



Impact of Exports Liberalization and Specialization in Cash  
Crop: What are the Expected Gains for Vietnamese Households?

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Paper presented at the  
International Agricultural Trade Research Consortium  
Analytic Symposium

***“Confronting Food Price Inflation:  
Implications for Agricultural Trade and Policies”***

June 22-23, 2009  
Seattle, Washington

# Impact of exports liberalization and specialization in cash crop: what are the expected gains for Vietnamese households?

May 22, 2009  
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This paper discusses the link between trade liberalization and farmers' specialization in exported cash crops. It first estimates how more favorable tariffs abroad on Vietnamese exports in the early 2000's have contributed to an increase in the production of exported cash crops. In order to relate agricultural households' behavior and tariffs abroad on Vietnamese exports, an agricultural trade index is constructed at the province level. This index measures the average tariffs on Vietnamese cash crop exports, applied by Vietnam's trade partners, taking into account each province's natural resources endowment and controlling for endogeneity issues. We then estimate the impact on agricultural production of a variation of the index, using panel data drawn from two household surveys conducted in 2002 and 2004. However, not all agricultural households will gain from export liberalization. We distinguish between households specializing in export cash crops, those who entered the export market, those who have never entered and those who have quit. Income gains are indeed strikingly different among these households groups.

**JEL Classification numbers:** Q17, Q12, F16

**Key Words:** trade liberalization, agriculture, income gains, Vietnam

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I'm very grateful to: Loren Brant, Jean-Pierre Cling, François Roubaud and Akiko Suwa Eisenmann. I also want to thank Lionel Fontagné, Ann E. Harrison, Sylvie Lambert, Brian McCaig, Nina Pavcnik, all the participants at PSE/Inra workshop "trade and development" (10/08), and the two anonymous referees.

## 1. Introduction

Starting from the mid nineties Vietnam opened gradually to international trade. In parallel, the Doi Moi structural reforms distributed new land use rights and farmers were given greater freedom in their production choices. The extent of price distortions diminished.<sup>2</sup> The combined trade liberalization and structural reforms resulted in a surge of agricultural exports. Vietnam became a major exporter not only of rice, but also coffee, cashew, black pepper and tea. This phenomenon is expected to exacerbate in the future, following Vietnam's accession to the WTO in 2007. As Vietnam is still mainly an agricultural economy with more than half of the labor force employed in agriculture, trade liberalization could then be a good candidate to explain the country performance in terms of growth, poverty alleviation and decrease in inequality.

Little is known however on the actual impact of trade liberalization on agricultural households. This paper intends to bridge the gap. It aims to identify how trade liberalization has impacted the production of export crops. It stresses that the impact was heterogeneous among households. We distinguish between farmers producing export crops and the rest of agricultural households. Also, using a household panel between 2002 and 2004, we are able to distinguish between farmers who remained in the export crop production, those who entered on the export market, those who quitted this market, and those who never entered. We show that indeed, the impact of trade liberalization was of different size and sign, according to these groups of households.

This paper relates to the growing literature on trade liberalization and income distribution (Winters, MacCulloch, McKay, 2004; Goldberg and Pavcnik, 2007). Most of the previous studies focus on wages in manufacturing sectors, and due to data availability, often on Latin or Central American countries (Hanson and Harrison, 1999, Feliciano, 2001; Attanasio, Goldberg and Pavcnik, 2004, Nicita, 2004; Goldberg and Pavcnik, 2005). Moreover, they focus on the dismantlement of import protection. However, as we will see below, Vietnam began by liberalizing exports, while keeping imports protected.<sup>3</sup> Hence, this paper studies the impact of trade liberalization on the export side, that is, a reduction of the tariffs applied by Vietnam's trading partners on its exports. In order to distinguish them from the effects of national trade reforms, such as Vietnam own tariff reductions, in the rest of the paper we will call tariffs faced by Vietnam "tariffs abroad".<sup>4</sup> Of course, a pre-condition for tariffs abroad to matter, is that exports themselves are allowed, and export quotas or taxes are suppressed. These pre-conditions were met at the end of the nineties for most agricultural products with the exception of rice. This paper thus stresses the significance of export liberalization for developing countries, a point also made by Porto (2003) in a general equilibrium model of Argentina that compared import and export liberalization.

The reduction of barriers to exports in partners countries are one dimension of market access, that is, the world demand perceived by a producer in a given localization. Determinants of market access, as stressed in the New Economic Geography literature are more broadly, producers prices, transport costs, tariff and non tariff barriers, and as well, the degree of competition on foreign markets (Mayer 2008, Redding and Venables 2003). Here, we focus

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<sup>2</sup> See Paquet, 2004 and Lavigne, 1999 for more details on this economic renovation.

<sup>3</sup> During this period, the government implemented policies that limited imports in competitive sectors (through ad valorem tariffs and non-tariff barriers, such as quantitative restrictions, duty quotas, prohibitions, licensing and special regulations). Athukorala, 2006 .

<sup>4</sup> We will defined precisely this term in Section 4a where we construct an agricultural trade index that include those "tariffs abroad"

on one aspect of this market access, namely, the reduction in tariff protection abroad faced by Vietnamese exporters, that we will call export liberalization in the rest of the paper.<sup>5</sup>

An important issue when one wants to relate households welfare and trade liberalization at the micro level, is to get a measure of the latter that is relevant for a household. Contrary to firms' data, it is not possible to know the amount of a given household's agricultural production that is actually exported. This paper proceeds in two steps. First, we define export crops as those crops that are sold on markets and not consumed domestically. For those crops, we compute an agricultural trade index, which is defined as the average tariff levied on these export crops, by Vietnam's trade partners. The agricultural trade index is defined at the provincial level in the following manner: the average tariff of Vietnam's trade partners is weighted by each province endowment in natural resources. Hence, trade liberalization in export crops will impact households, depending on the easiness to grow these crops in the province where they live. We also control for the possible endogeneity of the agricultural trade index.

The agricultural trade index is inspired from a trade index used in Topalova (2005), who computes import liberalization in India, at the district level. In Topalova's paper, Indian import tariff is weighted by the district share of employment in the sectors that are likely to be affected by trade liberalization. Our agricultural trade index is computed on the export side, and is weighted by lagged provincial acreage share of export crops, a variable that is likely to be less endogenous than employment.

The agricultural trade index allows estimating the impact of export liberalization on the production of cash crops. More precisely, we will estimate the incentive to go into export crop production. In that respect, our paper is close to Balat and Porto (2006) who examined the constraints that prevented farmers in Malawi from entering export commodity markets. Another related paper is Pham (2007) that estimates the impact of trade policy at the household level, looking at non-farm employment of Vietnamese rural households. However both papers are based on repeated cross-sections.

Here, we use the panel component of the Vietnam Household Living Standard Surveys in 2002 and 2004 that keep track of 2662 agricultural households and collect data on all the crops they cultivated during these years. Using the panel data, we know who reaped the benefit of export liberalization, who remained exporter or became one and who quitted the export market and turned to domestic-oriented crops. By stressing heterogeneity among agricultural households, this paper relates to another strand of the trade literature that shows firms' heterogeneity with respect to trade, due to fixed costs in exporting (Bernard, Jensen, Redding and Schott, 2007). Hence, trade liberalization may have an impact not only on firms already present in the export market (the intensive margin), but also on initially domestic-oriented firms (the extensive margin). Trade liberalization could also push out of the export market some less productive firms that used to export (Das, Roberts and Tybout, 2007). From this literature, we take the idea of heterogeneous households with respect to trade, and we check whether households responded differently to export liberalization because of their crop specialization.<sup>6</sup>

In the following, section 2 describes briefly trade liberalization in Vietnam; section 3 presents the data and some descriptive statistics; section 4 explains the empirical strategy for computing the agricultural trade index and its impact on cash crop production and results are described in section 5. Section 6 measures household agricultural income gains, taking into

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<sup>5</sup> A previous paper deal with the rising price pass-through that is the fact that during the liberalization the domestic price of tradable crops converged at the province level more rapidly to international markets (Coello, 2008)

<sup>6</sup> See also Brambilla and Porto, 2006.

account their heterogeneity with respect to crop specialization; section 7 checks the robustness of the agricultural trade index and section 8 concludes.

