Zentrum für Entwicklungsforschung
Center for Development Research
University of Bonn

ZEF-Discussion Papers on
Development Policy No. 189

Beatrice W. Muriithi and Julia Anna Matz

Welfare Effects of Vegetable Commercialization: Evidence from Smallholder Producers in Kenya

Bonn, April 2014

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Beatrice W. Muriithi and Julia Anna Matz, Welfare Effects of Vegetable Commercialization: Evidence from Smallholder Producers in Kenya, ZEF-Discussion Papers on Development Policy No. 189, Center for Development Research, Bonn, April 2014, pp. 27.

ISSN: 1436-9931

Published by:
Zentrum für Entwicklungsforschung (ZEF)
Center for Development Research
Walter-Flex-Straße 3
D – 53113 Bonn
Germany
Phone: +49-228-73-1861
Fax: +49-228-73-1869
E-Mail: zef@uni-bonn.de
www.zef.de

The authors:
Beatrice W. Muriithi, Center for Development Research (ZEF). Contact: muriithi@uni-bonn.de, beatomuriithi@yahoo.com
Julia Anna Matz, Center for Development Research (ZEF). Contact: jmatz@uni-bonn.de

Acknowledgements

The authors would like to thank particularly Joachim von Braun for his advice and support. Beatrice W. Muriithi gratefully acknowledges financial support from the German Academic Exchange Service (DAAD) and Dr. Hermann Eiselen, Doctoral Program of the Foundation Fiat Panis. Our gratitude extends to the International Centre for Insect Physiology and Ecology (ICIPE) for providing the data for 2005, thereby enabling the construction of a panel dataset, and to the individual farmers who participated in the field survey interviews. An earlier version of the paper was presented at the Spring Meeting of Young Economist (SMYE 2013) at Aarhus, University of Denmark, and at the 4th International Conference of the African Association of Agricultural Economists in Hammamet, Tunisia. We are grateful for the helpful comments from participants at these meetings and at research seminars at the Center for Development Research (ZEF), University of Bonn.

Abstract

We investigate the impact of smallholder vegetable commercialization through the export and domestic market channels on household income and assets in Kenya. We use a survey panel dataset, which allows us to control for unobserved heterogeneity across households, and show that the commercialization of vegetables through both market channels contributes positively to welfare, even when addressing the issue of selection into commercialization. While the production of vegetables for the export market is consistently associated with income in a positive way, the results for asset holdings as the measure of household welfare are weaker and supportive only for the domestic market channel, which weakens the notion of smallholder commercialization being a “pro-poor” strategy.

Keywords: horticulture, commercialization, welfare, poverty, smallholders, Kenya

JEL classification: O12, O13, Q13, Q17

1. INTRODUCTION

The commercialization of smallholder agriculture is often viewed as an opportunity for economic growth and development for less-developed countries whose economies depend on agriculture to a large extent (von Braun *et al.*, 1994; Pingali & Rosegrant, 1995; Pingali, 2007). To set an example, horticulture, especially with respect to high-value crops, has been identified as one of the fastest growing agricultural sub-sectors in Sub-Saharan Africa in the past two decades (Gioè, 2006; Afari-Sefa, 2007; Henson & Jaffee, 2008). Furthermore, Kenyan horticultural exports have increased at impressive rates of 10-15% per annum between 2000 and 2008 (GoK, 2010; GoK, 2012). As a result of this remarkable growth, policy makers, donors, and researchers understand growth of the sub-sector as a viable "pro-poor" rural development strategy, assuming that the growth reaches rural smallholders, the majority of whom are involved in horticulture (GoK, 2007). Testing the validity of this notion by investigating the impact of vegetable commercialization on household welfare, measured both by income and by asset ownership, is the aim of this study.[1]

The perception of smallholder horticultural commercialization as a means of reducing poverty at the household-level is supported in the literature (e.g. McCulloch and Ota, 2002; Asfaw, 2008; Neven *et al.*, 2009; Rao & Quim, 2011), and positive income effects of the commercialization of high-value export crops have also been found for Senegal (Maertens and Swinnen, 2009), Ghana (Afari-Sefa, 2007), and Zimbabwe (Henson *et al*., 2005). The limitation of these existing studies is that they mostly use cross-sectional data, which prohibits controlling for unobserved characteristics of farmers that do not change over time, for example, and that they typically focus on export-oriented market participation, thereby neglecting commercialization through the domestic market. Empirical studies using panel data or measuring the extent to which the horticultural sub-sector impacts on rural poverty based on welfare outcomes other than income are non-existent to the best of our knowledge. To examine the potential of horticultural farming as a pro-poor rural development strategy, consistent estimation of the livelihood impacts of smallholder commercialization is necessary, for which issues arising from the participation in commercialization being a choice need to be addressed, which we attempt to do in this study. The extent to economic gains from smallholder commercialization reach the rural

poor and whether the sub-sector can act as the basis of an effective pro-poor strategy in Kenya is, thus, still to be determined. This is particularly important for a country like Kenya, where, despite agriculture predominantly occurring in rural areas and acting as the backbone of the economy, poverty is widespread with just under half of the rural population living below the poverty line (IMF, 2012).

Despite the widespread positive reputation of smallholder commercialization as a means to reduce poverty, there are also less optimistic views. A first concern is that smallholder farmers are being pushed out of the horticultural business. With the increasing integration of developing countries in global trade, non-tariff barriers such as food quality and safety standards are becoming increasingly constraining for small producers as compliance may be too costly (Dolan & Humphrey, 2000; Jaffee, 2003; Henson & Reardon, 2005; Okello, 2005; Jaffee *et al.*, 2005; Muriithi *et al*., 2010a). In line with this, exporters are shifting away from smallholder contract farming to large-scale producers or diversifying their own agribusinesses into crop production (Adekunle *et al*., 2012; Graffham *et al*., 2007; Okello *et al*., 2007; Maertens & Swinnen, 2009). The modern vegetable marketing channels in the domestic market are also presenting challenges to smallholder farmers (Neven & Reardon, 2004) as, similarly to the international market, domestic supermarkets have established stringent food safety standards (Neven *et al.*, 2009). Alternative market pathways for smallholders are traditional supply chains that are highly uncoordinated and provide returns that are low in comparison (Muendo & Tschirley, 2004). Further constraints regarding the commercialization of smallholder horticulture include the lack of physical infrastructure (information technology, roads, markets); high marketing risks and transaction costs; the lack of access to credit, production technologies such as high yield crop varieties, affordable fertilizer, post-harvest processing equipment, and irrigation infrastructure; and high production costs (Jaffee, 2003; Adekunle *et al*., 2012).

In addition, competition in the international market is increasing, especially from North Africa and South America, where horticultural production costs are often lower due to subsidized farm inputs (Adekunle *et al*., 2012). Similarly, since early 2011, a high influx of horticultural produce into the regional market from neighboring countries such as Tanzania and Uganda, where production costs are lower, has been observed (USAID, 2011; GoK, 2012). The high production costs in Kenya are partially due to the reliance on imported chemical fertilizer, whose price has risen sharply over the last decade (Gitau *et al*., 2012),

and to increasing labor costs due to inflation. Despite the growing demand for horticultural produce due to population growth, smallholder market participation is decreasing. For these reasons, the gains from the commercialization of horticulture may be limited, especially for smallholder farmers, thus, weakening the notion of horticulture being a pro-poor rural development strategy.

We contribute to the existing literature by employing panel survey data on rural smallholder farmers, thereby enabling us to control for unobserved heterogeneity across farmers. Furthermore, we address the problem of potential self-selection into the production of vegetables for commercial purposes in a suitable framework. Overall, we find positive effects of commercialization on household welfare, particularly of participation in the export market channel on income, and of the domestic market channel on asset holdings. While the latter are less robust, our results are generally very stable across specifications and different measures of commercialization. Interestingly, we find evidence for selection being an issue in our attempt to identify the causal effect for commercialization through the domestic market channel only.

The article proceeds as follows: Section 2 describes the data and provides descriptive statistics for the producers of vegetables for the domestic and export markets. We outline our empirical strategy including different specifications in Section 3. Section 4 presents the results, Section 5 concludes.

