The Intertemporal Evolution of Agriculture and Labor over a Rapid Structural Transformation: Lessons from Vietnam

Yanyan Liu[1], Christopher B. Barrett[2], Trinh Pham[3], William Violette[4]

June 2019 revised version

Abstract

We combine nationally representative household and labor force survey data from 1992 to 2016 to provide a detailed description of rural labor market evolution and how it relates to the structural transformation of rural Vietnam, especially within the agricultural sector. Our study adds to the emerging literature on structural transformation in low-income countries using micro-level data and helps to answer several policy-related questions. We find limited employment creation potential of agriculture, especially for youth. Rural-urban real wage convergence has gone hand-in-hand with increased diversification of the rural economy into the non-farm sector nationwide and rapid advances in educational attainment in all sectors' and regions' workforce. Minimum wage laws seem to have played no significant role in increasing agricultural wages. This enhanced integration also manifests in steady attenuation of the longstanding inverse farm size-yield relationship. Farming has remained securely household-based and the farmland distribution has remained largely unchanged. Small farm sizes have not obstructed mechanization nor the uptake of labor-saving pesticides, consistent with factor substitution induced by rising real wage rates. As rural households rely more heavily on the labor market, human capital accumulation (rather than land endowments) have become the key driver of improvements in rural household well-being.

Keywords: Vietnam, structural transformation, rural labor market, inverse farm size and productivity relationship

[1] International Food Policy Research Institute. Email: y.liu@cgiar.org
[2] Dyson School of Applied Economics and Management, Cornell University. Email: cbb2@cornell.edu
[3] Dyson School of Applied Economics and Management, Cornell University. Email: tp347@cornell.edu
[4] Federal Trade Commission. Email: william.j.violette@gmail.com

The Intertemporal Evolution of Agriculture and Labor over a Rapid Structural Transformation: Lessons from Vietnam

1. Introduction

Over the past three decades, Vietnam has undergone one of the most rapid structural transformations of any low-income agrarian nation in history. Since the Doi Moi reforms initiated in late 1986 with the objective of creating a robust, socialist-oriented, market economy out of what had been a fully centrally-planned one, Vietnam has consistently experienced well-above-average real GDP growth of 4–8 percent annually.[5] From 1992 – the earliest year for which nationally-representative survey data are available – to 2016, per capita real gross national income (GNI) more than tripled, turning Vietnam from one of the world's poorest countries, at less than US $500/year (in constant 2010 dollars) to roughly $1700, while the share of GDP in agriculture fell from 34% to 16% and the share of the workforce employed in agriculture fell from 68% to 42% (World Bank 2019). Put differently, in 1992 Vietnam's income level and economic structure was strikingly similar to present day Liberia. Today it is a solidly (lower) middle-income country enjoying comparatively rapid economic growth and poverty reduction. Starting as one of the poorest, most agriculture-intensive economies with still-above-average population growth, Vietnam provides a valuable case study for understanding the structural transformation process among low-income countries and its implications for agriculture and labor markets. Since the global poor disproportionately reside in rural areas and work (at least part-time) in agriculture, understanding this process is essential to developing viable poverty reduction strategies in today's low-income agrarian economies.

---

[5] See Timmer (1993) for the policy context for the government's reforms to agriculture and the rural economy as the starting point of our analysis.

Our study is motivated by several current policy concerns in developing countries, in particular:

i.   Does structural transformation lead to regional specialization, with rural areas concentrating in farming and losing workers who leave for cities? Do we see rapid transition into the non-farm sector within rural areas?

ii.   To what extent does an increasingly productive farming sector absorb young workers in low-income countries?

iii.   Do real wages for farmworkers converge to those earned by non-farm workers, and do rural wage rates converge to urban rates? Do minimum wage laws enacted primarily for urban non-farm workers seem to bind in the agricultural sector?

iv.   Does structural transformation lead to farm consolidation, mechanization, and the displacement of workers as farms grow larger and more mechanized?

v.   Does the commonly observed inverse farm size–productivity relationship in developing countries attenuate and farming households rely less autoconsumption of own food production over time, suggesting more competitive and integrated rural factor and output markets and less rationale for agricultural policies favoring smaller farms?

vi.   Is structural transformation associated with rapid increases in well-being for households that remain in rural areas?

This paper offers descriptive evidence on the structural transformation process that Vietnam has undergone. We combine nationally representative household data (Vietnam Household Living Standards Surveys, VHLSS) from 1992 to 2016 and labor force survey (LFS) data from 2007 to 2016 in order to provide a detailed description of rural labor market evolution and how it relates to the transformation of Vietnamese agriculture. This paper thereby adds to the emerging literature

on structural transformation in low-income countries using micro-level data. Most studies on structural transformation rely on macro-level data (Timmer 2002, 2009, Rodrik 2013, Dercon and Gollin 2014, Gollin 2014, Gollin et al. 2016, Rodrik 2016, Diao et al. 2017), while micro-level data shed light on transformation within one country and unmask potential heterogeneity in the growth process (McCullough 2016, 2017).[6] To our knowledge, our study covers a longer period (24 years) than do prior studies using microdata.

We have four main findings. First, Vietnamese households have diversified out of agriculture, manifest not only in decreasing shares of farming households, but also in a decline in the agricultural labor force within farming households, and in the agricultural income of rural households. We also observe uneven structural transformation across regions, with sharper reduction in the share of agricultural labor forces in more urbanized Red River Delta and Southeast regions. These findings are consistent with those in McCaig and Pavcnik (2017) and demonstrate the continuation into the 2010s of the transition they already documented.

Second, real wages have increased rapidly in both the farm and nonfarm sectors, seemingly driven by rapid advances in educational attainment and not by changes in statutory minimum wage rates. The nonfarm sector has seen significantly higher real wage growth than the farm sector and the inter-sectoral wage gap has widened, although this likely reflects selection on human capital. Increasing employment in higher-productivity nonfarm sectors points to a successful structural transformation, which contributes to the overall economic growth (McMillan and Rodrik 2011).

---

[6] See also the papers in recent special journal issues on the topic of structural transformation, such as *Agricultural Economics* (48, S1; 2017), *World Development* (105; 2018), or *Journal of Development Studies* (54, 5; 2018).

And real wage growth faster than overall GDP expansion indicates an inclusive growth process benefitting workers disproportionately.

Third, the rapid structural transformation does not lead to farm consolidation. Farm size remains small and the land distribution changed remarkably little over two-plus decades of rapid rural transformation. Nevertheless, mechanization – mainly through rental markets – and the use of labor-saving inputs like pesticides has grown steadily, likely driven by rising labor costs and farmers' improved access to finance as farm productivity grew. Rice yields continued increasing, though more rapidly in the earlier years than recently. In line with more efficient factor and output markets, over time the commonly observed inverse farm size–productivity relationship has attenuated and farm household have come to rely increasingly on market purchases for their food.

Fourth, we show that, as rural households rely more heavily on the labor market rather than agriculture, human capital accumulation plays an increasingly more important role in household well-being. In contrast, land endowment becomes less strongly associated with per capita consumption expenditures over time, further underscoring the transition from an agrarian economy where sector-specific assets such as land are the main determinants of income to a more modern economy based more on the returns to accumulated human capital. Women's participation in labor markets and real wage rates lag men's, but by a smaller margin than the global average, again signaling a relatively inclusive growth process.

McCaig and Pavcnik (2017) and Tarp (2017) also describe structural transformation in Vietnam. In particular, McCaig and Pavcnik (2017) document labor reallocation across sectors using the

1990s-2000s nationally representative household survey and population census data. They show how structural transformation has been driven mainly by rapid expansion of nonfarm sectors and enhanced integration of markets for credit, labor, land, machinery, and other factors of production throughout the country (McCaig and Pavcnik 2017). As the nonfarm sectors provided more job opportunities, people moved out of farming, driving up agricultural real wages and shrinking the rural-urban wage gap between agricultural and nonagricultural sectors. Tarp (2017) also describes the rural transformation, relying on the 2006-2014 Viet Nam Access to Resources Household Survey (VARHS) data. VARHS focuses on rural areas and is not nationally representative, however.

Our study builds on these two studies in at least four aspects. First, we use a longer duration of nationally representative data to document the evolution of rapid structural transformation over 24 years in Vietnam. Second, we provide a more detailed description of rural, and especially agricultural transformation. Third, we complement the nationally representative household survey data with LFS data to provide a more detailed description of rural labor markets and a cross-check on the household survey data. Fourth, we show important, policy-relevant findings beyond those from the existing studies, including the increasing role of human capital (and declining role of land holdings) in determining welfare of rural households, the attenuation of farm size-productivity relationship over time, as well as increased role of machinery in farming.

For any of several reasons, the Vietnamese case might not provide an apt lens through which to view today's low-income agrarian economies. Vietnam has retained an extraordinarily strong state while shifting from a centrally planned to a market economy. Its proximity to the east Asian boom

economies of China, Korea, and Taiwan, along with normalization of relations with the United States, has enabled buoyant export growth,[7] which is perhaps less accessible to other low-income agrarian nations. The country has a high population density, but rapidly slowing population growth, leading to an aging population. The central government invested heavily in education and health, leading to educational performance and health indicators more characteristic of upper-middle- and high-income countries. Nonetheless, the Vietnamese experience can be instructive for today's low-income agrarian economies, in part because its experience contrasts with some common narratives of what might be inevitable as such economies undergo structural transformation.

The paper proceeds as follows. Section 2 describes the data. Section 3 describes the evolution of rural and agricultural labor markets. Section 4 describes the evolution of the agricultural sector. Section 5 explores the evolution of well-being among rural households. Section 6 concludes.

2. Data

The data that we use come from two nationally representative data sets, the ten-round Vietnam Living Standard Survey from 1992 to 2016 and the six-round Labor Force Survey from 2007 to 2016. Such rich, nationally-representative descriptive analysis is uncommon during an extended period of rapid growth.

2.1. Vietnam Household Living Standards Surveys (VHLSSs)

This study uses data from the 1992 and 1998 Vietnam Living Standards Surveys (VLSS) and from the 2002-2016 biennial Vietnam Household Living Standards Surveys (VHLSS) (General

---

[7] For example, McCaig and Pavcnik (2018) demonstrate that the US-Vietnam Bilateral Trade Agreement boosted labor productivity in manufacturing, inducing a reallocation of workers into formal manufacturing.

Statistics Office of Vietnam, GSOV). For simplicity, we use VHLSS to refer to both the VLSS and VHLSS throughout. The VHLSSs are representative at national, regional, urban, rural, and provincial levels. Therefore, the subnational breakdowns that we report are all statistically representative of those populations. The VHLSS use similar survey instruments throughout the 1992-2016 period, including a household questionnaire and a commune questionnaire. The 1992 VHLSS sampling frame was the 1989 census. The VHLSS 1998 intended to interview all households from the VHLSS 1992. The 2002 to 2008 VHLSSs were sampled based on the 1999 census and the 2010-2016 rounds were sampled based on 2009 census. In each 2002-2008 VHLSS round and in the 2012-2016 VHLSS rounds, half of the communes surveyed in the previous round were randomly selected and the sample households in these selected communes were re-interviewed, and another group of households was added to the sample to construct a rotating panel.[8]

For some analyses, we merge the data from household and commune surveys to construct five rural household panels: VHLSS 1992/1998, VHLSS 2002/2004, VHLSS 2006/2008, VHLSS 2010/2012, and VHLSS 2014/2016. Appendix Table A1 summarizes the number of households and number of communes in each panel.[9] The household survey data provide information on household demographics, rice output by type of rice, rice planting area, landholdings, labor hiring, and agricultural inputs.

---

[8] Although the GSOV claims the data are representative of the country, households in surveyed communes are on average better off than households in other communes (Hansen and Le, 2013). This has created some concern that the sample selection deviated from a fully random approach at some point(s), although these differences are not substantial.

[9] As is apparent in Table 1, the 1992-98 VLSS sampled fewer communes and more households/commune than the subsequent 2002-2016 VHLSS.

The commune survey provides information on local agricultural wage by gender and by task (land preparation, planting, tendering, and harvesting). We generate median wage rates by gender, combining across all tasks for each commune and each panel round. To calculate the real wage, we deflate local nominal wage rates by the national consumer price index (CPI), which captures intertemporal inflation, and by the local CPI, which captures spatial price variation that matches the most disaggregated sampling units at which the VHLSS is statistically representative.

2.2. Labor Force Survey (LFS)

The Labor Force Survey (LFS) has been conducted by the Government Statistics Office of Vietnam with technical support from the International Labor Organization in 2007, 2009, and annually since 2010. LFS is representative at the national, urban, rural, and regional level.[10]

The LFS surveys consist of household and employment information. The household part provides brief demographic characteristics, such as relationship to the household head, gender and year of birth of all members of each household. The employment part is focused on employment aspects, such as highest general education and/or technical education qualification, economic activities, employment status, occupation, industry in which the person is working, hours worked, and income/wage of individuals aged 15 and above. Individuals are categorized into five sub-groups: fully-employed, under-employed, un-employed, discouraged, and other; of which the first three are considered workforce, whereas the latter two are considered out of the workforce. Appendix Table A2 summarizes the number of individuals aged 15 and above surveyed in each round.

---

[10] See Appendix A for description of the sampling framework.

3. **Evolution of Rural and Agricultural Labor Markets**

3.1. Evolution of agricultural and non-farm employment patterns

Table 1 reports the share and number of households working in agriculture (including forestry and aquaculture) in each survey round from 1992-2016, for all of Vietnam and by region, based on VHLSS data. The share of households engaged in agriculture fell from 83.5% in 1992 to 62.9% in 2016 (a slight uptick from the 61.6% low in 2014). Meanwhile, the number of households engaged in agricultural production increased moderately from 12.67 to 15.78 million due to population growth.

Subnational results show large disparities in the evolution of employment in agriculture. As the most economically developed region – home to the largest municipality (Ho Chi Minh City) – the Southeast region had the lowest share of agricultural households over this period. In 2016, only 30.7% of households were involved in agriculture, down from 53.3% in 1992 in this relatively urban region. The Red River Delta region, home to Hanoi (Vietnam's capital and second largest city by population), experienced the fastest transition out of agriculture among all regions, as the share of households involved in agriculture decreased from 83.8% in 1992 to 56.3% in 2016.

