



Global value chains, large-scale farming, and poverty: Long-term effects in Senegal



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ABSTRACT

This paper presents panel data evidence on the impact of expansion of global value chains and large-scale export-oriented farms in developing countries over almost a decade. We estimate the income effects of wage employment on large-scale farms in the horticultural export sector in Senegal, using data from two survey rounds covering a seven-years period of rapid expansion of the sector. We estimate average income effects as well as heterogeneous income effects, using fixed effects and quantile fixed effects regressions. We find that poverty and inequality reduced much faster in the research area than elsewhere in Senegal. Employment in the horticultural export sector is associated with higher household income and the income effect is strongest for the poorest households. Expansion of the horticultural export sector in Senegal has been particularly pro-poor through creating employment that is accessible and creates substantial income gains for the poorest half of the rural population. These pro-poor employment effects contrast with insights in the literature on increased inequality from rural wage employment.

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1. Introduction

The expansion and transformation of high-value food export chains, and the implications for rural households in developing countries and emerging markets remain highly debated (Beghin et al., 2015; McCullough et al., 2008; Swinnen, 2007; Van den Broeck and Maertens, 2016). Evidence shows that these value chains take on different forms and affect a large number of rural households. High-value export chains are often dominated by a limited number of export companies, and organized based on contract-farming with local farmers and/or on vertically integrated production on large-scale farms (Maertens et al., 2012). These chains can include thousands of smallholder farmers – e.g. the vegetable export sector in Madagascar (Minten et al., 2009) – and/or ten- or hundred-thousands of estate workers – e.g. the horticultural export sectors in Kenya, Peru and Ethiopia (Humphrey et al., 2004; Schuster and Maertens, 2016; Staelens et al., 2016).

The literature largely points to positive welfare effects for rural households, either through product markets and contract-farming or through labor markets and wage employment (Maertens et al., 2012; Swinnen, 2007). On the other hand, the available evidence suggests that contract-farming in high-value export sectors often excludes the poorest households, while employment is found to be more inclusive. Yet, some studies point to low wages, insecure employment contracts and inferior working conditions; and expect expansion of high-value exports to lead to increased vulnerability of poor households (Barrientos et al., 2011; Tallontire et al., 2005).

Despite a growing number of studies, empirical evidence still has shortcomings. First, most studies use cross-sectional household survey data to analyze productivity, income and poverty effects of the expansion of global value chains. Solving endogeneity problems is difficult with such data and estimates from existing studies are likely biased. Panel data evidence can help to control better for selection bias and better identify causality, and corroborate or fine-tune earlier findings from cross-sectional studies.

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Recent studies use panel data to identify income and welfare effects of smallholder participation in supermarket supply chains and high-value export chains (Andersson et al., 2015; Dedehouanou et al., 2013) and the impact of standards and supply chain modernization on smallholder farms (Van Herck and Swinnen, 2016) but no panel data evidence exists for workers in high-value export chains.

Second, there is no evidence on the long-term welfare effects of the expansion of global value chains. Existing studies mainly analyze short-term effects by analyzing income variation between households participating in global value chains, either as contract-farmers or as workers, and non-participating households. There is no evidence whether positive welfare effects persist over time – a limitation that arises from the lack of longitudinal data. Given that high-value exports from developing countries started to boom in the early 2000s, a need for insights into the long-term effects arises.

In this paper, we address both these shortcomings. We use panel data to estimate the long-term¹ income effects of wage employment in the horticultural export sector in Senegal after more than a decade of investments. We use data from a balanced panel of 255 households and two survey rounds conducted in 2006 and 2013. Investments in horticultural exports in the research area, the Senegal River Delta, started in 2003 and the first exports were realized in 2005. Hence, our two-period panel data covers a 7-year period from the early export years up to a decade after the first investments started. During that period four new horticultural export companies established in the area; and wage employment in the sector expanded to include 42% of households in the area. We present descriptive evidence on the employment, income, poverty and inequality dynamics in the research area. We use a fixed effects regression approach to estimate the average income effect of wage employment in the horticultural export sector and eliminate bias from time-constant unobserved heterogeneity. In addition, we use a fixed effects quantile regression approach to reveal how effects differ along the income distribution² and we compare the impact of wage employment in the horticultural export sector with the impact of wage employment in other sectors.

The research area experienced a spectacular reduction in poverty of almost 30 percentage points over the panel period 2006–2013. Our analysis reveals that entry into wage employment in the horticultural export sector is a major source of poverty reduction, increasing household income for the poorest decile of the population with 53%. A comparison with other employment sectors reinforces conclusions on the potential for pro-poor growth from the development of global agri-food value chains and large-scale farming.

2. Global value chains and development: A brief review of the empirical literature³

The early literature on global value chains and development focuses on product market effects and investigates the

development implications of contract-farming for high-value export markets. Studies from around the world demonstrate positive welfare effects of smallholder participation in high-value contract-farming schemes: e.g. Asfaw et al. (2009) find that contract-farming in the horticultural export sector in Kenya improves farm incomes and productivity; Maertens and Swinnen (2009) point to a doubling of farm incomes and Dedehouanou et al. (2013) to increased subjective well-being for contract-farmers in the vegetable export sector in Senegal; Minten et al. (2009) demonstrate that vegetable contract-farming with a large export company increases farm incomes and reduces the length of the hungry season in Madagascar; Wang et al. (2009) and Miyata et al. (2009) point to positive income effects for smallholder horticultural farmers in China; Carletto et al. (2011) find that smallholder contract-farming in the horticultural export sector in Guatemala results in improved asset accumulation; and Dries and Swinnen (2004) and Dries et al. (2009) show that contract-farming in the dairy sector leads to larger investments, technology transfer and productivity growth on smallholder farms in Eastern and Central European countries. However, studies indicate that smallholder participation in high-value export sectors through contract-farming is decreasing and biased towards more capitalized and larger farms. A shift towards large-scale integrated farming, leading to the exclusion of smallholders, has been documented for example in the horticultural export sector in Kenya (Dolan and Humphrey, 2000; Jaffee and Masakure, 2005) and in Peru (Schuster and Maertens, 2013). A bias towards more capitalized and larger farms has been observed in horticultural export sectors in Kenya (Asfaw et al., 2010), Senegal (Maertens and Swinnen, 2009), Thailand (Kersting and Wollni, 2012), Guatemala (Hernández et al., 2007), and Chile (Handschuch et al., 2013).

