**Horticultural exports, female wage employment and primary school enrolment: Theory and evidence from a natural quasi-experiment in Senegal[1]**

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**Abstract**

In this paper we analyse the indirect effects of the boom in horticultural exports in Senegal on child schooling. The export boom has caused a dramatic increase in female off-farm wage employment, which led to increased female bargaining power in the household. We investigate the causal effect of female wage income on primary school enrolment. We develop a collective household model with endogenous bargaining power to show that, if women have higher preferences for schooling than men, the impact of female wage income on school enrolment will be the result of a positive income effect, a negative labour substitution effect and a positive empowerment effect. We address the question empirically using original household survey data from Senegal. We use different econometric techniques and show that female off-farm wage income has a positive effect on primary school enrolment, and that the effect is larger for girls than for boys. Our results imply that the horticultural export boom in Senegal has indirectly contributed to the second and third Millennium Development Goals of universal primary education and elimination of gender disparities in primary education.

## 1. Introduction

The recent boom in horticultural exports from developing countries is a much debated issue. It is recognized that horticultural exports entail the potential to raise rural incomes and alleviate poverty because of the link with the rural economy, the high intrinsic value of produce and the labour-intensive production systems (Maertens et al., 2012). There is a growing body of empirical literature that analyses the welfare effects of the development of horticultural export chains (Mithoefer and Waibel, 2011). Most studies point to positive effects of smallholder contract-farming in horticultural export chains on farm productivity, income mobility and poverty reduction (e.g. Minten et al., 2009; Asfaw et al. ,2007). Some studies have emphasized the exclusion of smallholders, especially the poorest ones,  from the chains (e.g. Dolan and Humphrey, 2000; McCulloch and Ota, 2002). A few studies emphasized that important effects emerge through labour markets as well and showed that horticultural export chains importantly contribute to poverty reduction through the creation of rural employment (e.g. Barron and Rello, 2000; Maertens and Swinnen, 2009; Maertens et al, 2011).

Yet, very few studies have looked beyond the direct income and poverty effects of the growth in high-value export chains. Exceptions include Minten et al (2007) who find that smallholder contract-farming with horticultural export companies in Madagascar leads to increased rice yields through technology spillover effects. Asfaw et al (2009) find that there are managerial spillover effects from contracting with certified horticultural exporters in Kenya, leading to led to less hazardous pesticide use and improved health conditions of farmers. Maertens (2009) finds that wage employment in the horticultural export industries in Senegal creates investment spillovers and leads to higher input use and improved productivity in smallholder production for the local market.

In this paper we address a completely unexplored issue and analyse the indirect effects of the boom in horticultural exports in Senegal on child schooling. Previous studies have found that the export boom has been associated with a sharp increase in rural employment, especially female employment, and that this employment importantly contributed to poverty reduction (Maertens and Swinnen, 2009; Maertens et al., 2011) and female empowerment (Maertens and Swinnen, 2012). In this paper we analyse whether female wage employment in the horticultural export sector and associated female empowerment has resulted in better outcomes for children, with a focus on primary school enrolment of boys and girls. We will reveal whether the development of horticultural export chains indirectly contributed to second

and third Millenium Development Goal of universal primary school enrolment and elimination of gender disparities in primary education by 2015 (United Nations, 2010).

This is an important question because education is a critical asset for rural people and schooling is an important determinant of agricultural growth and rural development in the long run (World Bank, 2008). As with many other productive assets, nowhere is the lack of education as large is in Sub-Saharan Africa (SSA[2]). Adult literacy is only 62% in SSA – compared to more than 90% in East Asia and Latin America (World Bank, 2010). More anxiously, progress in education is slow. Primary school enrolment is only 76% in SSA while close to 100% in East Asia and Latin America (World Bank, 2010). Currently still 69 million of primary school-age children are not in school worldwide, about half of them in SSA (United Nations, 2010). In Senegal, primary school enrolment is very low with huge disparities between rural and urban areas and between boys and girls (Bennell, 2002). Primary school enrolment is estimated at 78% for boys and 73% for girls in urban areas versus 62% for boys and 51% for girls in rural areas (Montgomery and Hewett, 2005).

In 2001 Senegal adopted a change in the constitution that stipulates the responsibility of the state to provide adequate public institutions to guarantee primary education for all children, and that all children, boys and girls, have the right to go to school (République du Sénégal, 2003). After this, in 2003, the government of Senegal embarked on a 'Primary education for all – *Education première pour tous'* program under the auspices of the United Nations and with the support of several donors such as the World Bank, USAID and the French Development Agency. The program has mainly focussed on the supply side of schooling; on increasing the number and the quality of classrooms, the quality of teachers, and the availability of textbooks. As a result, net primary school enrolment in Senegal increased from 62% in 2003, when the program started, to 73% in 2009 (World Bank, 2010). This progress is important but not sufficient to guarantee primary education for all by 2015.

Education programs that focus on the supply side of schooling are necessary but they do not suffice to reach the second Millennium Development Goal. A low demand for primary education among poor and rural households has been argued to be the most critical factor in low primary school enrolment rates in SSA (Bennell, 2002). Empirical evidence from several developing countries has shown that household income and wealth are the main factors

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[2] Abbreviations: SSA(Sub-Saharan Africa), ANSD (Agence National de la Statistique et de la Démographie), TLU (Tropical Livestock Unit), IV (Instrumental Variable).

determining schooling; for example Tansel (1997) for Ghana and Ivory Coast, Behrman and Knowles (1999) for Vietnam, Rosati and Rossi (2003) for Pakistan, Gitter and Barham (2008) for Nicaragua, Lincove (2009) for Nigeria, and Zhao and Glewwe (2010) for China. It has been argued that in addition to the level of income, intra-household control over income and resources matters for school enrolment. Some studies have empirically documented that increased bargaining power for women increases school enrolment or school expenditures (or decreases child labour); for example Thomas (1994) for Ghana and Brazil, Reggio (2011) for Mexico, and Gitter and Barham (2008) for Nicaragua, Lancaster, Maitra and Ray (2006) for India. Our study will contribute to this literature by focussing on female off-farm wage income and its effect on child school enrolment.

To analyze the effect of female wage employment in the export agro-industry on primary school enrolment, we first develop an analytical framework based on a household bargaining model in which the bargaining power of women is endogenous and a function of the income women generate from wage employment outside the household. Our model resembles the model described by Basu (2006) but focuses more generally on the impact of maternal wage income on child school enrolment and also accounts for effects that are not necessarily related to the distribution of power in the household. The theoretical analysis reveals that the impact of maternal wage income on child schooling results from three different types of effects: an income effect, a labour substitution effect, and an empowerment effect. Some effects have opposite signs such that the ultimate impact of maternal off-farm wage income on child schooling remains an empirical question.

We empirically address the question using original and unique household survey data from the *Niayes* region in Senegal. In this area, female off-farm wage employment has increased tremendously since the early years 2000 as a result of the horticulture export boom and associated employment on the fields of large agro-industrial estates and in processing and packing units. We can treat this case as a natural quasi-experiment in the sense that a treatment (female wage employment) has arisen serendipitously but where selection into treatment is likely not random (Rosenzweig and Wolpin, 2000). We exploit the quasi-experimental nature of the data and use different econometric techniques to estimate the casual effect of female wage income on the propensity of children to be in school, controlling for individual, household and village characteristics. We find that female wage employment in the horticultural export industry has a significant positive and large effect on primary school enrolment, and that the effect is larger for girls than for boys. This implies that the

horticultural export boom in Senegal indirectly contributed to reaching universal primary education and eliminating gender disparities in primary education.

The remainder of the paper is structured as follows. In the next section we develop an analytical model and theoretically derive how maternal wage employment can affect child schooling. In section three we shortly present the survey data. In section four we give some details on our case-study and argue why this can be treated as a natural quasi-experiment for our analysis. In section five we describe the econometric methods used for a causal analysis of the impact of female wage employment in the horticultural export sector on child school enrolment, and discuss the estimation results. We conclude in a final section.

