Participation in Modern Agri-food Supply Chain in Senegal and Happiness

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Abstract

This paper uses the framework of subjective wellbeing in order to analyze the welfare implication of rural households involved in modern agri-food supply chains in Senegal. It is argued that small farmers are increasingly excluded from high value commodities chains. There is also evidence that despite increasing food standards, vegetable export chains can improve rural households' welfare through contract farming or by the creation of employment. As an alternative and complementary framework, this paper uses self reported happiness instead of the commonly income-based measure to assess the household welfare. We find that using a cross section analysis may lead to the conclusion that the participation in modern agri-export chain as contract farming does not get more happiness than the non-participation (or as equal as). However contracting may be more happy than non-contracting when taking into account unobserved individual/households heterogeneity.

1. Introduction

When asked about their life satisfaction, some individuals with low incomes respond that they are satisfied, while others with the same low income state the opposite. A similar situation is observed when asking that same question to individuals with high incomes. That is, individuals answer being happy or unhappy regardless of their income level. Subjective wellbeing (SWB) surveys have often revealed this discrepancy between individuals' income and their perception of life satisfaction or happiness. In developing countries and particularly in rural areas where poverty levels are more pronounced, it follows that subjective wellbeing reported by rural households might not match results often found in studies regarding poverty reduction.

Poverty issues are most relevant among the rural agricultural population in developing countries. Like many sub-Saharan African countries, agriculture is the main economic activity in rural Senegal. About half of the active population is involved in this sector, which has been Senegal's engine of economic and social development for a long time. Many strategies have been adopted to create wealth for these poor target groups, such as the diversification and promotion of agricultural export products. Moreover, in the last two decades production and trade of high-value agricultural products have substantially increased in international food markets. And at the same time the importance and stringency of food standards have increased as well. The emerging modern agri-food supply chains have increasingly affected developing countries' agri-food systems and thus rural household's wellbeing (Fulponi, 2007; McCluskey, 2007; Swinnen, 2007 and Henson and Jaffee, 2008).

The welfare implications of the integration of developing countries into global markets are one of the important questions raised in agricultural economics. Thus far, the answers in the literature are mixed. Some authors have argued that modern supply chains

lead to the exclusion of small farmers which cannot comply with high food standards (Farina and Reardon, 2000; Swinnen, 2007). However, others have shown that high standards exports can benefit small farmers and rural households through product markets by contract farming or through labor markets by the creation of employment from large scale estate production or agro-industrial processing (Minten et al., 2009; Maertens et al., 2007). In the case of Senegal, some studies have found that the expansion of modern supply chains increases rural incomes and alleviates rural poverty (Maertens et al., 2008 and Maertens and Swinnen, 2009). Either positive or negative, all these empirical findings are based on household income effects. This paper refers to the alternative framework of SWB to examine the welfare implications of rural households involved in the modern agri-food supply chains in Senegal.

The literature on SWB reveals that income, albeit important, is not sufficient to assess welfare impacts and stresses the effects of other socio-economic factors (Gerdtham and Johannesson, 2001). Several researchers have used individuals' or households' reported happiness to study welfare questions instead of the more common income-based measure. SWB, happiness or life satisfaction[1] reflects the own assessment of people's situation. In the words of Veenhoven (1991), happiness is conceived as the degree to which an individual judges the overall quality of his life as favorable. After psychologists, economists have acknowledged that individuals' observable choices do not provide full information to infer their individual utility (Frey and Stutzer, 2005). A broad number of studies show the usefulness of subjective measures of wellbeing as a complement to traditional welfare analysis (see Kahneman and Krueger, 2006). According to Graham (2005), the potential contribution of these measures increases when they are matched with objective income data from the same individual. This matching shows that non-income

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[1] Several authors use these terms interchangeably even though these concepts cover different aspects of life, such as health, financial situation, job, leisure, housing, and environment (Van Praag et al., 2003). See Fischer (2009) for a recent review of these concepts.

factors are important for individual welfare and may explain the observed discrepancy between income and reported happiness.

The reported happiness of individuals has been also related to a wide range of issues related to individuals or households' environment. For instance, some studies link subjective wellbeing to migration (Knight and Gunatilaka, 2008) or labor market questions (Clark, 2003; Hamermesh, 1999; Böckerman, 2005). Other examples include other social dimensions such as criminal victimization (Powdthavee, 2005; Di Tella et al., 2009), as well as political aspects (Di Tella et al., 2007). Most of these studies focus on developed countries. The literature about subjective wellbeing has only recently been applied to developing countries. To the best of our knowledge, there is little research on the relationship between subjective well-being and standard measures of poverty (Pradhan and Ravallion, 2000; Fafchamps and Shilpi, 2008; Farid and Lazarus, 2008). Yet the gap remains to be filled in African countries, and particularly in rural agricultural areas which have recently experienced structural changes in international food markets.

The objective of this study is to investigate how these structural changes are related to reported happiness levels of rural households participating in modern agri-food supply chains in Senegal. The rest of the paper is structured as follows. The next sections present the modern agri-food context, the data and some descriptive statistics. Section five explains the methodology used. Section six presents the results and section seven discusses and concludes.