More recent literature notes that many high-value export sectors include more rural households as hired laborers than as contract farmers, and points to the importance of labor market effects. Some studies point to positive welfare effects from wage employment in high-value export sectors: e.g. Maertens and Swinnen (2009) and Maertens et al. (2011) document that employment on large-scale horticultural export companies in Senegal creates substantial income gains; Mano et al. (2011) point out that employment in the cut flower export sector in Ethiopia reduces poverty; and Herrmann and Grote (2015) show that large-scale sugarcane farming in Malawi contributes to poverty reduction through employment creation. Other authors are more skeptical and argue, based on observations from various countries and sectors, that the economic impact of employment in high-value export sectors is limited due to inferior working conditions, low wages and insecure employment contracts (e.g. Barrientos et al., 2000; Barron and Rello, 2000; Baumgartner et al., 2015; Patel-Campillo, 2010; Trifkovic, 2014; Ulrich, 2014; Schuster and Maertens, 2016; Staelens et al., 2016). While there is consensus on the importance of employment creation in high-value export chains, viewpoints on the rural development and poverty-reduction potential of such employment is mixed. Yet, evidence is still scarce and mainly comes from cross-sectional studies estimating short-term effects.

The debate on the employment and development implications of global value chains should be put in perspective to the broader literature on rural wage employment. In the development economics literature, off-farm and non-farm wage employment are considered to be crucial for poverty reduction and rural development (Barrett et al., 2001; Lanjouw and Lanjouw, 2001; Haggblade et al., 2010). Wage employment is argued to play an important role in the livelihoods of many farm-households, either to diversify income and reduce or cope with risks, to supplement low-season income, or to finance agricultural inputs and investments (Kijima et al., 2006; Bezu and Barrett, 2012; Adjognon

¹ The term “long-term effects” refers to both the panel period of 7 years and the estimation of effects more than a decade after the initial investments in the horticultural export sector in the study region were made. The term “long term” is also consistent with other publications in development economics using this term to refer to a similar period, such as Carter et al. (2007) and Banerjee et al. (2016).

² While the impact evaluation literature has moved beyond the estimation of average welfare effects and heterogeneous effects have been analyzed in studies on the impact of entrepreneurship, contract-farming, standards and cooperative membership (e.g. Fisher and Qaim, 2012; Hansen and Trifkovic, 2014; Verhofstadt and Maertens, 2015; Narayanan, 2014; Ramaswami et al., 2009; Vial and Hanoteau, 2015), evidence on heterogeneous effects is largely lacking in the literature on high-value exports.

³ For more elaborate reviews on global value chains, standards and development, we refer to Beghin et al. (2015), Swinnen et al. (2015), Swinnen (2016) and Van den Broeck and Maertens (2016).

et al., 2016). Yet, evidence suggests that the poorest segments of the rural population are often excluded from participation in high-paid employment, as they lack necessary skills and capital to perform such jobs (Oya, 2013). As a consequence, development of rural labor markets may lead to increased inequality (Loison, 2015). This paper investigates whether or not this holds for employment in high-value agri-food sectors.

3. Data and methods

3.1. Research area

Our research area is the area around the Senegal River Delta, located in the region of Saint-Louis in the northern Sahel part of Senegal, upstream of Saint-Louis town and the estuary of the Senegal River. The area stretches over two rural communities, Gandon and Diama, in two of the three departments in the region, Saint-Louis and Dagana. The region has become one of the two principal horticultural export areas in Senegal, besides the Niayes region north of Dakar. Since the mid 2000s five horticultural export companies established in the region: a first multinational company started to invest in the area in 2003 and realized its first export season in 2005; four other companies followed with exports since 2007. Horticultural exports from the region are increasing rapidly; the cultivated area is expanding and product variety is increasing. Tomatoes, beans and mangoes are the main export crops, and are largely destined for the European market. Production mainly occurs from October to May, when horticultural production in Europe is less competitive. The companies are all vertically integrated and lease land from rural communities to establish large-scale estate farms and one or several conditioning units. Approximately 5000 people are employed on the fields and in the conditioning units of the companies in 2013; of which 80% female workers. The employees have daily, seasonal or more permanent employment contracts and mainly come from the surrounding villages.

Households in the research area belong to Wolof, Peulh and Maure ethnic groups. The majority of them are Muslim and live in large extended families within one compound. Polygamy is common in the area, with members of polygamist households living in the same compound. Traditionally, households in the research area are farm-households deriving income from cropping, including irrigated rice production and rain-fed vegetable production, and livestock-rearing, including selling of meat and milk from cattle, goats and sheep. Households increasingly complement their farm income with wages earned in the horticultural export companies or in other jobs. Small business activities, such as petty trade, hair-dressing and tailoring are also emerging in the area.

3.2. Data collection

We conducted fieldwork in this area in the period 2006–2013 and collected data and information from several sources. First, we conducted semi-structured interviews with all five horticultural export companies – the oldest ones several times throughout the period – on production activities, sourcing strategies, employment strategies and working conditions. Second, we conducted a two-round household survey, with the first baseline round implemented in February–April 2006 and the second follow-up round in April–June 2013. The panel period covers seven years during which the first export company expanded activities and four additional companies started export activities. The first survey round covered 284 households in 17 villages across the two rural communities Gandon and Diama. We used a two-stage stratified sampling design. In the first stage, villages were stratified according to their distance to the road and randomly selected within the strata with

an oversampling of villages closer to the road. In the second stage, households in the sampled villages were stratified according to whether or not members of the household are employed in the horticultural export industry and randomly selected within the strata with an oversampling of households with employment. To draw population inferences from descriptive statistics, we use sampling weights to correct for the oversampling of households close to the road and employed in the horticultural export sector. The weights are calculated with census information from the rural communities and villages.

