The effect of agricultural commercialization on food security

The case of crop producing households in post-reform Vietnam

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Abstract

There has been relatively little research that assesses the direct impact of commercialization on food security in the past couple of decades. Yet, agricultural commercialization remains widely pursued in development projects. This is especially the case in developing countries which turn from a central planned economy towards a more market-based economy such as Vietnam in the 1990s and Myanmar nowadays. In the 1980s Vietnam witnessed rapid declines in poverty and malnutrition shortly after implementing major economic reforms. These reforms were targeted at smallholders to increase their income and to reduce poverty through agricultural commercialization. In this thesis I examine the effect of agricultural commercialization on the food security status of crop producing households in Vietnam between 1993 and 1998. I distinguish between indicators of commercialization of input markets (seeds, fertilizer, etc.) and of commercialization of output markets (crops), as I expect that these have distinct impacts. Using the panel data from the Vietnam Living Standards Survey (VLSS) for 1992-1993 and 1997-1998, I conducted pooled OLS, fixed effects (FE), and random effects (RE) analyses. With Instrumental Variables (IV) techniques, I controlled for endogeneity for the OLS and FE models. The results show that the effect of commercialization on food security strongly depends upon the choice of the commercialization indicator and the region or province in Vietnam. In general, I found significant positive effects of the cash crop production share and crop output market participation on food variety in the south of Vietnam, and a significant negative effect of crop output market participation on caloric intake.

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Preface

This thesis is part of a larger project with the aim of identifying development pathways in agriculture that stimulate both commercially viable agriculture and improve the production and consumption of nutritious foods for Myanmar. Such a research is particularly interesting due to the recent political changes that are taking place in Myanmar, as opposed to its recent history.

In 1962, the military took control over Myanmar, and started a socialist regime. In 1988, however, the prodemocracy protests led to a change in governments, which steered the country towards a more market-based economic system. The objectives were to improve the role of the private sector and to encourage foreign direct investments and trade. The agricultural sector was given special attention (Findlay et al., 2016). Things took an unexpected turn when foreign governments started imposing economic sanctions on Myanmar after the government locked up the leader of the opposition party upon winning the 1990 elections. This led to Myanmar's international isolation for the next two decades (Bünte and Dosch, 2015). During this period the country struggled with high inflation rates, corruption and weak governance (Findlay et al., 2016). The government has mostly tried to achieve self-sufficiency by forcing the production of rice upon farmers (Fujita and Okamoto, 2006; Tun et al., 2015), but otherwise has been quite indifferent about agriculture. Instead, their main focus seems to have been on avoiding social unrest and sustaining the regime (Fujita and Okamoto, 2006).

When the government allowed democratic elections in 2010, Myanmar headed into a new direction. The changes that President U Thein Sein initiated when he took office in March 2011, strengthened governance, promoted economic development, and eventually got rid of the economic sanctions that had been imposed by other countries. Trade restrictions were relaxed and in 2012, the government addressed the issue of land rights for smallholders and poor farmers and included it into their policy priorities for the next 3 years (Tun et al., 2015). In the same year, they also eliminated import tariffs for fertilizers, which, together with better land rights, is likely to increase productivity in the agricultural sector. As agriculture is the largest economic sector in Myanmar, and as it employs the majority of its population, these changes might improve the lives of many households.

Due to the low levels of productivity in Myanmar, but despite its self-sufficiency in rice, the country has high levels of poverty and food insecurity. Half of the households have reported to have insufficient food supplies two months per year (Haggblade et al., 2014). The recent political and economic changes in Myanmar have the potential to change this situation, if the government continues to increase agricultural productivity and stimulate agricultural commercialization. On the other hand, the commercialization of smallholder agriculture might also come with certain risks. One of the aims of the research therefore is to identify pathways to mitigate the potential risks and exploit potential opportunities to food and nutrition security posed by commercial agriculture.

In specific, this thesis will concentrate on the effects of commercialization on food security. However, as there is very limited and reliable data available for Myanmar, I consider a country that has experienced similar developments, namely Vietnam. The liberalizations of Myanmar in the 1980s originally were quite similar to those of Vietnam in the same period, but due to weak governance and other problems in Myanmar, the outcomes were not (Findlay et al., 2016). It could be said that Myanmar only finally enter a meaningful transition period with the elections in 2010 (Findlay et al., 2016).

The results from this thesis can be used to roughly sketch the possible effects of commercialization on food security in Myanmar, and similar methods can be used to estimate the actual effect once more data is available. Another option is to create a projection of a certain region of Vietnam on a similar region of Myanmar through the means of simulations.

1. Introduction

There has been a lot of discussion on the effects of commercialization on food and nutrition security, especially in the 1970s and 1980s. On the one hand, it was thought that as a result of commercialization, households would receive more cash income, which would lead to better food security. On the other hand, there are also authors who claim that commercialization does not necessarily lead to improved food security. Von Braun (1995) argues that, due to inequality, risks and market failure, agricultural commercialization might make the poor even worse off. Even though there was no conclusive evidence on the effects of commercialization on food security, the topic has received much less attention since the 1980s-1990s (Carletto et al., 2016). A recent study by Carletto et al. (2016) tried to shed new light on the above-mentioned relationship, as there are many projects focusing on increasing agricultural commercialization, while the benefits on nutrition and food security have not been proven.

The main difference between the research by Carletto et al (2016) and a large part of the older literature, was that previous research has often defined agricultural commercialization as whether a household is producing a given cash crop or not. In reality, households can not only market cash crops, but also food crops (Jaleta et al., 2009). Randolph (1992) addressed this issue and took a different measure of agricultural commercialization, namely the crops sold as a proportion of the crops produced by a household. Carletto et al also used this indicator and looked at three different African countries and, in consonance with previous research, found little evidence of a relationship. I agree that purely looking at cash crops as a measure of commercialization might produce incorrect estimates. However, even the operationalization used by Carletto et al. (2016) does not fully address the complexity of commercialization, as they only consider output markets.

Due to its large declines in poverty and malnutrition during a period of major reforms, Vietnam of the 1990s provides us with an interesting case study to investigate the effects of commercialization on food security. During the 1990s Vietnam achieved an impressive decline in poverty. Whereas 58 percent of the population was living in poverty in 1993, this number dropped to 37 percent in 1998 (World Bank, 1999). Additionally, in just four years, from 1991 to 1995, the percentage of the population that was undernourished decreased from 45.6 to 35.4 percent (World Bank, 2015a). These declines were accompanied by high levels economic growth during the same decade (Glewwe and Dang, 2011). The cause of these changes were a set of economic reforms (Rozelle and Swinnen, 2004), the so-called *doi moi*, which Vietnam introduced in order to recover the country from its troublesome socio-economic situation. The reforms started in 1986 and focused on transforming the centrally planned economy gradually towards a more market-oriented system (Nguyen, 2009). As the policy environment is crucial in shaping the ability and willingness of households to commercialize (Carletto et al., 2016; Von Braun and Kennedy, 1994), and as the policy changes during the *doi moi* strongly encouraged agricultural commercialization, I focus on Vietnam during the 1990s.

One of the main focuses of the reforms was the agricultural sector. Agriculture in developing countries is known to be a crucial provider of income, livelihoods and environmental services (World Bank, 2007). At the start of the reforms, 80 percent of the population of Vietnam was living in rural areas. Even ten years after the *doi moi* started, in 1996, the agricultural sector was still employing 70 per cent of the population (World Bank, 2015b). In developing countries like Vietnam, agriculture also has the potential to be the main source of economic growth and poverty reduction. However, in order to achieve this, attention should be given to increasing access to assets, improving the competitiveness and sustainability of smallholder farming, for example through increasing market access to input, output and credit markets,

and diversifying income sources towards the labor market and out of agriculture (World Bank, 2007). The specialization and commercialization of agriculture could improve the productivity and competitiveness of smallholders, while at the same time reducing the amount of labor required on farms, enabling people to move towards other sectors of the economy. One of the key reforms of the *doi moi,* was the privatization of the agricultural sector. Before the reforms, the government decided how much households had to produce of each crop, and against which prices. As a result of the reforms, households were allowed to make all decisions regarding allocation, production and sales themselves. Additionally, the prices for crops and inputs were liberalized (Nguyen, 2009). I expect that these liberalizations have had a positive effect on agricultural commercialization levels.

The expected increase in agricultural commercialization in Vietnam could have had varying effects on the food security status of agricultural households. It could have improved, worsened, or matching most previous research (e.g. Carletto et al. (2016), Bouis and Haddad (1990) & Kennedy and Cogill (1988)), have had no significant effect on food security at all. This thesis aims to provide meaningful additions to the existing literature through, in the first place, adding to the relatively small amount of research that has considered more appropriate indicators of commercialization than cash crop production, and secondly, through considering a case study that is very different from other studies due to the rapid changes in policy. The main question that I will be answering is as follows:

What is the effect of agricultural commercialization on the food security status of crop producing households in Vietnam between 1992-1993 and 1997-1998?

I answer this question by looking at the following sub-questions:

- How did commercialization and food security change in Vietnam between 1992-1993 and 1997-1998?
- What is the effect of the increased production of cash crops (cashew, coffee, pepper, rubber and tea) on household food security?
- What is the effect of the increased participation in output markets on household food security?
- What is the effect of the increased commercialization of input markets on household food security?
- What are the differences between the three abovementioned ways of measuring commercialization and how do their effects on commercialization compare with each other?

In order to gain some more understanding of the context within which this research takes place, I will first provide a detailed description of the reforms that took place in the late 1980s and early 1990s in Vietnam (chapter 2). Then, in chapter 3, I will define the central concepts and introduce the theoretical framework that is mainly based upon the frameworks of Kanter et al. (2015), Von Braun (1995) and the agricultural household model. In this chapter I will also present a review of the existing literature on the topic of this research. In chapter 4 I will describe the methodology and the data that is used, as well as present the descriptive statistics. Chapter 5 provides the main results on the effects of commercialization on food security, and the remaining chapter will present the discussion and conclusion (chapter 6).

2. Reforms in Vietnam

After the war ended in 1975, North and South Vietnam were reunited. The northern part of the country had already witnessed the collectivization of agriculture at the end of the 1950s, and in 1975 the south followed suit (Ravallion and Van De Walle, 2008). The government followed principles that were also used in other communist countries like the Soviet Union. Almost all prices and production decisions were set by the government (Glewwe and Dang, 2011). As mentioned before, the overwhelming majority of the population, about 81 percent in 1975 (World Bank, 2015c), lived in rural areas and therefore worked on the collective farms.

The collective farms were very unpopular, both amongst the rural laborers as well as the urban elites. Due to the inefficiency of the system, the rural population started to resist, up to the point where they refused to work on the collective farms altogether. Instead, they only worked on the small amounts of private land they owned or even used the collective land for their private production (Ravallion and Van De Walle, 2008). The collective system had some obvious incentive problems. As the households' efforts on the farms were not directly linked to their income, they were not motivated to work as hard as they could. The resistance against the collective system increased the inefficiencies even further, causing frequent food shortages. These shortages were most detrimental for the urban areas, where people had no possibility to grow their own basic necessities (Ravallion and Van De Walle, 2008). During this period, which encompassed most of the 1970s and 1980s, economic growth stagnated and over three fourth of the population ended up living in poverty (Glewwe and Dang, 2011).

Ultimately the Vietnamese government came to the conclusion that the system was inefficient, and introduced the *doi moi*, gradually moving the agricultural system back to family farming. Already one year before the start of the *doi moi*, the government introduced the product contract system, where a shift was initiated from cooperatives to households as the main economic unit. In order to incentivize households to increase their productivity, the households were assigned a certain amount of land within the cooperatives and demanded to produce and deliver a set amount of output, while being allowed to keep any surplus production. The cooperatives remained in control of providing services like ploughing, irrigation, pest control and the supply of inputs (Nguyen, 2009; Vo, 1990). Then, in 1988 the product contract system was followed up by the 1988 Land Law, which disposed the collectives, freed the prices for crops and inputs, and allowed households to make all production decisions and marketing decisions themselves (Nguyen, 2009; Ravallion and Van De Walle, 2008).

Switching back to the family farm system quickly increased agricultural productivity and solved the food crisis, but the final step in liberalizing the agricultural sector was made with the 1993 Land Law. Under the 1988 Land Law, households were given long-term rights over privately using the land, but it remained property of the state (Ravallion and Van De Walle, 2008). The 1993 Land Law transferred official land titles to households and allowed land transactions. The land still officially remained property of the state, but the usage rights could now be exchanged, which reduced inefficiencies in the allocation of land (Ravallion and Van De Walle, 2008).

On a higher level of aggregation, in 1987, the government lifted price controls on major commodities like rice and kerosene, and numerous checkpoints were demolished, which led to a boost in (international) trade (Nguyen, 2009). In the same year, a new law on foreign investments was introduced, which opened the country up to FDI. As a result, FDI grew

rapidly, up to 10 percent of GDP in 1994 (Vuong, 2014). This boosted production levels and increased income and employment rates. The next year, in 1988, important changes in foreign trade were made. Quantitative restrictions on imports and exports were replaced by tariffs and the government let go of its exclusive control over foreign trade (Nguyen, 2009). In 1989 the transition process was accelerated even further by some structural reforms. In order to decrease the governments' budget deficit, there were major cuts in government spending, especially the subsidies to the state-owned enterprises. Also, price controls were abolished. All of this led to large decreases in inflation (Nguyen, 2009). Finally, there were also attempts to strengthen the private sector. In 1990 the Corporate Law and the Private Enterprise Law were introduced, which allowed the establishment of private firms under certain conditions (Kerkvliet et al., 2003; Vuong, 2014). This led to flourishing informal commercial and service sectors. The regulations regarding the industrial sector, however, had barely changed, as the government did not intend to privatize their state-owned enterprises (Nguyen, 2009).

Overall, the changes in policy towards a market-based system led to a period of rapid economic growth, followed by large decreases in poverty. Exports increased by almost 480 percent between 1986 and 1996 (World Bank, 2015d), leading to Vietnam becoming the world's second largest exporter of rice and coffee in the 1990s (Glewwe and Dang, 2011). The percentage of the population that was undernourished declined by almost 10 percent between 1991 and 1995 (World Bank, 2015a), and the share of the dietary energy supply derived from cereals, roots and tubers as a share of the total energy supply decreased from 79 to 74 percent (FAO, 2017). This indicates that not only did people consume more calories, but they also consumed more diverse diets.

3. Theoretical framework

3.1 Central concepts

The two central concepts that will be dealt with in this thesis are commercialization and food security. In this section I will first present the theory and definition of commercialization, and then move towards those of food security.

3.1.1 Commercialization

According to Von Braun (1995), the commercialization of agriculture in developing countries implies a movement away from subsistence agriculture towards an increased market orientation of agricultural households, which I define as "all the people who normally live and eat their meals together in the dwelling" (Glewwe, 1994). The commercialization of agriculture is about more than just the marketing of agricultural outputs though, as it also involves the substitution of non-traded inputs to traded inputs and the marketing of the household's labor supply (Pingali and Rosegrant, 1995). This means that households increasingly base their production and input use decisions on the principles of profit maximization (Pingali and Rosegrant, 1995), which increases the strength of the linkage between these households and the market (Jaleta et al., 2009). The definition of commercialization that I will be using, is similar to the one used by Jaleta et al. (2009):

> *"The commercialization of agricultural households implies the increased focus on market signals and comparative advantages in a households' production decisions, as opposed to a primary focus on subsistence production and the sale of purely the surplus that remains after the household's consumption requirements have been satisfied."*

In order to avoid any confusion, it is important to understand the differences between agricultural commercialization, and two important other interlinked processes that change agriculture as economies develop: agricultural transformation and agricultural diversification. Timmer (1997) introduced a graphic visualization of these processes, based on the historical experiences of rice-based economies in Asia (see figure 1 on the next page).