### 2. Trade liberalization in Vietnam

During the Doi Moi initiated in 1986, the government dismantled centralized planning and promoted exports, while protecting imports. Imports in competitive sectors were limited by ad valorem tariffs and non-tariff barriers, such as quantitative restrictions, duty quotas, prohibitions, licensing and special regulations. On the other hand, the government created Export Processing Zones (EPZ) in 1991, exempted agricultural exporters from tax and eliminated tariffs on fertilizer imports. Vietnam involved in an active trade policy, joined the Association of South East Asia Nations (ASEAN) in 1995, the ASEAN Free Trade Area (AFTA) in 1996, the Asia-Europe Meeting (ASEM) in 1996 and the Asia-Pacific Economic cooperation (APEC) in 1998. Vietnam made its first demand of accession to the WTO in 1995. In 2001, Vietnam signed a bilateral trade agreement with the US. However, throughout the 90s and early 2000s, Vietnam protected domestic agriculture heavily, with tariff rates stable at around 27% on average (“Other Crops<sup>7</sup> tariffs applied” in Figure 1). Meanwhile, tariffs faced by Vietnamese agricultural exports dropped from 14% in 1990 to 7% in 2004. The larger drop has been experienced by pepper, followed by rubber, cashew and coffee. Tea followed a different pattern during the period: “tariff faced” increased between 1990 and 1992 and remained stable afterwards. Indeed, as import tariffs remained high and stable, changing specialization to the export side is not due, during this period, to the need to escape import competition.

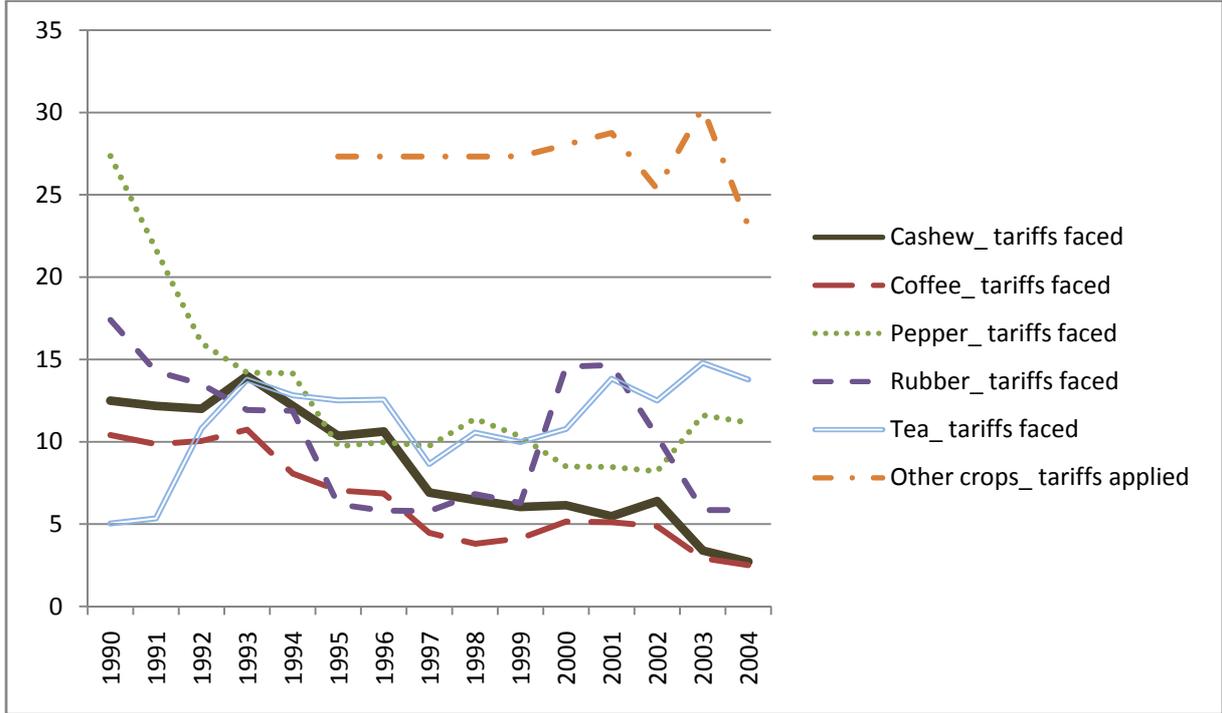


Figure 1. Evolution of tariffs faced by Vietnam’s exports of crops and tariffs applied by Vietnam on other crops, 1990-2004 (Source: TRAINS and author’s calculation)<sup>8</sup>

<sup>7</sup> “Other crops” are those listed in table 2.

<sup>8</sup> The tariffs are weighted AHS. The average partners’ tariffs are the tariffs applied by Vietnam main partners in 2004 (see section 4 below), interpolated for missing years.

Figure 2 shows that most of agricultural trade, at least until 2006, occurred on the export side, through improved market access. “Export crops” are the five cash crops listed on Figure 1, the “Other crops” are the rest of the crops that are produced in Vietnam, including rice.<sup>9</sup> Export crops quickly responded to lower tariffs abroad. At the end of the 90s, trade balances, both for the exported crops and other crops were positive at similar levels. Both types of crops were hit by the Asian Financial Crisis. However, only export crops’ trade surplus recovered after 2004 and rose steadily between 2001 and 2006.

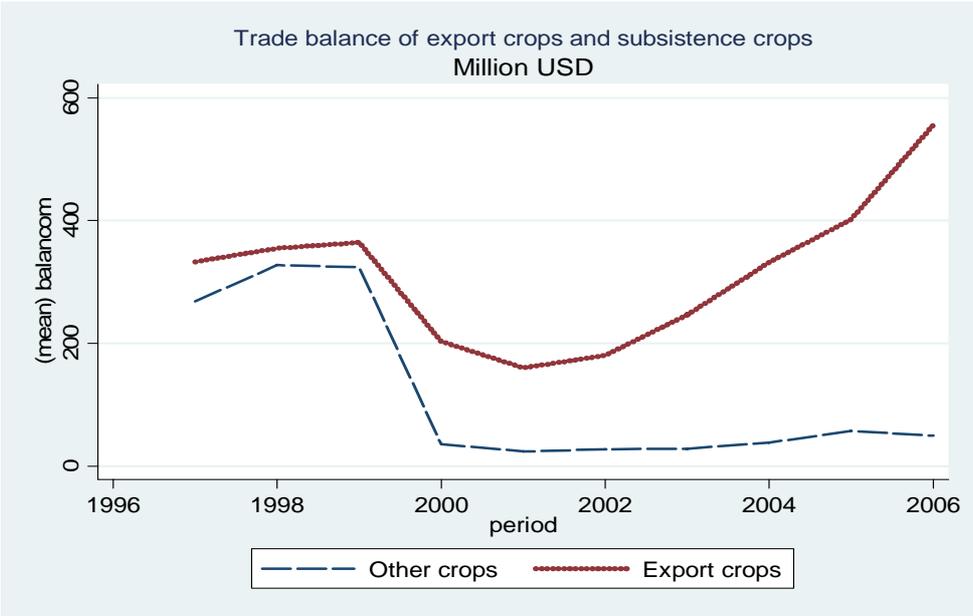


Figure 2. Trade balance by types of crops (Source COMTRADE and author’s calculation)

### 3. Data

#### a. A panel of agricultural households

The paper uses two waves of the Vietnam Household Living Standards Surveys (VHLSS), in 2002 and 2004. The 2002 wave surveyed 30,000 households; the 2004 wave, 9,000 households. Both include a household module and a commune module. The household questionnaire provides demographic information for all household members (age, sex, relationship to head), household expenditures (by expenditures purposes: food, education, health, etc.), income, employment and labor force participation, education of household members (literacy, highest diploma, fee exemption), health status (use of health services, health insurance), housing (type of housing, electricity, water source, toilet, etc.), assets and durable goods and participation in poverty programs. The VHLSS 2004 also includes an expanded module on agriculture (Phung and Phong, 2006)