2. DATA AND DESCRIPTIVE STATISTICS

Survey and sample description

We employ panel household survey data for 2005 and 2010 collected in five districts of the major vegetable producing provinces in Kenya (Nyeri, Kirinyaga, and Murang'a of the Central Province, and Meru and Makueni of the Eastern Province) (Asfaw, 2008). These districts represent approximately 50% of the smallholders that produce vegetables for the export market (Mithofer *et al*., 2008) and also have the highest levels of horticultural commercialization for locally consumed vegetables (Sindi, 2008). The districts are endowed with a generally favorable climate for horticultural production, but differ in the intensity and type of vegetable crops being produced, agro-ecological characteristics, and accessibility (Asfaw, 2008). Three hundred and seventy households of the 539 households that were

surveyed in 2005/06 by the International Center for Insect Physiology and Ecology (ICIPE) were randomly selected and revisited in 2011 by one of the authors to collect data referring to 2010.[2] As we use only the balanced panel, we therefore exploit information on a sample of 309 households that were successfully interviewed. Similarly to the 2005 survey, the 2010 questionnaire gathers information on the production and marketing of vegetables, on agricultural production, household demographics, land use, household assets including livestock and agricultural assets, off-farm income, remittances, on market access and characteristics of vegetables markets by type, access to credit, and membership in farmers' groups.

We distinguish between the contribution of export vegetable crops and domestic vegetable crops to household income rather than entirely focusing on either market. Therefore, we classify households according to which market they produce vegetables for and, thus, according to which channel they commercialize through – the export market, the domestic market, or both jointly.[3] The contribution of income obtained from vegetables sold through the traditional market to household welfare have largely been ignored in past studies that place greater emphasis on export market vegetables (e.g. McCulloch & Ota, 2002) or on those for modern domestic supply chains, i.e. domestic supermarkets (e.g. Rao & Qaim, 2011). Figure 1 shows the fraction of households in each category out of the total sample.

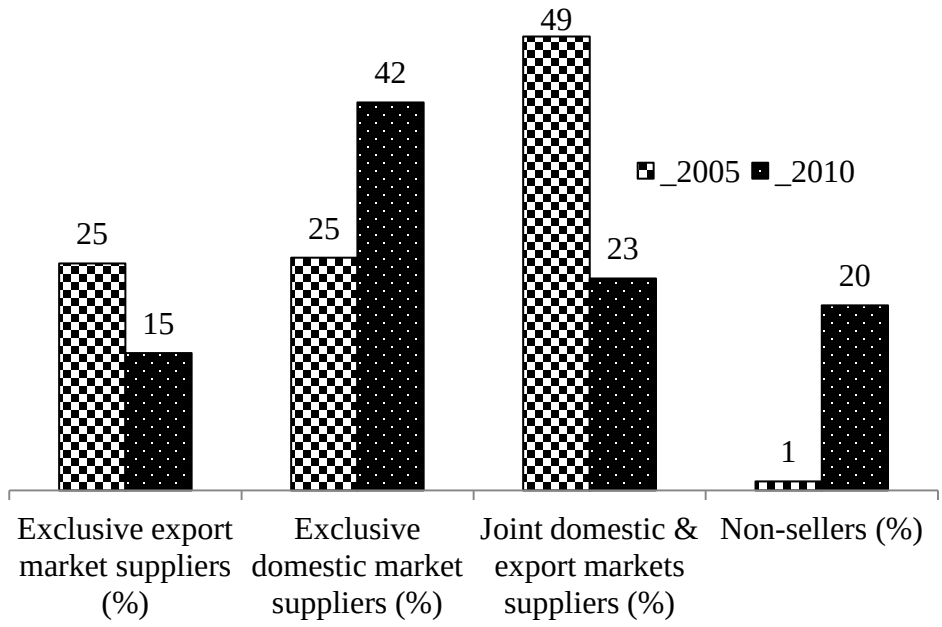

Figure 1: Sample households by market pathway and survey year

Farm and household characteristics

Table 1 compares households producing vegetables exclusively for the export market to those producing for the domestic market. We begin by examining the two household welfare outcomes of interest in this study: per adult equivalent (AE) income and per AE asset holdings. Annual household income comprises income from crops, livestock, business activities, and remittances of all household members, with agriculture contributing the largest share of about 80% to total household income. Asset holdings are measured with an index that is constructed using Principal Component Analysis (PCA) following Rutstein and Johnson (2004), Irungu (2002), Henry *et al*. (2003), and Zeller *et al.* (2006). The assets that are important in the study area and therefore included are livestock assets of all types, agricultural assets, productive durables, consumer durables, and dwelling assets.[4] Due to the lack of monetary values, the construction of the asset index is based on binary ownership indicators for each asset with the exception of livestock, which is measured in tropical livestock units. None of the differences in income per adult equivalent units, household assets, or asset ownership per AE between producers for the export and domestic markets is statistically significant. However, per AE income shows an upward trend between the two survey rounds while the per AE asset index follows an opposite trend. Vegetable sales contribute substantially to household income, but the share of income from vegetable production in total household income decreased significantly between 2005 and 2010 as indicated by the horticultural commercialization indices (HCIs).

With respect to demographic characteristics, export market suppliers have younger household heads than domestic market suppliers, with the difference being statistically significant in 2005 only. A possible reason is that young farmers may be more likely to adopt risky and labor-intensive farm enterprises such as high-value vegetables. Moreover, household heads are mostly male across both market channels although the ratio is slightly higher among producers for the export market but the difference is statistically significant in 2010 only. None of the other demographic characteristics like education of the head, household size, or the dependency ratio yield a statistically significant difference.

Export market suppliers own less land on average than domestic market suppliers but the difference is statistically significant in 2010 only. While neither of the differences of the area of cultivated land is statistically significant, producers for the export market are more likely to own fertile land than producers for the domestic market, at least in 2010.

Table 1: Selected household characteristics

		2005				*2010*				*Diff. (export-domestic)*	
		Export		Domestic		Export		Domestic			
Variable	Description	(n=76)		(n=78)		(n=46)		(n=130)		2005	2010
		Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Income	Annual household income ($)	1887	1706	1702	2884	3659	5001	2520	2470	184	1139**
Per AE income	Per adult equivalent income ($ per day)	1.4	1.4	1.3	2.9	2.0	2.5	1.9	4.7	0.11	0.09
Household asset	Household asset index	3.569	0.833	3.557	0.787	3.740	0.917	3.876	0.665	0.01	-0.14
Per AE asset	Per adult equivalent asset index	0.973	0.521	1.010	0.815	0.963	0.772	0.984	0.825	-.037	-0.02
Head age	Age of household head (years)	43.3	10.2	50.1	13.0	47.9	12.3	51.1	12.2	-6.78***	-3.25
Male head	Gender of household head (binary: 1=male*)*	0.9	0.2	0.9	0.3	1.0	0.1	0.9	0.3	0.011	0.09*
Head education	Years of schooling of household head	8.8	3.0	8.2	3.9	8.5	2.7	8.9	3.9	0.66	-0.38
Household size	Household size in adult equivalent units	4.4	1.9	4.7	2.3	5.0	2.3	5.3	2.3	-0.31	-0.3
Dependency	Dependency ratio	2.1	11.4	1.9	11.3	1.3	0.6	1.4	0.9	0.14	-0.05
Owned land	Total land owned (acres)	3.50	4.24	3.55	7.08	1.89	1.99	3.02	3.28	-0.51	-1.13**
Cultivated land	Land cultivated (acres)	2.28	1.81	2.27	3.41	1.82	1.99	2.17	1.99	0.012	-0.36
Land fertility	Fertile land (binary: 1=yes*)*	0.38	0.48	0.33	0.47	0.43	0.50	0.30	0.46	0.048	0.13*
Off-farm	Off-farm employment (binary: 1=yes*)*	0.36	0.48	0.49	0.50	0.13	0.34	0.24	0.43	-0.13*	-0.11
Business	Ownership of business (binary: 1=yes*)*	0.13	0.34	0.21	0.41	0.41	0.50	0.42	0.49	-0.07	-0.002
Remittances	Remittances (binary: 1=yes*)*	0.26	0.44	0.18	0.39	0.20	0.40	0.40	0.49	0.08	-0.20*
Credit	Credit (binary: 1=yes*)*	0.42	0.50	0.12	0.32	0.80	0.40	0.42	0.50	0.31***	0.38***
Shock	Experienced an economic shock in past year (binary: 1=yes*)*	0.39	0.49	0.47	0.50	0.35	0.48	0.47	0.50	-0.08	-0.12
Rainfall	Total annual rainfall (mm, lagged)	1113.9	147.4	1138.1	90.82	1034.9	24.45	1011.47	95.16	23.2	23.43
Rainfall CoV	Covariance of variation of rainfall (%)	57.8	6.45	52.9	8.34	56.60	5.96	54.08	6.73	4.9	2.52
HCI_1_export (%)		46.9	28.4			28.71	22.8				
HCI_1_domestic (%)				24.0	26.1			26.6	26.8		
HCI_2_export (%)		62.3	30.9			55.73	35.6				
HCI_2_domestic (%)				40.7	33.3			59.7	39.2		
HCI_3_export (%)		98.6	9.3			93.75	11.5				
HCI_3_domestic(%)		-	-	96.6	13.3	-	-	75.5	21.9		

Notes: Significant at 1% (***), 5% (**), 10% (*). The tests for equality of means are based on unpaired data with unequal variances and on households involved in the production for either the export or the domestic market exclusively.
HCI_1= [Vegetable sales of household *i* in year *t*/ Total household income of household *i* in year *t*]*100
HCI_2= [Vegetable sales of household *i* in year *t* / Total crop sales of household *i* in year *t*]*100
HCI_3= [Vegetable sales of household *i* in year *t* / Total value of vegetable crops produced of household *i* in year *t*]*100
Source: Authors' calculations based on the survey data.