The first process, agricultural transformation, is depicted on the horizontal axis and refers to the transformation that is inevitably linked to economic growth. It might for instance be operationalized as the value added per worker in agriculture. The vertical axis shows agricultural diversification, which has been an important policy objective of most Asian countries (Timmer, 1997). The relationship between agricultural transformation and diversification can be analyzed on three different levels of scale, which are visualized as the three curves in figure 1. The lowest level of aggregation is the farm level. At the farm level, diversification is the highest when farmers are self-subsistent. At this point, markets are imperfect and there are few risk coping strategies. But as markets develop, households will increasingly allocate their resources towards the production of a limited amount of crops, while depending on the market for the remainder of their demand.

The level of specialization during agricultural transformation is likely to remain much higher at the second level of scale, the agricultural sector as a whole, as compared to the farm level. The gap between these two is widening due to the commercialization of agriculture, which has already been described above. The commercialization of agriculture is often accompanied by a movement towards more intensive farming systems and higher agricultural productivity. As a result of increasing off-farm employment opportunities, both the opportunity costs of labor and the demand for food grows (Pingali and Rosegrant, 1995).

Households in different areas with different resources will specialize in different crops when the agricultural transformation takes place, leading to greater diversification on the level of the agricultural sector as a whole due to commercialization effects. Finally, on the highest level of aggregation, the economy as a whole, eventually shows the highest level of diversification. The economy as a whole is measured by the diversity in food consumption. Originally, this diversity is expected to be low, but the increased importance and accessibility of international trade will fuel the inherent desire of people for more diverse diets (Timmer, 1997).

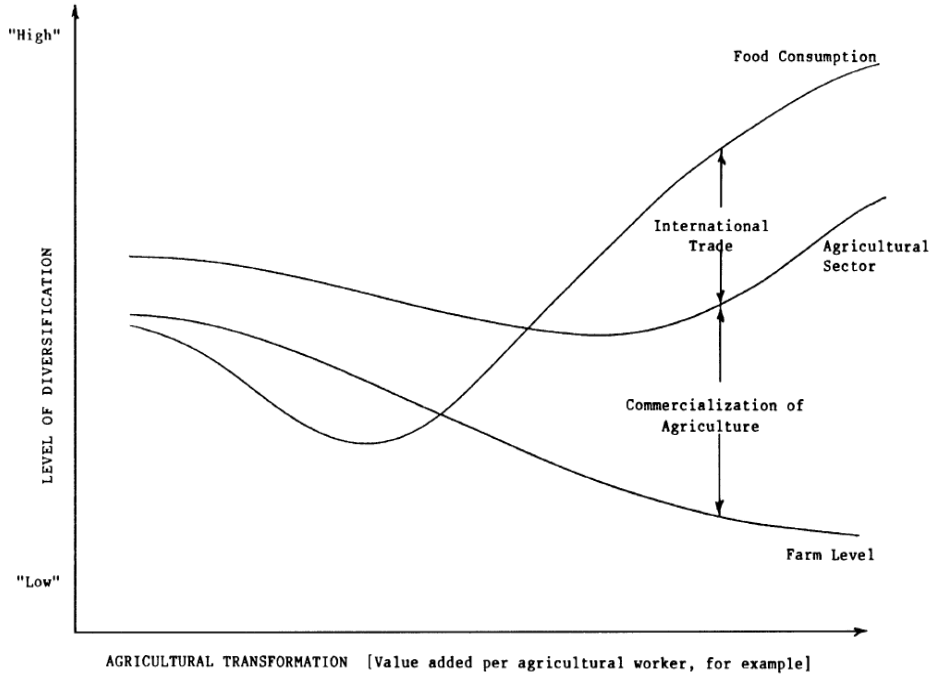

Figure 1: Relationships among alternative measures of food crop diversification during agricultural transformation. Source: Timmer (1997).

As seen above, Timmer (1997) argues that at the farm level, agricultural transformation will inevitably lead to lower levels of diversification. At the same time, however, agricultural diversification has often been used as a way to protect households from all kinds of risks (Chavas and Di Falco, 2012; Heady, 1952). Regardless of whether a household specializes their agricultural production towards a smaller range of crops or not, they can still decide to market more of their production. Of course, the cost advantages of economies of scale will not occur if a household does not specialize, but this does not mean that a household cannot sell more of what they are producing. In order to capture both of the possibilities, I will not be looking at the agricultural specialization of households, but purely at commercialization, so, the share of output sold to the market.

3.1.2 Food security

The production, consumption and marketing of agricultural products all influence food security. Both on a global scale, as well as in post-reform Vietnam, food security has improved considerably. The global supply of food has increased, but this does not automatically translate to higher levels of food security. Food security is part of a much

broader discourse on nutrition security, which is defined by the FAO (2015) as "a situation that exists when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, in order to ensure a healthy and active life for all household members". As nutrition security thus also requires adequate caring practices and knowledge of health and hygiene, nutritious diets are essential for nutrition security, but by far not sufficient to ensure a nutritional secure life (FAO, 2015; IFAD, n.d.).

Over the years, the definition and focus of food security have changed. The term emerged during the food crisis of the early 1970s (Jones et al., 2013). During this time, food security equaled food availability, which is now only one of four pillars of food security. It was about the availability of sufficient quantities of food in a country through either domestic production or imports (Achterbosch et al., 2014). It was believed that due to the food shortages during this period, political stability might be negatively affected (Jones et al., 2013).

Soon thereafter, scholars started to realize that sufficient national food availability does not guarantee that households also have this food sufficiency; there might be issues regarding access to food. Even when food supply is sufficient, prices might be too high or wages too low for households to be able to obtain enough of it. From now on, food security also required "physical and economic access to basic food" (FAO, 1983; Jones et al., 2013). The second pillar of food security thus encompasses the access of households to adequate resources, given their political, economic and social conditions, for obtaining enough food (Achterbosch et al., 2014).

Then, around the mid-1990s, two changes occurred. First, there was increased attention for the individual level within food security during this time. Aggregation, even over just households, still allows for variability within these households, which would lead to biased estimates of food insecurity (Barrett, 2002). Especially children are in danger of being food insecure while their household as a whole appears food secure, due to their dependency on their parents for the obtaining of their food (Barrett, 2002; Jones et al., 2013). Focusing on individual measures of food security would avoid such bias. Secondly, the focus in nutrition researched switched from caloric towards micronutrient sufficiency, particularly in iron, vitamin A and iodine (Jones et al., 2013). Both of these processes eventually led to the third pillar of food security: utilization. Food utilization refers to the utilization of adequately nutritious diets and the extent to which these nutrients can be properly absorbed by individuals. Differences in the latter might for example be caused by differences in the health status of individuals, which provides linkages towards sanitation, health care and other factors often dealt with in nutrition security (Achterbosch et al., 2014; Jones et al., 2013).

Finally, the last pillar of food security concerns the stability of food supply. Due to many different causes like seasonal shocks or regional conflicts, the availability, access and utilization of food might fluctuate over time (Jones et al., 2013). For food security to be stable, a household or individual must therefore have access to adequate food at all times, without having the risk of losing their access to food due to sudden shocks or cyclical events (Achterbosch et al., 2014). All of the above led to the 1996 World Food Summit definition that is still widely used today:

> *"Food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." (FAO, 1996).*

This definition, as well as the evolution of the concept of food security, both have stressed the importance of looking at the level of the individual. This thesis considers the effects of agricultural production and commercialization, which takes place at the level of the household. Moreover, the available data does not allow for a food security analysis at the individual level. For these reasons, I work with food security at the household level.

3.2 The framework

Commercializing is not something that households can choose to do freely. Instead, whether households can commercialize their income generating activities is influenced by many different factors, including the environment in which they are situated. Some households might be better able to commercialize than others, for example as a result of differences in access to credit or infrastructure (Barrett, 2008). In order to get a clear overview of the most important ways through which commercialization could potentially affect food security, I adjusted and combined the frameworks of Kanter (2015) and Von Braun et al. (1991). The framework is quite similar to the one developed by Von Braun et al. (1991), but as I am only looking at food security instead of both food and nutrition security, it excludes a detailed representation of the channels through which nutrition works. Moreover, the adjusted framework includes some aspects that were missing in the Framework by Von Braun et al (1991) but were present in the framework of Kanter (2015), such as the local food environment. This adjusted framework can be found in figure 2 and will be elaborated on below.

In many cases, and especially in developing countries, markets are imperfect, and local prices are determined endogenously (De Janvry and Sadoulet, 2006; Seng, 2016). Market access may differ across regions and even households, leading to heterogeneous transaction costs (Barrett, 2008). When markets are far or hard to reach, transaction costs will be higher, and incentives to stay self-sufficient will be too. Household-specific factors, like household assets and human capital endowments, will also determine the prices which influences the decision making process (Mason and Smale, 2013). For example, a household that has a bicycle will face lower transaction costs than a household that does not, as they will need less time to reach the market, and therefore can spend more hours on income generating activities.

Such situations with imperfect markets and heterogeneous transaction costs can best be understood through the non-separable agricultural household model. The agricultural sector is an important source of income in most developing countries, including Vietnam. In these areas, most households are not only producers, but also consumers of their own agricultural products. Also the inputs that they use partially originate from the market, and partially from their own production (Singh et al., 1986). The fact that many households in Vietnam in the 1980s and 1990s were both consumers and producers complicates traditional consumer theory. Agricultural household models show which factors determine the level of household production, consumption, their demand for inputs and supply of labor and the relationships between those (Singh et al., 1986).

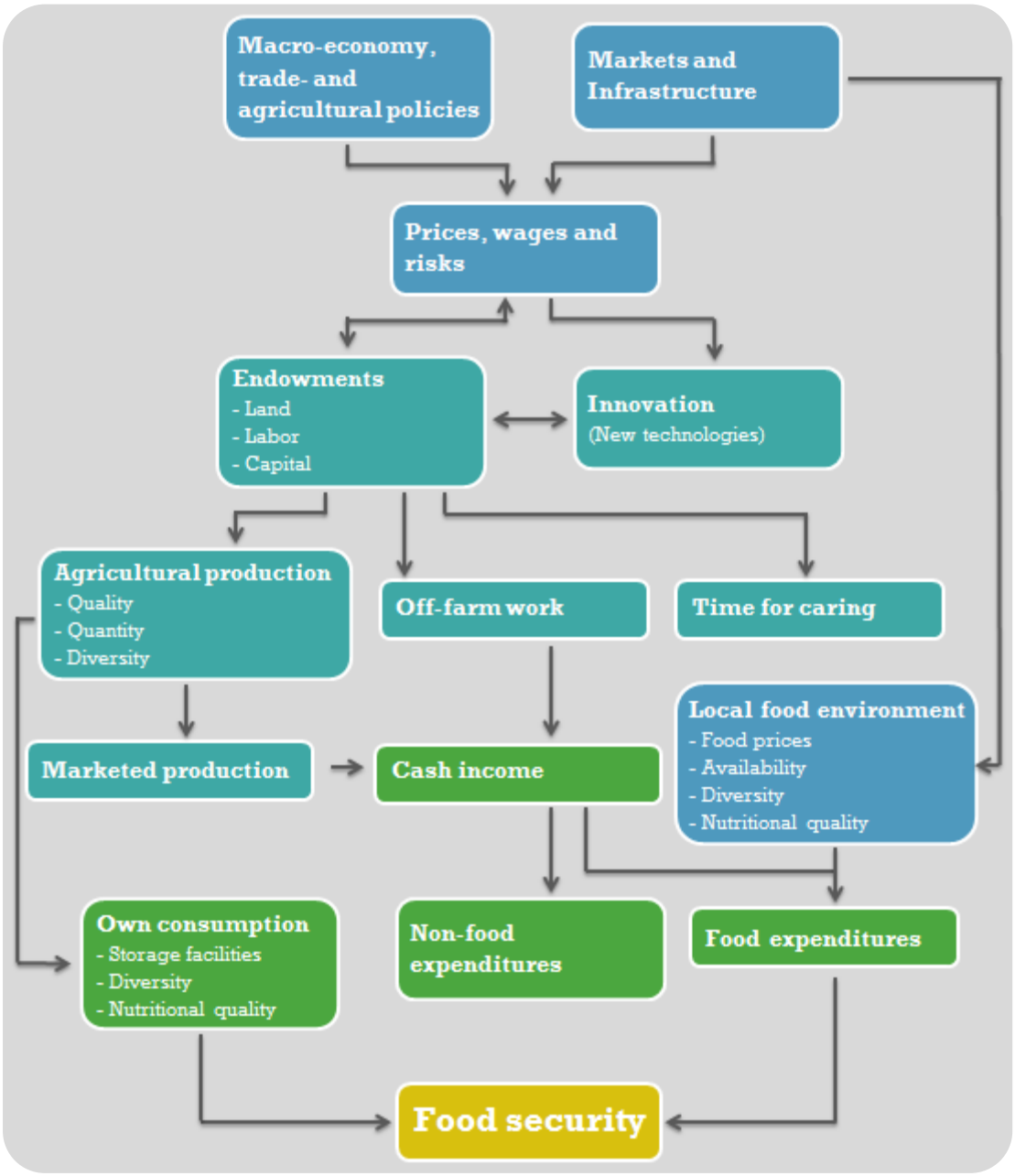

Figure 2: A theoretical framework of commercialization on food security

In contrast to the non-separable model, the separable agricultural household model is problematic in developing countries, as it assumes perfect markets (Mason and Smale, 2013). It assumes a one-way relationship between consumption and labor supply and production. A household maximizes its profits independently of its decisions regarding consumption and labor supply (Singh et al., 1986), but these decisions on consumption and labor supply cannot be made independently from production. The household's production decisions decide their income. This income can then be used to spend on the produced good, the bought good and leisure. The households are considered to be price-takers, and depending on the prices of each of the above, optimal consumption is determined. This also determines how much of the produced good is consumed, and how much is marketed. If prices of the produced gqood are high, the household might demand less of it, because they can achieve higher utility if they

sell it. In contrast to the non-separable model, the prices in the separable model are determined exogenously which allows the separability of households' production decisions from their consumption decisions.

Looking back at the framework, the non-separable agricultural household model has shown us how differences in *market access* and household characteristics, like their *endowments*, can influence household specific transaction costs and prices. At the same time, the relationship between household endowments on the one hand, and *prices, wages and risks*, on the other, also works the other way around. Depending on the prices, wages and risks, households will determine the allocation of their resources. If wages are high, they might for example opt to replace some of their *labor* from their own farm to off-farm activities.

Besides region and household specific characteristics, also the larger environment in which households are situated matters. As we have seen before, the 1990s was a period where large liberalizations took place in Vietnam. Several policy changes gradually increased the autonomy of households in their production decisions, which might have increased the possibilities for households to commercialize. According to Minten (1999), the switch from fixed to liberalized agricultural prices, which also took place in Vietnam, had a great effect on welfare, but whether prices rose or decreased depended on market access. At the same time, there still remain quite some restrictions on households. Even in 2006 still, 35 percent of the agricultural land in Vietnam was set for the production of rice, forbidding the production of other crops on this land (Markussen et al., 2011). Therefore, also the *macro-economy and trade- and agricultural policies* will influence prices, wages and risks.

Both depending upon which resources the household actually has access to, and upon all the above-mentioned factors that influence the characteristics and decision-making of households, the agricultural household will allocate their endowments. Their labor will be allocated towards either *agricultural production, off-farm work, or time for caring* (Von Braun et al., 1991). The latter refers to time spent on, for example, cooking and looking after infants or the elderly. The time that is spent on these types of actions might affect the nutrition security status of households (Von Braun et al., 1991). The *land* to which a household has access to can be allocated to the production of different crops, some of which might be better suited for sale on the market than others. The allocation of resources towards the more marketable commodities is what Gebremedhin and Jaleta (2010) call the "household market orientation", a specific type of commercialization. Lastly, *farm capital or assets* might be used to reduce risks, for example through savings, or on investments in technological *innovations*, such as the increased use of purchased inputs (Von Braun, 1995). Households with more capital might be better able to invest in innovations than those with less capital. Moreover, some households, for example those with larger pieces of land, might have higher returns to innovations than others. At the same time, technological progress, both within and outside of agriculture, will also influence the allocation of their resources.

