Notes: Probit models. Standard robust errors are shown in parenthesis. The dependent variables are: (1) Participation in ESC; (2) and (3) Participation in HVESC; and (4) Participation in RESC. ESC: Export supply chains; TM: Traditional markets; HVESC: High-value export supply chains; RESC: Regular export supply chains.

*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.

[a] The reference division is Poli.

Table A3.2. Validity of the instruments - Effects of the instruments on household per capital income of non-participating producers

	ESC vs. TM (1)	HVESC vs. TM (2)	HVESC vs. All (3)	RESC vs. TM (4)
Household head age	-0.010 (0.007)	-0.012* (0.007)	-0.009 (0.006)	-0.011 (0.007)
Household head education	0.091*** (0.030)	0.097*** (0.031)	0.059*** (0.022)	0.094*** (0.032)
Household head male	0.017 (0.349)	0.029 (0.359)	0.220 (0.267)	0.039 (0.347)
Household size	-0.226*** (0.054)	-0.227*** (0.055)	-0.254*** (0.050)	-0.224*** (0.052)
Dependency ratio	-0.000 (0.001)	-0.000 (0.001)	0.000 (0.001)	-0.000 (0.001)
Farm size	0.145*** (0.036)	0.154*** (0.036)	0.101*** (0.030)	0.153*** (0.036)
Off-farm employment	0.325** (0.144)	0.315** (0.145)	0.496*** (0.122)	0.309** (0.145)
Access to credit	-0.083 (0.328)	-0.068 (0.323)	0.163 (0.252)	-0.082 (0.321)
Membership in a non-producer organization	-0.217 (0.210)	-0.254 (0.205)	-0.230 (0.167)	-0.241 (0.202)
Access to electricity	0.235* (0.136)	0.219 (0.136)	0.170 (0.126)	0.214 (0.137)
Access to piped water	0.410** (0.186)	0.431** (0.185)	0.305** (0.151)	0.420** (0.188)
Distance to public transportation	0.043 (0.029)	0.033 (0.029)	-0.003 (0.027)	0.037 (0.028)
Distance to the collection centre	0.074 (0.080)	0.060 (0.078)	0.066 (0.078)	0.074 (0.080)
Access to extension services	-0.186 (0.171)	-0.212 (0.178)	-0.090 (0.145)	-0.199 (0.170)
Access to NGO services	-0.293 (0.191)	-0.258 (0.191)	-0.057 (0.152)	-0.261 (0.185)
Mobile phone ownership	-0.140 (0.179)	-0.133 (0.183)	-0.238 (0.170)	-0.126 (0.179)
Motorbike ownership	0.262 (0.165)	0.244 (0.161)	0.095 (0.131)	0.249 (0.162)
Livestock units	0.085*** (0.032)	0.084*** (0.032)	0.072*** (0.025)	0.085*** (0.032)
Altitude in meters	0.001 (0.000)	0.000 (0.001)	-0.000 (0.000)	0.000 (0.000)
Division Kongo´ri [a]	-0.307 (0.316)	-0.095 (0.313)	0.048 (0.249)	-0.197 (0.275)
Division Mbuguni [a]	0.559 (0.341)	0.344 (0.346)	0.395 (0.301)	0.517* (0.311)
Division Moshono [a]	-0.128 (0.253)	-0.074 (0.241)	0.305 (0.201)	-0.118 (0.242)
Share of export producers in the village	-0.425 (0.513)			
Neighbours aware of the export markets	0.049 (0.067)	0.045 (0.065)	0.039 (0.057)	0.074 (0.071)
Share of high-value export producers in the village		0.427 (0.597)	0.189 (0.406)	
Share of regular export producers in the village				-0.955 (0.600)
Constant	5.474*** (0.840)	5.878*** (0.913)	6.518*** (0.743)	5.920*** (0.849)
Observations	178	178	240	178
F-Statistic on the instruments	0.490	0.410	0.300	1.310
(p-value)	(0.616)	(0.664)	(0.742)	(0.273)
R^2	0.426	0.426	0.373	0.433
F-Statistic	7.572***	7.218***	6.380***	7.329***

Notes: OLS models. Standard robust errors are shown in parentheses. The dependent variable in the four models is log household per capita income. TM: Traditional markets; ESC: Export supply chains; RESC: Regular export supply chains; HVESC: High-value export supply chains.

*Significant at the 10 percent level, **significant at the 5 percent level, ***significant at the 1 percent level.

[a] The reference division is Poli

4 General conclusion

4.1 Main findings

The rise and consolidation of modern supply chains within the global agri-food systems have had important implications for rural development, in particular with respect to the welfare of the participating small producers in developing countries. These implications have been the focus of a fast-growing literature, which has shown that in many cases modern supply chains can effectively contribute to poverty reduction in rural areas. A large body of evidence from this literature shows that small producer participation in these supply chains can affect household income positively (Maertens and Swinnen, 2009; Miyata et al., 2009; Rao and Qaim, 2011; Bellemare, 2012; Andersson et al., 2015). There is also additional evidence that when small producers participate in these supply chains, their hired labour demand increases which can generate agricultural wage labour opportunities for rural women in particular (Rao and Qaim, 2013). Through this dissertation focusing on the case of export vegetable supply chains in Tanzania, we aim to contribute to this literature by analysing the effects of small producer participation in modern supply chains on both household labour allocation and poverty of participating producers and their households.

With the first chapter, we have analysed whether and how small producers' household labour allocation process is affected by their participation in these supply chains. In doing so, we have considered the potential interdependence between on-farm and off-farm labour decisions at the household level. We have also analysed to which extent these labour effects can affect rural youth. This is a relevant approach since significant employment effects benefitting rural youth may convey high implications for rural development.

First, we find that participation in export vegetable supply chains increases overall on-farm hired labour demand on the participating producers' farms. This may be the result of the need to respond to the quality requirements imposed in these supply chains as well as to keep up with the higher labour intensity of the produced vegetable crops. As their family labour endowments may not be sufficient to respond to these needs, participating producers eventually hire a larger number of casual labourers to work on-farm and complement their own labour force. Since we also fail to reject the separability assumption in our research context, we may assume that the on-farm labour market is functioning relatively well and that these producers do not encounter significant difficulties to find and hire labourers on their farms. Furthermore, we find that these effects on on-farm hired labour demand benefit mostly rural youth, as these generated casual labour opportunities are mostly taken up by young

casual labourers. This may be due to the fact that they are either more readily available to take up these casual labour opportunities, or that they offer labour skills more adequate to those further sought by the participating producers. Overall, this specific result stresses some implications of these supply chains for rural development and poverty reduction beyond participating households, in particular for neighbouring households who may not be able to enter these markets as suppliers but can eventually benefit from this hired labour demand.

On the other hand, we find no statistically significant evidence of a direct effect of participation in modern export supply chains on participating households' off-farm labour decisions, neither in terms of labour market entry, nor in terms of the quantity of labour endowments allocated off the farm by the household members. In our research setting, the production of French beans and snap peas does not span continuously over the full year, but is rather pursued by supplying households over a few months. In this context, off-farm activities and on-farm production may thus not always be in competition and actually substitute each other throughout the year. Furthermore, the potential accumulation of capital from the generated on-farm profits may have not taken place or not led directly to investments in household-led non-farm enterprises or other off-farm activities. Finally, the consolidation of export supply chains in our research area may have also not generated off-farm employment activities along the supply chains in or close to the supplying villages.

Our second chapter focuses on the potential effects of small producer participation in modern supply chains on poverty. We contribute to the current findings from the literature on this topic by considering the heterogeneity of these modern supply chains as the various exporters active in the latter may vary from each other and actually set up different types of supply arrangements with the producers. We thus assess and compare in this chapter the effects of supplying what we define as high-value vegetable export supply chains (HVESC) with those of supplying regular vegetable export supply chains (RESC). Our results confirm that this heterogeneity is important when assessing the effects of the different types of modern export supply chains. Indeed, while these results suggest that overall participation in export supply chains has a positive effect on household income, which is line with various findings from the literature, we find evidence that the effects differ for the two types of export supply chains. On the one hand, participation in HVESC has indeed a strong positive effect on participating producers' income. On the other hand, participation in RESC actually conveys a negative effect on income. Given the high differences in terms of the prices received by the producers in the two types of supply chains, we hypothesize that this effect is mostly determined by the

level of premium compensation received by the contracted producers, considering that the production costs between the two groups of producers are rather similar. Yet, it is also noteworthy that some of the poorer producers could actually benefit from participation in RESC, since this may potentially represent a better opportunity for them than the vegetables they would otherwise produce and market on the traditional markets.

