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**Commercialization in agriculture in rural  
Viet Nam, 2006-14**

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**Abstract:** The vast majority of households in rural Viet Nam undertake agricultural activities and for many this is their main livelihood. Moreover, this agriculture has become increasingly commercialized over time. This paper uses the five wave VARHS balanced panel data set to analyse three aspects of this commercialization: the likelihood of (1) selling rice (the dominant crop); (2) growing cash crops; and (3) engaging in aquaculture. A panel regression analysis identifies factors commonly associated with a more commercial orientation, with important factors including land size, the nature of cultivation, access to infrastructure, and receipt of credit.

**Keywords:** agriculture, commercialization, Vietnam, panel data

**JEL classification:** O13, Q12, Q22

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Tables and Figures at the end of the paper.

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## 1 Introduction

Without doubt, a key part of Viet Nam's economic transformation over the past 30 years has been the substantial progress made in agriculture. The main crop grown in Viet Nam has always been rice, and with the economic transformation, originating from the launch of the Doi Moi reforms in 1986, the country switched from being a net importer to a substantial net exporter of rice. At the same time Viet Nam has become much more involved in the cultivation of cash crops, notably coffee, and fishery products are also an area of export growth. To some extent, these activities take place at the household level.

The VARHS survey allows a detailed analysis of the role played by households in these different activities, and the panel feature of the data allows the dynamics of this role to be investigated over the period 2006-14. The large majority of households interviewed in the VARHS survey earn at least some of their income from agriculture, even if over time non-agricultural livelihoods are becoming increasingly more important, as expected with economic development. Although in several provinces wage earnings have overtaken agriculture as the main source of income, most households still have some income from agriculture or natural-resource-based activities. In provinces in the Central Highlands and Northern Uplands, agriculture remains the dominant activity.

The VARHS survey collects detailed information on the agricultural activities undertaken by households: the crops grown and sold, livestock activities, land use including engagement in aquaculture, and use of inputs, among other things. This material enables a substantial and detailed analysis of these issues. This paper is only a start at this, presenting a largely descriptive approach to look at households' engagement in three important areas of activity: rice cultivation, production of cash crops, and engagement in household-level aquaculture activities. Since most households grow rice, the paper focuses on commercialization seen through sale of rice. In addition, fisheries production in this paper consists principally of aquaculture, being all deliberate activities undertaken by households on their own land; quite a few households also catch fish products from common property resources, on which information is also available, but this is not examined here.

Again, the analysis is based on the 2,162 households included in the five-wave panel between 2006 and 2014, looking in particular at the extent to which households cultivating rice sell it and on what scale. For most households engaged in agriculture, rice commercialization is a dominant income source. For cash crops and aquaculture, the outputs are sold almost by definition. The interest here is on modelling the correlates of households engaging in these activities. In practice, much of the analysis compares the five cross sections that make up the panel data set, but we also exploit the panel feature of the data to look at the dynamics of these activities over time.

The rest of this paper is structured as follows. Section 2 briefly reviews some relevant literature, after which Section 3 provides an introduction to the extent of household participation in these activities. Section 4 examines patterns of engagement in rice cultivation and sales, cash crops, and aquaculture by geographic region and income quintile, following which Section 5 exploits the panel to examine among other things, the extent of consistency of these activities over time at the household level. An econometric analysis of correlates of engagement in these different commercial activities is presented in Section 6, after which Section 7 concludes.

## 2 Some relevant literature

This paper relates to the growing literature that examines the determinants of small farmer participation in commercial activities in agrarian economies. Much of this literature focuses on food crops, which households often produce for their own consumption but may also choose to sell. This literature has sought to understand primarily the role of transaction costs and market failures in smallholder decision-making. Differential asset endowments, together with differential access to public goods and services that facilitate market participation, are identified as key factors underlying heterogeneous market participation among smallholders (Key et al. 2000; Barrett 2008). Differences in transaction costs across households are also important determinants of market participation: each household faces some fixed time and monetary costs in searching for available marketing options, and if high enough these costs, invariant to the quantity transacted, may prevent market participation altogether. According to Goetz (1992), transaction costs affect market participation behaviour through the labour-leisure choice: thin markets make it costly (i.e. time consuming) to discover trading opportunities. Similarly, poor market access due to lack of transport, distance, and/or barriers such as ethnicity or language increases households' cost of observing market prices to make transaction decisions, thus reducing households' leisure time (Goetz 1992).

For staple food markets in particular, another important factor influencing the participation decision is risk, and household attitudes towards it. Households concerned about their own food security and facing a high degree of price and non-price risk, especially in the presence of missing or imperfect credit and insurance markets, may choose not to sell in the attempt to ensure that own consumption requirements can be met. On the other hand, lack of liquidity resulting from the absence of alternative income sources and credit may also force households to sell rice to generate cash in order to meet other non-food expenditures.

The determinants of smallholder participation in agricultural markets have been investigated empirically mainly in the context of sub-Saharan Africa. These studies identify strong positive associations between market participation and: (1) household assets (especially land, but also livestock, labour, and equipment) and income;<sup>1</sup> (2) access to credit and insurance;<sup>2</sup> (3) input use and access to extension services;<sup>3</sup> and (4) low levels of transaction costs, including transport costs and information costs.<sup>4</sup>

The literature on aquaculture is significantly less developed than it is in relation to selling of food crops or the choice to engage in cash crop production, but similar factors are likely to be as relevant here as in the case of cash crops.

With respect to Viet Nam, Rios et al. (2009) find that households with higher productivity tend to participate in agricultural markets regardless of market access factors (e.g. distance to roads or quality of transport networks). Such a finding suggests that programmes targeted at improving poorer households' productive capital, and other assets, have the potential to increase both productivity and market participation, while investments in market access infrastructure seem to

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<sup>1</sup> Nyoro et al. (1999), Cadot et al. (2006), Stephens and Barrett (2006), Boughton et al. (2007), Levinsohn and McMillan (2007).

<sup>2</sup> Cadot et al. (2006); Stephens and Barrett (2006).

<sup>3</sup> Alene et al. (2008).

<sup>4</sup> Heltberg and Tarp (2002), Alene et al. (2008), Ouma et al. 2010).

be relatively less of a priority (Rios et al. 2009). It seems then that already in the early 1990s, Viet Nam had much better coverage of basic rural infrastructure in most regions compared to countries with similar levels of income (Aksoy and Isik-Dikmelik 2007).

This analysis draws and builds on prior analyses by the authors of some of these issues based on earlier waves of the VARHS survey (McCoy et al. 2010; Cazzuffi et al. 2011; Cazzuffi and McKay 2012). However, these studies also addressed more detailed issues not considered here for lack of space, for example the channels used to sell rice (Cazzuffi and McKay 2012) or the analysis of open access fisheries (McCoy et al. 2010).

### **3 Agricultural activities in the VARHS panel**

In the VARHS panel data set, 100 per cent of households in 2006 reported income from crops, livestock, or aquaculture as one or more sources. This proportion fell gradually over time but in 2014, 86.4 per cent of households reported positive income from one or more of these sources. This reinforces the point made in the introduction about the importance of agricultural or aquaculture activities for almost all households.

Figure 1 reports some summary statistics relating to these three activities for households included in the five-wave panel, treating the different waves as separate cross sections for now. A large majority of households grows rice in each of the years. The proportion does decline gradually over time but even by 2014; more than 65 per cent of households grow rice in at least one of their plots. Rice is a dominant consumption commodity in Viet Nam as well as a very important export; in addition, the authorities often require households to grow rice on some plots. Further, most locations covered by the survey are very suitable for rice cultivation.

The next set of columns in the figure relates to the proportion of rice-growing households who sell some of their output. Starting out from nearly 50 per cent of households in 2006, participation in rice sales shows a consistently increasing trend over time. While fewer households may be growing rice between 2006 and 2015, an increasing proportion of these are selling. This latter effect outweighs the former, such that the absolute numbers who sell show an increase. The survey also reports on channels of sales, the most important channels being sales to traders or sales to other individuals or households. Channels vary by province and unsurprisingly the scale of sales reflects the channel used. The following bars of Figure 1 report on the average proportion of the harvest sold, which again shows an upward trend over time. The first years of the panel were a period where the rice price increased significantly, but the extent of commercialization according to these two indicators has continued to increase since, even though the rice price has fallen. This increasing commercialization takes place alongside continued increases in rural household income over this period (see McKay and Tarp 2015).