Our summary statistics show, furthermore, that a higher proportion of domestic market suppliers is engaged in off-farm employment and small businesses than export market suppliers, while the only statistically significant difference is found for *Off-farm* in 2005. While producers for the domestic market are more likely to receive remittances in 2010, producers for the export market report statistically significantly higher annual household income in the same year, which is in line with McCulloch and Ota (2002). Interestingly, producers of vegetables for the export market are statistically significantly more likely to have received a loan in the 12 months prior to the survey (*Credit*) than producers of vegetables mainly sold through the domestic market channel. Weather shocks and weather risk are observed as important determinants of fluctuations in farm income according to Hertel and Rosch (2010). They are measured in this study as annual rainfall during the year prior to the survey (*Rainfall)* and as the variability of rainfall during the year of the survey (*Rainfall CoV*), respectively.

While the national figures show an increasing trend in the volume of vegetables produced in the country, and especially those for the export market (GoK, 2010), the picture looks different among the smallholders in our sample. Figure 1, for example, displays a decrease in the number of households specializing in the production of vegetables for the export market or supplying both markets jointly, and a simultaneous increase in the number of suppliers for the domestic market. The majority of farmers exiting from the horticultural business entirely were also producers of vegetables for the export market. Further evidence supporting the decline of commercialization, especially through the export market channel, is given by the Horticultural Commercialization Indices. The share of income derived from export market sales in total household income (*HCI_1_export*) decreased from 46.9% in 2005 to 28% in 2010. Similarly, the share of income derived from export market sales out of total crop sales (*HCI_2_export*) and out of the total value of vegetable crops (*HCI_3_export*) decreased over the same period. The contribution of vegetable sales from the domestic market indicates a positive trend, on the other hand. For instance, the share of vegetable income from domestic markets out of total household income (*HCI_1_domestic)* increased from 15.3% in 2005 to 19.7% in 2010. While the share of income from vegetables sold through the domestic market channel out of total crop sales increased during the period, the share out of the total value of vegetable crops produced declined, surprisingly. The shift towards the domestic market may be motivated by a larger market potential of locally consumed

vegetables, especially in urban areas due to population growth and also due to an increase in the demand for vegetables in the regional market, as is the case for carrots in Uganda according to USAID (2011).

On the other hand, the decline in the number of households participating in the export market may be attributed to a number of factors: an increasing number of regulations in the international market, especially regarding food safety and quality, such as GlobalGap as observed by Muriithi *et al.* (2010); increased uncertainty in the international market, for example due to the global financial crisis in 2008 during which the volume of exported vegetables and other products plummeted (HCDA, 2009); and food price spikes in the recent past that may have shifted the focus of rural producers to the production of food crops, not only to cope with the unexpected food shortage, but also to benefit from high prices from the sale of their produce, for example maize. Other possible factors that may be driving smallholder producers out of the production for the export market are related to the increasing costs of inputs: labor costs (wage rates of unskilled labor have increased by about 30% between 2005 and 2010 according to our data), fertilizers, pesticides, and other chemicals (Gitau *et al.*, 2012; Adekunle *et al*., 2012).

3. ESTIMATION STRATEGY

In any given year the choice of a household to participate in commercialization or not will be determined by its expected utility associated with either option. We argue that the participation in vegetable commercialization has important positive marginal effects on household income and wealth besides the direct influx of income from this activity, but also indirectly due to established market access, possibly higher prices of produce, and better access to technologies, including use of inputs.

To start with, suppose commercialization of horticulture is exogenous, i.e. the choice to produce vegetables for sale is independent of material well-being and there are presumably no factors that simultaneously affect commercialization and household welfare. We, thus, use ordinary least squares (OLS) to estimate the following equation:

$$Y_{idt} = \theta_t + \gamma_1 Exp_{idt} + \gamma_2 Dom_{idt} + \mathbf{X}_{idt}\boldsymbol{\beta} + Dist_d + \upsilon_{idt} \quad (1)$$

where Y_{idt} is a measure of household welfare for household *i* in district *d* at time *t*: the asset index per adult equivalent (*per AE assets*) or income per adult equivalent and day (*per AE*

income). Exp is a measure for commercialization through the export channel and Dom for commercialization through the domestic channel. Both measures may be binary indicators for participation or continuous variables in the form of a HCI depending on the specification. Note that households that supply both markets are included in the analysis and therefore used to estimate both the effects of commercialization through the export and domestic markets. The parameter θ denotes a time-varying intercept; *Dist* controls for unobserved heterogeneity across districts, and υ is a statistical error term and assumed to be uncorrelated with the explanatory variables in this specification.

Explanatory variables included in $\mathbf{X}$ that are likely to affect household welfare comprise household demographics such as the gender, age, and education of the household head, the dependency ratio, and household size. A high dependency ratio is often associated with lower asset ownership and households with heads that are more educated are likely to have more assets and higher per AE income than those with less educated ones. Further explanatory variables are related to the diversity of household income sources as rural households that have access to off-farm income activities can use them to smooth fluctuations in crop income (Fafchamps *et al.*, 1998) and other non-farm income sources such as businesses and remittances are important means of *ex-ante* diversification (Reardon & Berdegué, 2002). Land endowments (size and quality) are important control variables for obvious reasons when looking at the effects of vegetable production. Annual rainfall during the year prior to the survey and the variability of rainfall (CoV) during the year of the survey are included to capture weather shocks and risk, respectively, aspects which have been ignored in earlier studies on the impacts of horticultural commercialization on household income (e.g. McCulloch & Ota, 2002; Omiti *et al.*, 2007). In addition, a binary variable indicating whether a household experienced any economic shocks between 2005 and 2010, such as droughts or floods, loss of employment, loss of the major income earner, or other non-natural shocks is included among the covariates.

We hypothesize that the commercialization of horticulture through either of the two market pathways has positive effects on the outcome variable and thus expect γ_1 and γ_2 to be positive and statistically significant. However, the estimates of γ_1 and γ_2 would be biased if commercialization was not exogenous, which is a valid concern. For example, households with more resources or those that possess better skills, capabilities, and motivation (which are all likely to also affect household welfare) may decide to participate in the

commercialization of certain vegetables and thereby self-select into commercialization through the export market pathway, while those with fewer resources may be more likely to be active in the domestic market. If this is true, the effect of commercialization through the export market found with the help of Eqn. (1) will be overestimated. Second, there may be geographical selection because farmers who are more distant to the market face higher transaction costs of delivering their produce to the market as do traders who buy from such farmers, and location may itself be correlated with household welfare as well.

Leaving behind the assumption of commercialization being exogenous, we follow two empirical approaches exploiting the panel nature of our data: standard fixed (within) effect regression estimation and a fixed effect specification corrected for potential self-selection. Beginning with the standard fixed effects specification; we amend Eqn. (1) as follows:[5]

$$Y_{it} = \theta_t + \gamma_1 Exp_{it} + \gamma_2 Dom_{it} + \mathbf{X}_{it}\boldsymbol{\beta} + M_i + \mu_{it} \quad (2)$$

where *M* controls for the unobserved heterogeneity across households.

Due to potential selection into commercialization and the resulting bias, the causal relationship between participation in the commercialization of horticulture and household welfare may be over- or underestimated as discussed above. To address this issue, we employ a framework similar to Heckman's two-stage estimation. It involves estimating a selection equation for commercialization using a Probit model:

$$\Pr(Comm_{ijt} = 1 \mid \mathbf{Z}_{it}) = \phi(\mathbf{Z}_{it}\psi_t) \quad (3)$$

where $\mathbf{Z}$ contains $\mathbf{X}$ and additional variables that affect commercialization through market channel *j*, which may be the domestic or the export one, but not household welfare Y, which is what identification of the causal effect hinges on. Transaction costs generally affect the decision to commercialize but not necessarily household welfare so we use measures of transaction costs to identify the commercialization decision. These variables include the use of extension services, years of farmer group membership, distance to the market and condition of the road, all of which are proxies for the access to information, and the price of important vegetable crops in the study area. Price variables are included as a proxy for market price information in conjunction with other market characteristics following Heltenberg and Tarp (2002); we include the prices of French beans, snow peas, potatoes, and cabbage. [6]

From Eqn. (3), we obtain an inverse Mills ratio $\hat{\lambda}$ for each market pathway and year. The Mills ratios are then included in Eqn. (2) to control for possible self-selection into each commercialization pathway, which is then estimated using household fixed effects, such that:

$$Y_{it} = \theta_t + \gamma_1 Exp_{it} + \gamma_2 Dom_{it} + \zeta_1 \hat{\lambda}_{itExpo} + \zeta_2 \hat{\lambda}_{itDom} + \mathbf{X}_{it}\boldsymbol{\beta} + M_i + \mu_{it}. \quad (4)$$

The estimation results of the outlined specification for our data of rural smallholder farmers are presented in the following section.