2. Agri- food supply chain context

International food markets have experienced a huge metamorphose in the last two decades. In case of the fresh fruit and vegetables (FFV) sectors, these structural changes include a shift from traditional tropical exports to non-traditional high-value exports, from developing to developed countries. This shift also includes an increasing importance of food quality and safety standards, increasing consolidation in the agri-food chain with large retail chains and food multinationals gaining importance, and an increasing industrialization of the agriculture sector (Swinnen, 2007). Poverty rates are higher in most rural agricultural areas in developing countries and the development of agricultural supply chains is seen to be one potential way out of poverty.

An important change in the FFV export sector in developing countries is that the overall agri-food quality has improved substantially since food safety standards and requirements imposed by the European Union market[2] have become more demanding. However, the question has risen whether small farmers or rural households are able to benefit from these changes. Warning and Key (2002) argue that small farmers, by contracting with large agro-industry companies, may alleviate the typical constraints they face[3]. Key and Runsten (1999) also stress the new employment opportunities for rural households provided by the expansion of the activities of these agro-industry companies.

Despite these potential positive income impacts, many others studies remain skeptic while considering the strict standards food requirements as new trade barriers (Unnevehr, 2000; Brenton and Manchin, 2002; Augier et al., 2005). Some argue that small farmers are excluded from high value commodity chains because they cannot comply with

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[2] These standards measures take the form of common marketing standards for FFV, sanitary and phytosanitary measures, traceability and also private standards.

[3] For example access to credit and all other assistance.

these requirements (Kherallah, 2000; Reardon and Barrett, 2000 ; Gibbon, 2003). Additionally it is argued that, even if small farmers are able to participate, the revenue gains resulting from this trade are likely to be small for poor farmers (Reardon et al., 1999; Dolan and Humphrey, 2000). Some studies provide empirical evidence that most FFV exports from developing countries like Madagascar (Minten et al., 2006) and Kenya (Minot and Ngigi, 2004) stem from contract farming with small farmers.

Several others studies have also extensively documented the structural changes in the horticulture export sector in Senegal. The diversification towards high-value commodities is one of the strategies undertaken by this country to integrate into international agricultural markets. During the last two decades, horticultural exports from Senegal have become more diversified and have increased (see Maertens and Swinnen, 2009; Maertens et al., 2008). Maertens and Swinnen (2009) show that, despite increasing standards, Senegal's FFV export chain may improve rural households' welfare even if this exporting takes place through large scale agro-industrial production. This improvement may result from farm-non farm investment linkages (Maertens, 2008). Credit and input markets constraints faced by small farmers can be partially offset by off-farm employment and income resulting from increased agricultural production. Based on a 2005 survey data, Maertens and Swinnen (2009) find significant positive effects on household income from participation in high standards FFV export production either as estate employees or contract farmers. And incomes of participating households are substantially higher than incomes of non-participating households.

Despite the positive income impact of participating in the supply chains, all these arguments in the literature are worth to be considered since households' welfare might be affected by other factors beyond the income. In many developing countries agriculture per se is itself considered as a risky activity rendering income unstable. The change from

smallholder contract-based production to large-scale integrated estate production often reported in the modern agri-food supply chain literature is an example of such volatile environment which might additionally affect household welfare. Although farmers gain from contract farming, small farmers might also face difficulties related to this process. As alternative of income-based analysis, our study draws from subjective wellbeing literature accounting thereby for others factors in the assessment of the welfare of households involved in Senegal agri-food supply chain.

3. Data

The data used in this paper stem from the household survey implemented in July-August 2007 and 2010 in Senegal. The collection of data was intended to measure the welfare impact of rural household participation in the Fresh Fruit and Vegetables export chain. The 2007 survey covered the main horticulture area, "les Niayes". Most of the export companies are based in this area where they source produce and recruit laborers. 451 households were randomly selected in 37 villages. The villages were also randomly selected in four rural communities in the regions Dakar and Thiès—Sangalkam, Diender, Noto and Darou Khoudoss. The same households were surveyed in 2010[4].

The distribution of the sample is presented in Table 1. We keep only the sample of the main respondents and who were the (non) contracting household heads. 784 observations are finally used in the panel data after cleaning of the data. Over the 397 households considered in 2007, 26.45 % took part in export supply chains through contract farming, either in green bean or mango production. This percentage is reduced in 2010. 21.19% of the 387 households were involved as contracting.

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[4] 296 households of the sample were surveyed in a previous survey organized in August–September 2005. The 2007 extended survey accounted additionally for the households that produced mangoes on contract with an agro-exporting company.