The surveys include 20,156 agricultural households in 2002 and 6,300 in 2004. In the following, we focus on a panel subset of 2662 agricultural households.<sup>10</sup> An agricultural

<sup>9</sup> Please refer to table 2 for a detailed list of the Other crops.  
<sup>10</sup> The panel linkage dataset was provided by Brian McCaig, as the one provided by the statistical institute (GSO) showed some inconsistency.

household is defined as a household reporting a positive harvest value in any crop in the VHLSS household questionnaire.<sup>11</sup> We thus ignore households that dropped farming or began farming between 2002 and 2004.

| Dataset                            | 2002   | 2004   |
|------------------------------------|--------|--------|
| Households Cross Section           | 20,156 | 6,300  |
| Household Panel                    |        |        |
| Hslds present each year in farming | 2,662  | 2,662  |
| Hslds Exiting from farming         | 147    |        |
| Hslds Entering into farming        |        | 352    |
| Total                              | 2,809  | 3,014  |
|                                    |        |        |
| Household-Crop Panel               | 2002   | 2004   |
| Crops present each year            | 10,018 | 10,018 |
| Crops Exiting                      | 5,389  |        |
| Crops Entering                     |        | 6,228  |
| Total                              | 15,407 | 16,246 |

Table 1. Description of VHLSS 2002 2004 data

The 2,662 farmers in the panel cultivate 15,407 crops in 2002 and 16,246 in 2004. Moreover 10,018 crops are cultivated both years, providing an original panel of household-crops. This paper uses the panel crop element as well as the 5,389 crops that are abandoned between 2002 and 2004 and the 6,228 crops introduced over the same period.

### **b. Export cash crops**

As no export data directly related to households are available, it is the type of crops grown by households that identify them as exporters or not. Exported crops are identified based on the amounts traded internationally, reported in COMTRADE and GSO statistics. The resulting (export) cash crops are tea, coffee, rubber, pepper and cashew (table 2). They are all perennials. The crops labeled "Other" can also be exported but without generating a significant trade surplus. They can also be staple food locally consumed. Rice is a special case, as it is exported, imported and domestically consumed.

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<sup>11</sup> 38 crops are reported in the survey. Actually, more crops are grown but they are not identified separately by their names in the survey.

| Cash crops   | Other          |                       |                                |                           |                         |                |                     |
|--------------|----------------|-----------------------|--------------------------------|---------------------------|-------------------------|----------------|---------------------|
| Black pepper | Apples         | Custard apple         | Jackfruit, durian              | Mulberry                  | Pineapple               | Sesame seeds   | Tobacco             |
| Cashew       | Bananas        | Fresh legumes (beans) | Jute, ramie (fibe textile)     | Oranges, limes, mandarins | Plums                   | Soy beans      | Tomatoes            |
| Coffee       | Cassava manioc | Glutinous rice        | Kohlrabi, cabbage, cauliflower | Other leafy greens        | Potatoes                | Specialty rice | Water morning glory |
| Tea          | Coconut        | Grapes                | Litchi, logan, rambutan        | Papaya                    | Rice                    | Suger cane     |                     |
| Rubber       | Cotton         | Indian Corn           | Mango                          | Peanuts                   | Sapodilla (grosse baie) | Sweet potatoes |                     |

Table 2. Definition of crops' trade orientation

Map 1 (in the Appendix) shows the geographical distribution of cash crop producers across Vietnam provinces and indicates the average provincial level of agricultural income in 2002.<sup>12</sup> Regions in Vietnam are presented in Map 2 (in the appendix). Mekong river delta in the extreme South is the richest agricultural region in Vietnam, but not because of cash crops. It is followed by the Southeast region, where many cash crop producers live. The Central Highlands also count many cash crop producers but with a lower level of agricultural income. The Central Highlands includes Dac Lak province, where coffee started successfully in the mid-nineties. Conversely, North Central Coast is the poorest region, with cash cropping spread evenly. Finally the Northeast is the more heterogeneous region in terms of agricultural income and spatial distribution of cash crop farmers.

Table 3 shows the average share of household harvest that is sold on the market (and not retained for own consumption), by types of crops. For instance, cash crop farmers sell on average more than 78% of their harvest, while households growing other crops sell only 30% of their harvest, retaining the rest for own consumption. The share for rice producers is even lower, at 24% on average. These shares have remained fairly stable between 2002 and 2004.

|            | 2002    |           | 2004    |           |
|------------|---------|-----------|---------|-----------|
|            | Average | Std. Dev. | Average | Std. Dev. |
| Cash crops | 0.7865  | 0.3793    | 0.7967  | 0.3724    |
| Rice       | 0.2461  | 0.3167    | 0.2470  | 0.3020    |
| Other      | 0.2977  | 0.3915    | 0.3069  | 0.3944    |

Table 3. Share of harvest sold on market, by types of crops

### c. Some patterns of export producers

We now turn to the change in crop specialization between 2002 and 2004 (Table 4). Out of the 2662 households in the panel, 359 households stayed in cash crops production during both years. Conversely, a vast majority of 2142 households remained specialized in crops other than export crops over the same period. 105 households began to produce cash crops in 2004 and 56 abandoned cash crop production. We shall, for simplicity, call these farmers respectively stayers, domestic-oriented, newcomers and quitters. The same classification can

<sup>12</sup> The maps have been created with Philcarto, using the class magnitude procedure that is the maximum minus the minimum divided by the number of classes (EF procedure).

be done for each cash crop separately, except rubber, for which little mobility is observed.<sup>13</sup> For each cash crop, say tea, we distinguish among households not producing tea, those who are domestic orientated (2142), and those producing another cash crop than tea, say coffee (286).

| Type of farmers   | All Cash Crops | Tea   | Coffee | Pepper | Cashew | Rubber |
|-------------------|----------------|-------|--------|--------|--------|--------|
| Domestic Oriented | 2,142          | 2,142 | 2,142  | 2,142  | 2,142  | 2,142  |
| Other cash crops  |                | 286   | 344    | 393    | 401    | 506    |
| Newcomer          | 105            | 72    | 20     | 43     | 37     | 2      |
| Stayers           | 359            | 127   | 133    | 76     | 64     | 12     |
| Quitters          | 56             | 35    | 23     | 8      | 18     |        |
| Total             | 2,662          | 2,662 | 2,662  | 2,662  | 2,662  | 2,662  |

Table 4. Descriptive statistics on cash crop specializations

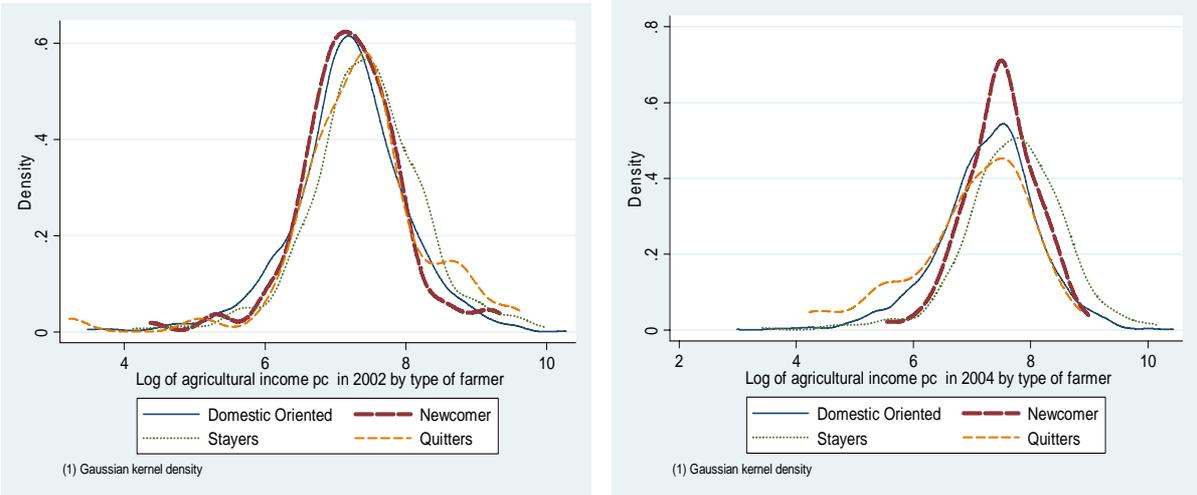


Figure 3. Kernel density distribution of agricultural income per capita, by type of farmers<sup>14</sup> for 2002 for 2004

Figure 3 shows the kernel distribution of the per capita agricultural income in 2002 and in 2004. The evolution of agricultural income has been different depending on farmers’ crops specialization. In 2002, the households already engaged in cash crop production (stayers and quitters) are more numerous to the right of the distribution, with future quitters even richer. In 2004 the income distributions of stayers and newcomers have shifted right, whereas the one of quitters has shifted left.