4.2 Policy implications

By generating on-farm labour demand and employment opportunities in this sector, modern supply chains can thus contribute to poverty reduction in rural areas. Although most of the labour force in Sub-Saharan Africa is still involved in agriculture (McMillan and Headey, 2014; Davis et al., 2017), the increasing land scarcity (and thus access to farming) has pushed many rural households to diversify their activities into low-entry barrier and returns non-farm activities (Jayne et al., 2014). These on-farm casual and agricultural wage labour opportunities could allow some of the poorer and land-constrained households to diversify their income sources and increase their livelihoods. Policies should thus promote small producers' access to these supply chains, especially in areas where land is not equally distributed or many rural households face difficult to access or cope with farming. Our results also showed that extension services influenced positively the labour demand of these producers. They can connect producers to potential casual labourers from surrounding households, hence facilitating the hiring process and potentially stimulating on-farm labour markets at the village level. It would thus be important to support them and ensure they are active in the rural villages, especially those where on-farm labour markets may fail.

Similar policy implications can be drawn from the noted labour effects for rural youth. The fact that these labour opportunities are being taken up in majority by rural youth shows that agriculture can still provide livelihood opportunities to landless youth or those who struggle to access farming or other non-farm livelihoods. Considering the recent evidence showing that remaining in agriculture can provide a viable poverty reduction pathway (Christiaensen and Todo, 2014) – at least in a short-term perspective (Dorosh and Thurlow, 2014), the difficulties that some individuals can meet in their intent to migrate (Brauw et al., 2014) and youth dependence on farming activities (Jayne et al., 2014), this is a welcome result to partially address the employment challenge conveyed by the youth bulge in the continent. A further two-fold lesson can also be drawn to ensure the sustainability of this effect: first, it is important to make sure that these labour opportunities remain attractive enough for rural youth, including to avoid distress migration, which can have important negative consequences

(Deotti and Estruch, 2016). This may be done through ensuring sustainable and higher daily wages, potentially through an increase in productivity, and improving the working conditions, although this may be difficult in informal settings (Wiggins and Keats, 2014). Second, these opportunities may currently not bear long-term growth potential for youth, considering the expected low returns and irregularity of the labour demand. Thus, increased access to land for rural youth should be sought, as this would potentially allow young producers to directly enter these lucrative supply chains or make their livelihoods with their own farm business.

We can infer from the results from the second chapter that the supply schemes and arrangements linking producers to exporters matter for the income effects. This should be taken into account when promoting small producer participation in these supply chains. It is important to ensure beforehand that the supply schemes set up to connect buyers with the producers will benefit the latter. In this light, we have observed that the major difference between the two types of supply schemes in our research setting lies in the price received by the producers. It is thus important that producers receive a sufficiently high enough price that could guarantee them sustainable livelihoods. Should this price not be guaranteed, there is a risk that these supply chains may no longer be profitable for small producers and lead to their exit from the latter, with producers opting themselves out (Narayanan, 2014).

A short qualitative follow-up survey that we performed with the leaders of the producer organizations in our study sample confirms this risk: more than half of the groups who had been supplying the RESC had left this supply chain less than two years after entering it. The main reason invoked in all cases was the low price received, which confirms that premium price remains an important element of the success of these supply chains (Reardon et al., 2009). Should the price offered to producers in these supply chains turn out to be difficult to increase, we have observed that high costs of hired labour inputs were key to explain the negative effects of participation in RESC on household income. An alternative option could thus consist in improving specifically the agricultural labour productivity to potentially increase the benefits for the producers. Yet, we also found that these supply chains could improve the livelihoods of some of the poorer producers, which stresses the aforementioned point that the effects of modern supply chains should be analysed not only through the lens of the heterogeneity of the types of supply chains, but also based on the characteristics of the small producers involved, and their own specificities (Narayanan, 2014).

Finally, since participation in HVESC has been shown to actually improve household income, the specific determinants of participation in the latter should be considered. Besides the

needed improvement of the infrastructure and other conditions for improved market access, the results from the endogenous switching regressions (Chapter 3) show that access to credit and NGO services are important factors and should thus be promoted. For instance, policies should support producers in building up their physical capital and fostering their investment capacity[42] while provision of credit or other financial services by the buyers should also be encouraged. The instruments we used in this chapter also stress the importance of informal knowledge sharing within rural communities (Holloway and Lapar, 2007; Hansen and Trifković, 2014). Agricultural extension services could thus play a role in informing and raising awareness about these export markets within the rural villages, targeting especially isolated or remote households.

4.3 Limitations and suggestions for future research

Some limitations of the research presented in this dissertation should also be acknowledged. First of all, the analysis performed in both chapters relies on cross-sectional data, which may bring up some concerns regarding any potential self-selection bias and unobserved heterogeneity. We used a control function approach and endogenous switching regression models to address to the best extent possible these problems. However, these techniques rely strongly on the quality of the instruments used and may not always fully address these issues. Performing further survey rounds to generate a panel dataset could help addressing some of these issues. For the results from the second chapter, this may also help to properly assess whether long-term capital accumulation through participation in modern export supply chains can actually play a role in the off-farm labour supply effects. In the third chapter, we stress that the regular exporter supplied by some of the producers in our sample was just starting its activities by the time of the survey and that some adjustment period might be needed. Through our follow-up survey, we have learnt that some adjustment took place with a slight increase of the price offered to the producers after the data collection period, but that some of the groups nevertheless left the supply chains. Panel data could help analyse the participation dynamics of these groups and the related impacts, for both the groups who stayed in the supply chains and those who left for another exporter or went back to supply exclusively the traditional markets. A similar research was performed by Andersson et al. (2015) for the supermarket supply chains in Kenya, and it would be interesting to build on the first round of data used in this dissertation to conduct a similar type of panel-based analysis in the context

[42] This could consist in, among others, fostering public rural finance services, support rural credit institutions and groups such as the Savings and Credit Cooperative Organizations (SACCOs) in the specific case of Tanzania.

of (heterogeneous) export supply chains. This could for instance also be interesting to look into the potential movement from a type of export supply chains to the other.

With respect to the generalization of our results, other limitations directly linked to the research setting of this analysis and dissertation should be taken into account. With respect to the findings of the second chapter, we fail to reject the assumption of separability of the production and consumption decisions at the household level. This should be taken into account in the generalization of our results. In a context with a marked non-separability, the effects on household labour allocation may go through different pathways and directions. Furthermore, we have underlined that the producers in our households were located too far away from the agro-processing facilities and potential off-farm jobs created along the export supply chains. The results may thus be different in a context where the exporter (or any other type of modern buyer) sources their supply from neighbouring or closer villages and stimulate the local non-farm economy. Moreover, we build our analysis in the third chapter on the heterogeneity of the exporters and the supply schemes linking them to the producers. However, as mentioned earlier, there are only four exporters in our sample, and only one considered as regular. The results rely thus on a low number of exporters and there may also be a lack of variation among them in general. Conducting this analysis on a sample with a higher number of exporters or modern buyers and a larger variety in their outsourcing arrangements and characteristics could provide more insights on their effects on participating households' poverty and welfare.

Finally, a few limitations should also be mentioned regarding the measurement of labour in the second chapter. We measured hired labour use through recall data procedures. While this being to the best of our knowledge the most common way to measure this type of labour data in a such a research setting, there is some evidence that this method may introduce a recall bias (Arthi et al., 2016). Regarding the measurement of off-farm labour supply, we have considered the effects on the off-farm labour supply aggregated at the household level. However, reflecting on the collective household theoretical framework (Doss, 1996; Vermeulen, 2002), we do not exclude that heterogeneous effects on off-farm labour supply may take place at the individual level, especially if one would consider the potential differences between the different age-cohorts' members within a household.