4. RESULTS

To investigate the effects of commercialization on household welfare we employ four different measures of commercialization for both the export and domestic market each: A binary variable denoting participation and the three horticultural commercialization indices presented above. Table 2, for example, displays the estimated coefficients for the binary variables denoting participation in the export and domestic markets in panel [1]. Similarly, panels [2], [3], and [4] present the results for *HCI_1*, *HCI_2*, *HCI_3*, respectively, all differentiated by the type of market. In order to test the poverty effects of vegetable commercialization, all specifications are separately estimated for a sub-sample of households whose income per AE and day was below the standard poverty line of 1.25 US-dollars in 2005 in addition to estimation on the full sample.

Naïve OLS Estimation

The naïve OLS estimates corresponding to Eqn. (1) are presented in Table 2. We find all measures of the commercialization of horticulture through the export market channel to yield a positive and statistically significant coefficient for per AE income, both for the total sample in column (1) and for the originally poor sub-sample in column (3). Interestingly, the magnitude of the impact is nearly identical in the total and reduced samples. With respect to the binary measure of participation, households that commercialize through the export market channel are found to have incomes per day and AE that are 40% to 42% higher, which is a sizeable effect. Regarding the commercialization indices, holding other variables constant, per AE income for a household commercializing through the export market

increases by 0.5% for every 1% point-increase in income generated from export vegetables out of total household income (*HCI_1_export*) or out of total crop sales (*HCI_2_export*), and by 0.7% for every 1% point-increase in income generated from export vegetables out of the total annual value of vegetables produced (*HCI_3_export*). Columns (2) and (4) present the estimation results for per AE assets as the measure of household welfare in the total and poor sub-sample, respectively. There is only very limited evidence of a relationship with commercialization through the export market: The only statistically significant coefficient is positive but rather small and found for *HCI_3* in the total sample.

Table 2: Naïve OLS estimates

		Total sample		*Households poor in 2005*	
		ln(per AE income)	*ln(per AE asset index)*	*ln(per AE income)*	*ln(per AE asset index)*
		(1)	*(2)*	*(3)*	*(4)*
[1]	Export (binary)	0.396***	0.001	0.421***	-0.011
		(0.080)	(0.0228)	(0.092)	(0.0285)
	Domestic (binary)	0.130	0.033	0.181*	0.049
		(0.082)	(0.0248)	(0.099)	(0.0324)
	R-squared	0.386	0.806	0.31	0.7806
[2]	HCI_1_export	0.005**	0.00002	0.005**	-0.00003
		(0.002)	(0.0005)	(0.002)	(0.0006)
	HCI_1_domestic	0.0002	0.0007	0.001	0.0009
		(0.002)	(0.0005)	(0.002)	(0.0007)
	R-squared	0.368	0.806	0.2788	0.7796
[3]	HCI_2_export	0.005***	0.0002	0.004**	-0.00004
		(0.001)	(0.0004)	(0.002)	(0.0005)
	HCI_2_domestic	0.003*	0.001**	0.002	0.0007
		(0.001)	(0.0005)	(0.002)	(0.0006)
	R-squared	0.373	0.808	0.2803	0.7801
[4]	HCI_3_export	0.007***	0.0007*	0.007***	0.0007
		(0.002)	(0.0004)	(0.002)	(0.0005)
	HCI_3_domestic	0.005***	0.001***	0.004**	0.0012**
		(0.002)	(0.0004)	(0.002)	(0.0006)
	R-squared	0.38	0.81	0.3024	0.7825
	N	618	618	392	392

Notes: Significant at 1% (***), 5% (**), 10% (*). Robust standard errors in parentheses. The sub-sample of households used in columns (3) and (4) consists of households whose real income per AE and day in 2005 was below 1.25 US-dollars.

Commercialization through the domestic market channel only in some cases exhibits a positive and statistically significant relationship with per AE income. Participation in the domestic vegetable market is associated with per AE income that is 18% higher in the poor sub-sample in column (3) only, all other things equal. Compared to commercialization

through the export market, it is also with respect to the HCIs that the effects of domestic commercialization are somewhat smaller, conditional on being statistically significant. Specifically, a 1% point-increase in *HCI_2_domestic* and *HCI_3_domestic* increase per AE income by 0.3% to 0.5%. Note that only *HCI_3_domestic* is statistically significant in the poor sub-sample as well. Moving to assets as the dependent variable and holding other factors constant, a 1% point-increase in *HCI_2_domestic* or *HCI_3_domestic* increase per AE assets by 0.1%, where only the latter is also statistically significant in the poor sub-sample. The results from this naïve estimation should be interpreted with care, however. As the decision to commercialize agricultural produce is not random, we need to adjust our specification to account for possible endogeneity.

Standard Fixed Effects Estimation

Our first attempt in this direction is a standard fixed effects specification as outlined in Eqn. (2). The results are presented in Table 3, which is organized in the same way as Table 2. Similarly to the results from the naïve OLS specification, the standard fixed effects estimation results suggest a positive and statistically significant relationship between all measures of vegetable commercialization through the export market channel and per AE income, both in the full sample and the poor sub-sample. When household fixed effects are included, the coefficients for the binary explanatory variables are of similar range while those of the HCIs are slightly larger in magnitude compared to Table 2. Specifically, participation in the export market is associated with a 41%-increase in per AE income, and a 1% point-increase in the levels of commercialization as measured by the HCIs with a 0.6% to 0.7%-increase in this dependent variable. The coefficients are slightly weaker for the households classified as poor in 2005 as presented in column (3). Again, when the per AE asset index is the dependent variable instead, the finding of a positive relationship between commercialization through the export market and household welfare is not supported, both in the full and reduced sample.

In contrast to the OLS estimates, commercialization through the domestic market channel exhibits no statistically significant relationship with per AE income or per AE assets, except for *HCI_3*. Specifically, the share of income derived from domestic market vegetables out of the value of produced vegetables yields positive and statistically significant coefficients on per AE asset ownership in both samples (columns (3) and (4)).

Table 3: Household fixed effect estimates

			Total sample		*Households poor in 2005*	
			ln(per AE income)	*ln(per AE asset index)*	*ln(per AE income)*	*ln(per AE asset index)*
			(1)	*(2)*	*(3)*	*(4)*
[1]		Export (binary)	0.4091***	-0.0346	0.3814***	-0.0249
			(0.1069)	(0.0310)	(0.1307)	(0.0381)
		Domestic (binary)	-0.0878	0.0039	0.0279	0.0379
			(0.1181)	(0.0353)	(0.1393)	(0.0445)
	R-squared		0.20	0.81	0.24	0.82
[2]		HCI_1_export	0.0067**	0.0001	0.0062*	0.0001
			(0.0025)	(0.0007)	(0.0035)	(0.0008)
		HCI_1_domestic	-0.0037	0.0007	-0.0038	0.0006
			(0.0027)	(0.0008)	(0.0034)	(0.0011)
	R-squared		0.19	0.81	0.23	0.82
[3]		HCI_2_export	0.0059***	0.0002	0.0044*	0.0003
			(0.0019)	(0.0005)	(0.0026)	(0.0006)
		HCI_2_domestic	-0.0009	0.0007	-0.0008	0.0007
			(0.0019)	(0.0006)	(0.0024)	(0.0007)
	R-squared		0.20	0.81	0.23	0.82
[4]		HCI_3_export	0.0071***	0.0005	0.0063***	0.0007
			(0.0019)	(0.0005)	(0.0024)	(0.0005)
		HCI_3_domestic	0.0031	0.0010**	0.0028	0.0013**
			(0.0021)	(0.0005)	(0.0024)	(0.0006)
	R-squared		0.20	0.82	0.24	0.82
N			618	618	392	392

Notes: Significant at 1% (***), 5% (**), 10% (*). Robust standard errors in parentheses. The sub-sample of households used in columns (3) and (4) consists of households whose real income per AE and day in 2005 was below 1.25 US-dollars.

