POLICY REFORMS FOR SMALLHOLDER AGRICULTURE: AN ANALYSIS USING HOUSEHOLD DATA FOR VIETNAM

by

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Declaration

I, Huy Quynh NGUYEN, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the Arndt-Corden Department of Economics, Crawford School of Public Policy, College of Asia and the Pacific, The Australian National University, is wholly my own work unless otherwise referenced or acknowledged. This thesis has not been submitted for qualifications at any other academic institution.

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Abstract

During Vietnam's thirty years of economic growth since 1986, government policies have been central in raising rice production and export. However, the relevance of the 'rice first' policy and the place of smallholder agriculture have recently been questioned in the discussion on Vietnam's agricultural development strategy. The objective of this thesis is to contribute to designing appropriate agricultural development strategies for Vietnam, based on empirical analysis at the farm household level.

The thesis begins by reviewing theories and literature on the agricultural transformation. This review assists in the development of the analytical framework and research issues for the thesis. The next chapter provides an overview of agricultural reforms and structural transformation in Vietnam since 1986. The core of the thesis is contained in the next three chapters. Chapter 4 examines the merit of crop diversification in rural Vietnam. Chapter 5 investigates the effect of nonfarm participation on household production choices. Chapter 6 studies the effect that land reforms directed towards land consolidation have on labour allocation and promoting the economic diversity of farm households. The final chapter discusses policy implications.

The findings indicate that economies of scale are evident in Vietnam's multiple crop production. Output complementarity is found to exist between rice and other annual crops. Also, substantial technical inefficiency exists in diversified farms. Enhancing education, particularly for women, and further land reforms are the main technical efficiency shifters. Results also show that in a multiple crop environment, households with smallholder production respond to cost stress by lowering family labour use. In addition, in the short run, labour movement into nonfarm activities reduces rice production in the north of Vietnam. In contrast, in the south, labour participation in nonfarm activities has induced rice farmers to maintain rice production by hiring more labour during periods of peak labour demand, and by investing in more capital to facilitate less labour-intensive farming. While agriculture in the north is losing its comparative advantage, the stability of rice production at the national level is welcome news for policy makers in that it suggests that food production can be maintained, despite the rapid structural change in rural areas. Finally, land reforms that lead to less labour-intensive farming, along with the development of credit and insurance markets in rural areas, are important in raising agricultural productivity and the promotion of economic structural transformation.

In general, in light of increasing rural wages and structural change, Vietnam's agricultural transformation replicates the early East Asian experience, characterised by the dominance of smallholder agriculture. There has so far been no definitive policy resolution of the optimal structure of Vietnam's smallholder agriculture. The balance between efficiency and equity, between lowering production costs and raising prices, is a challenge for policy makers. The findings suggest policies for maintaining the comparative advantage of agriculture. The government should relax the 'rice first' policy to improve household welfare. In addition, land reforms responding to less labour-intensive farming, and the development of the nonfarm economy, should play a central role in restructuring smallholder agriculture.

List of Abbreviations and Acronyms

ADB	Asian Development Bank
AHM	Agricultural Household Model
CPI	Consumer Price Index
DHM	Double Hurdle Model
FAO	Food and Agriculture Organization of the United Nations
FD	First Difference
FE	Fixed Effect Estimation
GSO	General Statistic Office of Vietnam
IFPRI	International Food Policy Research Institute
LDCs	Less Developed Countries
MARD	Ministry of Agriculture and Rural Development
MES	Morishima Elasticity of Substitution
MOLISA	Ministry of Labour – Invalids and Social Affairs
MPL	Marginal Product of Labour
NELM	New Economics of Labour Migration
OLS	Ordinary Least Squares Estimation
RE	Random Effect Estimation
SOE	State-Owned Enterprise
SPF	Stochastic Production Frontier
2SLS	Two State Least Squares
TE	Technical Efficiency
UNDP	United Nations Development Program
VHLSS	Vietnam Household Living Standards Survey
VLSS	Vietnam Living Standards Survey
VND	Vietnamese Dong (Vietnamese currency)
WB	World Bank

Table of Contents

List of Tables

List of Figures

List of Appendices

Chapter 1

Introduction

1.1 Study motivation

Vietnam started its economic reforms in 1986, and has subsequently transformed itself from a poor to a middle-income country (World Bank 2011a). Economic growth has brought about great achievements in poverty reduction and rising incomes. According to the World Bank (2011a), Vietnam's GDP per capita was USD 1,543 in 2011, compared with USD 437.1 in 1986. The proportion of people living below the poverty line fell from 58 per cent in 1993 to 14 per cent in 2011. In addition, prolonged economic growth has also enabled Vietnam to improve social welfare and the living standards of most households (World Bank 2007 and 2011a).

Many factors have contributed to Vietnam's economic success, including agricultural reforms. In the late 1980s, Vietnam's agricultural collective system was at a crossroads in the setting of stagnant agricultural production, and the successes in agricultural production promoted by the household responsibility system adopted in China in 1979. Consequently, the Vietnamese government decided to decollectivize the agricultural system under Resolution 10 in 1988, and allocated land to farm households, which contributed greatly to raising both food production and rural households' welfare (Minot and Goletti 1998; Benjamin and Brandt 2004; Dang et al. 2006). As a result, from a country with a food shortage in the late 1980s, Vietnam has become one of world's leading rice exporters (Fforde and Seneque 1995, p.108; Glewwe et al. 2004; World Bank 2012). During the thirty years of economic growth, government policies have been central in improving rice production to meet increasing domestic demand, while at the same time expanding Vietnam's rice exports. However, Vietnam's agricultural sector is again at a crossroads in the new setting of the development of the nonfarm economy, along with rising wages in both urban and rural areas, and the dynamic evolution of the food system.

With continued economic growth, the proportion of agriculture in Vietnam's GDP has fallen rapidly since 1986. The agricultural growth rate has slowed since 1999, and the absolute number of total employment in agriculture has started to decrease (Dang et al. 2006). The rising trends of abandoning paddy fields and crop switching have concerned

the government. Despite efforts in land reforms, the average farm size per household has shown virtually no increase during the period of fast economic structural transformation. More than 85 per cent of total households using paddy land have farm sizes less than one hectare (GSO 2012). Likewise, the importance of nonfarm incomes has increased visibly. Rice income has declined relative to other sources of farm and nonfarm incomes. Part-time farming and off-farm employment as a mean of bolstering farm income have become dominant trends in the Vietnamese agriculture. The rural nonfarm economy has grown rapidly, thereby enabling farm households to diversify their income while still relying on agricultural production for their principal livelihood (Van de Walle and Craty 2004; Marsh et al. 2006). Based on the experience of the agricultural transformation in East Asia, the comparative advantage of smallholder agriculture will decline in the face of rising part-time farming and rising rural wages in this middle-income stage of development. Otsuka and Estudilo (2010) argue that as the economy develops and wages increase, labour-intensive small-scale farming becomes costly. If small and fragmented landholdings are not restructured, comparative advantage in agriculture will be lost and the country is likely to become an importer of food. However, whether Vietnam, as a late comer to East Asian rapid growth, can replicate the early East Asian experience remains the subject of on-going policy debates on the design of strategies during this period of agricultural transformation in Vietnam.

To avoid the problems generated by accelerated structural change, and to avoid increases in income disparity, in 2013, the government of Vietnam issued Decision 899 to restructure the agricultural sector toward raising added value and promoting sustainable development. The agricultural restructuring plan was aimed at maintaining the agricultural growth rate, increasing agricultural productivity to improve farm incomes, and diversifying agricultural production. Sustainable growth and preventing the decline in the comparative advantage of agriculture are the government's top priorities. In 2013, for the first time since the decollectivisation of agriculture in 1988, agricultural transformation has become a primary agenda item of the government.[1] Until then the restructuring agenda had focused on non-agricultural issues such as state-owned enterprises, public investments, and the banking system.

[1]Resolution 10 on decollectivisation was issued in 1988. On the 10th of June 2013, the government issued Decision no. 899/QD-TTg approving the plan of restructuring the agricultural sector. The objectives of Decision 899 are to raise the growth of GDP of agriculture to 3.5 - 4 per cent during 2016-2020. The government also set up a steering committee to help the government guide the national agricultural restructuring. The Deputy Prime Minister and Minister of Agriculture and Rural Development are head and deputy head of the committee, respectively (see further details in www.mard.gov.vn).