We also see the emergence of regional differentiation over this period. Omitting the Southeast, which was an outlier in 1992, the inter-region range of the share of households in farming expanded considerably, from 0.84-0.96 in 1992 to 0.56-0.83 in 2016. Even in 2016, the most agrarian, rural provinces – the Central Highlands, North and South-Central Coast, and North East and North West – still had three-quarters or more of households engaged in farm production. While the urbanizing Red River Delta and Southeast regions had relatively little growth in their

agricultural workforce, the number of households farming nearly quadrupled over this period in the Central Highlands, from 0.36 million to 1.25 million.

Consistent with household-level results from VHLSS, individual-level LFS data reveal similar patterns (Table 2). The share of individual workers employed in agriculture declined from 48.4% to 39.4% from 2007 to 2016. The fact that these shares are far less than the proportion of households farming signals that even agricultural households have long diversified their earnings portfolios across sectors (on which, more below), as is true in sub-Saharan African low-income agrarian nations as well (Barrett et al. 2001). The South East and Red River Delta regions had the lowest shares of agricultural labor forces in 2016 (12.7% and 27.2%, respectively).

The estimated total number of individuals working in agriculture climbed slowly over the 2007-14 period, from 22.75 million to 24.57 million in 2014, before dipping to 21.41 million in 2016, even as Vietnam's population grew by more than 10% from 2007-14 (World Bank 2019). Given growth in the number of households engaged in agriculture, this strongly signals the rapid diversification of activities within agricultural households, a pattern also observed in today's high-income countries during their structural transformations. Even among individuals living in rural areas, only 53% of the labor force worked in agriculture in 2016, as compared to 61.7% in 2007. Indeed, although 91.5% of the total agricultural labor force resides in rural areas, as of 2016, the number of individual workers employed in agriculture fell faster in rural than in urban areas over the 1992-2016 period. This diversification of the rural economy out of agriculture, even as regions become increasingly differentiated by economic sector and as agricultural productivity grows (on which, more below), is a key feature of the structural transformation.

This increasing diversification into non-farm employment is perhaps best seen by looking at individual household members' employment in farming (as farmers or farm workers) within farming households. Panel A of Table 3 reports the mean share of farming household members who are full-time farmers or farm workers, defined as 35 hours or more per week spent working in agriculture. On average, full-time farmers only accounted for 16.7% of total household members in 2002, declining to 9.0% in 2016. Even among the members engaged in farming, full-time farmers only accounted for 31.2% in 2012 and 16.0% in 2016. Farming is clearly a part-time activity for most people employed in it.

Panel B of Table 3 reports the mean share of farming household members involved in nonfarm activities (self-employed or as wage/salaried laborers). Rural households have steadily diversified out of agriculture, especially into wage labor in the non-farm sector. In 1992, only 4.6% of farming household members had non-farm work paying a wage; by 2016, that number had climbed to 16.6%, surpassing the proportion employed in farming. Much of this expansion came at the extensive margin, as farming households began to place family members into wage non-farm employment for the first time. The share of farming households with a member earning non-farm wages increased from 16.8% in 1992 to 44.4% by 2016.

Furthermore, the rise of wage non-farm employment by farming household members also eclipsed non-farm self-employment over this period. In 1992, 37.6% of farming households were also engaged in non-farm self-employment, but that share declined steadily over time to 26.9% in 2014-

2016. Combined, the share of farming household members employed in (wage or self-employed) non-farm activities grew from 17.4% to 26.5% from 1992-2016.

Another way to grasp the sharp, nationwide transition of rural households towards non-farm, and especially wage labor, is through the shares of total household income arising from agricultural versus wage earnings. Table 4 summarizes the evolution of the median shares of agricultural income and wage income, by region. All regions share the common trend that the income share from farming continuously reduces while the share from wages continuously increases. In the South East and the Red River regions, a median rural household only had 2.3% and 7.8% income from farming in 2016, respectively. Rural households' lower dependence on farming is most pronounced in the Red River region, which saw a sharp reduction of median income share from farming, from 41.1% to 7.8%, during the merely 14-year period. This is consistent with the rapid urbanization surrounding the metropolitan area of Hanoi. This resembles patterns in high income countries, where even within the farm sector, most households earn more net income from wages than from agriculture.

Indeed, as shown in Figure 1, from 2002 to 2016, the median share of rural households' income from agriculture declined from 0.465 to 0.197; and the median share of wage income increased sharply from 0.076 to 0.345. Since 2010, wage income has represented a larger share of median rural household incomes than agricultural earnings do. This figure perhaps best represents the dramatic structural transformation of the rural Vietnamese economy over this period, as agriculture has become less important as an employer and as a source of income for households even as its

13

productivity has increased sharply and the use of modern inputs that boost labor productivity – e.g., fertilizers, improved seeds, machinery, pesticides – has increased rapidly (see section 4).

Vietnamese agriculture is traditionally dominated by farmers who cultivate their own land. This pattern remained largely unchanged during the structural transformation. Among the population employed in agriculture, only 5.1% were hired workers in 1992. That share increased very slowly, to just 8.0% by 2016. Farming has remained concentrated among households with access to land who employ predominantly family labor on the farm. The corollary to this is that Vietnam has not seen the emergence of a farmworker class. As shown in Appendix Table A3, farmworker households (i.e., households that are employed in agriculture but do not own livestock or farm land) remained just 2-5% of all households from 2002 to 2016, with no discernible increase in the share of landless farmworker households. Rapid growth in agricultural productivity (see section 4) has not translated into increased employment in agriculture, nor to the rise of a landless farmworker population. This may stem from the lack of farm consolidation (see section 4).

In Appendix Table A4 we see that hired agricultural workers increasingly earn hourly or daily wages, growing from 57 to 71% of all payment methods from 2007-2016. There was a corresponding, modest fall in the rate of piece rate work, from 25 to 17%, and in in-kind payments, which declined from 4.5% in 2007 to essentially disappear in more recent years. The share of salaried workers has remained constant at just 11%. This underscores further how much Vietnamese agriculture continues to depend on family-based production units.

Table 5 reports the agricultural labor force composition by age, gender, and education levels from 2007 to 2016. Panel A shows that the shares of the agricultural labor force in age groups below 50 years old (15-20, 20-30, 30-40, 40-50) all declined over this period while older age groups (50-60, 60-70, and 70+) accounted for increasing shares of the agricultural labor force. This observation may partly reflect the aging of the overall labor force in Vietnam. However, the aging in agricultural labor force is more severe than in the overall labor force. The share of labor force younger than 50 years old fell from 75 to 60 percentage points (a 20% reduction) for agriculture only, in comparison with a 10% reduction (from 81 to 73 percentage points) for the overall labor force.

The aging of the national and agricultural labor force is in line with broader demographic patterns within the Vietnamese population, as shown in Appendix Figure A1 which plots population pyramids by age and gender, for all Vietnam and rural only, from the 1989, 1999, and 2009 census. A sharp reduction in fertility rates manifests in a rapid demographic transformation that does not differ meaningfully between rural and urban areas.[11]

Panel B of Table 5 indicates that the education level (i.e., highest level of education completed) of the agricultural labor force steadily increased during this period, consistent with improvements in education for the overall labor force in Vietnam. From 2007 to 2016, the share of the agricultural labor force that had never attended school fell from 36% to 22%, and the share of workers with lower secondary education or above dramatically increased from 15% to 49%. But this reflects the

---

[11] Note that the absence of a rural-urban difference may also reflect the census' practice of counting many rural-urban migrants as rural population due to the Vietnam's restrictive residential registration system (*ho khau*).

rapid rise in education nationwide, not sector-specific selection. Moreover, with merely 10% possessing upper secondary education and 3% with college education or above, the agricultural labor force still had much lower educational levels than the overall labor force, within which 16% of workers had completed upper secondary school and another 16% college or above in 2016. The government's massive investments in education were clearly translating into a better educated workforce, with those gains accruing in all sectors, but disproportionately in the non-farm sectors.

The gender composition of the agricultural labor force was virtually unchanged during this period (Table 5 Panel C). Throughout the 2007-2016 period, male labor accounted for 46-47% of the overall agricultural labor force. The nation's total labor force, by contrast, was slightly majority male, at 51-52% throughout this period. Women's labor force participation rates, including in agriculture, are thus roughly comparable to men's in Vietnam. This is remarkable, given that International Labor Organization (ILO 2018) estimates the global gap in women's labor force participation at 27 percent.

Appendix Table A5 summarizes labor conditions for agriculture. Both regular work hours per week and actual work hours per week fell from 2007 to 2016 (6% and 9% reductions, respectively) for agriculture.[12] Although work hours also declined mildly in the nonfarm sectors, the magnitude of this reduction is much smaller (0.1% for regular hours and 5% for actual hours). In 2016, both regular and actual work hours of agriculture were 10% lower than those in nonfarm sectors,

---

[12] "Regular work hours" denotes the number of hours a labor normally/regularly work in a week; "Actual work hours" denotes the number of hours a labor actually work during the last seven days at the time of survey or seven days before temporarily stopping work.

consistent with observations in sub-Saharan Africa of fewer work hours in agriculture than in other sectors (McCullough 2017). Similar patterns are shown for the sample of rural residents only.

3.2 Growth in real agricultural wages

The VHLSS and LFS surveys provide complementary measures of real agricultural wages over the structural transformation. Real wage measures from the VHLSS come from the commune module in which commune leaders approximate the average daily payment for farm work in their communes. By contrast, individual workers in both agricultural and non-agricultural sectors report their wages directly in the LFS. While direct reports from the LFS may include less measurement error than commune leader reports of local averages from the VHLSS, the LFS may also produce biased estimates by underreporting part-time, seasonal, or migrant labor. Comparing the evolution of real wages in both surveys may help to identify changes in real agricultural wages that are robust to sampling designs and different sources of non-classical measurement error.

Figure 2 provides median daily real agricultural real wages from the VHLSS and LFS data reported separately for women and men from 1992 to 2016. In the VHLSS, these daily wages more than quadrupled over this period, rising from 24,570 VND (or 1.32 USD) for men and 21,500 VND (or 1.15 USD) for women in 1992 up to 82,373 VND (or 4.42 USD) for men and 73,685 (or 3.96 USD) in 2010, according to the 2010 exchange rate of 18,612 VND per USD (World Bank 2019). This increase implies a very robust compound annualized growth rate of 7% for both men and women between 1992 and 2010. Figure 2 also includes the complementary analysis for the LFS data over a shorter and later time interval from 2007 to 2016. These data match trends in the VHLSS, showing steep increases over this period, from 53,923 VND (or 2.90 USD) to 83,141 VND (or

4.47 USD) for men and 45,251 VND (or 2.43 USD) to 71,249 VND (or 3.83 USD) for women. These similar results across sampling procedures support the conclusion that there has been a robust increase in real agricultural wages over this period.[13]

Disparities between men and women remain relatively constant over both samples, with women suffering 11.4% and 14.2% wage penalties on average in the VHLSS and LFS, respectively. These disparities do not appear to vary systematically over time, reaching a minimum of 1.7% in 2008 in the VHLSS and a maximum of 18.9% in 2014 in the LFS. This gender pay gap is a bit lower than the global average of 15.6% (ILO 2018).

To examine whether particular regions may be driving trends in agricultural wages, Appendix Table A6 reports median real agricultural wages by gender as well as across the six main geographic regions. While there is substantial heterogeneity in wage levels across regions, all regions experienced similarly large increases in real agricultural wages over this period, with parallel changes across genders within each region. Wages appear to converge across regions over time with the coefficient of variation across regions dropping from 0.39 in 1992 to 0.13 to 2010 for men and 0.22 to 0.17 for women over the same interval. While the Mekong River Delta begins the sample as the wage leader, the Red River Delta and South East regions become wage leaders by 2010 for both men and women. This shift in wages is consistent with the Red River Delta and South East regions being outliers in their high rates of transition away from agricultural employment towards toward non-farm employment, as shown in Tables 4 and 6. The Red River

---

[13] Results for mean wages included in Appendix Figure A2 exhibit almost identical patterns to median wage results in Figure 2.

Delta and South East regions are home to fast-growing cities of Hanoi and Ho Chi Minh City respectively.

One factor driving these agricultural wage increases over this period may be increasing minimum wages imposed by the national government under the general Labor Code. Minimum wages vary by region and sector and are typically adjusted annually. Unlike in some countries, minimum wage requirements apply to farms, households, cooperatives, in short to any individuals or organizations who employ workers. But enforcement is widely understood to be spotty and thus it is unclear how much compliance there is. One might naturally suspect that agricultural wages fall below the required minima or that the minimum wage rates set by government bind for farms and firms. But especially if minimum wages constrain agricultural employers, then minimum wages might help boost real wages, both by directly inducing higher wages for agricultural workers as well as indirectly, by increasing reservation wages throughout the economy.

Perhaps surprisingly, median and mean wage rates in agricultural consistently exceed the minimum wage rate.[14] As shown in Panel A of Table 6, in 1992 average agricultural wages for both men and women were below the relevant minimum wage. But from 1998-2016 agricultural wages have consistently exceeded the minimum wage rates, by 17-119%, without any clear time trend. In Panel B of Table 6, we see that the percentage of individual-specific wage rates that fell below the district-and-year-specific minimum wage has been consistently around 3% in the non-

---

[14] There are four minimum wage "regions" in Vietnam into which each (sub-provincial) district is categorized. Before 2012, there were separate minimum wage schedules for domestic and foreign firms. In 2012, the two were merged into a single schedule. The minimum wage rates ('000 VND) for four regions for 2012, 2014, and 2016 ranged from (1400, 1900,2400) to (2000, 2700, 3500), reflecting differential rates of minimum wage growth across space.

agriculture sectors but has risen significantly, from 8.7% to 15.3% nationwide, 2012-2016, in agriculture. This masks sharp regional variation in minimum wage compliance in agriculture, with the highest rate of compliance in the South East, the most developed region (around Ho Chi Minh City), and the lowest rate of compliance in the Red River Delta region around Hanoi. But where the minimum wage noncompliance rate in agriculture steadily increased in all other regions, 2012-16, it has steadily declined in the Red River Delta region so that – beyond the outlier in the South East region – all regions had noncompliance rates of 17-20% in 2016, versus the wider 8-23% spread back in 2012. So although mean and median agricultural wages steadily exceed minimum wages, it does appear that there has been increasing dispersion in agricultural wages, with the lowest wages not keeping pace with increases in region-specific minimum wages, especially in the more agricultural regions (those other than Red River Delta and South East). Minimum wage laws do not seem to be driving growth in real agricultural wages since noncompliance rates have been increasing in agriculture nationwide.