The remaining groups of columns in Figure 1 relate to the extent of household engagement in cash crop production and in aquaculture activities on their own land. A small minority of households participate in these activities and, in the case of aquaculture at least, there may be a declining trend. But the choice to undertake these activities is a significant investment by households and climatic and other conditions need to be appropriate. The dominant cash crop cultivated by households in the survey is coffee, which is grown predominantly in the Central Highlands provinces. Other cash crops include tea, cocoa, cashew nut, sugarcane, pepper, and rubber. Around 10 per cent of households earn some income from aquaculture, an activity that requires a significant investment in order to convert one or more of their plots into a pond; this

can also be a relatively labour-intensive activity and with an uncertain return from one year to another.

What is clear from this initial introductory analysis is the importance of agricultural activity, especially rice, for households and the extent of engagement in sales for a majority of these households. That in itself is a signal of the success with which these activities have been conducted in rural Viet Nam. However, the analysis to date is only conducted at an aggregate level and does not exploit the panel features of the data set; the remainder of this paper now analyses these three activities separately and in more detail.

#### **4 Rice cultivation and sales, cash crops, and aquaculture in rural Viet Nam**

While the role of rice as a dominant crop in Viet Nam has been stressed above, Table 1 shows variations in its importance by province and by household income quintile. The numbers of households cultivating rice are very high in the three northern upland provinces (Lai Chau, Dien Bien, and Lao Cai) and do not fall over time. Typically 90 per cent or more of households grow rice there. By contrast in Dak Nong and Lam Dong in the Central Highlands and in Khanh Hoa, relatively few households grow rice. The remaining provinces lie in-between these extremes. In a number of these provinces such as Ha Tay and Quang Nam the proportion of households growing rice is falling over time. In these locations non-agricultural activities, notably wage work, become increasingly important over time (see McKay and Tarp 2015). Looking by income quintiles, it is clear that rice cultivation is higher in lower quintiles than in higher ones, though the numbers cultivating rice remain substantial in the fifth quintile. In the higher income quintiles, more non-agricultural opportunities exist, reflecting both their more urbanized nature and higher levels of development. To some extent, the quintile pattern correlates with the geographic pattern: the northern upland provinces referred to above are disproportionately found in the lower income quintiles.

The geographic disaggregation of the proportion of rice growers selling their output is presented in Table 2, showing the very high market engagement in the Long An province in particular. While between 55 per cent and 70 per cent of rural households in this province grow rice, almost all of them sell. The Long An province is very much the commercial heartland of Viet Nam. Many households there grow and sell on quite a large scale and they have the major advantage of being very close and well connected to a highly concentrated population in Ho Chi Minh City and elsewhere. When these households choose to grow rice they almost all aim to sell and as it can be seen in Table 3, they also sell by far the highest proportion of their output.

Rates of sales are much lower in other provinces, not least in the Northern Uplands provinces seen above where most households grow rice. It is clear that many of these households are not able to produce enough to be able to sell on a consistent basis; they also have significantly greater difficulty in getting access to buyers. A similar point is true of Phu Tho where again many households grow rice. Although this province has much easier access to Hanoi and bigger urban centres than the Northern Uplands provinces, still relatively few rice growers sell. This clearly reflects the scale of production plus the greater importance of market access to participate in rice commercialization. Among the other provinces, Quang Nam, Dak Lak, and Khanh Hoa are provinces with relatively high proportions of rice growers engaged in sales.

The geographic distribution of the proportion of output sold is shown in Table 3. In almost all provinces, except Long An, households are selling a minority, and often a small minority, of their output. It is quite clear that rice cultivation and commercialization is radically different in Long

An compared to the other provinces. The proportions sold are particularly low in the Northern Uplands provinces as well as in Phu Tho, Dak Nong, and Lam Dong; this is partly accounted for in some cases by the small proportion of households selling, and in other cases by a relatively small scale of production. The proportion of output sold generally increases with the income quintile, though again this partly reflects the geographic distribution of the provinces, with Long An being disproportionately represented in the higher quintiles.

Both rice cultivation and sales can of course fluctuate from one year to the next, an issue that will be explored in the next section using the panel. For now, we examine patterns of household engagement in cash crops and in aquaculture. Tables 4 and 5 report the percentage of households engaged in these activities by province and quintile, and these tables again show some quite distinct patterns. In particular cash crops are predominantly grown in the Central Highlands provinces of Dak Lak, Dak Nong, and Lam Dong, with the dominant part of this being coffee cultivation. Cash crop cultivation is much lower elsewhere, and almost non-existent in the provinces of Ha Tay, Dien Bien, Quang Nam, and Long An. In general, households in higher quintiles are more likely to be engaged in cash crop cultivation even if the relationship is less strong in 2014.

The highest incidence of aquaculture is observed in the Dien Bien province; depending on the year, between one-third and one-half of households report income from this activity. Reasonable numbers of households in Lao Cai, Phu Tho, and Long An also report earnings from aquaculture. Elsewhere the proportions are lower.

## **5 Using the panel to look at production and sales dynamics**

To date, the analysis has been entirely based on comparisons between the repeated cross sections in the panel data set, but looking at dynamics helps identify the extent to which behaviour varies over time or is consistent from one period to another. The panel data are exploited here by looking at the extent to which households engage in these activities, growing rice, selling rice, growing cash crops, and earning from aquaculture, in all years (Table 6). Those not engaged in these activities in any of the five years are also included in these data. The patterns vary by province and quintile in much the same way that the number of households growing rice do; in most locations those that grow rice do so consistently year-on-year.

In relation to rice sales, Long An has by far the highest number of households who sell each year in the panel; not only do many households sell and sell a high proportion of their output, they also tend to do so every year. The number of consistent sellers is much smaller elsewhere, but this also reflects the lower numbers of people selling in any of the cross sections.

The numbers that consistently grow cash crops are not much lower than the numbers reported in the cross section. This reflects the fact that much of these cash crops are tree crops and therefore a long-term commitment. As in the cross section, the numbers are highest by far in the Central Highlands provinces. On the other hand, the same is not true for aquaculture; here the numbers with consistent earnings are consistently lower than the numbers in the cross section, suggesting that there is quite a lot of variability from one wave to the next. This may reflect households starting and stopping the activity, but it may also reflect major shocks in particular years leading to a loss of earnings from this source.

## 6 In-depth analysis of determinants of commercialization

Three different forms of commercialization have been considered in this paper: the choice by a household to sell some of the rice it produces, the choice to grow cash crops, and the choice to engage in aquaculture. Some initial descriptive analysis of the types of patterns of commercialization by location and income quintile have been presented above, but here we turn to a more detailed analysis of the characteristics of households choosing to participate in these forms of commercialization. This starts with further descriptive analysis but then progresses to multivariate analysis of the decision by rice-growing households to sell some of their output. Following this, we present a brief but similar analysis of the factors associated with households growing cash crops or engaging in aquaculture activities.

Comparing rice growers who sell and those who do not (Table 7), the striking difference between those selling and those who do not is that the former cultivate larger areas of land, spend much more on inputs, and are less likely to be poor according to the Ministry of Labour, Invalids and Social Affairs (MOLISA) classification. These differences are true in every year. Unsurprisingly, those households selling rice report much more agricultural income but not necessarily much higher income overall. Interestingly, those selling rice are further away from roads on average, though this does not stop them selling; many households sell to traders. Other differences such as household characteristics, group membership, and use of other inputs are much less striking or are less consistent across the different waves.

When it comes, however, to cash crops (Table 8), households cultivating these crops have substantially higher incomes (and agricultural incomes) on average than those who do not, although interestingly they are not systematically any less likely to be poor. It is clear that some households benefit substantially from growing cash crops, but many others do not. Those growing cash crops cultivate much bigger areas on average, spend much more on inputs overall (although less on inputs specifically for rice) and are more likely to have accessed credit. But in other respects there are not many other systematic differences between cash crop growing farmers and those not cultivating cash crops. Looking at aquaculture (Table 9), those engaged in this activity earn more from agriculture (which includes aquaculture) and more income overall, they also cultivate larger areas. They also spend more on rice inputs showing that many households combine aquaculture with rice cultivation. In addition, those engaged in aquaculture are more likely to have borrowed. In other respects the differences are less apparent.