Table 1 : Distribution of the sample used

	Contracting (green bean/mango)	Non Contracting	Total
2007	105	292	397
	26.45 %	73.55 %	
2010	82	305	387
	21.19 %	78.81 %	
Total	187	597	784
	23.85 %	76.15 %	

The first variable of interest in our study is the reported happiness of the main respondent (household head) contracting or not. After questions related to household's characteristics, farm and off farm activities and more other questions, the household head was asked to answer the single question: "In general, are you happy?". We first reorder the initially coded categories from 1 (very unhappy) to 7 (very happy) and then reduce the number of self-rated to five since only few households fall respectively into these extreme categories[5]. The five-scale level of reported happiness used in this study belongs to the interval of 3 to 7 categories generally observed in many studies. Although answered by the household head, we note that the answer might be also affected by household considerations as a whole because of the likely interdependencies in wellbeing among members of household (Powdthavee, 2005; Kingdon and Knight, 2007). Nevertheless we include in our regressions both household and the main respondent characteristics in order to account for this fact.

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[5] The recoded values of reported happiness are: 1 "unhappy", 2 "more or less unhappy", 3 "not happy/not unhappy", 4 "more or less happy" and 5 "happy".

4. Descriptive Statistics

A first look of Table 2 shows that households involved in agri food supply chains as contracting in our sample differ in some demographics characteristics from those that do not participate as contracting. Total households income is significantly higher on average for participating than non-participating households. The same picture is observed for the demographic characteristics (size of the household, the years of education of the household head) and for some non-income wealth indicators (landholdings and livestock units). The figures show that on average participating households are well endowed. For example the distribution of household income over the two years of study (see Graph A1 in appendix) confirms that fact.

Table 2 : Mean comparison of Happiness and some households characteristics across households (2007 sample)

	Overall	Contracting	Others	t-test
Number of households	397	105	292	
Happiness	3.69	3.73	3.67	-0.42
Total household income (1,000 FCFA)	1548.5	2048.6	1368.6	-2.70***
Per capita household income (1,000 FCFA)	137.17	163.95	127.54	-2.07**
Total household size	11.42	12.83	10.91	-3.02***
Age of the household head	53.97	54.97	53.61	-0.95
Years of education of the household head	1.22	1.76	1.03	-1.75**
Landholdings (ha)	3.84	5.75	3.15	-4.63***
Livestock units	2.63	3.40	2.35	-1.50*
Surface of the house (m^2)	244.23	200.54	260.06	1.56*

Note : t-test comparisons are made between contracting households (*Contract in grean bean or mango export production*) and non contracting households (*others*). Significant differences are indicated with *p < .10; **p < .05; ***p < .01.

However although participating households are well endowed on average, there is on average no significant difference in reported happiness between participating and non-participating households. Looking at the distribution of happiness provides more insight (Graph 1). Irrespective of the status of participation, the distribution of the reported happiness has a negative skew. While it has approximately a similar trend over the type of

participation in 2007 and 2010, the distribution is somehow different between the two years. At the two low (high) scales, 20% (70.4%) of contracting and 18.83% (66.44%) of non-contracting reported being unhappy (happy) or more or less in 2007. Less (more) of these households (head) were unhappy (happy) or more or less in 2010. In addition more of non-contracting (92.62%) declared being happy or more or less comparatively to the contracting and to the year 2007.

Graph 1 : Distribution of reported happiness over 2007/2010
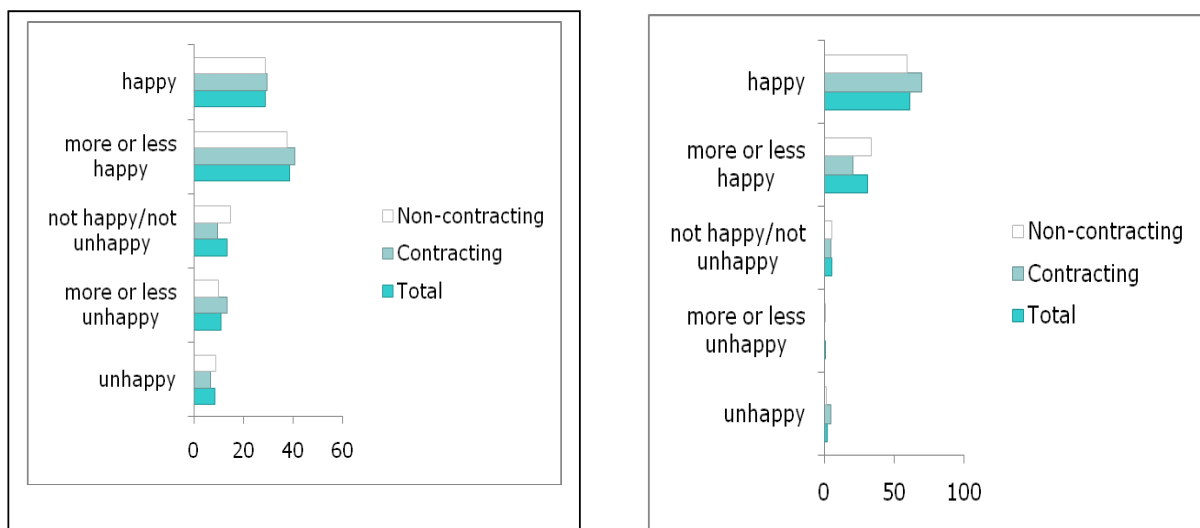
In general, whether participating or not in the export supply chain as contracting, about 64% of the households (head) declared at least being happy or more or less. In short, this is one example of the discrepancy observed in SWB data. Having high (or low) income or (not) participating in agri food supply chain can be matched with high score of reported happiness. The first implication is that considering only household income does not give much information about the wellbeing of the participating in the agri food supply chains. In the next section we address this issue using the SWB framework by taking into account other factors like households characteristics.