As described in the non-separable household model, there are many factors that will influence a household's production and consumption decisions. The crop choices that are made will inevitably influence the share of the production that will be marketed, as opposed to the share that will be kept for *own consumption* (Von Braun et al., 1991). If a household is solely producing cash crops, they will sell all of their produce. The decisions on the allocation of the households' endowments, in combination with their decisions regarding the marketization of their outputs, are what we could call the households' commercialization "decisions". I do not consider this decision to be autonomous, because it is very much dependent upon local and household specific characteristics such as market access. At the same time, households decide what to spend their *cash income* on. This income could either be spent on *food or non-*

food items. But as people of different ages and genders have different preferences in the allocation of household income, the effects of commercialization might be different across and within households, depending upon who controls the expenditures of the household (Von Braun, 1995).

The food that was acquired through the market, under the conditions of the local food market (Kanter et al., 2015), in combination with the share of own production intended for consumption, eventually lead to the *food security* status of a household. Their food security status is, as mentioned before, not only dependent on the (caloric) quantities consumed, but also on its nutritional quality as well as the diversity in the consumed food products.

As stated before, I argue that commercialization is a multi-dimensional concept and involves both input and output markets. For the input market commercialization I will look at the interaction between a household's endowments and their agricultural production. The main focus with regards to output market commercialization is on the interaction between a household's agricultural production and their marketed production. The fact that commercialization can be found in two different sections of the framework indicates that the effects of commercialization on food security can be most accurately captured by addressing the multi-dimensionality of the concept instead of only looking at the output markets.

3.3 Previous research

Even though the reforms in Vietnam as a whole seem to have decreased poverty, we do not yet know the exact effects of the agricultural commercialization that is linked to these reforms. The specialization and commercialization of agriculture are theoretically much more efficient than subsistence farming. At stable prices, gains in income would occur through comparative advantages, economies of scale and different changes caused by social learning effects (Gebremedhin et al., 2010). On the other hand, due to market imperfections, risks for agricultural households increase. The commercialization of agriculture leads to a decline in crop diversity at the production side of farm households (Fleuret and Fleuret, 1980). Households become less self-sufficient and more dependent on local markets. In regions where markets are not well-integrated, volatile market prices of crops and inputs, inefficient marketing institutions and poor infrastructure pose risks to household income (Immink and Alarcon, 1993; Jaleta et al., 2009). Moreover, due to the lack of access to credit, households are unable to mitigate these risks (Immink and Alarcon, 1993). In such regions subsistence farming serves as a kind of insurance against the risks and costs of the market (Von Braun, 1995).

Whereas the effect of commercialization on income ranges from negative to positive, depending on the local conditions, the effects of increased income on food security are either positive or neutral, depending on household decisions. DeWalt (1993) suspected that this effect depends on culture and social groups. Increases in income provide farmers with the opportunity to make investments, such as better seed varieties, which could lead to higher productivity. This, in turn, would improve food security (Achterbosch et al., 2014; Babatunde and Qaim, 2010). In addition, according to Abdulai & Aubert (2004), increased income will increase the demand for diversified and nutritious diets. This would increase expenditures on animal products, fruits and vegetables, replacing cereals and pulses (Abdulai and Aubert, 2004). However, whereas increased diversification is beneficial for the micronutrient content of diets (Gibson and Hotz, 2001), this might not be the case for caloric intake. When income increases, households do not spend everything on obtaining more calories. Instead, they often buy better-tasting and more expensive calories (Banerjee and Duflo, 2012). Moreover,

also non-food expenditures are an important factor at play. Households might prioritize things that make life less boring, like a television, over increasing their caloric intake (Banerjee and Duflo, 2012).

As the theories about vulnerability to risk and market dependence predicted, in specific situations, like the Malawian domestic food crisis, the effects might be negative. Wood et al. (2013) found that there are negative health effects of cash crop production on children that were in utero during the food price shock. However, most empirical studies so far have found a positive effect of commercialization on income, but only a marginal effect on nutrition or food security (Carletto et al., 2016). In a study of the Philippines by Bouis and Haddad (1990), results showed that the production of cash crops significantly increased household income, but due to the purchasing of more expensive calories and nonfood items, this increase did not translate into a higher preschooler nutritional status. Similar results were found by Kennedy and Cogill (1988) in a study about Southwestern Kenya. Cash crop production was found to increase income, and have a small positive effect on household caloric intake. The increased income was most likely spent on nonfood items like housing and school fees.

4. Methodology & data

This chapter will introduce the data and variables which I will use, and present their descriptive statistics. I will start by presenting the model, and then move onto the presentation of the data. The last part of the chapter will focus the approach that I use to come to the results in chapter 5.

4.1 Model

Resulting from the theoretical framework, I estimate an equation that captures the effects of both input and output commercialization on food security in Vietnam under economic change in the 1990s. Due to the agricultural reforms around this period, and the numbers of malnutrition by the World Bank, I expect that both variables will have increased during this period. The model that I estimate was adjusted from the models used by Wood et al. (2013) and Bouis and Haddad (1990) and is as follows:

$$\mathrm{Y_{it}} = \beta_0 + \beta_1 C_{\mathrm{it}} + \beta_2 X_{\mathrm{it}} + \varepsilon_{\mathrm{it}} \qquad i = 1, \ldots, N$$

Where Y_{it} is the food security status of household i at time t, and C_{it} is the household's commercialization rate. X_{it} is a vector of household and region specific characteristics of the household, and $\varepsilon_{\mathrm{it}}$ is the error term. For Y_{it} I consider both caloric intake and a food variety score (FVS). Since commercialization can be defined in different ways, as shown in the conceptual framework in the previous section, I operationalize C_{it} by means of three different indicators of commercialization. I consider an indicator that looks at cash crops, one that looks at the overall output market participation of households, and one that looks at input markets. In line with previous research, I expect that the effect of commercialization on food security is positive but small. I predict that the effect is larger for some indicators of C_{it} than for others. When only looking at cash crops, for example, I expect that the effect is smaller.

4.2 Vietnam Living Standards Survey

This thesis uses the panel data from the Vietnam Living Standards Survey (VLSS) of the years 1992-1993 and 1997-1998, conducted by Vietnam's General Statistics Office, in collaboration with the World Bank (General Statistical Office (GSO) and State Planning Committee (SPC), 2014; Nguyen and Winters, 2011). Both surveys are representative on the national and regional level. The survey of 1992-1993 interviewed 4,800 households, while the 1997-1998 survey contains information on 6,000 households. A total of about 4,300 households is participating in both of them (Glewwe and Dang, 2011). The questionnaire includes data on a wide range of topics, including employment, education, agricultural activities and expenditures. On top of the household survey, the VLSS also contains a community questionnaire that was administered for 120 rural communities where the participating households were selected from. This community questionnaire consists out of questions on demographics, economy and infrastructure, education, health and agriculture and prices.

4.3 Variables

Table 1 provides a structured overview of all variables that will be used and their definitions, including the food security and commercialization indicators. The variables used will be expanded upon in the paragraphs below, starting with the food security indicators.

4.3.1 Food security

The focus in this thesis is on the different ways of operationalizing commercialization, which is why I only consider two measures of food security: the food variety score (FVS) and caloric intake. For both indicators I use purchased food items and food items produced for own consumption as a proxy for actual consumption. This is due to the lack of actual data on nutrients or food intake in the dataset that I use. As a consequence of this, it is necessary to include the assumption that no food is wasted, in order to generate existing food security existing food security indicators (Molini, 2006), which might lead to overestimations of the indicators.

Table 1: Variable definitions

Category	Variable	Description
Food security	Caloric intake	Caloric intake per day per adult male equivalent
	Food variety score	Food variety score for a household over the last two weeks
Commercialization	Cash crop production share	Value of cash crop production as a share of total value of production
	Crop output market participation	Value of crops sold on the market as a share of total value of crop production
	Input market use	Value of market purchased fertilizers as a share of value of total fertilizer use
Control variables	Age	Age of the household head in years
	Education	Education level of household head
	Gender	Gender of household head (1= male)
	Size	Amount of people who normally live and eat in the dwelling
	Dependency ratio	Share of household members below 15 or above 64
	On-farm income*	Total yearly household income in Dongs from agricultural activities
	Off-farm income*	Total yearly household income in Dongs from non-agricultural activities
	Food expenditures*	Total yearly food expenditures in Dongs
	Harvest value*	Total yearly harvest value in Dongs
	Land holdings	Landholdings in M^2
	Total livestock units (poultry)	Amount of buffalo, horses and/or cows measured in total livestock units (see Appendix A)
	Total livestock units (small)	Amount of goats and/or pigs measured in total livestock units (see Appendix A)
	Total livestock units (large)	Amount of chicken, ducks and/or (wild) geese measured in total livestock units (see Appendix A)
	Farm assets	Current value of farming equipment, machinery and tools in Dongs
	Region	Region in which the household is located

* These variables will not be included in the regression as they might correlate with the error term

The first indicator, caloric intake, has often been used in research on food and nutrition security (see for example Bouis & Haddad (1990), Von Braun et al. (1991), or Carletto et al (2016)). Caloric intake will be measured in adult male equivalents (AME), which takes into account that people, especially children and females, have different energy requirements. See appendix A for the conversion table. The VLSS data on food expenditures and production for own consumption will be transformed into the caloric intake per day per adult male equivalent using an adjusted version of the calorie conversion table that was designed by Vietnam's National Institute of Nutrition. This table (see appendix A) is expected to present more accurate numbers than the table designed by the FAO, as it is specifically based on Vietnamese diets (Nguyen and Winters, 2011).

As a second measure I consider the FVS, which counts how many food items a household has consumed within the past two weeks, out of the 45 food items measured in the VLSS (Hatloy et al., 1998; Torheim et al., 2003). Even when households have sufficient calorie consumption levels, they might still lack diversity in the intake of their nutrients (Carletto et al., 2013). The FVS helps identifying such issues as the VLSS lacks data on micronutrient consumption. Even though this score does not provide us with a full picture of the household's nutrient intake, it does provide a fairly good indication (Hatloy et al., 1998). The VLSS only includes data over a two-week period for purchased goods, for which information was obtained for the households' expenses since the first visit, two weeks earlier (General Statistical Office (GSO) and State Planning Committee (SPC), 2014). The questions about consumption from produced food items were asked about the past year, but additional questions were asked which items out of the total produced crops were currently being stored in the household. As a measure of which food items were consumed from own production within the last two weeks I therefore selected those items consumed from home production that were currently being stored by the household.

4.2.2 Commercialization

In total, I consider three separate measures of commercialization. Two of the indicators focus on output markets, and one focuses on input markets. I consider the effect of each of these measures on food security separately.

5.2.1.1 Cash crop production share

One of the main focuses of this research is comparing different ways of operationalizing commercialization. As addressed in the introduction, most research so far has taken a binary variable for the production of cash crops as the definition of commercialization (Carletto et al., 2016). Cash crop production is frequently accompanied by the modernization and intensification of cultivation, through for example, inputs or investments (Niemeijer and Hoorweg, 1994). Still, commercialization of agriculture is about much more than whether a cash crop is present or not, and multiple indicators should be take into account, both at the input and the output side of production (Gebremedhin et al., 2010; Von Braun, 1995). Since it is unlikely that a significant amount of the population does not trade anything at all, I expect that only looking at cash crops would produce incorrect estimates. However, to be able to compare the estimates to a model that includes a different way of measuring commercialization, I still include a cash crop indicator.

I am not using a binary variable for cash crops however, as I would like to have a variable that is more directly comparable to the other commercialization indicators, such that they are all shares. For cash crops, therefore the cash crop production share (CCPS) is used, which is calculated as the proportion of the value of cash crops produced to the total value of crop production.

$$CCPS_i = \frac{\sum_{c=1}^{c} \bar{P}_c Q_{ic}}{\sum_{k=1}^{K} \bar{P}_k Q_{ik}}$$

Where Q_{ic} is the total quantity of cash crop *c* produced by household *i* evaluated at an average community level price (P_c). Q_{ik} is the total quantity of all crops *k* produced by household *i* (including the cash crops) at an average community level price (P_k).

The crops in Vietnam that are mainly produced for export, are cashew, coffee, pepper, rubber and tea. Rice is both produced for export and domestic consumption, but the share of rice that is sold on the markets, is much lower than the shares of the cash crops named above (Coello, 2009). Moreover, rice is not only the main crop produced in Vietnam, but there are also land restrictions that compel the production of rice in certain areas (Markussen et al., 2011). For these reasons, following Coello (2009), rice is not included in the list of cash crops.

4.2.1.2 Crop output market participation

The most commonly used measure of commercialization is that of output markets. The cash crop indicator that was mentioned above is also an example of this, as this indicator shows whether households are participating in cash crop production or not. In the case of cash crops, production equals participation in output markets, as they are not destined for own consumption at all. However, to create a more general measure of output market participation, I use the indicator used by von Braun et al. (1991). The crop output market participation (COMP) (Von Braun et al., 1991) is calculated as the proportion of the value of crops sold to the total value of crop production.

$$COMP_i = \frac{\sum_{k=1}^{K} \bar{P}_k S_{ik}}{\sum_{k=1}^{K} \bar{P}_k Q_{ik}}$$

Where S_{ik} is the quantity of output k sold by household *i* evaluated at an average community level price (P_k). Q_{ik} is the total quantity of output *k* produced by household *i*.

4.2.1.3 Input market use

For the input markets the proportion of the value of inputs bought at the market to the total value of inputs used by a household is used. The VLSS unfortunately does not include data on the total amount of seeds used, but only the amount of seeds bought. Therefore, it is not possible to generate the value of purchased seeds as a share of the value of total seeds used. For this reason, I consider only fertilizer, both chemical and organic, as a measure of input market use.

$$IMU_i = \frac{\sum_{r=1}^{R} X_{ir}}{\sum_{r=1}^{R} I_{ir}}$$

Where X_{ir} is the value of chemical and organic input *r* purchased by the household *i* and I_{ir} is the total amount of chemical and organic input *r* used in the production of the household.

4.2.3 Control variables

The vector of region and household specific characteristics from the model will consist out of household characteristics, economic and farm characteristics of the household, and an location indicator (see table 1). The variables that have been chosen are a combination of

control variables used in similar studies such as Kennedy and Cogill (1988), Bouis & Haddad (1990) and Von Braun et al. (1991).

I expect that with regards to age, as people get older for example, they gain more experience, so a household with an older household head might have higher farm productivity, which in turn could lead to a higher food security status. The education level of the household head could influence the food security status in the same way, but a higher educated household head might also be more able to do off-farm work which also influences the food security status, as seen in the theoretical framework. Larger families with more mouths to feed, and especially those of young children or elderly who usually do not generate much income or food themselves, might be more likely to have a lower food security status. Also assets will be likely to influence a household's productivity and thereby the food security status of the household. Environmental and climatological aspects are extremely variable throughout Vietnam, which is captured by the region dummy variable. I expect that the economic variables might be correlated to the error term, and may thus cause endogeneity problems. For this reason they are not included in the regression, but only their descriptive statistics are provided.

4.4 Household selection

Agricultural production is not limited to rural areas. The data shows that there are households generating income from crops, livestock or both, in both rural as well as urban communities. A more detailed description of the division of households over different production categories can be found in table 2. The table shows that in 1993 about a third of the urban population was involved in agricultural production, and a quarter in 1998. As agricultural production is not limited to rural areas, I do not base the household selection upon whether a household is living in an urban or rural community, but instead focus on whether they are generating agricultural products or not. Agricultural products can originate from both crops as well as livestock, but most households own a combination of the two. Since I am interested in the effect of commercialization of farm households, and since all of the commercialization indicators apply to the production or marketing process of crops, and not of livestock, the sole household selection criterion is that households must be crop producers.

