Can Fresh Produce Farmers Benefit from Global Gap Certification? The case of litchi producers in Madagascar*

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Abstract

For few years, the emergence of private standards has been a major concern for developing countries that have managed to achieve substantial exports of fresh produces. It is often argued that the emergence of food standards will lead to marginalization of those farmers who are not able to comply with requirements. In this paper, we investigate a very special case of food standard emergence where certification costs are entirely supported by exporters themselves, often with financial support and technical assistance from donors and trade facilitators. We use a quasi-experimental approach to estimate the causal effect of certification on certified export farmers' marketing performance. The results suggest indeed an impact of certification on quantities. On average, currently certified producers sell larger quantities than their matched counterparts but this is almost uncorrelated to farmers performances since certification is highly driven by market forces and external assistance. Moreover we are able to show that ex-certified farmers do not benefit from certification's impact afterward.

Key words: standards; certification; developing countries; exports; fresh produce

JEL: Q12, Q17, Q56.

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1 Introduction

For few years, private standards have played an increasingly role in the export of fresh fruits and vegetables. Compliance with private standards for FFV now seems inevitable for exporting developing countries. The emergence of private standards is a major concern for developing countries that have managed to achieve substantial exports of fresh produces. At the same time, it is often argued that the emergence of food standards will lead to marginalization of those farmers who are not able to comply with requirements. In this paper, we investigate a very special case of food standard emergence where certification costs are entirely supported by exporters themselves, often with financial support and technical assistance from donors and trade facilitators.

The effects of private standards, although widely discussed from a theoretical point of view (Hammoudi et al., 2009; Henson and Humphrey, 2010; Swinnen and Vandemoortele, 2009), remain rarely assessed on the basis of empirical analyses. Interestingly, existing empirical studies do not test the hypothesis that food standards tend to exclude smallholders from export value chains. Instead, they stress collateral positive effects of certification such as increased salaried employment (Maertens and Swinnen, 2009) or improved health outcomes among farmers (Asfaw et al., 2009 and 2010).[1]

In the empirical literature, the identification strategy is not always convincing, for reasons that are inherent to the research question. We argue that more attention should be paid to the validity of the assumptions underlying quasi-experimental techniques. In particular, we should wonder whether we are able to find a control group while food standards are likely/designed to affect the fresh fruit market as a whole. We argue that the specificity of the Malagasy experience with GlobalGAP standard provides us a rare opportunity to properly assess the direct impact of certification on marketing performances of smallholders.

We use a quasi-experimental approach to estimate the causal effect of certification on certified export farmers' marketing performance. Performance is measured through traded volumes (in tons) and selling prices (in Malagasy ariary/kg). As exporters pay for certification, they are expected to buy litchis from certified farmers first; we thus expected

[1] One exception being Henson, Masakure, and Cranfield (2011) who try to estimate the impact of certification on exporters' revenue rather than focusing on smallholders.

a positive impact on sold quantities at the producer level. Moreover, exporters who sell certified litchis may benefit from a price premium; this may translate in a price premium for farmers too. But actually, we did not expect such an impact as previous qualitative evidence indicates that certification do not guarantee price premium at the exporter level.

Finally, the results suggest indeed an impact of certification on quantities. On average, currently certified producers sell larger quantities than their matched counterparts. They sell about 5.6 tons, 1 to 1.6 tons more than their matches. We fail to detect a significant effect on prices, except for a very specific group of litchi growers, grouped in association of producers, all of whom being certified. Moreover, we provide some answers to the questions raised in impact analyses of food standards. Do exporters who want to increase the proportion of certified products to better meet European demand cheat by sourcing ex-certified farmers? Otherwise stated: do ex-certified farmers still benefit from positive impact of certification - if there is any?

This paper is organized as follows: the litchi export sector in Madagascar and the emergence of Global Gap standards in presented in section 2; the empirical framework and identification strategy are discussed in section 3; the data used in the paper are presented in section 4; results are presented in section 5; and section 6 concludes.