Thus, besides the abovementioned limitations, a few additional areas for further research may be briefly elicited. With respect to the latest point above, it would be interesting to analyse whether a household participation in modern supply chains could affect off-farm labour

supply at the individual level, *i.e.* affect differently the various individuals from the household in terms of their own participation in off-farm labour markets. Related to the effects on hired labour demand for rural youth, it would be interesting to assess and compare in a broader perspective to which extent modern supply chains can generate employment and livelihood opportunities for rural youth through, either agricultural wage labour (as shown in Chapter 2), non-agricultural wage labour opportunities in the agro-processing facilities or along other segments of the supply chains, as this was the case in rural Senegal or Peru to quote a few examples (Maertens and Swinnen, 2009; Schuster et al., 2017), or through a direct participation as supplier in these supply chains, provided that rural youth can access these. Measuring the welfare and employment effects of each of these options for rural youth would be useful to assess in a more exhaustive way how the transformation of the agri-food systems and modern supply chains could contribute to broader welfare in rural areas.

Finally, considering the aforementioned heterogeneity of these modern supply chains, it would be interesting and relevant to conduct future research on their effects on participating producers' farm efficiency and productivity. There is evidence that participation modern supply chains can affect positively agricultural efficiency (Rao et al., 2012) and productivity (Minten et al., 2007). As for the effects on income, we could also expect that the heterogeneity of the modern supply chains and related contract schemes could also lead to heterogeneous effects on farm efficiency and productivity for participation producers. For instance, the different services and inputs provided to the producers, the different planting and production requirements imposed by the buyers or the different behavioural reactions of the producers to the contract terms (*e.g.* with respect to their capacity or willingness to invest on this production), could affect both the technical efficiency on this specific production (Rao et al., 2012) or broader farm productivity (Minten et al., 2007) in different ways. This is relevant, considering the importance of raising the agricultural yields and productivity for growth in Africa (Dorosh and Thurlow, 2014; Benin, 2016).

Therefore, besides the different pathways considered in this dissertation and through which small producer participation in modern supply chains can generate overall welfare effects, further research could complement these results and provide additional evidence on potential welfare effects that are relevant from a rural development and poverty reduction perspective.

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Georg-August-Universität Göttingen

GRK 1666 GlobalFood
Transformation of Global Agri-Food Systems

RTG 1666: GlobalFood - University of Göttingen
Small producer participation in high-value vegetables supply chains and effects on livelihoods in Tanzania

Farm and household Survey (2015)

Habari, my name is _____, I work with AVRDC - The World Vegetable Center. We are currently collaborating with the University of Göttingen (Germany) on a farm and household survey on vegetables production and marketing in the northern Highlands in Tanzania. The aim of this study is to better understand the effects of vegetable marketing in local and export markets on small producers´ livelihoods. The gathered information will be **strictly confidential**, serving a research purpose only. In this context we are interviewing about 370 Tanzanian vegetable producers and we would very much appreciate if you would agree to participate in our survey and respond to a range of questions. If you confirm your consent, shall we start?

Location of the survey:

1. Region: _____ (Region ID: _____)
2. District: _____ (District ID: _____)
3. Division: _____ (Division ID: _____)
4. Village: _____ (Village ID: _____)
5. GPS coordinates: Latitude: _____
   Longitude: _____ Altitude: _____

Household identification and details:

1. Name of household head (Surname, Middle name, First name):
   _____
2. Name of respondent (Surname, Middle name, First name):
   _____
3. Phone number: _____
4. E-mail address (if any): _____
5. Produces vegetable since: _____ /_____

Interview protocol:

1. Enumerator: _____ (Enumerator ID: _____)
2. Date: _____ /_____ /2015
3. Starting time: _____ : _____ (24h)

Questionnaire identification number:

REG-ID	DIS-ID	DIV-ID	VILL-ID	HH-ID	EN-ID

Data check and entry:

1. Check performed by _____ on ____ /____ /2015
2. Data entry performed by _____ on ____ /____ /2015

I am very grateful to Christine Chege for allowing me to use her household questionnaire as a reference and to adapt questions from it. This is much appreciated. The specific measurement units used to measure agricultural outputs and inputs are adapted from her questionnaire and the measurement units used in the questionnaire developed by Christiaensen and Sarris (2007). The procedure to collect recall data on household off-farm labour occupations (module 3) followed the procedure developed by The World Bank (2008) for such data.

Module 1. General farm and household characteristics

1. *Household Information roster*

I.1.1. Please provide the following information regarding your household:

Household member ID	Relationship to HH head (Code 1)	Gender *1=Male; 2=Female*	Age	Marital Status (Code 2)	Years of schooling	Higher degree obtained (Code 3)	Main occupation (Code 4)	Participation in farm work *1=Yes; 0=No*	Years of farming experience	Off-farm occupation *1=Yes; 0=No*
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Code 1: Relationship with household head

1= Head
2= Husband/wife
3= Child
4= Parent
5= Grand-child
6= Siblings
7= Grandparents
8= Sister/brother-in law
9= Parent-in-law
10= Children-in-law
11= Stepchildren
12= Migrant
13= Others (please specify)

Code 2: Marital Status

1= Married
2= Single
3= Divorced/Separated
4= Widowed

Code 3: Degree obtained

0= Illiterate
1= Primary school finalized
2= Lower secondary school finalized
3= Upper secondary school finalized
4= University Bachelor
5= University Master
6= No degree obtained yet

Code 4: Main occupation

1= On-farm work
2= Paid employment (civil servant, working in private company)
3= Self-employed
4= Wage labour (working on other farms)
5= Student
6=Family worker
7= Unemployed
8= Others (please specify)

2. *Socio-economic indicators and infrastructures*

I.2.1. Please provide the following information on the following social amenities and infrastructures:

	Do you have access to this facility *1= Yes; 0= No*	**Do you use this facility? (Code 5)**	**Distance (in km)**	**Transportation time (in minutes)**	**Main means of transportation (Code 6)**
Electricity					
Solar power					
Piped water					
Public transportation system					
Bank					
Agricultural extension office					
Agricultural input market					
Produce collection centre					
Tarmac road					

Code 5: Use of facility
1= Yes; 2= No, no need; 3= No, too far; 4= No, too expensive; 5= No, do not know; 6= Other (please specify)

Code 6: Means of transportation
1= Walk; 2= Bicycle; 3= Daladala/Public transport; 4= Motorbike; 5= Individual Car; 6= Other (please specify)

I.2.2. Please provide the following information on your current group membership:

	Are you member of any of these groups? *1= Yes; 0= No*	**For how long?** *e.g. Since 2001; 2006-2010*	**How often do you attend group meetings and activities per month?**	**What type of benefits and services do you receive? (Code 7)**	**Membership fees per month (in TZS)**
Producer associations					
Credit/saving groups					
Women´s Group					
Youth group					
Religious group					
Others: _____					

Code 7: Group benefits
1= Credit; 2= Market information; 3= Information on technology/practices; 4= Access to input; 5= Group marketing; 6= Solidarity/support; 7= Other (please specify)

I.2.3. Please provide the following information on your access to agricultural NGOs, programmes and extension services:

	Do you receive services from these organizations? *1= Yes; 0= No*	**Please indicate the time period** *e.g. Since 2010; 2010-2012*	**What type of benefits and services do you receive? (Code 8)**	**Are you satisfied with these services?** *1= Yes; 0= No*	**Distance (in km)**
Public extension services					
TAHA					
AVRDC					
TAPP - USAID					
NGO 1 : _____					
NGO 2 : _____					

Code 8: Benefits
1= Credit; 2= Market information; 3= Information on technology/practices; 4= Access to input; 5= Solidarity/support; 6= Other (please specify)

3. *Farm characteristics*

I.3.1. Please describe your **whole farmlands** for **the current season**:

Total land endowment (in acres)	**How long have you been cultivating it? (in years)[a]**	**Total cultivated area (in acres)**	**Total irrigated area (in acres)**	**Types of irrigation used (Code 9)**	**How long have you been using irrigation? (in years)**

[a] It refers to the oldest farmland

Code 9: Irrigation techniques - *0= No irrigation; 1= Water pump; 2= Water tank; 3= Drip irrigation system; 4= Sprinkler; 5= Watering can; 6= Farrow irrigation; 7= Other (please specify).*

I.3.2. Please provide the following information on the **crops you grew** on your whole farm during the **last agricultural year 2014 (March-September 2014 and October 2014-February 2015)**. *Enumerator: if a crop is grown different times in this period, please add another line for this crop.*

Crops	Sowing period *Month and year (MM/YYYY)*	Harvesting period *Month and year (MM/YYYY)*	Total area cultivated (in acres)	Total irrigated area (in acres)	Ownership of the plot (Code 10)	Production		Post-harvest losses	HH Consumption	Marketed	
						Unit (Code 11)	Quantity	Quantity *Please use the same unit/code 11*	Quantity *Please use the same unit/code 11*	Quantity *Please use the same unit/code 11*	Total money received (in TZS)

Code 10: Ownership status - *1= Title; 2= Customary law; 3=Rented in; 4= Other (please specify).*

Code 11: Unit of production, marketing and consumption
1=Kg; 2= 50 kg bags; 3= 100 kg bags; 4= Debe tins (18-20 kgs); 5= 5 kgs tins; 6= bunch (specify weight); 7=15Kg crates; 8= pieces; 9= Others (please specify)

I.3.3. For the crops indicated above, please specify your utilization of inputs during the **last agricultural year 2014 (March-September 2014 and October 2014-February 2015):**

Crops	Land rent (in TZS)	Seeds			Fertilizers			Manures			Pesticides			Machinery cost (in TZS)
		Unit (Code 12)	*Qty*	*Total Cost (TZS)*	*Unit (Code 12)*	*Qty*	*Total Cost (TZS)*	*Unit (Code 12)*	*Qty*	*Total Cost (TZS)*	*Unit (Code 12)*	*Qty*	*Total Cost (TZS)*	

Code 12: Units
1= Kgs; 2= Grams; 3= Litres; 4= Other (please specify)

I.3.4. Please provide the following information on the **crops you grow** on your whole farm **for the current season (March-September 2015)**. *Enumerator: if a crop is grown different times in this period, please add another line for this crop.*

Crops	Sowing period *Month and year (MM/YYYY)*	Harvesting period *Month and year (MM/YYYY)*	Total area cultivated (in acres)	Total irrigated area (in acres)	Ownership of the plot (Code 10)	Production		Post-harvest losses	HH Consumption	Marketed	
						Unit (Code 11)	Quantity	Quantity *Please use the same unit/code 11*	Quantity *Please use the same unit/code 11*	Quantity *Please use the same unit/code 11*	Total money received (in TZS)

Code 10: Ownership status - *1= Title; 2= Customary law; 3=Rented in; 4= Other (please specify).*

Code 11: Unit of production, marketing and consumption
1=Kg; 2= 50 kg bags; 3= 100 kg bags; 4= Debe tins (18-20 kgs); 5= 5 kgs tins; 6= bunch (specify weight); 7=15Kg crates; 8= pieces; 9= Others (please specify)

I.3.5. For the crops indicated above, please specify your utilization of inputs during **the current season (March-September 2015)**:

Crops	Land rent (in TZS)	Seeds			Fertilizers			Manures			Pesticides			Machinery cost (in TZS)
		Unit (Code 12)	*Qty*	*Total Cost (TZS)*	*Unit (Code 12)*	*Qty*	*Total Cost (TZS)*	*Unit (Code 12)*	*Qty*	*Total Cost (TZS)*	*Unit (Code 12)*	*Qty*	*Total Cost (TZS)*	

Code 12: Units
1= Kgs; 2= Grams; 3= Litres; 4= Other (please specify)

I.3.6. Please provide the following information on your livestock **since March 2014** until now (for the last agricultural year 2014 and the current season):

	Quantity owned		**Quantity sold**		**Unit price (in TZS)**		**Total costs of production (in TZS)**							
							Fodder and feeds		*Hired labour*		*Veterinary care*		*Other*	
	LAY 2014	**Current season**	**LAY 2014**	**Current season**	**LAY 2014**	**Current season**	**LAY 2014**	**Current season**	**LAY 2014**	**Current season**	**LAY 2014**	**Current season**	**LAY 2014**	**Current season**
Cattle														
Goat														
Donkey														
Sheep														
Poultry (chicken, turkey etc.)														
Pigs														
Milk (in litres)														
Egg														

I.3.7. Is your farm certified? If yes, please provide the following details:

	Certified *1= Yes; 0= No*	**Total area certified (in acres)**	**Please indicate the time period** *e.g. Since 2010; Between 2010-2012; In 2011*	**Did you receive any support in getting the certification? (Code 13)**
GlobalGap				
UTZ				
FairTrade				
Organic/SAN				
Rainforest Alliance				
Others: _____				

Code 13: Support in certification
0= No; 1=Producer organization; 2= Exporter 1; 3= Exporter 2; 4= Exporter 3; 5= Exporter 4; 6= TAPP-USAID; 7= TAHA; 8= SHOP-USAID; 9= Other (please specify)

Module 2. Vegetables production and marketing

1. *Information and marketing*

II.1.1. What are your most important sources of information for production and marketing of vegetables? *Enumerator: please rank the 3 most important sources (1 the most important, 3 the less important)*

	INFORMATION ON PRODUCTION *(e.g. production techniques, input requirements)*		**MARKET INFORMATION** *(e.g. sale opportunities, prices etc.)*	
Sources of information	**Export markets**	**Local markets**	**Export markets**	**Local markets**
1. Public extension officers				
2. NGOs				
3. Input dealers				
4. Radio				
5. SMS/Mobile services				
6. Print medias (Newspapers and internet)				
7. Local traders				
8. Collector				
10. Other farmers				
11. Contract firm/exporter				
12. Cooperative/farmer's association				
13. Others (please specify): _____				
	INFORMATION ON PRODUCTION		**MARKET INFORMATION**	
	Export markets	**Local markets**	**Export markets**	**Local markets**
Are you satisfied with this information (*1= Yes; 0= No***)**				
If you are not satisfied about this information, please state why?				
Information is not available **(***1= Yes; 0= No***)**				
Information is not accurate **(***1= Yes; 0= No***)**				
Information is too complex **(***1= Yes; 0= No***)**				
Information is not helpful **(***1= Yes; 0= No***)**				
Others (please specify): _____				

II.1.2. How long have you been engaged in vegetable export markets: _____
(Please indicate as follows: Years + Months; ***0 if the farmer is not engaged*** *in export) Enumerator:* ***If answer is 0****, please ask the respondent why he is not engaged in export markets and fill the table below.*

I am not engaged in export markets because	***1 =Yes; 0= No***
1. Not aware of possible sales to these	
2. Could not access a supplying group	
3. Require reliable means of transport that are not available	
4. Unable to supply the required quality	
5. Unable to supply the required quantity consistently	
6. High-rejection rates	
7. Price is too low for the work intensity	
8. Exporter do not pay promptly	
9. Exporter do not buy all produce	
10. Other reasons (specify): _____	

II.1.3. Do you face any marketing problems to sell your vegetables **on the local markets**?