Table 2: Amount of households by production category

	1993			1998		
Household type	**Rural**	**Urban**	**Total**	**Rural**	**Urban**	**Total**
Total	3,840	960	4,800	4,270	1,732	6,002
Only livestock production	83	113	196	66	95	161
No agricultural production	215	631	846	322	1,325	1,647
Only crop production	331	26	357	533	71	604
Both crop and livestock production	3,211	190	3,401	3,349	241	3,590
Households involved in crop production	3,542	216	3,758	3,882	312	4,194
Share of households involved in crop production	92.20%	22.50%	78.30%	90.90%	18.00%	69.90%
Included in both years			3,231			3,231
Only present in one year			527			963

As mentioned in paragraph 4.2, there were 4,800 households interviewed in 1993 and about 6,000 in 1998. After the selection of crop producing households, 3,758 households remain in 1993 (78.3 percent of the total amount of households) and 4,194 in 1998 (69.9 percent), which is a decline of 8.4 percent (see table 2). However, when only considering the households that were present in both years of the VLSS, there were 205 households that were producing crops in 1993, but not in 1998, which corresponds to a decline of about 6 percent. The declining trend is confirmed by the World Bank (2017), which also reported a strong decline in the employment in agriculture from 70 percent of the total employment in 1996 to 65.3 percent in 1998. Overall, 3,333 have been interviewed in both years, and producing crops in at least one year, out of which 3,231 households were producing crops in both years.

For each of the different household categories listed above, I calculated the means of the food security indicators and presented the amount of observations for the commercialization indicators (see: table 3). Overall, I am excluding two categories from the remainder of the analysis: households which are not generating any agricultural products at all, and households which are only generating products from livestock. Table 3 shows that especially the non-agricultural households stand out. They have much lower caloric intake levels than most other household categories but a higher FVS. Moreover, urban households tend to have lower caloric intake and higher FVSs compared to their rural counterparts. This is not very surprising, as most agricultural households are located in rural areas and vice versa.

Table 3: Amount of observations of commercialization and means of food security by household category

		Observations			Means	
Type of households	Year	Cash crop production share > 0	Crop output market participation > 0	Input market use > 0	Caloric intake	Food variety score
Only crop production	1993	53	268	298	2369	10.14
	1998	120	530	538	2477	11.96
Only livestock production	1993	-	-	6	2415	13.22
	1998	-	-	18	2383	14.16
Both crop and livestock production	1993	622	2956	3125	2549	9.37
	1998	651	3287	3372	2531	10.94
No agricultural production	1993	-	-	-	2253	15.53
	1998	-	-	15	2221	15.32
Rural	1993	617	3061	3288	2512	9.42
	1998	741	3570	3689	2496	11.03
Urban	1993	58	163	141	2342	15.67
	1998	30	247	254	2290	15.52
Total	1993	675	3224	3429	2478	10.68
	1998	771	3817	3943	2437	12.33

4.5 Descriptive statistics

This paragraph covers the descriptive statistics of the data. The first section will focus on temporal developments between 1993 and 1998, while the second section will concentrate on differences between regions.

4.5.1 Temporal developments

Based upon the household selection in paragraph 4.4, this section provides an overview of the temporal developments in the variables, starting with the outcome variables, then moving on to the commercialization indicators, and lastly the control variables.

4.5.1.1 Food security indicators

The yearly mean values for the households' caloric intake and their FVS, as well as an appropriate t-test, can be found in table 4. The average household consumed 2532 kcal/day/AME in 1993 against 2523 in 1998, which means that there was no significant change in caloric intake. The FVS, on the other hand did change and increased significantly. Households consumed on average 9 different food items within the two-week period between each part of the survey in 1993. In 1998 this had increased to 11 food items.

Table 4: Means for food security indicators

	1993			1998			
Variable	N	Mean	s.d.	N	Mean	s.d.	Test-statistic
Caloric intake (kcal/day/AME)	3,758	2,532	859.1	4,194	2,523	591.0	0.529
Food Variety Score	3,758	9.341	4.616	4,194	11.03	4.863	15.57***
Note:	*p<0.1; **p<0.05; ***p<0.01						

A households' total caloric intake can originate from both purchased food items as well as produced food items. Table 5 shows the means for both of these categories with a variable amount of observations as there is a larger difference between the amount of households in each category in 1998 than there is in 1993. The averages for the amount of calories from purchased and the amount of calories from produced food items, show that there actually is an increase in purchased calories, but a decrease in produced calories. This indicates that households are increasingly depending upon the market for their caloric intake.

Table 5: Means for calories from purchased and produced food items

	1993			1998			
Variable	N	Mean	s.d.	N	Mean	s.d.	Test-statistic
Calories from purchased food items	3732	912	977	4189	994.1	839.9	4.021***
Calories from produced food items	3720	1643	905.7	4121	1557	869.5	4.2878***
Total caloric intake (kcal/day/AME)	3,758	2,532	859.1	4,194	2,523	591.0	0.529
Note:	*p<0.1; **p<0.05; ***p<0.01						

An additional indicator which is relevant for the calculation of household caloric intake is the AME. To calculate the caloric intake which is used above, I first took the total household caloric intake, and then divided it by the amount of AMEs living in the household. The mean AME in 1993 was 3.954 and 3.936 in 1998, which is a very marginal decline. The average household size is declining much faster (see section 5.3.1.3) compared to the AME, which could imply that households are having fewer children, as children have a lower AME than adults. This hypothesis is confirmed if we look at the data reported by the World Bank (2017)

4.5.1.2 Commercialization indicators

As described in the beginning of this chapter, I use three different indicators for commercialization. The cash crop production share (CCPS) is a households' value of cash crop production as a share of their total production. Table 6 shows that the average value of a households' total crop production was 5,250 thousand dongs in 1993 (in 1998 prices), and sharply increased to 8,255 thousand dongs in 1998. A relatively large part of this increase seems to have come from an increase in the value of cash crop production, which went from about 280 thousand dongs in 1993 to 1620 thousand dongs in 1998. Not all households engaged in cash crop production though. In paragraph 4.5.2 I will show that cash crop production is concentrated in two specific regions. For this reason the average value of cash crop production over all households does not tell us very much about cash crop producers themselves. Table 6 also shows the (cash crop) production values and the CCPS for the cash crop producing households only. This shows that the cash crop producing households have slightly higher values of total production in 1993, but the gap strongly increased over the years.

Table 6: Cash crop production value, total production value and CCPS for all farmers and cash crop farmers (in 1998 prices)

	1993			1998			
	N	Mean	s.d.	N	Mean	s.d.	Test-statistic
Value cash crop production (x1,000 dong)							
Full sample	3,758	279	2,009.6	4,194	1,620	9,176.6	12.720***
Cash crop producers only	675	1,553	4,530.3	771	8,815	19,876.2	9.283***
Value total production (x1,000 dong)							
Full sample	3,758	5,251	6,257.1	4,194	8,255	12,268.8	13.517***
Cash crop producers only	675	5,875	6,604.3	771	13,570	20,733.4	9.241***
Cash crop production share							
Full sample	3,758	0.035	0.143	4,194	0.07	0.227	8.118***
Cash crop producers only	675	0.194	0.289	771	0.38	0.402	9.974***

Note: *p<0.1; **p<0.05; ***p<0.01

The amount of households producing cash crops was about 18 percent of all households in both years. Yet the CCPS more or less doubled between 1993 and 1998. This indicated that those households that were already producing cash crops seem to increasingly concentrate their production towards the production of cash crops, which might at least partially explain the strong increase in the value of their production.

Table 7 shows the same information as table 6, but this time for COMP. Therefore, instead of the value of cash crops and total production, it shows the value of sold production and total production. The first thing to note is that most of the households are selling at least some part of their production. In 1993 this was, on average, about 30 percent, and by 1998 this percentage increased to about 44 percent. As the majority of the households are selling towards the market, the figures for crop selling households do not differ as much from the figures for the full sample as the difference we encountered with the CCPS. Still, the table shows that the total value of production is about 500 thousand dongs higher for those households that do engage in the sale of their production, as opposed to the total sample of crop producing households. This shows that households that do not sell anything to the market have a lower total production value.

Table 7: Value of sold production, total production value and COMP for all farmers and crop selling households (in 1998 prices)

	1993			1998			
	N	Mean	s.d.	N	Mean	s.d.	Test-statistic
Value sold production (x1,000 dong)							
Full sample	3,758	2,094	4,476.1	4,194	5,152	11,084.7	15.797***
Crop selling households only	3,225	2,440	4,743.8	3,817	5,661	11,494.7	15.897***
Value total production (x1,000 dong)							
Full sample	3,758	5,251	6,257.1	4,194	8,255	12,268.8	13.517***
Crop selling households only	3,225	5,733	6,574.6	3,817	8,848	12,680.0	12.594***
Crop output market participation							
Full sample	3,758	0.296	0.263	4,194	0.439	0.307	22.179***
Crop selling households only	3,225	0.345	0.253	3,817	0.482	0.288	21.048***

Note: *p<0.1; **p<0.05; ***p<0.01

Both the table for the CCPS as well as the table for COMP indicate that there might have been large increases in agricultural productivity between 1993 and 1998. There are many factors at play for the significant increases in CCPS and COMP (as reported in tables 6 and 7), such as significant increases in landholdings (which will be shown in section 4.5.1.3), or perhaps increased farm gate prices (as the correction for inflation is based upon consumer prices). However, given the context of the Vietnamese reforms during this period, as described in Chapter 2, we see that farms were increasingly privatized which improves households' incentives to increase their level of productivity. Increased agricultural productivity, which was also reported by the World Bank (2017), is therefore the main explanation for these increases in production value.

Lastly, table 8 shows the variables that have been used to construct the IMU. The value of purchased inputs was divided by the total value of inputs used. Households can use chemical fertilizer, organic fertilizer or both. The value of organic fertilizer from home production was directly taken from the VLSS, as it included a question where households were asked how much their home produced fertilizer would be worth if it would have been bought on the market.

Table 8: Value of purchased and produced chemical and organic fertilizer and IMU (in 1998 prices)

	1993			1998			
	N	Mean	s.d.	N	Mean	s.d.	Test-statistic
Value of organic fertilizer purchased (x1,000 dong)	3,758	14.17	122.5	4,194	41.21	380.5	4.167***
Value of chemical fertilizer purchased (x1,000 dong)	3,758	713.2	1115.5	4,194	1100	2219.6	9.647***
Total value of purchased fertilizer (x1,000 dong)	3,758	727.4	1138	4,194	1141	2341.8	9.836***
Value of organic fertilizer used (x1,000 dong)	3,758	854.8	1102.4	4,194	816.9	1265.9	1.416
Total value of used fertilizer (x1,000 dong)	3,758	1568	1537.5	4,194	1917	2573.5	7.236***
Input market use	3,758	0.488	0.350	4,194	0.528	0.358	5.027***

Note: *p<0.1; **p<0.05; ***p<0.01

As table 9 shows, there were 3,420 households using chemical fertilizer in 1993, and 3,910 in 1998 in total. Organic inputs were used by 2,675 households in 1993, compared to 2,777 households in 1998. This indicates that there is a large amount of households using both organic as well as chemical fertilizer, but there are more households using chemical fertilizer than households using organic fertilizer. The percentages in table 9 show that there is a significant increase in the amount of households that use chemical fertilizer, while there is no significant change in the amount of households that use organic fertilizer. Whereas chemical inputs can only be bought, organic inputs can be both bought as well as obtained from home production. Only a very small selection, 180 in 1993 and 192 in 1998, of the households is buying organic fertilizer. Overall, there is a significant increase in input market use between 1993 and 1998.

Table 9: Number of households using chemical and organic fertilizer

	1993		1998	
	N	% of total	N	% of total
Chemical fertilizer	3,420	91%	3,910	93.23%
Organic fertilizer	2,675	71.18%	2,777	66.21%

Table 9 shows that the share of households using chemical fertilizer is increasing, while the share of households using organic fertilizer is declining. These changes are not surprising considering the change in IMU. As most organic fertilizer is not bought, it would be expected that the IMU increases, which it indeed does. Whereas households were on average buying about 49 percent of their used inputs in 1993, this number had risen to 53 percent in 1998.

As all of the above are different indicators of commercialization, it is interesting to investigate how they correlate with each other. Appendix B presents a scatterplot matrix of the three measures of commercialization, including their respective frequency distributions. Additionally, table 10 shows the Pearson's correlation coefficients for all three commercialization indicators. Two out of three correlation coefficients are above 0.3, indicating a weak correlation. All correlation coefficients are positive, indicating that, for instance, if a household is selling a higher share of their crops on the market, they are also more likely to obtain a larger share of their inputs from the market. Only between the CCPS and IMU the correlation coefficient is too low to indicate a correlation between both variables.

Table 10: Correlation coefficients for commercialization indicators

	Input market use	Crop output market participation	Cash crop production share
Input market use		0.358	0.201
Crop output market participation	0.358		0.37
Cash crop production share	0.201	0.374	

4.5.1.3 Control variables

Table 11 shows the descriptive statistics for the control variables. It reports the mean values for each continuous variable and its standard deviation. A Levene's test was used to test for equal variances for each variable. If equal variances could be assumed, a two sample t-test was used. If not, I used a Welch test. The appropriate test-statistic for each variable, together with its significance level, is reported in table 11.

The average age of the household head was 45 in 1993, while it was about 47 in 1998. The majority of the crop producing households that were interviewed, are included in both years. Therefore, it would be expected that the difference in age of the household head between the two years should be around 5 years. The difference between both years in the surveys is much smaller, which could imply that the newly added households have younger household heads than the average household head that is present in both surveys. Another reason could be that some households have changed their head of the household for a younger one. In appendix C, tables 11 and 12 have been recreated for the panel part of the dataset only. Here I find that the difference in ages between both years remained more or less the same, which means that the age of the newly added households in 1998 is not the cause of the small difference being less than 5 years.

Table 11: Means for control variables

	1993			1998			
Variable	N	Mean	s.d.	N	Mean	s.d.	Test-statistic
Age (head)	3,758	44.92	14.68	4,194	47.26	13.61	7.4***
Household size	3,758	5.04	2.11	4,194	4.875	1.90	3.61***
Dependency ratio (%)	3,758	0.43	0.23	4,194	0.40	0.24	4.35***
Food expenditures (x1,000 dong)[a]	3,757	2,686.39	3,159.72	4,191	3,513.44	3,069.01	11.81***
Harvest value (x1,000 dong)[a]	3,758	5,104.02	6,106.68	4,194	8,254.55	12,268.83	14.72***
Off-farm income (x1,000 dong)[a]	3,758	3,684.41	11,499.75	4,194	4,152.66	8,746.05	2.03
Total income (x1,000 dong)[a]	3,758	7,769.43	13,384.99	4,194	11,838.99	23,692.52	9.29***
Land holdings (m^2)	3,758	2,740.76	3,977.72	4,194	4,186.57	6,258.13	12.42***
Poultry (TLU)	3,758	0.137	0.216	4,194	0.156	0.429	2.45**
Small cattle (TLU)	3,758	0.416	0.873	4,194	0.588	2.018	4.85***
Large cattle (TLU)	3,758	0.420	0.560	4,194	0.481	1.113	3.03***
Farm assets (x1,000 dong)[a]	3,758	780.41	3,419.09	4,194	1,451.58	5,252.63	6.82***

*p<0.1; **p<0.05; ***p<0.01

Note:
[a] *in 1998 prices*

In general, most of the differences between years shown in table 11 match my expectations. The average household size is around 5, but decreased significantly, and so did the dependency ratio. After correcting for inflation[1], it is found that food expenditure, harvest value, on-farm income and total income significantly increased. Land holdings, livestock and farm assets also increased. Farm assets consist of the current value of a households' farming equipment, machinery and tools such as tractors, sprinklers and insecticide pumps. The livestock categories are measured in total livestock units (TLU), which converts all livestock into units that are comparable (see appendix A for conversion table). In 1993 the average household had about 14 chicken and ducks, whereas they had about 16 in 1998. The average household in both years owned less than one cow, buffalo or horse, yet there was a significant increase in all three types of livestock.