However, in order to restructure the agricultural sector successfully, the government must learn what works for small farmers, and understand how small farmers make decisions in new settings. Timmer (2013) argues that the future of food security in Asia depends on the performance of small farmers. Similarly, Otsuka (2015) claims that the big question for the future of small farms in Asia, particularly in land-poor countries like Vietnam, is about the role of land reforms. Taylor and Lybbert (2015) argue that the biggest difference between agriculture and most other sectors is that agricultural production decisions are almost always made within economic units that also function as households. As a result, responding to the changing needs of small farm households is a major challenge that needs to be addressed by the government (Hazell et al. 2010). Hazell and Rahman (2014) conclude that the survival of small farms in the transformation process depends on how they adapt to their changing economic environment. The authors argue that the key adjustments are the diversification into higher-value products, expansion of nonfarm sources of income employment, and land reforms. Moreover, policies are needed to raise agricultural productivity, which is the most effective way to deal with food insecurity (Warr 2014). Thus, new challenges require an analytical and empirical understanding of what is happening to agricultural transformation at the household level, to support the design of effective policies.

1.2. Conceptual framework and policy propositions of the thesis

The voluminous literature on agricultural transformation under new settings reflects the complexity of the subject, and shows the difficulty in combining theoretical concepts and empirical studies at the micro level. Research has examined the agricultural transformation along three broad dimensions.[2] The first dimension is the dynamic evolution of the food system in light of the growth and production of high-value commodities, more diverse diets and the sustainable intensification in agricultural production. The second dimension concerns the impact of the nonfarm economy and part-time farming on household production choices. The final one is the role of technological changes and institutional innovation, particularly land institutions, in maintaining the comparative advantage of agriculture in land-poor countries.

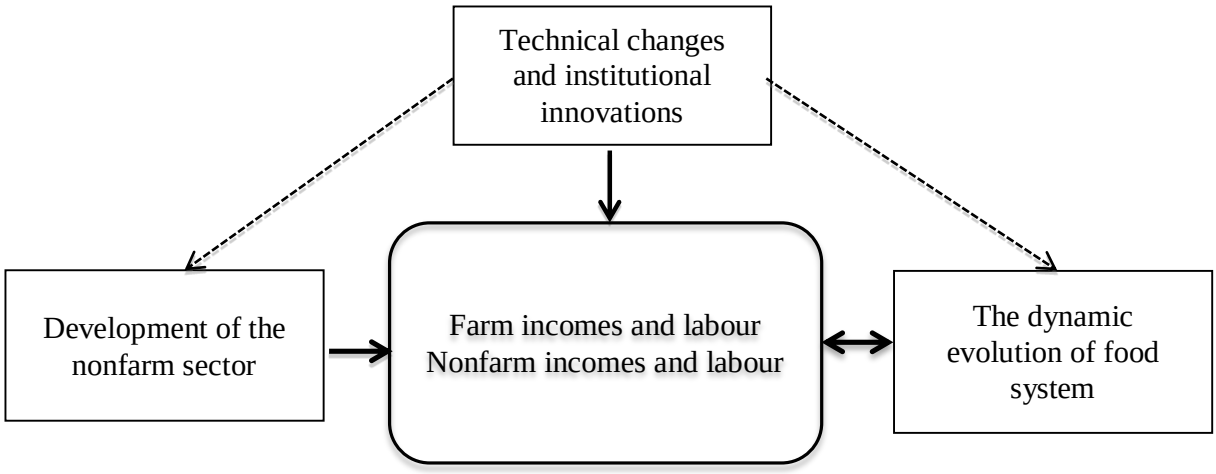
As illustrated in Figure 1.1, the increase in incomes has led to a shift in food consumption from grains and other staple crops to high-value products such as fruits, vegetables, and livestock. Until recently, policies mainly focused on a single commodity

[2]The literature on each of these dimensions is reviewed in Chapters 4, 5, and 6 of the thesis.

because the Vietnamese government chose to link the strategy of food self-sufficiency almost exclusively to rice (McPherson 2012; Tran et al. 2013). However, the role of rice is changing in Asia (Timmer 2014). Economic growth and structural transformation have resulted in the dynamic evolution of the food system into higher-value commodities. Moreover, this dynamic evolution has been induced by the consumption and production linkages arising from technological changes and institutional innovations (Hayami and Ruttan 1985; Haggblade et al. 2007). This relationship is expressed by the broken line in Figure 1.1. New policies are required to further the diversification of production and promote agricultural productivity growth. Therefore, it seems reasonable to postulate the following policy proposition:

> *Proposition 1: Economic growth and increasing incomes result in changes in food systems. With the growth of consumption and production of high value commodities, diversion of resources from the staple cereal sector to commodities with higher income elasticities becomes important in maintaining incentives for the use of resources in agricultural production. Thus, new patterns of product combination and resource use have to be developed, instead of intensive mono-crop systems.*

Figure 1.1 **Conceptual framework showing agricultural transformation in the process of industrialization and the central role of technical changes and institutional innovations**



As the economy grows, the development of the nonfarm economy and part-time farming in small farms significantly increases nonfarm incomes, thereby affecting household production choices. There are four possible choices that small farms can make: (1) Farmers can reduce rice production as labour moves into nonfarm sectors. (2) They may

hire labour to substitute for the loss of family members, leaving agricultural production unaffected. Economic theories do not show unambiguous predictions in terms of the magnitude or signs of the effects (Taylor and Lybbert 2015). (3) Farm households can apply less labour-intensive farming, or reorganize agricultural production by spending more effort on farm from the remaining labour in the family in order to keep output stable. (4) Households can spend nonfarm incomes on relaxing the liquidity constraints on agricultural production, e.g. investing in capital or hiring more labour. These arguments result in the following policy proposition:

> *Proposition 2: In land-poor countries at the middle-income stage, as the economy develops and wages rise rapidly, low income from grain production causes the consequent move by farmers into nonfarm sectors as a means of improving household income, thereby increasing part-time farming and resulting in a decline in agricultural production. As a result, policies that keep food production stable place food self-sufficiency in conflict with the goals of improved household welfare and rural structural transformation.*

Otsuka (2013) concludes that the agricultural sector in Asia will lose its comparative advantage in the process of industrialization with increasing part-time farming and wage rates if land reforms fail to expand farm sizes and reduce land fragmentation. This current study hypothesizes that technical changes and institutional innovations play a vital role in maintaining the comparative advantage of agriculture, and increasing agricultural productivity. Without technical changes and institutional innovations, agricultural incomes are likely to fall seriously behind nonfarm incomes, thus widening rural-urban inequalities (Hayami and Ruttan 1985). Thus, to validate these arguments, this study postulates the following proposition:

> *Proposition 3: In the face of industrialization and rapidly increasing rural wages, technical change and institutional innovations are key strategies to improve agricultural productivity and prevent the comparative advantage of agriculture from declining when agricultural productivity growth reaches its threshold in spite of increasing supporting policies. Land reforms directed toward land consolidation, which result in increasing labour-saving farming and more mechanization, are important strategies in the long term during the transitional period from middle-income stage to high-income stage.*

Although technical changes and institutional innovations play an important role in maintaining the comparative advantage of agriculture, the application of productivity-improving technical change is likely to be limited to small farms with access to seasonal finance and markets (Dorward et al. 2004). Dorward et al. (2004) thus suggest that the government should intervene to assist farmers to reduce transaction costs and risk when accessing seasonal finance, and input and output markets. Furthermore, according to Dorward et al. (2004), it is important to invest in institutional innovations that supply agricultural services, and in developing input supply systems. This consideration leads to the following policy proposition:

> *Proposition 4: Small farms respond to increasing cost stress by reducing farm labour. Therefore, subsidies may be necessary to make input purchases for improved technologies both profitable and affordable. This may be contrary to arguments dominating development policies on subsidies.*

1.3 The objective, scope, and research questions

The objective of this thesis is to contribute to the discussion on appropriate agricultural development strategies for Vietnam based on empirical analysis at the farm household level. While the Vietnamese government is reviewing the system of current policies and strategies to implement Decision 899, which aims to restructure the agricultural sector, this thesis contributes to the discussion of policy formation and strategies. It also provides some insights into small-scale Vietnamese farming facing industrialization and economic structural transformation.