## 2. A collective household model with endogenous bargaining power[3]

We consider a household consisting of a female and male head, who have unequal bargaining power, and an unspecified number of children. We assume a collective household bargaining model in which the household's utility ($U$) is a weighted sum of women's ($U_f$) and men's ($U_m$) utility:

$$U = \theta U_f\big(C, l_f, S\big) + (1-\theta)U_m(C, l_m, S) \quad \text{with} \quad \theta \epsilon [0,1] \tag{1}$$

$$\forall x \in C, l, S: U_x > 0, \ U_{xx} < 0$$

$$\forall x \in C, l, S; \ \forall y \in C, l, S: U_{xy} < 0$$

Utility is a concave function of consumption ($C$), leisure ($l_f$ and $l_m$) – with women/men deriving utility only from their own individual leisure time – and the schooling of children ($S$). The weights ($\theta$ and $1-\theta$) capture the balance of bargaining power in the household; as $\theta$ increases the power of the wife increases. We assume no savings and investment in the model such that income is completely consumed – this is not a crucial assumption while it simplifies the model. Income is derived from own household production – this includes production at the household farm but can include off-farm businesses and households' reproductive and maintenance activities as well – and from wage employment outside the household. Household production is a concave function of labour ($L$) and land or other fixed assets ($A$). Both women and men allocate labour to household production ($L_f$ and $L_m$).

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[3] The model is inspired by Basu (2006); Reggio (2011); and Emerson and Souza (2002, 2007).

Children can either work in the household ($L_c$), go to school ($S$), or both. Household production can be sold in the market or can be consumed directly and is valued at a price $p$. As we are specifically interested in the impact of maternal off-farm wage employment on child education, we assume that only women can involve in employment outside the household ($E$) for a wage ($w$). Schooling of children is assumed to have a direct impact on utility and to entail a direct costs ($q$), including school fees and other school-related expenses (uniform, books, stationary, etc.).

$$C = pf\left(L_f, L_m, L_c, A\right) + wE - qS \text{ with } \forall x \in L_f, L_m, L_c, A: f_x > 0, f_{xx} < 0 \qquad (2)$$

$$\forall x \in L_f, L_m, L_c, A; \; \forall y \in L_f, L_m, L_c, A: f_{xy} < 0$$

We assume men and women always spent some time on household production and that female wage employment and child schooling can be zero or positive:

$$L_m, L_f > 0, \; E \geq 0 \text{ and } S \geq 0 \qquad (3)$$

We further assume that men's, women's and children's time constraints are always binding:

$$l_f = 1 - L_f - E, l_m = 1 - L_m \text{ and } S = 1 - L_c \qquad (4)$$

In most collective household models and in empirical studies estimating the impact of female bargaining power on child outcomes, the balance of power between men and women is assumed to be determined exogenously; for example by the prevailing market wage rate for female workers (e.g. Bourguignon and Chiappori, 1994), by women's non-labour income (e.g. Thomas, 1994), or by women's education relative to men's education (e.g. Gitter and Barham, 2008). In this paper we use a different approach, inspired by Basu (2006) who considers the bargaining power of women in the household to depend on what women actually earn in the labour market. The bargaining power of women is a function of their wage income ($Ew$) and of a vector of exogenous factors (z): $\theta(Ew, z)$ with $\theta$ increasing in $E$. Hence, in our model, as in the model developed by Basu (2006), women's bargaining power is endogenous as it is influenced by the household's decision on female wage employment.

We assume that female bargaining power in the household depends on women's off-farm wage income but not on their labour effort in household (farm) production and the income derived from that. This is quite realistic for rural areas in Africa, where family labour is often unpaid and where women's decision-making power on farm income is low because they lack statutory rights over land. Off-farm wage employment, on the other hand, might contribute to

female empowerment in the household because the derived income is more directly attributable to women's own labour and because women directly receive the cash (Zhang et al., 2004; Maertens and Swinnen, 2011).

In our model, the collective household will decide on female and male labour in household production ($L_f$ and $L_m$), female labour in off-farm wage employment ($E$), and the schooling of children ($S$). The household's maximization problem can be written as:

$$Max\ \theta U_f\big(C, 1 - L_f - E, S\big) + (1 - \theta)U_m(C, 1 - L_m, S) \tag{5}$$

$$\text{with} \qquad C = pf\big(L_f, L_m, 1 - S, A\big) + wE - qS$$

$$\text{subject to} \qquad E \geq 0 \text{ and } S \geq 0$$

The objective function of the maximization problem is:

$$\Psi = \theta U_f\big(C, 1 - L_f - E, S\big) + (1 - \theta)U_m(C, 1 - L_m, S) - \mu S - \pi E \tag{6}$$

The maximization leads to the following Kuhn-Tucker first order conditions:

$$\frac{\partial \Psi}{\partial L_m} = 0 \implies \theta \frac{\delta U_f}{\delta C} pf_{L_m} + (1 - \theta)\frac{\delta U_m}{\delta C} pf_{L_m} - (1 - \theta)\frac{\delta U_m}{\delta l_m} = 0 \tag{7}$$

$$\frac{\partial \Psi}{\partial L_f} = 0 \implies \theta \frac{\delta U_f}{\delta C} pf_{L_f} + (1 - \theta)\frac{\delta U_m}{\delta C} pf_{L_f} - \theta \frac{\delta U_f}{\delta l_f} = 0 \tag{8}$$

$$\frac{\partial \Psi}{\partial E} \leq 0; \ E\frac{\partial \Psi}{\partial E} = 0$$

$$\implies \ \theta_E U_f - \theta_E U_m - \pi + \theta \frac{\delta U_f}{\delta C} w + (1 - \theta)\frac{\delta U_m}{\delta C} w - \theta \frac{\delta U_f}{\delta l_f} \leq 0 \tag{9}$$

$$\frac{\partial \Psi}{\partial S} \leq 0; \ S\frac{\partial \Psi}{\partial S} = 0$$

$$\implies \ \theta \frac{\delta U_f}{\delta S} + (1 - \theta)\frac{\delta U_m}{\delta S} - \theta \frac{\delta U_f}{\delta C}\big(pf_{L_c} + q\big) - (1 - \theta)\frac{\delta U_m}{\delta C}\big(pf_{L_c} + q\big) - \mu \leq 0 \tag{10}$$

Rearranging equation (7) and (8), leads to the following first two equilibrium conditions:

$$pf_{L_m} = \left. (1 - \theta)\frac{\delta U_m}{\delta l_m} \middle/ \theta \frac{\delta U_f}{\delta C} + (1 - \theta)\frac{\delta U_m}{\delta C} \right. \tag{11}$$

$$pf_{L_f} = \left. \theta \frac{\delta U_f}{\delta l_f} \middle/ \theta \frac{\delta U_f}{\delta C} + (1 - \theta) \frac{\delta U_m}{\delta C} \right. \tag{12}$$

These equilibrium conditions (11) and (12) specify that women and men will allocate labour to household production such that the marginal return to that labour equals their implicit or subjective wage rate. The latter is given by the marginal rate of substitution of own leisure for weighted consumption. In their labour allocation decisions, both men and women take into account the effect on the other person's utility. According to equation (12), women with a higher bargaining power in the household will work less and will have a higher marginal value product of labour in household production.

Substituting (12) in equation (9) and rearranging leads to a third equilibrium condition (13) indicating that women will work in off-farm wage employment if the market wage rate reaches a level that is equal to the marginal return to women's labour in household production plus an additional factor $T$ in which $U_m^*$ and $U_f^*$ stand for men and women's utility levels in equilibrium:

$$E \begin{cases} = 0 & if\ w < pf_{L_f} + T \\ > 0 & if\ w = pf_{L_f} + T \end{cases} \quad with \quad T = \left. \theta_E\left(U_m^* - U_f^*\right) \middle/ \theta \frac{\delta U_f}{\delta C} + (1 - \theta) \frac{\delta U_m}{\delta C} \right. \tag{13}$$

On the one hand, since $pf_{L_f}$ is increasing with $\theta$, women who initially have a smaller bargaining power will have a lower reservation wage and will more likely enter off-farm wage employment. On the other hand, the factor $T$ specifies that women's bargaining position in the household changes with wage employment; and can be positive or negative, depending on whether men's equilibrium utility level is higher than that of women or not. When $U_f^*$ is higher then $U_m^*$, women's reservation wage will be lower than their marginal value product in household production. A higher equilibrium utility level for women will likely require a relatively high bargaining power initially. Hence, initial bargaining power has an ambiguous effect on female off-farm employment. Women might be more willing to take up off-farm wage employment when they have less decision-making power over income from household production but their low bargaining power might interfere with the decision on their own labour allocation.