For the second survey round, we tried to resurvey all the households from the original sample but 25 households moved out of the region, an attrition rate of 8.8%. We do not know the reasons for their resettlement, but attrition bias is deemed to be sufficiently low because the relocated households are not statistically different from other sampled households. Four observations were not retained for the analysis in this paper because of missing information. The final sample consists of a balanced panel data set of 255 households, including 169 households who were employed in the horticultural export industry in the first round, of which 99 remained employed in the second round, and 38 households who newly entered this employment over the panel period.

We used a structured quantitative questionnaire with different modules. We used the same questionnaire in both survey rounds but in the follow-up survey some less relevant modules were dropped while other modules were added. The survey data include information on demographic characteristics, productive assets, living standards, and income from agricultural production (both crop and livestock production), off-farm wage employment and self-employment, and non-labor income (mainly remittances). We complemented the household survey with a village survey to collect information on geographic and institutional characteristics of the sampled villages.

3.3. Poverty, inequality and income calculations

We calculate income per adult equivalent for both survey rounds. We define total income as the income a household earned during the 12 months before the survey. We include different sources of income: on-farm self-employment (both crop and livestock production), off-farm self-employment, wage employment (in horticultural export sector and other sectors) and non-labor income, such as received remittances and state subsidies. We use real income data to compare income over time and inflate all income data to 2013 price levels using consumer price indices (IMF, 2015). We use the modified OECD adult-equivalence scale, which assigns a value of 1 to the household head, 0.5 to each additional adult member and 0.3 to each child. We define a household as all members who lived, slept and ate together in the same compound for at least six months during the past year.

We derive incidence of poverty and extreme poverty using the national rural poverty and extreme poverty line of 2011, which we adapt to 2013 price levels using consumer price indices (République du Sénégal, 2014). A household is poor if per adult equivalent income is lower than 225,909 *Franc Communauté Financière d'Afrique* (FCFA) per year and extremely poor if it is lower than 141,521 FCFA per year⁴. As robustness check, we calculate poverty based on the Multidimensional Poverty Index, which takes into account households' living standards, health and education (Alkire and Santos, 2010). We have these data only for 2013. We calculate income inequality using the Gini coefficient. We correct all population statistics using sampling weights.

⁴ The national currency FCFA has a fixed exchange rate to the Euro: €1 is 655.957 FCFA.

3.4. Econometric analysis

We estimate the effect of wage employment in the horticultural export sector and in other employment sectors on household income. We estimate mean effects using fixed effects regression, and heterogeneous effects using quantile fixed effects regression. Mean effects are commonly estimated in impact studies and in our case entail the estimation of an average impact of wage employment on household income in the population. Heterogeneous effects are emerging in the impact evaluation literature (e.g. Fisher and Qaim, 2012; Hansen and Trifkovic, 2014; Verhofstadt and Maertens, 2015) and in our case entail the estimation of the impact of employment on household income along the income distribution. This allows us to reveal if the income effect of wage employment is different for poorer households than for better-off households.

3.4.1. Estimation of mean effects

We estimate the mean impact of wage employment on household income according to the following model:

$$Y_{ijt} = \beta EH_{ijt} + \gamma EO_{ijt} + \delta X_{ijt} + \alpha_{ij} + v_{jt} + \theta_t + \varepsilon_{it}, \quad (1)$$

where β , γ and δ are coefficients to be estimated, α_{ij} is a set of time-constant unobservable household variables, v_{jt} is a set of time-variant unobservable village variables, θ_t is a year dummy (taking the value of one for 2013) and ε_{it} is a set of time-variant unobservable household variables. The dependent variable Y_{ijt} is the logarithm of income per adult equivalent of household i in village j at time t . It is measured as explained in Section 3.3.

The main variables of interest are EH_{ijt} and EO_{ijt} . EH_{ijt} represents a dummy variable for household i in village j at time t having at least one member being employed for a wage in the horticultural export industry during the 12 months periods before the survey and irrespective of the length of that employment; and EO_{ijt} represents a similar dummy variable for wage employment in other sectors (which is not the horticultural export sector). Employment in the horticultural export sector represents all jobs that are performed in one of the five horticultural export companies in the Senegal River Delta, and other sectors represents all other job types whereby a person received a wage in exchange for labor. The majority of the jobs in this sector entail low-skilled professions, such as domestic, garment and construction workers. A minority of these jobs are high-skilled professions, such as teachers and civil servants. Our data are not detailed enough to distinguish further between low-skilled and high-skilled employment in other sectors. We use the definitions of employment in the horticultural export sector and other sectors for the remainder of this paper.

We include a vector of other explanatory time-variant household variables X_{ijt} that are likely to influence income. We control for human capital by including age, education, and gender of the household head, household size (both number of members able to work⁵ and number of dependents), and physical capital by including total land and total livestock units that a household possesses. Additionally, we include the variable θ_t to capture all temporal variation in the region between 2006 and 2013, such as weather shocks and price variation. We cluster the standard errors at village level and report robust errors.

We use a fixed effects regression to reduce the bias caused by a non-random assignment of households into wage employment. This model focuses on the variation within households over time and removes all time-invariant observable and unobservable household characteristics. This approach solves the potential endo-

geneity related to unobserved time-invariant heterogeneity. Forty percent of the sampled households switched wage employment status over time, which renders sufficient within-household variation to use a fixed effects approach.

The fixed effects estimator can still suffer from endogeneity bias when unobservable time-variant factors are correlated with both income and the decision to be wage employed. We therefore include v_{jt} , which is a set of village-year dummies to control for all time-variant village characteristics, including a change in wage employment opportunities (e.g. through expansion of a horticultural export company), a reduction in transaction costs (e.g. through road construction), or project interventions (e.g. through investments by the Senegalese government to develop new rice irrigation perimeters in villages along the Senegal River).