We turn now to modelling the determinants of these different activities: selling rice (for those producing), cultivating cash crops and engagement in aquaculture, exploiting the balanced panel data set. In each case the outcomes are zero-one variables; these outcomes for the panel households are modelled as a function of household characteristics in the same time period, using either a linear probability model or a probit model. Table 10 shows the outcomes for the agricultural variables. The first model is estimated based on the pooled data set and including district level fixed effects. The second and third model exploit explicitly the panel features, the former using a linear probability model and household level fixed effects, and the latter a probit model with household level random effects as well as province level fixed effects. As some of the explanatory variables here are liable to be endogenous, these models should be interpreted in terms of showing association rather than causality.

In each of the three models, households, which sell rice are likely to cultivate larger areas, are likely to have more of their area irrigated, are likely to use hybrid seed and to hire more labour, are more likely to have received extension support, and are more likely to have market in their commune. Unsurprisingly larger and poor households are less likely to sell, but more

surprisingly, Kinh households and households who speak Vietnamese are also less likely to sell in these models. Apart from the last findings, these results are quite intuitive in terms of explaining who is likely to sell rice in Viet Nam. These results are relatively consistent across the three modelling approaches.

Fewer strong correlates are identified for the likelihood of growing cash crops. There is a strong geographic effect here, with cash crops being cultivated much more in the Central Highlands provinces (coffee especially) compared to the others included in the VARHS sample. Larger land area is associated with a higher likelihood to grow cash crops, and those growing cash crops are much more likely to have received credit (though this may be precisely a consequence of them choosing to grow cash crops). The third model shows a positive association between being of Kinh ethnicity and growing cash crops, though this is not evident in the other models. And there is weak evidence that those with their own means of transport are more likely to grow cash crops, a factor, which also had a similarly weakly significant influence in the previous models on the likelihood of selling rice.

Equivalent models for the likelihood of engaging in aquaculture are presented in Table 11. Here land area, receipt of credit, being literate, and being a male-headed household are all positively associated with engagement in aquaculture. Larger households are also significantly more likely to undertake aquaculture, an activity with high labour requirements. Poor households are less likely to be involved in aquaculture. It was already noted above that those engaged in aquaculture are typically better off than average. Analysis of the data shows that the return, in terms of income earned per unit time spent, is higher on average in aquaculture compared to crop cultivation, though it is also riskier in that the return is also more variable (McCoy et al. 2010)

Households that speak Vietnamese are slightly less likely to engage in aquaculture, perhaps reflecting the geographic pattern of this activity (with this activity for instance being relatively popular in the Northern Uplands as well as Long An). The results in the fourth and fifth columns of Table 11 add variables to the base specification. In the fourth column, natural shocks reduce the likelihood of having been engaged in aquaculture, given that they make this activity infeasible in a particular year, whereas past investment in aquaculture is of course positively associated with undertaking the activity. This is an activity requiring a significant degree of planning and investment. The main results here are relatively consistent across the different model specifications, including in relation to the variables added in the fourth and fifth columns.

These regression results are first estimates and focus only on contemporaneous correlations, and can only identify associations. They do though confirm several of the patterns already suggested in the descriptive analysis above. In the case of rice, those engaged in selling are generally those cultivating on a larger scale. Geographic factors are important in relation to both cash crops and aquaculture, which can reflect many factors including climatic conditions as well as potentially local policies. In general, there is a clear association between engagement in these commercial activities and being better off. But of course it is not possible to say anything about causality based on this; better off households may be better placed to be engaged in commercial activity (e.g. by having more land), but households may also become better off by being engaged in these activities. In reality both processes are probably at work.

## **7 Conclusions**

This paper has presented an initial analysis of the extent of commercialization of agriculture in these 12 provinces of rural Viet Nam, focusing on the five waves of the VARHS panel. What is

clear first is the continuing importance of agriculture in rural Viet Nam, and this remains true for households who may now earn more of their income from wages or other sources. Second, agriculture is increasingly commercialized in rural Viet Nam with rice sales being the main area of commercialization. The vast majority of rural households grow rice, of whom around half sell in any given year. There are variations in this by geography and wealth, but unsurprisingly those producing more and using more inputs are more likely to sell. However, the panel shows that not many households sell consistently from one year to another. Presumably the decision to sell reflects the scale of production in a given year and perhaps available opportunities. The exception to this is Long An where the activity is on a much larger scale, with households selling more and much more regularly compared to any other provinces.

Cash crop production and aquaculture are clearly also commercial activities undertaken by a non-negligible minority of these surveyed households, although strong geographic patterns exist, in part reflecting the suitability of different locations for these activities. Unsurprisingly given its nature, usually involving tree crops, cash crop activity shows substantial persistence over time in the panel, but in aquaculture, there are many fluctuations from one year to another. This is potentially a high-return activity for households, but it is relatively labour-intensive and relatively risky. It may therefore be harder for households to guarantee a worthwhile return from this activity every year.

One thing that clearly emerges from this initial analysis of the data is a strong association between commercialization and wealth. There is very likely to be a two-way process of causality at work here. But it is almost certainly the case that increased commercialization of agricultural activities in rural Viet Nam has been an important contributor to the impressive rural poverty reduction the country has experienced.

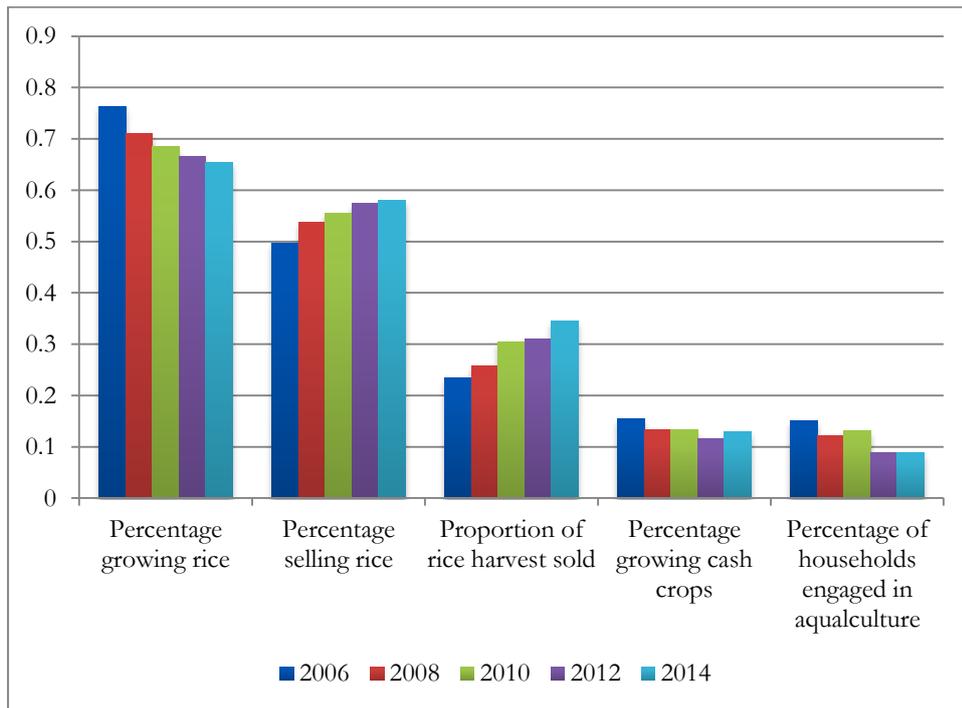
There is much scope to analyse these questions in more depth in subsequent work, in particular exploiting more the panel features of the data set. This is expected to allow clearer conclusions to be drawn about the nature of the factors facilitating commercialization in agriculture in rural Viet Nam, including the ability to engage consistently in commercial activities over time. These issues will be addressed in more detail in future work.