2 Litchi export sector in Madagascar and Global Gap standards

Litchi value chain An island country located off the southeastern coast of Africa, Madagascar is essentially an agricultural economy: the primary sector accounted for 27% of GDP in 2006, although agricultural productivity seems to be declining (Maret, 2009). Madagascar is the main litchi supplier for the European Union. In 2006, the total value of litchi exports reached nearly USD 3 million (almost 9% of all exports) (World Bank, 2007). Since 2004, Madagascar exports an average volume of 20,000 metric tons each year.

The litchi production area extends over 800 km along the eastern coastline between Toamasina and Fort Dauphin and involves over 30,000 families (Thierry and Schneider, 2007). Total annual production was estimated at roughly 180,000-200,000 metric tons between 2003 and 2006 (World Bank, 2007). For logistic reasons, the production area for

exported litchis is concentrated around the island's main harbor: Toamasina (Tamatave) and the neighboring districts of Vavatenina, Fénérive-Est, Tamatave II, Brickaville and Vatomandry. In Europe, litchi consumption is both highly seasonal and very short: litchis from Madagascar arrive in Europe between mid-November and mid-January. As a result of such concentration in time (the campaign lasts 3 months) and space (Toamasina province), a variety of actors temporarily participate in litchi related activities (pickers, collectors, transporters, exporters) before returning to other activities the rest of the year.

Around 30 exporters operate in Toamasina. Exporters work through collectors and directly with producers for their litchi supply. In both cases they pay in advance for their litchis. The rest of the year, these companies export other commodities. Exporters are in charge of sorting and applying chemical treatment to the litchis, packaging and bringing the litchis to the boats. Exporters are quite a heterogeneous group in terms of turnover activity. While some exporters only operate during the litchi season and do not have their own packaging unit, others collect large volumes of litchis and are in relation with several importers. Recently, some exporters started producing litchis themselves in large orchards.

Over 3,000 collectors operate in the area (World Bank, 2007). Two main types of collectors can be distinguished: (a) professional collectors - who also collect cloves, vanilla, pepper, coffee, the rest of the year - are based in Toamasina. They work with one or several exporters and have their own network of trusted suppliers to whom they provide cash advances and technical advice; they only collect litchis for the export market; (b) more occasional collectors from Toamasina or Antananarivo, whose participation depends on market opportunities, on the availability of a vehicle to bring the litchis to the exporters' treatment plants and packaging units. These operators sell to the exporters by queuing in front of their treatment plants. They have no contract with the producers and may switch producers from one year to another. One the export season is over, they sell the remaining litchis on local markets or in Antananarivo.

Most litchi producers (80 to 90%) only own a few trees - less than 20 - that are scattered on their plots. Trees are not very well tended and receive little inputs. The main activity is the organization of the harvest using both family and seasonal workers from neighboring villages. Workers are in charge of picking, sorting and packaging the litchis in traditional baskets (garaba). Most producers have little knowledge about markets and depend on the

collectors to market their litchis.