3.4.2. Estimation of heterogeneous effects

In a second step, we estimate the heterogeneous impact of wage employment on household income by using quantile regressions. While ordinary least squares regressions estimate impacts at the mean, quantile regressions estimate treatment effects at different quantiles of the outcome distribution. We extend the model of Eq. (1) and estimate a fixed effects panel quantile regression:

$$q_\tau(Y_{ijt} | EH_{ijt}, EO_{ijt}, X_{ijt}) = \beta_\tau EH_{ijt} + \gamma_\tau EO_{ijt} + \delta_\tau X_{ijt} + \alpha_{ij} + v_{jt} + \theta_t, \quad (2)$$

where $q_\tau(Y_{ijt} | EH_{ijt}, EO_{ijt}, X_{ijt})$ is the τ^{th} conditional quantile of the logarithm of income per adult equivalent and τ ranges between zero and one. The coefficients β_τ and γ_τ represent the estimated percentage change in income of a change in employment status over time at the τ^{th} quantile of the log income distribution.

We follow the approach proposed by Canay (2011) to estimate the panel quantile regressions. This approach has recently been used e.g. by Nguyen et al. (2013) who investigate the magnitude of earnings gaps between the informal and formal sector in Vietnam, and by Vial and Hanoteau (2015) who investigate the returns of micro-entrepreneurship in Indonesia. The estimation procedure consists of two steps. First, we run a standard fixed effects model at the conditional mean of the logarithm of income and get an estimator for the household fixed effects, α_{ij} . Canay (2011) assumes that α_{ij} has a pure location shift effect on the conditional quantiles of the dependent variable. In other words, α_{ij} is assumed to affect all quantiles in the same way. Second, we generate a new dependent variable by subtracting the estimator for α_{ij} from Y_{ijt} and run a quantile regression for different quantiles on this new dependent variable. We apply 100 bootstrap replications on this two-step estimation procedure to correct the standard errors.⁶

4. Results and discussion

4.1. Employment and welfare dynamics

Our results show that economic development in the Senegal River Delta has been remarkably pro-poor. Between 2006 and 2013, there was a substantial poverty reduction and a slight decrease in income inequality in the region (Fig. 1). The rate at which poverty and inequality decreased is much higher than in (rural) Senegal in general. The incidence of poverty decreased with 29.5 percentage points from 56.2% in 2006 to 26.7% in 2013; and the incidence of extreme poverty with 13.4 percentage points from 30.8% to 17.4%. Over a similar time period (2005–2011) the incidence of rural poverty in Senegal in general decreased with only

⁵ This is defined as the number of people between 18 and 65 years old and who are no student.

⁶ We also applied 10 and 1000 bootstrap replications and found similar standard errors, implying that standard errors are consistently estimated and robust to the number of bootstrap replications.

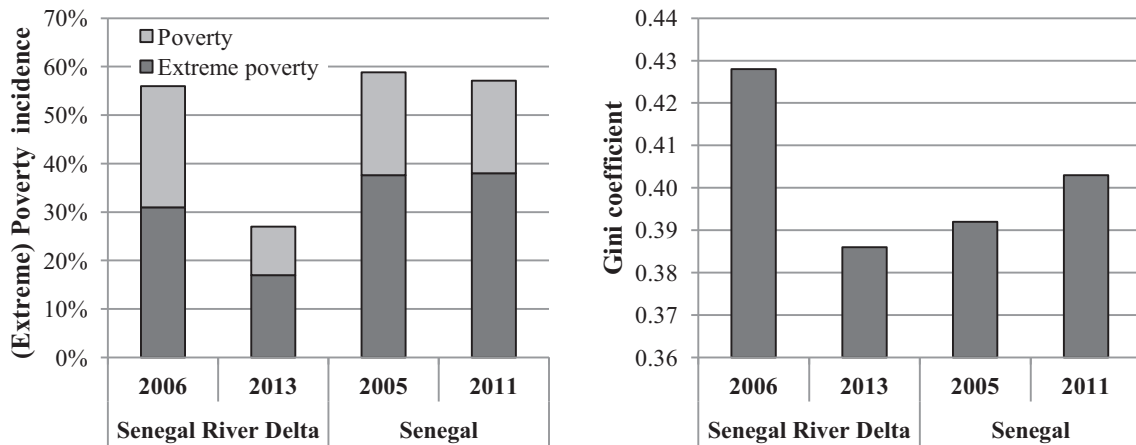


Fig. 1. Poverty headcount ratio (left panel) and Gini coefficient (right panel) for Senegal and the Senegal River Delta. Poverty measures are based on national rural poverty and extreme poverty lines (République du Sénégal, 2014). Source: National data are derived from World Development Indicators (World Bank, 2016) and Senegal River Delta data are calculated based on own survey data using sampling weights.

Table 1

Labour market participation rates in the Senegal River Delta in 2006 and 2013. Source: Calculated from survey data.

	Total population	Income distribution (from low to high income)					
		0-10%	10-25%	25-50%	50-75%	75-90%	90-100%
<i>2006</i>							
Employment in horticultural sector	0.30	0.06	0.13	0.26	0.53	0.30	0.53
Employment in other sectors	0.10	0.00	0.03	0.02	0.13	0.31	0.10
<i>2013</i>							
Employment in horticultural sector	0.42	0.63	0.30	0.45	0.34	0.46	0.56
Employment in other sectors	0.25	0.00	0.28	0.24	0.11	0.33	0.63

Population statistics are derived using sampling weights.

1.7 percentage points while the incidence of extreme poverty even increased with 0.4 percentage points. The Gini coefficient for the Senegal River Delta decreased with 4.2 percentage points from 42.8% in 2006 to 38.6% in 2013 while the Gini coefficient in Senegal increased from 39.2% in 2005 to 40.3% in 2011.

Table 1 summarizes the labor market participation of rural households in the research area in 2006 and 2013. The horticultural export sector is the main source of wage employment in the area, providing jobs for 42% of the households in 2013. As the sector expanded after initial investments and exports, employment increased from 30% of households in 2006 to 42% in 2013. Also wage employment in other sectors increased, from 10% of households in 2006 to 25% of households. Labor market participation rates along the income distribution differ substantially across the sectors. For the horticultural export industry we find that employment rates are more evenly distributed in 2013 while for other sectors we find the highest employment rates in the highest income classes. Expansion of employment in the horticultural export sector between 2006 and 2013 especially includes households below the median income quantile, indicating that particularly poorer households entered employment in the sector, while expansion of employment in other sectors is highest for households in the highest income decile.