The scope of policy reforms during agricultural transformation is broad.[3] Thus, this thesis mainly focuses on four issues (stated above in the policy propositions) in the context of Vietnam. First, it examines crop diversification and the economic performance of diversified farms. Second, the thesis pays special attention to the increasing importance of the nonfarm economy and its implication for households' agricultural production choices. Third, this thesis attempts to evaluate the impact that land reforms directed towards land consolidation have on labour allocation and the economy diversity of farm households. Fourth, it examines the response of farm households to increasing cost stress in annual crop production. These issues are frequently posed in the debates on agricultural policies in Vietnam. In addition,

[3]Agricultural transformation is defined as a significant change in the pattern of product combination, production sequences, and resource use in agriculture (Hayami and Ruttan 1985, p. 428).

agricultural transformation includes several sub-sectors such as livestock, annual and perennial crops, forestry, and aquaculture. Thus, this thesis mainly concentrates on small farm households who produce annual crops.

There are underlying issues that must be identified in order to understand farmers' decision-making and farm household behavior in the face of new settings. To do so, the thesis attempts to answer the following questions:

i) *Crop diversification*: Does crop diversification result in scale and output complementarity in agricultural production? How can technical efficiency be improved in a multi-output environment? How does farm labour respond to increasing cost stress in multi-crop production? These questions are answered in Chapter 4.

ii) *The development of the nonfarm economy*: What choices of agricultural production do small farms make when household members participate in nonfarm activities and part-time farming increases? Are nonfarm activities of farm households complementary to agricultural production? These questions are answered in Chapter 5.

iii) *Technical changes and institutional innovation (land reforms directed toward land consolidation)*: Do land reforms directed towards land consolidation affect labour allocation and economic diversity in farm households? And if so, how? This question is dealt with in Chapter 6.

In addition to the above research questions, the thesis further contributes to the literature on agricultural research. First, the role of sustainable intensification in agriculture is also investigated by examining the economics of diversification of annual crop producing farms. Second, the concept of the elasticity of substitution in agricultural production is used, instead of using multivariate regression estimation, to evaluate the response of family labour to rising cost stress in farm production. Third, it provides evidence on the linkages between the farm and nonfarm sectors, particularly reverse linkage, which is rarely studied in the literature. Finally, it analyses the role of Hicks-neutral and factor-biased technical changes in structural transformation in developing countries, using both theoretical and empirical evidence.

1.4 Contribution of the thesis

The thesis is distinguished from other studies on agriculture and rural development in at least three aspects. First, the above specific issues are important for policy, but have

not previously been investigated in the context of Vietnam.[4] Second, the thesis develops theoretical frameworks to support an empirical analysis of crop diversification, nonfarm participation, and land reforms directed towards land consolidation in Vietnam. It contributes to theoretical studies by examining the role of agricultural productivity growth on structural transformation under the different assumptions of Hicks-neutral and factor-biased technical change. The thesis is also the first study to apply the elasticity of substitution in evaluating household behaviour in labour allocation in light of the increasing cost stress in agricultural production in Vietnam. These frameworks can then also be applied in other developing countries.

Finally, the thesis contributes to the existing literature on new directions for smallholder agriculture. In addition, it highlights current issues facing agricultural development and rural structural transformation in Vietnam, including policies directed toward crop diversification, the development of rural nonfarm economies, and land reforms. The analysis contributes to the discussion on restructuring the agricultural sector, and supporting policy makers in designing appropriate policies and strategies. Detailed contributions are described in each chapter.

In order to implement the objectives, the thesis employs a national dataset of the VHLSS 2004 and 2006 surveys for the core chapters. Both are nationally representative surveys and cover a variety of household information such as income, expenditure, employment, agricultural production, and other household characteristics. Moreover, the VHLSS surveys also cover communal characteristics. VHLSS 2004 and 2006 each include a panel sample, representing half of the total sample. The details and descriptions of VHLSS are presented in each core chapter. Besides the application of household data, this thesis also uses data provided by the General Statistics Office of Vietnam (GSO) and the Ministry of Agriculture and Rural Development (MARD).

1.5 Structure of the study

The thesis has seven chapters. Chapter 2 introduces the analytical framework of agricultural transformation in a land-poor and labour-abundant country. The objective of this chapter is to survey theories on the agricultural transformation process, which facilitates the development of the analytical framework and research issues for the thesis. It also aims to clarify the main problems facing smallholder agriculture and strategies

[4]See the detailed literature reviews in Chapters 4, 5 and 6.

needed to cope with them. It mainly focuses on theoretical frameworks that are relevant for the context of Vietnam. The chapter begins with an analysis of the Fei-Ranis dual economy model, which is an extension of the Lewis model (1954). It discusses the movement of labour from agriculture to industry, or from farm to nonfarm sectors, in a dual economy model and the impact of this process on the agricultural transformation. Next, this chapter discusses technical changes and institutional innovations in agricultural development discussed by Hayami and Ruttan (1985). This theory plays an important role in policy reforms, particularly land reforms and product diversification. The chapter also reviews the analysis of agricultural problems by Schultz (1953 and 1978) and Hayami (2004 and 2007), and the evolutionary processes of agricultural development in land-poor countries developed by Otsuka (2013 and 2015), Otsuka and Estudillo (2010). The experience of agricultural transformation in selected East Asian countries is also reviewed. Finally, the chapter provides a framework of policy reforms for transformation of smallholder agriculture, which emphasises product diversification, the development of a rural nonfarm economy and land reforms.

An overview of agricultural reforms and structural transformation in Vietnam are presented in Chapter 3. The discussion surveys the evolution of agricultural reforms, which provides the policy setting for examining the themes of crop diversification, nonfarm participation and part-time farming, and land reforms in rural Vietnam in the ensuing chapters. In addition, this chapter provides insights into Vietnam's smallholder agriculture in the light of increasing industrialization. First, the chapter examines land policy reforms. The causes and problems of land fragmentation are analyzed. Second, a detailed examination is carried out on food security and the 'rice first' policy. Finally, the chapter discusses the development of the rural nonfarm economy, part-time farming and rural wages in Vietnam. After examining the development of the Vietnamese agricultural sector, it then focuses on current issues in Vietnam's agricultural transformation, which are empirically studied in the next chapters.

The core of the thesis consists of Chapter 4 to 6 dealing with crop diversification (Chapter 4), nonfarm participation and household production choices (Chapter 5), and the effect of land reforms toward land consolidation (Chapter 6). Chapter 4 focuses on investigating the economies of diversification, determinants of technical efficiency, and responses of family labour to increasing cost stress in a multi-output environment. This chapter applies the method proposed by Paul and Nehring (2005), which is widely used in the literature, in looking for the evidence of scale economies, economies of scope,

output complementarity, and technical efficiency in multi-crop production. In addition, this chapter uses the method developed by Blackorby and Russell (1989), and Grosskopf et al. (1995) to compute the cross and own elasticity of shadow prices with respect to input, and the Morishima elasticity of substitution, which support the study of household behaviour in response to rising cost stress in farm production. This study estimates the input distance function to measure the economic performance of diversified farms. The model is transformed into a stochastic production frontier perspective, which can be estimated by maximum likelihood techniques (Paul and Nehring 2005).

Chapter 5 investigates the effect of nonfarm participation on household production choices in rural Vietnam. While the previous chapter provides new insights into changes from the 'rice first' policy to crop diversification, this chapter explicitly studies the backward linkage in agricultural production from an increasingly important aspect: nonfarm development and part-time farming. The potential impact of nonfarm participation on household production choices is quite complex (Taylor and Lybbert 2015). Therefore, this chapter applies different methods such as OLS, 2SLS, and matching techniques to estimate the model using total, north, and south survey samples. It covers the impact on rice production, farm revenue and non-rice farm revenue, and crop and livestock expenses. In addition, this chapter investigates the effect of nonfarm participation on total real household expenditure. By using different methods, it is possible to check the consistency of the empirical results.