5. Empirical methodology

In this section we formalize the link between modern agri-food supply chain participation and the happiness of rural households (head) involved in this chain in Senegal.

5.1. Model and variables

The model we estimate takes the general implicit form:

$$Hap_h = f(P\_contracting_h, \ y_h, \ y_{rh}, \ x_h) \qquad\qquad (1)$$

where Hap_h, is the happiness of the household head h contracting or not. y_h is the wealth variables indicating either household's income or non-income variables. x_h is a vector of socio-economic and demographic characteristics of the household (head) as highlighted in the SWB literature.

In our study, we hypothesize that participation in agri-food supply chains as contracting may in itself be a source of satisfaction for rural households in Senegal. For example abstracting from the labor market perspective related to SWB (see Clark and Oswald, 1996, Hamermesh, 1999), we can consider that kind of participation as an employment status. Therefore controlling for the household's income or non-income wealth indicators, we include in the equation (1) a dummy variable that reflects participation in contract farming, $P\_contracting_h$ which may affect wellbeing.

The variable y_{rh} in equation (1) stands for the relative concept often used in SWB literature. The introduction of this variable takes into account the discrepancy often observed between reported happiness and income. For a given distribution of income, higher income might be matched with a lower reported happiness score. The SWB literature attributes this negative influence on wellbeing to the relative income. Individuals

compare their income relatively to a norm and feel happy as long as their income is greater than the reference income. Simply stated, the relative income hypothesis assumes that the rise in this standard income level might eliminate or reduce the effect of the increased income (McBride, 2001). However a concern when analyzing relative concept in subjective wellbeing study is the choice of the reference group. There is no strict indication about this question in the literature. Some studies use as reference group the cohort including individuals of similar age or inside a certain range of age, similar race (Powdthavee, 2005; Kingdon and Knight, 2007) or locality reference like village, district or province (Knight et al., 2007; Fafchamps, 2007). Others consider various criteria (Ferrer-i-Carbonell, 2005).

In the model (1), we restrict our notion of space-based comparison groups to the village assuming that households (head) are most likely to compare themselves to others within the most nearest area to which they belong. We use a measure of the relative concept related to the income per capita. By relative concept, *other's income* is then defined as the group average of income per capita, the reference group being the household's village. Table A1 in appendix lists all the variables used in the regressions.

5.2. Estimation method

We estimate the following model:

$$Hap_h = \beta_1 P\_contracting_h + \beta_2 y_h + \beta_3 y_{rh} + \beta_4 x_h + \alpha + \varepsilon_h \qquad (2)$$

Where the variables in the model are as described above, ε_h is the error term and the β_i and α are coefficients to be estimated.

One important caveat deserves attention in that formulation. Many sources of bias can arise when identifying welfare effects from subjective data (Ravallion and Lokshin,

2001; Fischer, 2009). Two important sources of bias are endogeneity and heterogeneity problems. Assuming homogeneity between households in the model (2) is quite a strong hypothesis since personality traits are one of the main sources of heterogeneity in perceived wellbeing[6]. According to Ravallion and Lokshin (2001), if these psychological factors are correlated with the other observed variables, there is no need to control for them when measuring the wellbeing effect. Households' or individuals' specific attributes are then reflected through the variables x_h. That is the assumption made in most of SWB studies since personality traits are related to many demographic variables (Ferrer-i-Carbonell and Frijters, 2004). We apply first this assumption by including many household (head) demographic variables in x_{ht}.

Yet, there might be other unobserved factors and it is hard to rely only on observable control variables. Particularly, in the model (2), there is a potential endogeneity problem which stems from the dummy participation variable. Participation in Fresh Fruit and Vegetables export production as contract farming is likely to be non-random. Maertens and Swinnen (2009) provide three important reasons for this. First, households can decide—based on their access to resources and their preferences—to participate and self-select into contract farming. Second, exporting companies might select or exclude potential contractors based on their skills, access to resources, etc. Third, there might be some geographic selection because of increasing transaction costs of firms in sourcing from distant (or isolated) farmers. In these cases, standard regressions results may be biased and inconsistent if unobserved factors in the error term ε_h affecting happiness are correlated with those affecting the participation process. We deal with this selection bias problem in two ways.

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[6] Psychological trait measures are also biased in socioeconomic surveys and may lead to endogeneity problems leaving the individual specific attributes' problem unsolved.