Table 2 presents poverty and income data for 2006 and 2013, distinguishing between self-employed households (these are households without wage employment who derive their income from self-employment in agriculture, livestock rearing and/or small businesses), and households with employees in the horticultural sector and in other sectors. In 2006, households with employees in the horticultural export sector have a significantly higher total income but are as likely to be poor as self-employed house-

holds. Households with employees in other sectors have a significantly higher total and per capita income and are less likely to be poor than self-employed households. In 2013, income levels are substantially higher and poverty incidences substantially lower for all households. Income increased more rapidly for households with employees and we observe significantly larger total and per capita incomes in 2013 for households with employees than for self-employed households. Poverty reduction is sharpest among households with employees in the horticultural export sector. The incidence of poverty and extreme poverty among these households reduced from 54% to 25% and from 30% to 15% respectively, resulting in significantly lower poverty rates than for self-employed households. These data on income poverty are corroborated by the data on multidimensional poverty based on households' living standards, health and education. The figures in Table 2 further reveal that wages earned in the horticultural export industry and other sectors contribute the major part of total household income for households with employees while self-employed households derive their income mainly from agricultural production and non-farm businesses.

Fig. 2 presents the cumulative income distribution for households with employees versus self-employed households. For employment in the horticultural export sector (left panel), we observe that for 2006 the income distribution is very similar to the one for self-employed households. For 2013 the income levels of households with employees are higher than those of self-employed households with the largest differences at lower income levels and convergence towards higher income levels. This suggests that wage employment in the horticultural export industry is positively correlated with total income, especially for households at the lower end of the income distribution. For employment

Table 2

Poverty incidence and income levels for households with and without employees for 2006 and 2013.

	2006			2013		
	Self-employed households	Households with employees in		Self-employed households	Households with employees in	
		Horticultural export sector	Other sectors		Horticultural export sector	Other sectors
Number of observations	75	169	26	97	137	49
Share of poor households ^a (%)	58.67 (5.72)	54.44 (3.84)	23.08*** (8.43)	50.52 (5.10)	25.55*** (3.74)	18.37*** (5.59)
Share of extremely poor households ^a (%)	34.67 (5.53)	30.18 (3.54)	11.54** (6.39)	37.11 (4.93)	15.33*** (3.09)	16.33*** (5.33)
Share of multidimensionally poor households ^b (%)	NA	NA	NA	36.34 (1.68)	31.69** (1.53)	25.21*** (2.19)
Total household income (1000 FCFA/year)	1222 (136)	1953*** (141)	2006*** (219)	1408 (135)	2487*** (180)	3491*** (380)
Income per adult equivalent (1000 FCFA/year)	261 (26)	279 (19)	406*** (53)	349 (35)	484*** (32)	640*** (73)
Average share of income (%) from Wage employment	0.00 (0.00)	54.39*** (2.17)	63.00*** (3.89)	0.00 (0.00)	56.34*** (2.74)	68.26*** (4.24)
Self-employment in agriculture	41.49 (4.46)	27.31*** (2.07)	19.27*** (4.15)	42.35 (4.35)	15.40*** (2.00)	11.90*** (3.07)
Non-farm self-employment	41.76 (4.36)	11.40*** (1.42)	11.25*** (3.62)	31.03 (3.87)	19.86*** (2.28)	14.77*** (3.20)
Non-labor	19.72 (3.76)	8.00*** (1.23)	6.48*** (2.40)	27.07 (3.78)	11.30*** (1.64)	8.93*** (2.22)

We used one-sided t-tests to compare households without employees and households with employees in the horticultural export/other sectors. Significant differences are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$. Standard errors are reported between parentheses. Households with employees in the horticultural export sector and households with employees in other sectors are not mutually exclusive classes; 15 households were employed in both sectors in 2006 and 28 in 2013.

^a Poverty measure based on the national rural (extreme) poverty lines (République du Sénégal, 2014).

^b Poverty measure based on the Multidimensional Poverty Index, calculated according to the guidelines by the UNDP (Alkire and Santos, 2010).



Fig. 2. Cumulative real income distribution in 2006 and 2013 for households with employees in the horticultural export industry versus households without employees (left panel) and for households with employees in other sectors versus households without employees (right panel). Source: Derived from survey data.

in other sectors, we observe a different pattern (right panel). Income levels of households with employees are consistently higher than those of self-employed households but the difference is highest for medium income levels in 2006 and for upper income levels in 2013. This suggests that employment in other sectors is correlated with higher total household income, and this correlation becomes stronger for relatively wealthier households.

4.2. Job and worker characteristics

To compare working conditions across sectors we present kernel density distributions of daily wages and employment duration (Fig. 3). First, we observe that daily wages in the horticultural export sector are on average lower than in other sectors. This dif-

ference has become more pronounced over time as the average real wage in other sectors increased with 66% (from 3002 FCFA/day in 2006 to 4982 FCFA/day in 2013) while in the horticultural export sector there is hardly an increase (from 2537 to 2550 FCFA/day). We note that wages in the export companies are on average 67% higher than the national minimum wage of 1500 FCFA per day. The variability in wages is larger in other sectors – likely because of more variability in the type of jobs – and the distribution is skewed with a long tail towards higher wages but with a similar median value as for the horticultural export sector.