The VHLSS data identify agricultural wages separately by task, as captured in Appendix Figure A3. Wages for harvesting exceed those of planting, preparing, and tending tasks for both women and men, consistent with greater overall demand for labor during harvest time. While the gap between harvesting wages and other wages increases slightly over time, this trend is vastly overshadowed by the absolute increases in real wages for all agricultural tasks over the same period. Appendix Table A7 supports this analysis by finding little evidence of systematic changes in the harvest season wage premiums for men and women. These results suggest that any changing task composition likely has little role in driving observed increases in real agricultural wages.

In order to understand agricultural wage increases within the context of the national labor market in Vietnam, Table 7 examines the evolution of urban/rural real wage ratios overall as well as urban/rural real agricultural wages specifically. Panel A of Table 12 indicates a rapidly shrinking urban-to-rural wage ratio for both men and women, suggesting spatial convergence in labor markets. Panel B of Table 12 finds that agricultural wages evolved at similar rates in both urban and rural areas, with slight spatial convergence in female wage rates, but none for men. These results suggest agricultural labor market integration across regions, consistent with evidence in Appendix Table A6, and that the convergence comes primarily through the already-described rise of non-farm wage employment in rural areas, with rural non-farm wage rates that are more comparable to those in urban areas.

Figure 3 supplements this analysis by plotting the ratio of agricultural wages to industrial wages and service sector wages over time and across both rural and urban areas in panel (a) and examining rural areas only in panel (b) for the LFS data. Despite the broad increases in real agricultural wages observed in Figure 2, agricultural wages are increasingly exceeded by wages in the industrial sector while wages in service industries maintain a relatively stable, high ratio to agricultural wages. These findings are consistent with greater premiums to education in the non-farm sectors. Growing industrial wage disparities may help to explain increasing rates of urbanization and substitution away from agricultural towards nonagricultural employment. Comparing panels (a) and (b) of Figure 3, we observe similar trends in both urban and rural areas. This is a pattern of intersectoral differentiation in the returns to labor, not a rural-urban difference. Taken together, these findings imply that the wage changes in rural areas are broadly driven by intersectoral integration in labor markets, rather than any inherent productivity differences

21

between rural and urban areas. Continuous transition of the labor force from agriculture to nonfarm sectors, combined with increasing industrial sector-agriculture wage ratio, features a successful structural transformation in which "high-productivity employment opportunities (in nonfarm sectors) have expanded and structural change has contributed to overall growth" (McMillan and Rodrik 2011).

4. Evolution of the Agricultural Sector

Vietnam experienced a rapid transition over the 1992-2016 period, with large-scale movement of workers into non-farm employment, in rural as well as urban areas, and at sharply increasing real wage rates. What sort of transitions happened in the agricultural sector during this time, in particular do we see evidence of farm consolidation due to labor exits, labor-saving factor substitution due to rising real agricultural wages in response to intersectoral labor market integration, and any erosion of small farms' competitiveness within Vietnamese agriculture?

4.1 Farm size distribution

Does farmland become inevitably consolidate during a rapid rural transformation? The answer in the Vietnamese case is clearly no. Vietnamese agriculture rests on very small farm units; that has remained unchanged throughout the structural transformation. As shown in Appendix Figure A4, a median farm household cultivated 0.35 ha and 0.29 ha in 1992 and 2016, respectively, while the mean cultivated area was essentially unchanged, increasing very slightly from 0.57 ha to 0.61 ha from 1992 to 2016. The cultivated area of annual crops dropped from 0.31 ha in 1992 to 0.20 ha in 2016 for the median farm household while the mean cultivated area of the annual crops only slightly dropped from 0.49 ha to 0.43 ha during the same period. Therefore, there has been some

modest substitution in land use, much of it towards use for livestock, reflecting rapid expansion in demand for animal source foods arising due to increasing incomes.

Figure 4 offers a different view of the land distribution evolution, plotting the distribution of total cultivated land area per household in 1992 and 2016. Landholding has a single modal distribution in both rounds and is quite concentrated. This landholding structure likely results from egalitarian allocation during the period of central planned economies. Compared to 1992, the landholding distribution in 2016 is slightly less dispersed and has a slightly lower mode. We do not see any evidence of farm consolidation. Farm sizes were small and remained small during Vietnam's rapid structural transformation, despite the fact that the Government of Vietnam started its land reform in the late 1980s, focusing on decollectivization that allocated secure land use rights to farm households under the 1993 Land Law (Ravallion and van de Walle 2008). Land consolidation may nonetheless have been deterred by certain government regulations, including the limits of annual cropland holding size and land use restrictions (World Bank 2016). Our finding is consistent with Tarp (2017) who also finds no evidence of inter-farm consolidation though there is some evidence in the VARHS data he uses of intra-farm consolidation (i.e., reduced number of plots within farm).[15]

Small farms have not ignited a significant increase in land rental markets either. As shown in Appendix Figure A5, the proportion of farm households that rent land in or out has remained low and relatively stable, at 10% or less throughout the period. We do see some modest convergence between reports of renting in and renting out land, which might reflect survey respondents'

---

[15] See Tarp (2017) for a more detailed description on land policy.

increased willingness to report renting out land over time as the market-orientation of the economy became more firmly established, or could reflect the sectoral outmigration of workers from farm families, leading to small-scale rentals.

4.2 Mechanization

With small farm sizes, one might naturally expect that mechanization rates would have remained very low, given economies of scale in mechanization, especially for motorized equipment such as tractors, harvesters, combines, etc. (Binswanger 1986; Foster & Rosenzweig 2011, 2017; Otsuka et al. 2013; Yamauchi 2016; Takeshima 2017). Yet rapidly increasing real wages and the steady migration of workers out of agriculture call for the replacement of labor by machine. Which effect has dominated in determining the pattern of mechanization of Vietnamese agriculture: the farm size scale or the real wage substitution effect?

The answer, as in China, is that robust machine rental markets have emerged rapidly to address the scale-based, indivisibility problems in machinery and permit mechanization in the face of labor out-migration and rising real wages, enabling small farmers to benefit from machinery adoption (Zhang et al. 2017). Figure 5 plots the proportion of households that owned tractors, owned any machinery, rented machinery, or hired labor from 1992 to 2016.[16] We do not see much change in tractor ownership from 1992-2008 (such information is not available in the later rounds); the rate remains very low, which is not surprising given the small landholdings that dominate agriculture

---

[16] Because the VHLSS survey instruments do not consistently list all agricultural machinery, machine ownership is proxied by cost of fuel and depreciation of fixed assets used in farming activities of the household, as those are included consistently throughout the survey years.

in Vietnam. Ownership of any machinery increased from 1 percent in 1992 to 23 percent in 2016. The percentage of cultivating households that rented in machines more than tripled, however, from 19 percent in 1992 to 59 percent in 2016. This observation mirrors recent findings from China (Yang et al. 2013). The percentage of households that hired labor also increased sharply, from 32 percent in 1992 to 43 percent in 2016.

Figure 6 plots the proportion of households adopting/using, renting and owning machinery conditional on farm size, from 1992 to 2016. Here we define machinery adoption as a binary variable which equals one if a household owns machinery or has incurred machinery rental expenses during the past year and zero otherwise. As expected, machinery ownership has been increasing in farm size throughout the sample period, reflecting economy of scale considerations. Machinery ownership has been steadily increasing over time throughout the entire farm size distribution, but increasing most and fastest among the largest farms, again consistent with economy of scale incentives.

The bigger story, however, is in machinery rental markets. In the early VHLSS rounds, 1992-2002, larger farmers had a far higher propensity to rent machinery. However, the machinery rental curves flatten in the later rounds, suggesting that smaller farmers have become almost equally likely to rent machinery in this decade. As a result, small farmers have machinery adoption rates almost as large as those of the biggest farm in later rounds. Clearly, rising real wage rates and/or reduced agricultural labor supply have compelled mechanization, even on the smallest farms where machinery ownership does not pay. Rental markets have emerged to fill the gap.

4.3 Agrochemicals use

Agricultural modernization commonly involves increased use not only of machinery, but also of agrochemicals, both chemical fertilizers and pesticides (which include fungicides, herbicides, and insecticides). Fertilizer boosts crop and weed growth, stimulating demand for labor, while pesticides typically reduce labor demand by substituting for labor-intensive methods of pest eradication. Unlike machinery, there are no economies of scale to fertilizer or pesticide use. So the dominant drivers of agrochemicals uptake will typically be the profitability of use, which is driven both by crop and input prices and by real wage rates.

As reflected in Figure 7, we see different patterns of use between fertilizers and pesticides. Labor-saving pesticide use has followed a pattern similar to that of machinery. In the earliest years of the VHLSS surveys, agrochemicals use was sharply increasing in farm size. The largest farms were more than twice as likely to use pesticides as the smallest farms. That relationship attenuated dramatically over time, so that by 2012 there was effectively no difference, with roughly 80% of farms of any size applying pesticides. [17]

By contrast, fertilizer use has been widespread through the 1992-2016 period. Back in the 1990s, 85% or more of farms of all sizes used chemical fertilizer. By 2012 and 2016, however, farms in

---

[17] Pesticides can also pose human health risks, especially to agricultural workers. Research in southeast Asian rice systems has previously established increased human health costs associated with expanded uptake of pesticides (Antle and Pingali 1994) and recent survey data from sub-Saharan Africa establish similar correlations as pesticide use increases in some parts of that region (Sheahan et al. 2017). We leave exploration of the pesticide-health relationship in Vietnamese agriculture to future work.

the lower half of the farm size distribution were becoming less likely to apply fertilizer, leading to the emergence of a more pronounced, positive farm size-fertilizer use gradient. The data do not permit us to establish what caused the divergent paths in the fertilizer and pesticide gradients across the farm size distribution. But these patterns are consistent with farmer response to increasing real wage rates.

4.3 Land productivity

Along with labor, the main input in agriculture is land. And in Vietnam, the main crop is rice. Therefore, understanding the evolution of rice yields provides a useful indicator of the evolution of agricultural land productivity more broadly. It is possible that higher real wages lead farmers to apply less labor, leading to lower yields unless they compensate by using other inputs. We have just seen that Vietnamese farmers' use of machinery and agrochemicals increased significantly over the 1992-2016 period. Did this offset any adverse yield effects arising due to the higher costs of agricultural workers?

Figure 8 plots the locally weighted polynomial regression result of log rice yield against log planting area for each VHLSS survey round from 1992 to 2016. The sharp upward displacement of the yield curves between each successive survey round from 1992 to 2004 demonstrates the rapid growth in rice land productivity on farms of all sizes. Rice yields kept growing, though at a much slower and less stable pace, after 2004. The increased intersectoral integration of rural labor markets and the rise of real agricultural wages do not appear to have held back growth in rice yields.

It has long been observed in developing country agriculture that smaller farms are more productive per unit area cultivated than larger ones, on average (Chayanov 1926/1986; Sen 1962; Berry and Cline 1979; Carter 1984; Barrett 1996; Benjamin and Brandt 2002; Barrett, Bellemare, and Hou 2010; Carletto, Savastano, and Zezza 2013). The dominant narrative behind the inverse relationship has historically been that multiple market failures can generate a size-productivity gradient even if the underlying technology of agricultural technology exhibits constant returns to scale (Feder 1985; Barrett 1996). The evidence of such an inverse farm size–productivity relationship has often justified land policies favoring small landholders and deterring farm size expansion, as well as agricultural credit policies to promote smallholder access to commercial inputs.[18]

However, as a low-income agrarian economy undergoes rapid structural transformation, do factor markets for agricultural labor and machinery become more active, driving up real wages and attenuating the inverse relationship? Otsuka (2013) and Foster and Rosenzweig (2017) suggest that increasing real wages may reduce demand for agricultural labor, promote the use of machinery as a substitute for labor, and decrease any disadvantage larger farms might have once had, or even flip the inverse relationship to a direct relationship due to scale economies in machine use and access to financing. The 1992-2016 VHLSS panels offer an uncommon opportunity to test this intertemporal hypothesis. To our knowledge, a similar test has only been done in India based on a three-round household panel data (Deininger et al. 2018).

---

[18] A recent literature suggest that the inverse farm size-productivity relationship appears attributable to measurement error in crop output in multiple data sets from Africa (Gourlay et al. 2017, Desiere and Jolliffe 2018, Abay et al. 2019). Since there is no reason to expect an intertemporal trend in such measurement error in the VLSS data and yet we see a clear trend in the size-productivity relationship parameter, we suggest that the attenuation we observe is at least partly real, not merely an artefact of measurement error.

As described in section 4.1, we do not observe an increase in farm size or consolidation of farms in Vietnam during dramatic structural transformation. Did small farms ever have a yield advantage? If so, could it be reversed without land consolidation? If so, this would further reinforce the story of increasingly integrated labor markets – as well as credit and machinery rental markets – that attenuate the inverse relationship.

To answer this question, we investigate the evolution of the inverse farm size-productivity relation using VHLSS panels from 1992/98 to 2014/16. We first estimate a rice yield equation using the five panels separately:

$$\ln y_{it} = \beta_i + \beta_1 \ln h_{it} + \beta_2 z_{it} + \beta_3 D_t + \varepsilon_{it}, \tag{1}$$

where $\ln y_{it}$ is log rice yield (in kilogram per hectare) for farm/household i, and year t; β_i is a household fixed effect which captures time invariant household and location-specific effects such as land quality and weather; $\ln h_{it}$ is log rice planting area (in hectare); z_{it} is a vector of household-specific time-varying characteristics; D_t is a year dummy which captures period-specific fixed effects (including interest rates, prices, and wages) that are common across communes; and ε_{it} is a random error term. The coefficient of interest, β_1, reflects the elasticity of rice yield with respect to planting area. A negative and statistically significant β_1 estimate supports the presence of an inverse relationship. If such a relationship lessened over time, the absolute value of β_1 will be smaller in a later panel than in an earlier panel. If such relationship is reversed, the β_1 estimate will be positive.

Table 8 reports the regression results of equation (1) for the five panels. The dependent variable is rice yield aggregated over all rice varieties. We have two main findings. First, the coefficient estimate on planting area is statistically significantly negative in all panels, suggesting the existence of an inverse farm size–productivity relationship throughout the study period. This result is consistent with most of the published literature.

Second, the estimated coefficient of planting area gets smaller (in absolute term) in later panels than the earlier panels. With a value of –0.036, the estimated coefficient of planting area in the most recent 2014/2016 panel is lower than that in the 1992/1998 (–0.155), the 2002/04 (–0.148), the 2006/08 (-0.066), and the 2010/12 panel (-0.079). Tests of the differences between the coefficient estimates in the 2014/16 panel and the previous panels show that the 2016/18 panel has a statistically significantly lower estimate of the size-productivity parameter than three out of the four previous panel rounds. The far lower explanatory power of the 2014/16 regression is also consistent with the idea that farm size and the other explanatory variables matter less over time.