In the first way, we consider (2) as a selection model and the dummy participation variable as endogenous selection (*treatment*) variable. We can then use the treatment-effects (TE) model to estimate (2). The TE model requires to estimate two regressions simultaneously where the endogenous dummy variable $P\_contracting_h$ is replaced by its predicted probability estimated from a first stage probit model:

$$P\_contracting_h = \lambda \ z_h + \varphi + \mu_h \qquad\qquad (3)$$

z_h are potential covariates for selection adjustment and μ_h, the error term. Although no exclusion restrictions are needed to identify the treatment-effects model (Heckman, 1978), z_h include one additional variable measured at village level which do not belong to x_h[7]. The additional variable in z_h is a dummy variable indicating whether the household's village is situated near an asphalted road[8]. The exclusion restriction considered is likely to make the estimates more robust (see Miranda and Rabe-Hesketh, 2006). In the TE model, endogeneity is modeled through the correlation between the errors terms ε_h and μ_h and can be tested.

The selection model (2) is intended to be estimated primarily by ordered probit (OP) to account for the ordinal comparability in SWB. Yet it is difficult to estimate such model with ordered probit in the second stage[9]. We use the conditional mixed process estimator (cmp) which is more suitable for multiple equations estimations involving

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[7] The treatment-effects model can be estimated without exclusion restrictions (i.e when $z_h = x_h$) but the estimation is based on the (untestable) assumption about the joint distribution of the error terms. This assumption (normality) is sufficient to just identify the system.

[8] As stressed above, there might be some geographic selection that affects the participation process.

[9] The usual treatment-effects model estimates only the effect of one endogenously binary *treatment* on a continuous variable using OLS in the second stage. Manually two step procedure may overcome the problem in our case but can lead also to inconsistent estimates.

different types of dependent and independent variables (see Roodman, 2009). By applying this command, we are thus able to jointly estimate the system of reduced and structural equations in the selection model (2) assuming ordinal comparability in the second stage.

In the second way, we consider cardinal comparability in self-reported happiness as psychologists often assume. The model (2) is thus estimated by the two stage least square method (2SLS) with the same specification in the first stage and the same exclusion restriction (instrument) as for the TE model i.e. a dummy variable indicating whether the household's village is situated near an asphalted road.

All previous methods take only observable characteristics and the potential endogeneity of the dummy participation variable into account, while other variables such as income might be also potentially endogenous. In order to consider the omitted variables bias as a whole and not only with respect to the dummy participation variable, the models should take into account time variant household (head) specific effects and time invariant household fixed effects. We use the fixed effect regression to account for the unobserved heterogeneity.

6. Estimation results

Table 3 presents the Pooled Ordered Probit and the Pooled OLS estimation results of the models (2). Columns 1 and 4 show the basic regression results of the model controlling only for the household (head) characteristics. The two others columns include wealth indicators as additional controls, either income or non-income variables.

Only few variables are significant in all regressions. Any individual or household characteristic is not significantly related to happiness except the number of children in the household and the years of education of the household head. Having more children lowers happiness while more education increases happiness. Being a female household head

decreases happiness even though less significantly in the Pooled Ordered Probit regression. Age does not determine the happiness in our regressions. Apparently the commonly U-shaped pattern of SWB over age stressed in the literature (Blanchflower and Oswal, 2008) does not appear in the regressions as indicated by the non-significant and even null effect of the square of this variable.

Table 3: Basic regression results. The dependent variable is : Happiness

	Pooled Ordered Probit			Pooled OLS		
	1	2	3	4	5	6
P_contracting	0.038	-0.034	0.043	0.002	-0.049	0.003
HHsize_adult	0.012	-0.009	0.012	0.011	-0.009	0.010
HHsize_child	-0.029**	-0.031**	-0.029**	-0.028**	-0.027**	-0.028**
HHhead_age	-0.028	-0.028	-0.028	-0.018	-0.017	-0.017
HHhead_age2	0.000	0.000	0.000	0.000	0.000	0.000
HHhead_female	-0.410*	-0.334	-0.390*	-0.386	-0.311	-0.373
HHhead_educ_yrs	0.042***	0.044***	0.041***	0.033***	0.031***	0.032***
HH_nonmigrant	-0.056	-0.082	-0.057	-0.059	-0.079	-0.059
HH_polygamous	0.135	0.051	0.134	0.127	0.051	0.127
HH_ethnic_wolof	-0.112	-0.164*	-0.106	-0.060	-0.108	-0.061
Landholdings (ha)		0.031***			0.021**	
Livestock units		0.008			0.006	
Housing_dirtfloor		-0.384***			-0.425***	
Housing_comb		0.028			0.056	
ln(surface house)		0.208***			0.213***	
ln(HH_income_cap)			0.020			0.023
ln(other's income)			-0.103			-0.057
Constant				4.873***	4.114***	5.295***
R^2				0.151	0.193	0.153
F-test				12.12***	11.15***	10.22***

The Number of observations is 769. Year's dummy is included. Significant effects are indicated with *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Table A1 in appendix gives the definition of variables.

Considering the wealth indicators, some access utilities variables have significant and expected effect on happiness as found in other studies (Kingdon and Knight, 2007). Having a dirt floor in the house lowers significantly happiness while living in a large house have a positive and significant impact. Happiness is related to the size of the land

holding by the household. The coefficient of income per capita is positive but not significant in all regressions.