Second, the number of days worked per year is substantially smaller in the horticultural export sector than in other sectors. Workers are hired in export companies for on average 6.8 months in 2006 and 8.2 months in 2013 while employment in other sectors

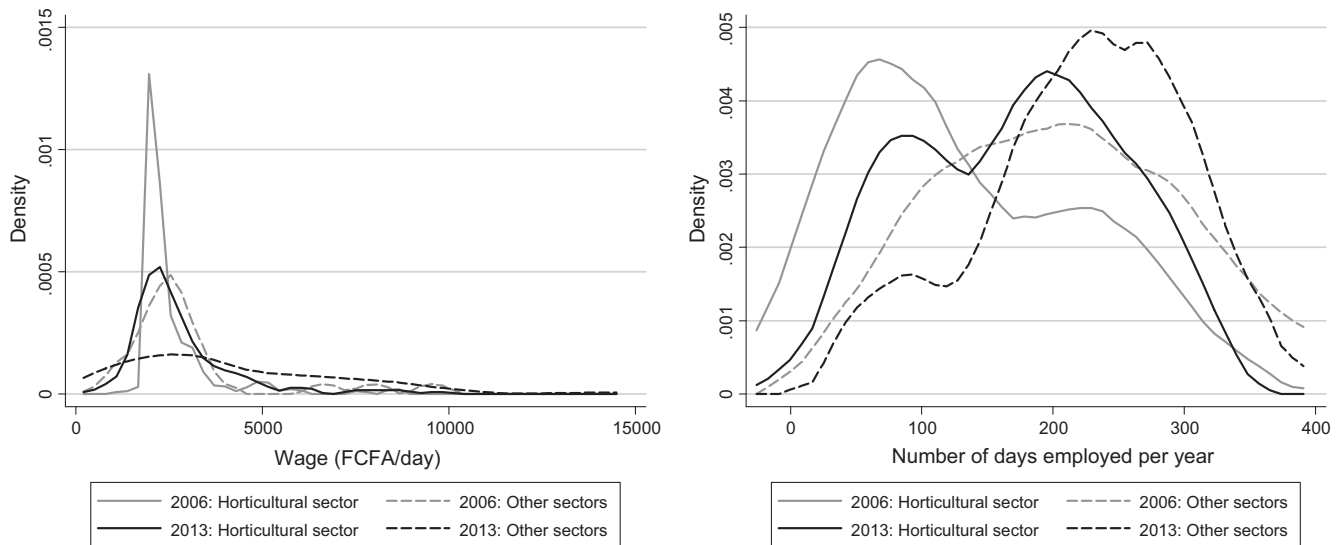


Fig. 3. Kernel density distribution for wages (left panel) and employment days (right panel) in the horticultural export sector and in other sectors for 2006 and 2013. Source: Derived from survey data.

is almost full-time and year-round. This reflects the seasonal character of horticultural export activities that are concentrated in the off-season in Europe. The distribution of employed days in the horticultural export sector shows a bimodal pattern, which reflects the employment of day-to-day workers during peak labor times and the employment of seasonal workers with a contract of six to eight months. The increase in number of working days over time for employment in export companies is important. Companies have been able to expand their product variety and to prolong their export season, which results in longer employment periods for temporary workers.

Table 3 presents demographic household characteristics for 2013, distinguishing between self-employed households, households with employees in the horticultural export sector and households with employees in other sectors. We observe that households with employees in the horticultural export sector and in other sectors have significantly more workers and more dependent household members, a higher likelihood to be ethnic Peulh, and live closer to Saint Louis town than self-employed households. The level of education is higher for households with employees than for self-employed but the level of education in general is very low with the large majority of household heads not having finished

Table 3
Demographic characteristics of households by employment status for 2013.

	Self-employed households	Households with employees in	
		Horticultural export sector	Other sectors
Number of observations	97	137	49
Age of HH head (years)	58.05 (1.40)	59.31 (1.13)	59.37 (2.31)
Female HH head (%)	9.28 (2.96)	8.76 (2.42)	16.33 (5.33)
Education of HH head (years)	1.46 (0.29)	2.65*** (0.32)	3.18*** (0.55)
Number of workers ^a	4.45 (0.30)	5.70*** (0.27)	6.33*** (0.46)
Number of dependents ^a	5.20 (0.28)	5.86* (0.32)	6.65*** (0.55)
Total land (ha)	5.20 (1.57)	1.93** (0.25)	3.54 (0.79)
Livestock units ^b	8.18 (1.78)	8.89 (1.67)	7.80 (3.37)
Wolof ethnicity (%)	59.79 (5.00)	37.96*** (4.16)	42.86** (7.14)
Peulh ethnicity (%)	15.46 (3.69)	35.04*** (4.09)	38.78*** (7.03)
Distance to Saint-Louis (km)	30.98 (0.98)	24.51*** (1.00)	22.98** (1.58)
Distance to closest company (km)	4.29 (0.32)	2.60*** (0.20)	3.37 (0.43)
Lives next to road (%)	64.95 (4.87)	62.77 (4.15)	73.47 (6.37)

We used one-sided *t*-tests to compare households with and without employees in the horticultural export/other sector. Significant differences are indicated with **p* < 0.1, ***p* < 0.05 or ****p* < 0.01. Standard errors are reported between parentheses. Households with employees in horticultural export sector and in other sectors are not mutually exclusive; 15 households were employed in both sectors in 2006 and 28 in 2013.

^a HH members who are able to work are all members between 18 and 65 who are no student, while the dependent HH members are the remaining people in the HH.

^b One tropical livestock unit (TLU) equals 1 cow/horse, 0.8 donkey, and 0.2 sheep/goat.

Table 4

Results of fixed effects and quantile fixed effects regressions on the logarithm of income per adult equivalent.