Correcting for Selection Bias

The results in which we address the possible selection into commercialization and control for the unobserved heterogeneity across households are presented in Table 4. The specification allows controlling for selection that may be based on both individual-specific time-variant observable and on individual-specific time-invariant unobservable characteristics. Both when per AE income and per AE assets are the dependent variables, we estimate the second stage using a fixed effects approach including the inverse Mills ratios generated by estimating the selection equations as specified in Eqn. (3) for each market pathway and year of survey using a Probit approach.[7] Table 4 displays the results for the full sample, while those for households that were below the poverty line according to income per AE and day in the base year are presented in Table A1 in the appendix.

Table 4: Fixed effects estimates correcting for selection bias (total sample)

	ln(per AE income)				*ln(per AE assets)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export (binary)	0.4164***				-0.0370			
	(0.1235)				(0.0328)			
Domestic(binary)	-0.0233				0.0246			
	(0.1199)				(0.0370)			
HCI_1_export		0.0064***				0.0000		
		(0.0026)				(0.0007)		
HCI_1_domestic		-0.0031				0.0009		
		(0.0026)				(0.0008)		
HCI_2_export			0.0056***				0.0001	
			(0.0020)				(0.0005)	
HCI_2_domestic			-0.0003				0.0009	
			(0.0020)				(0.0006)	
HCI_3_export				0.0075***				0.0007
				(0.0021)				(0.0005)
HCI_3_domestic				0.0040*				0.0014***
				(0.0021)				(0.0005)
Male head	-0.1979	-0.1483	-0.1653	-0.2195	-0.1019	-0.1134	-0.1064	-0.1138
	(0.2418)	(0.2407)	(0.2407)	(0.2444)	(0.0785)	(0.0772)	(0.0774)	(0.0786)
Head education	0.0051	0.0056	0.0083	0.0028	0.0116**	0.0116**	0.0114**	0.0104*
	(0.0272)	(0.0268)	(0.0272)	(0.0274)	(0.0056)	(0.0056)	(0.0056)	(0.0055)
Household size	-0.120***	-0.114***	-0.118***	-0.120***	-0.195***	-0.196***	-0.196***	-0.196***
	(0.0278)	(0.0268)	(0.0268)	(0.0284)	(0.0080)	(0.0082)	(0.0080)	(0.0078)
Dependency	0.0097**	0.0110***	0.0107**	0.0102**	0.0028***	0.0028***	0.0028***	0.0028***
	(0.0045)	(0.0042)	(0.0043)	(0.0042)	(0.0009)	(0.0009)	(0.0010)	(0.0009)
Off-farm	0.2861**	0.2653**	0.2586**	0.2654**	-0.0282	-0.0215	-0.0238	-0.0254
	(0.1191)	(0.1217)	(0.1207)	(0.1208)	(0.0320)	(0.0319)	(0.0315)	(0.0318)
Business	0.3375***	0.3380***	0.3359***	0.3291***	-0.0084	-0.0038	-0.0080	-0.0085
	(0.1065)	(0.1064)	(0.1046)	(0.1068)	(0.0293)	(0.0307)	(0.0294)	(0.0294)
Cultivated land	0.1141*	0.1142	0.1154	0.1090	-0.0119	-0.0105	-0.0104	-0.0116
	(0.0692)	(0.0727)	(0.0729)	(0.0730)	(0.0167)	(0.0167)	(0.0168)	(0.0173)
Rainfall	-0.0015	-0.0019*	-0.0019	-0.0019	-0.0000	0.0000	-0.0001	-0.0001
	(0.0012)	(0.0011)	(0.0012)	(0.0013)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Rainfall CoV	-0.0015	0.0036	0.0023	0.0024	0.0029	0.0021	0.0020	0.0029
	(0.0116)	(0.0117)	(0.0116)	(0.0118)	(0.0031)	(0.0031)	(0.0031)	(0.0031)
2010 -dummy	-0.0695	-0.1027	-0.1159	-0.0647	0.0723	0.0823	0.0676	0.0820
	(0.2093)	(0.2039)	(0.2220)	(0.2263)	(0.0590)	(0.0598)	(0.0575)	(0.0566)
Shock	0.0325	0.0432	0.0338	0.0446	-0.0274	-0.0291	-0.0235	-0.0222
	(0.1303)	(0.1301)	(0.1293)	(0.1298)	(0.0328)	(0.0328)	(0.0332)	(0.0325)
Mills ratio (export)	-0.0268	-0.1214	-0.0846	-0.0379	-0.0259	-0.0155	-0.0213	-0.0117
	(0.1656)	(0.1613)	(0.1628)	(0.1617)	(0.0397)	(0.0375)	(0.0377)	(0.0390)
Mills ratio (domestic)	0.3656*	0.2745	0.2491	0.4275*	0.1112**	0.1113**	0.1226**	0.1417***
	(0.2176)	(0.2104)	(0.2184)	(0.2195)	(0.0535)	(0.0494)	(0.0499)	(0.0518)
Constant	0.5191	0.6334	0.7201	0.4402	0.8331	0.8350*	0.9357*	0.8328*
	(1.5123)	(1.4915)	(1.5308)	(1.5206)	(0.4517)	(0.4373)	(0.4279)	(0.4327)
N	618	618	618	618	618	618	618	618
R-squared	0.2107	0.2023	0.2062	0.2167	0.8171	0.8165	0.8175	0.8203
F(20,308)	3.69***	4.02***	3.90***	3.83***	54.0***	53.2***	53.9	57.6

Notes: Significant at 1% (***), 5% (**), 10% (*) probability levels. Robust standard errors in parentheses. The dependent variable is *ln(per AE income)* in columns (1) through (4) and *ln(per AE asset index)* in columns (5) through (8). The following variables are included in all columns but statistically insignificant: age of the household and its square, remittances, *owned land*, and *land fertility*.

In both tables, per AE income is the dependent variable in columns (1) through (4), and the asset index per AE takes its place in columns (5) through (8). For both dependent variables we again start by investigating the binary indicators for commercialization first (columns (1) and (5)), and then look at the *HCI_1*, *HCI_2*, and *HCI_3* in columns (2) through (4) and in columns (6) through (8), respectively.

The estimates of the inverse Mills ratios for commercialization through the export market are not statistically significant in either specification, which ameliorates our concern for potential selection bias with regards to this market channel. On the other hand, the null hypothesis of no significant difference between households who supply the domestic market and those that do not is rejected in most columns as demonstrated by statistically significant inverse Mills ratios for participation in the domestic market, which supports the use of the specification allowing for selection into commercialization.

The results indicate that export market commercialization is positively and statistically significantly related to per AE income, but not to per AE asset holdings, which is in line with our earlier results. Interestingly, the coefficients are again of a similar magnitude as in Tables 2 and 3. Specifically, per AE income for a household commercializing through the export market channel increases by 0.6% to 0.8% for every 1% point-increase in the share of income generated from export vegetables out of total household income (*HCI_1_export*), out of total crop sales (*HCI_2_export*), or out of the total value of vegetables produced (*HCI_3_export*). Similar results with slightly smaller coefficients are found in the reduced sample of (originally) poor households with the exception of *HCI_2_export*, which does not yield a statistically significant coefficient. Again, the results are not confirmed when we investigate the effect on per AE assets: none of the measures of commercialization through the export market are statistically significant.

Participation in the domestic market does not appear to be strongly associated with a change in per AE income or per AE asset holdings. However, a positive and statistically significant association of a 0.4%-increase in per AE income for every 1% point-increase in the proportion of income generated from the domestic market out of the total value of vegetables produced (*HCI_3_domestic*) is found as presented in column (4) of Table 4, which is not supported in the poor sub-sample. This measure of commercialization through the domestic market channel also exerts positive and statistically significant effects on per AE assets in both the total and reduced samples. Specifically, a 1% point-increase in the share of

income derived from domestic market vegetables out of the total value of vegetables produced (*HCI_3_domestic*) increases per AE assets by approximately 0.15%, *ceteris paribus*. These results indicate that participation in the domestic market, unlike in the export market, has some potential to increase per AE assets, while the stronger positive effect of commercialization through the export market is confined to income. These surprising and orthogonal relationships between participation in the export market and per AE income, and between participation in the domestic market and per AE assets may be explained based on our observations in the field during data collection. Our qualitative data indicate that income from the export business is generally received in small amounts that are spread out over the season or year. Since most of the smallholders do not use the formal money saving facilities, they may simply use the money to take care of immediate needs such a school fees, clothing, and food items. Domestic market vegetables, on the other hand, are sold at once in large quantities, which is likely to generate enough cash at once to invest in larger assets.