_____ (*Yes=1; No=0*) E*numerator: **If the answer is 0** please go to question II.1.4.*

I face the following marketing challenges in local markets	***1 =Yes; 0= No***
1. I cannot find buyers	
2. No means of transport for the produce	
3. Deterioration of the product as market outlets are lacking	
4. Prices are too low	
5. Too much competition in the market	
6. Losses and damages due to disease and pest	
7. I cannot sell all my produce	
8. I cannot comply with the required quality in the market	
9. Others: _____	
10. Others: _____	

II.1.4. How is mostly spent the income generated by your vegetables sales? *Enumerator, please ask the three main reasons given by the respondent and rank them (1 the most important, 3 the less important).*

Food	
Land purchase/rental	
Agricultural equipment rental/purchase	
Schooling	
Agricultural input	
House Rent	
Credit and reimbursements	
Leisure	
Other (please specify): _____	
Other (please specify): _____	

II.1.5. Please provide the following information regarding your five closest neighbours:

	Name	**Distance from your house (in km)**	**Membership in your producer organization** *1= Yes; 0= No*	**Produces vegetables?** *1= Yes; 0= No*	**Supplies the export market?** *1= Yes; 0= No*
Neighbour 1					
Neighbour 2					
Neighbour 3					
Neighbour 4					
Neighbour 5					

II.1.6. During the **last agricultural year 2014 (March-September 2014 and October 2014-February 2015) and the current season**, how did you sell your **VEGETABLES ON THE LOCAL MARKETS**? *For the enumerator: first identify the marketing channels for each vegetable crop and then fill a line for each market if a vegetable crop has different outlets.*

Vegetable crops	Market Channels (Code 14)	Quantity supplied		Quantity lost		Total value (in TZS)	What are the main reasons for supplying this market *In order of importance* (Code 16)	Access to the market		Agreement with the buyer? (Code 17)	Services provided by the buyer? (Code 18)
		Unit (Code 15)	*Quantity*	*Unit (Code 15)*	*Quantity*			*Time to reach the market (in hours)*	*Distance (in kms)*		
Agricultural year 2014 (March 2014-February 2015)											
Current season (March 2015-September 2015)											

Code 14: Market channels
Traditional markets: *1= Retail green market; 2= Wholesale green market; 3= Collector/trader;* ***Local high-value markets:*** *4= To a restaurant, hotel, school; 5= To a supermarket; 6= To an agro-processing firm;* ***Others:****7= To a farmer cooperative; 8= To the regional market; 9=Direct consumers; 10= Other (please specify).*

Code 15: Unit : *1=Kg; 2= 50 kg bags; 3= 100 kg bag; 4= Debe tins (18-20 kgs); 5= 5 kgs tins; 6= bunch (specify weight); 7= 15 kg crate; 8= pieces; 9= Other (please specify).*

Code 16: Reasons to choose this market
1= Stable and reliable outlet; 2= Higher prices; 3= Price stability; 4= Facilitation to access to credits; 5= Facilitation to access to inputs; 6=Closer (distance); 7= Trust relationship with the buyer; 8= Lack of transportation to other markets; 9= More information than the other outlets; 10= Lack of alternatives/access to the other markets; 11= Other (please specify).

Code 17: Agreement with the buyer
0= No agreement; 1= On the type of crop; 2= On the price per season; 3= On the quantity of the supply; 4= On the regularity of the supply/delivery; 5= On the regularity of the payment; 6= On the quality of the product; 7= On the choice of the inputs and production techniques; 8= Other (please specify).

Code 18: Services provided by the buyer
0= No services; 1 = Input provision ; 2= Cash advances; 3= Information/training for production; 4=Market information; 5=Credit; 6= Transportation /Collection of produce;7= Other (specify).

2. *Contract farming for export produce (only applicable for contracted farmers)*

If no contract farming, please go to the section II.3. (Input and Output).

II.2.1. Please provide the following information on your crops under contract farming during the **last agricultural year 2014 (March-September 2014 and October 2014-February 2015) and the current season.** *Enumerator: If a crop is supplied to different exporters, please write one line per exporter for this crop.*

Vegetable crops	Exporter supplied (Code 19)	Quantity supplied		Quantity rejected		Total revenue received (In TZS)	What are the main reasons for supplying this exporter *In order of importance* (Code 21)	Price agreement? (Code 22)	Timing of payment *In weeks after delivery*	Services/benefits (Code 23)
		Unit (Code 20)	*Quantity*	*Unit (Code 20)*	*Quantity*					
Agricultural year 2014 (March 2014-February 2015)										
Current season (March 2015-September 2015)										

Code 19: Exporter supplied
1= Exporter 1; 2= Exporter 2; 3= Exporter 3; 4= Exporter 4

Code 20: Unit: *1=Kg; 2= 50 kg bags; 3= 100 kg bag; 4= Debe tins (18-20 kgs); 5= 5 kgs tins; 6= bunch (specify weight); 7= 15 kg crate; 8= pieces; 9= Other (please specify).*

Code 21: Reasons to choose this market
1= Stable and reliable outlet; 2= Higher prices; 3= Price stability; 4= Facilitation to access to credits; 5= Facilitation to access to inputs; 6=Closer (distance); 7= Trust relationship with the buyer; 8= Lack of transportation to other markets; 9= More information than the other outlets; 10= Lack of alternatives/access to the other markets; 11= Other (please specify).

Code 22: Price agreement
1= Fixed for a specific season; 2= Floating

Code 23: Benefits/services
1= Agricultural training/extension services; 2= Management capacity building/training; 3= Cash advance; 4= Credit; 5= Collection of the produce; 6= Other (specify)

II.2.2. Please provide the following information on the **inputs received** in the framework of these contracts during the **last agricultural year 2014 (March-September 2014 and October 2014-February 2015) and the current season:**

Crops	Exporter (Code 19)	Seeds			Fertilizers			Pesticides			Others:_____		
		Unit (Code 24)	*Quantity*	*Quality (Code 25)*	*Unit (Code 24)*	*Quantity*	*Quality (Code 25)*	*Unit (Code 24)*	*Quantity*	*Quality (Code 25)*	*Unit (Code 24)*	*Quantity*	*Quality (Code 25)*
Agricultural year 2014 (March 2014-February 2015)													
Current season (March 2015-September 2015)													

Code 19: Exporter supplied
1= Exporter 1; 2= Exporter 2; 3= Exporter 3; 4= Exporter 4

Code 24: Units
1= Kgs; 2= Grams; 3= Litres; 4= Millilitres; 5= Pieces; 6= Other (please specify).

Code 25: Quality of the inputs
1= Very low; 2= Low; 3= Average; 4= Good; 5= Very

II.2.3. How many times a week/month do you usually receive the visit of extension officers from the export company?

_____ per week/month (*Enumerator: please delete as appropriate*)

II.2.4. How did you first enter into contract farming? *Enumerator: please ask the respondent how they accessed their various contracts for the first time and fill the table below accordingly.*

Access to contract farming	1 =Yes; 0= No
1. Approached by the company/exporter	
2. Approached by the producer organization	
3. You/your group approached the company/exporter	
4. Approached by the local extension/agriculture officer	
5. Through neighbours/neighbouring farmers	
6. Through an NGO or development agency	
7. Others (specify): _____	

II.2.5. Do you face challenges and problems under your contract farming situation? _____ (*Yes=1; No=0*) *Enumerator: If no challenges met, please proceed to the next question.*

Challenges met in contract farming	*1= Yes: 0= No*
1. Too high quality standards – Cannot comply	
2. High levels of rejection (due to quality etc.)	
3. Delays in input delivery	
4. Lack of cash advance	
5. Price uncertainty	
6. Delay in payment by the exporter	
7. Cannot sell all produce because of the market	
8. Delays in produce collection	
8. Others (specify): _____	
9. Others (specify): _____	

II.2.6. Have you subcontracted the production of some export crops during the **last agricultural year 2014 (March-September 2014 and October 2014-February 2015) and the current season?**

_____ (*Yes=1; No=0*) Enumerator*: If the answer is yes, please ask for the following details on these subcontracts in the table below. If no, please go to the next section.*

Crops	Total area subcontracted (in acres)	Share of the inputs given from those received in the contract farming (in %)	Total quantity subcontracted/received (in kg)	Total price given to the subcontracted (in TZS)
Agricultural year 2014 (March 2014-February 2015)				
Current season (March 2015-September 2015)				

3. Input and output

Please select two plots - one where the most exported crop is grown (if any – cf. section II.2.) and one where the vegetable you sell the most to your main local market (question II.1.6) is grown.

II.3.1. Please give the following information for these plots, **from preparing the crop until its harvest (crop season)**.