<sup>13</sup> Thus, rubber will be ruled out from the analysis of crop specialization by cash crop in the rest of the paper (but still included in the “all cash crops” category).

<sup>14</sup> The household agricultural income used in this paper has been recomposed based on the agriculture section of the VHLSS. Physical harvests of each crop are valued by a provincial price computed from unit values at the household level. The latter are defined as the ratio of values sold on the market over quantities, deflated by a month and a year deflator. The base period is January 2002. These unit values are then averaged by crop and province. The highest and lowest percentile are dropped.

## 4. Empirical Strategy

We now turn to the impact of export liberalization abroad on specialization in cash crop, controlling for household, farm, and infrastructure characteristics.<sup>15</sup>

### a. The agricultural trade index

In order to relate household income to export liberalization, we construct an indicator of trade liberalization abroad. Intuitively, one would take the average tariffs paid by Vietnam on the exports of each cash crop. However, an endogeneity problem arises, due to the aggregation procedure (Bouët, Decreux, Fontagné et al., 2007). Thus, we take the list of Vietnam's partners in the *final* year (2004), because we want to capture the fact that a country decreases its tariff rate and thus starts trading with Vietnam. Then for each partner, we compute an average weighted tariffs (AHS) applied by the partner country to the rest of the world *excluding* Vietnam.

At the micro level, other problems have to be taken into account. First, households need some lap of time in order to get the information on market conditions abroad, mainly due to information asymmetry. Moreover, households are heterogeneous with respect to risk. During a field survey in Binh Phuoc province,<sup>16</sup> most farmers reported during the interviews that they “will change their cropping patterns because someone they know has already done so and is doing well”. The first household who enters the export market is thus likely to be self-selected, in terms of risk aversion and credit constraints. Farmers also need some time to adjust their crop specialization and, in the case of perennials, to obtain the first harvest: perennial crops need on average five years to bear fruits. Thus we construct a lagged index of ad-valorem tariffs variation applied by Vietnam partners (in 2004) to the rest of the world (excluding Vietnam) in the 1990's. The agricultural trade index shows the variation between 1992-95 and 1997-2000.

For each product, Vietnam as a whole faces the same international price and tariffs abroad. However each province has a different supply capacity that depends on its natural resource endowments, such as the type of climate, or the altitude, that determine the possibility to grow a given crop or not. In line with Topalova (2005), the identification strategy exploits differences of trade exposure at the provincial level. The difference in natural resource endowments across provinces is proxied by the acreage devoted to a given crop in each province in 2000 (based on GSO data).<sup>17</sup> The initial acreage captures the likelihood that the province will be able to respond to trade liberalization and is used to weight the variation in tariffs abroad. Finally, the agricultural trade index for province  $p$  and crop  $e$  writes:

$$I_{p,e} = \left( \frac{A_{e,p,00}}{\sum_p A_{e,p,00}} \right) \Delta t_e$$

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<sup>15</sup> Households characteristics used as controls are the number of children, the gender, age and marital status of household head and his or her educational level. Farm characteristics are the size, the use of organic pesticides, and the level of diversification of the farmer. Infrastructure variables are the ownership of transport facility (such as car) by the household.

<sup>16</sup> Conducted by Loren Brandt for a survey on land redistribution (World Bank) and attended by the author. In this province, farmers are mostly switching to cashew growing

<sup>17</sup>The data on acreage are not published and were obtained when the author was collaborating in a joint project with the World Bank and the Center of Agricultural Policy (CAP) at IPSARD, Hanoi, Vietnam.

where  $\Delta t_e$  is the average tariffs variation for cash crop  $e$  between 1992-95 and 1997-2000 in Vietnam' partner countries,  $A_{e,p,00}$  is the acreage of crop  $e$  in province  $p$  in 2000. A decrease in tariffs abroad will translate into a decrease of the agricultural trade index and will lead to a rise of access for Vietnamese exports. The agricultural trade index  $I_{p,e}$  will take a value of zero in provinces where no acreage was devoted to this crop in 2000.

## b. Cash crop production and trade liberalization

We estimate households' variation in cash crop harvest between 2002 and 2004 and relate it to the agricultural trade index ( $I_{p,e}$ ), controlling for households' demographic characteristics ( $X_{ht}$ ) and the farm plot characteristics ( $Z_h$ ):

$$\Delta Y_{h,e} = \alpha + \beta_1 \cdot I_{p,e} + \beta_2 \cdot X_h + \beta_3 \cdot Z_h + \varepsilon_{h,e} \quad (Eq 1)$$

$\Delta Y_{h,e}$  is the change in harvest production for household  $h$  and export crop  $e$  between 2002 and 2004. The harvest production is calculated based on the quantities reported by the household and valued by a regional unit value. The latter is computed based on the quantities and values sold by the household on local markets. The vector  $X_h$  represents households' time invariants characteristics in 2002. Farm invariant variables  $Z_h$  are taken in the agriculture special module of the 2004 wave. We expect the coefficient of the agricultural trade index,  $\beta_1$ , to be negative.

## 5. Results

### a. At the household level

Table 5 shows the results of the estimation of equation 1.<sup>18</sup> The coefficient of the agricultural trade index for all cash crops is significant and negative, equal to -4.025. With an average provincial share of cash crop of 0.0833, a 1% point reduction in the agricultural trade index will increase the harvest production of each household on average by 1,398 VND. This amount would represent 0.17% of the average household harvest in cash crop in 2002.

The coefficient of the agricultural trade index is still negative but far smaller (equal to -0.551) when all types of crops are considered. When the same regression is performed for each cash crop, one finds similar effects, the largest one being for pepper.

|                          | Dependent variable : change in harvest production 2002-2004 |                    |                     |                      |                   |                     |
|--------------------------|---|--------------------|---------------------|----------------------|-------------------|---------------------|
|                          | cash crops  | tea                | coffee              | pepper               | cashew            | all crops           |
| Agricultural trade Index | -4.025<br>[0.154]**   | -1.59<br>[0.197]** | -5.937<br>[0.274]** | -14.654<br>[0.804]** | -3.8<br>[0.099]** | -0.551<br>[0.051]** |
| Constant                 | -16.759<br>[8.522]*   | 2.628<br>[4.815]   | -5.719<br>[5.568]   | -0.842<br>[4.057]    | -5.071<br>[4.004] | 6.313<br>[2.817]*   |
| Observations             | 2317  | 2317               | 2317                | 2317                 | 2317              | 2317                |
| R-squared                | 0.27  | 0.09               | 0.22                | 0.15                 | 0.41              | 0.53                |

Table 5. Change in cash crop harvest and the agricultural trade index<sup>19</sup>

<sup>18</sup> Households, farm and commune controls are showed in appendix, Table A2

<sup>19</sup> In all tables, standard errors are in brackets. Results are \* significant at a 5% level of confidence; and \*\* significant at a 1% level of confidence.