The average crop producing household had 2,741 square meters of land in 1993, an average income, in 1998 prices, of about 7,770 thousand dongs (which would be about 891.84 USD in current[2] prices) of which they spent about 2,690 thousand dongs on food, which is about 34.6 percent of their income. In 1998, the average household had 4,187 square meters of land, with an average income of 11,840 thousand dongs, of which about 3,510 thousand dongs was spent on food (29.5 percent). In the early 1990s there were large scale land privatizations,

1 Based upon on the average yearly consumer price inflation (https://www.imf.org/external/pubs/ft/scr/1999/cr9956.pdf) the cumulative inflation between 1993 and 1998 was 66.559 percent.
2 On 19 June 2017

which means that private usage rights were given to formerly communal plots (see chapter 2). This explains the significant increase in landholdings between 1993 and 1998.

Whereas there is a significant difference between 1993 and 1998 in mean on-farm and mean total income, there is no significant increase in mean off-farm income. A possible explanation is that I only selected households that are producing crops. Because they are producing crops, they might have less labor available for off-farm work. Another explanation could be that the average household size has declined, which also decreases the available labor per household. Appendix C shows that if we only look at households that are present (and thus producing crops) in both years, there is a significant increase, but only at a 5 percent significance level.

Table 12: Frequency distributions for gender, age and region

		1993		**1998**		
		N	Freq (%)	N	Freq (%)	Chi squared
Gender (head)	Female	881	23.40%	926	22.10%	2.0235
	Male	2877	76.60%	3268	77.90%	
Education (head)	No education	480	12.77%	422	10.06%	15.329***
	≤ lower secondary	2637	70.17%	3067	73.13%	
	> lower secondary	641	17.06%	705	16.81%	
Region	1. Northern Mountains and Midlands	671	17.86%	747	17.81%	161.11***
	2. Red River Delta	1006	26.77%	814	19.41%	
	3. North Central Coast	593	15.78%	608	14.50%	
	4. South Central Coast	403	10.72%	530	12.37%	
	5. Central Highlands	124	3.30%	359	8.56%	
	6. Southeast	259	6.89%	392	9.35%	
	7. Mekong River Delta	702	18.68%	744	17.74%	

Note: *p<0.1; **p<0.05; ***p<0.01

Table 12 shows the frequency distributions for the gender, education and region dummy variables with their respective chi squared values. The chi squared value in table 12 shows that there is no significant change in the gender of the household head. In both years, more than three quarters of the households had a male head. When looking at the changes in the age of the household head, I concluded that a part of the households must have changed heads, but apparently they were generally replaced by someone of the same gender.

For the education variable I split the sample into three different categories: households whose heads have had no education at all, households with heads that went to primary school and/or lower secondary school, and households whose heads went to higher secondary school or higher. The education dummy frequencies show that in five years, the average education level of the household head did significantly change. Whereas in 1993 about 13 percent of the household heads did not have any form of education, this number dropped to 10 percent in 1998. On the other hand, the amount of households that went to higher secondary school or higher forms of education, remained more or less the same, but declined marginally. This could mean that the newly assigned household heads were higher educated, that that household heads improved their education level, or that the difference is caused by the selection of households for each year of the survey.

Lastly, the table shows that the regional distribution is significantly different between 1998 and 1993. The significance disappears if we only look at the households that were included in both years (see appendix C), which indicates that households did not actually move to a different region, but rather that the difference in table 12 is caused by a different sampling strategy that was used in 1998. The next section will take a more detailed look at the actual differences between regions.

4.5.2 Regional differences

As described in the theoretical framework, not only differences between households, but also regional differences matter. For the regional analysis I considered the administrative division that was used in the 1993 survey, which consists of seven regions. I already mentioned that if we would only consider those households that are present in both surveys, there is no significant difference between the distribution of households in both years. This would imply that a majority of the households did not change regions. Still, there are several differences between the relative amount of households interviewed in each survey, and also compared to the actual demographics. Table 13 shows the actual distribution of the Vietnamese population over the seven regions, as well as the percentage of households that were interviewed by region. The table shows that the two delta areas are the most populous areas, whereas the central highlands is the least populous region. For some regions, the share of respondents in the survey for each year is quite different, for example in the Central Highlands. Moreover, the share of respondents in the survey does not always match with the actual population distributions. Whereas the actual population statistics showed that 13 percent of the population was living in the Northern Midlands and Mountains, about 18 percent of the interviewed households in the VLSS came from this region, for example.

Table 13: Regional population and respondent distributions and land restrictions

	Actual % of population (1998)	% of respondents (1993)	% of respondents (1998)	% of land restricted land for rice production (Markussen et al., 2011)
Northern midlands and mountains	13.2	17.9	17.8	17.9
Red River Delta	23.4	26.8	19.4	74.9
North central coast	14.0	15.8	14.5	40.0
South central coast	9.7	9.8	12.6	23.4
Central highlands	5.2	3.3	8.6	4.9
Southeast	13.2	6.9	9.3	9.6
Mekong delta	21.2	19.6	17.7	68.3

Figure 3: Regions of Vietnam according to the VLSS 1993 division

The last column of table 13 shows the percentage of land in each region that was predestined by the government for the production of rice in 2006. As Vietnam has been liberalizing its policies, I expect that these numbers would have been similar or higher in the 1990s. My expectation is that restrictive land use policies such as these might influence households' food security and/or commercialization indicators. As the two delta regions, the Mekong delta and the Red River Delta, are both populous regions, and both have very high levels of land restrictions for rice production, I expected that they would be comparable in terms of food security and commercialization. Table 14 shows the actual means of all variables for each region and for both years, as well as the absolute test statistic and significance level for the t-tests between both years.

Table 14: Means for and change in all variables by region

		Northern midlands & mountains	Red River delta	North central coast	South central coast	Central highlands	Southeast	Mekong delta	Test statistic: North vs South
Household size	1993	5.121	4.336	4.811	5.324	5.984	5.349	5.693	
	1998	5.023	4.066	4.724	4.885	5.802	5.094	5.164	
	Test statistic	1.016	3.560***	0.806	2.846***	-0.782	1.586	4.820***	15.695***
Dependency ratio (%)	1993	0.428	0.414	0.447	0.426	0.478	0.401	0.417	
	1998	0.408	0.394	0.439	0.404	0.454	0.363	0.365	
	Test statistic	1.643	1.627	0.616	1.280	1.134	2.150**	4.451***	3.169***
Age (head)	1993	41.01	43.52	45.33	48.53	45.35	47.06	47.42	
	1998	44.01	46.93	47.89	50.6	44.15	49.04	48.57	
	Test statistic	4.320***	5.185***	3.026***	2.093**	0.869	1.831*	1.571	5.517***
Education (head) (range: 0-2)	1993	1.091	1.129	1.184	0.872	0.726	0.939	0.943	
	1998	1.079	1.130	1.235	0.983	0.967	1.008	0.991	
	Test statistic	-0.439	0.043	1.681*	2.947***	3.885***	1.660*	1.899*	11.563***
Gender (head) (1=male)	1993	0.769	0.758	0.776	0.747	0.766	0.778	0.769	
	1998	0.782	0.762	0.783	0.742	0.827	0.796	0.788	
	Test statistic	0.576	0.160	0.300	0.171	1.502	0.556	0.861	2.134**
Food expenditure (x1,000 dong)	1993	2151	1548	2406	2903	4068	4775	3878	
	1998	2583	2396	2812	3472	4632	6549	4131	
	Test statistic	4.113***	11.557***	3.171***	3.214***	1.514	4.262***	1.291	29.998***
Harvest value	1993	3965	4044	3151	3286	7211	4678	9229	
	1998	5275	4549	3889	5884	8567	6570	9367	
	Test statistic	5.721***	4.246***	4.553***	8.261***	4.520**	4.890***	7.372***	21.200***
Land holdings (m^2)	1993	2243	2103	2266	2135	1262	2309	5152	
	1998	3850	2191	2589	3208	4268	5932	7751	
	Test statistic	8.525***	1.582	1.403	5.969***	4.821***	6.306***	5.914***	23.079***
Total livestock units (small)	1993	0.391	0.420	0.441	0.522	0.419	0.375	0.397	
	1998	0.706	0.706	0.809	0.605	0.373	0.460	0.317	
	Test statistic	9.874***	8.432***	1.823*	1.689*	0.663	1.152	2.153**	5.339***
Total livestock units (large)	1993	0.807	0.172	0.632	0.778	0.274	0.307	0.098	
	1998	0.899	0.222	0.608	0.744	0.499	0.441	0.067	
	Test statistic	1.541	1.349	0.347	0.372	0.370**	1.600	1.633	14.163***
Total livestock units (poultry)	1993	0.192	0.119	0.124	0.112	0.041	0.107	0.162	
	1998	0.213	0.139	0.154	0.104	0.107	0.264	0.124	

		Northern midlands & mountains	Red River delta	North central coast	South central coast	Central highlands	Southeast	Mekong delta	Test statistic: North vs South
	Test statistic	1.948*	2.157**	2.835***	0.549	4.958***	2.056**	2.747***	0.096
	1993	334.9	275.9	274.2	335	2061	1870	1904	
	1998	598.2	425.8	571	456.4	4320	2932	2695	
Farm assets	Test statistic	3.704***	3.659***	5.633***	1.194	2.431**	1.556	2.440**	21.200***
Cash crop production share	1993	0.025	0.003	0.014	0.016	0.341	0.204	0.002	
	1998	0.009	0.003	0.022	0.012	0.475	0.236	0.002	
	Test statistic	4.431***	0.153	1.902*	0.924	2.998***	1.145	0.079	28.943***
Crop output market participation	1993	0.209	0.212	0.210	0.218	0.591	0.491	0.480	
	1998	0.319	0.294	0.299	0.379	0.642	0.661	0.659	
	Test statistic	8.966***	8.709***	7.865***	10.161***	1.464	6.536***	12.300***	52.732***
Input market use	1993	0.2453	0.3567	0.28	0.4024	0.7557	0.791	0.9729	
	1998	0.3291	0.3859	0.3112	0.5161	0.7606	0.8346	0.9853	
	Test statistic	6.995***	2.865***	2.519**	3.502***	0.132	1.987**	2.299**	93.884***
	1993	2631	2549	2379	2465	2801	2607	2501	
	1998	2583	2620	2466	2432	2432	2598	2472	
Caloric intake	Test statistic	1.294	2.529**	1.713*	0.715	5.454***	0.129	0.755	0.375
	1993	8.43	8.307	9.302	9.651	11.37	11.26	10.79	
	1998	10.12	10.03	10.89	12.36	11.07	14.31	10.76	
Food variety	Test statistic	7.349***	8.073***	6.490***	7.458***	0.541	8.137***	0.110	14.735***

Upon looking at the results it becomes clear that the characteristics of crop-farming households in two delta regions are not as similar as we might have expected by just looking at the land restrictions for rice production. Contrarily, there appears to be a division between the Central Highlands, the Southeast and the Mekong delta (which I will now refer to as 'the south') and between the Northern Midlands and Mountains, the Red River Delta, the North Central Coast and the South Central coast (which will be called 'the north'). The column on the right of Table 14 shows the absolute test-statistic and significance levels for the t-tests between the northern and southern regions for each variable.

The table shows that the southern regions, on average, have significantly larger households with lower levels of education of the household head. With regards to economic and farm asset variables, the table shows higher food expenditures, harvest values, landholdings and farm assets for the south. The south also has significantly lower total livestock units for cattle. Very high values of the test statistic are shown for the commercialization indicators. The table shows that cash crops are almost exclusively produced in the Central Highlands and the Southeast. These regions might thus be most suitable for cash crop production. Furthermore, COMP and IMU is significantly higher in the south compared to the north.

The region that differs the most from all other regions is the Central Highland region. Table 13 showed that this is the least populous region and that it has the lowest share of land restrictions for rice production. The size of households is even higher than that of the other southern regions, and also the dependency ratio of households in the Central Highlands is slightly higher compared to all other regions. Land holdings are the lowest and farm assets the highest. The Central Highlands is the region with the highest share of cash crops and also the highest COMP, which is not surprising, as cash crops are produced for sale.

We can see that the CCPS has only significantly increased in the Central Highlands, whereas COMP is increasing significantly everywhere (from 35 percent in the southeast up to 75 percent in the south central coast), except for the Central Highlands. This region already had a very high initial COMP in 1993, which might be the key explanatory reason for the absence of a significant increase in this region. IMU is showing similar trends compared to COMP. The increases in the south are lower compared to the increases in IMU in the north, which, once more, can be explained through their much higher initial values of IMU.

There are no significant differences between the north and the south for caloric intake. The only thing that stands out is the extremely high initial value for the central highland region, but this region is the only one with a sharp decline between 1993 and 1998. In 1998, the values of caloric intake are similar to the values found in the other districts. The FVS was initially much higher in the southern three regions, but with the exception of the southeast, these were also the only regions to not experience any growth in their FVS, so that in general, the disparity in FVS between the north and the south is decreasing.

4.6 Approach

To assess the effect of agricultural commercialization on household food security, several different estimation procedures are used. These procedures will estimate the relationship between the different indicators of commercialization and food security. Based upon the theoretical framework in figure 2, we assume the relationship between commercialization and food security to be causal. This implies that when a positive relationship between commercialization and food security is found, the assumption will be that there is a positive effect of commercialization on food security.

When regressing the effect of commercialization on food security at the household level, there might be a selection bias. Because as we have seen before, there are some household- and region specific factors like access to credit or markets that influence a household's transaction costs (Barrett, 2008). According to the theoretical framework, these region specific transaction costs and market constraints influence whether a household can commercialize or not. This implies that commercialization is not something that a household can freely choose to do, but something that is pre-determined by their situation. However, households might still have differing preferences. Moreover, it is very hard to capture all market constraints in the model, which indicates that these might still be influenced by unobserved characteristics of the household such as the marketing skills of household members or the size of the households' social network. For this reason it is likely that the model suffers from endogeneity.

As the indicators for food security are ratio indicators, it is possible to use a standard linear model. Therefore, I start by doing a pooled OLS model. A time period dummy will be included to correct for temporal heterogeneity, as the data only consists of two time periods (Kidoido and Korir, 2015). As a part of the data contains information on households for both years, the panel part of the data can be used for either a fixed effects (FE) or random effects (RE) estimation of the equations. The Hausman test for endogeneity is used to determine which one is more appropriate. Doing a panel analysis allows us to deal with individual effects of the unobserved factors in the model. The drawback of using a FE model, however, is that it is not possible to include time-constant variables such as gender or variables which increase proportionally with time such as age. Moreover, the amount of observations will be lower compared to the pooled OLS model.

To test and correct for endogeneity, I tried several instrumental variable (IV) methods. The use of IV methods crucially depends on the presence of accurate instruments. Finding a valid instrument to serve as a source of exogenous variation proved difficult. I expect that households are more likely to commercialize when their neighbors are doing the same. This could be caused through learning effects, or, for example, the presence of infrastructure and well-functioning markets in a certain region. Therefore, following the instrumental variable used by Nguyen and Van Den Berg (2014), I took the average value of each commercialization indicator in a community, while excluding the value of the specific household itself. This reflects the commercialization rate of the community in which the household is living. This commune-level variable will have a strong correlation with the commercialization rate of the households in the area, but since it is measured at a higher spatial level, it will most-likely not interfere with the household-level error term of food security.

In addition to the instrument based upon the method applied by Nguyen and Van Den Berg (2014), I also use another, relatively new, identification strategy developed by Lewbel (2012) and applied by Hoang et al. (2014). This method uses heteroskedasticity in the first stage regression of commercialization as an identification strategy (Hoang et al., 2014). The residuals that are retrieved in the first stage are plotted against exogenous variables to find those variables that generate the needed heteroskedastic residuals. These are then used to construct variables that can be used as standard instrumental variables in the second stage (Hoang et al., 2014).