One reason these results may be biased is if the choice of rice varieties is correlated with farm size and if the productivity differs across rice varieties. We thus run the same regressions for spring ordinary rice and autumn ordinary rice separately as a robustness check. The 2002 VHLSS does not distinguish between these rice varieties; therefore, the 2002/2004 panel is left out of these analyses. The results, reported in Appendix Tables A8 and A9, are similar to those reported in Table 8, showing a significantly decreasing inverse size-productivity relationship for both spring and autumn rice over 1992/1998 and 2014/2016. These results suggest that small farms' advantage

in land productivity becomes smaller over time, consistent with the finding in India (Deininger et al. 2018).

4.4 Diversification of agricultural production

Just as many observers expect structural transformation to lead to farm consolidation, so too might one naturally expect rising incomes and enhanced market access have naturally led to diversification of agricultural production over time. We can explore this hypothesis by constructing a Herfindahl–Hirschman Index (HHI) for each farm household as

$$HHI_i = \sum_{j=1}^{8} S_{ij}^2 \,,$$

where i indexes the farm household and j indexes each of eight categories of agricultural outputs: ordinary rice, glutinous rice, high-quality rice, other food crops, industrial crops, fruits, aquaculture, and livestock. S_{ij} is the value share of output j of the total output value for farm i. HHI ranges from 0 to 1, with a higher value indicating lower diversification.

The top panel of Table 9 summarizes the HHI of agricultural output over the 2002-2016 period. Remarkably, the sector overall has exhibited decreased production diversity relative to the early 2000s. As seen in the bottom two rows of Table 9, this effect is especially pronounced among the smallest farms. The largest quintile of farms, by land size, have seen some diversification. Appendix Table A10 summarizes the shares of agricultural output (by value) of the eight categories in 2002, 2010, and 2016. These results point to a bifurcation in diversification patterns: the largest farms gradually diversified their output into other food crops and industrial crops; but the smaller farmers increasingly concentrated on rice production. We observe a high concentration of rice production in the 2010 survey round (which measured the 2009 harvest value) especially

among smaller farms, in line with the sharp rise of rice prices during the 2008 global food price crisis. Neither larger nor smaller farms seem to diversify into livestock or horticulture significantly.

While Vietnamese farms have not been diversifying their product mix appreciably over time, there has been a dramatic rise in farm households' reliance on markets. Appendix Table A11 reports the share of food consumption expenditure coming from own production, i.e., autoconsumption. The median share of autoconsumption of own food production dramatically decreased from 0.535 in 1992 to 0.197 in 2016. This reflects sharply increased dependence on markets to source food, even among increasingly productive farm households. Rising rural incomes lead to more diverse diets, but with more efficient food markets, smaller farms have opted to concentrate on specific crops. This may reflect market-driven specialization according to comparative advantage, or the need to specialize in order to benefit from labor-saving mechanization that exhibits economies of scale. In contrast, larger farms may resort to higher diversification as a hedge against greater price risk exposure (Bellemare et al. 2013).

5. The evolution of well-being among rural households

As rural households have diversified out of agriculture, how has their well-being changed over time? Figure 9 plots the 10, 50, and 90 percentiles of per capita expenditure over the 1992-2016 period. The median per capita expenditure steadily increased from approximately 0.234 million VND (about USD 10.11) in 1992 to 1.221 million VND (about USD 52.75) per month in 2016 (based on the 2010 consumer price index). The 10 and 90 percentiles also increased steadily over time. But the 90 percentile grew more quickly than the median and the 10 percentile, suggesting increased wellbeing gap between the poorer and the richer rural households. Appendix Figure A6

plots the distribution of per capita consumption expenditure from 1992 to 2016 using VHLSS. Consistent with our observation from Figure 9, The curve moved steadily and rapidly to the right over time, indicating improvement of well-being among rural households during the structural transformation period. The distribution also gets more dispersed in later rounds, pointing to increased variation in well-being among rural households.

To understand what factors are associated with household welfare over time, we regress the logarithm of household per capita consumption expenditures on land and human capital endowments, the latter measured by years of schooling of the highest educated member of a household. We control for household demographics and regional fixed effects and cluster standard errors at the commune level.

Table 10 reports that results for the VHLSS rounds with land endowment data available. Both landholdings (owned land) and education have positive effects on consumption in all rounds. However, the effect of landholding becomes smaller over time, even becoming statistically insignificantly different from zero in the 2016 round, while the effect of education becomes larger and more significant over time. This reinforces the earlier findings that although rural households in Vietnam have remained engaged in farming, they are increasingly dependent on the returns to human capital in labor markets and depend less today than previously on landholdings to support their well-being. Although agricultural productivity has increased sharply over time, the large improvements observed in rural well-being (Figure 9) appear most strongly associated with improvements in human capital remunerated in labor markets increasingly integrated across sectors and space.

In Tables 11 and 12, we look at the effect of landholding and human capital on income shares from agriculture and from wages, respectively. Not surprisingly, landholding is positively associated with the household income share from agriculture and negatively associated with the share from labor earnings. Education is negatively associated with the income share from agriculture and positively associated with that from wages. The coefficient estimate relating education (years of schooling) to income share from wage increased steadily, from 0.0086 in 1992 to 0.0211 in 2016, suggesting that better educated rural households rely more on labor markets as an income source over time. The younger labor force is also better educated and more likely to migrate from agriculture to nonfarm sectors, leaving a more severely aging agricultural labor force than the nonfarm sectors. Not surprisingly, as we observed earlier, rural households now earn more from labor markets than from agriculture.

Education and location also begin to matter more to well-being as (spatially heterogeneous) labor market performance matters become a more prominent determinant of wellbeing. As the economy has moved away from reliance on primary agricultural production, the relationship between landholdings and well-being has diminished. Labor market performance becomes a more important factor. Our finding also suggests that, for rural households, human capital accumulation (rather than land endowment) is an essential means of successful transformation.

6. Conclusions

Vietnam's dramatic structural transformation over the past generation offers an uncommon glimpse into the path followed as a low-income agrarian economy grows rapidly. In 1992, Vietnam

looked remarkably comparable to current day Liberia in terms of per capita income, share of output and employment in agriculture, reliance on rice and cassava as staple crops, etc. Today it continues to grow at a rapid rate (6-7% annually), diversifying and creating jobs quickly, and transforming into an increasingly urban and non-farm lower middle-income economy. Several key patterns of Vietnam's structural transformation merit comment as they relate to prospective futures for today's low-income agrarian economies.

First, the direct employment creation potential of agriculture, especially for youth, is limited. The agricultural labor force is slowly shrinking and aging more rapidly than is the labor force as a whole. Even farming families are diversifying out of agriculture, increasingly earning more of their total household income from the non-farm sector. Youth are increasingly well educated, enjoying a wider array of remunerative non-farm job options than their parents did. Meanwhile, the endogenous changes in agriculture, especially mechanization and uptake of labor-savings inputs such as pesticides, relax farm households' labor constraints, freeing young people to seize non-farm opportunities.

Second, real wage convergence between rural-urban regions has gone hand-in-hand with increased diversification of the rural economy into the non-farm sector nationwide and rapid advances in educational attainment in all sectors' and regions' workforce. This enhanced integration also manifests in steady attenuation of the longstanding inverse farm size-yield relationship, which only exists when there exist multiple rural market failures.

Third, minimum wage restrictions do not seem to explain growth in real agricultural wages. Indeed, while compliance with minimum wage laws appears quite high in the non-farm sector, noncompliance in the agriculture sector has been increasing this decade, especially in the most agriculturally dependent regions. Minimum wage laws have not prevented a widening in the intersectoral wage differential, which likely reflects differing returns to human capital, particularly educational attainment.

Fourth, farming has remained securely household-based. There is no indication of significant disinvestment of households from farmland nor of significant growth in agricultural labor demand nor the growth of a farmworker population. Indeed, the farmland distribution has remained largely unchanged over these 24 years, as has the share of workforce earning wages in agriculture. There has been no farm consolidation and no appreciable diversification out of rice production. Although this precludes seizing economies of scale, thanks to the emergence of robust machinery rental markets it has not obstructed mechanization, nor the uptake of labor-saving pesticides. Rice yields increased rapidly in the earlier years, more slowly over the past decade. But farm households have clearly become better integrated into commercial marketing channels, as reflected in the sharp decrease in the share of food autoconsumed from home production.

Fifth, nonfarm sectors have been providing high-productivity employment opportunities, which is a driving force contributing to wellbeing improvement among rural households. As rural households rely more heavily on the labor market, human capital accumulation (rather than land endowment) is an essential means for rural households to benefit from successful transformation.

Will today's low-income agrarian economies necessarily follow the path Vietnam has taken over this past quarter century? That seems unlikely, given the many context-specific features that have guided Vietnamese development over the past generation. Nonetheless, there are important lessons to be learned from the experience of one of the world's most rapidly transforming rural economies.

7. References

Abay, K., G. Abate, C.B. Barrett, and T. Bernard (2019), "Correlated Non-Classical Measurement Errors, 'Second Best' Policy Inference, and the Inverse Size-Productivity Relationship in Agriculture," *Journal of Development Economics* 139: 171-184.

Antle, J.M., Pingali, P.L. (1994)." Pesticides, Productivity, and Farmer Health: A Philippine Case Study." *American Journal of Agricultural Economics* 76, 418–430.

Barrett, C.B. "On Price Risk and The Inverse Farm Size-Productivity Relationship," *Journal of Development Economics*, vol. 51, no. 2 (December 1996): pp. 193-215.

Barrett, C.B., T. Reardon and P. Webb (2001), "Nonfarm Income Diversification and Household Livelihood Strategies in Rural Africa: Concepts, Dynamics and Policy Implications," *Food Policy* 26(4): 315-331.

Barrett, C.B., M.F. Bellemare, and J.Y. Hou, (2010). "Reconsidering Conventional Explanations of the Inverse Productivity-Size Relationship," *World Development*, 38(1): 88–97.

Bellemare, M.F., C.B. Barrett, and D.R. Just (2013). "The welfare impacts of commodity price volatility: evidence from rural Ethiopia." *American Journal of Agricultural Economics* 95(4): 877-899.

Benjamin, D., and Brandt, L. (2002). "Property rights, labor markets, and efficiency in a transition economy: The case of rural China," *Canadian Journal of Economics*, 35(4): 689–716.

Berry, R. A., and Cline, W. R. (1979). *Agrarian structure and productivity in developing countries*, Baltimore: Johns Hopkins University Press.

Binswanger H. (1986). Agricultural mechanization: A comparative historical perspective. *World Bank Research Observer* 1(1), 27-56.

Carletto, C., S. Savastano, and A. Zezza, (2013). "Fact or artifact: The impact of measurement errors on the farm size–productivity relationship," *Journal of Development Economics*, 103: 254-261.

Carter, M. (1984). "Identification of the Inverse Relationship between Farm Size and Productivity," *Oxford Economic Papers,* 36: 131-145.

Chayanov, A. V. (1926/1986). *The Theory of Peasant Economy*, Madison: University of Wisconsin Press.

Deininger, K., S. Jin, Y. Liu, and S. Singh (2018). "Can Labor Market Imperfections Explain Changes in the Inverse Farm Size-Productivity Relationship? Longitudinal Evidence from Rural India", *Land Economics*, 94(2): 239-258.

Dercon, S. and D. Gollin (2014), Agriculture in African Development: Theories and Strategies. *Annual Review of Resource Economics* 6:471–92.

Desiere, S. and D. Jolliffe (2018). Land productivity and plot size: Is measurement error driving the inverse relationship? *Journal of Development Economics* 130: 84-98.

Diao, X., Harttgen, K., and M. McMillan (2017). The Changing Structure of Africa's Economies. *World Bank Economic Review*, 31: 412–433.

Feder, G. (1985). "The Relation between Farm Size and Farm Productivity," *Journal of Development Economics*, 18: 297-313.

Foster, A.D., and M.R. Rosenzweig, (2011). "Are Indian Farms Too Small? Mechanization, Agency Costs, and Farm Efficiency," Brown University, Providence, RI, US.

Foster, A.D. and M.R. Rosenzweig (2017). "Are There Too Many Farms in the World? Labor-Market Transaction Costs, Machine Capacities and Optimal Farm Size," National Bureau of Economic Research Working Paper 23909.

Gollin, D. (2014) "The Lewis Model : A 60-Year Retroperspective" *Journal of Economic Perspectives* 28-3: 71-88.

Gollin, D., R. Jedwab, and D. Vollrath (2016) "Urbanization with and without Industrialization" *Journal of Economic Growth* 21: 35-70.

Gourlay, S., Kilic, T., and D. Lobell (2017). Could the Debate Be Over? Errors in Farmer-Reported Production and Their Implications for Inverse Scale - Productivity Relationship in Uganda. Paper Presented at the 2017 World Bank Land and Poverty Conference, March 23, 2017, Washington, DC.

Hansen, H. and T.D. Le,(2013). The importance of being surveyed: the representativeness and impact of the Vietnam household living standards surveys. Copenhagen. University of Copenhagen.

International Labour Office (2018), *Global Wage Report 2018/19: What lies behind gender pay gaps*. Geneva: International Labour Office.

McCaig, B. and N. Pavcnik (2017). "Moving out of agriculture: Structural change in Vietnam," In "Structural change, fundamentals, and growth: A framework and case studies," (Eds.) M. McMillan, D. Rodrik, and C.P. Sepulveda. Washington, D.C.: International Food Policy Research Institute. 2017.

McCaig, B. and N. Pavcnik (2018). "Export Markets and Labor Allocation in a Low-Income Country." *American Economic Review*, 108 (7): 1899-1941.

McCullough, E.B. (2016). "Occupational Choice and Agricultural Labor Exits in Sub-Saharan Africa." African Development Bank Group Working Paper, No 244.

McCullough, E.B. (2017). "Labor productivity and employment gaps in Sub-Saharan Africa"*Food Policy* 67: 133-152.

McMillan, M.S. and D. Rodrik (2011). "Globalization, Structural Change and Productivity Growth," NBER Working Paper No. 17143.

Ravallion, M. and D. van de Walle (2008). *Land in Transition: Reform and Poverty in Rural Vietnam*. Washington, DC : World Bank and Palgrave Macmillan.