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Figure 1: Some summary characteristics relating to commercialization for the full sample



Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 1: Percentage of households growing rice, by year, province, and quintile

|                      | 2006  | 2008  | 2010  | 2012  | 2014  |
|----------------------|-------|-------|-------|-------|-------|
| Province             |       |       |       |       |       |
| Ha Tay               | 0.864 | 0.815 | 0.768 | 0.706 | 0.689 |
| Lao Cai              | 0.906 | 0.882 | 0.859 | 0.871 | 0.906 |
| Phu Tho              | 0.889 | 0.791 | 0.731 | 0.710 | 0.737 |
| Lai Chau             | 0.945 | 0.908 | 0.881 | 0.881 | 0.908 |
| Dien Bien            | 0.980 | 0.960 | 0.939 | 0.939 | 0.960 |
| Nghe An              | 0.739 | 0.707 | 0.670 | 0.681 | 0.644 |
| Quang Nam            | 0.824 | 0.820 | 0.784 | 0.734 | 0.694 |
| Khanh Hoa            | 0.417 | 0.236 | 0.389 | 0.361 | 0.361 |
| Dak Lak              | 0.542 | 0.489 | 0.550 | 0.527 | 0.473 |
| Dak Nong             | 0.380 | 0.283 | 0.250 | 0.293 | 0.293 |
| Lam Dong             | 0.250 | 0.281 | 0.266 | 0.250 | 0.172 |
| Long An              | 0.668 | 0.585 | 0.567 | 0.588 | 0.581 |
| Consumption quintile |       |       |       |       |       |
| 1                    | 0.880 | 0.822 | 0.680 | 0.851 | 0.850 |
| 2                    | 0.770 | 0.768 | 0.742 | 0.762 | 0.762 |
| 3                    | 0.724 | 0.730 | 0.751 | 0.711 | 0.729 |
| 4                    | 0.598 | 0.583 | 0.718 | 0.651 | 0.625 |
| 5                    | 0.481 | 0.454 | 0.576 | 0.459 | 0.494 |
| Total                | 0.764 | 0.710 | 0.685 | 0.666 | 0.654 |

Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 2: Percentage of rice-growing households who sell, by province and year

|           | 2006  | 2008  | 2010  | 2012  | 2014  |
|-----------|-------|-------|-------|-------|-------|
| Ha Tay    | 0.424 | 0.512 | 0.568 | 0.605 | 0.590 |
| Lao Cai   | 0.545 | 0.467 | 0.562 | 0.662 | 0.506 |
| Phu Tho   | 0.212 | 0.374 | 0.350 | 0.218 | 0.324 |
| Lai Chau  | 0.515 | 0.364 | 0.302 | 0.479 | 0.515 |
| Dien Bien | 0.887 | 0.411 | 0.505 | 0.581 | 0.484 |
| Nghe An   | 0.518 | 0.459 | 0.341 | 0.484 | 0.645 |
| Quang Nam | 0.459 | 0.640 | 0.789 | 0.637 | 0.658 |
| Khanh Hoa | 0.600 | 0.706 | 0.536 | 0.846 | 0.654 |
| Dak Lak   | 0.465 | 0.625 | 0.472 | 0.609 | 0.597 |
| Dak Nong  | 0.571 | 0.538 | 0.609 | 0.444 | 0.444 |
| Lam Dong  | 0.250 | 0.611 | 0.529 | 0.813 | 0.455 |
| Long An   | 0.870 | 0.914 | 0.879 | 0.914 | 0.907 |

Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 3: Average proportion of rice output sold, by location, quintile, and year

|                             | 2006  | 2008  | 2010  | 2012  | 2014  |
|-----------------------------|-------|-------|-------|-------|-------|
| <b>Province</b>             |       |       |       |       |       |
| Ha Tay                      | 0.146 | 0.210 | 0.260 | 0.286 | 0.312 |
| Lao Cai                     | 0.203 | 0.119 | 0.198 | 0.259 | 0.227 |
| Phu Tho                     | 0.042 | 0.094 | 0.131 | 0.075 | 0.156 |
| Lai Chau                    | 0.147 | 0.109 | 0.121 | 0.181 | 0.203 |
| Dien Bien                   | 0.355 | 0.175 | 0.209 | 0.261 | 0.231 |
| Nghe An                     | 0.179 | 0.177 | 0.174 | 0.200 | 0.293 |
| Quang Nam                   | 0.211 | 0.281 | 0.457 | 0.290 | 0.380 |
| Khanh Hoa                   | 0.367 | 0.213 | 0.361 | 0.510 | 0.420 |
| Dak Lak                     | 0.272 | 0.400 | 0.375 | 0.384 | 0.383 |
| Dak Nong                    | 0.302 | 0.365 | 0.334 | 0.210 | 0.200 |
| Lam Dong                    | 0.094 | 0.494 | 0.360 | 0.406 | 0.221 |
| Long An                     | 0.730 | 0.755 | 0.696 | 0.849 | 0.883 |
| <b>Consumption quintile</b> |       |       |       |       |       |
| 1                           | 0.189 | 0.215 | 0.270 | 0.194 | 0.282 |
| 2                           | 0.251 | 0.233 | 0.279 | 0.273 | 0.259 |
| 3                           | 0.307 | 0.286 | 0.276 | 0.298 | 0.338 |
| 4                           | 0.282 | 0.318 | 0.314 | 0.389 | 0.376 |
| 5                           | 0.245 | 0.363 | 0.350 | 0.384 | 0.432 |
| Total                       | 0.234 | 0.258 | 0.304 | 0.311 | 0.345 |

Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 4: Proportion of households growing one or more cash crop, by province, quintile, and year

|                             | 2006         | 2008         | 2010         | 2012         | 2014         |
|-----------------------------|--------------|--------------|--------------|--------------|--------------|
| <b>Province</b>             |              |              |              |              |              |
| Ha Tay                      | 0.019        | 0.009        | 0.015        | 0.002        | 0.002        |
| Lao Cai                     | 0.106        | 0.082        | 0.082        | 0.071        | 0.082        |
| Phu Tho                     | 0.212        | 0.145        | 0.141        | 0.061        | 0.108        |
| Lai Chau                    | 0.110        | 0.073        | 0.028        | 0.037        | 0.055        |
| Dien Bien                   | 0.000        | 0.000        | 0.010        | 0.000        | 0.010        |
| Nghe An                     | 0.170        | 0.112        | 0.144        | 0.112        | 0.112        |
| Quang Nam                   | 0.018        | 0.014        | 0.018        | 0.004        | 0.004        |
| Khanh Hoa                   | 0.083        | 0.083        | 0.097        | 0.111        | 0.111        |
| Dak Lak                     | 0.634        | 0.672        | 0.626        | 0.649        | 0.626        |
| Dak Nong                    | 0.717        | 0.609        | 0.598        | 0.609        | 0.739        |
| Lam Dong                    | 0.719        | 0.781        | 0.734        | 0.750        | 0.766        |
| Long An                     | 0.011        | 0.011        | 0.022        | 0.004        | 0.011        |
| <b>Consumption quintile</b> |              |              |              |              |              |
| 1                           | 0.123        | 0.094        | 0.083        | 0.062        | 0.124        |
| 2                           | 0.165        | 0.145        | 0.092        | 0.108        | 0.110        |
| 3                           | 0.179        | 0.115        | 0.097        | 0.111        | 0.114        |
| 4                           | 0.142        | 0.138        | 0.129        | 0.114        | 0.135        |
| 5                           | 0.253        | 0.238        | 0.203        | 0.156        | 0.147        |
| <b>Total</b>                | <b>0.155</b> | <b>0.134</b> | <b>0.134</b> | <b>0.115</b> | <b>0.129</b> |

Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 5: Proportion of households engaged in aquaculture activity on their own land, by province, quintile, and year

|                 | 2006  | 2008  | 2010  | 2012  | 2014  |
|-----------------|-------|-------|-------|-------|-------|
| Province        |       |       |       |       |       |
| Ha Tay          | 0.055 | 0.062 | 0.038 | 0.040 | 0.055 |
| Lao Cai         | 0.294 | 0.176 | 0.259 | 0.212 | 0.176 |
| Phu Tho         | 0.273 | 0.175 | 0.152 | 0.121 | 0.128 |
| Lai Chau        | 0.156 | 0.101 | 0.037 | 0.037 | 0.028 |
| Dien Bien       | 0.333 | 0.475 | 0.515 | 0.475 | 0.485 |
| Nghe An         | 0.133 | 0.080 | 0.080 | 0.074 | 0.053 |
| Quang Nam       | 0.036 | 0.022 | 0.018 | 0.025 | 0.007 |
| Khanh Hoa       | 0.014 | 0.042 | 0.056 | 0.042 | 0.014 |
| Dak Lak         | 0.084 | 0.115 | 0.115 | 0.076 | 0.023 |
| Dak Nong        | 0.196 | 0.098 | 0.109 | 0.087 | 0.076 |
| Lam Dong        | 0.078 | 0.047 | 0.016 | 0.047 | 0.031 |
| Long An         | 0.271 | 0.217 | 0.343 | 0.090 | 0.134 |
| Income quintile |       |       |       |       |       |
| 1               | 0.141 | 0.123 | 0.118 | 0.095 | 0.086 |
| 2               | 0.116 | 0.123 | 0.12  | 0.079 | 0.081 |
| 3               | 0.155 | 0.132 | 0.127 | 0.09  | 0.093 |
| 4               | 0.179 | 0.118 | 0.15  | 0.102 | 0.09  |
| 5               | 0.167 | 0.118 | 0.144 | 0.083 | 0.095 |
| Total           | 0.151 | 0.123 | 0.132 | 0.090 | 0.089 |

Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 6: Proportion of households engaged in some commercial agricultural activities in all years of the panel

|           | Grow rice<br>in all years | Selling in<br>all years* | Cash crops<br>in all years | Aquaculture in<br>all years |
|-----------|---------------------------|--------------------------|----------------------------|-----------------------------|
| Ha Tay    | 0.619                     | 0.189                    | 0.000                      | 0.011                       |
| Lao Cai   | 0.776                     | 0.121                    | 0.071                      | 0.047                       |
| Phu Tho   | 0.636                     | 0.021                    | 0.027                      | 0.024                       |
| Lai Chau  | 0.853                     | 0.097                    | 0.000                      | 0.009                       |
| Dien Bien | 0.929                     | 0.163                    | 0.000                      | 0.192                       |
| Nghe An   | 0.606                     | 0.175                    | 0.059                      | 0.011                       |
| Quang Nam | 0.640                     | 0.292                    | 0.000                      | 0.004                       |
| Khanh Hoa | 0.167                     | 0.250                    | 0.042                      | 0.000                       |
| Dak Lak   | 0.336                     | 0.364                    | 0.519                      | 0.000                       |
| Dak Nong  | 0.163                     | 0.267                    | 0.500                      | 0.011                       |
| Lam Dong  | 0.141                     | 0.222                    | 0.641                      | 0.000                       |
| Long An   | 0.455                     | 0.762                    | 0.000                      | 0.025                       |
| Quintile  |                           |                          |                            |                             |
| 1         | 0.717                     | 0.182                    | 0.050                      | 0.030                       |
| 2         | 0.559                     | 0.289                    | 0.091                      | 0.021                       |
| 3         | 0.533                     | 0.283                    | 0.100                      | 0.019                       |
| 4         | 0.337                     | 0.273                    | 0.096                      | 0.016                       |
| 5         | 0.253                     | 0.225                    | 0.196                      | 0.023                       |
| Total     | 0.568                     | 0.231                    | 0.085                      | 0.022                       |

Notes: \* from among those growing each year.

Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 7: Characteristics of households engaged in selling rice, compared to non-sellers

|                            | 2006     |          | 2008     |          | 2010     |          | 2012     |          | 2014     |          |
|----------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|                            | No       | Yes      |
| Total income               | 22,600.1 | 22,942.3 | 38,701.2 | 40,520.5 | 69,721.5 | 74,741.5 | 72,366.1 | 71,252.6 | 85,629.0 | 92,732.4 |
| Agricultural income        | 6,296.5  | 9,254.9  | 11,478.6 | 17,006.0 | 17,589.5 | 23,025.6 | 18,972.6 | 24,057.0 | 20,483.8 | 30,691.4 |
| If poor (MOLISA)           | 0.259    | 0.222    | 0.242    | 0.183    | 0.170    | 0.121    | 0.230    | 0.154    | 0.160    | 0.104    |
| Cultivated area            | 7,663.4  | 13,175.3 | 6,704.2  | 10,451.2 | 6,930.5  | 10,173.8 | 6,887.9  | 9,909.8  | 6,127.3  | 9,997.7  |
| Cropland area              | 4,724.7  | 9,983.4  | 4,481.1  | 8,373.9  | 5,032.7  | 7,667.2  | 4,988.0  | 8,256.6  | 4,700.1  | 8,189.5  |
| Crop input expenses        | 2,529.8  | 6,966.8  | 8,043.5  | 25,509.3 | 10,517.6 | 28,529.5 | 15,741.0 | 38,496.6 | 16,310.5 | 41,525.4 |
| Rice input expenses        | 1,284.6  | 5,986.4  | 1,972.7  | 10,135.2 | 2,459.8  | 10,858.7 | 3,804.6  | 14,110.0 | 3,638.1  | 15,218.0 |
| Per cent irrigated         | 0.705    | 0.766    | 0.711    | 0.841    | 0.745    | 0.856    | 0.801    | 0.879    | 0.193    | 0.182    |
| Per cent with restrictions | 0.583    | 0.574    | 0.534    | 0.569    | 0.378    | 0.399    | 0.627    | 0.615    | 0.395    | 0.334    |
| If received credit         | 0.642    | 0.713    | 0.457    | 0.473    | 0.464    | 0.549    | 0.403    | 0.425    | 0.358    | 0.373    |
| If has red book            | 0.913    | 0.921    | 0.874    | 0.874    | 0.785    | 0.833    | 0.879    | 0.920    | 0.887    | 0.934    |
| Household size             | 4.7      | 4.8      | 4.8      | 4.7      | 4.6      | 4.5      | 4.5      | 4.4      | 4.4      | 4.3      |
| If Kinh                    | 0.806    | 0.735    | 0.718    | 0.787    | 0.695    | 0.795    | 0.723    | 0.772    | 0.681    | 0.784    |
| If speak Vietnamese        | 0.977    | 0.961    | 0.969    | 0.965    | 0.979    | 0.994    | 0.987    | 0.988    | 0.990    | 0.995    |
| If head male               | 0.823    | 0.839    | 0.824    | 0.817    | 0.831    | 0.819    | 0.808    | 0.811    | 0.797    | 0.806    |
| Age                        | 50.2     | 49.9     | 50.5     | 51.6     | 51.7     | 52.5     | 53.4     | 53.5     | 54.6     | 54.7     |
| Literacy                   | 0.903    | 0.886    | 0.894    | 0.910    | 0.893    | 0.920    | 0.896    | 0.916    | 0.879    | 0.907    |
| Distance to road           | 0.948    | 1.795    | 3.262    | 12.854   | 2.722    | 2.969    | 2.553    | 3.248    | 1.586    | 2.397    |
| If has own transport       | 0.883    | 0.875    | 0.913    | 0.940    | 0.901    | 0.947    | 0.912    | 0.947    | 0.578    | 0.632    |
| If used extension          | 0.367    | 0.415    | 0.042    | 0.035    | 0.522    | 0.547    | 0.533    | 0.646    | 0.555    | 0.655    |
| If in farmer group         | 0.549    | 0.523    | 0.385    | 0.426    | 0.517    | 0.447    | 0.524    | 0.523    | 0.506    | 0.521    |
| If in women's group        | 0.719    | 0.653    | 0.587    | 0.598    | 0.641    | 0.634    | 0.687    | 0.631    | 0.661    | 0.605    |

Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 8: Characteristics of households engaged in cash crop cultivation, compared to those not growing cash crops

|                            | 2006     |          | 2008     |          | 2010     |           | 2012     |           | 2014     |           |
|----------------------------|----------|----------|----------|----------|----------|-----------|----------|-----------|----------|-----------|
|                            | No       | Yes      | No       | Yes      | No       | Yes       | No       | Yes       | No       | Yes       |
| Total income               | 22,741.9 | 29,263.4 | 39,686.6 | 63,855.8 | 69,733.0 | 114,758.7 | 71,410.7 | 114,830.6 | 90,926.3 | 137,878.2 |
| Agricultural income        | 7,146.6  | 16,913.2 | 13,277.7 | 39,337.5 | 19,501.8 | 40,220.7  | 19,695.0 | 67,071.6  | 24,551.4 | 71,374.2  |
| If poor (MOLISA)           | 0.235    | 0.264    | 0.207    | 0.209    | 0.146    | 0.111     | 0.185    | 0.165     | 0.128    | 0.111     |
| Cultivated area            | 9,830.1  | 16,258.6 | 7,884.1  | 17,318.1 | 8,063.1  | 16,323.1  | 7,891.7  | 17,981.1  | 7,648.4  | 17,185.9  |
| Cropland area              | 6,956.9  | 12,461.4 | 5,967.3  | 14,047.4 | 6,089.4  | 13,015.2  | 6,215.0  | 15,412.1  | 6,062.0  | 14,955.8  |
| Crop input expenses        | 4,496.3  | 10,675.2 | 16,274.6 | 50,541.1 | 18,615.5 | 57,093.2  | 25,482.2 | 100,695.3 | 27,812.1 | 98,579.4  |
| Rice input expenses        | 3,807.1  | 1,104.3  | 6,614.4  | 1,987.6  | 7,143.5  | 3,334.4   | 9,793.2  | 3,785.4   | 10,575.5 | 3,059.4   |
| Per cent irrigated         | 0.757    | 0.618    | 0.790    | 0.794    | 0.808    | 0.858     | 0.845    | 0.875     | 0.158    | 0.706     |
| Per cent with restrictions | 0.595    | 0.285    | 0.542    | 0.740    | 0.377    | 0.665     | 0.615    | 0.754     | 0.339    | 0.750     |
| If received credit         | 0.664    | 0.769    | 0.451    | 0.638    | 0.503    | 0.630     | 0.399    | 0.578     | 0.356    | 0.538     |
| If has red book            | 0.913    | 0.901    | 0.870    | 0.879    | 0.813    | 0.841     | 0.904    | 0.911     | 0.914    | 0.925     |
| Household size             | 4.7      | 4.9      | 4.7      | 4.9      | 4.5      | 4.7       | 4.4      | 4.7       | 4.4      | 4.5       |
| If Kinh                    | 0.785    | 0.722    | 0.766    | 0.738    | 0.765    | 0.734     | 0.767    | 0.699     | 0.757    | 0.677     |
| If speak Vietnamese        | 0.968    | 0.961    | 0.965    | 0.990    | 0.987    | 0.986     | 0.987    | 0.992     | 0.992    | 0.993     |
| If head male               | 0.821    | 0.889    | 0.812    | 0.879    | 0.816    | 0.879     | 0.805    | 0.871     | 0.798    | 0.842     |
| Age                        | 50.2     | 47.5     | 51.4     | 47.5     | 52.4     | 49.2      | 53.7     | 50.3      | 54.9     | 52.0      |
| Literacy                   | 0.892    | 0.907    | 0.906    | 0.907    | 0.913    | 0.907     | 0.912    | 0.892     | 0.894    | 0.896     |
| Distance to road           | 1.370    | 1.308    | 3.876    | 27.238   | 2.888    | 2.286     | 3.089    | 1.196     | 2.130    | 1.088     |
| If has own transport       | 0.874    | 0.907    | 0.926    | 0.955    | 0.926    | 0.940     | 0.929    | 0.955     | 0.617    | 0.373     |
| If used extension          | 0.390    | 0.344    | 0.040    | 0.038    | 0.523    | 0.578     | 0.595    | 0.548     | 0.609    | 0.616     |
| If in farmer group         | 0.522    | 0.593    | 0.385    | 0.510    | 0.460    | 0.526     | 0.519    | 0.562     | 0.506    | 0.513     |
| If in women's group        | 0.678    | 0.737    | 0.580    | 0.648    | 0.630    | 0.637     | 0.655    | 0.651     | 0.626    | 0.606     |

Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 9: Characteristics of households engaged in aquaculture, compared to those not doing aquaculture

|                            | 2006     |          | 2008     |          | 2010     |          | 2012     |          | 2014     |           |
|----------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|
|                            | No       | Yes       |
| Total income               | 23,202.9 | 29,454.7 | 42,256.3 | 54,523.8 | 73,596.8 | 97,532.4 | 77,240.9 | 84,451.2 | 98,393.2 | 104,638.4 |
| Agricultural income        | 8,033.9  | 13,234.3 | 16,022.9 | 26,107.4 | 19,983.1 | 39,524.2 | 25,421.0 | 37,499.8 | 31,650.4 | 42,479.7  |
| If poor (MOLISA)           | 0.261    | 0.145    | 0.223    | 0.112    | 0.155    | 0.063    | 0.188    | 0.139    | 0.131    | 0.080     |
| Cultivated area            | 9,796.1  | 17,057.3 | 8,662.8  | 13,790.9 | 8,251.6  | 16,001.9 | 8,952.4  | 13,099.2 | 8,918.1  | 12,326.5  |
| Cropland area              | 7,630.8  | 9,756.3  | 6,844.1  | 9,329.8  | 6,532.7  | 11,238.9 | 7,341.1  | 9,523.6  | 7,451.4  | 8,538.4   |
| Crop input expenses        | 5,482.0  | 6,290.1  | 20,423.7 | 31,213.5 | 22,145.5 | 41,808.3 | 37,788.7 | 33,180.6 | 40,556.1 | 39,729.3  |
| Rice input expenses        | 3,165.7  | 3,906.5  | 5,073.7  | 10,568.1 | 5,104.8  | 14,095.1 | 8,949.6  | 7,998.9  | 8,938.8  | 11,985.5  |
| Per cent irrigated         | 0.745    | 0.668    | 0.802    | 0.742    | 0.826    | 0.769    | 0.860    | 0.756    | 0.253    | 0.232     |
| Per cent with restrictions | 0.570    | 0.392    | 0.598    | 0.457    | 0.462    | 0.233    | 0.641    | 0.588    | 0.413    | 0.378     |
| If received credit         | 0.655    | 0.816    | 0.466    | 0.566    | 0.507    | 0.621    | 0.425    | 0.430    | 0.380    | 0.434     |
| If has red book            | 0.899    | 0.967    | 0.872    | 0.877    | 0.813    | 0.843    | 0.905    | 0.890    | 0.919    | 0.891     |
| Household size             | 4.7      | 5.0      | 4.7      | 5.0      | 4.5      | 4.7      | 4.4      | 4.7      | 4.4      | 4.7       |
| If Kinh                    | 0.790    | 0.712    | 0.776    | 0.715    | 0.783    | 0.645    | 0.778    | 0.582    | 0.764    | 0.594     |
| If speak Vietnamese        | 0.967    | 0.967    | 0.967    | 0.978    | 0.986    | 0.992    | 0.988    | 0.988    | 0.993    | 0.994     |
| If head male               | 0.815    | 0.908    | 0.812    | 0.877    | 0.815    | 0.883    | 0.801    | 0.915    | 0.793    | 0.909     |
| Age                        | 49.6     | 50.3     | 50.7     | 50.9     | 51.9     | 51.3     | 53.4     | 52.0     | 54.5     | 54.2      |
| Literacy                   | 0.879    | 0.961    | 0.903    | 0.939    | 0.914    | 0.906    | 0.907    | 0.921    | 0.893    | 0.903     |
| Distance to road           | 1.314    | 1.619    | 8.624    | 3.931    | 2.425    | 4.768    | 2.708    | 3.598    | 1.750    | 3.524     |
| If has own transport       | 0.871    | 0.921    | 0.931    | 0.942    | 0.926    | 0.937    | 0.931    | 0.952    | 0.579    | 0.537     |
| If used extension          | 0.365    | 0.424    | 0.031    | 0.088    | 0.537    | 0.520    | 0.577    | 0.655    | 0.606    | 0.629     |
| If in farmer group         | 0.525    | 0.559    | 0.402    | 0.395    | 0.471    | 0.484    | 0.523    | 0.539    | 0.512    | 0.457     |
| If in women's group        | 0.682    | 0.688    | 0.591    | 0.575    | 0.643    | 0.559    | 0.650    | 0.685    | 0.621    | 0.646     |

Source: Authors' computations based on VARHS survey data for years 2006-14.