Lastly, I will present the results of a fixed effects regression with instrumental variables. This fixed effects instrumental variable (FE-IV) will control for time variant and time invariant unobserved heterogeneity at the household level that might affect both the households' commercialization rate and their food security status (Chia, 2013). The model corrects for the unobserved elements which do influence the households' commercialization rate, while assuming that these elements are constant over time. Just as with the normal FE model, the drawback of this model is that, once again, the amount of observations will be lower, as it is only possible to include those households that appear in both years.

5. Results

In this chapter, the results of both food and nutrition security indicators, FVS and caloric intake per day per AME are presented for the three different commercialization indicators. I start by providing a more detailed description of the approach. Then, I show the results for each of the three commercialization indicators one by one, with separate sections for the FVS and caloric intake. At the end of the chapter I provide a short recapitulation with the effects of the commercialization indicators on each food security indicator from the preferred models.

Following the methodological approach in chapter 4.3, I first ran a pooled OLS on the complete crop producing sample. The panel data analysis takes the changes over the years for each household into account, instead of assuming that all observations are unique. For this analysis I then selected those households that are producing crops in both years and ran a pooled OLS, a FE and a RE model. For each combination I performed an F-test between the pooled OLS model and the FE model for individual effects and a Hausman test was used to decide between fixed effects and random effects.

In paragraph 4.5.2 the importance of regional differences was stressed. The lack of cash crop production in other regions besides the Central Highlands and the Southeast shows that the CCPS is not an accurate measure of commercialization for the entire nation. Conducting analysis at the national level on the CCPS might yield inaccurate results. The CCPS might be suitable for a regression on only the Central Highlands and the Southeast though. Therefore, I only took a sample of crop-growing farmers these two regions to analyze the impact of CCPS, see paragraph 5.1. Due to the importance of the regional differences, I also report the results of the pooled OLS with an interaction term with dummy variables for the south and the north. The interaction term will show the possible differences in the effect of commercialization on food security between the north and the south. As I am only presenting the CCPS for two regions, this version of the pooled OLS will only be presented for COMP and IMU.

As described in chapter 4, I also present the results for the IV and FE-IV in this chapter. In both cases, I took the community level commercialization rate as an instrumental variable, as well as one or more instruments generated according to the Lewbel method. The results of the first stage regressions can be found in appendix D. For all combinations of commercialization and food security indicators I first conducted a Breusch Pagan test to check for heteroskedasticity. In all cases I found that the null hypothesis of homoscedasticity was rejected and therefore heteroskedasticity could be assumed. For the OLS IV, a J-test for overidentification was used, of which the null hypothesis should not be rejected. The J-test is accompanied by a partial F-test to detect weak IVs, which should have a value of at least 10. I expect that the analyses using the CCPS would be most susceptible to endogeneity issues, since this focuses solely on the Central Highlands and the Southeast, where land restrictions for rice production are the lowest, and commercialization is much more of a free choice than something that is determined by the regional and household specific characteristics.

5.1 Cash crop production share

Table 15 shows the regression results for the CCPS on the food security indicators in the Central Highlands and the Southeast.

5.1.1 CCPS: Food Variety Score

The pooled OLS on the full crop producing sample shows that there significant positive relationship between a households' CCPS and its FVS: households with a higher share of cash crop production more often have a higher FVS. Out of the control variables, household size, education, landholdings and small cattle all have a significant positive relationship with the FVS as well. There also is a significant positive relationship with the year dummy for 1998. Larger households more often have a higher FVS, and the same goes for households with a higher level of education of the household head, higher landholdings and more small cattle. Households, on average, had a higher FVS in 1998 compared to 1993 after correcting for the other variables.

For the panel part of the data, I show the results of a fixed effects model in the 2nd column. For this part, I first consider the Hausman test and the F-test. The null hypothesis for the Hausman test is not rejected, which would mean that we prefer the random effects model. However, the F-test is not rejected at a 5 percent significance level, which indicates that individual effects are rejected and the OLS model is preferred. Moreover, the adjusted R squared for the fixed effects model is negative. This means that the inclusion of individual effects decreases the share of variance explained, which is another reason to suspect that a fixed effects model might not be the best model for the data.

As described before, I expect that the model probably suffers from endogeneity problems, especially for the CCPS. Upon examining the results for the IV OLS, it is found that the results for the IV OLS are similar to those of the pooled OLS. There is a significant positive relationship between the CCPS and the FVS. The conclusions with regards to the control variables are also the same. The partial F-test for weak IV detection shows that the instruments are significantly strong, and the J-test for overidentification shows that the over-identifying restrictions are valid.

The OLS IV is preferred over the FE IV in this case for multiple reasons. First of all, the F-statistic for the FE IV model is negative and not significant. Moreover, in the models without instrumental variables, the F-test for individual effects rejected individual effects. Moreover, both FE models have the drawback that the amount of observations is lower for these models, as not all households participated in both years of the survey. Therefore, some observations needed to be dropped. As the OLS IV is preferred, I conclude that there is a significant positive relationship between the CCPS on the FVS.

5.1.2 CCPS: Caloric intake

The results for caloric intake differ compared to the FVS. The pooled OLS (column 5) shows that there is no significant relationship between the CCPS and caloric intake. There are significant positive relationships between caloric intake and the education level of the household head, landholdings and the value of farm equipment. Larger households tend to have lower average caloric intake per adult male equivalent. Average caloric intake per adult male equivalent was lower in 1998 than in 1998. The F-test shows that there are individual effects, and according to the Hausman test, a random effects (RE) model is preferred over fixed effects (FE). The conclusion at the FE model with regards to the CCPS is the same compared to the pooled OLS. However, the adjusted R square is negative once again. I decided to present the results for the FE model rather than the RE model, because RE

requires the error to be uncorrelated with the independent variables, which we cannot safely assume. Moreover, the Hausman test was rejected at a 10 percent significance level, indicating that the preference of RE over FE is not very strong.

Interestingly, the IV OLS shows a significant positive relationship between the CCPS and the FVS. The partial F-test and J-test show that the instruments used are sufficiently strong and that the overidentifying restrictions are met. Under the assumption that the models for the CCPS might suffer from endogeneity, and as the F-test for individual effects showed that individual effects were present, I prefer the IV FE model in this case. The IV FE model shows the highest F-statistic, and additionally, in contrast to the IV OLS model, the result for the CCPS matches the result for the CPPS in all other models. I therefore conclude that there is no significant relationship between the CCPS and caloric intake.

Table 15: Regression results for the Cash Crop Production Share on food security

	Food Variety				Caloric intake			
	Pooled OLS (1)	Fixed effects (2)	IV OLS (3)	IV Fixed effects (4)	Pooled OLS (5)	Fixed effects (6)	IV OLS (7)	IV Fixed effects
Cash crop production share	2.388 ***	-2.117 *	3.001 ***	6.258 ***	102.546	-89.622	205.549 ***	-393.615
	(0.40)	(1.23)	(0.48)	(2.14)	(64.44)	(173.92)	(72.67)	(279.95)
Age	0.006		0.004		-1.675		-1.700	
	(0.01)		(0.01)		(1.87)		(1.84)	
Sex	-0.448		-0.465		-65.739		-66.750	
	(0.37)		(0.36)		(60.80)		(55.07)	
Household size	0.188 ***	-0.008	0.186 **	-0.051	-96.772 ***	-133.403 ***	-96.622 ***	-128.645 ***
	(0.07)	(0.21)	(0.07)	(0.22)	(11.70)	(28.66)	(11.10)	(159.27)
Dependency ratio	0.508	-1.152	0.527	-1.219	-54.889	-616.083 ***	-62.311	-595.232 ***
	(0.67)	(1.48)	(0.65)	(1.62)	(108.82)	(207.56)	(118.78)	(212.03)
Education: ≤ lower secondary	2.142 ***		2.102 ***		119.139 *		111.406 *	
	(0.41)		(0.42)		(66.03)		(57.20)	
Education: > lower secondary	2.939 ***		2.782 ***		226.141 **		218.263 *	
	(0.56)		(0.55)		(90.13)		(114.48)	
Landholdings (M2)	0.000 **	-0.000	0.000 **	0.000 ***	0.018 ***	0.023 ***	0.020 ***	0.011
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
TLU: poultry	0.099	0.501	0.101	0.903	6.788	298.375 *	6.060	257.214
	(0.19)	(1.11)	(0.19)	(1.22)	(31.17)	(156.52)	(26.93)	(159.27)
TLU: large cattle	-0.150	0.199	-0.139	0.562	37.354	74.254	38.203 **	69.547
	(0.15)	(0.48)	(0.11)	(0.51)	(24.02)	(65.43)	(19.10)	(67.242)
TLU: small cattle	0.713 ***	0.853 **	0.725 ***	1.187 ***	38.008	-147.360 **	42.000 *	-167.013 ***
	(0.17)	(0.35)	(0.17)	(0.38)	(28.08)	(48.46)	(22.12)	(49.56)

Value farm equipment	0.000		0.000		0.000		0.000	0.007	**	-0.005	0.005	**	-0.008
	(0.00)		(0.00)		(0.00)		(0.00)	(0.00)		(0.01)	(0.00)		(0.00)
Southeast	2.644	***			2.760	***		-22.618			-2.973		
	(0.31)				(0.34)			(50.52)			(47.75)		
Year	1.381	***	2.717	***	1.342	***		-264.026	***	-210.113	***	-279.113	**
	(0.31)		(0.41)		(0.34)			(50.98)		(57.58)		(57.66)	
Constant	5.463	***			5.322	***		3,172.274	***		3144.328	***	
	(0.92)				(0.93)			(147.83)			(155.64)		
Observations	1,122		629		1,121		640	1,136		640	1,135		640
R^2	0.167		0.183				0.000	0.102		0.185			0.156
Adjusted R^2	0.157		-0.710				-0.022	0.091		-0.674			0.137
F Statistic	15.908*** (df = 14; 1107)		7.467*** (df = 9; 300)				-7.166 (df = 7; 312)	9.141*** (df = 14; 1121)		7.855*** (df = 9; 311)			76.870*** (df = 7; 312)
F-test for individual effects	F = 1.213, df1 = 769, df2 = 158, p-value = 0.067							F = 1.875, df1 = 783, df2 =159, p-value = 0.000					
Hausman test	chisq = 7.7885 df = 9, p-value = 0.556							chisq = 15.334, df =9, p-value = 0.082					
Partial F-test for weak IV detection					326.418						332.929		
J-test					J-test = 0.092, p-value = 0.762						J-test = 0.008, p-value = 0.929		

Note: *p<0.1; **p<0.05; ***p<0.01

5.2 Crop output market participation

In contrast to the analysis for the CCPS, the analysis for COMP will show an additional pooled OLS model with a dummy for the north-south division. The results for COMP can be found in table 16.

5.2.1 COMP: Food Variety Score

Whereas the regular pooled OLS in column 2 of table 16 shows a significant positive relationship between COMP and the FVS, the regional dummies in column 1 show that this significant relationship is in fact not the same in the entire country. In North Vietnam, an increase in COMP is not associated with any change in a households' FVS, while in South Vietnam it is associated with an increase of the FVS. For both pooled OLS models, most of the control variables show significant relationships with the FVS. Besides the regional differences, households with male household heads, with higher dependency ratios and with larger landholdings have lower food variety scores, whereas larger households, households with a higher educated household head, households with more large cattle and households with higher values of farm equipment have higher food variety scores.

Column 3 of table 16 shows the results of the fixed effect model. Similar to the pooled OLS, the relationship between COMP and the FVS is significant and positive for the fixed effects model. The F-test for individual effects shows that there are individual effects, and the Hausman test shows that a random effects model is inconsistent and that a fixed effects model is preferred. Once again, the fixed effects model suffers from a negative value for the adjusted R square, and the FE IV model has a negative value for the F-test, which makes the results unreliable. As endogeneity is assumed, I therefore prefer the OLS IV model. However, overall, all four models lead to the same conclusion with regard to the relationship between COMP and the FVS: an increase in COMP is associated with a significant increase in the FVS, but as indicated by column 1, this is only the case for the southern provinces. In Northern Vietnam there is no significant relationship between COMP and the FVS.

5.2.2 COMP: Caloric intake

The results for caloric intake are less unambiguous compared to those for the FVS. The pooled OLS shows that there is no significant relationship between COMP and caloric intake. Column 6 indicates that this is the case for both the north as well as the south. Once again, the tests show that there are individual effects and a fixed effects model is preferred. The fixed effects model in column 8 and the FE IV model in column 10 show a significant negative relationship between COMP and caloric intake. The IV OLS model, however, shows a significant positive relationship. As the F-test for individual effects showed that there were individual effects, as endogeneity is assumed, and as the F-test for the FE IV model is significant, the results for the FE IV model might be preferable, meaning that an increase in COMP as associated with a decrease in caloric intake. According to the control variables, larger households and households with a higher dependency ratio, on average have a lower caloric intake per AME. Households with more poultry and large cattle, on the other hand, on average have higher caloric intake per AME.

Table 16: Regression results for Crop Output Market Participation on food security

	Food Variety					Caloric intake				
	Pooled OLS – Regions (1)	Pooled OLS (2)	Fixed effects (3)	OLS IV (4)	Fixed effects IV (5)	Pooled OLS - Regions (6)	Pooled OLS (7)	Fixed effects (8)	OLS IV (9)	Fixed effects IV (10)
Crop output market participation		0.428 **	0.711 *	1.484 ***	7.321 ***		15.241	-249.610 ***	283.995 ***	-248.056 **
		(0.21)	(0.38)	(0.42)	(0.74)		(32.14)	(61.25)1	(67.82)	(113.243)
Crop output market participation - North	-0.350									
	(0.29)					30.940				
						(44.66)				
Crop output market participation - South	1.243 ***									
	(0.29)					1.325				
						(44.86)				
Age	0.003	0.002		0.002		-2.123 ***	-2.107 ***		-2.282 ***	
	(0.00)	(0.00)		(0.00)		(0.60)	(0.60)		(0.63)	
Sex	-0.587 ***	-0.557 ***		-0.569 ***		-60.820 ***	-61.081 ***		-62.849 **	
	(0.13)	(0.13)		(0.13)		(20.16)	(20.12)		(24.87)	
Household size	0.251 ***	0.250 ***	0.284 ***	0.264 ***	0.295 ***	-97.866 ***	-97.922 ***	-105.084 ***	-94.884 ***	-105.178 ***
	(0.03)	(0.03)	(0.06)	(0.03)	(0.06)	(4.39)	(4.38)	(9.77)	(5.46)	(9.89)
Dependency ratio	-0.504 **	-0.528 **	-0.528	-0.518 **	-0.566	-127.126 ***	-129.606 ***	-154.466 **	-126.725 ***	-160.407 **
	(0.22)	(0.22)	(0.39)	(0.21)	(0.41)	(33.82)	(33.75)	(63.08)	(38.73)	(63.08)
Education: ≤ lower secondary	1.677 ***	1.675 ***		1.598 ***		65.827 **	65.809 **		48.319 *	
	(0.18)	(0.18)		(0.18)		(27.13)	(27.09)		(27.64)	
Education: > lower secondary	2.821 ***	2.811 ***		2.714 ***		80.407 **	80.169 **		57.349	
	(0.21)	(0.21)		(0.22)		(32.95)	(32.89)		(35.47)	
Landholdings (M2)	-0.000 **	-0.000 **	0.000	-0.000 **	0.000	0.011 ***	0.011 ***	-0.002	0.011 ***	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