Inputs, activities and outputs	**Codes**	**Unit**	**Plot 1: _____**	**Plot 2: _____**
Crop cycle				
Number of times this vegetable is grown		Unit/year		
Length of the full growing cycle/season		Months		
Land endowment				
Total area *(use decimals)*		Acres		
Total harvested area *(use decimals)*		Acres		
Soil quality	Code 26			
Inputs				
Normal seeds - *Quantity*	Code 27			
Normal seeds - *Unit Value*		TZS/Unit		
Normal seeds - *Source*	Code 28			
Improved seeds - *Quantity*	Code 27			
Improved seeds - *Unit Value*		TZS/Unit		
Improved seeds- *Source*	Code 28			
Own manure- *Quantity*	Code 27			
Own manure - *Unit Value*		TZS/Unit		
Own manure - *Source*	Code 28			
Purchased manure - *Quantity*	Code 27			
Purchased manure - *Unit value*		TZS/Unit		
Purchased manure - *Source*	Code 28			
Chemical fertilizer - *Quantity*	Code 27			
Chemical fertilizer - *Unit Value*		TZS/Unit		
Chemical fertilizer - *Source*	Code 28			
Organic fertilizer- *Quantity*	Code 27			
Organic fertilizer- *Unit Value*		TZS/Unit		
Organic fertilizer- *Source*	Code 28			
Insecticide- *Quantity*	Code 27			
Insecticide- *Unit Value*		TZS/Unit		
Insecticide- *Source*	Code 28			
Fungicide- *Quantity*	Code 27			
Fungicide- *Unit Value*		TZS/Unit		
Fungicide- *Source*	Code 28			
Herbicide- *Quantity*	Code 27			
Herbicide- *Unit Value*		TZS/Unit		
Herbicide- *Source*	Code 28			

Stacking and roping - *Total Value*		TZS		
Stacking and roping - *Source*	Code 28			
Irrigation techniques	Code 29			
Irrigation cost- *Total Value*		TZS		
Electricity cost- *Total Value*		TZS		
Fuel cost- *Total Value*		TZS		
Machine and equipment rental- *Total*		TZS		
Land rental- *Total Value*		TZS		
Methods of land preparation	Code 30			
Output				
Number of harvesting rounds until replanting		Unit		
Output per harvest - *Quantity*	Code 31			
Total sales per harvest- *Quantity*	Code 31			
Total sales per harvest- *Value*		TZS		
Average price per unit		TZS/Unit		
Lowest price per unit		TZS/Unit		
Highest price per unit		TZS/Unit		
Is the price affected by the quality?	1= Yes; 0= No			
Quality of the product	1= Good; 0= Bad			
Consumption per harvest - *Quantity*	Code 31			
Losses - *Quantity*	Code 31			
Share of the losses - *Percentage*		%		
Causes of losses	Code 32			

Code 26: Soil quality
1=Excellent; 2= Good; 3= Average; 4= Poor; 5= Very poor
Code 27: Units of inputs quantity
1= Kgs; 2= Grams; 3= Litres; 4= Other (please specify).
Code 28: Source of seeds and inputs
1= Input dealer; 2= NGO; 3= Trader; 4= Fellow farmers; 5= Informal markets; 6= Exporting company; 7= Trader/collector; 8= Other (please specify).
Code 29: Irrigation techniques - *0= No irrigation; 1= Water pump; 2= Water tank; 3= Drip irrigation system; 4= Sprinkler; 5= Watering can; 6= Fallow; 7= Other (please specify).*
Code 30: Method of land preparation
1= Tractor; 2= Animal traction; 3= Manual
Code 31: Unit of output
1=Kg; 2= 50 kg bags; 3= 100 kg bags; 4= Debe tins (18-20 kgs); 5= 5 kgs tins; 6= bunch (specify weight); 7= pieces; 8= 15kg crates; 9= Other (please specify).
Code 32: Causes of losses
1=Birds/animals; 2= Insects; 3= Diseases; 4= Theft; 5= Other (please specify).

II.3.2. For the identified plots, please specify how often and by how many people **each time** the following operations are carried out **from preparing the crop until its harvest**. *Enumerator: to differentiate between male and female labourer, please use the letters "M" and "F" within the boxes (e.g. 3M; 2F).*

Plot 1: _____	**How many times?**	**No. days required each time**	**No. of hours per day**	**Number of family labourers each time**						**Number of hired labourers each time**						**Total hired labour cost per activity (in TZS)**
				-15	*15-17*	*17-24*	*25-34*	*35-60*	*60+*	*-15*	*15-17*	*17-24*	*25-34*	*35-60*	*60+*	
1. Land preparation																
2. Planting																
3. Gap filling																
4. Stacking and roping																
5. Weeding																
6. Irrigation																
7. Fertilizer/manure application																
8. Pest control																
9. Harvesting																
10. Packing																
11. Transportation																
12. Others : _____																

Plot 2: _____	**How many times?**	**No. days required each time**	**No. of hours per day**	**Number of family labourers each time**						**Number of hired labourers each time**						**Total hired labour cost per activity (in TZS)**
				-15	*15-17*	*17-24*	*25-34*	*35-60*	*60+*	*-15*	*15-17*	*17-24*	*25-34*	*35-60*	*60+*	
1. Land preparation																
2. Planting																
3. Gap filling																
4. Stacking and roping																
5. Weeding																
6. Irrigation																
7. Fertilizer/manure application																
8. Pest control																
9. Harvesting																
10. Packing																
11. Transportation																
12. Others : _____																

4. Transaction cost (last transaction)

II.4.1. Please provide the following information regarding **your last transaction for the same export crop as above and your last transaction for the same vegetable crops as above** (referred to in section II.3).
All information is at the sight of the last complete transaction for each crop.

		Export crop	Locally sold vegetable
When did this transaction take place? *Please write as follows: MM/YYYY*			
How much did you sell **(in kg)?** *Please convert it in Kg with the farmer*			
Who did you sell to? **(Code 33)**			
Total transaction costs (in TZS)			
Packing **(in TZS)**			
Transportation **(in TZS)**			
Loading and Off-loading **(in TZS)**			
Payments at checkpoint or road-block **(in TZS)**			
Personal transport to market and/or back **(in TZS)**			
Entry license fee at the market **(in TZS)**			
Intermediaries at the market **(in TZS)**			
Weighing fees **(in TZS)**			
Grading **(in TZS)**			
Phone and communication **(in TZS)**			
Others: _____ **(in TZS)**			
Others: _____ **(in TZS)**			
Was there any commission?	**%**		
	TZS		
Quantity wasted **(in kg)**			
Loss in the transaction **(in TZS)** (*e.g. deliver a higher amount than paid*)?			
Advance received **(in TZS)** *Write 0 if no advance received*			
Total revenue received for the transaction **(in TZS)**			
Payment modalities **(Code 34)**			
Transaction time **(in hours)** *(travel to the market/cold store; transaction and time on market/cold store; travel from the market/cold store to home)?*			
Distance **(in kms)** *(from home to the market)*			
Means of transportation **(Code 35)**			

Code 33: Market outlets
***Exporters**:*
1= Exporter 1; 2= Exporter 2; 3= Exporter 3; 4= Exporter 4
Traditional markets:
5= Local spot market; 6= Major green/fresh market; 7= Collector/trader
Local high-value markets:
8= To a restaurant, hotel, school; 9= To a supermarket; 10= To an agro-processing firm
Others:
11= To a farmer cooperative; 12= To a Kenyan importer/regional market; 13= Other (please specify).

Code 34: Payment modalities
1= Cash; 2= M-Pesa; 3= Cheque; 4= Kind (goods); 5= Other (please specify).

Code 35 : Means of transportation
1= Walk; 2= Bike; 3= Bus/Public transport; 4= Motorbike; 5= Car; 6= Truck; 7= Other (please specify).