Table 4 also presents estimated coefficients of the included household observables that are likely to influence household welfare. Education of the household head exerts a positive and statistically significant influence on per AE asset holdings as given in columns (5) through (8). We do not find any evidence for this variable to correlate with per AE income in a statistically significant way, however. The size of the household, on the other hand, yields a negative and statistically significant coefficient for both dependent variables, while the one for the dependency ratio is statistically significant and positive in all columns. Off-farm employment and business ownership exert positive and statistically significant influences on per AE income in all specifications, while neither of them shows evidence of a statistically significant relationship with per AE asset holdings. The positive and statistically significant relationship between off-farm employment and business ownership emphasizes the importance of diversification among smallholders for their material well-being. Contrary to expectations, the coefficients on weather shocks (*Rainfall*) and weather risk (*Rainfall CoV*) as well as the more general measure of shocks are statistically insignificant in all columns, which is also the case for the coefficient on the size of the cultivated land in all but one column. Overall, the results are rather similar in the sub-sample of households classified as poor based on their per AE income in 2005.

Summarizing our results, we find that commercialization through the export market channel has a limited potential to increase the material well-being of smallholder farmers. While

participation in this market is shown to alleviate income poverty through positive effects on per AE income in the total sample and in the sub-sample of (originally) poor households, no consistent evidence for an effect on asset holdings is found. The statistically insignificant effects of export market commercialization on household asset accumulation are not surprising, however. In their study on the impact of the tomato agro-industry on the rural poor in Mexico, Barron and Rello (2000) find that, although household income increases, it is not sufficient to increase investment in assets, which is similar to the finding of Carletto *et al.* (2009) who investigate the commercialization of snow peas in Guatemala. Barron and Rello (2000) conclude that the earned income is fundamental for survival in villages located in regions characterized by poverty, but insufficient to really alleviate poverty due to the inability of inducing capital formation or of creating conditions for endogenous local development. This is in line with our speculative explanation above: Income from commercialization through the export market is paid out in a large number of small installments, which may make it more likely that it is used to meet daily expenditures.

Even though the findings are not as robust as the ones for commercialization through the export market, we find some evidence for a positive relationship between participation in the domestic market and asset holdings. Again, our earlier explanation of the income from commercialization through the domestic market being paid out in bigger sums and thereby enabling the investment in durable assets appears sensible.

5. CONCLUSIONS

The aim of this study was to investigate the effects of the commercialization of vegetables by smallholders for their welfare in order to shed some light on the ongoing debate of whether the horticultural sector may be an engine of pro-poor growth in developing countries. Besides using panel data and exploiting the possibilities associated with the structure of the data, this study contributes to the literature by investigating the effects of smallholder horticultural commercialization through different market pathways on two measures of household welfare in Kenya: income and asset ownership.

Starting from a naïve OLS estimation that assumes the commercialization of vegetables to be exogenous, we move on to controlling for the unobserved heterogeneity across households, thereby adding to the existing literature that mainly relies on cross-sectional data. Further,

we address the problem of potential selection into commercialization and test all specifications in the sub-sample of households classified as poor in 2005. Our results for commercialization through the export market channel are robust across specifications, thereby ameliorating our concerns about unobserved heterogeneity across farmers and selection into commercialization. We find consistent evidence for a positive relationship between the commercialization of vegetables through the export market channel and income per adult equivalent, but not for asset holdings as the dependent variable.

Considering the domestic market pathway, the naïve OLS specifications overestimates the effects of commercialization on household income and the results, furthermore, are less stable and suggest more strongly that selection into commercialization may be an issue. While we find some evidence for participation in this market to be beneficial for household welfare, the results appear stronger with respect to asset ownership than income. Overall, we conclude that the commercialization of vegetables has mixed effects on household welfare: While production for the export market is associated with higher income, the ability of commercialization to alleviate poverty appears limited due to the mixed evidence for an association with asset holdings.

Our study emphasizes the need to measure household material well-being with other factors in addition to household income or expenditure. Asset ownership is an additional helpful indicator due to the rather large initial expense needed to accumulate them. Policies encouraging the participation in commercial agriculture, thus, should be supported by strategies to improve access to credit and encourage savings in rural areas in order to facilitate asset accumulation. On a related note, it would be interesting to test whether a payment scheme for export vegetables that is more similar to the one for domestic market sales in that it hands out bigger sums would have effects on asset holdings as well as income, possibly in an experimental setting.

Further research is needed on the intra-household allocation and utilization of the income generated from vegetable commercialization, which is an important topic to understand the relationship at a more disaggregated level. In addition, while this study uses the physical counts of assets to develop the index, further research using monetary values of assets would be helpful in order to provide a better representation of the capital stock of a household.

REFERENCES

Adekunle, A. A., Ellis-Jones, J., Ajibefun, I., Nyikal, R. A., Bangali, S., Fatunbi, O., & Ange, A. (2012). Agricultural innovation in sub-Saharan Africa: Experiences from multiple-stakeholder approaches. Forum for Agricultural Research in Africa (FARA), Accra, Ghana. <http://www.fara-africa.org/media/uploads/library/docs/fara_publications/agrl_innovations_in_ssa.pdf> Accessed September 5, 2012.

Afari-Sefa, V. (2007). The dynamics of horticultural export value chains on the livelihood of small farm households in Southern Ghana. *African Journal of Agricultural Research*, *2*(9), 435–440.

Alkire, S., & Santos, M. E. (2010). Acute Multidimensional Poverty: A New Index for Developing Countries. *OPHI Working Paper No. 38.* UK: Oxford Poverty & Human Development Initiative (OPHI), University of Oxford.

Anand, S., & Sen, A. (1994). Gender inequality in human development: Theories and Measurement. *Human Development Report Office Occasional Paper 19.* New York: United Nations Development Programme.

Asfaw, S. (2008). *Global Agrifood supply Chain, EU Food-Safety Standards and African Small-Scale producers - The case of High-Value Horticultural Export from Kenya*. Published Doctoral Dissertation, Leibniz Universität Hannover, Germany.

Attanasio, O., & Szekely, M. (1999). An Asset-Based Approach to the Analysis of Poverty in Latin America. *IADB Working Paper No. R-376*. Washington D.C.: Inter-American Development Bank.

Barrett, C. B., & Dorosh, P. A. (1996). Farmers' Welfare and Changing Food Prices: Nonparametric Evidence from Rice in Madagascar. *American Journal of Agricultural Economics*, *78*(3), 656–669.

Barron, M. A., & Rello, F. (2000). The impact of the tomato agroindustry on the rural poor in Mexico. *Agricultural Economics*, *23*(3), 289–297.

Carletto, C., Kilic, T., & Kirk, A. (2009). Long-Term Welfare Impacts of Export Crop Adoption among Guatemalan Smallholders. *Policy Research Working Paper No. 5142.* Washington, D.C.: The World Bank.

Cornwell, C., Schmidt, P., & Wyhowski, D. (1992). Simultaneous equations and panel data. *Journal of Econometrics*, *51*(1–2), 151–181.

Dercon, S. (2004). Growth and shocks: evidence from rural Ethiopia. *Journal of Development Economics*, *74*(2), 309–329.

Deaton, A. (1991). Saving and Liquidity Constraints. *Econometrica*, *59*(5), 1221–1248.

Deaton, A. (1990). Saving in Developing Countries: Theory and Review. Proceedings of the World Bank Annual Conference on Development Economics 1989. Washington D.C.: World Bank.

Deaton, A. 1997. The Analysis of Household Surveys: A Microeconometric Approach to Development Policy. Baltimore, MD, USA: Johns Hopkins University Press

Dolan, C., & Humphrey, J. (2000). Governance and Trade in Fresh Vegetables: The Impact of UK Supermarkets on the African Horticulture Industry. *Journal of Development Studies*, *37*(2), 147–176.

Dorsey, B. (1999). Agricultural Intensification, Diversification, and Commercial Production among Smallholder Coffee Growers in Central Kenya. *Economic Geography*, *75*(2), 178–195.

Fafchamps, M., Udry, C., & Czukas, K. (1998). Drought and saving in West Africa: are livestock a buffer stock? *Journal of Development Economics*, *55*(2), 273–305.

Fischer, E., & Qaim, M. (2012). Gender, agricultural commercialization, and collective action in Kenya. *Food Security*, *4*(3), 441–453.

Gioè, M. (2006). Can horticultural production help African smallholders to escape dependence on export of tropical agricultural commodities? *Crossroads*, *6*(2), 16–65.