EU requirements Under the Everything but Arms agreement (2001), Madagascar enjoys a duty-free and quota free access to the European Union for fruits and vegetables (Minten, Randrianarison, and Swinnen, 2009). However, important public regulations limiting the entry of fresh fruit and vegetable into the EU include: EC Regulations 396/2005 and 178/2006 on pesticide regulation and the general food safety regulation imposing traceability of food products within the EU (EC regulation 178/2002) (Codron, Giraud-Heraud, and Soler, 2005). In the case of imported products such as litchis, it is the responsibility of the importer to ensure compliance with the relevant requirements. The main private quality standard used in the EU for fresh produce is GlobalGAP, a collective standard created by European food retailers in 1997 in response to consumer health concerns. GlobalGAP is a set of guidelines established to ensure the hygiene and safety of agricultural products. As most litchi trees are unattended, GlobalGAP focuses mainly on harvest (access to clean water for pre-harvest hand washing, packaging of litchis) and post-harvest procedures (safety, hygiene and working conditions at the sulfur treatment plant, respect of maximum residue limits). Litchi producers may be certified individually (option 1) or as a group (option 2). Certification is obtained when passing an on-farm inspection and paying a fee that must be renewed every year. Quality management systems must be developed to ensure safe pesticide use, and compliance with handling and hygiene standards. Last, exporters must be able to trace production back to a specific farm from which it was procured in order to ensure the compliance of the product with the standard. Compliance with the standard involves fixed costs (e.g. the construction of sheds and of latrines with running water) and recurring costs (e.g. record keeping of all farm activities related to the production of the certified crop, both at the individual and the group level, monitoring costs). Recently, some exporters have received financial support from donors as part of development project. In particular, the year 2007 was characterized by a peak in the number of certified producers in the country (over 1,000 based on the evidence of certification bodies). After the withdrawal of donors, it is clear that the number of certified producers has declined substantially. The relationship between the Malagasy litchi producers and exporters can be analyzed in the conceptual framework proposed by Barrett, Bachke, Bellemare, Michelson, Narayanan, and Walker (2011), where firms (exporters here) make the contracting

choice sequentially: first, they choose where to locate its procurements activities (Toamasina and the neighboring districts of Vavatenina, Fénérive-Est, Tamatave II, Brickaville and Vatomandry); second, they choose specific farmers who are able to comply with their requirements; thirdly, farmers may accept or not (in the Malagasy case, qualitative evidence shows that costs supported by farmers are actually negligible compared to exporters' costs).

3 Empirical framework

We use a quasi-experimental approach to estimate the causal effect of certification on certified export farmers' marketing performance. Performance is measured through traded volumes (in tons) and selling prices (in Malagasy ariary/kg). As exporters pay for certification, they are expected to buy litchis from certified farmers first; we thus expect a positive impact on sold quantities at the producer level. Moreover, exporters who sell certified litchis may benefit from a price premium; this may translate in a price premium for farmers too.

The quality of the data collected allowed us to use difference-in-differences (DID) matching estimators[2]: nearest-neighbor matching (Abadie, Drukker, Herr, and Imbens, 2004), kernel-based matching, and local linear matching (Leuven and Sianesi, 2003). Such matching strategy allows for temporally invariant differences in outcomes between certified and uncertified farmers. Description of estimators used is given in Table 1.

The validity of matching estimators relies on strong statistical assumptions. And yet, we argue that in the special case of Madagascar, we can reasonably suppose that they hold. First, based on qualitative evidence, we can safely assume that the conditional independence condition will be valid because there are actually few factors that could be sources of selection bias and we are able to observe them. Indeed, main determinants of certification status of exporters are: pressure from buyers (European importers) who require compliance

[2]Traditional matching estimators assume that after conditioning on a set of observable characteristics, outcomes are conditionally mean independent of certification participation. However, for a variety of reasons there may be systematic differences between participant and nonparticipant outcomes, even after conditioning on observables that could lead to a violation of the identification conditions required for matching. A DID matching strategy, as defined in Heckman, Ichimura, and Todd (1997), and Heckman, Ichimura, Smith, and Todd (1998), allows for temporally invariant differences in outcomes between participants and nonparticipants (Todd, 2007).