The impact of export liberalization on each cash crop taken separately is significant and large. A 1% point reduction in the agricultural trade index for tea will increase household average harvest by 1.39 % relative to the average household production of tea in 2002. Similarly, coffee would increase by 0.36% relatively to the average level of household's harvest in 2002 and pepper by 1.10%.<sup>20</sup>

## **b. At the national level**

The impact of export liberalization at the household level of table 5 can be used to calculate what would be the impact of a reduction of the agricultural trade index, at the national level, using the weights available in the VHLS surveys. The latter allows retrieving national harvest productions for each cash crop as well as the number of cash crop producers in the whole country.

|  | cash crops   | tea        | coffee     | pepper     | cashew     |
|--|--------------|------------|------------|------------|------------|
| At a national level<br>(In thousand VND) | 2,079,607.59 | 952,918.67 | 682,199.52 | 694,110.16 | 351,895.28 |
| At a national level<br>(In Dollars)      | 138,640.51   | 63,527.91  | 45,479.97  | 46,274.01  | 23,459.69  |
| In percentage of<br>national output      | 0.02%        | 0.07%      | 0.02%      | 0.03%      | 0.04%      |

Table 6. Impact of a one percentage point reduction in the agricultural trade index on the national harvest production of cash crop <sup>21</sup>

As the total number of cash crop producers in Vietnam in 2002 was 1,487,003, a 1 % point reduction of the agricultural trade index would have increased national cash crop production by 0.02% representing 2,079,607,590 VND. The effect would be slightly larger for the national production of tea.

## **6. Measuring households gains according to crops' specialization**

The previous section has shown the average effect of export liberalization on households. However, the effect differs for each cash crop. Moreover, the impact might also be different as households are heterogeneous in terms of their choice of crops, between cash and domestic crops, and within cash crops.

In this section we estimate precisely the gains (or losses) of households, depending on their crop specialization. We compare two groups of households, households who produce cash crops and households who do not, controlling for other observable characteristics. The methodology is similar to the estimation of an average treatment effect, the "treatment" being cash cropping.

The definition of the control group is difficult. First, we want to be sure that no farmers in the control group are exporting. That would rule out rice, as this crop is at the same time, exported, imported and locally consumed. However, we keep rice producers in the control group when they retain most of their harvest for their own consumption. In that case, we are sure that these farmers are not exporting, and thus, will not be influenced by the agricultural

<sup>20</sup> Results are given on the basis of the average Vietnamese 2002 cash crop production and the average provincial share of each cash crop that is 0.2941 (tea), 0.0417 (coffee), 0.050 (pepper), 0.0476 (cashew).

<sup>21</sup> On January 2002, 1 \$US (or 1.12 EUR) is equivalent to 15,000 VND.

trade index. Hence, the definition of the two groups of households is as follows. Export-oriented households are households who are producing the cash crops listed in table 2 (tea, coffee, pepper, cashew and rubber). We know from table 3 that most of their harvest is sold on the market. Households in the control group, hereafter labeled the “subsistence-group” are : i) households who are not producing any cash crop listed above, and ii) who sell less than 50% of their harvest production on markets.<sup>22</sup>

### a. Comparing comparables.

Let us start with the agricultural income  $Y_h^i$  of households  $h$ . Households involved in cash crops production ( $i=1$ ) have an agricultural income defined as  $Y_h^1$  and those who are not export-oriented ( $i=0$ ) earn  $Y_h^0$ . We want to estimate the expected income differential of export-oriented households versus the other households, that is, the average “treatment effect” of being an export-oriented household:

$$E[Y_h^1 - Y_h^0 | i = 1]$$

$$E[Y_h^1 | i = 1] - E[Y_h^0 | i = 1]$$

The two incomes are not observed at the same time for the same household. Hence, we calculate a propensity score of the probability of being export-oriented, based on observable characteristics.<sup>23</sup> The regression is similar to equation 1, except for the definition of the control group and that we run a probit instead of an OLS (table 7).

| Probability of producing cash crops in both years (2002 and 2004) relative to staying domestic orientated |                     |                     |                       |                   |                     |
|---|---------------------|---------------------|-----------------------|-------------------|---------------------|
|   | cash crops          | tea                 | coffee                | pepper            | cashew              |
| Agri index  | -2.806<br>[0.218]** | -4.784<br>[0.426]** | -6.125<br>[0.651]**   | 5.81<br>[8.116]   | -4.648<br>[0.669]** |
| Constant  | -13.435<br>[11.662] | 8.179<br>[15.128]   | -95.482<br>[30.936]** | -0.107<br>[1.457] | -68.369<br>[35.916] |
| Observations  | 1393                | 1262                | 1079                  | 1262              | 1169                |

Table 7. Propensity score first step estimation<sup>24</sup>

Export-oriented households are then matched with other households, with whom they share the same observable characteristics, based on their propensity score. In the case of transition dynamics, we compare farmers to their initial group. Hence, newcomers are compared to subsistence-oriented households, and quitters to stayers.<sup>25</sup>

The method used here is the Kernel matching: all treated are matched with a weighted average of all households in the control group; the weights are inversely proportional to the distance

<sup>22</sup> Other definitions of the control group have been estimated, for instance, a control group including only farmers who do not produce any cash crop in the broader sense of non staple crop. A second one has been estimated, without any restriction on the control group. The results hold and can be provided by the author on request.

<sup>23</sup> See Heckman & al, 1997 for a theoretical description and an empirical application on labor markets of the different matching method, and more particularly of the Local Linear Propensity score matching

<sup>24</sup> Data used in the regression are presented in Appendix, Table A2.

<sup>25</sup> We drop 73 households that have different kinds of dynamics as for example starting coffee and quitting cashew production.

between the propensity scores of the treated and the households in the control group. A necessary assumption is that observations with a given propensity score have the same distribution of observables in the two groups of households. Thus we impose a balancing property.<sup>26</sup> We use the procedure suggested by Dehejia and Wahba (2002).

Results are shown in table 8.<sup>27</sup> All specifications satisfy the balancing property. Households who stay in cash cropping in both years do not earn significantly more than subsistence oriented households. The groups who gain significantly are the newcomers: their increase in per capita agricultural income amounts to 317 thousands VND on average. This represents 124% of the average growth in agricultural income per capita. By contrast, the quitters are clearly worse off. Their increase in agricultural income is almost 600 thousands VND less than if they had stayed in cash cropping. To summarize, the positive gain due to export liberalization was distributed unevenly across households. Newcomers clearly gained, quitters clearly lost, and those who stayed in cash cropping were not significantly better than subsistence-oriented households. It is interesting to note that quitters remained in the agriculture (by definition of the group). Thus, the loss in agricultural income due to leaving the cash crop sector would likely not be compensated by other crops' source of incomes.

When looking at specific crops, it seems that both newcomers and stayers were clearly better off for coffee production. However, this coincides with a high increase of the coffee international price averaging 40%.<sup>28</sup> The picture is more mixed for other crops (due also to the small number of observed transitions).

| Situation                        |      | Gain in per capita agricultural income<br>(In thousand Vnd) |               |               |               |               |
|----------------------------------|------|---|---------------|---------------|---------------|---------------|
| 2002                             | 2004 | Cash crops  | Tea           | Coffee        | Pepper        | Cashew        |
| new comers<br>vs.<br>Subsistence |      | 317.72  | 98.68         | 1330.12       | 348.93        |               |
|                                  |      | <i>134.40</i>   | <i>113.27</i> | <i>385.12</i> | <i>399.18</i> |               |
| Stayers<br>vs.<br>Subsistence    |      | 152.04  | 270.77        | 676.09        | 420.13        | 143.66        |
|                                  |      | <i>373.77</i>   | <i>139.82</i> | <i>346.93</i> | <i>404.09</i> | <i>821.31</i> |
| Quitters<br>vs.<br>Stayers       |      | -599.01   | -884.34       |               |               |               |
|                                  |      | <i>227.67</i>   | <i>460.68</i> |               |               |               |

Table 8. Estimated agricultural income gains over 2002-2004<sup>29</sup>

Note: bootstrapped standard-errors in italics

In terms of welfare, per capita expenditure is more relevant than income. Indeed, households may have other sources of income or be able to smooth consumption through savings (which indeed increased in these very years). Table 9 shows the results in terms of changes in per

<sup>26</sup> This means that there are a sufficiently large number of treated and non-treated households, who are comparable controlling for all households covariates.