Further, it is clear from equation (13) that in households with more land and other productive assets, women's reservation wage will be higher as the marginal value product of their labour in household production is higher. When preferences for consumption are high – for example because of a large number of children and other dependents in the household – women's reservation wage will be lower.

A fourth equilibrium condition can be derived from rearranging condition (10) and substituting equation (12) in the condition:

$$S \begin{cases} = 0 & if\ pf_{L_C} + q > R \\ > 0 & if\ pf_{L_C} + q = R \end{cases} \tag{14}$$

$$\text{with} \qquad R = \frac{\theta\frac{\delta U_f}{\delta S}+(1-\theta)\frac{\delta U_m}{\delta S}}{\theta\frac{\delta U_f}{\delta C}+(1-\theta)\frac{\delta U_m}{\delta C}} = pf_{L_f}\frac{\theta\frac{\delta U_f}{\delta S}+(1-\theta)\frac{\delta U_m}{\delta S}}{\theta\frac{\delta U_f}{\delta l_f}}$$

This equilibrium condition (14) specifies that households will send their children to school if the benefits from schooling in terms of derived utility are larger than the costs, including a direct cost ($q$) and an opportunity cost that equals the marginal return to child labour in household production. As long as the costs are larger than the benefits, schooling will be zero. This is in line with human capital theory. Using equation (14) we can examine how female off-farm wage employment affects child education. We can distinguish three different effects. First, there is a general income effect. Female wage income ($wE$) adds to total income and increases consumption ($C$). As utility is a concave function of consumption, the marginal utility of consumption, ($\partial U_f/\partial C$) and ($\partial U_m/\partial C$) will decrease. According to equation (14), the marginal utility of schooling ($\partial U_f/\partial S$) and ($\partial U_m/\partial S$) will need to decrease as well while the marginal return to child labour ($pf_{L_C}$) increases. This implies an increase in schooling ($S$) and a decrease in child labour ($L$).

Second, there is a labour substitution effect. Female wage employment ($E$) reduces women's leisure time ($l_f$), their time in household production ($L_f$), or both. A decrease in women's leisure time will lead to an increase in the marginal utility of leisure ($\partial U_f/\partial l_f$), which according to equation (14) will need to result in an increase in the marginal utility of schooling, ($\partial U_f/\partial S$) and ($\partial U_m/\partial S$), and a decrease in the marginal return to child labour in household production ($pf_{L_C}$). This implies a decrease in schooling ($S$) and an increase in child labour ($L_c$). Likewise, a decrease in women's labour time in household production, will

increase the marginal return child labour ($pf_{L_C}$), leading to an increase in child labour ($L_c$). and a decrease in schooling ($S$).

Third, there is an empowerment effect arising from the fact that female wage employment contributes to women's bargaining power in the household. If women's preferences for schooling are larger than those of men ($\partial U_f/\partial S > \partial U_m/\partial S$) while women's preference for consumption are smaller than those of men ($\partial U_f/\partial C > \partial U_m/\partial C$), then an increase in $\theta$, resulting from an increase in $wE$, will, according to equation (6), lead to an increase in schooling and a decrease in child labour.

In summary, if women have higher preferences for child schooling than men and if off-farm wage employment by women positively contributes to women's empowerment in the household, than the impact of increases in off-farm wage income earned by women on child education will be the result of a positive income effect, a negative labour substitution effect and a positive empowerment effect. The ultimate effect remains an empirical question.

The impact of maternal off-farm wage employment might differ for girls and boys. Parental preferences for schooling might be different for girls and boys. Our model reveals that if the discrepancy in preferences for schooling between women and men is larger for girls than for boys (i.e. $\partial U_f/\partial S - \partial U_m/\partial S$ is larger for girls), the impact of female off-farm wage employment on child education will be larger (or less negative) for girls. Also, the marginal return to child labour might differ for boys and girls. If a decrease in female labour in household production has a larger impact on the marginal return to child labour for girls than for boys (i.e. if $pf_{L_c L_f}$ is more negative for girls), than the impact of female off-farm wage employment on child education will be smaller (or more negative) for girls. So, also the differential impact of maternal wage employment on schooling for boys and girls remains an empirical question.

Other factors might influence child education as well. Land and other productive assets ($A$) result in higher marginal returns to labour in household production for women, men and children. On the one hand, this increases the opportunity costs of schooling and leads to lower levels of schooling. On the other hand, more productive assets lead to higher income and consumption levels, which lowers the marginal utility of consumption, enlarges the benefits of schooling and leads to more schooling. Other factors such as parental education and

demographic characteristics may also affect households' schooling decisions as they determine preferences.

In what follows we will empirically address the question of how maternal wage employment in the horticultural export industry in Senegal – and other factors, such as land and non-land assets, parental education and demographic factors – affect child schooling and analyse differential effects for boys and girls.

## 3. Data collection

We use original survey data from the *Niayes* region in Senegal, which is the main horticulture region in the country where some 20 export companies are located. Data were collected in 2007 using a stratified random sampling technique, resulting in the selection of 451 households in 36 villages in four rural communities in the region. The survey instrument included separate and specific sections for the household head and for the spouse. The survey provides general data on household demographic characteristics, land and non-land asset holdings, agricultural production and marketing, off-farm employment and income, non-labor income, credit and savings. Specifically important for the analysis in this paper is that the survey data include detailed and gender disaggregated information on wage employment in the horticulture export industry and associated wage income. In addition the data allow calculating total household net income from different farm and non-farm sources. Also information on child schooling is available at the individual level for all children between the age of 6 and 18. This includes information on school enrolment during the past year, the years of schooling and the highest grade obtained. These data allow analyzing school enrolment but more detailed information on school attendance and performance is lacking.

These household data are complemented with original data from a village survey in all selected villages and with secondary village-level data from ANSD (*Agence National de la Statistique et de la Demographie*). This includes information on institutional and infrastructure characteristics such as the presence of a primary school in the village and distances to markets, schools and agro-industrial export companies.

## 4. A natural quasi-experiment

Horticulture exports from Senegal increased sharply during the past 15 years; from less than 2.5 million US$ in 1995 to more than 30 million US$ in 2009 (Figure 1). The sharpest growth was since the early years 2000. The three main export crops are beans, mangoes and tomatoes of which the first two are mainly sourced from the *Niayes* region. Apart from some small volumes to neighbouring countries, exports are mainly destined for markets in the EU.

The horticulture export boom has been associated with increased wage employment on the fields and in the processing and packing units of agro-industrial export companies. Especially since the early years 2000 employment in horticulture export companies increased sharply. This is due to the sharp export growth but also to structural changes in the export supply chain. Due to increasing requirements on traceability, quality and food safety in the EU, horticultural exporters in Senegal shifted their sourcing strategy from relying on contracting with smallholder family farms to vertically integrated estate production based on hired labour[4]. In addition, high quality and safety standards increased the need for labour-intensive post-harvest handling. Importantly, mainly women are employed in the sector. Figure 2 shows that the share of households in the region with one or more members working for wages in the horticulture export industry increased sharply; from less than 5% of households in 2001 to more than 30% in 2007. For the large majority of these households it is specifically female household members who are employed in the agro-industry. Almost one third of rural households in the region have one or several female members working in the agro-industry.

The wages women earn in the export agro-industry contribute importantly to total household income. Households with female wage employment have significantly higher total and per capita incomes, and the wages received by women constitute on average almost a quarter of the total income of these households (table 1). This has important implications for intra-household bargaining power: 94% of women working as wage laborer in the horticulture agro-industry indicate that this employment increased their decision-making power in the household. It is also important to note that these employment opportunities for women in the horticulture export industry are new: 89% of women working as wage laborer indicate to have never been employed outside the home and the household farm before, and 83% indicate to have no other possibilities for wage employment outside the horticulture export industry. The

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[4] This is in detail explained in Maertens and Swinnen (2009).

figures in table 1 further reveal that farming constitutes the main part of household income, and that other non-labor sources of income for women are very limited.