Table 1: Description of estimators

	Name	Definition	Variances
1	NNM_PS_1	nearest neighbour (pscore, 1 match)	A&I formula
2	NNM_X_1	nearest neighbour (covariates, 1 match)	A&I formula
3	NNM_PS_4	nearest neighbour (pscore, 4 matches)	A&I formula
4	NNM_X_4	nearest neighbour (covariates, 4 matches)	A&I formula
5	NNM_PS_1	nearest neighbour (pscore, 1 match)	bootstrap
6	PSM_Kernel	kernel matching	bootstrap
7	PSM_LLR	local linear regression	bootstrap
8	OLS_X	OLS including covariates	
9	OLS_PS	OLS including pscore	

with GlobalGAP standards and the existence of financial support and technical assistance from donors and trade facilitators. On the producers' side, determinants of certification are: their ability to produce large volumes, the quality of their product and their ability to participate in GlobalGAP training course:

$$Pr(D_i = 1|X_i) = \Phi(X_i\beta) \tag{1}$$

where X_i represent the vector of determinants of certification and $\Phi(.)$ is the standard normal cumulative distribution function. Let $D = 1$ if farmers are treated, $D = 0$ if not.

Obviously, factors on the exporter side are not correlated with marketing performances of producers and can be considered as (unobserved) instruments. Thus, by controlling for factors on the producer side only, we are able the get rid of the selection bias. The basic intuition behind this design is the following: when comparing currently certified farmers to non-certified farmers with similar location, production and education levels, we actually compare farmers who supply to two different exporters: one who chose to pay for certification because of market forces and possibly with the help of financial support and another one who decided to give up certification.

Secondly, the stable unit treatment value assumption (SUTVA) is central to the identification strategy. And yet, it is often difficult to ignore potential general equilibrium effects when assessing the impact of food standards, as they are likely to affect the FFV market as a whole, meaning that we would not be able to find any control group in this case. However, in the special case of the litchi market in Madagascar, certified farmers account

for a very small share of traded quantities. Therefore, even a significant impact on them is not likely to result in a general equilibrium effect. This means that we can safely assume that our control group will not be contaminated by the effect of certification - if there's any.

Thirdly, the recent withdrawal of certification by a large number of producers guaranties the existence of a large common support. In other words, we are able to find both currently certified and no-currently certified farmers with high probability of being certified. Under these assumptions, the DID matching estimator which compares the conditional before-after outcomes of GG farmers with those of matched counterparts (EX certified farmers' outcomes in this paper) can be written as follows:

$$\begin{aligned}\widehat{\Delta}^{DID} = n_t^{-1} \sum_{i=1} \left\{ Y_{1ti}(X_i) - \widehat{E}(Y_{0ti}|P(X_i), D_i = 0) \right\} - \\ n_{t'}^{-1} \sum_{j=1} \left\{ Y_{0t'j}(X_j) - \widehat{E}(Y_{0t'j}|P(X_j), D_j = 0) \right\}\end{aligned} \tag{2}$$

where Y_1 denotes the outcome of currently certified farmers (considered as treated), Y_0 denotes the outcome of ex-certified farmers (considered as untreated).

4 Data and descriptive statistics

4.1 Sampling and data

The purpose of the analysis is to estimate the causal effect of certification on certified export farmers' performance during the litchi season 2009-2010. The survey has been run in August 2010. It has been a recall survey about what happened during the marketing season 2009/2010. The followings topics have been investigated through the questionnaire:[3] household's general characteristics, household's assets, land, litchi production, litchi marketing, EurepGap/GlobalGap standards, other cash crops, social network, saving and credit, other activities, health and consumption. Moreover, regarding data requirements for the analysis, the survey also included some questions referring to the pre-certification period, namely season 2005-2006 .

[3]See the questionnaire:`http://web.supagro.inra.fr/partage/subervie/MADA/Questionnaire_06_08_10.pdf`

The targeted population is that of export producers of litchi. The study area covers the districts of Brickaville, Vatomandry, Tamatave, Vavatenina, and Fenerive East, which are the main exporting regions of litchis. The location map of surveyed districts is given in Figure x. The survey covers a total of 506 producers, surveyed individually even if they belong to a group or association. The sample includes:

- 73 farmers, who were certified during the 2009-2010 litchi season. Thereafter these producers are named GG farmers. Hopefully, this group includes the majority of producers actually certified in 2009-2010 across the country;
- 232 farmers, who were not currently certified in 2009-2010 but have been certified at least once since 2005 litchi season. In what follows, they are named EX farmers.