<sup>27</sup> For presentation purpose, we do not present the rest of the propensity score first stage estimation, but they can be provided by the author on request.

<sup>28</sup> Those numbers comes from the difference of Export Value (1000 \$) in FAOSTAT between 2002 and 2004.

<sup>29</sup> Empty boxes mean that we do not have enough observations to run a probit on all control variables. However when we relaxed restrictions on control groups, results on cashew's newcomers shows a very positive gain of agricultural pc income averaging more than 1000 thousand VND and small loss when looking at expenditure pc.

capita expenditures. The picture is quite different from that for agricultural income. Newcomers are not gaining anymore; they are even worse off compared to subsistence-oriented households. The result that persists is that quitters are still losing compared to stayers and in a similar order of magnitude than for agricultural income.

| Situation   |      | Gain in expenditure per capita<br>(In thousand Vnd) |               |               |               |               |
|-------------|------|---|---------------|---------------|---------------|---------------|
| 2002        | 2004 | Cash crops  | Tea           | Coffee        | Pepper        | Cashew        |
| new comers  |      |   |               |               |               |               |
| vs.         |      | -9.94   | -87.13        | 23.17         | 479.13        |               |
| Subsistence |      | <i>134.70</i>                                       | <i>132.58</i> | <i>289.35</i> | <i>393.63</i> |               |
| Stayers     |      |   |               |               |               |               |
| vs.         |      | 43.39   | 42.92         | 262.29        | 1166.69       | 659.39        |
| Subsistence |      | <i>245.73</i>                                       | <i>134.50</i> | <i>266.01</i> | <i>832.33</i> | <i>899.74</i> |
| Quitters    |      |   |               |               |               |               |
| vs.         |      | -538.02   | -235.47       |               |               |               |
| Stayers     |      | <i>151.48</i>                                       | <i>359.43</i> |               |               |               |

Table 9. Estimated per capita expenditure gains over 2002-2004

Note: bootstrapped standard-errors in italics

## 7. Robustness analysis

For robustness check, we first created an alternative agricultural trade index based on the Vietnam Living Standards Surveys (VLSS) 1997-1998 commune data. This survey reported the total area by sub-aggregate crops (i.e. perennials) and by communes. This information was used to compute the share of each province on the acreage of cash crops. Results are reported in table 10 column 1. The sign of the coefficient remain unchanged compared to table 5, despite a higher value for the alternative trade index.

We also tested the validity of the agricultural trade index by including in the regression, the distance from each province to the nearest maritime port. The latter is a proxy for the provincial distance to international markets (Nicita, 2004). The result in the second and third column of table 10 shows the robustness of our agricultural trade index. The distance variable is not significant and the coefficient of the index does not change much.

| Change in harvest production between 2002-2004 |                      |                     |                     |                     |
|--|----------------------|---------------------|---------------------|---------------------|
|  | All cash crops       |                     |                     |                     |
|  | (1)                  | (2)                 | (3)                 | (4)                 |
| Agricultural Trade Index                       |                      | -4.009<br>[0.155]** | -3.782<br>[0.146]** | -3.805<br>[0.146]** |
| Alternative Agricultural Trade Index           | -25.638<br>[1.126]** |                     |                     |                     |
| Distances                                      |                      | 0.033<br>[0.026]    | 0.043<br>[0.025]    |                     |
| Household characteristics                      | Yes                  | Yes                 | No                  | No                  |
| Constant                                       | -15.893<br>[8.628]   | -17.111<br>[8.525]* | -0.455<br>[0.462]   | -0.264<br>[0.448]   |
| Observations                                   | 2148                 | 2317                | 2555                | 2555                |
| R-squared                                      | 0.23                 | 0.27                | 0.23                | 0.23                |

Table 10. Alternative specifications of the change in total cash crop production 2002-2004

Finally in the last two columns we also tested the exogeneity of our explicative variables and more particularly the farm's characteristics as well as the communes' controls. Our coefficients of interest do not change significantly when we drop these controls. This gives us confidence in the exogeneity of our independent variables.

## 8. Conclusion

Vietnam has considerably increased its agricultural exports which, in turn, have significantly contributed to its trade surplus. In addition to enjoying a real competitive advantage, Vietnamese agricultural products benefitted from a reduction in barriers applied by the rest of the world to its exports during the last decade.

We have explored the impact of a reduction of protection abroad, for Vietnamese farmers. We proceeded in two steps. First we have estimated the increase in cash crop production due to a reduction of protection in the partners' countries. Secondly, we took into account the heterogeneity among farmers. We estimated households' propensity score according to their crop specialization between cash crop and subsistence crops, taking into account the transition dynamics between 2002 and 2004: farmers who entered into cash cropping, farmers who quitted those who remained in the same group. Based on observable characteristics, we matched households and compared their gain in agricultural income and expenditure between 2002 and 2004, depending on their crop specialization.

Export liberalization mattered for cash crop production. We estimated that a decrease of 1% in tariffs faced by Vietnam exports abroad would result in a 0.17% increase in household cash crop production relative to 2002 leading to a national increase of 138,640 \$ cash crop production. However, this gain is not equally distributed. The propensity score matching shows that households who entered the export market are those who benefitted the most, with a gain of 124% relative of the average growth between 2002 and 2004 in agricultural per capita income; alternatively, households who quitted the export market are those who were worse off compared to the group they were originating from. This last result holds even for expenditure per capita. Households who quitted the export market but stayed in the agricultural sector were not able to find other compensating sources of income.

This paper focuses on the trade determinants of the evolution of the agricultural income in Vietnam. Because of the timing of Vietnam trade liberalization, it deals only with the export side. However, after Vietnam's accession to the WTO, the action will move on the import side. For instance maize producers, who are mainly poor households from ethnic minorities, will have to compete with subsidized maize imports from the United States.

Of course, other determinants might also have influenced farmers' choices, such as the price at which they could sell their products. In a previous paper, we have shown that national and local prices converged towards international prices between 1993 and 1997, the more so for tradable agricultural goods (Coello, 2008).

This analysis is restricted to producers. Trade liberalization affected consumers as well. In Vietnam, following the recent surge in agricultural prices, authorities have implemented a new export tax on rice in April 2008, in order to ensure food security for Vietnamese consumers.

Finally, cash crop specialization may also entail long-run issues. Currently, Vietnam agriculture seems to overuse chemical pesticides at levels far higher than the optimal level for profit maximization (Nguyen and Tran, 2003).<sup>30</sup> The success of cash crops may also result in a shortage of arable land, and negative ecological externalities, like deforestation and soil erosion. This already happened in 1999, during the coffee price boom, as coffee farmers cleared more than 74,000 hectares of forest in Dak Lak province (World Rainforest Movement, 2001).