The horticultural export boom in Senegal has been associated with off-farm employment opportunities for women, sharply increased incomes from wages earned by women and increased bargaining power for women in rural households. This can be thought of as a natural quasi-experiment to analyse the impact of maternal off-farm wage income and female bargaining power on child school enrolment. The event, a horticulture export boom, has emerged 'naturally' without researchers' intervention and control (Rosenzweig and Wolpin, 2000) and has resulted in the existence of a treatment (female wage employment) but has been driven by factors that are exogenous to household decisions, such as demand in EU markets, and trade and investment liberalisation. As already revealed in section 2, the participation of rural women in off-farm wage employment is likely not randomly distributed across households and depends on observable and unobservable characteristics. We indeed observe some differences in observable characteristics between households with and households without female wage employment (table 2). Households with female wage employment have significantly more female workers, have slightly better educated women, are somewhat older and mainly come from the major ethnic group (Wolof). There is however not much difference between households in terms of ownership of land and non-land assets; households with female wage employment only have slightly lower livestock holdings. Also unobserved household and individual characteristics, most importantly initial bargaining power, may influence women's participation in the labor market. The selection into treatment is influenced by household and individual characteristics, which resembles a quasi-experimental design without random assignment.

Before turning to the econometric estimation of the impact of maternal off-farm wage income on child school enrollment, it is useful to compare schooling figures between households with and household without female off-farm wage employment. The figures in table 3 reveal that 58% of primary school age children in the sample are actually enrolled in school. This rate is somewhat higher for boys (60%) than for girls (55%), and quite a lot higher in households with female off-farm wage employment (65%) than in other households (53%). Also secondary school enrolment and expenditures for schooling are significantly higher in households with female wage employment. Question remains whether the observed differences in primary school enrolment can be attributed to female wage employment and

hence whether the boom in horticultural exports has led to positive spillover effects on child schooling.

## 5. Regression analysis

### 5.1. Econometric methods

To analyse the effect of maternal off-farm wage employment on primary school enrolment we estimate the propensity of each child in the age cohort 7-12 to have attended school during the past year[5] (S). Our main variable of interest is female off-farm wage income (W), which is measured at the household level and specified in three different ways: 1/ total female wage income; 2/ the natural logarithm of total female wage income; and 3/ the share of female wage income in total household income.

In the regression, we additionally control for a large set of individual child characteristics (C) – age, $age^2$ and gender of the child – household characteristics (H) – age, gender and ethnicity of the head, education of the head and the spouse, the number of male and female workers and children, land assets, livestock assets, and wealth indicators (no dirt floor in the house, use of non-wood energy sources) – and some village factor (V) – presence of a primary school in the village, distance from the village to the capital city Dakar, and distance to the nearest asphalt road. These covariates capture relevant factors in the model: the availability of labour in the household (the number of male and female workers), the presence of productive assets (land and livestock assets), differences in market prices (distance to roads and markets), and the direct cost of schooling (presence of a school in the village). In addition, differences in preferences of consumption, leisure and schooling may be partially captured by the household demographic characteristics, parental education and ethnicity of the household.

$$S = \begin{cases} 1 & if\ S^* > 0 \\ 0 & otherwise \end{cases}$$

$$S^* = \beta_0 + \beta_1 W + \beta_2 2C + \beta_3 H + \beta_4 V + \varepsilon$$

We estimate this model first using a simple probit estimation technique. However, this technique may lead to biased estimates due to unobserved heterogeneity. Initial bargaining power is an important unobserved factor that is likely positively correlated with child

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[5] This corresponds to the UN definition of net primary school enrolment (United Nations, 2010).

schooling, and that, according to the conceptual discussion in section 2, might be positively or negatively correlated with female off-farm wage employment. Hence, with a simple probit model we may over- or underestimate the effect of female wage income on primary school enrolment. We try to correct for unobserved heterogeneity by including an additional control variable that proxies for unobserved initial bargaining power. We use female non-labour income as a proxy variable . This indicator has been used in other studies to proxy for female bargaining power in the household (e.g. Thomas, 1994). Also preferences for schooling are unobserved and might be correlated with female wage income. To account for this, we use an additional proxy variable, defined as the share of children in the age cohort 13-18 that have attended at least one year of primary school during their primary school age period. This variable measures revealed preferences for schooling and can be considered exogenous to the decision of female wage employment because the primary school age period of these children dates from before the horticulture export boom and the associated rise in employment opportunities for women[6].

In addition, we use a two stage instrumental variable (IV) estimation technique to account for the endogenous character of female wage income. We instrument female wage income using measures that reflect transaction costs for employment in the export agro-industry. These include the distance the to the nearest horticultural export company in km, the total village population, and female membership of an organisation in 2000. To assure a sufficient supply of labour, export companies often recruit women through existing organisations and, during peak periods, provide transport from larger villages to their companies. We additionally use the number of children in the age cohort 0 to 3 as an instrument. This is negatively correlated with female employment in the export industry as women are not allowed to carry children on their back when working in these companies, while they are used to do so when working on their own fields. The selected instruments are highly correlated with female wage income but can be assumed to have no direct effect on current primary school enrolment. We use tobit models in the first stage as female wage income is zero for a substantial part of the observations. Next to the excluded instruments, only the household (H) and village (V) covariates are used in the first stage.

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[6] The 'preferences for schooling' variable is only observed for those households that have children in the age cohort 13-18, which might cause selection bias. We tested this using a Heckman selection model with having children in the age cohort 13-18 as selection criterion. The inverse Mills ratio's reveal that there is no selection bias. We therefore use a single stage probit model in which we proxy for preferences for schooling.

In summary, we use three different models (baseline probit model, probit model with proxies for unobserved factors, and an instrumental variable probit model) and three different specifications of the main variable of interest (total female wage income, the log of female wage income, and the share of female wage income in total household income). This allows us to test the robustness of the results. In addition, we test for quadratic effects of the main variable of interest, and estimate the models separately for boys and girls.

## 5.2. Results and discussion

The regression results, including estimated coefficients, of the different models with different variable specifications are reported in appendix, table A2 (baseline probit model), A3 (probit model with proxy variables) and A4 (IV probit model). The marginal effects – we report the average partial effect – for the main variable of interest are summarized in table 4. Our main finding is that female wage income from employment in the horticultural export industry has a positive effect on primary school enrolment. The effect of female wage income and the log of female wage income is significant at the 1% or 5% level in all three models. The effect of the share of female wage income is significant only in the model with proxy variables for unobserved effects and in the IV probit model. The results of the IV probit model indicate that for a ten percent increase in the wage income earned by mothers, the likelihood of primary school age children to be enrolled in school increases with 1% point. Likewise, a ten percent increase in the share of female wage income in total income, increases the likelihood of primary school enrolment with 4.2% points. These are large and important effects. In the quadratic specifications, the results are significant at the 1% or 5% level. The variables female wage income and the share of female wage income in total household income have a positive but decreasing effect on the probability of primary school enrolment. These empirically observed effects are in line with insights from the theoretical model that a negative labour substitution effect is offset by a positive income effect and a positive empowerment effect. The results indicate that the horticultural export boom and associated female wage employment have indirectly contributed to increasing child education.

Further, we compare the effect of female wage income on the primary school enrolment of boys and girls using the IV probit model. The full regression results, including estimated coefficients, are given in appendix A, table A5 (IV probit model for boys) and A6 (IV probit model for girls). The marginal effects for the main variable of interest are summarized in table

5. The results indicate that the effect of female wage employment on primary school enrolment is significantly positive for both boys and girls. The estimated marginal effects are substantially larger for girls than for boys. This is in line with the expectation that women, relative to their husband, have higher preferences for educating girls and that female bargaining power has a larger impact on the outcome for girls than for boys. Earlier studies also found evidence of such gender differential effects. For example, Reggio (2011) observes that only girls' labour time is affected by the distribution of power in Mexican households, while boys' labour time is not affected. Thomas (1994) provides evidence from the United States, Brazil and Ghana of female bargaining power having a larger impact on the health of girls than on the health of boys. Our findings imply that women have higher preferences for child schooling than men, and that this parental difference in preferences is larger for girls than for boys. In addition, these results indicate that the horticultural export boom and associated female wage employment have indirectly contributed to eliminating gender disparities in primary education.