Within the narrower context of this thesis, Chapter 6 rounds off the analytical core. It aims at evaluating the effect that land reforms directed towards land consolidation have on the labour allocation and economic diversity of farm households. The overview in Chapter 3 introduces equity-oriented land reform and its impacts. Chapter 6 further analyses the impact of land fragmentation. It begins empirically by providing a theoretical framework to determine the effect of land fragmentation on labour allocation. It extends the approach of Jia and Petrick (2013), who argue that the impact is theoretically ambiguous. By using the approach of agricultural technical changes, and the specification developed by Acemoglu (2010) and Bustos et al. (2013), the chapter first attempts to evaluate whether the effect of land fragmentation is theoretically determined. Regarding the empirical analysis, this chapter examines the impact of land fragmentation on nonfarm outcomes as nonfarm labour supply, and nonfarm profits, and farm outcomes such as farm labour supply, profits and output. In addition, the chapter investigates whether or not the change in land fragmentation in Vietnam is likely to be driven by factors such

as plot exchange, or land market transactions using household survey samples.

The final chapter, Chapter 7, summarizes the main findings of the thesis. By providing the evidence of small farms' behaviour and decision-making processes in the new settings, this chapter discusses policy implications for achieving successful outcomes of the transformation of smallholder agriculture in Vietnam. The findings of the thesis support policy makers in designing appropriate strategies on restructuring the agricultural sector. The chapter ends with suggestions for further research on selected issues that emerge from the study.

Chapter 2

Agricultural transformation in a land-poor and labour-abundant country: an analytical framework

2.1. Introduction

In most societies, the growth of agricultural output is essential to the development process despite the declining role of the agricultural sector during economic structural transformation (Thirlwall 2006; Perkins et al. 2006). Taylor and Lybbert (2015) find that a one per cent growth in agriculture is associated with nearly a half (0.45) percentage point increase in non-agricultural growth. While there have been theoretical studies on the role of agricultural growth to economic development, the process of agricultural transformation itself has also received the attention of most development economists.[5] The dual economy models developed by Lewis (1954), and then extended by Fei and Ranis (1961), present the impact of structural transformation on agriculture until the economy reaches the Lewis turning point (Fei and Ranis 1964). Experience during agricultural transformation in East Asian economies, which have small and fragmented landholdings in common, has shown that the agricultural sector lost its comparative advantage during industrialization process (Otsuka 2013 and 2015; Otsuka and Estudillo 2010). Given that the majority of farms are small in Asia, a major issue for smallholder agriculture is how to improve agricultural productivity and income. Focus is increasingly being shifted to technical change and institutional innovations during rapid economic structural change.

The objective of this chapter is to survey theories of the agricultural transformation process itself; this assists the development of the analytical framework for the thesis. It also aims to answer the question of what are main problems facing smallholder agriculture and strategies to cope with. Policy reforms are developed by identifying problems in the

[5] Agricultural transformation is defined as a significant change in the pattern of product combination, production sequences, and resource use in agriculture (Hayami and Ruttan 1985, p. 428). There are some books discussing agricultural transformation including "Transforming Traditional Agriculture" Schultz (1964), "Subsistence Agriculture and Economic Development" Wharton (1969), and "Agricultural Development: an International Perspective" Hayami and Ruttan (1985).

agricultural transformation in land-poor and labour-abundant countries.[6] The focus is mainly on theoretical frameworks that are relevant to the context of Vietnam. World Bank (2011a) shows that Vietnam has become a lower-middle-income economy.[7]

This chapter is structured as the follows. Section 2.2 reviews relevant theories on agricultural transformation. There are two groups of theories selected: (1) the dual economy model by Ranis and Fei (1961); and (2) the theory of technical changes and institutional innovations by Hayami and Ruttan (1971 and 1985). This section also reviews the evolutionary process of agricultural transformation developed by Schultz (1978), Hayami (2007), and Otsuka (2013). It is a summary of the agricultural transformation in land-poor countries, particularly in Asia, which has common features in agricultural development. Section 2.3 presents the experience of agricultural transformation in East Asia, which have the same characteristic of small and fragmented landholdings in agricultural production as Vietnam. The analytical framework of policy reforms is developed in Section 2.4, which provides the key arguments and ideas for underpinning the topics of this thesis.

2.2 Analytical framework

2.2.1 The dual economy model

This section reviews the model of a dual economy, first developed by Lewis (1954) and then further extended by Fei and Ranis (1961). The dual economy model describes the evolution of thought on agricultural development in a labour surplus country. The section mainly focuses on the model extended by Fei and Ranis (named Fei-Ranis model in this chapter) because the Lewis model neglects the role of the agricultural sector in promoting the development of the industrial sector (Taylor and Lybbert 2015). The Fei–Ranis model shows the importance of investing in agriculture if a country wants its industrial sector to grow. It describes the relationship between the agricultural and industrial sectors.[8] The movement of labour from agriculture to industry is the central process around which the theory is constructed. In the industrial sector, profit maximization operates in competitive markets as postulated by the neoclassical

[6] Land-poor countries are defined as countries with small and fragmented landholdings during the economic structural transformation. Small farms are defined as farms with less than two hectares of crop land and those depending on household members for most of the labour (Hazell and Rahman 2014).
[7] According to World Bank's classification. In 2011, GNI of Vietnam was USD 1010 USD (World Bank 2011a).
[8] For further details in the Fei-Ranis model, see Fei and Ranis (1961, 1964, 1997).

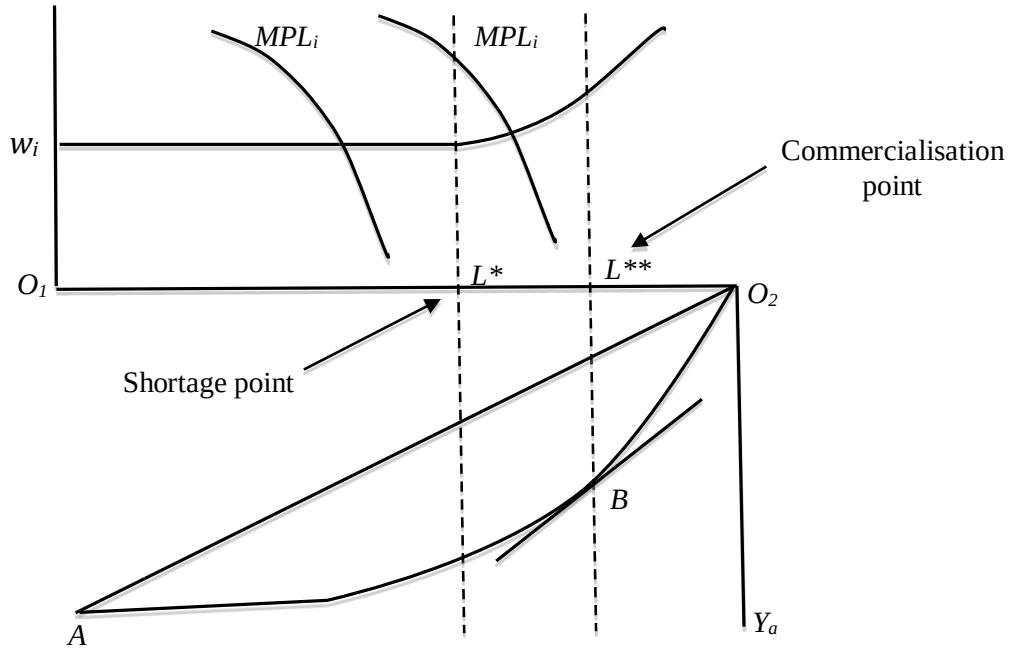
economists. In addition, labour is paid the value of its marginal product. Demand for labour in this sector depends on the availability of capital, technological advances, and the demand for industrial goods. In the agricultural sector, traditional methods of production employ simple techniques with a low level of capital. Furthermore, the wage rates are institutionally determined at or near the subsistence level, in the tradition of classical economics.

In the agricultural sector, there is an excess supply of labour at the institutionally determined wage. This situation ensures perfectly elastic supply of labour from agriculture to industry. If the industrial sector wishes to employ workers, it must pay a higher wage rate set slightly above the subsistence level to compensate for the higher costs of living over the subsistence economy. Given a labour surplus at this wage rate, output growth in the industrial sector does not increase wages, but raises the share of profits in the national incomes. Fei and Ranis argue that under these conditions, it is possible to transfer labour from the agricultural sector to the industrial sector without reducing agricultural output, and without increasing the wage rate in the industrial sector during the early stages of development. Moreover, they also argue that the movement of one worker from the agricultural sector to the industrial sector results in an agricultural surplus. In this system, agriculture contributes both workers and surplus production in the form of a wage fund for the expansion of the industrial sector.