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<sup>30</sup> Thus even if in the short run the use of chemical pesticides may improve yields, it may have the inverse effect in the long run. Industrialized countries, such as France, for instance have experienced negative externalities due to chemical pesticides' overuse during the last decades (Nicolino, 2007)

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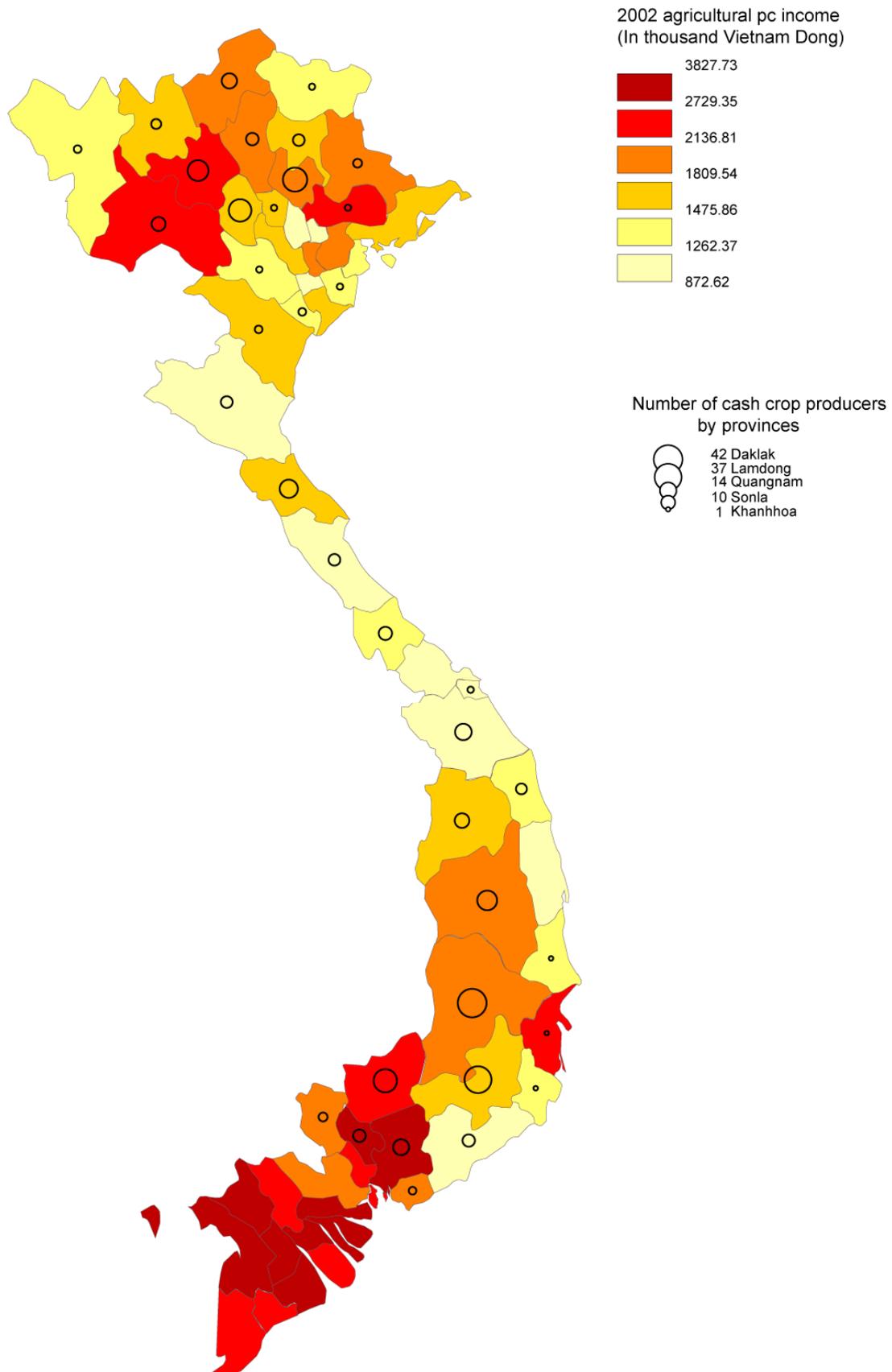
## Appendix

| Variable                       | Brief description   | Average | Std. Dev. |
|--------------------------------|---|---------|-----------|
| Age of the head                | Logarithm of the age of the head                            | 14.642  | 2.190     |
| Age squarred                   | Logarithm of the age squarred                               | 3.816   | 0.286     |
| Ethnic                         | =1 if none-kinh,=0 otherwise                                | 0.199   | 0.399     |
| Gender                         | =1 if male,=0 otherwise                                     | 0.842   | 0.365     |
| Married                        | =1 if married ,=0 otherwise                                 | 0.864   | 0.343     |
| H. primary                     | =1 if having primary education ,=0 otherwise                | 0.264   | 0.441     |
| H. secondary & upper           | =1 if having secondary or upper education ,=0 otherwise     | 0.370   | 0.483     |
| H. technical diploma           | =1 if having technical education ,=0 otherwise              | 0.047   | 0.211     |
| S. primary                     | =1 if having primary education ,=0 otherwise                | 0.269   | 0.444     |
| S. secondary & upper           | =1 if having secondary or upper education ,=0 otherwise     | 0.341   | 0.474     |
| S. technical diploma           | =1 if having technical education ,=0 otherwise              | 0.032   | 0.176     |
| Share of children 6-12         | Share of children between 6 and 12 years old                | 0.134   | 0.165     |
| Share of children < 6          | Share of children under 6 years old                         | 0.062   | 0.118     |
| Share of children 12-18        | Share of children between 12 and 18 years old               | 0.154   | 0.177     |
| Share of females 18-30         | Share of females between 18 and 30 years old                | 0.092   | 0.129     |
| Share of females 30-60         | Share of females between 30 and 60 years old                | 0.181   | 0.134     |
| Share of males 18-30           | Share of males between 18 and 30 years old                  | 0.101   | 0.147     |
| Share of males 30-60           | Share of males between 30 and 60 years old                  | 0.162   | 0.125     |
| Share of female >60            | Share of females upper 60 years old                         | 0.064   | 0.142     |
| Share of males >60             | Share of males upper 60 years old                           | 0.049   | 0.119     |
| Herfindahl index               | For households' crops                                       | 0.632   | 0.258     |
| Size of the household          | Logarithm of the size of the household                      | 1.465   | 0.378     |
| Size of the plot               | Logarithm of the size of the plot                           | 8.578   | 1.450     |
| Bus or train                   | Presence of a bus, train or boat in the commune             | 0.360   | 0.480     |
| Post Office                    | Presence of a post office in the commune                    | 1.613   | 0.487     |
| Period market                  | Presence of a periodic market in the commune                | 1.719   | 0.450     |
| Road                           | Presence of a road in the commune                           | 0.867   | 0.339     |
| Land distance                  | Log of Distance to their land                               | 5.942   | 1.876     |
| Quality of the land            | Quality of the land   | 0.576   | 0.494     |
| Two-wheeled vehicle            | =1 if households own a two-wheeled ,=0 otherwise            | 0.796   | 0.403     |
| Kitchen Assets                 | Score of kitchen asset =1 if hsltd posses all, =0 otherwise | 0.257   | 0.437     |
| Four-wheeled vehicle           | =1 if households own a four wheeled ,=0 otherwise           | 0.022   | 0.146     |
| Organic Pesticides             | Share spent on organic pesticides                           | 0.020   | 0.055     |
| Agricultural trade index for : |   |         |           |
| Tea                            |   | -0.055  | 0.139     |
| Coffee                         |   | -0.030  | 0.116     |
| Pepper                         |   | -0.008  | 0.028     |
| Cashew                         |   | -0.059  | 0.220     |
| All cash crops GSO             |   | -0.136  | 0.305     |
| All cash crops vlss            | With 1997comune vlss source for acreage provincial data     | -0.012  | 0.029     |
| Distances                      | Log of Distance to the main maritim port                    | 4.549   | 1.711     |