All basic regression results show that participation in agri food export supply chain as contracting has no significant impact on reported happiness, even controlling or not for individual and household demographic variables and wealth indicators. From these results, it seems that contracting households are not more happy than non-contracting. This is a very preliminary conclusion since participation as contracting is suspected to be endogenous as we have noticed in a previous section.

Table 4 presents regression results of the selection model (2) when taking into account the potential endogeneity of the participation dummy variable. Columns 1 to 2 display results of the treatment-effect models using the mixed process estimator (see Roodman, 2009). This model assumes ordinality comparability in the reported happiness and uses ordered probit for estimating the happiness equation in the final stage. The corresponding estimation results from the first stage probit models are presented in Table A2 in appendix.

The exclusion restriction used is significantly correlated to the probability of *treatment* (the participation dummy variable). Households that live in village near an asphalted road are more likely to be involved in contract farming for green beans or mangoes export production. Some of variables included in the outcome equation (happiness) also predict the likelihood of participating in the agri-food supply chains. For example, households with more land endowment or size, are more likely to be involved in contract farming either through green beans or mangoes export production.

Table 4: Selection model regression results. The dependent variable is : Happiness[1]

	Pooled TE[1]		Pooled 2SLS	
	1	2	3	4
P_contracting	0.133	0.361	0.476	0.458
HHsize_adult	-0.009	0.009	-0.010	0.007
HHsize_child	-0.032**	-0.032**	-0.029**	-0.033**
HHhead_age	-0.028	-0.027	-0.018	-0.017
HHhead_age2	0.000	0.000	0.000	0.000
HHhead_female	-0.312	-0.325	-0.245	-0.287
HHhead_educ_yrs	0.042***	0.039***	0.026*	0.029**
HH_nonmigrant	-0.075	-0.055	-0.062	-0.058
HH_polygamous	0.041	0.103	0.019	0.083
HH_ethnic_wolof	-0.169*	-0.111	-0.125	-0.069
Landholdings (ha)	0.026*		0.007	
Livestock units	0.008		0.006	
Housing_dirtfloor	-0.389***		-0.441***	
Housing_comb	0.032		0.070	
ln(surface house)	0.210***		0.222***	
ln(HH_income_cap)		0.016		0.018
ln(other's income)		-0.128		-0.091
Constant			4.074***	5.744***
Observations	773	775	767	769
Atanhrho[2]	-0.100	-0.195		
R2 /Wald chi2	163.31	130.32	0.158	0.124
Log pseudolikelihood	-1256.93	-1296.66		
F-test (exclud. Inst.)			13.27	15.95
Wu-Hausman F			0.583	0.530

[1]The selection model is estimated using the Conditional mixed process estimator (see Roodman, 2009). Ordered probit is used in the final stage (happiness equation). The first stage includes one exclusion restriction: a dummy variable indicating whether the household's village is situated near an asphalted road. The same instrument is used for the Pooled 2SLS.
[2] The coefficient of *atanhrho* is the transformed versions of *rho* which indicate the correlation between the errors terms of the happiness equation and the contracting equation.
Year's dummy is included in all equations. Significant effects are indicated with *** $p<0.01$, ** $p<0.05$, * $p<0.1$. Table A1 in appendix gives the definition of variables.

As stressed above, the potential endogeneity of the dummy participation variable is modeled through the correlation of the error terms between the outcome equation (happiness) and the *treatment* equation (participation). The test of the independence between these error terms and their correlations are displayed in the Table 4 by the

coefficient of *atanhrho*. The test shows that the coefficient is not significant, indicating that the error terms of the probit equation for contract farming and the happiness equation are not correlated. That means that participation as contracting is likely to be non-endogenous in our selection model. This result is consistent with that found in columns 3 and 4 with the pooled two stage least square (2SLS) method[10].

In these columns the dummy variable indicating whether the household's village is situated near an asphalted road, is not a weak instrument as the test of excluding instrument shows. As in the case for the Pooled treatment-effect models, the Wu-Hausman F test shows that participation as contracting is not indeed likely subject to selection bias. Both estimations suggest that households involved in the supply export chain as contracting are not more happy than the non-contracting households. The effect of all others variables remain the same as in the basic regression results. In general, using Odered Probit or OLS in the final stage gives approximately similar results confirming previous studies (Ferrer-i-Carbonell and Freijters, 2004).

Finally and contrary to the previous results, the fixed effect estimations (Table 5) show that participation as contracting becomes highly significant while the other variables remain approximately the same in terms of sign and significance as previously. The F-test invalidates the hypothesis that all fixed effects are null in all regressions.

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[10] We note that cardinal comparability in reported happiness is assumed here since this method uses OLS in the second stage of the estimation. OLS is used in the first stage contrary to the Pooled treatment-effect models where a probit regression is performed in the first stage. However, we use alternatively as instrument the predicted probality of *participation* derived from a probit regression in the Pooled 2SLS instead of the instrument "*dummy indicating whether the household's village is situated near an asphalted road*"; this latter being included in the probit regression (see Wooldridge, 2002). The results (not reported) are also consistent in this case.