TLU: poultry	-0.002		-0.021		0.614	*	-0.011		0.952	**	86.266	***	86.292	***	144.499	**	89.566	*	145.791	***
	(0.15)		(0.15)		(0.35)		(0.18)		(0.37)		(23.02)		(23.00)		(56.56)		(52.54)		(56.54)	
TLU: large cattle	-0.321	***	-0.329	***	-0.122		-0.324	***	-0.089		39.582	***	39.625	***	31.535	*	40.046	***	31.601	*
	(0.05)		(0.05)		(0.10)		(0.07)		(0.11)		(8.40)		(8.39)		(16.38)		(8.09)		(16.38)	
TLU: small cattle	0.047		0.047		0.053		0.054		0.111	**	11.255	**	11.337	**	1.237		12.867		1.494	
	(0.03)		(0.03)		(0.04)		(0.05)		(0.06)		(5.20)		(5.20)		(6.97)		(9.20)		6.934	
Value farm equipment	0.000	***	0.000	***	0.000		0.000	***	0.000	**	0.007	***	0.007	***	-0.004		0.006	***	-0.004	
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Red River Delta	-0.237		-0.166				-0.196				-67.916	***	-67.727	***			-62.472	**		
	(0.16)		(0.16)				(0.16)				(25.60)		(25.53)				(24.89)			
North Central Coast	0.626	***	0.635	***			0.662	***			-184.350	***	-184.532	***			-180.831	***		
	(0.18)		(0.18)				(0.17)				(27.78)		(27.75)				(30.33)			
South Central Coast	2.131	***	2.095	***			2.042	***			-122.50	***	-121.927	***			-133.162	***		
	(0.20)		(0.20)				(0.19)				(30.26)		(30.21)				(28.96)			
Central Highlands	0.396		1.121	***			0.736	**			39.158		26.639				-62.722			
	(0.31)		(0.26)				(0.29)				(48.11)		(39.58)				(40.87)			
Southeast	2.705	***	3.388	***			3.038	***			22.006		9.576				-66.830			
	(0.28)		(0.23)				(0.25)				(43.96)		(35.11)				(44.76)			
Mekong Delta	0.463	*	1.120	***			0.786	***			-78.565	**	-90.624	***			-168.095	***		
	(0.25)		(0.19)				(0.22)				(38.92)		(29.34)				(33.32)			
Year	1.410	***	1.364	***	1.524	***	1.272	***			-59.922	***	-59.843	***	4.818		-89.726	***		
	(0.11)		(0.11)		(0.11)		(0.12)				(16.64)		(16.59)		(18.24)		(19.36)			
Constant	6.508	***	6.363	***			6.115	***			3,158.57	***	3,163.57	***			3,117.23	***		
	(0.34)		(0.34)				(0.33)				(52.58)		(51.94)				(56.03)			
Observations	7,890		7,912		6,407		7,887		6,462		7,950		7,927		6,461		7,947		6,462	
R^2	0.125		0.121		0.071				0.000		0.086		0.086		0.046				0.046	

Adjusted R^2	0.123	0.118	-0.876	-0.002	0.084	0.084	-0.913	0.044
F Statistic	56.181^{***} (df = 20; 7896)	39.390^{***} (df = 19; 7952)	26.845^{***} (df = 9; 3173)	-56.63 (df = 7; 3223)	37.222^{***} (df = 21; 7929)	39.390^{***} (df = 19; 9752)	17.355^{***} (df = 9; 3221)	22.361^{***} (df = 7; 3223)
F-test for individual effects	F = 1.798, df1 = 2126, df2 = 3173, p-value = 0.000				F = 1.987, df1 =2126, df2 = 3221, p-value = 0.000			
Hausman test	chisq = 76.725, df = 9, p-value = 0.000				chisq = 106.47, df = 9, p-value = 0.000			
Partial F-test for weak IV detection				81.529				84.609
J-test				J-test = 1.233, p-value = 0.267				J-test = 0.460; p-value = 0.498

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

5.3 Input market use

Table 17 shows the regression results for the third measure of commercialization: IMU.

5.3.1 IMU: Food Variety Score

The pooled OLS shows a negative relationship between IMU and the FVS both with and without interaction variables with the north-south dummy. This means that for both regions, as well as for the country as a whole, an increase in IMU is associated with a significant decrease in the FVS. The tests show that there are individual effects and that the fixed effects model is preferred over random effects. The standard FE model also shows that there is a significant negative relationship between IMU and the FVS. Contrarily, the pooled OLS shows no significant relationship between IMU and the FVS and the FE IV shows a significant positive relationship. As endogeneity is assumed, but the FE IV shows a negative F-statistic, the pooled OLS model is preferred. This indicates there is no significant relationship between the share of inputs bought at the market and the FVS.

According to the preferred model, the pooled OLS, larger households consume more different food items, and so do households with a higher educated household head and those with more small cattle. Households with a higher dependency ratio, with a male head of the household and with more large cattle have lower FVSs.

5.3.2 IMU: Caloric intake

Lastly, with regards to caloric intake, no significant relationship between IMU and caloric intake for any of the models in neither the north, nor in the south of Vietnam. The only exception is the fixed effects model at a 10 percent significance level. This model shows a negative relationship. The tests show that individual effects are present and that FE are preferred over RE. Assuming the IMU is endogenous, and as individual effects are present, the FE IV model is preferred. This shows that larger households and households with higher dependency ratios consume fewer calories. Households with more poultry or large cattle have higher caloric intake per AME.

Table 17: Regression results for Input Market Use on food security

	Food Variety					Caloric intake				
	Pooled OLS – Regions (1)	Pooled OLS (2)	Fixed effects (3)	OLS IV (4)	Fixed effects IV (5)	Pooled OLS - Regions (6)	Pooled OLS (7)	Fixed effects (8)	OLS IV (9)	Fixed effects IV (10)
Input market use		-1.048 (0.233) ***	-0.850 (0.41) **	-0.354 (0.55)	4.564 (0.75) ***		-5.203 (36.59)	-115.198 (65.50) *	77.284 (81.15)	-168.264 (116.00)
Input market use - North	-0.826 (0.27) ***					10.879 (42.08)				
Input market use - South	-1.890 (0.46) ***					13.920 (72.19)				
Age	-0.001 (0.00)	-0.001 (0.004)		-0.000 (0.00)		-2.060 (0.62) ***	-2.053 (0.62) ***		-1.943 (0.64) ***	
Sex	-0.400 (0.13) ***	-0.393 (0.13) ***		-0.410 (0.13) ***		-56.600 (20.85) ***	-56.542 (20.80) ***		-57.809 (21.01) ***	
Household size	0.239 (0.03) ***	0.234 (0.03) ***	0.279 (0.06) ***	0.240 (0.03) ***	0.162 (0.06) ***	-100.936 (4.54) ***	-100.918 (4.53) ***	-112.304 (10.28) ***	-100.306 (5.02) ***	-100.729 (9.64) ***
Dependency ratio	-0.531 (0.22) **	-0.542 (0.22) **	-0.439 (0.40)	-0.548 (0.21) ***	-1.007 (0.41) **	-141.242 (34.89) ***	-144.158 (34.81) ***	-130.84 (65.67) **	-144.997 (37.90) ***	-144.511 (63.72) **
Education: ≤ lower secondary	1.284 (0.18) ***	1.285 (0.18) ***		1.318 (0.19) ***		29.578 (28.73)	29.519 (28.68)		-34.820 (28.55)	
Education: > lower secondary	2.271 (0.22) ***	2.261 (0.22) ***		2.325 (0.23) ***		46.834 (34.52)	46.546 (34.46)		-55.120 (36.70)	
Landholdings (M2)	-0.000 (0.00)	-0.000 (0.00)	0.000 (0.00) ***	-0.000 (0.00)	0.000 (0.00) **	0.010 (0.00) ***	0.010 (0.00) ***	0.002 (0.00)	0.010 (0.00) ***	-0.003 (0.00)
TLU: poultry	-0.123	-0.124	0.388	-0.089	0.925 **	85.634 ***	85.276 ***	145.354 **	87.589 *	146.486 ***

	(0.15)		(0.15)		(0.35)		(0.21)		(0.36)		(23.21)		(23.17)		(57.01)		(52.80)		(56.70)		
TLU: large cattle	-0.350	***	-0.349	***	-0.149		-0.323	***	-0.039		37.778	***	37.680	***	28.435	*	40.529	***	29.809	*	
	(0.05)		(0.05)		(0.10)		(0.07)		(0.11)		(8.52)		(8.51)		(16.44)		(8.72)		(16.43)		
TLU: small cattle	0.038	**	0.040		0.053		0.046		0.130	***	10.563	**	10.599	**	2.217		11.240		0.832		
	(0.03)		(0.03)		(0.04)		(0.05)		(0.04)		(5.20)		(5.19)		(6.95)		(8.06)		(6.97)		
Value farm equipment	0.000	***	0.0001	***	0.000		0.000	***	0.000	*	0.007	***	0.007	***	-0.004		0.007	***	-0.004		
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		
Red River Delta	-0.012		0.068				-0.030				-80.738	***	-80.731	***			-86.696	***			
	(0.17)		(0.16)				(0.16)				(26.01)		(25.88)				(24.81)				
North Central Coast	0.805	***	0.806	***			0.810	***			-189.756	***	-189.781	***			-191.278	***			
	(0.18)		(0.18)				(0.17)				(28.02)		(28.00)				(32.79)				
South Central Coast	2.553	***	2.601	***			2.466	***			-110.419	***	-111.620	***			-127.75	***			
	(0.21)		(0.20)				(0.21)				(32.13)		(31.85)				(32.79)				
Central Highlands	3.127	***	2.442	***			2.122	***			36.340		52.448				16.611				
	(0.43)		(0.28)				(0.35)				(68.25)		(43.60)				(54.05)				
Southeast	5.006	***	4.262	***			-3.902	***			7.717		24.711				-15.108				
	(0.44)		(0.25)				(0.37)				(68.71)		(39.20)				(56.16)				
Mekong Delta	2.945	***	2.062	***			-1.610	***			-92.752		-72.701	*			-125.999	**			
	(0.48)		(0.24)				(0.41)				(76.17)		(37.22)				(60.20)				
Year	1.401	***	1.373	***	1.471	***	1.374	***			-53.391	***	-53.853	***	-19.068		-57.292	***			
	(0.11)		(0.11)		(0.11)		(0.11)				(16.70)		(16.66)		(17.39)		(17.16)				
Constant	7.047	***	7.158	***			6.821	***			3,224.62	***	3,224.240	***			3,188.078	***			
	(0.36)		(0.35)				(0.549)				(55.96)		(55.50)				(65.88)				
Observations	7,512		7,534		6,232		7,509		6,462		7,545		7,567		6,260		7,542		6,462		
R^2	0.127		0.124		0.070				0.000		0.088		0.088		0.046				0.042		

Adjusted R^2	0.125	0.122	-0.919	-0.002	0.085	0.085	-0.961	0.040
F Statistic	54.549^{***} (df = 20; 7491)	55.857^{***} (df = 19; 7514)	25.365^{***} (df = 9; 3019)	-41.114 (df = 7; 322)	36.086^{***} (df = 20; 7524)	38.206^{***} (df = 19; 7547)	16.376^{***} (df = 9; 3044)	19.851^{***} (df = 7; 3223)
F-test for individual effects	F = 1.466, df1 = 4473, df2 = 3019, p-value = 0.000				F = 1.338, df1 = 4481, df2 = 3044, p-value = 0.000			
Hausman test	chisq = 111.68, df = 9, p-value = 0.000				chisq = 44.819, df = 9, p-value = 0.000			
Partial F-test for weak IV detection				50.220				51.606
J-test				J-test = 0.608, p-value = 0.436				J-test = 0.005; p-value = 0.942
Note:	*p<0.1; **p<0.05; ***p<0.01							

5.4 Summary of results

This paragraph provides a brief recapitulation of the results found in this chapter. Table 18 shows the regression coefficients of each commercialization indicator on the appropriate food security indicator from the most preferred model.

Table 18: Regression coefficients for commercialization indicators

	Food Variety Score	Caloric intake
CCPS	3.001*** (IV OLS)	-393.615 (FE IV)
COMP	1.484*** (IV OLS)	-248.056*** (FE IV)
IMU	-0.354 (IV OLS)	-186.264 (FE IV)

According to the results in table 18, there is a significant positive relationship between the commercialization and the FVS for two out of three commercialization indicators. There is no significant relationship with the remaining indicator. There is a negative relationship between caloric intake and one of the three commercialization indicators but no relationship with the other two indicators. COMP is significantly related to both indicators of food security, while the IMU is related to neither of the two.

With regards to the control variables, in all three IV OLS models, larger households and households with higher educated household heads had higher FVSs. In two out of three IV OLS models higher values of farm equipment were related to higher FVSs, whereas more large cattle, higher dependency ratios and male headedness were related to lower FVSs. For caloric intake, all three FE IV models showed that larger households and households with higher dependency ratios had lower caloric intake. Owning more poultry and large cattle was positively related to caloric intake.

6. Discussion & conclusion

6.1 Discussion

The results show that the relationship between commercialization and food security differs between the varying operationalizations of the commercialization indicator. When looking at the input side of commercialization, where households have different allocations of their resources and thereby different values for IMU, there are no significant relationships with the food security indicators. Following the causality as indicated in the theoretical framework, this means that there is no significant effect of IMU on food security.

However, when considering the output side of commercialization, where households have different shares of crop marketing (different values for COMP), there is a significant positive effect on the FVS, and a negative effect on caloric intake. It is important to note that the significant positive effect of COMP on the FVS only seems to be the case in the south of Vietnam. In the northern regions, there seems to be no significant effect. For the Central Highlands and the Southeast, which make up 2 out of 3 southern regions, I also considered the CCPS, which is not suitable for a national analysis due to the regional restrictions regarding cash crop production. In the theoretical framework (figure 2) this indicator fulfils a more complex role, as it is an output indicator that is heavily dependent on the input allocation in an earlier stage of production. My expectations were that I would not find any significant effects of the CCPS on either the FVS or caloric intake of households. However, the results showed that there is a significant positive effect on the FVS. This indicates that for regions with high levels of cash crop production, the CCPS may be more appropriate than I expected. It was not possible to include both a measure of input and output commercialization in one regression due to the correlation between both variables.

In general, there is limited variation for the caloric intake indicator, as there is no trend between 1993 and 1998. This makes it harder to run statistical analyses on caloric intake. The lack of a general trend in caloric intake is therefore a possible explanation for the absence of relationships with two of the commercialization indicators.

The results from the previous chapter generally match the theoretical framework. Based upon the literature we know that Vietnam went through quite some policy changes during the 1990s. I expected that these would influence prices, wages and risks, and thereby the allocation of a households' endowments. The data shows that there were large increases in harvest values and agricultural productivity, which is what I expected after the liberalizations during the 1980s and early 1990s. It would have been possible that an important channel through which households make use of markets, would be through the labor market. The general trend in developing countries is that people move away from the agricultural sector. The data also show that there was a decrease of crop producing households between 1993 and 1998 of 8.4 percent. Yet, I found that by far the largest share of the increase in total average income was due to increases in on-farm income. This indicates that the commercialization of labor might not have been that important, but that with regards to household increases in income and food security, commercialization of the agricultural activities of households might have been more important.

The increases in income witnessed mainly came from increases in the quantities or returns to agricultural production. Households had higher total harvest values, but also the share of production sold on the markets, i.e. COMP, was significantly higher in 1998. According to the framework the increases in income could be spent on food and non-food items. If we compare the changes in average food expenditure and average total income, it appears that

households do spend a larger share of their increased incomes on non-food items, which is in line with Banerjee and Duflo (2012). The results are also in line with Banerjee and Duflo (2012) when it comes to households' food expenditures. The FVS increased on average, while caloric intake did not, which points to the increased demand for more diverse and better tasting diets instead of diets that generate the most calories. This also matches the findings of Abdulai and Aubert (2004). In this case we would still consider there to be a positive change in food security, as the caloric intake is not declining while the FVS is increasing.

With regards to the effect of commercialization on food security, the findings for commercialization do not completely match the findings of Carletto et al. (2016). Whereas Carletto et al. (2016) did not find any significant effects, I did find some. This was especially the case for the COMP, which was exactly the indicator used by Carletto et al. (2016). The difference between the effect for the north and the south of Vietnam might be explained by the difference in institutions and markets. For Northern Vietnam, it could be the case that institutions and markets were less functional during the 1990s compared to the south of the country, which according to Immink and Alacon (1993), Jaleta et al. (2009) and Von Braun (1995), would pose households in these regions at risk if they start depending more upon the market. I do currently not know if this is the reason behind the lack of a positive effect in the North, or if there are other factors at play and which. More research would be needed to cover these dynamics.