Apart from female wage income, other factors have an impact on the probability of child school enrolment as well. These can be revealed from the full regression models reported in appendix A, table A2 till A6. First, child characteristics matter. We find that children's age has a positive but decreasing effect on school enrolment. This quadratic effect might be specific for our research area were children often enter regular primary school at a later age, after spending one or several years in private Islamic schools. The turning point where school enrolment starts to decrease is at around the age of 10, pointing to increased drop-out rates from that age onwards. The results further indicate that the likelihood to be in school is significantly lower for girls than for boys. A calculation of the partial effects for this variable reveals that the likelihood for girls to be in school is about 11% points lower than for boys. This confirms the existing gender imbalance in schooling in rural Senegal.

Second, primary school enrolment is further influenced by household demographic characteristics, ethnicity and parental education. We find that having more brothers decreases a child's own likelihood of being in school. Concerning parental education, our results indicate that father's education has a significant positive effect on school enrolment for children in general and for girls, but not for boys, while mother's education does not have a significant effect in any of the regressions. This implies that father's education is an important determinant of school enrolment, especially for girls, while mother's education is not important for schooling, neither for boys nor for girls. Tansel (1997) found similar effects in

Ghana and Ivory Coast but these results are not consistent with the main body of literature indicating that mother's education has a more important impact on schooling (or labour) of daughters while father's education is more important for sons – for example Emerson and Souza (2007) for Brazil – or that mother's education is more important than father's education for both boys and girls – for example Reggio (2011) for Mexico. The most likely explanation, as also put forward by Tansel (1997), is that education is simply very low for all rural women in poor African countries – on average only 0.16 years in our sample – such that an effect on child school enrolment cannot be observed.

Third, also the asset and wealth position of the household is important in determining primary school enrolment. We find that better housing conditions and larger livestock holdings increase the likelihood of primary school enrolment but the effects are not significant in all model specifications. The wealth position seems to be more important for girls than for boys. These findings are consistent with a large body of literature, already summarized in the introduction, pointing to the importance of income and wealth in the demand for schooling. In addition, our results indicate that landholdings have a negative but increasing effect on child schooling, with a turning point at around 9 to 10 ha. Such a quadratic effect of land was also observed by Basu, Das and Dutta (2010): they find that the effect of landholdings on child labour is positive and decreasing, and attribute this to labour market imperfections. The most likely explanation for our finding is that higher landholdings results in a higher opportunity cost of child schooling because of higher returns to child labour in household farm production. Larger landholdings also result in higher income and consumption levels, which at a certain point lead to higher school enrolment.

Fourth, the presence of a school in the vicinity of the village significantly increases primary school enrolment. This is in line with earlier empirical observation; for example with the findings from Tansel (1997) that the distance to the nearest school decreases primary schooling in Ivory Coast and Ghana. Along with the previously discussed results on the effect of wealth and female wage income on schooling, this implies that both the demand and the supply side of schooling are important in increasing primary school enrolment rates in rural areas. When looking at the regression results for boys and girls separately, we observe that the presence of a school in the village has a strong positive and significant effect on the school enrolment of girls while the effect for boys is not significant. This implies that also for eliminating gender disparities in primary school enrolment both the demand and supply side of schooling are important. In addition, distance to the road is found to have a positive effect

on primary school enrolment. This might be explained by a lower opportunity cost of child education since the marginal return to child labour in farm production is lower further from the road where output prices are lower.

Finally, the results of the first stage tobit models are reported in appendix, table A1. The four instruments (village population, distance to the nearest horticultural export company, children in the age cohort 0 to 3, and female membership of an association in 2000) all have a significant effect, which indicates the relevance of the instruments. In addition, female off. farm wage income is determined by household demographic characteristics and ethnicity.

## 6. Conclusion

In this paper we have demonstrated that there are important indirect effects of the boom in horticultural exports from poor countries. We found that through the creation of rural employment for women, the horticultural export sector in Senegal indirectly contributed to increasing primary school enrolment. The effect of female wage employment in the export agro-industry on school enrolment was found to be larger for boys than for girls. This implies that the development of the horticultural export sector in Senegal indirectly contributed to the second and third Millennium Development Goals of reaching universal primary education and eliminating gender disparities in primary education. This is an important contribution in a country were school enrolment rates lack behind those of Sub-Saharan Africa on average. Our results demonstrate that indirect effects can be important and should be considered in evaluating the contribution of high-value exports on welfare and development.

Apart from female wage income, also father's education and the asset and wealth position of households, were found to be important determinants of primary school enrolment. Our results stress the importance of demand factors in increasing school enrolment rates and hence in reaching universal primary education in poor countries. A main conclusion from our paper is that empowering women in rural households benefits school enrolment rates and that rural women can be empowered through participation in the labour market. This calls for attention to labour markets in policy strategies on gender and education.

Further, our study supports the idea that female bargaining power is to some extent endogenous to household decisions, and the use of female wage income as an alternative measure for female bargaining power in empirical studies. This could be valuable especially

in cases were women's education and non-labour income are generally so low – as in many rural areas in SSA – that the use of these variables as exogenous measures of bargaining power is difficult. Finally, the analysis and results in this paper support the use of collective household models with heterogeneity in preferences across household members to analyse farm-household behaviour, rather than the more widely-used unitary household models.

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**Figures**

**Figure 1: Exports of fruits and vegetables from Senegal, 1995-2009**
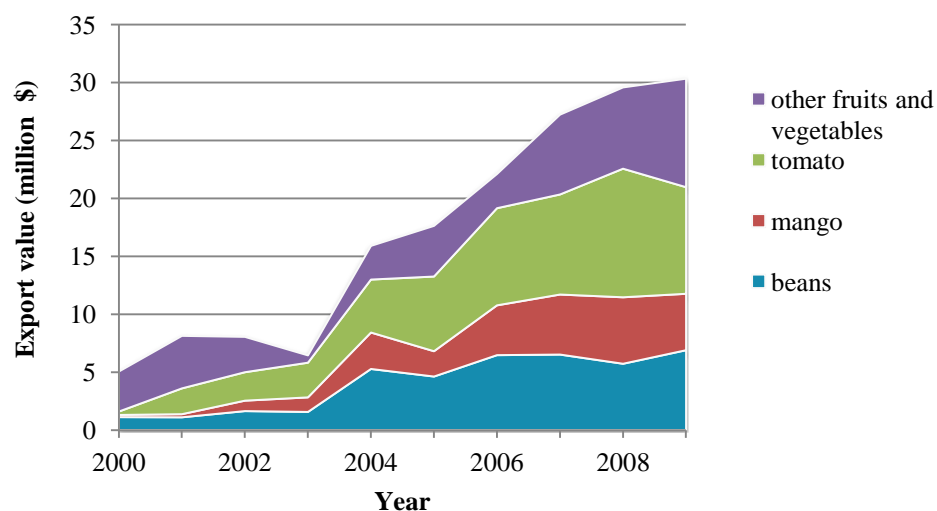


*Source: Comtrade (2010)*

**Figure 2:   Gender disaggregated participation in wage employment in the horticulture export industry, *Niayes* region, 1995 - 2007**
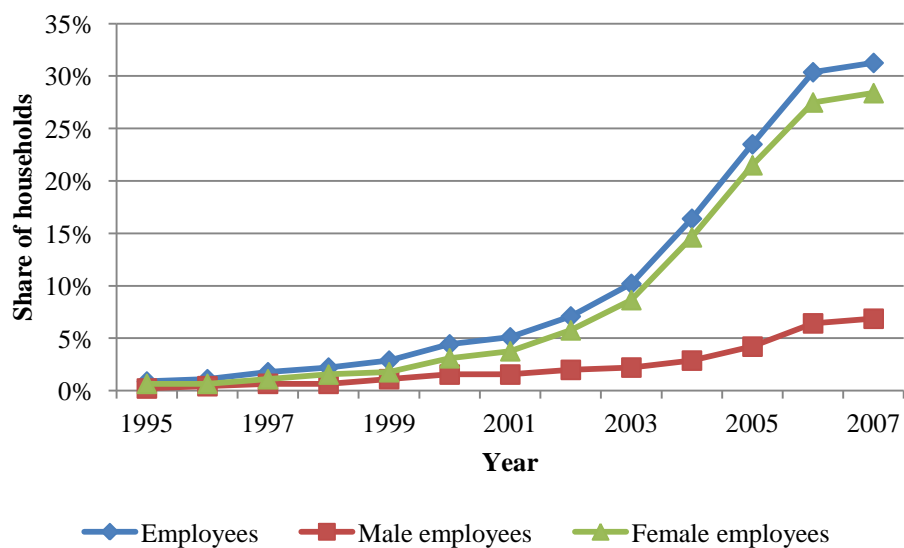