Based on product dualism, Fei and Ranis (1964) elaborate on features of the marginal product of labour in the agricultural sector in three periods. The first period starts with zero marginal products in agriculture so that a shift in labour from agriculture to industry does not reduce the former's output. In the second period, however, the marginal product becomes positive, labour reallocation does not force the agricultural wages to rise, as long as in agriculture the marginal product is less than the wage rate. Agricultural output reduces and the terms of trade between two sectors are changed in favour of the agricultural sector. If migration continues, the commercialisation point is reached. As a result, the third period begins when the marginal product reaches the wages, causing a further shift in labour to the industrial sector, and accelerating both the marginal product and wages in the agricultural sector to the same degree. This is defined as the commercialisation point. This period marks the end of the take-off and the beginning of self-sustained growth.

The Fei-Ranis model presenting a transfer of abundant labour from the agricultural sector to the industrial sector is depicted in Figure 2.1. In this diagram, O_1O_2 represents the total labour force, with industrial labour measured from O_1 to the right and agricultural labour from O_2 to the left. Curve O_2BA is the total product curve for food. The line w_i represents the supply curve for labour to the industrial sector. If the agricultural labour force is greater than O_2L^* (the shortage point), the marginal product of labour is zero. If the agricultural labour force is less than O_2L^{**} (the commercialization point), the marginal product of labour exceeds the constant institutional wage rate. As long as the demand for labour in the industrial sector is less than O_1L^*, the movement of labour from the agricultural sector does not reduce agricultural output. Labour is available to the industrial sector at the constant institutional wage rate.

Figure 2.1 **Labour allocation in the Fei-Ranis model**



Source: Fei and Ranis (1964)

However, when labour demand in the industrial sector exceeds O_1L^*, the transfer of workers from agriculture results in a reduction of agricultural output, a relative increase in food prices and a rise in wage rates in the industrial sector. In addition, if labour demand in industry exceeds L^{**} (the commercialization point), the wage rate in the agricultural sector increases, along with the wage rate in the industrial sector. As a result, the agricultural surplus to the industrial sector reduces further, because of both

the effect of the decline in the agricultural labour force on production, and the rise in food consumption from higher wages received by agricultural workers.

The Fei-Ranis model emphasizes that at the "commercialisation point", the marginal product of labour exceeds the institutionally determined wage rates in agriculture. Therefore, the industrial sector is required to raise the industrial wage to compete with the agricultural sector for labour. The commercialization point in the Fei-Ranis model is bolstered by two effects that are further intensified because of the international context.[9] These include the 'push' effects of technology change in agriculture in conjunction with the 'pull' of industrial labour demand, both domestically and internationally. Further, Fei and Ranis decompose technological change into two components. First, innovation intensity implies the adaptation of external technology to domestic production. This technology permits output to expand without increasing capital or labour stock. Second, a factor bias of production is related to the selection of imported technology, whether labour using or capital using.

Implicit in the discussion so far is the hypothesis that the transfer of labour from agriculture to industry stimulates agricultural transformation in a labour-abundant country. This transfer only reduces agricultural output if there is no labour surplus in the agricultural sector and rural wages rise. However, the dual economy model carries with its various notable limitations that have been observed over the past several decades. One criticism is that a labour surplus issue appears to ignore the microeconomic foundation. Taylor and Lybbert (2015) claim that the dual economy model does not provide insights into what happens on a micro level to enable people to move up economically by participating in off-farm employment. There is no feedback of nonfarm participation on agricultural investments in the dual economy model.

In addition, Dixit (1970) shows that one of the most serious limitations in the Fei-Ranis model is that the treatment of productivity gain in agriculture is a result of neutral and exogenous shifts in the production function without any capital accumulation in the agricultural sector. Hayami and Ruttan (1985) point out that technical changes are difficult for an economy in the early phases of economic development. Nevertheless, it is applied in the agricultural sector when it becomes available. For instance, agricultural households can substitute labour workers by applying more labour saving machinery in

[9] As noted earlier, a commercialisation point coincides with the Lewis turning point in the Lewis model (Fei and Ranis 1961).

agricultural production, and thus coping with the increasing trend in wage rates in the agricultural sector in the Fei-Ranis model.

2.2.2 The theory of induced technical and institutional change

The purpose of this section is to review the theory of induced technical and institutional change in the process of agricultural transformation developed by Hayami and Ruttan (1971 and 1985) (named Hayami-Ruttan model in the chapter). The arguments in this theory are relevant for a better understanding of the important role of technical change and institutional innovations on the growth of agricultural productivity in developing countries. It should be noted that the focus of the thesis is to emphasize policies to promote both agricultural productivity and incomes of farm households in maintaining food security in the face of the rapidly economic structural change in Vietnam.

In the previous section, the Fei-Ranis model examines structural change in a labour-abundant country in the process of industrialization at the aggregate level. The Hayami-Ruttan model relaxes the assumption in the Fei-Ranis model by allowing technical changes and institutions as endogenous to the economic system and agricultural transformation. The Hayami-Ruttan model is examined in two sections. First, it addresses the role of technical changes in economic development when labour is transferred from agriculture to industry. Second, it discusses the theory of induced institutional innovation and the implications of property rights, efficiency and equity in agricultural policy.

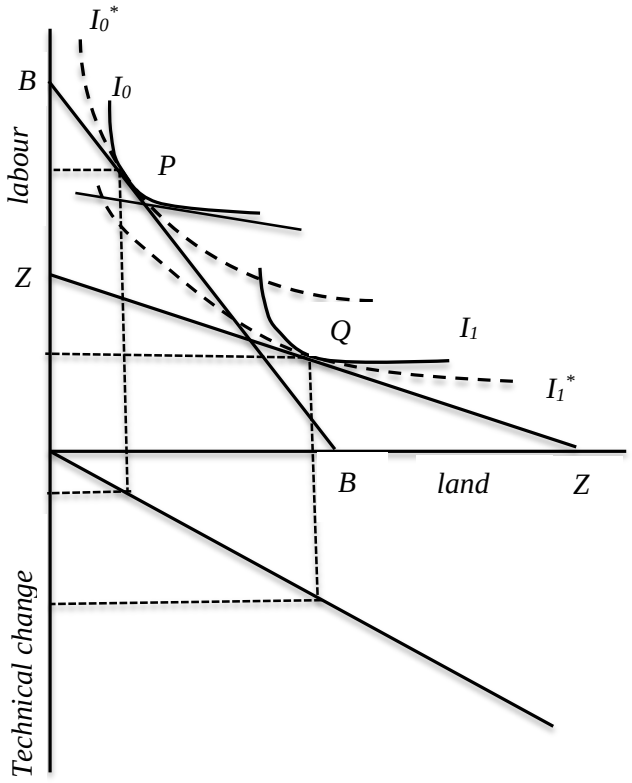
2.2.2.1 A model of induced technical change in agricultural transformation

Technical change is defined as any change in production coefficients resulting from the purposeful resource-using activity directed to the development of new knowledge embodied in designs, materials, or organizations (Hayami and Ruttan 1985, p. 86). This definition is similar to the approach of Hicks (1963). According to Hicks's definition, technical changes developed to facilitate the substitution of other inputs for labour "labour-saving" and ones developed to facilitate the substitution for other inputs for land "land-saving".[10] In addition, technical changes such as new husbandry practices or new varieties of seeds are not themselves substitutes for labour or land, but they are inputs,

[10] See Hicks, 'The Theory of Wages' (1963), Hayami and Ruttan (1971 and 1985) for further details of the definition of technical change and models.

which behave as catalysts to assist the substitution of the relatively scarce factors for the less scarce factors. Hicks (1963) argues that rising wages motivate labour-saving innovations. In agricultural economics, Hayami and Ruttan (1971 and 1985) further contribute to the development of theories related to technical change.