Our sample also includes 201 farmers, who have never been certified; they are called NEVER farmers. Although the main part of the analysis is based on comparisons between GG farmers and EX farmers (indeed, by definition matching on ex-certified farmers gives definitively better estimates than matching on no-certified farmers who may be very different from certified farmers in terms of unobservable characteristics), this third group may be used to assess potential impacts due to permanent changes induced by previous certification.

As practical constraints did not allow us to survey much more than 500 farmers as a whole, the non-certified villages (where we aim at selecting a subset of potential matched counterparts for comparison with GG-farmers) have been selected based on the following conditions: being in the same area as GG producers; being about the same distance from the road as GlobalGap villages; having litchi producers with a number of trees close to that of GlobalGap villages. In practice, once the villages have been selected on the basis of geographical criteria (distance from the road), the enumerators had to go door-to-door randomly until they get the number of respondents that had been set for each village. This sampling implies that the EX and NEVER groups are not representative of their respective populations. However, it increases our chances of achieving a satisfactory matching procedure (see next section).

4.2 Descriptive statistics

Table 6 shows that, in this sample, litchi farmers who have experienced certification (GG and EX) do not differ from other litchi farmers in terms of farm size, family size, nor access to water, non-agricultural activity. However, they differ in terms of number of trees, production, traded volumes. Moreover, they seem to be part of a kind of professional network as they are usually under contract with the exporter. Interestingly, litchi producers who have never been certified have even never heard of it. This basic information confirms that certification is driven by exporters mainly: farmers are offered to be certified by exporters themselves, meaning that farmers who produce large quantities, of good quality and have developed the trust in their relationship with the exporter are more likely to be chosen for certification.

Basic statistics on the cumulative number of years as a GG producer show that it could be one or two mainly. The majority of EX farmers (153) were certified once in 2007, the year the number of certified producers was the highest. Our intuition is that compliance is not a very heavy burden in the case of litchi producers in Madagascar. They must follow one or two training per year, they even ignore the cost of certification, meaning that they do not pay for it. They are sometimes but not always inspected. They do not seem constrained by the collector, at least not more than other producers.

5 Results

5.1 What are (endogenous) determinants of farmer participation in certification?

Conditional probabilities for certification are computed by estimating a probit model. Description of observable variables in pre-certification period are given in Table 7. Results of probit regression are displayed in Table 2. Apart from household head's education level and litchi sales, we failed to detect significant factors likely to determine certification for 2009, which is the expected result when comparing GG farmers to EX certified farmers. This result is consistent with qualitative evidence based on interviews with both farmers and exporters which suggest that the main determinant for certification should be looked

Table 2: Probit regression

Variable	Coef.	SE	z	P>z	[95%	CI]
number_zebu05	-0.01	0.02	-0.66	0.51	-0.04	0.02
farm_size05	0.00	0.01	-0.37	0.71	-0.03	0.02
litchi_worforce05	0.00	0.00	0.73	0.47	0.00	0.01
number_litchi05	0.00	0.00	0.64	0.52	0.00	0.00
litchi_sale05	0.00	0.00	3.64	0.00	0.00	0.00
head_of_hh_educ	0.41	0.18	2.27	0.02	0.05	0.76
contrat05	-0.30	0.29	-1.03	0.31	-0.86	0.27
early_produce_area	0.19	0.21	0.90	0.37	-0.22	0.59
cons	-1.40	0.23	-6.20	0.00	-1.84	-0.95

on the exporter side.

Propensity score and common support From the parameter estimates of the probit model, the propensity scores are calculated for every farmer, which are then used for the matching analysis. We define the common support following Petra Todd's procedure: after excluding points for which the estimated density is zero, we exclude an additional small percentage of the remaining points for which the estimated density is positive but very low. The graph of the distribution of propensity scores suggests that densities are high enough for a wide range of propensity scores (see Figure 1).