*Source: calculated from survey data*

**Tables**

**Table 1. Household income from different sources across households with and without female wage employment**

| | total sample | hh with female wage employment | hh without female wage employment | |
|---|---|---|---|---|
| Number of observations | 449 | 185 | 264 | |
| Total household income (1000 FCFA) | 1,555.71 | 1,970.18 | 1,265.27 | *** |
| Per capita household income (1000 FCFA) | 222.27 | 261.63 | 194.69 | *** |
| Share of total household income from household farm and non-farm businesses | 76% | 63% | 86% | *** |
| non-labour income | 6% | 5% | 7% | |
| off-farm wages | 18% | 32% | 7% | *** |
| Share of total household income from female non-labour income | 1.5% | 1.0% | 1.8% | |
| female off-farm wages | 10% | 23% | 0% | *** |

Comparisons are made between household with and without female wage employment using t-test. Significant differences are indicated with *p < .15; **p < .10; ***p < .05.

*Source: own calculations from survey data*

**Table 2.** **Household demographic characteristics and asset ownership across households with and without female wage employment**

| | total sample | hh with female wage employment | hh without female wage employment | |
|---|---|---|---|---|
| Number of female workers | 4.34 | 5.05 | 3.84 | *** |
| Number of male workers | 4.52 | 4.75 | 4.36 | |
| Number of children age cohort 0 to 6 | 1.29 | 1.26 | 1.30 | |
| Number of children age cohort 7 to 12 | 1.40 | 1.47 | 1.35 | |
| Number of children age cohort 13 to 16 | 1.15 | 1.23 | 1.09 | |
| Age of the household head | 54.86 | 56.09 | 53.99 | ** |
| Female headed households (share) | 3.3% | 2.7% | 3.8% | |
| Ethnic Wolof households (share) | 67% | 77% | 59% | *** |
| Years of education of the household head | 1.34 | 1.46 | 1.26 | |
| Years of education of the spouse | 0.16 | 0.23 | 0.10 | * |
| Total landholdings (ha) | 3.77 | 3.99 | 3.62 | |
| Per capita landholdings (ha) | 0.31 | 0.31 | 0.31 | |
| Total livestock units[2] | 2.59 | 2.36 | 2.74 | |
| Per capita livestock units[2] | 0.20 | 0.17 | 0.22 | * |
| Value of productive assets (1,000 FCFA) | 332 | 315 | 344 | |

Comparisons are made between household with and without female wage employment using t-test. Significant differences are indicated with *p < .15; **p < .10; ***p < .05.

Wolof is the main ethnic group in Senegal

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

*Source: own calculations from survey data*

**Table 3.  Average school enrolment rates and school expenditures across households with and without female off-farm wage employment**

| | | total sample | hh with female wage employment | hh without female wage employment | |
|---|---|---|---|---|---|
| Primary school enrolment | total | 58% | 65% | 53% | ** |
| (age cohort 7-12) | boys | 60% | 71% | 53% | *** |
| | girls | 55% | 58% | 52% | |
| Secondary school enrolment | total | 46% | 53% | 41% | ** |
| (age cohort 13-16) | boys | 49% | 62% | 40% | *** |
| | girls | 44% | 46% | 42% | |
| Expenditures for schooling (1,000 FCFA) | | | | | |
| total expenditures | | 32.88 | 41.11 | 27.11 | *** |
| expenditures per child | | 10.24 | 11.92 | 8.94 | ** |

Comparisons are made between household with and without female wage employment using t-test. Significant differences are indicated with *p < .15; **p < .10; ***p < .05.

*Source: own calculations from survey data*

**Table 4.  Summary of regression results on the impact of female wage income on the probability of primary school enrolment using different specifications**

| | Estimated marginal effects [a] | | |
|---|---|---|---|
| | Baseline probit models | Probit models, proxy for unobserved factors | IV probit models, female wage income instrumented |
| **Linear specification** | | | |
| Female wage income | 0.033  ** | 0.028  ** | 0.043  *** |
| Log of female wage income | 0.108  *** | 0.094  ** | 0.100  *** |
| Share of female wage income | 0.191 | 0.337  * | 0.427  *** |
| **Quadratic specification** | | | |
| Female wage income | 0.090  *** | 0.092  *** | |
| Female wage income $^2$ | -0.010  ** | -0.011  ** | |
| Share of female wage income | 0.877  ** | 0.641  ** | |
| Share of female wage income $^2$ | -1.157  ** | -0.589  ** | |

Significant effects are indicated with *p < .10; **p < .05; ***p < .01.

[a] Average partial effects are reported

*Source: own estimations from survey data*

**Table 5. Summary of regression results on the impact of female wage income on the probability of primary school enrolment for boys and girls using IV probit models**

| | Estimated marginal effects[a], IV probit models with female wage income instrumented | |
|---|---|---|
| | **boys** | **girls** |
| Female wage income | 0.034 * | 0.060 ** |
| Log of female wage income | 0.076 * | 0.141 ** |
| Share of female wage income | 0.325 * | 0.608 *** |

Significant effects are indicated with *$p < .10$; **$p < .05$; ***$p < .01$.

[a] Average partial effects are reported

*Source: own estimations from survey data*

## Appendix

**Table A1. Estimation of first stage tobit models with different measures of female wage income as dependent variable**

| | Estimated coefficients of first stage tobit models | | |
|---|---|---|---|
| | Female wage income | Log female wage income | Share of female wage income |
| Number of male workers | -0.289 *** | -0.120 *** | -0.032 *** |
| Number of female workers | 0.621 *** | 0.240 *** | 0.057 *** |
| Number of boys | -0.078 | -0.048 | -0.017 * |
| Number of girls | 0.145 | 0.046 | 0.009 |
| Ethnicity (1=hal pular) | -1.857 *** | -0.768 *** | -0.195 ** |
| Ethnicity (1=peulh) | -1.925 ** | -0.821 ** | -0.194 ** |
| Ethnicity (1=other) | -2.041 ** | -0.829 ** | -0.200 * |
| Gender head (1=female) | 0.148 | 0.047 | 0.017 |
| Age household head | -0.013 | -0.004 | -0.001 |
| Education head (years) | 0.020 | 0.014 | 0.001 |
| Educatin spouse (years) | 0.202 | 0.093 | 0.028 |
| Land owned | 0.096 | 0.043 | 0.010 |
| Land owned$^2$ | -0.008 | -0.003 | -0.001 |
| Livestock units | -0.040 | -0.018 | -0.005 * |
| Dirt floor | -0.110 | -0.030 | -0.011 |
| Non-wood energy | 0.166 | -0.003 | 0.030 |
| School in the village | -1.098 ** | -0.514 ** | -0.092 * |
| Distance to Dakar (km) | -0.008 | -0.004 | -0.001 |
| Distance to road (km) | -0.200 | -0.070 | -0.016 |
| Village population | 0.000 ** | 0.000 ** | 0.000 ** |
| Distance to export company (km) | -0.054 ** | -0.022 ** | -0.006 *** |
| Children age cohort 0 to 3 | -0.679 * | -0.233 ** | -0.048 |
| Female association, year 2000 | 0.909 ** | 0.354 * | 0.132 *** |
| Constant | 0.815 | 0.530 | 0.148 |
| Number of observations | 449 | 449 | 449 |
| Log likelihood | -436.40 | -325.74 | -141.10 |
| F( 23, 426) | 11.430 | 12.430 | 9.780 |
| Prob > F | 0.000 | 0.000 | 0.000 |
| Pseudo R$^2$ | 0.130 | 0.168 | 0.300 |

Significant effects are indicated with *$p < .10$; **$p < .05$; ***$p < .01$.