Variables	Mean effect	Heterogeneous effects at different quantiles				
		Q10	Q25	Q50	Q75	Q90
Wage employment in horticultural sector	0.375 (0.411)	0.527*** (0.202)	0.494*** (0.131)	0.297*** (0.105)	0.142 (0.141)	0.146 (0.107)
Wage employment in other sectors	0.831*** (0.269)	0.742*** (0.128)	0.566*** (0.133)	0.625*** (0.114)	0.824*** (0.137)	0.842*** (0.139)
Age of HH head	−0.022 (0.016)	−0.019*** (0.004)	−0.018*** (0.003)	−0.018*** (0.003)	−0.022*** (0.004)	−0.029*** (0.005)
Female HH head	−0.210 (0.491)	−0.160 (0.172)	−0.183 (0.122)	−0.244* (0.133)	−0.286* (0.171)	−0.332* (0.187)
Education of HH head	−0.034 (0.057)	−0.036** (0.016)	−0.027** (0.013)	−0.025** (0.012)	−0.020 (0.013)	−0.025* (0.016)
Number of HH members able to work	−0.039 (0.065)	−0.032* (0.017)	−0.028** (0.014)	−0.038*** (0.013)	−0.043*** (0.013)	−0.047*** (0.016)
Number of dependent HH members	−0.052 (0.047)	−0.048*** (0.016)	−0.046*** (0.011)	−0.035*** (0.010)	−0.034*** (0.011)	−0.040*** (0.014)
Total land	−0.023 (0.016)	−0.021** (0.009)	−0.025*** (0.007)	−0.028*** (0.009)	−0.021** (0.009)	−0.024** (0.009)
Livestock units	0.008 (0.012)	0.007* (0.004)	0.007 (0.004)	0.012*** (0.005)	0.014*** (0.004)	0.008 (0.005)
2013 dummy	0.274* (0.154)	0.245 (0.525)	0.783** (0.393)	0.481* (0.287)	0.065 (0.363)	0.080 (0.414)
Constant	13.751*** (1.228)	12.687*** (0.330)	12.683*** (0.331)	13.401*** (0.282)	14.335*** (0.412)	15.170*** (0.451)
Village fixed effects	Included	Included	Included	Included	Included	Included
Number of observations	507	507	507	507	507	507
R ² - between	0.003	/	/	/	/	/
R ² - within	0.139	/	/	/	/	/

Variables are specified in Table 3. Column 1 reports the coefficients of the fixed effects regression and columns 2 to 6 report the coefficients of the quantile fixed effects regression at the 10%, 25%, 50%, 75% and 90% quantiles. Bootstrapped standard errors clustered at village level are reported in parentheses. Significant coefficients are indicated with * $p < 0.1$, ** $p < 0.05$ or *** $p < 0.01$.

primary school. Households with employees in the horticultural export sector have significantly less agricultural land – which might be an important push factor for employment – and live closer to export companies – which might be an important pull factor for employment.

4.3. Income effects of wage employment

In this section we present and discuss the results of the fixed effects and quantile fixed effects regressions on household income. These are reported in Table 4: column 1 reports the mean effect from the fixed effects regression and columns 2–6 report the heterogeneous effects from the quantile fixed effects regression at the 10%, 25%, 50%, 75% and 90% quantiles of the income distribution. We first discuss the effects of wage employment in the horticultural export sector and then compare this with the effects of wage employment in other sectors.

4.3.1. Income effects of wage employment in the horticultural export sector

The results of the fixed effects regression (Table 4 – Column 1) show that wage employment in the horticultural export sector does not have a significant mean effect on per capita income. While the estimated coefficient is quite large, showing an income increase of 37.5%, the effect is statistically not significant due to a large standard error. On the other hand, the results from the quantile fixed effects regression show that the impact of employment differs significantly across quantiles, justifying the use of quantile regressions (Table 4 – Columns 2–6). The estimated effects of employment in the horticultural export industry are strongest for the poorest income groups, at the 10–50% quantiles of the income distribution. Wage employment in the horticultural export sector increases per capita income with 53% at the 10% quantile, with 49% at the 25% quantile, and with 30% at the 50%

quantile. The effect reduces to less than 15% and is not significant at the 75 to 90% quantiles, implying that wage employment in horticultural export sector does not benefit relatively wealthier households in the region.

The results reveal that expansion of the horticultural export sector in the Senegal River Delta has brought about substantial positive welfare effects by increasing the incomes of the poorest half of the rural population through employment on the fields and in the conditioning centres of the export companies. The sector has created both increased employment that is accessible for poorer and better-off households, and has hired workers for an increasingly longer period of the year. It has thereby strongly increased the incomes of wage workers, and particularly so for the poorest: incomes for the poorest 50% of the population increased by 30% and incomes of the poorest 10% of the population increased by 53%. A decade after the first investments were made, the horticultural export sector has contributed substantially to poverty reduction in the region.

Our results corroborate and nuance the findings from cross-sectional studies on the impact of employment in high-value export sectors. Maertens and Swinnen (2009) and Maertens et al. (2011) previously documented average income effects of 47% to 60% for employment in the Senegalese horticultural export industry in the Niayes region and the Senegal River Delta region. The evidence in this paper corroborates this earlier finding and additionally shows that the income effect persists over time and that specifically for the poorest quantiles the impact of employment on income is high. Studies on other sectors and countries are scarce and point to larger income effects – Herrmann and Grote (2015) find that employment in the Malawi sugarcane export industry doubles rural incomes – as well as a lack of effects – Trifkovic (2014) finds no significant effect of employment in the Vietnamese catfish export sector on household income. These cross-sectional studies are likely more prone to over- or

underestimation of impacts but results on the magnitude of income effects likely remain country- and sector-specific. Our study documents the importance of looking beyond mean income effects and analyzing heterogeneous effects across the population. The more nuanced effect that especially poorer households benefit – as we show for the horticultural export sector in Senegal and as has been indicated by Barron and Rello (2000) based on qualitative evidence for the tomato industry in Mexico – might remain hidden in the estimation of mean effects. Our results do not at all confirm the assertions in the literature that high-value export sectors provide inferior and insecure jobs for which wages are too low to get people out of poverty (Barrientos et al., 2000; Ortiz and Aparicio, 2007; Patel-Campillo, 2010; Ulrich, 2014).

4.3.2. Comparison with income effects of wage employment in other sectors

The results of the fixed effects regression (Table 4 – Column 1) show that wage employment in other sectors increases per capita income on average with 83%, which is significant at the 1% level. The results of the quantile fixed effects regression show large and statistically significant effects of employment on per capita income at all quantiles (Table 4 – Columns 2–6). Employment in other sectors increases per capita income with 74% at the 10% quantile; this effect decreases slightly to 63% for the median income quantile; and increases again to 84% at the 90% quantile.