Matching procedure and balancing tests Matching procedure is considered successful when significant differences of covariates among participants and non-participants are removed. Table 3 displays means of covariates among GG farmers and EX certified farmers (unmatched and matched) for the pre-treatment year 2005. After the matching procedure has been applied, the differences between GG and EX are much smaller and there is no case significantly different from zero at the 5 per cent level. In addition, we test the balancing property following the algorithm proposed by Becker and Ichino (2002). The balancing property is satisfied in all cases.

5.2 Does certification increase marketing performances of certified farmers?

On average, currently certified producers receive about 400 ariary, which is not a (significantly) higher price than what their matched counterparts receive (see Table 8). Indeed, we fail to detect an effect significantly different from zero (it appears smaller than 25 ariary

Table 3: Unadjusted and adjusted means of covariates in 2005

controls	untreated	treated	matched	pvalue
contrat05	0.10	0.07	0.02	0.08
early_produce_area	0.74	0.76	0.71	0.26
farm_size05	5.32	5.37	5.44	0.93
head_of_hh_educ	0.43	0.63	0.63	*exact*
litchi_sale05	3.35	3.98	3.94	0.12
litchi_workforce05	20.00	22.02	17.32	0.08
number_litchi05	43.29	53.56	44.95	0.23
number_zebu05	2.48	2.27	1.29	0.15

Table 4: Impact of GlobalGAP on certified farmers' prices in 2009 (Fakra group only)

estimator	att	se	stat	
nnm_1_ps	190.63	71.56	2.66	***
nnm_1_x	125.00	84.29	1.48	
nnm_4_ps	175.53	61.38	2.86	***
nnm_4_x	185.94	67.60	2.75	***
psm_kernel	170.79	67.88	2.52	**
psm_llr	176.88	80.42	2.20	**
ols_ps	170.83	44.01	3.88	***
ols_x	177.30	44.31	4.00	***

note: exact matching on litchi_sale05, head_of_hh_educ

on average whatever the estimator considered, which is very small). This results confirm previous qualitative evidence which indicates that certification does not guarantee price premium at the exporter level either. Moreover, this result hides heterogeneous effects, namely a large effect on prices received by the specific group called Fakra: they receive about 530 ariary, 170 to 190 more than their matches depending on the estimator considered (see Table 4). The interpretation has yet to be further documented. However, previous qualitative study suggests that this farmer group has specific organization (in particular all of them are certified) which may help them negotiate better prices.

Main results of our analysis are displayed in Table 5. Results indicate that currently certified producers sell larger quantities than their matched counterparts (ex-certified). They sell about 5.6 tons, 1 to 1.6 tons more than their matches depending on the estimator considered. Interestingly, matching on NEVER farmers leads to slightly larger estimates (see Table 12), which suggests that our empirical strategy allowed us to correct for selection bias due to unobservable characteristics of certified (or ex-certified) farmers - namely their

Table 5: Impact of GlobalGAP on certified farmers' sales in 2009

estimator	att	se	stat	
nnm_1_ps	1.26	0.61	2.06	**
nnm_1_x	1.61	0.65	2.48	**
nnm_4_ps	1.65	0.58	2.83	***
nnm_4_x	1.53	0.61	2.52	**
psm_kernel	1.20	0.56	2.12	**
psm_llr	1.11	0.60	1.84	*
ols_ps	1.06	0.42	2.53	**
ols_x	0.96	0.41	2.33	**

note: exact matching on litchi_sale05, head_of_hh_educ

ability to provide high quality products and their professional relationship with their buyer.