Otsuka, K., Y. Liu, and F. Yamauchi, (2016). "Growing advantage of large farms in Asia and its implications for global food security," *Global Food Security*, 11: 5-10.

Rodrik, D. (2013) "Unconditional Convergence in Manufacturing" *Quarterly Journal of Economics* 128(1): 165-204.

Rodrik, D. (2016) "Premature Deindustrialization" *Journal of Economic Growth* 21: 1-33.

Sen, A. K. (1962). "An Aspect of Indian Agriculture," *Economic Weekly*, 14: 243–266.

Sheahan, M., C.B. Barrett, and C. Goldvale (2017), "Human health and pesticide use in Sub-Saharan Africa," *Agricultural Economics* 48(S1): 27-41.

Takeshima H. (2017). Custom-hired tractor services and returns to scale in smallholder agriculture: A production function approach. *Agricultural Economics* 48(3), 363–372.

Tarp, F. (ed.) (2017). *Growth, Structural Transformation, and Rural Change in Viet Nam: A Rising Dragon on the Move*. Oxford: Oxford University Press.

Timmer, C. P. (1993) "Food Policy and Economic Reform in Vietnam." In B. Ljunggren, ed., *The Challenge of Reform in Indochina*. Cambridge: Harvard University Press.

Timmer, C. P. (2002) "Agriculture and Economic Growth." In B. Gardner and G. Rausser, eds., *Handbook of Agricultural Economics, Vol. IIA*. Amsterdam: North-Holland.

Timmer, C. P. (2009). *A World without Agriculture: The Structural Transformation in Historical Perspective*, Henry Wendt Lecture, American Enterprise Institute, 2008.

World Bank (2016). *Transforming Vietnamese Agriculture: Gaining More from Less.* Washington, DC: World Bank.

World Bank (2019). *World Bank Open Data.* https://data.worldbank.org/.

Yamauchi, F. (2016). Rising real wages, mechanization and growing advantage of large farms: Evidence from Indonesia. *Food Policy* 58, 62-69.

Yang, J., Z. Huang, X. Zhang, and T. Reardon, (2013). "The rapid rise of cross-regional agricultural mechanization services in China," *American Journal of Agricultural Economics*, 95(5): 1245-1251.

Zhang X., J. Yang and T. Reardon. (2017). Mechanization Outsourcing Clusters and Division of Labor in Chinese Agriculture. *China Economic Review* 43, 184-195.

Table 1. Share and Number of Households Involved in Agriculture

	1992	1998	2002	2004	2006	2008	2010	2012	2014	2016
Panel A: Share of households involved in farming										
Rural	0.950	0.949	0.907	0.895	0.876	0.859	0.820	0.819	0.809	0.810
Total	0.835	0.786	0.758	0.744	0.705	0.683	0.637	0.643	0.616	0.629
By region										
Central Highlands	0.961	0.981	0.894	0.872	0.850	0.839	0.805	0.794	0.805	0.814
Mekong River Delta	0.844	0.801	0.787	0.773	0.733	0.740	0.675	0.695	0.664	0.666
North and South-Central Coast	0.955	0.909	0.872	0.873	0.836	0.802	0.798	0.805	0.811	0.826
North East and North West	0.875	0.855	0.819	0.809	0.773	0.752	0.746	0.747	0.712	0.749
Red River Delta	0.838	0.796	0.777	0.765	0.717	0.694	0.651	0.636	0.605	0.563
South East	0.533	0.480	0.439	0.415	0.391	0.354	0.297	0.316	0.296	0.307
Panel B: Number of households involved in farming										
Rural		11.628	11.883	11.739	12.465	12.968	12.692	13.310	12.950	13.907
Total		12.671	13.102	13.042	13.843	14.318	14.197	14.922	14.915	15.775
By region										
Central Highlands		0.357	0.784	0.741	0.864	0.925	0.970	0.999	1.093	1.246
Mekong River Delta		2.619	2.795	2.730	2.905	3.098	2.826	3.038	3.063	2.988
North and South-Central Coast		2.514	2.094	2.162	2.317	2.331	2.479	2.668	2.650	3.127
North East and North West		3.072	3.069	3.069	3.233	3.307	3.302	3.509	3.358	3.820
Red River Delta		2.930	3.263	3.244	3.334	3.464	3.390	3.344	3.360	3.244
South East		1.180	1.096	1.097	1.191	1.194	1.229	1.361	1.391	1.350

Source: Estimated from VHLSS

Table 2. Agricultural Labor Force and Households Involved in Agriculture

	2007	2009	2011	2012	2014	2016
Panel A: Share of agricultural labor force in general						
	0.484	0.463	0.475	0.466	0.457	0.394
By region						
Central Highlands	0.672	0.707	0.727	0.703	0.718	0.691
Mekong River Delta	0.516	0.491	0.504	0.512	0.500	0.455
North and South-Central Coast	0.698	0.673	0.669	0.669	0.657	0.587
North East and North West	0.535	0.553	0.552	0.539	0.531	0.451
Red River Delta	0.404	0.339	0.368	0.347	0.338	0.272
South East	0.201	0.216	0.203	0.193	0.178	0.127
Panel B: Share of agricultural labor force in rural areas						
	0.617	0.593	0.613	0.605	0.592	0.530
Panel C: Agricultural labor force (Mil. Persons) in total						
	22.753	22.827	24.519	24.348	24.571	21.406
Panel D: Agricultural labor force (Mil. Persons) in rural areas						
	21.361	20.940	22.266	22.026	22.293	19.598

Source: Estimated from LFS

Table 3. Members' Engagement in Farming Within Farming Households

	1992	1998	2002	2004	2006	2008	2010	2012	2014	2016
Panel A: Mean share of farming household members who are full-time farmers/farm workers										
Full-time/Total household members	-	-	0.167	0.128	0.125	0.125	0.096	0.100	0.097	0.090
Full-time/Total self-employed farm members	-	-	0.329	0.243	0.241	0.232	0.181	0.184	0.185	0.172
Full-time/Total (self-employed/waged) farm members	-	-	0.312	0.233	0.232	0.223	0.170	0.171	0.173	0.160
Panel B: Mean share of farming household members involved in nonfarm activities										
Self-employed Nonfarm members	0.132	0.131	0.119	0.127	0.120	0.111	0.107	0.100	0.101	0.103
Waged Nonfarm members	0.046	0.055	0.094	0.117	0.126	0.130	0.135	0.142	0.156	0.166
(Self-employed/Waged) Nonfarm members	0.174	0.183	0.209	0.238	0.242	0.237	0.239	0.240	0.254	0.265
Panel C: % farming households involved in nonfarm activities										
Self-employed nonfarm activities	0.376	0.366	0.332	0.348	0.328	0.303	0.282	0.263	0.269	0.269
Waged nonfarm activities	0.168	0.196	0.305	0.359	0.374	0.385	0.384	0.395	0.422	0.444

Notes: full-time are those who work at least 35 hours per week.
Source: Estimated from VHLSS

Table 4. Median Share of Agricultural and Wage Income in Total Household Income

		2002	2004	2006	2008	2010	2012	2014	2016
Central Highlands	Agriculture	0.731	0.665	0.664	0.625	0.587	0.627	0.583	0.521
	Wage	0.076	0.056	0.106	0.094	0.215	0.138	0.175	0.220
Mekong river delta	Agriculture	0.412	0.373	0.331	0.212	0.248	0.208	0.231	0.191
	Wage	0.163	0.104	0.130	0.134	0.192	0.232	0.231	0.251
North East and North West	Agriculture	0.689	0.615	0.580	0.603	0.520	0.491	0.477	0.410
	Wage	0.000	0.071	0.080	0.071	0.127	0.207	0.224	0.251
North and Central Coast	Agriculture	0.475	0.431	0.389	0.377	0.305	0.251	0.234	0.228
	Wage	0.000	0.063	0.104	0.094	0.248	0.279	0.322	0.331
Red river delta	Agriculture	0.411	0.341	0.299	0.278	0.187	0.147	0.119	0.078
	Wage	0.117	0.156	0.174	0.229	0.384	0.379	0.431	0.445
South East	Agriculture	0.172	0.176	0.158	0.085	0.010	0.011	0.010	0.023
	Wage	0.316	0.300	0.315	0.371	0.480	0.497	0.516	0.547

Note: The pattern is qualitatively identical in means.
Source: Estimated from VHLSS

Table 5. Labor Force Composition by Age, Gender and Education Levels

	Agricultural labor force					Total labor force				
	2007	2011	2012	2014	2016	2007	2011	2012	2014	2016
Panel A: Age										
15-20	8.03	7.23	5.87	5.91	4.78	6.78	5.97	5.13	4.72	3.76
20-30	19.22	17.95	17.25	15.90	14.25	23.42	23.34	22.16	21.07	20.78
30-40	22.93	21.19	20.52	19.55	18.35	25.80	25.01	24.62	24.31	24.92
40-50	24.95	23.69	24.21	23.07	22.58	24.64	23.43	24.31	23.65	23.41
50-60	15.87	18.78	20.21	21.95	24.19	13.48	15.44	16.48	18.02	18.33
60-70	6.60	7.93	8.61	10.15	12.21	4.33	4.97	5.43	6.33	7.01
70 and above	2.40	3.24	3.33	3.47	3.64	1.55	1.84	1.88	1.90	1.81
Panel B: Education level										
None	36.40	25.03	24.76	24.06	21.61	26.29	19.68	19.97	19.65	13.22
Primary school	48.72	29.60	30.25	29.79	29.51	43.36	24.42	24.51	23.61	22.95
Lower secondary school	9.78	35.57	34.70	34.87	35.84	14.41	31.53	30.72	30.23	31.44
Upper secondary school	2.94	8.08	8.38	8.84	9.85	3.55	12.46	12.38	12.58	16.04
College and above	2.16	1.72	1.91	2.45	3.20	12.39	11.90	12.42	13.93	16.36
Panel C: Gender										
Male	0.465	0.466	0.467	0.472	0.470	0.508	0.513	0.515	0.514	0.515

Source: Estimated from LFS

Table 6. Agricultural Wage Rates vs. Minimum Wage Levels

Panel A: Ratio of agricultural wage rates to minimum wage rates

	1992	1998	2002	2004	2006	2008	2010	2012	2014	2016
Median										
Male	0.972	1.944	1.905	1.724	1.444	1.852	2.192	1.714	1.526	1.250
Female	0.778	1.653	1.619	1.379	1.333	1.852	1.918	1.429	1.263	1.167
Mean										
Male	0.990	1.861	1.984	1.618	1.415	1.950	1.961	1.485	1.326	1.704
Female	0.788	1.559	1.638	1.389	1.252	1.746	1.747	1.315	1.192	1.599

Panel B: Percentage of wage rates below the statutory minimum wage

	Agriculture			Non-agriculture		
	2012	2014	2016	2012	2014	2016
General	8.69	12.59	15.28	3.21	2.85	3.05
By region						
Central Highlands	10.38	15.16	16.98	2.39	2.44	2.72
Mekong River Delta	10.03	15.97	16.56	5.80	5.47	5.31
North Central and South Central Coast	9.76	13.63	17.41	3.38	3.13	3.69
North East and North West	8.34	12.96	18.55	2.55	1.77	2.19
Red River Delta	23.36	22.96	20.03	3.09	2.96	3.06
South East	2.06	2.14	5.18	2.10	1.57	1.71

Notes: Monthly minimum wage level applied to domestic firms. In panel A, monthly minimum wage is converted to daily minimum wage using the median (mean) working days per month of agriculture workers in the sample (VHLSS). In panel B, monthly minimum wage is converted to daily rate using the median working days per month of agriculture/non-agriculture workers in the sample (LFS).

Source: Estimated from VHLSS and LFS

Table 7. Evolution in urban/rural real wage ratios over time

	2007	2009	2011	2012	2014	2016
Panel A: Ratio of urban to rural real wage ratios over time						
General	1.460	1.310	1.266	1.280	1.293	1.272
Male	1.457	1.323	1.278	1.292	1.323	1.275
Female	1.478	1.336	1.266	1.274	1.270	1.230
Panel B: Ratio of urban to rural real agriculture wage ratios over time						
General	1.257	1.221	1.130	1.200	1.208	1.244
Male	1.281	1.456	1.160	1.296	1.257	1.291
Female	1.223	1.083	1.114	1.141	1.166	1.152

Source: Estimated from LFS

Table 8. Regression Results on Land Productivity of Rice (All Varieties Included)

	1992/98	2002/04	2006/08	2010/12	2014/16	Difference	Difference	Difference	Difference
	(1)	(2)	(3)	(4)	(5)	(6)=(5)-(4)	(7)=(5)-(3)	(8)=(5)-(2)	(9)=(5)-(1)
Log total area of rice (all varieties)	-0.1554***	-0.1477***	-0.0664***	-0.0794***	-0.0360**	0.0434*	0.0304	0.1116***	0.1193***
	(0.0228)	(0.0235)	(0.0167)	(0.0171)	(0.0158)	(0.0233)	(0.0229)	(0.0283)	(0.0276)
Male household head	-0.0041	0.0663**	-0.0039	-0.0313	0.0130	0.0443	0.0170	-0.0532	0.0171
	(0.0317)	(0.0330)	(0.0326)	(0.0299)	(0.0341)	(0.0453)	(0.0472)	(0.0475)	(0.0465)
Age of household head	0.0001	0.0007	0.0003	-0.0003	0.0002	0.0005	-0.0002	-0.0005	0.0000
	(0.0011)	(0.0012)	(0.0010)	(0.0022)	(0.0011)	(0.0025)	(0.0015)	(0.0016)	(0.0016)
Highest education of household members	0.0127***	-0.0000	-0.0021	0.0045	0.0038	-0.0007	0.0059	0.0038	-0.0089*
	(0.0044)	(0.0046)	(0.0040)	(0.0044)	(0.0031)	(0.0054)	(0.0050)	(0.0055)	(0.0053)
Number of male members	0.0193	-0.0039	0.0082	-0.0045	0.0154	0.0199	0.0071	0.0193	-0.0039
	(0.0159)	(0.0139)	(0.0139)	(0.0155)	(0.0114)	(0.0192)	(0.0179)	(0.0180)	(0.0195)
Household size	0.0056	0.0156*	0.0035	0.0141*	-0.0068	-0.0208*	-0.0103	-0.0224*	-0.0123
	(0.0079)	(0.0095)	(0.0079)	(0.0083)	(0.0070)	(0.0109)	(0.0106)	(0.0118)	(0.0105)
Year	0.0334***	0.0209***	0.0108***	0.0103	0.0018	-0.0085	-0.0090**	-0.0190***	-0.0315***
	(0.0028)	(0.0039)	(0.0030)	(0.0064)	(0.0029)	(0.0070)	(0.0042)	(0.0048)	(0.0040)
Observations	5917	4625	4333	3993	3782				
R-squared	0.205	0.080	0.029	0.098	0.010				

Notes: Standard errors in parentheses, clustered at commune level. The variable "Log total area of rice" centered around their sample means. * p<0.10, ** p<0.05, *** p<0.01.