Table 5: Fixed effects regression results. The dependent variable is : Happiness

P_contracting	0.402***	0.399***	0.409***	0.404***	0.411***
HHsize_adult	0.027	0.026	0.040	0.039	0.024
HHsize_child	-0.077***	-0.076***	-0.076***	-0.074***	-0.077***
HHhead_age	0.013		0.008		
HHhead_age2	0.000		0.000		
HH_polygamous	-0.024	-0.030	0.096	0.088	-0.007
Landholdings (ha)	0.028	0.028			0.028
Livestock units	0.014	0.014			0.014
Housing_dirtfloor	-0.394**	-0.402**			-0.386**
Housing_comb	-0.120	-0.126			-0.125
ln(surface house)	0.079	0.079			0.072
ln(HH_income_cap)			0.046	0.045	0.033
ln(other's income)			0.026	0.027	0.021
Constant	3.132	4.114***	2.460	3.540**	3.503**
Observations	770	773	769	772	770
R^2	0.328	0.327	0.316	0.315	0.330
F test (all u_i=0)		1.34***	1.40***	1.41***	1.33***

Year's dummy is included. Significant effects are indicated with *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Table A1 in appendix gives the definition of variables.

7. Discussion and conclusion

Are rural households involved in modern agri food supply chain in Senegal as contracting happier than non-participating households? The results from the cross section (pooled) analysis show that it is less likely to happen. Participation in modern agri-export chains as contract farming may not get more happiness than non-participating (or at least as equal as). The results might be surprising at first sight, given that rural households benefit from contract farming by their derived income (Maertens and Swinnen, 2009).

However the fixed effects results show that contracting may be more happy than non-contracting when taking into account unobserved individual/households heterogeneity. Some studies highly relate personality traits like moods to happiness (Emmons and Diener, 1985; Stewart et al., 2005; Tkach, 2006; Furnham and Christoforou, 2007). It might be expected that moods are more likely to be affected by daily problems or

other problems related to the households activities and then happiness or wellbeing. For example, agricultural activities in general and the modern agri-food supply chains in particular is one of the contexts which can put a strain on farmer's nerves. In our sample, rural households involved in green bean contract farming have coped with a refusal of share of their produce from the company they contract with. And most of them have reported quality problem as main raison.

A lack of evidence regarding the income effect on happiness is another observation noted in our results. This result goes against some studies in the SWB literature even if they nevertheless recognize the weak impact of income. The aspiration (Easterlin, 2001) and social comparison (Diener and al., 1993) arguments advance that there is only a weak link between income and happiness if income increases along with desires or the reference group's income. In our Senegal case study, income gained by rural households might be viewed as not so substantial in this area as their needs increase. Contrary to a permanent salary, rural households' income might be volatile so that they live from day to day. Even if income is consistent, it might be that community relationships (solidarity) are important between households and that the income gained is shared through this channel. Living in poor area and sharing the same reality might also render income comparative effect of rural households nearly nonexistent. Evidence from rural Ethiopia show that this is more likely to be occur (Akay and Martinsson, 2008).

In general our study show that the views in the literature, concerning whether the modern agri food supply chains benefits more or not to rural households involved in, are not opposite ones. Particularly in our Senegal case study, when using alternative SWB framework, failing to control for unobserved heterogeneity may lead to the conclusion that contracting farmers are not more happy (or as equal as) than non-contracting.

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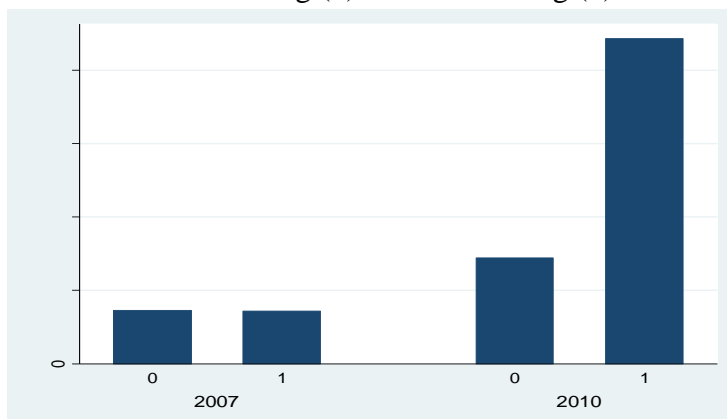Wooldridge, J. M. (2002) *Econometric Analysis of Cross Section and Panel Data*. Cambridge: The MIT Press.