5.3 Do ex-certified farmers still benefit from positive impact of certification?

Another question traditionally asked when studying food standard compliance is whether exporters who want to increase the proportion of certified products tend to cheat by sourcing ex-certified farmers. In other words, do ex-certified farmers still benefit from positive impact of certification? The composition of the sample provides an opportunity to estimate the impact of having been certified over the whole period, by comparing EX certified farmers to NEVER certified ones. As argued above, such comparison, even based on matching procedure, may lead to (positively) biased estimates because of unobservable characteristics of EX farmers. And yet, the results show that EX farmers do not seem to sell significantly larger quantities than their matched counterparts (never-certified). Indeed, as shown in Table 9, we fail to detect an effect significantly different from zero, except when considering the LLR estimator, which suggests a small impact of +400 kg (but we cannot exclude that this can be due to unobservable only).

Moreover, ex-certified producers seem to receive slightly higher prices than what their matches receive (see Table 10). Although the difference appears significant, it remains very small (around 50 ariary). We find similar results (although less stable) when matching GG with NEVER (see Table 11). Obviously such results are related to unobservable

characteristics which make (ex-)certified farmers different from others - their ability to supply higher quality products, for example.

6 Conclusion

Our analysis contributes to the empirical literature on the emergence of food standards by focusing on the special case of the Malagasy litchi industry, characterized by a flourishing growth in ten years and compliance costs entirely supported by exporters themselves, often with financial support and technical assistance from donors and trade facilitators. In this special case, contrary to common result in the literature, there is no indirect eviction of no-certified farmers. Even if certified farmers tend to sell larger quantities, they are too few to overshadow the other 20.000 Malagasy producers who supply the European market. There is indeed a non-negligible positive impact for certified (1 to 1.3 ton more), but this is almost uncorrelated to farmers performances since certification is highly driven by market forces (and external assistance). The recent slowdown in demand (resulting in the implementation of quotas this year) could change that. Indeed, certification may become mandatory to ensure a place in the refeer to European markets.

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Table 6: Mean value of a selection of variables in 2009

	Global Gap certified in 2009		Ex-Global Gap certified		Never certified	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
time as a certified farmer (years)	2.53	1.21	1.38	0.57	0	0
family size (number of persons)	6	2	5	2	5	2
land size 09 (ha)	9.20	18.40	5.25	4.25	10.60	70.31
rented land 09 (ha)	0.41	1.27	0.34	0.84	0.90	7.35
access to water 09	0.11	0.31	0.06	0.25	0.08	0.27
non-agricultural activity (Y/N)	0.60	0.49	0.57	0.50	0.51	0.50
money transfer (Y/N)	0.03	0.16	0.10	0.31	0.13	0.34
number of trees 2005	68	61	43	46	31	38
number of trees 2009	90	101	55	56	44	49
production by tree 2009 (kg)	233	117	170	98	162	95
totale production 2009 (ton)	13.32	16.24	5.29	7.74	3.51	4.57
traded volume 2009 (ton)	9.47	10.81	3.62	4.45	2.46	5.34
minimum sell price 09 (Ar/kg)	350	171	319	152	246	113
maximum sell price 09 (Ar/kg)	652	286	558	181	446	164
season sell price 09 (Ar/kg)	430	188	413	156	315	124
you do tree maintenance (pruning trees) (Y/N)	0.64	0.48	0.77	0.42	0.77	0.42
you do picking (Y/N)	0.36	0.48	0.33	0.47	0.34	0.48
you do selection (handpicking) (Y/N)	0.44	0.50	0.41	0.49	0.43	0.50
you carry lychee to the buyer (Y/N)	0.34	0.48	0.31	0.46	0.32	0.47
Employee work time for harvesting (days per tree)	1.11	1.24	0.92	1.34	1.23	2.41
Employee work time for handpicking (days per tree)	1.63	2.17	1.09	2.32	1.51	4.61
contract with buyer (Y/N)	0.75	0.43	0.56	0.50	0.04	0.20
you know GlobalGAP (Y/N)	1.00	0.00	1.00	0.00	0.05	0.22