Source: Estimated from VHLSS

Table 9. Herfindahl–Hirschman Index (HHI) of agricultural output (by value)

		2002	2004	2006	2008	2010	2012	2014	2016
Total farms	Mean	0.426	0.417	0.475	0.501	0.498	0.466	0.461	0.468
	S.D	0.262	0.254	0.275	0.292	0.307	0.324	0.322	0.322
	Median	0.389	0.382	0.455	0.472	0.476	0.435	0.439	0.448
Smallest 20%	Mean	0.512	0.487	0.555	0.583	0.601	0.604	0.577	0.600
	S.D	0.256	0.261	0.274	0.281	0.294	0.318	0.319	0.309
	Median	0.479	0.452	0.516	0.541	0.577	0.582	0.558	0.569
Largest 20%	Mean	0.391	0.382	0.391	0.405	0.386	0.333	0.363	0.336
	S.D	0.329	0.312	0.337	0.356	0.356	0.354	0.358	0.348
	Median	0.314	0.323	0.319	0.315	0.297	0.192	0.250	0.216

Notes: Small (large) farms are those whose production land (annual crop land, perennial crop land, and water surface) falls in the bottom (top) 20% of the land distribution.

Source: VHLSS data

Table 10. Regression Results of Per Capita Consumption Expenditure

Log of real per capita expenditure ('000 VND/year)	1992 (1)	2004 (2)	2006 (3)	2008 (4)	2012 (5)	2014 (6)	2016 (7)	Difference (7)-(1)
Log of total land owned (square meters)	0.0619***	0.0633***	0.0461***	0.0555***	0.0252***	0.0112	0.0098	-0.0521***
	(0.0173)	(0.0079)	(0.0079)	(0.0076)	(0.0088)	(0.0094)	(0.0096)	(0.0197)
Highest grade completed of household members	0.0505***	0.0634***	0.0650***	0.0605***	0.0690***	0.0720***	0.0679***	0.0175**
	(0.0059)	(0.0025)	(0.0026)	(0.0029)	(0.0030)	(0.0030)	(0.0037)	(0.0069)
Male household head	0.0128	0.0369**	0.0418**	0.0250	0.0372*	0.0167	0.0340	0.0213
	(0.0233)	(0.0172)	(0.0179)	(0.0183)	(0.0215)	(0.0221)	(0.0235)	(0.0330)
Age of household head	0.0242***	0.0258***	0.0226***	0.0216***	0.0350***	0.0328***	0.0359***	0.0117**
	(0.0037)	(0.0029)	(0.0032)	(0.0035)	(0.0035)	(0.0033)	(0.0033)	(0.0050)
Age of household head (squared)	-0.0002***	-0.0002***	-0.0002***	-0.0002***	-0.0003***	-0.0003***	-0.0003***	-0.0001**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of male members	0.0097	-0.0023	0.0083	0.0150*	0.0214**	0.0106	0.0014	-0.0083
	(0.0078)	(0.0073)	(0.0076)	(0.0089)	(0.0107)	(0.0110)	(0.0110)	(0.0134)
Household size	-0.0850***	-0.1209***	-0.1219***	-0.1432***	-0.1400***	-0.1376***	-0.1613***	-0.0763***
	(0.0064)	(0.0054)	(0.0053)	(0.0063)	(0.0076)	(0.0072)	(0.0080)	(0.0103)
Observations	3513	4899	4638	4455	4815	4902	4626	
R-squared	0.272	0.366	0.355	0.338	0.339	0.347	0.381	

Notes: Standard errors in parentheses, clustered at commune level. Regression with region dummies.

Source: Estimated from VHLSS

Table 11. Regression Results of Income Share from Agriculture

	2004	2006	2008	2012	2014	2016	Difference
	(1)	(2)	(3)	(4)	(5)	(6)	(6)-(1)
Log of total land owned (square meters)	0.1296***	0.1269***	0.1308***	0.1449***	0.1336***	0.1305***	0.0009
	(0.0053)	(0.0051)	(0.0085)	(0.0050)	(0.0049)	(0.0052)	(0.0075)
Highest grade completed of household members	-0.0182***	-0.0128***	-0.0169***	-0.0112***	-0.0137***	-0.0110***	0.0072***
	(0.0015)	(0.0024)	(0.0023)	(0.0016)	(0.0017)	(0.0018)	(0.0024)
Male household head	0.0570***	0.0539***	0.0153	0.0544***	0.0552***	0.0613***	0.0043
	(0.0103)	(0.0140)	(0.0138)	(0.0111)	(0.0118)	(0.0118)	(0.0157)
Age of household head (/1000)	-0.4431	0.7243	3.2342	2.7048	3.4613*	2.6211	3.0642
	(1.8651)	(2.1494)	(2.6455)	(1.8682)	(1.8122)	(1.9030)	(2.6644)
Age of household head (squared/1000)	-0.0118	-0.0186	-0.0378	-0.0378**	-0.0475***	-0.0312*	-0.0194
	(0.0174)	(0.0207)	(0.0250)	(0.0176)	(0.0166)	(0.0169)	(0.0243)
Number of male members	-0.0076	-0.0205**	-0.0063	-0.0132**	-0.0046	-0.0131**	-0.0055
	(0.0049)	(0.0103)	(0.0071)	(0.0061)	(0.0062)	(0.0062)	(0.0079)
Household size	-0.0056	-0.0065	-0.0171***	-0.0122***	-0.0127***	-0.0136***	-0.0080
	(0.0035)	(0.0043)	(0.0042)	(0.0041)	(0.0040)	(0.0041)	(0.0053)
Observations	4899	4638	4455	4815	4902	4626	
R-squared	0.237	0.137	0.174	0.352	0.301	0.314	

Notes: Standard errors in parentheses, clustered at commune level. Regression with region dummies.

Source: Estimated from VHLSS

Table 12. Regression Results of Income Share from Wage

	2004	2006	2008	2012	2014	2016	Difference
	(1)	(2)	(3)	(4)	(5)	(6)	(6)-(1)
Log of total land owned (square meters)	-0.0836***	-0.0706***	-0.0817***	-0.1014***	-0.0874***	-0.0981***	-0.0145*
	(0.0051)	(0.0049)	(0.0050)	(0.0052)	(0.0060)	(0.0056)	(0.0076)
Highest grade completed of household members	0.0086***	0.0073***	0.0106***	0.0182***	0.0112***	0.0211***	0.0124***
	(0.0015)	(0.0016)	(0.0016)	(0.0018)	(0.0023)	(0.0019)	(0.0024)
Male household head	-0.0635***	-0.0750***	-0.0417***	-0.0487***	-0.0269	-0.0605***	0.0029
	(0.0112)	(0.0121)	(0.0120)	(0.0135)	(0.0180)	(0.0145)	(0.0184)
Age of household head	-0.0017***	-0.0024***	-0.0021***	-0.0022***	-0.0017***	-0.0026***	-0.0009*
	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0005)	(0.0004)	(0.0005)
Number of male members	0.0260***	0.0198***	0.0253***	0.0287***	0.0212**	0.0292***	0.0032
	(0.0050)	(0.0054)	(0.0058)	(0.0073)	(0.0090)	(0.0076)	(0.0091)
Household size	0.0154***	0.0234***	0.0223***	0.0247***	0.0220***	0.0271***	0.0117*
	(0.0034)	(0.0036)	(0.0040)	(0.0049)	(0.0061)	(0.0051)	(0.0061)
Observations	4899	4638	4455	4815	2623	4626	
R-squared	0.112	0.117	0.138	0.175	0.142	0.173	

Notes: Standard errors in parentheses, clustered at commune level. Regression with region dummies.

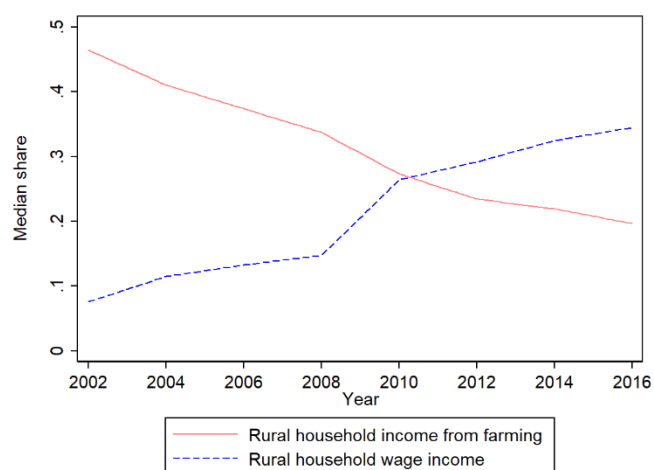Source: Estimated from VHLSS

FIGURES

Figure 1. Median share of income of rural households from farming and from wage earnings

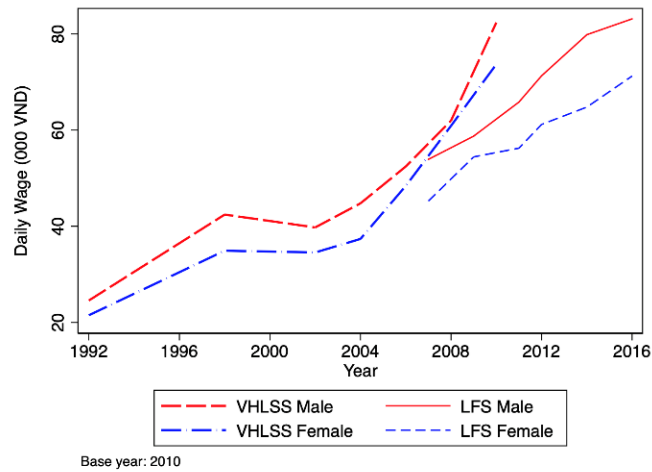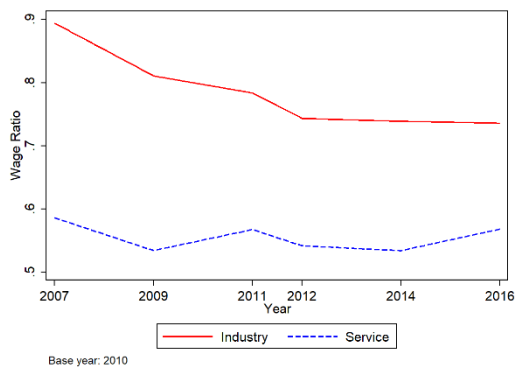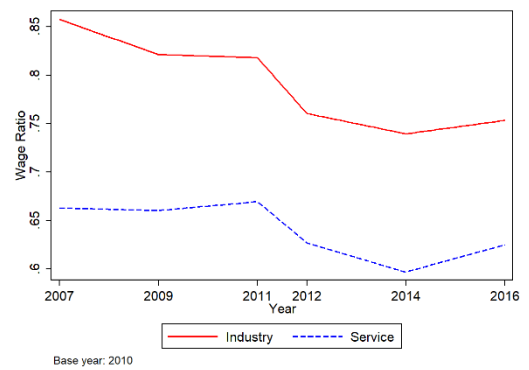Source: Estimated from VHLSS data

Figure 2. Median daily real male and female agricultural wage, 1992-2016

Source: Estimated from VHLSS and LFS data

(a) Total

(b) Rural

Figure 3. Ratio of agricultural to non-agricultural wages, 2007-2016
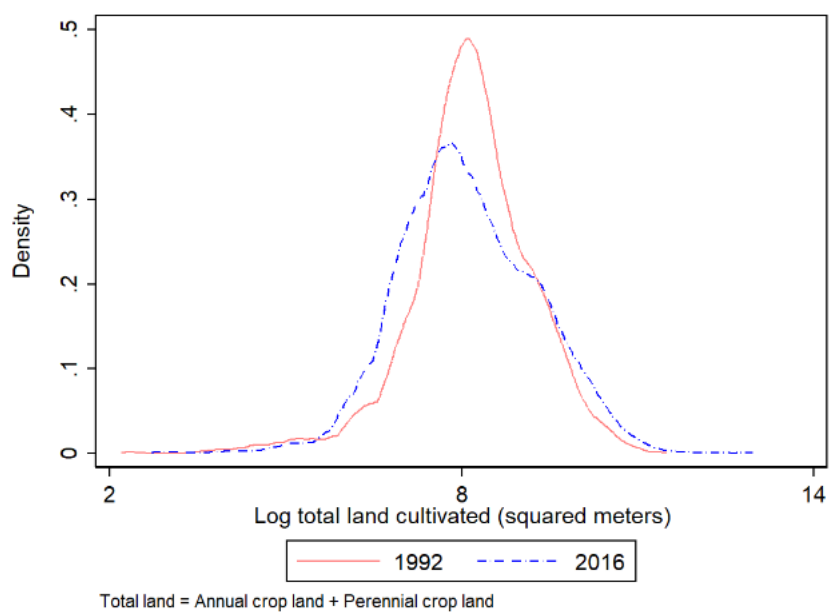
Source: Estimated from LFS data

52

Figure 4. Distribution of total cultivated land per household in 1992 and 2016
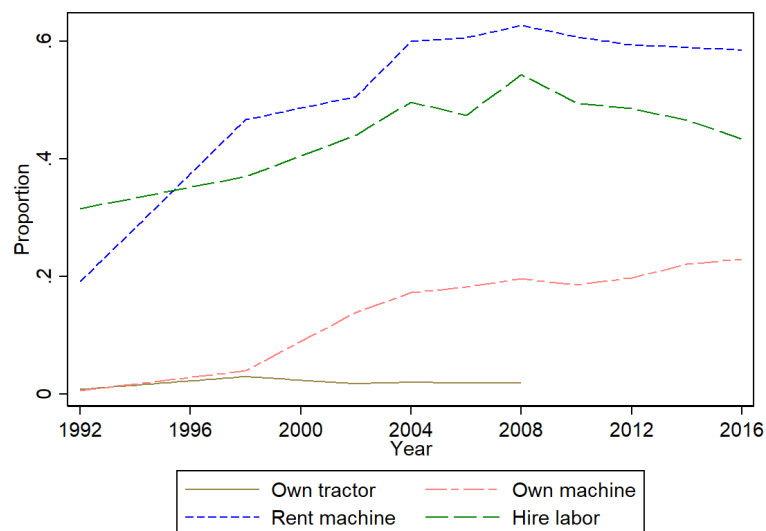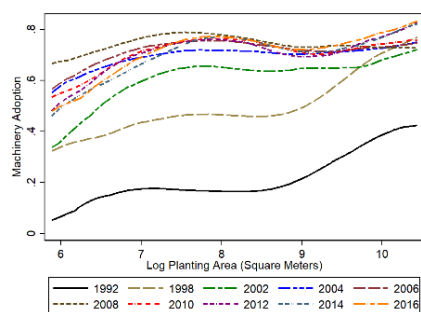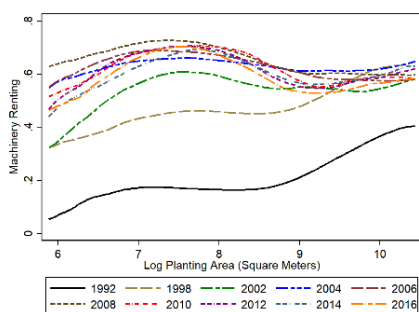
Source: Estimated from VHLSS data