*Source: own estimations from survey data*

**Table A2. Estimation of the probability of children in the age cohort 7-12 to be enrolled in primary school and the impact of female wage income, baseline probit model**

| | Estimated coefficients of baseline probit model | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Female wage income | 0.101 | ** | 0.281 | *** | | | | | | |
| Female wage income $^2$ | | | -0.030 | ** | | | | | | |
| Share of female wage income | | | | | 0.581 | | 2.687 | ** | | |
| Share of female wage income $^2$ | | | | | | | -3.547 | ** | | |
| Log female wage income | | | | | | | | | 0.334 | *** |
| Child age | 1.478 | *** | 1.525 | *** | 1.499 | *** | 1.508 | *** | 1.498 | *** |
| Child age $^2$ | -0.074 | *** | -0.077 | *** | -0.075 | *** | -0.076 | *** | -0.075 | *** |
| Child gender (1=girl) | -0.367 | *** | -0.356 | *** | -0.358 | *** | -0.364 | *** | -0.362 | *** |
| Number of male workers | 0.014 | | 0.022 | | 0.013 | | 0.015 | | 0.020 | |
| Number of female workers | 0.008 | | 0.003 | | 0.024 | | 0.015 | | 0.003 | |
| Number of boys | -0.102 | *** | -0.099 | *** | -0.099 | *** | -0.096 | *** | -0.101 | *** |
| Number of girls | 0.014 | | 0.015 | | 0.012 | | 0.011 | | 0.013 | |
| Ethnicity (1=hal pular) | -0.313 | * | -0.269 | | -0.359 | ** | -0.312 | * | -0.278 | |
| Ethnicity (1=peulh) | -0.349 | * | -0.293 | | -0.398 | ** | -0.346 | * | -0.309 | |
| Ethnicity (1=other) | -0.010 | | 0.017 | | -0.047 | | -0.014 | | 0.014 | |
| Gender head (1=female) | -0.019 | | 0.002 | | -0.044 | | -0.052 | | -0.008 | |
| Age household head | 0.006 | | 0.006 | | 0.006 | | 0.005 | | 0.006 | |
| Education head (years) | 0.067 | *** | 0.064 | *** | 0.069 | *** | 0.065 | *** | 0.065 | *** |
| Educatin spouse (years) | 0.054 | | 0.046 | | 0.053 | | 0.046 | | 0.049 | |
| Land owned | -0.076 | ** | -0.079 | ** | -0.073 | ** | -0.072 | ** | -0.079 | ** |
| Land owned$^2$ | 0.004 | *** | 0.004 | *** | 0.004 | *** | 0.004 | *** | 0.004 | *** |
| Livestock units | 0.007 | | 0.008 | | 0.005 | | 0.006 | | 0.007 | |
| Dirt floor | -0.316 | * | -0.324 | * | -0.342 | * | -0.351 | * | -0.309 | * |
| Non-wood energy | 0.828 | *** | 0.957 | *** | 0.860 | *** | 0.918 | *** | 0.856 | *** |
| School in the village | 0.366 | ** | 0.407 | *** | 0.360 | ** | 0.408 | *** | 0.396 | *** |
| Distance to Dakar (km) | -0.005 | ** | -0.005 | ** | -0.004 | * | -0.004 | * | -0.005 | ** |
| Distance to road (km) | 0.108 | ** | 0.116 | ** | 0.094 | ** | 0.104 | ** | 0.115 | ** |
| Constant | -6.916 | *** | -7.205 | *** | -7.043 | *** | -7.121 | *** | -7.047 | *** |
| Number of observations | 616 | | 616 | | 616 | | 616 | | 616 | |
| Log likelihood | -351.2 | | -348.9 | | -353.5 | | -351.0 | | -349.8 | |
| LR Chi$^2$ | 132.5 | | 137.2 | | 128.0 | | 132.8 | | 135.3 | |
| Prob > Chi2 | 0.000 | | 0.000 | | 0.000 | | 0.000 | | 0.000 | |
| Pseudo R$^2$ | 0.159 | | 0.164 | | 0.153 | | 0.159 | | 0.162 | |

Significant effects are indicated with *p < .10; **p < .05; ***p < .01.

*Source: own estimations from survey data*

**Table A3. Estimation of the probability of children in the age cohort 7-12 to be enrolled in primary school and the impact of female wage income, probit models with proxy variables for unobserved effects**

| | Estimated coefficients of probit models with proxy variables for unobserved effects | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Female wage income | 0.095 | ** | 0.320 | *** | | | | | | |
| Female wage income $^2$ | | | -0.036 | ** | | | | | | |
| Share of female wage income | | | | | 1.151 | * | 2.193 | * | | |
| Share of female wage income $^2$ | | | | | | | -2.017 | | | |
| Log female wage income | | | | | | | | | 0.322 | ** |
| Child age | 1.780 | *** | 1.872 | *** | 1.769 | *** | 1.806 | *** | 1.810 | *** |
| Child age $^2$ | -0.090 | *** | -0.095 | *** | -0.090 | *** | -0.092 | *** | -0.092 | *** |
| Child gender (1=girl) | -0.476 | *** | -0.471 | *** | -0.469 | *** | -0.473 | *** | -0.476 | *** |
| Number of male workers | 0.026 | | 0.039 | | 0.033 | | 0.034 | | 0.033 | |
| Number of female workers | -0.011 | | -0.021 | | -0.002 | | -0.006 | | -0.017 | |
| Number of boys | -0.132 | *** | -0.131 | *** | -0.126 | *** | -0.126 | *** | -0.132 | *** |
| Number of girls | 0.010 | | 0.013 | | 0.009 | | 0.009 | | 0.010 | |
| Ethnicity (1=hal pular) | -0.548 | ** | -0.502 | ** | -0.566 | ** | -0.547 | ** | -0.518 | ** |
| Ethnicity (1=peulh) | -0.252 | | -0.172 | | -0.262 | | -0.235 | | -0.205 | |
| Ethnicity (1=other) | 0.055 | | 0.106 | | 0.017 | | 0.040 | | 0.085 | |
| Gender head (1=female) | -0.434 | | -0.373 | | -0.471 | | -0.469 | | -0.409 | |
| Age household head | 0.006 | | 0.006 | | 0.005 | | 0.005 | | 0.005 | |
| Education head (years) | 0.047 | * | 0.044 | * | 0.049 | ** | 0.048 | * | 0.046 | * |
| Educatin spouse (years) | -0.009 | | -0.021 | | -0.012 | | -0.015 | | -0.014 | |
| Land owned | -0.100 | *** | -0.109 | *** | -0.102 | *** | -0.101 | *** | -0.105 | *** |
| Land owned$^2$ | 0.006 | *** | 0.006 | *** | 0.006 | *** | 0.006 | *** | 0.006 | *** |
| Livestock units | 0.018 | * | 0.019 | * | 0.017 | | 0.018 | * | 0.019 | * |
| Dirt floor | -0.332 | | -0.343 | | -0.357 | * | -0.364 | * | -0.323 | |
| Non-wood energy | 1.057 | *** | 1.262 | *** | 1.056 | *** | 1.102 | * | 1.095 | *** |
| School in the village | 0.460 | *** | 0.510 | *** | 0.474 | *** | 0.502 | *** | 0.487 | *** |
| Distance to Dakar (km) | -0.003 | | -0.003 | | -0.002 | | -0.002 | | -0.003 | |
| Distance to road (km) | 0.088 | | 0.103 | ** | 0.080 | | 0.082 | | 0.098 | * |
| Preferences for schooling | 0.745 | *** | 0.758 | *** | 0.767 | *** | 0.754 | *** | 0.738 | *** |
| Female non-labour income | 0.141 | | 0.114 | | 0.151 | | 0.142 | | 0.129 | |
| Constant | -8.584 | *** | -9.117 | *** | -8.651 | *** | -8.838 | *** | -8.769 | *** |
| Number of observations | 530 | | 530 | | 530 | | 530 | | 530 | |
| Log likelihood | -273.8 | | -271.0 | | -274.1 | | -273.6 | | -272.8 | |
| LR Chi$^2$ | 168.2 | | 173.7 | | 167.6 | | 168.5 | | 170.3 | |
| Prob > Chi2 | 0.000 | | 0.000 | | 0.000 | | 0.000 | | 0.000 | |
| Pseudo R$^2$ | 0.235 | | 0.243 | | 0.234 | | 0.235 | | 0.238 | |

Significant effects are indicated with *p < .10; **p < .05; ***p < .01.