Appendix

Graph A1: Distribution of household income over 2007/2010

Contracting (1)/non-contracting (0)
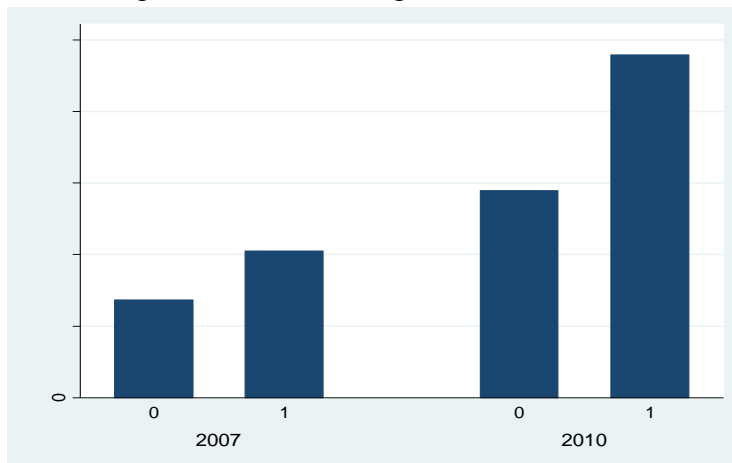
Green Bean Contracting (1)/non-contracting (0)

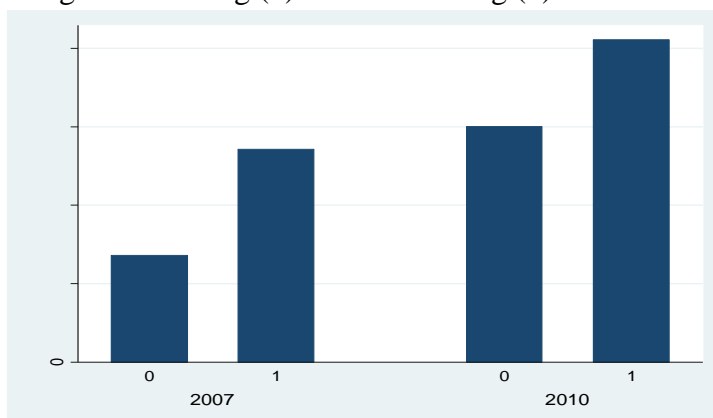Mango Contracting (1)/non-contracting (0)

Table A1 : Definition of the variables used

Variables	Definition
Variables of interest	
Hap	Household's reported happiness; 1"unhappy" to 5"happy"
P_contracting	Dummy if household participates as contract farming=1; 0 otherwise
Main respondent's characteristics	
HHhead_age	Age of household head
HHhead_educ_yrs	Years of education for household head
HH_nonmigrant	Dummy if the household head is born in the village=1; 0 otherwise
HH_polygamous	Dummy if the household head is polygamist=1; 0 otherwise
Household characteristics	
ln(HH_income_cap)	Ln(household per capita income + 1)
HHsize_adult	Number of adults in the household
HHsize_child	Number of children in the household
HHhead_female	Dummy for households with female head=1; 0 otherwise
HH_ethnic_wolof	Dummy if household belongs wolof ethnic=1; 0 otherwise
Landholdings (ha)	Owned land, including land leased out
Livestock units	Number of livestock units (cow, horse is 1; donkey is 0.8; sheep, goat is 0.2)
Housing_dirtfloor	Dummy if household lives with a dirt floor in the house=1; 0 otherwise
Housing_comb	Dummy if household uses a non-wood energy source for cuisine=1; 0 otherwise
ln(surface house)	Ln(surface of the house)
Exclusion restrictions	
Near_road	Dummy if household's village is situated near an road=1; 0 otherwise
Comparison variables	
ln(other's income)	Ln(village average of household per capita income)

Table A2: First stage regression results of the selection model (2)

	Pooled TE[1]		Pooled 2SLS	
	1	2	3	4
near_road	0.651***	0.717***	0.143***	0.162***
HHsize_adult	0.014	0.026*	0.003	0.008*
HHsize_child	0.019	0.040**	0.006	0.012**
HHhead_age	0.007	-0.005	0.001	-0.002
HHhead_age2	-0.000	0.000	-0.000	0.000
HHhead_female	-0.871*	-1.035**	-0.141*	-0.192**
HHhead_educ_yrs	0.024	0.018	0.008	0.005
HH_nonmigrant	-0.051	0.044	-0.020	0.007
HH_polygamous	0.186	0.297**	0.052	0.083**
HH_ethnic_wolof	0.167	0.131	0.044	0.036
Landholdings (ha)	0.075***		0.024***	
Livestock units	0.008		0.002	
Housing_dirtfloor	0.050		0.017	
Housing_comb	-0.139		-0.035	
ln(surface house)	-0.057		-0.015	
ln(HH_income_cap)		0.037		0.009
ln(other's income)		0.152		0.045
Constant	-1.972**	-4.349**	-0.060	-0.726
Observations	773	775	773	775
R^2			0.139	0.085

Note: The selection model (2) is estimated by Pooled TE and Pooled 2SLS. This table presents only the first stage estimation results of the selection model when Ordered Probit and OLS are used in the final stage (happiness equation). Corresponding final stage regression results are found in Table 4 in the text. The two first stages include the same exclusion restriction: a dummy variable indicating whether the household's village is situated near an asphalted road (*Near_road*). Significant effects are indicated with *** p<0.01, ** p<0.05, * p<0.1. Table A1 in appendix gives the definition of variables.