Table 10: Regression results for correlates of selling rice and growing cash crops

|   | Sales of rice               |                          |                       | Cultivation of cash crops   |                          |                      |
|---|-----------------------------|--------------------------|-----------------------|-----------------------------|--------------------------|----------------------|
|   | Pooled OLS with district FE | Household FE panel model | RE probit model       | Pooled OLS with district FE | Household FE panel model | RE probit model      |
|   | coef/t                      | coef/t                   | coef/t                | coef/t                      | coef/t                   | coef/t               |
| Percentage of land area with restrictions | 0.032**<br>(2.305)          | 0.004<br>(0.308)         | 0.045<br>(0.989)      | 0.022***<br>(3.570)         | -0.001<br>(-0.242)       | 0.083<br>(0.741)     |
| Total land area                           | 0.003<br>(0.790)            | 0.004<br>(0.973)         | 0.006<br>(0.427)      | 0.003<br>(1.438)            | 0.003*<br>(1.736)        | 0.098***<br>(2.875)  |
| Percentage of land area irrigated         | 0.054***<br>(2.817)         | 0.030*<br>(1.899)        | 0.139***<br>(2.698)   | 0.023***<br>(2.658)         | 0.001<br>(0.241)         | 0.085<br>(0.691)     |
| Area used for crop cultivation            | 0.022***<br>(3.107)         | 0.009<br>(1.081)         | 0.079***<br>(2.674)   | 0.009***<br>(2.791)         | 0.000<br>(0.056)         | 0.014<br>(0.259)     |
| If household received credit              | 0.008<br>(0.676)            | 0.012<br>(0.967)         | 0.042<br>(1.064)      | 0.022***<br>(4.204)         | 0.014***<br>(2.932)      | 0.394***<br>(3.929)  |
| If household has red book for its land    | 0.029<br>(1.492)            | -0.006<br>(-0.255)       | 0.062<br>(0.958)      | 0.009<br>(0.997)            | -0.024***<br>(-2.742)    | -0.365**<br>(-2.029) |
| Distance to nearest road                  | 0.000<br>(1.121)            | 0.000<br>(0.375)         | 0.004<br>(1.360)      | 0.000<br>(0.593)            | -0.000<br>(-0.053)       | 0.005<br>(0.639)     |
| If market in commune                      | 0.046***<br>(3.472)         | 0.079***<br>(5.277)      | 0.160***<br>(3.649)   | -0.005<br>(-0.808)          | -0.006<br>(-1.084)       | -0.124<br>(-1.038)   |
| If uses hybrid seed                       | 0.023***<br>(4.433)         | 0.012**<br>(2.524)       | 0.073***<br>(4.167)   | -0.005*<br>(-1.934)         | 0.002<br>(1.012)         | 0.020<br>(0.470)     |
| Expenses on crop inputs                   | -0.002<br>(-1.181)          | 0.002<br>(0.987)         | 0.046***<br>(3.949)   | 0.001<br>(1.153)            | 0.000<br>(0.238)         | 0.026<br>(1.470)     |
| Amount of hired labour                    | 0.095***<br>(3.710)         | 0.070**<br>(2.537)       | 0.424***<br>(3.158)   | 0.005<br>(0.671)            | 0.008<br>(1.180)         | 0.258<br>(1.601)     |
| If household does wage work               | 0.018<br>(1.528)            | 0.004<br>(0.284)         | 0.049<br>(1.153)      | -0.014***<br>(-2.636)       | -0.000<br>(-0.036)       | -0.077<br>(-0.708)   |
| Household size                            | -0.010***<br>(-2.803)       | -0.017***<br>(-3.054)    | -0.053***<br>(-3.785) | 0.000<br>(0.199)            | 0.001<br>(0.362)         | 0.019<br>(0.479)     |
| If member of farmers' union               | 0.014<br>(1.187)            | -0.003<br>(-0.254)       | 0.041<br>(0.954)      | 0.006<br>(1.088)            | -0.004<br>(-0.725)       | -0.075<br>(-0.683)   |
| If member of women's union                | -0.004<br>(-0.299)          | -0.007<br>(-0.522)       | -0.013<br>(-0.285)    | -0.011**<br>(-1.963)        | -0.006<br>(-1.163)       | -0.188<br>(-1.630)   |
| If received extension                     | 0.035***<br>(2.821)         | 0.012<br>(1.025)         | 0.087**<br>(2.259)    | 0.006<br>(1.131)            | -0.002<br>(-0.391)       | -0.068<br>(-0.730)   |
| If owns a radio                           | -0.003<br>(-0.172)          | -0.015<br>(-0.913)       | -0.029<br>(-0.553)    | 0.011<br>(1.633)            | 0.006<br>(1.019)         | 0.125<br>(0.993)     |
| If has own transport                      | 0.035*<br>(1.932)           | 0.021<br>(1.143)         | 0.111*<br>(1.913)     | 0.015*<br>(1.835)           | 0.012*<br>(1.828)        | 0.259*<br>(1.769)    |
| If of Kinh ethnicity                      | -0.082***<br>(-2.732)       | -0.123*<br>(-1.762)      | -0.318***<br>(-3.532) | 0.053***<br>(4.225)         | 0.008<br>(0.291)         | 0.316<br>(1.401)     |

|                        | Sales of rice               |                          |                       | Cultivation of cash crops   |                          |                       |
|------------------------|-----------------------------|--------------------------|-----------------------|-----------------------------|--------------------------|-----------------------|
|                        | Pooled OLS with district FE | Household FE panel model | RE probit model       | Pooled OLS with district FE | Household FE panel model | RE probit model       |
|                        | coef/t                      | coef/t                   | coef/t                | coef/t                      | coef/t                   | coef/t                |
| If female headed       | 0.028*<br>(1.818)           | 0.008<br>(0.209)         | 0.043<br>(0.652)      | -0.005<br>(-0.632)          | -0.017<br>(-1.207)       | 0.084<br>(0.395)      |
| If speaks Vietnamese   | -0.121***<br>(-2.779)       | -0.106**<br>(-2.059)     | -0.346**<br>(-2.272)  | 0.030<br>(1.500)            | 0.025<br>(1.260)         | 0.998*<br>(1.709)     |
| If poor (MOLISA)       | -0.042***<br>(-2.762)       | -0.058***<br>(-3.155)    | -0.156***<br>(-2.915) | 0.001<br>(0.076)            | 0.009<br>(1.353)         | 0.110<br>(0.794)      |
| Age                    | 0.000<br>(0.569)            | 0.002<br>(1.389)         | 0.001<br>(0.699)      | -0.000<br>(-1.635)          | -0.001**<br>(-2.106)     | -0.011*<br>(-1.791)   |
| If can read and write  | 0.002<br>(0.080)            | 0.003<br>(0.099)         | 0.078<br>(1.023)      | -0.016<br>(-1.640)          | -0.016<br>(-1.510)       | -0.291<br>(-1.357)    |
| 2006 dummy             | (dropped)                   |                          |                       | (dropped)                   |                          |                       |
| 2008 dummy             | 0.073***<br>(4.147)         |                          |                       | -0.011<br>(-1.372)          |                          |                       |
| 2010 dummy             | 0.076***<br>(4.247)         |                          |                       | -0.010<br>(-1.189)          |                          |                       |
| 2012 dummy             | 0.057***<br>(3.127)         |                          |                       | -0.040***<br>(-4.730)       |                          |                       |
| 2014 dummy             | 0.106***<br>(4.857)         |                          |                       | -0.002<br>(-0.198)          |                          |                       |
| _cons                  | 0.275**<br>(2.088)          | 0.630***<br>(5.545)      | 0.178<br>(0.726)      | -0.080<br>(-1.286)          | 0.216***<br>(4.997)      | -7.355***<br>(-8.529) |
| Household FEs          |                             | y                        |                       |                             | y                        |                       |
| District FE            | y                           |                          |                       | y                           |                          |                       |
| Province FEs           |                             |                          | y                     |                             |                          | y                     |
| /Insig2u               |                             |                          | -0.563***<br>(-6.500) |                             |                          | 2.155***<br>(22.406)  |
| Number of observations | 7,335                       | 7,335                    | 7,335                 | 8,004                       | 8,004                    | 8,004                 |
| Rho                    |                             | 0.432                    | 0.363                 |                             | 0.818                    | 0.896                 |
| Sigma_u                |                             | 0.356                    | 0.755                 |                             | 0.344                    | 2.937                 |
| Sigma_e                |                             | 0.408                    |                       |                             | 0.162                    |                       |

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. RE=random effects; FE=fixed effects.