I expected that the effects of the CCPS would be smaller than those of COMP. For caloric intake it was indeed the case that COMP did show a significant effect, whereas the CCPS did not. In addition to my initial critique on this indicator, namely that commercialization can also be achieved through other crops or even markets, I found that the CCPS is unable to measure commercialization on a national level in Vietnam. Vietnam is most likely not the only country where cash crop production is not spread evenly across the country, or even concentrated in a certain region of the country. For this reason we should always be cautious of this issue when reviewing other studies on this topic. Also for the future analysis on Myanmar, which is also a large country with significant geographical variation, it is important to keep in mind that cash crop production might not be accurate for national analyses. The frequently used alternative to the CCPS, COMP, generates results that show a large regional difference. Because of the limitations of the CCPS, I prefer the results of COMP, but given the background information that I possess, it is hard to find a solid explanation behind this regional difference that goes beyond speculation.

I considered IMU as an alternative way of measuring commercialization, by looking at a different market related to agricultural production. The drawback is that I only considered one type of inputs, namely fertilizer. It would be interesting to see if the results are the same if we would consider seeds or labor. Generally, I find no significant relationships between IMU and food security. The fact that the effect of IMU on the FVS is not positive and significant, while this is the case for the CCPS and COMP, could possibly be explained by separate markets for inputs and outputs. This would imply that when a household (member) goes to a market to purchase inputs, they do not necessarily have to be in the vicinity of an output market, where they could easily acquire different types of food to improve their dietary diversity. Instead, the use of acquired inputs might be correlated with the production of specific crops that on their turn are correlated with a lower FVS. The preferred but ambiguous model for the FVS and IMU showed an insignificant but negative relationship, which might indicate that such mechanics might indeed be at play. More research needs to be done on the exact interactions between input- and output markets in Vietnam though, to properly explain the differences in results between IMU on the one and the CCPS and COMP on the other hand.

The fact that significant relationships between COMP and both food security indicators were found, but that this was not the case for the CCPS and IMU is not very surprising. As I have argued before, the CCPS only measures a small part of the possible ways through which output commercialization works, as it only looks at cash crops. Similarly, for the IMU, I only considered fertilizer as a proxy for total inputs. Between these three measures of commercialization, the COMP thus seems the most appropriate. The negative effect of COMP on caloric intake can be explained by the theory of Banerjee and Duflo (2012) that households tend to spend increased income on more diverse and better tasting diets instead of diets generating the most calories.

6.2 Conclusion

This thesis has tried to add the relatively small amount of research addressing multiple and more appropriate indicators of commercialization. The results show that the effect of commercialization on food security depends upon the choice of the commercialization indicator. Between 1993 and 1998 all types of commercialization increased for Vietnamese, crop producing households. While households improved their dietary diversity, their caloric intake remained constant.

I measured commercialization through a cash crop indicator, which was only suitable for two out of seven regions in Vietnam, due to the general absence of cash crops in other regions. I found that there is a significant positive effect of this cash crop indicator on food security. I also considered crop output market participation, which shows a significant, positive effect on the food variety score, and a significant negative effect on caloric intake. The positive effect only exists for the three southern regions of Vietnam though. In the northern regions there seems to be no significant effect of crop output market participation on food variety. The last indicator of commercialization that was measured is the commercialization of input markets, for which I find no significant effect on either of the two food security indicators. I have not been able to run a regression including multiple measures of commercialization at the same time, as the commercialization indicators are positively correlated to one another.

This thesis has indicated the importance of the operationalization of the commercialization indicator. More research is needed however to deepen the understanding of the channels through which commercialization works, and how different types of commercialization interact. With regards to the relationship with food security, it would be interesting to have a closer look at the causes of the increases in income and agricultural productivity, and their role in improving food security.

Appendix A: conversion tables

Table 19: Food items and calorie conversion rate (calories per 1000 grams). Source: Nguyen & Winters (2011), adjusted from Vietnam's National Institute of Nutrition (NIN) and GSO of Vietnam.

Food type	Calories	Food type	Calories
Ordinary rice	3,530	Beans	3,142
Glutinous rice	3,550	Water morning glory	210
Corn/maize	3,640	Kohlrabi	300
Cassava	1,560	Cabbage	370
Potatoes	1,088	Tomatoes	370
Barley, Malt, Millet, Kaoling*	3,320	Other vegetables	
Bread wheat, flour	3,015	Oranges	430
Noodle, pho noodle. instant rice soup	3,580	Bananas	830
Rice noodle	3,400	Mangoes	290
Vermicelli	1,285	Other fruits*	170
Pork	3,956	Fish sauce and dipping sauce	332
Beef & buffalo meat	1,233	Salt	-
Chicken	1,759	MSG	-
Duck and ocher poultry meat	1,260	Sugar, molasses*	3,870
Other meat*	2,630	Cakes, jams, sweets	4,026
Processed meat	3,259	Fresh milk	868
Fat and oil	9,270	Alcohol & beer	470
Fresh fish, shrimp	900	Coffee*	560
Dried and	2,409	Tea	-
processed fish and shrimp			
Other seafood (crab, snails etc.)*	660	Beverages (made with industrial methods)	470
Chicken or duck eggs (per one)**	1,482	Food and drink away from home (breakfast, lunch)*	410
Tofu	980	Others*	1,700
Peanuts, sesame seeds	5,445		

* Nguyen & Winters (2011) conversion rate was not available, so I used the FAO conversion rates listed by Mishra & Ray (2007)

** Multiplied with the average weight of a chicken egg in Vietnam (Duc & Long, n.d.)

Table 20: FAO adjustment factors for calculating the AME. Source: Fiedler et al. (2008)

Age (years)	Males	Females
< 1	0.27	0.27
1– 3	0.45	0.45
4–6	0.61	0.61
7–9	0.73	0.73
10–12	0.86	0.78
13–15	0.96	0.83
16–19	1.02	0.77
≥ 20	1	0.73

Table 21: TLU conversion rates. Source: FAO (2005)

Livestock	TLU	Category
Buffalo	0.70	Large cattle
Cow	0.65	Large cattle
Goats	0.10	Small cattle
Horses	0.65	Large cattle
Pigs	0.25	Small cattle
Chicken	0.01	Poultry
Ducks, wild geese, geese	0.01	Poultry

Appendix B: scatterplot matrices and distribution graphs

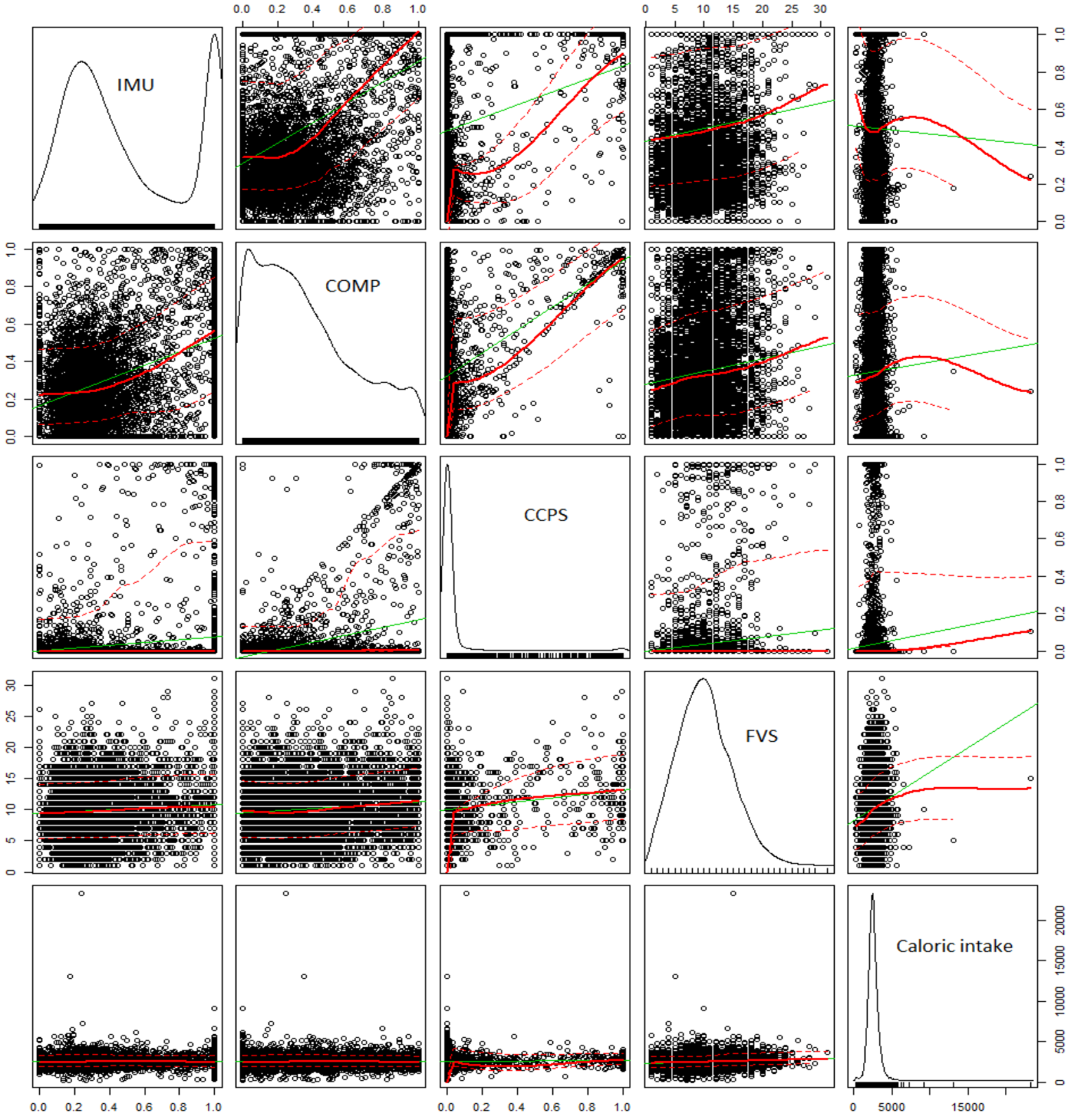

Figure 4: scatterplot matrices and distribution graphs for IMU, COMP, CCPS, FVS and caloric intake

Appendix C: descriptive statistics for panel data control variables

Table 22: Means for control variables for panel data

	1993			1998			
Variable	N	Mean	s.d.	N	Mean	s.d.	Test-statistic
Age (head)	3,436	45.25	14.66	3,333	47.68	13.63	7.041***
Size	3,436	5.098	2.109	3,333	4.855	1.903	4.980 ***
Dependency ratio	3,436	0.422	0.233	3,333	0.040	0.247	3.335 ***
Food expenditures	3,435	2,698	3,083.3	3,333	3,323.5	3,046.9	8.395***
Harvest value	3,436	5,185.0	6,184.5	3,333	7,683.0	11,570.1	11.03***
Off-farm income	3,436	3,657.6	11,747.6	3,333	4,206.0	9,181.5	2.143*
On-farm income	3,436	4,130.3	5,793.9	3,333	7074.334	23,611.6	6.997***
Total income	3,436	7,787.9	13,636.1	3,333	11,280.4	25,293.1	7.041***
Land holdings (log)	3,436	5.972	3.390	3,333	7.111	2.669	15.38***
Total livestock units	3,436	1.010	1.176	3,333	1.246	2.560	4.854***
Farm assets	3,436	809.3	3,517.7	3,333	1,343.0	5,027.9	5.046***

Note: *p<0.1; **p<0.05; ***p<0.01

Table 23: Frequency distributions for gender, age and region for panel data

		N	Freq (%)	N	Freq (%)	Chi squared
Gender (head)	Female	777	22.61%	774	23.22%	0.3214
	Male	2,659	77.39%	2,559	76.78%	
Education (head)	No education	454	13.21%	334	10.02%	17.701***
	≤ lower secondary	2,416	70.31%	2,459	73.78%	
	> lower secondary	566	16.47%	540	16.20%	
Region	1. Northern Mountains and Midlands	627	18.25%	669	20.07%	7.7406
	2. Red River Delta	865	25.17%	771	23.13%	
	3. North Central Coast	568	16.53%	575	17.25%	
	4. South Central Coast	396	11.53%	368	11.04%	
	5. Central Highlands	111	3.23%	110	3.30%	
	6. Southeast	244	7.10%	218	6.54%	
	7. Mekong River Delta	625	18.19%	622	18.66%	
Note:	*p<0.1; **p<0.05; ***p<0.01					

Appendix D: first stage IV results

Table 24: First stage IV results for IV OLS and FE IV

	CCPS		COMP		IMU	
	IV OLS	FE IV	IV OLS	FE IV	IV OLS	FE IV
Gender	0.013		0.007		-0.002	
	(0.017)		(0.006)		(0.006)	
Age	0.001		0.0004**		-0.001***	
	(0.001)		(0.0002)		(0.0002)	
Household size	0.002	0.007	-0.010***	-0.009***	-0.005***	-0.003
	(0.003)	(0.009)	(0.001)	(0.003)	(0.001)	(0.003)
Dependency ratio	0.031	-0.040	0.011	-0.005	0.046***	0.069***
	(0.031)	(0.068)	(0.010)	(0.017)	(0.009)	(0.018)
Education: ≤ lower secondary	0.025		0.024***		-0.033***	
	(0.019)		(0.008)		(0.007)	
Education: > lower secondary	0.031		0.030***		-0.048***	
	(0.026)		(0.010)		(0.009)	
Landholdings (M2)	-0.000***	-0.000***	0.000***	0.000**	0.000**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
TLU: Poultry	-0.001	-0.007	-0.013*	-0.021	-0.037***	-0.028*
	(0.009)	(0.051)	(0.007)	(0.015)	(0.006)	(0.016)
TLU: Large cattle	0.0002	-0.033	0.002	-0.001	-0.020***	-0.008*
	(0.007)	(0.021)	(0.003)	(0.004)	(0.002)	(0.005)
TLU: Small cattle	-0.010	-0.032**	-0.004**	-0.003*	-0.008***	-0.005***
	(0.008)	(0.016)	(0.002)	(0.002)	(0.001)	(0.002)
Value farm equipment	0.000***	0.000	0.000***	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year	0.065***	0.100***	0.102***	0.104***	0.044***	0.044***
	(0.014)	(0.018)	(0.005)	(0.005)	(0.004)	(0.005)
Red River Delta			-0.007		-0.019***	
			(0.008)		(0.007)	
North Central Coast			-0.007		-0.009	
			(0.008)		(0.008)	
South Central Coast			-0.005		0.011	
			(0.009)		(0.009)	
Central Highlands			0.012		0.029***	
			(0.013)		(0.011)	
Southeast	0.005		0.016		0.044***	
	(0.015)		(0.012)		(0.011)	
Mekong Delta			0.018*		(0.011)	
			(0.010)		(0.010)	
IV	0.933***	-0.076	0.896***	-6.369***	0.964***	1.051***
	(0.022)	(0.279)	(0.018)	(0.314)	(0.012)	(0.037)
Constant	-0.091**		-0.027*		0.109***	
	(0.043)		(0.016)		(0.015)	
Observations	1136	640	7952	6462	7952	6462

R2	0.711	0.135	0.491	0.276	0.712	0.234
Adjusted R2	0.708	-0.777	0.490	-0.451	0.711	-0.536
Residual Std. Error	0.217 (df = 1121)		0.212 (df = 7932)		0.193 (df = 7932)	
F Statistic	197.268*** (df = 14; 1121)	5.398*** (df = 9; 311)	402.525*** (df = 19; 7932)	136.605*** (df = 9; 3222)	1,032.768*** (df = 19; 7932)	109.286*** (df = 9; 3222)
Note:	*p<0.1; **p<0.05; ***p<0.01					

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