Module 3. Labour and time allocation for the household

1. *Household general time and labour allocation*

III.1.1. Please provide the following details on your household´s members 'time allocation (**AVERAGE HOURS PER INDIVIDUAL PER WEEK**) during the **current season (March – September 2015)**. *Enumerator: please refer to the question I.1. to recreate the same list of household members.*

ID	Home			On-farm	Off-farm				School/Study	Leisure
	House care	*Fetching water/fuel*	*Care work*		*Agricultural wage work*	*Non-agricultural wage work*	*Self-employment*	*Looking for off-farm employment*		
Long rainy season (March - September 2015)										
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

2. <u>On-farm labour</u>

III.2.2. Please provide the following information on the **<u>average</u>** use of **<u>FAMILY AND HIRED LABOUR</u>** on your **<u>whole farm</u>**, based on the **<u>gender</u>** and **<u>age</u>** of the labourers, during the **last agricultural year 2014 (March-September 2014 and October 2014-February 2015)**:

1. Last short rainy season (October 2014 - February 2015)

	Average number of labourers per week		***Average hours per day per labourer***		***Average number of days/week per labourer***		***Average number of weeks per month per labourer***		***Number of months worked per labourer during the season***		***Average daily wage per labourer (in TZS)***		***Three main activities performed by these labourers (Code 36)***	
FAMILY LABOUR	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***
-15														
15-17														
17-24														
25-34														
35-60														
60+														
HIRED LABOUR														
-15														
15-17														
17-24														
25-34														
35-60														
60+														

Code 36: Main activities
1= Land preparation; 2= Planting; 3= Gap filling; 4= Stacking and roping; 5= Weeding; 6= Irrigation; 7= Fertilizer/manure application; 8= Pest control; 9= Harvesting; 10= Packing; 11= Transportation

2. Last long rainy season (March 2014 - September 2014)

	Average number of labourers per week		*Average hours per day per labourer*		*Average number of days/week per labourer*		*Average number of weeks per month per labourer*		*Number of months worked per labourer during the season*		*Average daily wage per labourer (in TZS)*		*Three main activities performed by these labourers (Code 36)*	
FAMILY LABOUR	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***	***Male***	***Female***
-15														
15-17														
17-24														
25-34														
35-60														
60+														
HIRED LABOUR														
-15														
15-17														
17-24														
25-34														
35-60														
60+														

Code 36: Main activities
1= Land preparation; 2= Planting; 3= Gap filling; 4= Stacking and roping; 5= Weeding; 6= Irrigation; 7= Fertilizer/manure application; 8= Pest control; 9= Harvesting; 10= Packing; 11= Transportation

III.2.3. What is the typical number of working hours per day? _____ hours/day

3. Off-farm labour and occupations

III.3.1. Please provide the following details on the **TWO main off-farm occupations** of **ALL** your **household´s members over 5** during **the last agricultural year 2014 (March 2014-February 2015):** *Enumerator: please refer to the question I.1. to recreate the list of household members.*

ID	Any off-farm work during the last agricultural year 2014? *1= Yes 2= No*	Type of off-farm occupation (Open-ended question)	Category of off-farm occupation (Code 37)	How many months worked in this job?	How many weeks per month in this job?	How many hours per week in this job?	What is the payment/wage received?		Time needed to reach the workplace			Type of arrangement (Code 40)
							Unit (Code 38)	*TZS*	*Unit* (Code 39)	*Quantity*	Distance (in kms)	
1												
1												
2												
2												
3												
3												
4												
4												
5												
5												
6												
6												
7												
7												
8												
8												

Code 37: Type of occupation
1= Wage job
2= Agricultural wage jobs on someone else´s farm
3= Self-employment
4= Self-employment with employees
5= Others: _____

Code 38: Time unit
1= Hour; 2= Day; 3= Week; 4= Month

Code 39: Transportation time
1= Minutes; 2= Hours

Code 40: Type of agreement
0= No agreement
1= Verbal arrangement
2= Short-term/seasonal contract
3= Long-term contract

Module 4. Land ownership and value

IV.1. Please provide the following details on the **current ownership and status of your land**:

	Acres	**Total Value (in TZS)**	**Is this land yours?** *1= Yes; 0= No*
How much total land do you own?			
How much of this land is titled?			
How much of this land is under customary law?			
How much of this land is currently under other forms of tenure?			
How much do you sharecrop with others?			

IV.2. Please provide the following details on your **land endowment** (**in acres**) at the given dates:

	Beginning (acres)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Total land own									
Area under titling									
Area under customary law									
Land under other forms of tenure									
Area share cropped									

IV.3. Please provide the following details on your participation in the land rental and sales markets in the past five years.

	2011		**2012**		**2013**		**2014**		**2015**	
	Acres	**Total value/Rent per year (in TZS)**	**Acres**	**Total value/Rent per year (in TZS)**	**Acres**	**Total value/Rent per year (in TZS)**	**Acres**	**Total value/Rent per year (in TZS)**	**Acres**	**Total value/Rent per year (in TZS)**
Area bought										
Area sold										
Area rented in										
Area rented out										

IV.4. Do you face any constraints to rent in/out or sell/buy land?

	1= Yes: 0= No
1. No constraints faced, I can buy/sell/rent land easily	
2. I cannot find land buyers/sellers	
3. The land tenure system constraints land transactions	
4. Others: _____	

IV.5. With whom are you usually engaged in land sales and rental markets (if any participation in these markets)?

	1= Yes: 0= No
1. Your neighbour (s)	
2. Fellow farmers from your producer organization	
3. Your family	
4. Others: _____	

Module 5. Income and consumption

1. *Household income and assets*

V.1.1. During the **LAST 12 MONTHS**, what were the sources of your whole household´s income?

Income Source	In TZS
Income from sales of vegetables to exporters	
Income from sales of vegetables to local markets	
Income from sales of non-vegetable crops	
Income from off-farm occupations	
Income from sale of aquaculture products	
Income from agricultural equipment rental	
Income from non-agricultural rental	
Pensions	
Remittances	
Income from State and NGO assistance	
Other sources: _____	

V.1.2. Do you own a…

Asset	Number	Year of last purchase	Asset	Number	Year of last purchase
Vehicle			Water or irrigation pumping set		
Own house			Tractor		
Bicycle			Harrow		
Refrigerator or freezer			Trailers for tractors etc.		
Television			Milking machine		
Telephone			Harvesting or threshing machine		
Video and DVD - Tapes			Mill		
Radio			Generator		
Beds			Truck		
Lanterns or lights			Coffee pulping machine		
Motorbike					

V.1.3. Please describe us your house:

Type of house (Code 41)	Ownership (Code 42)	Value (in TZS)	Monthly rent (in TZS) *Write 0 house owned*

Type of walls (Code 43)	Type of roof (Code 44)	Type of toilets (Code 45)	No. of living/sleeping rooms

Code 41: Type of house
1= House; 2= Flat; 3= Hut; 4= Other: ----------
Code 42: Ownership
1= Own house; 2= Rented; 3= Belongs to relative

Code 43: Type of walls
1= Brick/stones; 2= Wood; 3= Iron; 4= Mud; 5= Other: ____
Code 44: Type of roofs
1= Tiles; 2= Wood; 3= Metal; 4= Concrete; 5= Other: ____
Code 45: Type of toilets
1= Toilet; 2= Latrine; 3= No toilets; 4= Other: ____

2. *Household total and food consumption expenditures*[1]

V.2.1. What was the amount of your total household and food expenditures in **THE LAST DAY/WEEK/MONTH/YEAR**:

	Day	Week	Month	Year
All expenditures (in TZS)				
Market purchased food (in TZS)				

V.2.2. What was the **AVERAGE MONTHLY** amount spent by your household during the **LAST 12 MONTHS**:

All expenditures (in TZS)	
Market purchased food (in TZS)	

3. *Shocks*

V.3.1. Through **THE PAST FIVE YEARS,** have you experienced any shock? If yes, how would you assess their intensity?

	2010 **(Code 46)**	***2011*** **(Code 46)**	***2012*** **(Code 46)**	***2013*** **(Code 46)**	***2014*** **(Code 46)**	***2015*** **(Code 46)**
Major fire						
Flood/cyclone						
Drought						
Major theft						
Major crop disease						
Major animal disease						
Major illness in the family						
Deaths in the family						
Divorce/separation						
Other big shock :						

Code 46: Shocks
0= No shock
1= No effect
2= Light effect
3= Moderate effect
4 = Severe effect

[1] The structure of the questions V.2.1. and V.2.2. has been adapted from the questionnaire used in Christiaensen and Sarris (2007).