*Source: own estimations from survey data*

**Table A4. Estimation of the probability of children in the age cohort 7-12 to be enrolled in primary school and the impact of female wage income, IV probit models with female wage income instrumented**

| | Estimated coefficients of IV probit models with female wage income instrumented | | | | | |
|---|---|---|---|---|---|---|
| Female wage income | 0.135 | *** | | | | |
| Share of female wage income | | | 1.324 | *** | | |
| Log female wage income | | | | | 0.308 | *** |
| Child age | 1.501 | *** | 1.511 | *** | 1.505 | *** |
| Child age $^2$ | -0.075 | *** | -0.076 | *** | -0.075 | *** |
| Child gender (1=girl) | -0.362 | *** | -0.366 | *** | -0.361 | *** |
| Number of male workers | -0.060 | | -0.052 | | -0.049 | |
| Number of female workers | 0.044 | | 0.047 | | 0.043 | |
| Number of boys | -0.086 | ** | -0.076 | ** | -0.083 | ** |
| Number of girls | -0.001 | | 0.006 | | 0.003 | |
| Ethnicity (1=hal pular) | -0.188 | | -0.180 | | -0.201 | |
| Ethnicity (1=peulh) | -0.219 | | -0.239 | | -0.223 | |
| Ethnicity (1=other) | 0.052 | | 0.036 | | 0.045 | |
| Gender head (1=female) | 0.007 | | 0.019 | | 0.013 | |
| Age household head | 0.006 | | 0.006 | | 0.005 | |
| Education head (years) | 0.053 | * | 0.055 | * | 0.052 | * |
| Educatin spouse (years) | 0.030 | | 0.017 | | 0.030 | |
| Land owned | -0.095 | ** | -0.096 | ** | -0.094 | ** |
| Land owned$^2$ | 0.005 | ** | 0.005 | ** | 0.005 | ** |
| Livestock units | 0.012 | | 0.014 | | 0.012 | |
| Dirt floor | -0.257 | | -0.264 | | -0.263 | |
| Non-wood energy | 0.911 | *** | 0.891 | *** | 0.934 | ** |
| School in the village | 0.602 | *** | 0.582 | *** | 0.608 | *** |
| Distance to Dakar (km) | -0.001 | | 0.000 | | -0.001 | |
| Distance to road (km) | 0.113 | ** | 0.109 | ** | 0.108 | ** |
| Constant | -6.918 | *** | -7.071 | *** | -6.999 | *** |
| Number of observations | 616 | | 616 | | 616 | |
| Log likelihood | -347.7 | | 347.0 | | -348.0 | |
| Wald Chi$^2$ | 150.6 | | 151.5 | | 149.4 | |
| Prob > Chi2 | 0.000 | | 0.000 | | 0.000 | |
| Pseudo R$^2$ | 0.167 | | 0.169 | | 0.166 | |

Significant effects are indicated with *p < .10; **p < .05; ***p < .01.

*Source: own estimations from survey data*

**Table A5. Estimation of the probability of boys in the age cohort 7-12 to be enrolled in primary school and the impact of female wage income, IV probit models with female wage income instrumented**

| | Estimated coefficients of IV probit models with female wage income instrumented | | |
|---|---|---|---|
| Female wage income | 0.105 * | | |
| Share of female wage income | | 1.001 * | |
| Log female wage income | | | 0.234 * |
| Child age | 1.328 ** | 1.338 ** | 1.331 ** |
| Child age $^2$ | -0.066 * | -0.067 * | -0.066 * |
| Number of male workers | -0.006 | 0.002 | 0.003 |
| Number of female workers | 0.033 | 0.035 | 0.032 |
| Number of boys | -0.078 * | -0.071 | -0.076 * |
| Number of girls | 0.001 | 0.006 | 0.004 |
| Ethnicity (1=hal pular) | -0.191 | -0.189 | -0.205 |
| Ethnicity (1=peulh) | 0.023 | 0.008 | 0.017 |
| Ethnicity (1=other) | 0.060 | 0.047 | 0.052 |
| Gender head (1=female) | -0.369 | -0.363 | -0.364 |
| Age household head | -0.002 | -0.002 | -0.002 |
| Education head (years) | 0.029 | 0.031 | 0.028 |
| Educatin spouse (years) | 0.066 | 0.057 | 0.067 |
| Land owned | -0.074 | -0.074 | -0.073 |
| Land owned $^2$ | 0.004 | 0.004 | 0.004 |
| Livestock units | 0.002 | 0.003 | 0.002 |
| Dirt floor | -0.339 | -0.347 | -0.346 |
| Non-wood energy | 0.970 ** | 0.954 ** | 0.985 ** |
| School in the village | 0.412 | 0.392 | 0.412 |
| Distance to Dakar (km) | -0.003 | -0.002 | -0.003 |
| Distance to road (km) | 0.093 | 0.087 | 0.089 |
| Constant | -5.717 * | -5.852 * | -5.781 * |
| Number of observations | 337 | 337 | 337 |
| Log likelihood | -191.9 | -191.8 | -192.1 |
| Wald Chi$^2$ | 52.7 | 53.1 | 52.8 |
| Prob > Chi2 | 0.000 | 0.000 | 0.000 |
| Pseudo R$^2$ | 0.141 | 0.141 | 0.140 |

Significant effects are indicated with *p < .10; **p < .05; ***p < .01.

*Source: own estimations from survey data*

**Table A6. Estimation of the probability of girls in the age cohort 7-12 to be enrolled in primary school and the impact of female wage income, IV probit models with female wage income instrumented**

| | Estimated coefficients of IV probit models with female wage income instrumented | | | | | |
|---|---|---|---|---|---|---|
| Female wage income | 0.203 | ** | | | | |
| Share of female wage income | | | 2.065 | ** | | |
| Log female wage income | | | | | 0.475 | ** |
| Child age | 1.929 | *** | 1.950 | *** | 1.933 | *** |
| Child age $^2$ | -0.097 | ** | -0.098 | ** | -0.097 | ** |
| Number of male workers | -0.153 | ** | -0.147 | ** | -0.140 | * |
| Number of female workers | 0.079 | | 0.085 | | 0.079 | |
| Number of boys | -0.122 | | -0.106 | | -0.117 | |
| Number of girls | 0.001 | | 0.012 | | 0.006 | |
| Ethnicity (1=hal pular) | -0.154 | | -0.125 | | -0.168 | |
| Ethnicity (1=peulh) | -0.428 | | -0.452 | | -0.425 | |
| Ethnicity (1=other) | 0.034 | | 0.007 | | 0.027 | |
| Gender head (1=female) | 0.680 | | 0.705 | | 0.693 | |
| Age household head | 0.017 | | 0.018 | | 0.016 | |
| Education head (years) | 0.098 | ** | 0.099 | ** | 0.096 | ** |
| Educatin spouse (years) | -0.004 | | -0.024 | | -0.005 | |
| Land owned | -0.177 | ** | -0.181 | *** | -0.177 | *** |
| Land owned$^2$ | 0.010 | *** | 0.010 | *** | 0.010 | *** |
| Livestock units | 0.029 | * | 0.034 | ** | 0.030 | * |
| Dirt floor | -0.225 | | -0.232 | | -0.229 | |
| Non-wood energy | 0.994 | * | 0.969 | * | 1.032 | ** |
| School in the village | 0.960 | *** | 0.934 | *** | 0.977 | *** |
| Distance to Dakar (km) | 0.002 | | 0.003 | | 0.002 | |
| Distance to road (km) | 0.162 | * | 0.162 | * | 0.154 | * |
| Constant | -9.847 | *** | -10.099 | *** | -9.960 | *** |
| Number of observations | 279 | | 279 | | 279 | |
| Log likelihood | -146.0 | | -144.9 | | -146.1 | |
| Wald Chi$^2$ | 52.1 | | 52.3 | | 51.6 | |
| Prob > Chi2 | 0.000 | | 0.000 | | 0.000 | |
| Pseudo R$^2$ | 0.241 | | 0.246 | | 0.240 | |

Significant effects are indicated with *p < .10; **p < .05; ***p < .01.

*Source: own estimations from survey data*