Gitau, R., Olwande, J., Mathenge, M., Kirimi, L., & Kamau, M. (2012). Potential effects of the imposition of value added tax on agricultural inputs and sifted maize meal*. Policy brief No. 8/2012.* Nairobi, Kenya: Tegemeo Institute of Agricultural Policy and Development.

Government of Kenya (GoK) (2007). *Kenya Vision 2013.* Nairobi, Kenya: Ministry of Planning and National Development.

Government of Kenya (GoK) (2010). *Agricultural Sector Development Strategy for the period, 2010- 2020*. Nairobi, Kenya: Ministry of Agriculture.

Government of Kenya (GoK) (2012). *National Horticulture policy. Republic of Kenya.* Nairobi, Kenya: Ministry of Agriculture.

Goletti, F. (2005). Agricultural Commercialization, value chains and poverty reduction. *Agrifood Consulting International Discussion paper No. 7*. Vietnam: Asian Development Bank.

Graffham, A., Karehu, E., & McGregor, J. (2007). Impact of EurepGAP on small-scale vegetable growers in Kenya. Fresh Insights No. 6. London: International Institute for Environment and Development.

Horticultural Crops Development Authority (HCDA) (2009). 2009 annual Horticultural Report, Kenya. Nairobi, Kenya: Horticultural Crops Development Authority. < http://www.hcda.or.ke/tech/> Accessed November 9, 2010.

Heltberg, R. and F. Tarp (2002): Agricultural supply response and poverty in Mozambique. *Food Policy, 27(2),* 103–124.

Henry, C., Sharma, M., Lapenu, C., & Zeller, M. (2003). Microfinance poverty assessment tool. *Technical Tool Series No. 5.* Washington D.C.: The World Bank.

Henson, S., & Jaffee, S. (2008). Understanding Developing Country Strategic Responses to the Enhancement of Food Safety Standards. *World Economy*, *31*(4), 548–568.

Henson, S., & Reardon, T. (2005). Private agri-food standards: Implications for food policy and the agri-food system. *Food Policy*, *30*(2005), 13.

Hertel, T. W., & Rosch, S. D. (2010). Climate Change, Agriculture, and Poverty. *Applied Economic Perspectives and Policy*, *32*(3), 355–385.

IMF (2012). Kenya: Poverty Reduction Strategy Paper- Progress Report. IMF Country Report No. 12/10. Washington, D.C.: International Monetary Fund.

Irungu, C. (2002). *Outreach Performance of Non- Governmental Development Organizations in Eastern Kenya*. Published Doctoral Dissertation, Göttingen University, Germany.

Jaffee, S. (2003). From challenge to opportunity: Transforming Kenya's fresh vegetable trade in the context of emerging food safety and other standards in Europe. A*gricultural and Rural Development Discussion Paper No. 2.* Washington, D.C.: World Bank.

Jaffee, S., Henson S., Sewadadh M., Lisazo M. B., Ignacio L., van der Meer K., de Haan C., and Lamb J. (2005): Food Safety and Agricultural Health Standards: Challenges and Opportunities for Developing Country Exports. Report No. 31207. Washington, D.C.: World Bank.

Kennedy, E. (1994). Health and Nutrition Effects of Commercialization of Agriculture. In: von Braun, J. & Kennedy, E. (Eds.), *Agricultural Commercialization, Economic Development and Nutrition* (pp. 79–102). Washington, D.C.: Johns Hopkins University Press.

Maertens, M., & Swinnen, J. (2009). Trade, Standards, and Poverty: Evidence from Senegal. *World Development*, *37*(2009), 161– 178.

McCulloch, N. (2001). Trade liberalization and poverty. *Vol. XXVI 405 S.* London: CEPR.

McCulloch, N., and Ota, M., (2002): Export Horticulture and Poverty in Kenya. *IDS working paper No. 174*. Brighton: Institute of Development Studies, University of Sussex.

Minot, N., & Ngigi, M. (2004). Are Horticultural exports a replicable Success story? Evidence from Kenya and Cote D'ivoire. *MTID Discussion paper No.120.* Washington D.C.: International Food Policy Research Institute (IFPRI).

Minot, N., & Roy, D. (2007). *Impact of high-value agriculture and modern marketing channels on poverty: An analytical framework*. Washington D.C.: International Food Policy Research Institute (IFPRI).

Mithofer, D., Nang'ole, E., & Asfaw, S. (2008). Smallholder access to the export market: the case of vegetables in Kenya. *Outlook on Agriculture*, *37*(3), 203–211.

Moser, C., & Felton, A. (2007). The Construction of an Asset Index Measuring Asset Accumulation in Ecuador. *Chronic Poverty Research Centre Working Paper No. 87*. Washington, D.C.: World Bank.

Moti J., Berhanu G., and Hoekstra D. (2009). Smallholder commercialization: Processes, determinants and impact. *Discussion Paper No. 18.* Nairobi, Kenya: Improving Productivity and Market Success (IPMS) of Ethiopian Farmers Project, ILRI (International Livestock Research Institute).

Muriithi, B., Mburu, J., & Ngigi, M. (2010). Constraints and Determinants of Compliance With EurepGap Standards: A Case of Smallholder French Bean Exporters in Kirinyaga District, Kenya. *Agribusiness*, *27(*2), 1–12.

Neven, D., Odera, M. M., Reardon, T., & Wang, H. (2009). Kenyan Supermarkets, Emerging Middle-Class Horticultural Farmers, and Employment Impacts on the Rural Poor. *World Development*, *37*(11), 1802–1811.

Neven, D., & Reardon, T. (2004). The Rise of Kenyan Supermarkets and the Evolution of their Horticulture Product Procurement Systems. *Development Policy Review*, *22*(6), 669–699.

Niemeijer, R., & Hoorweg, J. (1994). Commercialization of Rice and Nutrition: A case of West Kenya. In: von Braun, J. & Kennedy, E. (1994) (Eds.). *Agricultural Commercialization, Economic Development and Nutrition* (pp. 264–275). Washington, D.C: *Johns Hopkins University Press*.

Okello, J., Narrod, C., & Roy, D. (2007). Food Safety Requirements in African Green Bean Exports and Their Impact on Small Farmers. *IFPRI Discussion Paper No. 00737.* USA: International Food Policy Research Institute (IFPRI).

Omiti, J., Otieno, D., McCullogh, E., & Nyanamba, T. (2007). Strategies to Promote Market-oriented smallholder Agriculture in Developing countries: A case of Kenya. Proceedings at the Second AAAE Conference, August 20-22, 2007, Accra, Ghana.

Pingali, P. (2007). Agricultural growth and economic development: a view through the globalization lens. *Agricultural Economics*, *37*(s1), 1–12.

Pingali, P., & Rosegrant, M. W. (1995). Agricultural commercialization and diversification: processes and policies. *Food Policy*, *20*(3), 171–185.

Rao, E. J. O., & Qaim, M. (2011). Supermarkets, Farm Household Income, and Poverty: Insights from Kenya. *World Development*, *39*(5), 784–796.

Reardon, T., & Berdegué, J. A. (2002). The Rapid Rise of Supermarkets in Latin America: Challenges and Opportunities for Development. *Development Policy Review*, *20*(4), 371–388.

Reardon, T., Timmer, P., Barrett, C. B., & Berdegué, J. A. (2003). The Rise of Supermarkets in Africa, Asia, and Latin America. *American Journal of Agricultural Economics*, *85*(5), 1140–1146.

Rutstein, S. O., & Johnson, K. (2004). *DHS Wealth Index*. DHS Comparative Report. Calverton, Maryland USA: ORC Macro. <http://www.measuredhs.com/pubs/pdf/cr6/cr6.pdf> Accessed July 14, 2012.

Seshan, G. (2005). The Impact of Trade Liberalization on Household Welfare in Vietnam. *Policy Research Working paper No. 3541*. Washington D.C.: World Bank.

Sindi, J. (2008). *Kenya domestic horticulture subsector: What drives commercialization decisions by rural households?* Unpublished dissertation, The Michigan State University, USA.

Suri, T., Tschirley, D., Irungu, C., Gitau, R., & Kariuki, D. (2009). Rural incomes, inequality and poverty dynamics in Kenya. *Tegemeo Working paper No. 30.* Nairobi: Tegemeo Institute of Agricultural Policy and Development.