4. Access to credit

V.4.1. Do you usually use credit? _____ (*Yes=1; No=0*) *Enumerator: If the answer is yes, please fill the table below.*

V.4.2. Please provide the following information on your access and use of credit for **the last agricultural year 2014**:

Did you obtain credit in the past year? *1= Yes; 0= No*	If you cannot access credit, why is that? (Code 47)	Sources of credit (Code 48)	Reasons for borrowing money (Code 49)	Total amount borrowed? (in TZS)	Interest rates (in %)	Duration of credit (in months)

Code 47: Reasons for not getting credit
1= Lack of bank account; 2= Negative loans history; 3= Political/ethnical/religious reasons; 4= Lack of collateral; 5= High interest rates; 6= Negative perception of credit; 7= Other reasons: _____

Code 48: Sources of credit
1= Commercial Bank; 2= Cooperative and SACCOS; 3= Self-Help Group; 4= Main market outlet (supermarket; exporter, agro-processing firms); 5= NGO; 6= Government; 7= Input trader/dealer; 8= Friends/relatives; 9= Private moneylender; 10= Vicobas; 11= Others (please specify): _____

Code 49: Reasons for borrowing money
1= Food consumption; 2= Agricultural inputs; 3= Agricultural equipment; 4= Household items; 5= Payment of bills; 6= Health expenses; 7= Schooling; 8= Social activities; 9= Others (please specify): _____

Asante sana for your time and availability!

End time: _____ : _____

Georg-August-Universität Göttingen

GRK 1666 GlobalFood
ransformation of Global Agri-Food Systems

RTG 1666: GlobalFood - University of Göttingen
Small producer participation in high-value vegetables supply chains and effects on livelihoods in Tanzania

Follow-up questions with the export producer groups (2017)

Habari, my name is _____, I work with The World Vegetable Center. We are currently following-up on a survey performed in 2015 in collaboration with the University of Göttingen (Germany). In this context, we are asking a few questions to the leaders of the producer groups supplying the exporters and interviewed in the context of the aforementioned survey. We would very much appreciate if you would agree to participate in this follow-up effort and respond to the few questions below. The gathered information will be **strictly confidential**, serving a research purpose only. If you confirm your consent, shall we start?

Respondent identification and contact details:

6. Name of the producer group: _____
7. Name of the respondent (Surname, Middle name, First name):_____
8. Function of the respondent within the producer group: _____
9. Village: _____
10. Phone number: _____
11. E-mail address (if any): _____

Phone interview protocol:

4. Enumerator: _____
5. Date: _____ /_____ /2017

1a. Is your producer group still supplying one of the vegetable exporters in the area? ____ (*Yes/No)*
Enumerator: If the answer to this question is yes, please go to question 1b; if the answer is no, please go directly to the question 1c.

1b. *If yes*, which exporter(s) is your producer group currently supplying? Are you planning on keeping supplying them?

	Currently supplying this exporter *1= Yes; 0= No*	**Planning on keeping supplying the exporter** *1= Yes; 0= No*
Exporter 1		
Exporter 2		
Exporter 3		
Exporter 4		
Other: _____		

1c. *If not*, when did you stop supplying the respective exporter(s)? For which reasons?

	Stopped supplying the exporter in: *MM/YYYY*	**Reasons for stopping supplying the exporters** *Code 1 (Multiple answers possible)*	**Other reasons** *Open question*
Exporter 1			
Exporter 2			
Exporter 3			
Exporter 4			
Other: _____			

Code 1: Reasons for stopping supplying the exporters
1= Could not comply with the quality standards; 2= High-levels of rejection; 3= Delays in input delivery; 4= Lack of credit and cash advance; 5= Price uncertainty; 6= Low Price; 7= Delay in payment by exporters; 8= Delays in produce collection; 9= Lack of trust towards the exporter; 10= Others (please specify this in the column on the right)

The next questions should be asked if the respondent replied "Yes" at the question 1a.

2. If you are still supplying the exporters, how many members from your producer groups are currently producing French beans or snap peas for exporters? _____ producers

3a. If you are still supplying the exporters, have the contract arrangements changed, in comparison to 2015? _____ (*Yes/No).*

3b. Could you please provide more details on the current contract arrangements with the exporters?

Inputs currently provided by the exporter:

	Inputs provided *Code 2 (Multiple answers possible)*	**Seeds price** *in TZS (Please include the unit)*	**Fertilizers price** *in TZS (Please include the unit)*	**Pesticides price** *in TZS (Please include the unit)*
Exporter 1				
Exporter 2				
Exporter 3				
Exporter 4				
Other: _____				

Code 2: Inputs provided by the exporters
1= Seeds; 2=Fertilizers; 3= Pesticides; 4= Others (Specify)

Services currently provided by the exporter:

	Agricultural extension services *1= Yes; 0= No*	**Management training** *1= Yes; 0= No*	**Credit** *1= Yes; 0= No*	**Produce collection** *1= Yes; 0= No*	**Others** *Please specify*
Exporter 1					
Exporter 2					
Exporter 3					
Exporter 4					
Other: _____					

Current arrangements on the price of the produce and its determination:

	Price determination *Code 3*	**Timing of payment** *in weeks after delivery*	**Current price** *in TZS/kilogramme*
	French beans		
Exporter 1			
Exporter 2			
Exporter 3			
Exporter 4			
Other: _____			
	Snap Peas		
Exporter 1			
Exporter 2			
Exporter 3			
Exporter 4			
Other: _____			

Code 3: Price agreement
1= Fixed for a specific season; 2= Floating

3c. If there were any changes, could you please describe in a few words how these changes were prompted and the negotiation process? For example, did you as a group prompt these changes and which bargaining leverages were used? *(Open question)*

4a. Do you currently face some challenges in supplying the exporters? _____ (*Yes=1; No=0*).
Enumerator: If the answer to this question is no, please go directly to the question 5.

4b. *If yes*, which one?
Enumerator: please indicate these challenges in the table below, depending on the referred exporter.

	Exporter 1 *1= Yes; 0= No*	**Exporter 2** *1= Yes; 0= No*	**Exporter 3** *1= Yes; 0= No*	**Exporter 4** *1= Yes; 0= No*	**Other** *1= Yes; 0= No*
1. Cannot comply with the quality standards					
2. High levels of rejection					
3. Delays in input delivery					
4. Lack of cash advance					
5. Price uncertainty					
6. Delay in payment by the exporter					
7. Cannot sell all produce because of market					
8. Delays in produce collection					
9. Others: _____					

5. In your view, what are the main advantages of supplying the exporters? What are the main sources of satisfaction?
Enumerator: Please indicate these advantages in the table below, depending on the referred exporter.

	Exporter 1 *1= Yes; 0= No*	**Exporter 2** *1= Yes; 0= No*	**Exporter 3** *1= Yes; 0= No*	**Exporter 4** *1= Yes; 0= No*	**Other** *1= Yes; 0= No*
1. Stable and reliable 2. outlet					
3. Higher prices					
4. Price stability					
5. Facilitation to access to credits					
6. Facilitation to access to inputs					
7. Closer market outlet					
8. Trust relationship with the exporter					
9. Lack of access to other exporters					
10. Others: _____					

6. *To the enumerator*: Please feel free to add any other comments or element that you deem useful to understand the dynamics of this producer organization's interactions with the exporters:

Asante sana!

DECLARATIONS

1. I, hereby, declare that this Ph.D. dissertation has not been presented to any other examining body either in its present or a similar form.

   Furthermore, I also affirm that I have not applied for a Ph.D. at any other higher school of education.

   Göttingen, ...

   .....
   (Signature)

   .....
   (Name in block capitals)

2. I, hereby, solemnly declare that this dissertation was undertaken independently and without any unauthorised aid.

   Göttingen,.....

   .....
   (Signature)

   .....
   (Name in block capitals)