Figure 2.2 **The Hayami-Ruttan model of induced technical change in agriculture**



Source: Hayami and Ruttan (1985)

The model of induced technical change in agriculture is described in Figure 2.2. There are two phases in this model. It is assumed that the transformation from phase 0 to 1 causes the scarcity of labour relative to land in the agricultural sector, leading to the decline in land rent relative to wage rates. In addition, the model assumes that the price of technical change reduces relative to the wage rate for labour because it is facilitated from industry. As can be seen in Figure 2.2, I_o^* represents the innovation possibility curve at phase zero. It is the envelope of less elastic unit isoquants that correspond. I_0 captures a technical change, which is applied when the price ratio prevails. The point *P* in the model is defined as the minimum cost equilibrium point with a certain optimal combination of land, labour and nonhuman power to operate technical change. In this simplified model, technical change can be machinery or organizational changes in farm cultivation. Assume that machinery is substituted for labour in response to a change in wages. The change in the price ratio from *BB* to *ZZ* results in the technical

change represented by I_1. This change enables a farm labourer to work on larger land areas and use more technical change, for instance, machinery.

Figure 2.2 illustrates the trade-off between labour and land if there is an effect of technical change in agricultural transformation between phases in the industrialization process. The increase in wage rates, due to the shortage of labour as a result of economic structural transformation, induces invention and technical change, which in turn facilitates farm workers to cultivate a larger farmland. When the relative price of labour shifts from *BB* to *ZZ*, a new isoquant is chosen, which implies that a less labour and more land-intensive technique is selected. Thus, the model suggests that mechanization can substitute the shortage of labour workers, as shown in the Fei-Ranis model. Nevertheless, this model is not able to explain why East Asian countries such as Japan, Taiwan and Korea failed to expand farmland and transform the agricultural sector successfully during their industrialization. Ruttan (1981) successfully tested the model against the agricultural development experience of France, Great Britain, Germany and Denmark. Regarding the microeconomic version of the induced theory of technical change, Acemoglu (2001) further provides a microeconomic basis for the induced innovation theory. He argues that while the effect of factor prices induces technical change in order to raise the agricultural productivity of the scarcer factor, the growing market effect also induces changes to be geared toward improving the productivity of the more abundant factor of production.

2.2.2.2 A model of induced institutional innovations in agricultural transformation

This section continues a discussion on the theory of induced institutional innovations in the Hayami-Ruttan model, including the implications of property rights on efficiency and equity in agricultural policy. According to the model, the shift in the demand for institutional innovation is induced by changes in resource endowments and by technical changes. Institutions are defined as the rules of a society, or of organizations, that facilitate coordination among people by helping them form expectations, which each person can reasonably hold in dealing with others (Hayami and Ruttan 1985). This chapter focuses on property rights and the market institutions that are relevant to the analytical framework of the thesis.

According to the Hayami-Ruttan model, the development of new forms of property rights and more efficient market institutions may satisfy the demand for institutional innovations. The model finds that changes in factor endowments, technical changes, and

the growth in demand, induce changes in property rights and contractual arrangements to enhance more efficient resource allocation through market. Moreover, it shows that assigning more complete private property rights on land or other assets, is an institutional innovation that facilitates the allocation of land more efficiently. The land reform law that gives tenants stronger protection of their tenancy rights is a key such innovation. More interestingly, the model points out that institutional innovation increases efficiency at the expense of equity. On the contrary, institutions increase equity at the expense of efficiency.

There are several studies on the role of land tenure security on economic growth and agricultural development (Deininger and Feder 2009; Basley 1995; Brasselle et al. 2002; Fenske 2011). Secure property rights to land and well-functioning land markets are important in creating investment incentives, improving land allocations, developing financial markets, and increasing farm households' participation in off-farm labour markets (Deininger and Feder 2009). Moreover, the level and likelihood of land conflicts may decline when land rights are more secure (Fenske 2011). These studies support the Hayami-Ruttan model's view on institutional innovations

However, the agricultural transformation experience in East Asia in particular, and in other land-poor countries in general has been different, particularly in light of increasing part-time farming. These countries have maintained smallholder agriculture such as small farms and highly fragmented landholdings during their industrialisation and modernisation periods (Otsuka 2013). The average farm sizes showed no increase during the period of rapid economic growth in Taiwan where there are strongly protected tenancy rights (Bain 1993). Japan and Korea also seem to have experienced a similar pattern. Land constraints such as small and fragmented landholdings hinder mechanization in agricultural production in land-poor countries (Otsuka and Estudillo 2010). Although the Hayami-Ruttan model does not provide a comprehensive model of agricultural change in East Asia, it supports a framework to improve agricultural productivity. This can be achieved through the capacity to produce an ecologically adapted, and economically viable, agricultural technology in each country and region. The model also shows that the expected returns to political leaders from institutional changes that facilitate the opportunity to exploit technical change are key inducements to institutional innovations (Hayami and Ruttan 1985). The next section further explores the evolutionary changes of agricultural development in land-poor countries, particularly in Asia.

2.2.3 Agricultural problems and the evolutionary process of agricultural development in a land-poor country

The chapter further reviews agricultural problems at different stages of economic development and agricultural transformation in land-poor countries. It adapts the analysis of agricultural problems from Schultz (1953) and Hayami (2007), and agricultural transformation in tropical Asia from Otsuka (2013), Otsuka et al. (2014), and Yamauchi (2014). The agricultural problem is defined as a problem of overriding concern to policy makers in terms of designing and implementing agricultural policies (Hayami 2007).

Schultz (1953 and 1978) present the two different problems of low-income and high-income countries. The 'food problem' occurs in low-income economies, which is characterized by rapid population growth and the shortage in the supply of food relative to the demand. Thus, governments' agricultural policy in low-income countries focuses in preventing the food shortage from occurring. In contrast, high-income countries face a 'protection problem' (Schultz 1953 and 1978). At the high-income stage, the capacity in food production is strengthened by advanced technology. In addition, food prices and farm incomes tend to decline. Supported by the powerful lobbying by farmers, the goal of agricultural policies is to prevent agricultural incomes from declining. Consequently, agricultural protection policies are widely used to protect the agricultural sector at the expense of consumers and taxpayers. These two different policy approaches have been identified as a major source of the disequilibrium of world agriculture (Hayami 2007; World Bank 2008).

In addition to the theory on the two agricultural problems developed by Schultz (1953, 1978), Hayami (2004 and 2007) introduces an agricultural problem in middle-income economies, based on Schultz's theory. He argues that farm incomes tend to reduce relative to nonfarm incomes due to the widening inter-sectoral productivity gap. Therefore, the prime concern of governments at the middle-income stage is to prevent income inequality from widening. Improving agricultural productivity through mechanization is important. At the same time, policies are reoriented toward supporting farmers' incomes. This agricultural problem is known as the 'disparity problem' between sectors. Hayami (2007) also points out that underlying the widening income inequality between sectors at the middle-income stage is the reduction of the comparative advantage of agriculture. Moreover, the rate of decline is likely to exceed the rate of labour transfer from agriculture