The results of the quantile fixed effects regression suggest that employment in the horticultural export sector is more pro-poor and inequality reducing than employment in other sectors in the research area. Employment in the horticultural export sector has the highest impact on income for the poorest households and is also most inclusive towards these households. Contrary, employment in other sectors has the largest impact on income for households at the upper end of the income distribution and is not inclusive towards the poorest households. Employment participation rates for the horticultural export sector are higher than for other employment sectors along the whole income distribution (apart from the upper 10% of the income distribution) and much higher among the poorest 10% of the population. This documents the importance of the sector and its impact on pro-poor development in the research area.

Yet, the estimated income effect of employment in other sectors is higher than the estimated income effect of employment in the horticultural export sector, along the whole income distribution. This likely relates to longer employment periods in other sectors, where jobs are more year-round and full-time, and the seasonality of horticultural export activities that are confined to a specific export window and result in temporary jobs. It is less likely that the higher income effect of employment in other sectors relates to wages. Apart from a few households with access to highly remunerative jobs, there is not much difference in the distribution of wages between the two sectors. More nuanced findings would be possible if the heterogeneity in other employment sectors could be taken into account. This is difficult with our data because of the relatively low number of observations involved in wage employment outside the horticultural export sector and because more detailed information on other employment sectors is lacking.

The large and positive effects of participation in the labor market on household income are consistent with the idea in the broader development literature that labor market development and off-farm employment is important for rural development (Barrett et al., 2001; Haggblade et al., 2010; Lanjouw and Lanjouw, 2001). Empirical studies from various countries have shown that off-farm income in general, and wages in particular, increase rural incomes (Cramer et al., 2008; Oya, 2013; Rizzo et al., 2015); and that non-farm work has a positive effect on nutrition and food security (Babatunde and Qaim, 2010; Owusu et al.,

2011). Our study adds to this evidence but also contradicts it to some extent. Much of the evidence suggests that the poorest segment of the rural population is either excluded from off-farm employment opportunities or ends up in insecure and low-paid jobs that do not make major contributions towards improving welfare (Oya, 2013; Loison, 2015). There is ample evidence that upper income groups benefit more from rural wage employment than lower income groups; for example for Ghana and Uganda (Canagarajah et al., 2001), for Ethiopia (Bezu et al., 2012), for Honduras (Ruben and van den Berg, 2001), for India (Scharf and Rahut, 2014), and for Bangladesh (Mishra et al., 2015). This implies that rural labor markets are inequality increasing. This is consistent with our results for employment in other sectors in the research area, which are found to be most inclusive towards better-off households and have the largest income effect for those households. In contrast, the horticultural export sector is found to be most inclusive towards the poorest households and to have the largest relative impact on income for these households, which implies that these value chains contribute to reducing inequality.

4.3.3. Impact of other factors on income

The significant positive effect of the time dummy for the year 2013 in the fixed effects regression (Table 4 – Column 1) shows that *ceteris paribus* household per capita income in the region increased with 27% between 2006 and 2013. The estimated coefficients for household characteristics in the fixed effects regression are not significant (Table 4 – Column 1), likely because of limited within-household variation over time, but some are significant in the quantile fixed effects regression (Table 4 – Columns 2–6). In general, we observe smaller standard errors in the quantile regression than in the mean regression. This is likely related to quantile regressions being less sensitive to the distribution of observations around the mean (Wooldridge, 2002, p 451).

5. Conclusion

This paper is the first to present panel data evidence on the long-term impact of expansion of global value chains and large-scale export-oriented farms in developing countries. We estimate income effects of wage employment in the horticultural export sector in the Senegal River delta after more than a decade of investments and expansion of the sector. We use panel data from two survey rounds and fixed effects quantile regression to control for selection bias and estimate heterogeneous effects; and compare the horticultural export sector with other employment sectors in the research area. Over the seven-year period during which horticultural exports from the region increased rapidly, employment in the sector expanded substantially and poverty in the region reduced much faster than elsewhere in the country. The horticultural export sector has created employment that is accessible for poorer and better-off households, and that is associated with higher household income. The income effect of employment in the horticultural export sector is strongest for the poorest households. We conclude that expansion of the horticultural export sector in Senegal has been particularly pro-poor and increased the incomes of workers in the poorest half of the rural population with 30 to 60% through employment on the fields and in the conditioning centres of the export companies.

Employment in the horticultural export sector is more pro-poor than employment in other sectors in the research area as it has the highest impact on income for the poorest households and is also more inclusive towards these households. This finding contradicts much of the literature on rural labor markets that points to better-off households gaining most from wage employment and off-farm income. Possible reasons why the horticultural export sector in

Senegal is more pro-poor and inequality-reducing than other employment sectors, may relate to the combined effect of the size of the sector and its rapid expansion in an area where very few employment opportunities existed; the intensity of low-skilled labor in the sector; and the relative high return to that labor from selling a high-value product in high-value markets. Our results do not support the assertions in the literature that high-value export sectors provide inferior and insecure jobs for which wages are too low to get people out of poverty.

Using panel data we were able to corroborate the findings from earlier cross-sectional studies on the labor market and income effects of high-value exports; and using quantile regressions we were able to point to strong heterogeneity in the income effects and show a strong poverty-reducing impact. While panel data allow us to better deal with selection bias, estimation of heterogeneous impacts can lead to more nuanced findings than average welfare effects.

Our findings provide evidence in the debate on globalization and development; particularly in the discussion whether or not the integration of developing countries in global trade stimulates pro-poor growth and reduces inequality, and in the discussion on large land-lease deals in these countries (Deininger and Byerlee, 2012; Ezcurra and Rodríguez-Pose, 2013; Pieters et al., 2016; Wade, 2004). For Senegal in specific, further expansion of horticultural exports is likely to further improve rural incomes and reduce poverty but might have a superior welfare effect if product and/or destination variety could increase in such a way that export activities become less seasonal (which is possible in the Senegal River Delta where irrigation water is well accessible) and more year-round employment can be created.

Obviously, our findings are specific for our case study. Land and water are relatively well accessible in our research area and effects might be different in other regions where the conditions for the expansion of high-value export chains differ, e.g. where access to land is more problematic. Our study implies that it is important to pay attention to labor market issues for policy-makers concerned with channeling the implications of trade and foreign direct investments, and for researchers evaluating the impact of globalization on development.

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