Source: Authors' calculation based on VARHS 2006-14 panel data set.

Table 11: Regression results for correlates of engagement in aquaculture

|   | Base model                  |                          |                          | With shocks             | Shocks and investments  |
|---|-----------------------------|--------------------------|--------------------------|-------------------------|-------------------------|
|   | Pooled OLS with district FE | Household FE panel model | RE probit model          | RE probit model         | RE probit model         |
|   | coef/t                      | coef/t                   | coef/t                   | coef/t                  | coef/t                  |
| Percentage of land area with restrictions | -0.0171**<br>(0.00856)      | -0.00631<br>(0.00773)    | -0.0665<br>(0.0673)      | -0.0720<br>(0.0677)     | 0.0306<br>(0.0818)      |
| Total land area                           | 6.69e-07***<br>(2.01e-07)   | 2.44e-07<br>(2.27e-07)   | 2.41e-06**<br>(1.22e-06) | 2.33e-06*<br>(1.22e-06) | 4.72e-06*<br>(2.43e-06) |
| Percentage of land area irrigated         | 0.00847<br>(0.0116)         | 0.00110<br>(0.00913)     | 0.0246<br>(0.0793)       | 0.0274<br>(0.0796)      | 0.111<br>(0.0907)       |
| If household received credit              | 0.0272***<br>(0.00724)      | 0.0443***<br>(0.00701)   | 0.390***<br>(0.0613)     | 0.396***<br>(0.0617)    | 0.269***<br>(0.0705)    |
| If household has red book for its land    | 0.0107<br>(0.0121)          | -0.00643<br>(0.0130)     | 0.0523<br>(0.115)        | 0.0416<br>(0.115)       | 0.135<br>(0.131)        |
| Distance to nearest road                  | -5.36e-06<br>(4.46e-05)     | 3.97e-07<br>(3.96e-05)   | -0.000148<br>(0.000810)  | -0.000141<br>(0.000764) | -0.000161<br>(0.000853) |
| If market in commune                      | 0.000191<br>(0.0124)        | -0.0368***<br>(0.00783)  | -0.393***<br>(0.0773)    | -0.406***<br>(0.0779)   | -0.258***<br>(0.0828)   |
| If household does wage work               | -0.0101<br>(0.00749)        | 0.00696<br>(0.00793)     | -0.00705<br>(0.0653)     | -0.00881<br>(0.0655)    | 0.0345<br>(0.0763)      |
| Household size                            | 0.00693***<br>(0.00231)     | 0.0116***<br>(0.00331)   | 0.0632***<br>(0.0231)    | 0.0651***<br>(0.0232)   | 0.0188<br>(0.0255)      |
| If member of farmers' union               | 0.00384<br>(0.00750)        | -0.00264<br>(0.00759)    | 0.0106<br>(0.0649)       | 0.00248<br>(0.0653)     | -0.0198<br>(0.0755)     |
| If member of women's union                | 0.0132*<br>(0.00777)        | -0.00623<br>(0.00800)    | 0.0545<br>(0.0679)       | 0.0567<br>(0.0684)      | 0.0144<br>(0.0767)      |
| If owns a radio                           | 0.00254<br>(0.00951)        | -0.00284<br>(0.00890)    | -0.00162<br>(0.0770)     | -0.000920<br>(0.0776)   | 0.0129<br>(0.0901)      |
| If has own transport                      | 0.0107<br>(0.0113)          | 0.00504<br>(0.00999)     | 0.132<br>(0.0908)        | 0.116<br>(0.0913)       | 0.0818<br>(0.102)       |
| If of Kinh ethnicity                      | 0.0245<br>(0.0172)          | 0.0516<br>(0.0397)       | 0.0448<br>(0.147)        | 0.0304<br>(0.148)       | -0.00448<br>(0.146)     |
| If female headed                          | 0.0321***<br>(0.00947)      | 0.0338*<br>(0.0201)      | 0.414***<br>(0.125)      | 0.406***<br>(0.125)     | 0.295**<br>(0.124)      |
| If speaks Vietnamese                      | -0.0451<br>(0.0288)         | -0.0727**<br>(0.0308)    | -0.453*<br>(0.234)       | -0.447*<br>(0.234)      | -0.160<br>(0.341)       |
| If poor (MOLISA)                          | -0.0613***<br>(0.00985)     | -0.0253**<br>(0.0106)    | -0.415***<br>(0.0944)    | -0.421***<br>(0.0947)   | -0.369***<br>(0.112)    |
| Age                                       | 0.000724**<br>(0.000328)    | 0.000574<br>(0.000451)   | 0.00212<br>(0.00301)     | 0.00212<br>(0.00301)    | 0.00358<br>(0.00323)    |

|  | Base model                  |                          |                      | With shocks          | Shocks and investments |
|--|-----------------------------|--------------------------|----------------------|----------------------|------------------------|
|  | Pooled OLS with district FE | Household FE panel model | RE probit model      | RE probit model      | RE probit model        |
|  | coef/t                      | coef/t                   | coef/t               | coef/t               | coef/t                 |
| If can read and write                        | 0.0394***<br>(0.0134)       | -0.00621<br>(0.0158)     | 0.239*<br>(0.129)    | 0.232*<br>(0.129)    | 0.215<br>(0.144)       |
| If faced a natural shock                     |                             |                          |                      | -0.139*<br>(0.0760)  | -0.0357<br>(0.0838)    |
| If faced an economic shock                   |                             |                          |                      | 0.0723<br>(0.133)    | 0.0714<br>(0.139)      |
| If made cash investments in aquaculture land |                             |                          |                      |                      | 2.227***<br>(0.122)    |
| 2006 dummy                                   | 0.0592***<br>(0.0152)       |                          |                      |                      |                        |
| 2008 dummy                                   | 0.0308**<br>(0.0157)        |                          |                      |                      |                        |
| 2010 dummy                                   | 0.0366**<br>(0.0158)        |                          |                      |                      |                        |
| 2012 dummy                                   | -0.00412<br>(0.0134)        |                          |                      |                      |                        |
| _cons  | -0.165*<br>(0.0882)         | 0.0597<br>(0.0581)       | -3.678***<br>(0.408) | -3.620***<br>(0.409) | -3.545***<br>(0.492)   |
| Household FEs                                |                             | Y                        |                      |                      |                        |
| District FE                                  | Y                           |                          |                      |                      |                        |
| Province FEs                                 |                             |                          | Y                    | Y                    | Y                      |
| /Insig2u                                     |                             |                          | 0.639***<br>(0.0972) | 0.642***<br>(0.0976) | 0.216*<br>(0.128)      |
| Observations                                 | 8,466                       | 8,466                    | 8,466                | 8,400                | 6,568                  |
| R-squared                                    | 0.204                       | 0.018                    |                      |                      |                        |
| Number of unikid                             |                             | 1,959                    | 1,959                | 1,959                | 1,897                  |
| Rho  |                             | 0.512                    | 0.655                | 0.655                | 0.554                  |
| Sigma_u                                      |                             | 0.255                    | 1.376                | 1.378                | 1.114                  |
| Sigma_e                                      |                             | 0.249                    |                      |                      |                        |

Note: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. RE=random effects; FE=fixed effects.

Source: Authors' calculation based on VARHS 2006-14 panel data set.