Table 7: Description of pre-certification variables

Controls	Labels
early_produce_area	the producer leaves in the early-produce area (Brickaville) (yes/no)
family_size05	number of people living in the producer's house in 2005
head_of_hh_age	age of household head (year)
head_of_hh_educ	takes the value of 1 if the hh head has at least completed primary education
number_tv05	number of televisions in 2005
number_bicycle05	number of bicycles in 2005
number_zebu05	number of zebus in 2005
farm_size05	land size in 2005 (ha)
number_litchi05	number of litchi trees in 2005
litchi_sale05	litchi sales in 2005 (kg)
litchi_workforce05	workforce for litchi (family+employees+volunteers) in 2005
group_member05	member of any group in 2005 (yes/non)
admin_position05	administrative position in 2005 (yes/no)
saving05	savings in 2005 (Ar)
nonagri_income05	non-agricultural income in 2005 (Ar)

Table 8: Impact of GlobalGAP on certified farmers' prices in 2009

estimator	att	se	stat	
nnm_1_ps	-9.66	37.71	-0.26	
nnm_1_x	-17.93	37.23	-0.48	
nnm_4_ps	10.78	30.29	0.36	
nnm_4_x	14.18	30.60	0.46	
psm_kernel	19.87	25.84	0.77	
psm_llr	17.28	28.82	0.60	
ols_ps	21.70	24.94	0.87	
ols_x	20.65	25.11	0.82	
note: exact matching on litchi_sale05, head_of_hh_educ				

Table 9: Impact of GlobalGAP on EX-certified farmers' sales in 2009

estimator	att	se	stat	
nnm_1_ps	0.35	0.32	1.11	
nnm_1_x	0.20	0.30	0.68	
nnm_4_ps	-0.29	0.45	-0.63	
nnm_4_x	-0.29	0.46	-0.62	
psm_kernel	0.30	0.21	1.43	
psm_llr	0.37	0.22	1.68	*
ols_ps	-0.24	0.31	-0.77	
ols_x	-0.20	0.29	-0.67	
note: exact matching on litchi_sale05, head_of_hh_educ				

Table 10: Impact of GlobalGAP on EX-certified farmers' prices in 2009

estimator	att	se	stat	
nnm_1_ps	50.45	20.82	2.42	**
nnm_1_x	61.15	22.77	2.69	***
nnm_4_ps	59.89	18.16	3.30	***
nnm_4_x	49.78	17.74	2.81	***
psm_kernel	47.39	15.22	3.11	***
psm_llr	45.78	17.59	2.60	***
ols_ps	43.22	15.09	2.86	***
ols_x	44.60	14.86	3.00	***
note: exact matching on litchi_sale05, head_of_hh_educ				

Table 11: Impact of GlobalGAP on certified farmers' prices in 2009 comparing with never-certified matched counterparts

estimator	att	se	stat	
nnm_1_ps	103.90	33.09	3.14	***
nnm_1_x	110.85	32.25	3.44	***
nnm_4_ps	85.32	30.22	2.82	***
nnm_4_x	94.53	29.74	3.18	***
psm_kernel	68.98	29.03	2.38	**
psm_llr	58.01	47.99	1.21	
ols_ps	76.65	24.76	3.10	***
ols_x	74.12	24.43	3.03	***

note: exact matching on litchi_sale05, head_of_hh_educ

Table 12: Impact of GlobalGAP on certified farmers' sales in 2009 comparing with never-certified matched counterparts

estimator	att	se	stat	
nnm_1_ps	1.60	0.82	1.94	*
nnm_1_x	1.61	0.82	1.96	**
nnm_4_ps	1.67	0.74	2.27	**
nnm_4_x	1.72	0.78	2.20	**
psm_kernel	1.06	0.83	1.28	
psm_llr	1.13	0.96	1.17	
ols_ps	0.96	0.73	1.30	
ols_x	1.01	0.67	1.50	

note1: Fakra group excluded from sample.
note2: exact matching on litchi_sale05, head_of_hh_educ

Figure 1: Distribution of propensity scores among GG and EX