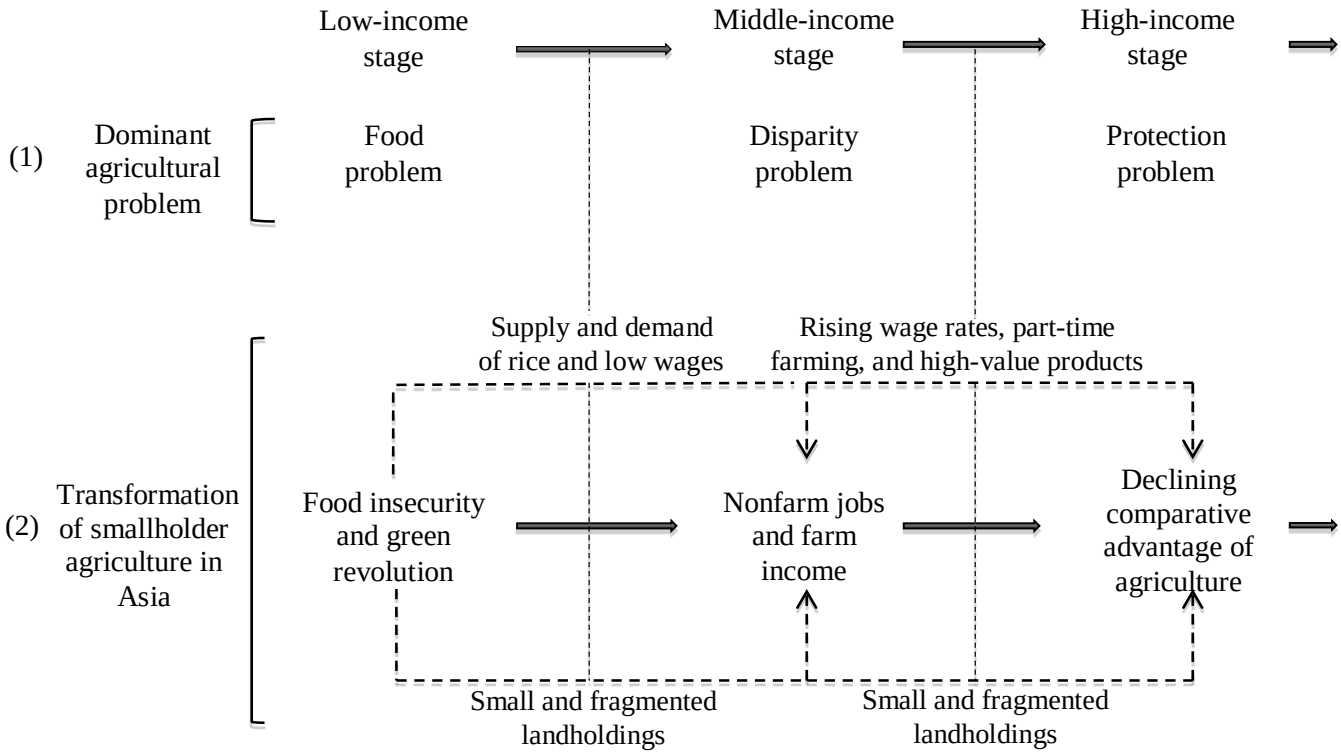
to industry in the dual economy model characterized by the weak absorption of rural labour into the formal sector. As a result, when the economy reaches a high-income level, protection measures have to be applied to keep social stability.

These three agricultural problems are integrated into the process of agricultural transformation in land-poor Asian countries. This chapter reviews both theoretical and empirical evidence, and provide a summary of agricultural transformation and the future of small farms in Asian land-poor economies.[11] It provides the background for the discussion on Vietnam's agricultural development and challenges facing smallholder agriculture in the following chapters. In order to illustrate the process of agricultural transformation in land-poor countries, this chapter develops a model that captures the theory of three agricultural problems by Schultz (1978) and Hayami (2004, 2007) with the findings in the literature. This is the first attempt in the literature that provides an integrated model on the agricultural development in land-poor countries. Furthermore, it focuses more on agricultural transformation at the middle-income stage because it is more relevant to the Vietnamese context.

Figure 2.3 shows the agricultural problems and agricultural transformation in land-poor countries in Asia at different stages of economic development including low-income, middle-income, high-income stages. Panel (1) describes the dominant agricultural problems in world agriculture, while Panel (2) is a summary of the process of agricultural transformation in land-poor economies in Asia. Otsuka (2013) argues that land-poor countries in Asia have experienced the 'common' evolutionary process of agricultural development. This process includes three following problems: food insecurity and the role of green revolution at the low income level; the emergence of nonfarm jobs; and rising income inequality between sectors at the middle-income stage; and the reduction of food self-sufficiency associated with the reduction of the comparative advantage of agriculture at the high-income level.

[11] There have been several studies on agricultural transformation in Asian region and in a specified Asian country (Haymi and Ruttan (1985) for theoretical studies and the case of Japan; Otsuka (2013) for the analysis of common evolutionary processes of agricultural development in land-poor countries, particularly in Asia; Yamauchi (2014) for empirical evidence in Indonesia).

Figure 2.3 **The agricultural problems and agricultural transformation in Asian land-poor countries at different stages of economic development**



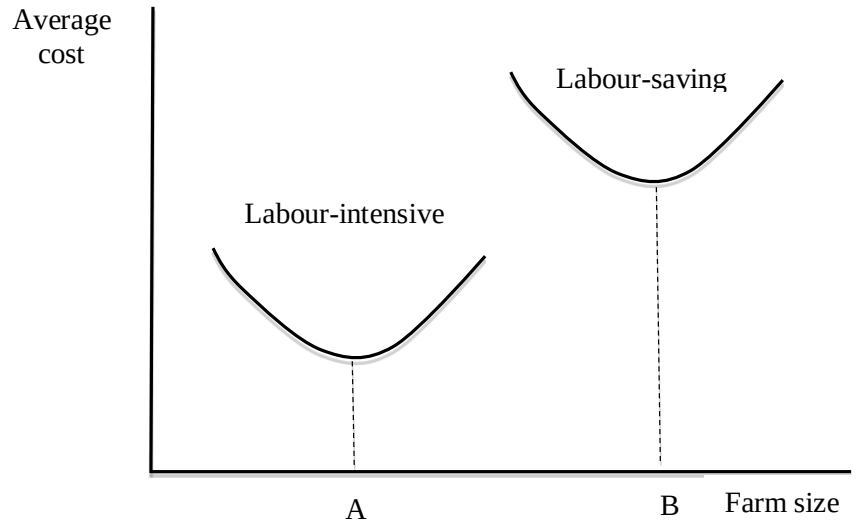
Source: Developed from Schultz (1978), Hayami (2007), Otsuka (2013) and the literature on the agricultural transformation in Asia.

Land-poor countries in Asia account for 87 per cent of the world's 450 million of small farms (IFPRI 2007). These countries have experienced a similar pattern of agricultural transformation as described in Figure 2.3. At the low-income stage, the food insecurity problem is similar to the 'food problem' firstly used by Schultz (1953 and 1978). Prior to 1965, the prime concern of governments in tropical Asia in designing agricultural policies was how to prevent a shortage of food (Otsuka 2013). Food security strategy at this stage was food self-sufficiency, which resulted in the first Green Revolution in tropical Asia. The Green Revolution, which took place between 1965 and 1995, contributed to improving rice yields in Asia in the late 1960s (Hazell 2009). It mainly focused on the application of technical changes such as high-yield varieties, irrigation reform, improved fertilisers and pesticides, substantial public investment and policy support for agriculture (Bain 1993; Hazell 2009). Some Asian countries also carried out equity-oriented land reforms e.g. land reform in Taiwan in the early 1950s, China in the late 1970s, and in Vietnam in the late 1980s. These land reforms contributed to increasing rice outputs in Asia (Bain 1993; Huang et al. 2012; Dang et al. 2006). The success of the Green Revolution enabled tropical Asian

countries to solve food insecurity problems and broaden opportunities for economic growth and structural change during the transitional period from low-income stage to middle-income stage (Thirwall 2006).

Nevertheless, the Asian Green Revolution had a significant impact on the demand and supply of rice. In addition, wage rates were low at this phase (Hazell and Rahman 2014). When wage is sufficiently low relative to machine rental, labour-intensive farming is cheaper and more efficient (Otsuka et al. 2014). This view is developed and illustrated by Otsuka et al. (2014) in Figure 2.4 by the lower average cost curve in low-wage economies. It should be noted that in land-poor countries in Asia, food production was characterized by small and fragmented landholdings during the transition to the middle-income stage.