USAID (2011). *Kenya's Intra Africa Horticultural Trade Executive Summary*. Nairobi, Kenya: Fintrac Inc. < http://www.hortinews.co.ke/article.php?id=210> Accessed May 2, 2012.

von Braun, J., Bouis, H., & Kennedy, E. (1994). Conceptual Framework. In: von Braun, J. & Kennedy, E. (1994) (Eds.). *Agricultural Commercialization, Economic Development and Nutrition (*pp. 11–33). Washington, D.C: Johns Hopkins University Press.

von Braun, J., & Immink, M. D. (1994). Nontraditional Vegetables crops and food security among Smallholder Farmers in Guatemala. In: von Braun, J. & Kennedy, E. (1994) (Eds.). *Agricultural Commercialization, Economic Development and Nutrition (*pp. 189–203). Washington, D.C: Johns Hopkins University Press.

von Braun, J., & Kennedy, E. (1994). *Agricultural Commercialization, Economic Development and Nutrition*. Washington, D.C.: Johns Hopkins University Press.

Wooldridge, J. M. (2002). *Econometric analysis of cross section and panel data*. London: Massachusetts Institute of Technology Press.

Zeller, M., Sharma, M., Henry, C., & Lapenu, C. (2006). An operational method for assessing the poverty outreach performance of development policies and projects: Results of case studies in Africa, Asia, and Latin America. *World Development*, *34*(3), 446–464.

APPENDIX

Table A1: Fixed effects estimates correcting for selection bias (households poor in 2005)

	ln(per AE income)				*ln(per AE asset index)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Export (binary)	0.3885***				-0.0408			
	(0.1488)				(0.0397)			
Domestic (binary)	0.0718				0.0715			
	(0.1461)				(0.0466)			
HCI_1_export		0.0060*				-0.0001		
		(0.0035)				(0.0008)		
HCI_1_domestic		-0.0036				0.0009		
		(0.0033)				(0.0010)		
HCI_2_export			0.0042				0.0000	
			(0.0027)				(0.0006)	
HCI_2_domestic			-0.0006				0.0010	
			(0.0024)				(0.0007)	
HCI_3_export				0.0065**				0.0005
				(0.0026)				(0.0006)
HCI_3_domestic				0.0032				0.0015*
				(0.0025)				(0.0006)
Male head	0.0630	0.1383	0.1252	0.0532	-0.0773	-0.1069	-0.0926	-0.1012
	(0.2835)	(0.2807)	(0.2819)	(0.2869)	(0.0963)	(0.0956)	(0.0980)	(0.0972)
Head education	-0.0086	-0.0049	-0.0046	-0.0074	0.0141*	0.0145**	0.0151**	0.0129 *
	(0.0328)	(0.0317)	(0.0324)	(0.0331)	(0.0073)	(0.0073)	(0.0073)	(0.0072)
Household size	-0.079**	-0.078**	-0.0815**	-0.0794**	-0.200***	-0.200***	-0.200***	-0.199***
	(0.0329)	(0.0316)	(0.0324)	(0.0338)	(0.0093)	(0.0096)	(0.0095)	(0.0093)
Dependency	0.0077***	0.0092***	0.0085***	0.0081***	0.0021*	0.0019*	0.0018	0.0021*
	(0.0021)	(0.0023)	(0.0022)	(0.0021)	(0.0011)	(0.0012)	(0.0012)	(0.0012)
Business	0.3110***	0.2994**	0.3172***	0.2986***	0.0448	0.0461	0.0440	0.0418
	(0.1196)	(0.1221)	(0.1187)	(0.1191)	(0.0353)	(0.0377)	(0.0357)	(0.0349)
Remittances	0.3493***	0.2985***	0.2982***	0.3276***	-0.0362	-0.0353	-0.0388	-0.0288
	(0.1179)	(0.1155)	(0.1202)	(0.1164)	(0.0366)	(0.0381)	(0.0388)	(0.0385)
Cultivated land	0.0530	0.0522	0.0520	0.0548	-0.0232	-0.0201	-0.0207	-0.0215
	(0.0779)	(0.0817)	(0.0821)	(0.0824)	(0.0222)	(0.0220)	(0.0221)	(0.0222)
Rainfall	-0.0025*	-0.0028*	-0.0027*	-0.0026*	-0.0004	-0.0004	-0.0004	-0.0004
	(0.0015)	(0.0015)	(0.0016)	(0.0016)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Rainfall Cov	0.0108	0.0140	0.0136	0.0137	-0.0012	-0.0020	-0.0023	-0.0013
	(0.0142)	(0.0141)	(0.0142)	(0.0143)	(0.0039)	(0.0038)	(0.0038)	(0.0039)
2010 -dummy	0.0182	-0.0104	-0.0248	0.0089	0.1063*	0.1124*	0.1005	0.1127
	(0.2505)	(0.2428)	(0.2663)	(0.2671)	(0.0639)	(0.0656)	(0.0627)	(0.0621)
Shock	-0.0587	-0.0590	-0.0646	-0.0165	-0.0371	-0.0419	-0.0353	-0.0264*
	(0.1605)	(0.1601)	(0.1588)	(0.1567)	(0.0408)	(0.0414)	(0.0414)	(0.0403)
Mills ratio (export)	-0.0184	-0.0900	-0.0709	-0.0035	-0.102***	-0.0905**	-0.096***	-0.0875**
	(0.2076)	(0.2031)	(0.2082)	(0.2011)	(0.0388)	(0.0367)	(0.0379)	(0.0379)
Mills ratio	0.2053	0.0892	0.0659	0.2128	0.1351**	0.1079*	0.1188**	0.1419**
(domestic)	(0.2911)	(0.2749)	(0.2815)	(0.2826)	(0.0651)	(0.0593)	(0.0588)	(0.0614)
_cons	0.5916	0.9188	0.9191	0.5210	1.388***	1.4467***	1.5214***	1.4333***
	(1.8764)	(1.8561)	(1.9277)	(1.8994)	(0.5150)	(0.5000)	(0.4924)	(0.5002)
N	392	392	392	392	392	392	392	392
R-squared	0.24	0.24	0.23	0.25	0.83	0.83	0.83	0.83
F	4.09***	4.2***	3.98***	4.14***	45.0	42.7	42.8	46.8

Notes: Significant at 1% (***), 5% (**), 10% (*) probability levels. Robust standard errors in parentheses. The dependent variable is *ln(per AE income)* in columns (1) through (4) and *ln(per AE asset index)* in columns (5) through (8). The following variables are included in all columns but statistically insignificant: *age of the household head and its square, owned land, and land fertility.*

NOTES

[1] Many studies use household expenditure or consumption data rather than income data because expenditure is less susceptible to seasonal and yearly fluctuations, thus generating less measurement error (Deaton, 1990; 1991). However, studies investigating both income and consumption do not find consumption to be superior to income as an indicator of economic welfare (Deaton 1997; Field 2003). Furthermore, Suri *et al.* (2009) compare analyses done in Kenya by two different institutions using expenditure in one case and income data in the other and find the results to be similar. Minot and Roy (2007) even recommend estimating poverty based on income rather than expenditure in studies evaluating the impact of high-value agriculture, for example horticulture, due to the key role of land and labor substitution effects. To give a conclusive picture of the effects on household welfare, we look at both income and asset holdings in this study.

[2] Data for the first round of the survey were collected for an ICIPE project on the "Economic Impact Assessment in Horticulture". Asfaw (2008) provides detailed information about the study area and the procedure of data collection.

[3] International (export) market vegetables include French beans, snow peas, baby corn, and Asian vegetables (including cucumbers, okra, aubergines, chilies, karella, valore, and brinjals). Domestic market vegetables include all other types of vegetables that are not produced mainly for the international market, such as tomatoes, cabbage, potatoes, peas, kales, onions, and capsicum.

[4] The mentioned categories of assets include livestock assets (cattle, small ruminants, poultry and traction animals), agricultural assets (hosepipes, water pumps, sprinklers, insecticides' pumps), productive durables (tractors, cars, ploughs, threshers, fridges, sewing machines, carts), consumer durables (TV, radio, motor-cycles, bicycles), and dwelling assets (iron roof, permanent wall, piped water, distance of 500m or less to water source).

[5] Note that the district indicators are lost when moving from Eqn. (1) to Eqn. (2), as they do not vary within households over time.

[6] French beans and snow peas are important export market vegetables, while potatoes and cabbage are the most important domestic market vegetable crops. Product prices are at the division level (the next lowest administrative unit after district) but obtained from the surveyed households and then averaged at the division level to minimize reporting bias. Furthermore, for 2010, the price data are validated by comparing them to market prices in the division at the time of data collection. Prices from the 2010 data are deflated, while those from the 2005 data are inflated, both to February 2009 using the consumer price index data available from the Kenya Bureau of Statistics. In 2005, one US-Dollar was equal to approximately 75 Kenyan shillings (Ksh), Ksh. 79 in 2010 and Ksh.79.9 in February 2009, our base period. See http://www.knbs.or.ke/consumerpriceindex.php for the data (Retrieved October 21, 2012).

[7] The results of the first stages are not presented here but available from the authors upon request.