Figure 5. Proportion of farm households that owned tractors, owned any machinery, rented machinery, or hired labor

Notes: Machine ownership is proxied by cost of fuel and depreciation of fixed assets used in farming activities of the household.
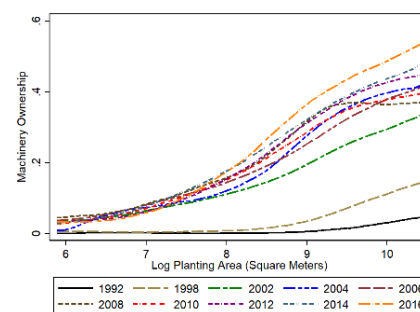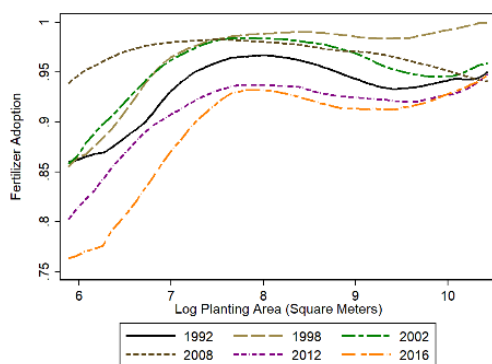
Source: Estimated from VHLSS data

(a) Machine Adoption   (b) Machinery Renting   (c) Machinery Owning
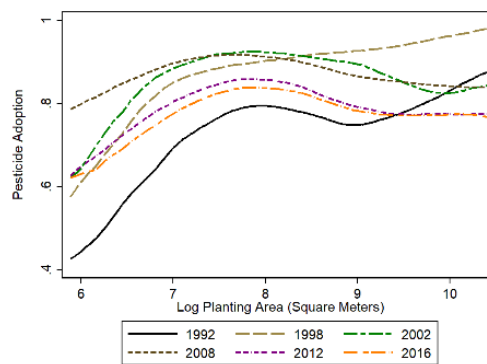
Figure 6. Nonparametric (local polynomial) regressions of machinery adoption, renting and owning conditional on farm size, over time

Source: Estimated from VHLSS data

(a) Fertilizers   (b) Pesticides

Figure 7. Nonparametric (local polynomial) regressions of agrochemical adoption conditional on farm size, over time
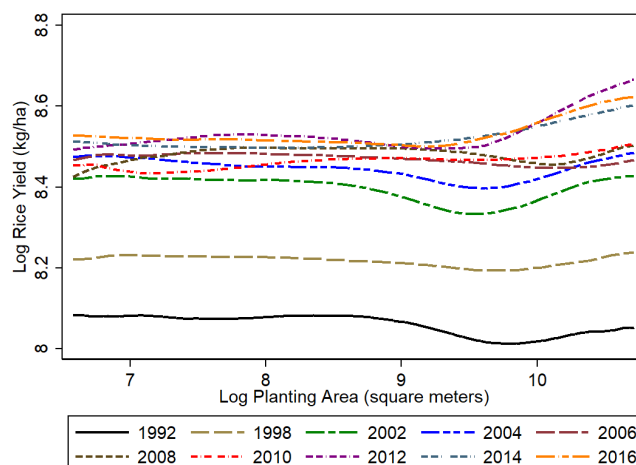
Source: Estimated from VHLSS data

Figure 8. Nonparametric (local polynomial) regression of rice yield versus planting area, 1992-2016
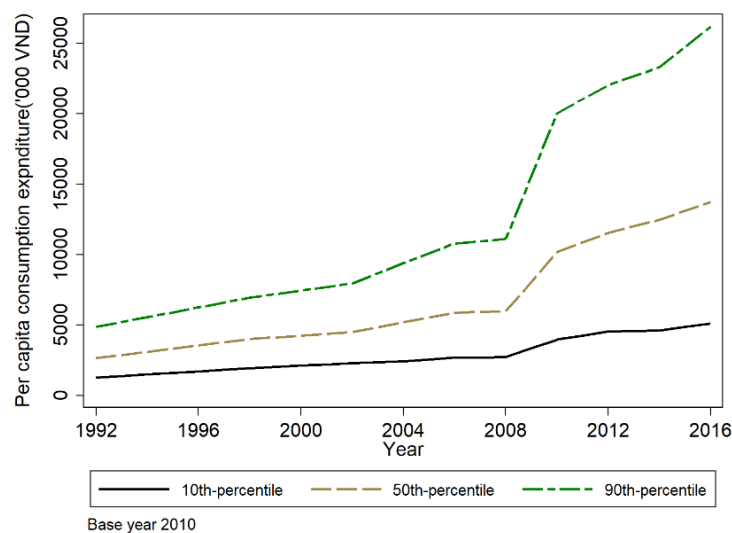
Source: Estimated from VHLSS data

Figure 9. Evolution of rural per capita expenditure per year ('000 VND), 1992-2016

Source: Estimated from VHLSS data

Appendix Tables and Figures

Appendix A: Labor Force Survey Sampling Framework

The LFS sample is randomly selected in a two-stage stratification design. In the first stage, each centrally governed city or province constitutes a main stratum, which is divided into two sub-stratums representing Population and Housing Census enumeration areas in rural and urban areas. Enumeration areas are then randomly selected using the Kish method. In the second stage, 15-20 households were selected from each sub-stratum enumeration area, yielding a sample that is statistically representative at the national, urban/rural, and six regional levels. The LFS 2007 was sampled based on the 1999 Population and Housing Census. The LFS 2009-14 used the 2009 Census as their sampling frame. The LFS 2015-16 sample is based on the 2014 Intercensal Population and Housing Survey. Unlike other rounds which were conducted over 12 months of the respective year, the 2009 round was conducted in September only. For LFS 2011-16, the sample was selected under the 2-2-2 rotation mechanism, under which each enumeration area was divided into two rotation groups, households of each rotation group were surveyed in two consecutive quarters, excluded from the next two consecutive quarters, and again included in the following two consecutive quarters. Each enumeration area was selected in the sample at a maximum of four times a year.

Table A1. Description of VHLSS samples

Panel	Total		Rural only	
	Number of households	Number of communes	Number of households	Number of communes
1992-1998	4,303	147	3,397	115
2002-2004	4,081	1,409	3,148	1,084
2006-2008	4,085	1,502	3,080	1,118
2010-2012	4,157	1,524	3,064	1,108
2014-2016	4,266	1,544	3,035	1,082

Table A2. Description of LFS samples

Survey round	Total individuals (persons)	Rural individuals (persons)	Estimated share of rural individuals (%)	Estimated labor force participation rate (%)	
				Total	Rural
2007	496,842	182,656	70.46	80.78	83.95
2009	49,431	21,729	69.24	82.42	85.03
2011	842,092	334,663	67.21	82.84	86.20
2012	562,168	288,426	66.71	82.98	85.98
2014	560,642	286,797	66.89	84.18	87.25
2016	615,986	348,445	64.72	83.52	86.96

Notes: Individuals aged 15 and above are included in the sample, otherwise stated. Labor force participation rate is the proportion of the population ages 15-60 that is economically active (employed, under-employed, un-employed). Estimation for share of rural individuals and labor force participation rate uses sampling weights available in the dataset.

Table A3. Emergence of Farmworker Population

	1992	1998	2002	2004	2006	2008	2010	2012	2014	2016
Share of households employed in farming who do NOT own livestock nor cultivate land themselves, i.e., pure farmworkers			0.027	0.015	0.019	0.050	0.027	0.031	0.028	0.028
Number of households employed in farming who do NOT own livestock nor cultivate land themselves, i.e., pure farmworkers (thousand)			355	201	266	722	375	451	407	444
Hired labor share of agricultural workers	0.051	0.038	0.078	0.060	0.062	0.060	0.073	0.083	0.075	0.080

Notes: Hired labor share of agricultural workers is calculated as ratio of waged agriculture workers to total agriculture workers.[19]
Source: Estimated from VHLSS

Table A4. Payment Terms for Hired Agriculture Labor

	Total			Rural		
	2007	2014	2016	2007	2014	2016
Salaried	11.1	11.18	11.34	9.13	10.17	10.06
Per hour or per day	57.28	68.18	70.95	58.47	69.15	71.45
By piece	25.4	19.61	16.56	26.04	19.6	17.43
Others	6.22	1.03	1.15	6.36	1.08	1.06
In which:						
In-kind	4.47	0.05	-	4.52	0.06	-
Unpaid	0.98	0.43	-	1.03	0.42	-
Others	0.77	0.54	-	0.81	0.6	-

Notes: In 2016, the questionnaire does not specify other types of payment.
Source: Estimated from LFS

---

[19] The estimates from VHLSS are quite similar with that from LFS, especially after 2012.

Table A5. Labor Conditions: Working Hours

		Regular Hours of Working per Week						Actual Hours of Working per Week					
		2007	2009	2011	2012	2014	2016	2007	2009	2011	2012	2014	2016
Total	Agriculture												
	Mean	45.88	46.71	45.49	44.65	43.63	43.19	45.88	45.36	45.01	43.98	42.28	41.85
	SD	10.51	13.23	10.37	10.02	10.18	10.33	10.51	14.18	10.67	10.51	10.95	10.99
	Median	45.00	48.00	48.00	45.00	42.00	42.00	45.00	46.00	47.00	43.00	42.00	42.00
	Non-agriculture												
	Mean	48.63	49.34	48.31	48.19	47.94	48.23	48.63	49.28	48.58	47.13	46.09	46.41
	SD	9.59	10.80	8.92	8.86	8.92	8.47	9.59	11.70	9.71	10.06	11.05	10.64
	Median	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00
Rural	Agriculture												
	Mean	45.90	46.38	45.49	44.73	43.54	42.99	45.90	45.03	45.01	44.07	42.20	41.70
	SD	10.62	13.34	10.46	10.04	10.25	10.43	10.62	14.26	10.74	10.57	10.98	11.00
	Median	45.00	48.00	48.00	45.00	42.00	42.00	45.00	45.00	47.00	43.00	42.00	42.00
	Non-agriculture												
	Mean	49.20	50.21	48.88	48.63	48.38	48.65	49.20	49.85	49.09	47.50	46.67	46.76
	SD	9.60	11.05	9.10	8.97	9.18	8.69	9.60	12.11	9.91	10.23	11.11	10.96
	Median	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00	48.00

Source: Estimated from LFS

Table A6. Median real agricultural wages across gender and six main geographic regions

Male	1992	1998	2002	2004	2006	2008	2010	2012	2014	2016
Central Highlands	25.68	36.83	37.80	39.62	49.69	70.55	74.94	92.61	101.85	99.43
Mekong river delta	43.52	53.56	49.37	53.73	60.51	67.96	84.51	97.91	104.86	104.13
North East and North West	14.51	28.73	31.28	34.67	40.15	54.81	66.93	81.11	83.94	99.53
North and Central Coast	20.70	34.25	39.77	44.78	50.71	61.97	82.51	99.63	107.40	107.81
Red river delta	21.50	40.17	39.02	48.56	59.95	73.29	103.23	119.59	123.76	136.75
South East	33.15	44.14	48.18	48.14	58.68	69.46	78.59	94.84	108.13	120.70
Female										
Central Highlands	25.68	31.43	31.71	35.22	49.69	58.79	69.95	92.61	88.27	99.43
Mekong river delta	29.01	39.32	39.50	39.85	48.40	55.61	63.38	73.43	82.39	83.30
North East and North West	14.51	25.63	28.63	33.11	40.15	48.80	63.16	79.52	83.94	97.72
North and Central Coast	20.70	32.81	31.10	37.37	48.27	61.71	75.25	84.13	93.08	101.08
Red river delta	21.50	39.46	35.77	48.56	59.95	73.29	103.23	119.59	120.12	136.75
South East	22.10	36.96	38.54	43.76	51.34	63.68	73.68	91.05	104.64	110.64

Source: Estimated from VHLSS

Table A7. Changes in the harvest season wage premiums for both men and women

		1992	1998	2002	2004	2006	2008	2010	2012	2014	2016
Median	Male	1.08	1.15	1.02	1.10	1.07	1.00	1.10	1.00	1.03	1.04
	Female	1.00	1.18	1.07	1.06	1.00	1.13	1.01	1.00	1.08	1.07
Mean	Male	1.07	1.10	1.07	1.09	1.08	1.08	1.09	1.08	1.10	1.01
	Female	1.06	1.09	1.08	1.11	1.09	1.10	1.12	1.09	1.11	1.02

Source: Estimated from VHLSS

Table A8. Regression results on land productivity of spring ordinary rice

	1992/98	2006/08	2010/12	2014/16	
	(1)	(2)	(3)	(4)	(5)=(4)-(1)
Log total area of spring ordinary rice	-0.1259***	-0.0426***	-0.0464***	-0.0331**	0.0544**
	(0.0214)	(0.0126)	(0.0142)	(0.0147)	(0.0228)
Male household head	0.0062	0.0044	-0.0568	0.0262	0.0235
	(0.0366)	(0.0342)	(0.0452)	(0.0454)	(0.0514)
Age of household head	-0.0005	-0.0006	0.0009	0.0004	0.0010
	(0.0012)	(0.0009)	(0.0017)	(0.0013)	(0.0016)
Highest education of household members	0.0050	-0.0021	-0.0008	0.0045	-0.0041
	(0.0056)	(0.0052)	(0.0040)	(0.0049)	(0.0055)
Number of male members	0.0070	0.0015	-0.0111	0.0104	0.0132
	(0.0177)	(0.0133)	(0.0168)	(0.0120)	(0.0188)
Household size	0.0010	-0.0010	0.0081	-0.0066	-0.0123
	(0.0102)	(0.0086)	(0.0080)	(0.0081)	(0.0109)
Year	0.0385***	-0.0046	0.0349***	-0.0056	-0.0270***
	(0.0029)	(0.0034)	(0.0035)	(0.0040)	(0.0037)
Observations	4932	3465	3247	2970	
R-squared	0.229	0.010	0.111	0.010	