Table A1. Variables description

|                          | harvest             |                     |                      |                    |                     |                     |
|--------------------------|---------------------|---------------------|----------------------|--------------------|---------------------|---------------------|
|                          | tea                 | coffee              | pepper               | cashew             | cash crops          | all crops           |
| Agricultural trade Index | -1.59<br>[0.197]**  | -5.937<br>[0.274]** | -14.654<br>[0.804]** | -3.8<br>[0.099]**  | -4.025<br>[0.154]** | -0.551<br>[0.051]** |
| Age squared              | 0.195<br>[0.339]    | -0.506<br>[0.393]   | 0.01<br>[0.286]      | -0.341<br>[0.282]  | -1.111<br>[0.601]   | 0.134<br>[0.199]    |
| Age of the head          | -1.424<br>[2.581]   | 3.364<br>[2.986]    | 0.146<br>[2.175]     | 2.722<br>[2.147]   | 8.474<br>[4.570]    | -1.179<br>[1.511]   |
| Ethnic                   | 0.184<br>[0.070]**  | -0.114<br>[0.081]   | -0.164<br>[0.059]**  | 0.064<br>[0.058]   | -0.012<br>[0.124]   | -0.233<br>[0.041]** |
| Gender                   | -0.137<br>[0.102]   | -0.143<br>[0.118]   | -0.017<br>[0.086]    | 0.071<br>[0.085]   | -0.212<br>[0.181]   | 0.041<br>[0.060]    |
| Married                  | 0.092<br>[0.108]    | -0.036<br>[0.124]   | 0.073<br>[0.090]     | 0.059<br>[0.089]   | 0.146<br>[0.190]    | 0.001<br>[0.063]    |
| H. primary               | 0.096<br>[0.068]    | 0.037<br>[0.078]    | -0.024<br>[0.057]    | -0.027<br>[0.056]  | 0.049<br>[0.120]    | -0.011<br>[0.040]   |
| H. secondary & upper     | 0.173<br>[0.075]*   | -0.113<br>[0.087]   | -0.056<br>[0.063]    | 0.026<br>[0.063]   | -0.011<br>[0.133]   | 0.012<br>[0.044]    |
| H. technical diploma     | 0.046<br>[0.136]    | 0.246<br>[0.158]    | -0.117<br>[0.115]    | 0.044<br>[0.113]   | 0.158<br>[0.241]    | 0.088<br>[0.080]    |
| S. primary               | 0.031<br>[0.067]    | -0.125<br>[0.077]   | 0.048<br>[0.056]     | 0.032<br>[0.055]   | -0.153<br>[0.118]   | 0.035<br>[0.039]    |
| S. secondary & upper     | 0.162<br>[0.074]*   | -0.053<br>[0.085]   | 0.038<br>[0.062]     | -0.019<br>[0.061]  | 0.026<br>[0.130]    | 0.022<br>[0.043]    |
| S. technical diploma     | 0.223<br>[0.163]    | -0.127<br>[0.188]   | 0.086<br>[0.137]     | -0.068<br>[0.135]  | 0.034<br>[0.288]    | -0.137<br>[0.095]   |
| Share of children 6-12   | -0.098<br>[0.297]   | 0.039<br>[0.343]    | 0.302<br>[0.250]     | 0.051<br>[0.247]   | 0.199<br>[0.526]    | 0.005<br>[0.174]    |
| Share of children < 6    | -0.383<br>[0.321]   | -0.163<br>[0.371]   | 0.133<br>[0.270]     | -0.408<br>[0.267]  | -0.536<br>[0.568]   | -0.434<br>[0.188]*  |
| Share of children 12-18  | -0.228<br>[0.290]   | -0.034<br>[0.335]   | 0.047<br>[0.244]     | 0.091<br>[0.241]   | -0.388<br>[0.513]   | 0.252<br>[0.170]    |
| Share of females 18-30   | -0.149<br>[0.332]   | -0.314<br>[0.383]   | -0.001<br>[0.279]    | -0.1<br>[0.275]    | -0.722<br>[0.586]   | 0.505<br>[0.194]**  |
| Share of females 30-60   | -0.058<br>[0.374]   | -0.199<br>[0.431]   | -0.063<br>[0.314]    | -0.411<br>[0.310]  | -1.093<br>[0.660]   | 0.488<br>[0.218]*   |
| Share of males 18-30     | -0.077<br>[0.306]   | -0.035<br>[0.353]   | 0.168<br>[0.257]     | -0.304<br>[0.254]  | -0.481<br>[0.541]   | 0.38<br>[0.179]*    |
| Share of males 30-60     | -0.201<br>[0.396]   | 0.221<br>[0.457]    | 0.177<br>[0.333]     | -0.496<br>[0.329]  | -0.636<br>[0.700]   | 0.579<br>[0.231]*   |
| Share of female >60      | 0.044<br>[0.389]    | 0.391<br>[0.450]    | 0.027<br>[0.327]     | -0.083<br>[0.323]  | 0.158<br>[0.688]    | 0.521<br>[0.227]*   |
| Share of males >60       | -0.314<br>[0.455]   | 0.356<br>[0.526]    | -0.01<br>[0.383]     | -0.292<br>[0.378]  | -0.623<br>[0.805]   | 0.295<br>[0.266]    |
| Herfindahl index         | -0.466<br>[0.101]** | -0.026<br>[0.115]   | -0.288<br>[0.085]**  | -0.149<br>[0.083]  | -0.364<br>[0.177]*  | -0.083<br>[0.058]   |
| Size of the household    | 0.139<br>[0.104]    | 0.232<br>[0.120]    | 0.11<br>[0.087]      | -0.128<br>[0.086]  | 0.232<br>[0.184]    | 0.399<br>[0.061]**  |
| Size of the plot         | 0.048<br>[0.020]*   | -0.02<br>[0.023]    | -0.012<br>[0.016]    | 0.02<br>[0.016]    | 0.096<br>[0.035]**  | 0.472<br>[0.012]**  |
| Bus or train             | -0.047<br>[0.051]   | -0.124<br>[0.058]*  | -0.035<br>[0.043]    | 0.108<br>[0.042]*  | -0.061<br>[0.089]   | 0.122<br>[0.030]**  |
| Post Office              | -0.01<br>[0.051]    | 0.093<br>[0.059]    | -0.029<br>[0.043]    | 0.062<br>[0.042]   | 0.068<br>[0.090]    | 0.053<br>[0.030]    |
| Period market            | -0.048<br>[0.055]   | 0.064<br>[0.064]    | 0.091<br>[0.046]     | -0.094<br>[0.046]* | 0.064<br>[0.097]    | 0.007<br>[0.032]    |
| Road                     | -0.106<br>[0.072]   | 0.168<br>[0.083]*   | -0.007<br>[0.061]    | -0.003<br>[0.060]  | 0.201<br>[0.128]    | -0.198<br>[0.042]** |
| Land distance            | -0.019<br>[0.015]   | 0.036<br>[0.017]*   | 0.012<br>[0.012]     | -0.014<br>[0.012]  | 0.021<br>[0.026]    | -0.014<br>[0.009]   |
| Quality of the land      | 0.143<br>[0.051]**  | -0.148<br>[0.059]*  | -0.052<br>[0.043]    | 0.009<br>[0.042]   | 0.016<br>[0.090]    | -0.092<br>[0.030]** |
| Two-wheeled vehicle      | 0.059<br>[0.065]    | -0.014<br>[0.075]   | 0.032<br>[0.055]     | 0.005<br>[0.054]   | 0.13<br>[0.115]     | 0.055<br>[0.038]    |
| Kitchen Assets           | -0.127<br>[0.058]*  | -0.031<br>[0.066]   | 0.003<br>[0.048]     | -0.065<br>[0.048]  | -0.147<br>[0.102]   | 0.117<br>[0.034]**  |
| Four-wheeled vehicle     | -0.174<br>[0.172]   | 1.107<br>[0.198]**  | 0.523<br>[0.144]**   | -0.033<br>[0.143]  | 1.214<br>[0.303]**  | 0.219<br>[0.100]*   |
| Organic Pesticides       | -0.37<br>[0.477]    | -0.449<br>[0.550]   | 1.31<br>[0.401]**    | -0.373<br>[0.396]  | 0.171<br>[0.843]    | -0.958<br>[0.279]** |
| Constant                 | 2.628<br>[4.815]    | -5.719<br>[5.568]   | -0.842<br>[4.057]    | -5.071<br>[4.004]  | -16.759<br>[8.522]* | 6.313<br>[2.817]*   |
| Observations             | 2317                | 2317                | 2317                 | 2317               | 2317                | 2317                |
| R-squared                | 0.09                | 0.22                | 0.15                 | 0.41               | 0.27                | 0.53                |

Table A2. Descriptive statistics on cash crops dynamics



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Map 1. Agricultural income pc in 2002 and cash crop producers



Map 2. Decomposition of Vietnam by its 8 administrative regions.