Notes: Standard errors in parentheses, clustered at commune level. The variables "Log total area of spring ordinary rice" centered around their sample means. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Source: Estimated from VHLSS

Table A9. Regression results on land productivity of autumn ordinary rice

	1992/98 (1)	2006/08 (2)	2010/12 (3)	2014/16 (4)	(5)=(4)-(1)
Log total area of autumn ordinary rice	-0.1995***	-0.0851***	-0.0250	-0.0152	0.0710*
	(0.0360)	(0.0197)	(0.0255)	(0.0248)	(0.0383)
Male household head	-0.0669	0.0369	0.0354	0.0044	0.0023
	(0.0527)	(0.0599)	(0.0578)	(0.0354)	(0.0504)
Age of household head	-0.0006	0.0009	0.0043	0.0014	0.0012
	(0.0021)	(0.0018)	(0.0035)	(0.0021)	(0.0022)
Highest education of household members	0.0153**	-0.0034	0.0014	0.0019	-0.0115**
	(0.0063)	(0.0062)	(0.0058)	(0.0037)	(0.0056)
Number of male members	0.0300	-0.0164	0.0332	0.0300**	0.0089
	(0.0223)	(0.0181)	(0.0250)	(0.0135)	(0.0205)
Household size	0.0117	0.0167*	-0.0090	-0.0128	-0.0236**
	(0.0124)	(0.0101)	(0.0142)	(0.0078)	(0.0116)
Year	0.0229***	0.0301***	0.0291***	0.0090**	-0.0294***
	(0.0050)	(0.0056)	(0.0059)	(0.0036)	(0.0044)
Observations	4431	2728	2514	2463	
R-squared	0.107	0.054	0.057	0.013	

Notes: Standard errors in parentheses, clustered at commune level. The variables "Log total area of autumn ordinary rice" centered around their sample means. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Source: Estimated from VHLSS

Table A10. Mean share of agricultural output (by value)

	Total farms			Small farms			Big farms		
	2002	2010	2016	2002	2010	2016	2002	2010	2016
Rice	0.408	0.507	0.368	0.401	0.554	0.428	0.377	0.379	0.300
Ordinary rice	0.385	0.475	0.340	0.384	0.523	0.411	0.357	0.357	0.268
Sticky rice	0.017	0.019	0.016	0.011	0.014	0.004	0.018	0.019	0.032
High-quality rice	0.006	0.013	0.013	0.005	0.018	0.014	0.002	0.003	0.000
Other food crops	0.100	0.110	0.123	0.083	0.092	0.104	0.132	0.151	0.157
Industrial crops	0.095	0.100	0.126	0.050	0.041	0.044	0.191	0.236	0.278
Fruits	0.068	0.051	0.062	0.074	0.048	0.054	0.068	0.054	0.062
Aquaculture	0.054	0.032	0.037	0.050	0.027	0.032	0.077	0.045	0.045
Livestock	0.274	0.199	0.284	0.343	0.238	0.338	0.156	0.134	0.158

Notes: Industrial crops include both annual and perennial crops. Other food crops include vegetables and other staples. Small (big) farms are those whose production land (annual crop land, perennial crop land, and water surface) falls within the bottom (top) 20% of the land distribution.
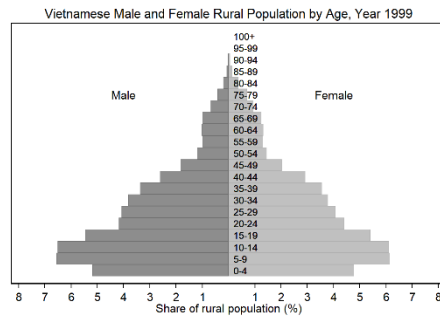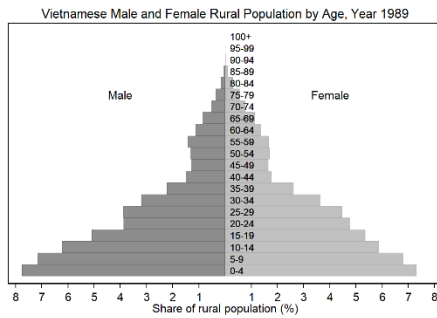Source: VHLSS data

Table A11. Share of food expenditures auto-consumed by farming households

	1992	1998	2010	2012	2014	2016
Mean	0.507	0.471	0.269	0.265	0.245	0.235
S.D	0.255	0.224	0.203	0.221	0.216	0.210
Median	0.535	0.504	0.249	0.240	0.212	0.197

Source: Estimated from VHLSS
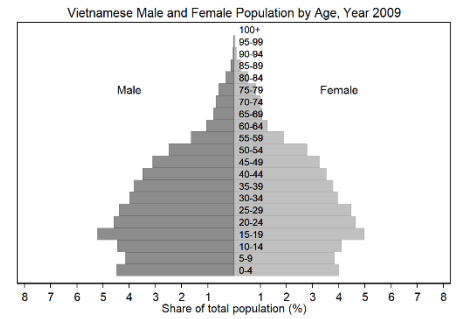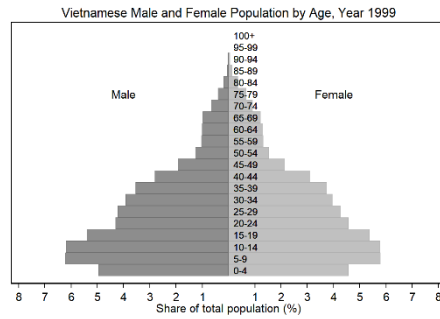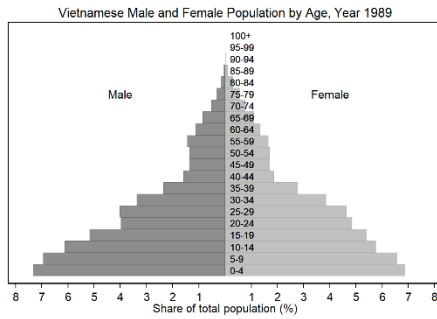
(a) Total population
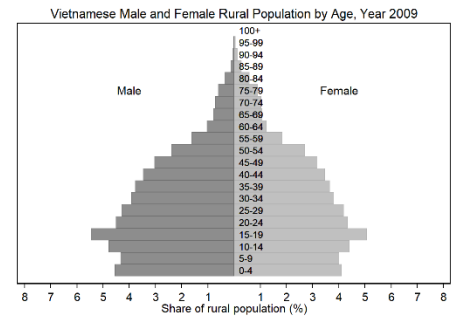
(b) Rural population

Figure A1. Population pyramid of Vietnam 1989, 1999, 2009

Source: Estimated from 5%, 3%, 15% Population and Housing Census 1989, 1999, 2009
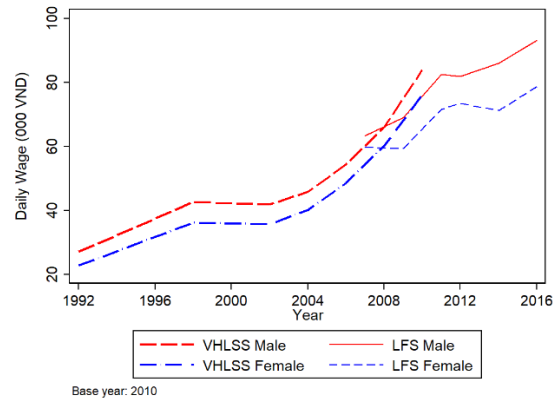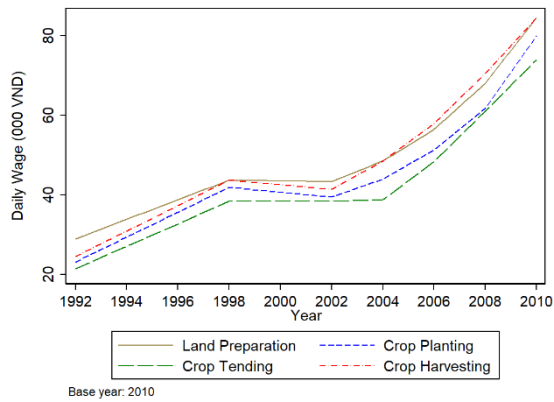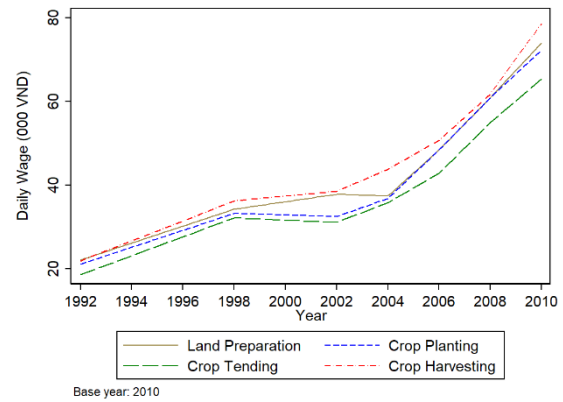
Figure A2. Mean daily real male and female agricultural wage, 1992-2016

Source: Estimated from VHLSS and LFS

(a) Male   (b) Female

Figure A3. Median daily real male and female agricultural wage by task, 1992-2016
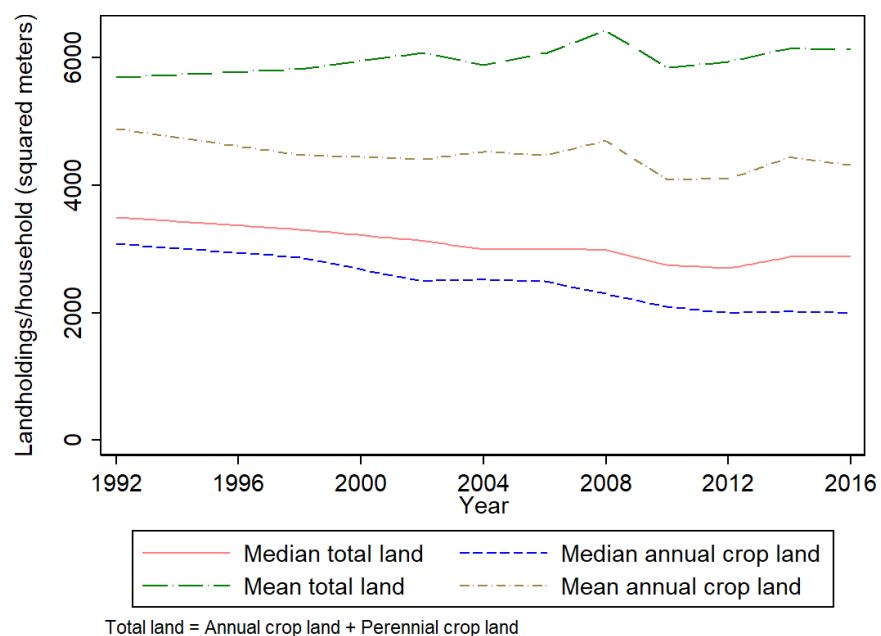
Source: Estimated from VHLSS

Figure A4. Trend of total land cultivated per household and total annual crop land cultivated per household, 1992-2016
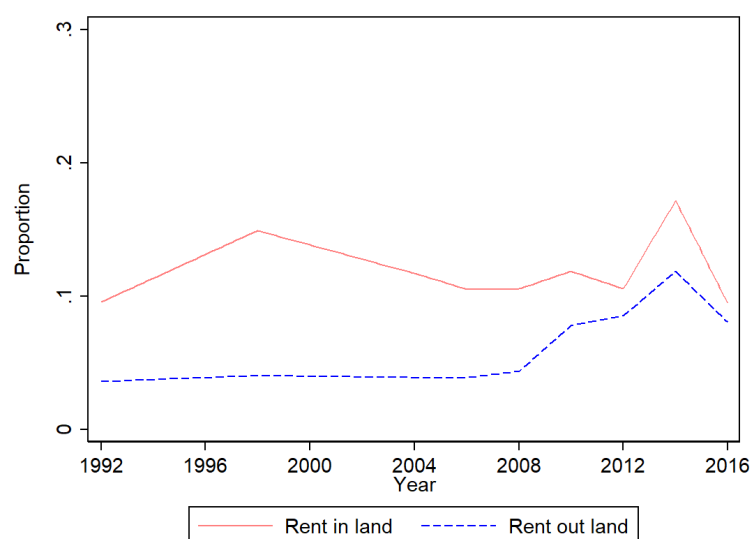
Source: Estimated from VHLSS

Figure A5. Proportion of farm households that rent in/out land, 1992-2016
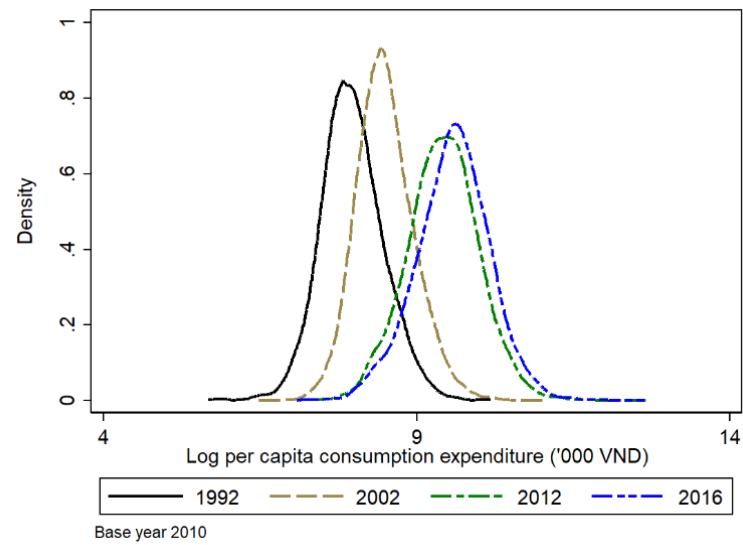
Source: Estimated from VHLSS

Figure A6. Distribution of per capita expenditure in 1992, 2002, 2012, and 2016

Source: Estimated from VHLSS