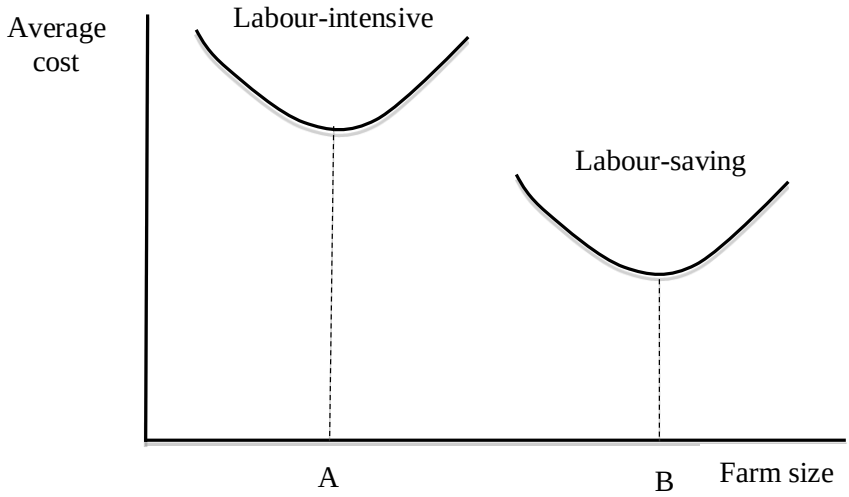
Figure 2.4 **Illustration of optimum farm size in low-wage economies**



Source: Otsuka et al. (2014)

At the middle-income stage, the disparity problem becomes the main concern when nonfarm sectors grow faster than farm sectors (Hayami 2004 and 2007). In addition, economic growth and improvement in cereal productivity affect supply and food consumption. Consequently, income from rice tends to fall, or not increase as much, relative to other sources of farm and nonfarm incomes. Given the hardship in small farms associated with a lifestyle of long hours and low returns of agriculture, part-time or off-farm employment is a means of bolstering income (Hazell and Rahman 2014; World Bank 2008). It is at the middle-income stage that the agricultural sector starts to face an income problem, as shown by Hayami (2007).

Figure 2.5 **Illustration of optimum farm size in high-wage economies**



Source: Otsuka et al. (2014)

In addition, the transitional period from middle-income to high-income in land-poor countries is accompanied by rising real wage rates and movement of farm labour into nonfarm sectors, which results in an increase in the number of part-time farm households (Figure 2.3). Consequently, labour costs increase. Otsuka (2015) argues that machines must substitute for labour, or farm households have to apply less labour-intensive farming, in order to save labour costs. However, in order to apply mechanisation efficiently, farm sizes and land consolidation must expand. If the wage rates increase substantially relative to machine rental, the optimum method of farm production should change from labour-intensive to labour-saving farming (Otsuka et al. 2014). As can be seen in Figure 2.5, the labour saving method is more efficient in large farms. If there are constraints in land markets and farm size cannot expand, the comparative advantage of agriculture will decline (Otsuka 2013).

At the high-income stage, in light of rising real wage rates, land-poor countries still keep smallholder agriculture. As a result, the prime concern of governments in high-income countries is to protect the agricultural sector, which is similar to the arguments of the protection problem developed by Schultz (1978). Otsuka (2015) concludes that given small and fragmented landholdings in most Asian economies, the decline in comparative advantage of agriculture is the result of preservation of labour-intensive small-scale agriculture in the midst of high and rising wages.

2.3 Experience of agricultural transformation in East Asia

This section surveys the agricultural transformation of the economies of Japan, Taiwan, and China. The situation in Taiwan and China is similar to Vietnam's labour abundant and land-poor context. Otsuka and Estudillio (2010) show that the path of agricultural transformation presented in Figure 2.3 can be followed by high-performing Asian economies, unless labour-saving methods are efficiently applied. This examination is set in the context of policy reforms that foster significant structural change as well as challenges facing the agricultural sector, in order to identify the most relevant comparisons for studying the Vietnamese experience during the restructuring of smallholder agriculture.

Lessons drawn from agricultural transformation in Japan, Taiwan, and China include that significant inefficiency in smallholder agriculture arises if farm sizes remain small and land fragmentation remains severe during the industrialization process. Moreover, the diversion of resources from rice production to the production of commodities with higher income elasticities becomes important for maintaining incentives for the use of resources in agricultural production (Hayami and Ruttan 1985). New patterns of product combination and resource use, different from traditional rice monoculture, need to be developed. The growth of agricultural productivity is important in sustaining food security and the comparative advantage of agriculture (Warr 2014).

Japan was the first successfully industrialized country in East Asia. Its agricultural sector was rapidly transformed after the Second World War. Japan carried out its land reforms from 1946 to 1950, which reallocated land to famers and established a land ceiling of 3 hectares for each farm household. This land reform caused severe land fragmentation and small farm sizes (Hayami 1988). The average farm size was 0.8 - 1 hectare with 10 to 20 plots. Each plot covered 0.06 hectare and the average distance between plots was 4 km (Ogura 1963). The number of farm households reduced by only 20 per cent from 1960 to 1978 (Hayami and Ruttan 1985).

According to Hayami and Ruttan (1985), the increase in the number of part-time farm households explains why there was so little reduction in the number of farm households, in spite of the reduction of population in the agricultural sector. Between 1960 and 1978, the number of part-time farm households increased from 30 per cent to 70 per cent of total farm households. As a result, farmers with secure nonfarm

employment kept their agricultural land and worked on their farms in their spare time. This created the difficulty faced by full-time farmers to expand their farm size.

In Japan, part-time farming mainly concentrates on rice production because the rice sector receives support from the government (e.g. the procurement policy and subsidies) (Hayami 1988). Rice farmers often sell rice through sole agents of government rice marketing. Moreover, the system of agricultural research and extension has traditionally been focused on the rice sector, which means rice production is easier than other crops. However, Otsuka (2013) shows that the grain self-sufficiency ratio in Japan has declined rapidly since 1961. Consequently, the Japanese agricultural sector has lost its comparative advantage. It should be noted that the rice self-sufficiency ratios also reduced significantly in other East Asian countries in parallel with Japan (Otsuka 2013).

Regarding Taiwan, this country has been transformed from an agricultural to an industrialized country, based on utilisation of labour abundance. Land reforms in the period 1948-1956 resulted in the vast majority of small and fragmented landholdings in the Taiwanese agriculture (Bain 1993). Taiwan started exporting its oversupply of rice in 1952. In the early 1980s, the decline in the international rice price caused low incomes for small farms and the consequent move by farmers into part-time off-farm employment as a means of increasing household incomes (Bain 1993, p. 44). As a result, Taiwan reduced rice production and changed to other crops with higher values.

In Taiwan, while the problems of farm sizes and land fragmentation were not solved in the second land reforms in the early 1980s, rapid increase in real rural wages and low agricultural prices during the industrialization process in the 1980s and 1990s led to high production costs and low returns in agricultural production (Fu and Shei 1999). Bain (1993) shows that "the Taiwan miracle" of industrial change was quite a different story for agricultural development. Consequently, the agricultural sector lost its comparative advantage. In order to maintain incentives in agricultural production, the Taiwanese government has spent huge amount on price support and input subsidies, accounting for 30 per cent of the total agricultural budgets in the 1990s (Fu and Shei 1999).

In the second Taiwan land reform in the early 1980s, the government encouraged farm households to consolidate their land. The land ceiling was demolished. Moreover, the government supported credit for farmers to purchase more land. However, these policies were not successful in reducing land fragmentation and small farm size (Bain,

1993). Bain argues that part-time farming can be attributed to the difference between demand and supply of agricultural land. Young family members worked in cities and industrial areas, while old people and women stayed in the rural areas. Furthermore, nonfarm income also supplemented the household income, thereby reducing the demand for land sales. Bain (1993) also shows that the expansion of the industrialization process pushed the increase in land prices in rural areas, which in turn discouraged farmers from expanding farm size or purchasing or renting neibouring plots in order to reduce the problem of land fragmentation.

Similar to Taiwan, China is also an interesting case of a land-poor and labour-abundant country that underwent a remarkable agricultural transformation in the process of industrialisation. China started its land reform in 1978 by establishing the household responsibility system and increasing the state purchase prices for agricultural products, which led to a large improvement in agricultural production (Lin 1992; Perkins 1988). Agricultural land was reallocated in egalitarian principles, which led to small farm sizes and severe land fragmentation (Jia and Petrick 2013). According to Lin (1992), agricultural outputs increased at the annual rate of 7.4 per cent from 1979 to 1984. During this period, the reform brought incentives for farmers to increase agricultural production. As a result, agricultural growth contributed to poverty reduction and pushed the country out of the stagnation resulting from the Culture Revolution and the central-planning mechanism in the 1970s. Agricultural growth has, however, slowed down since 1985. Lin (1992) argues that the reasons for the reduction of agricultural output were the completeness of the household responsibility system in 1983, and the increase in migration of rural labour to urban areas, along with and the development of the rural nonfarm economy.

However, Otsuka (2013) shows that sharply rising rural wage rates in light of massive migration to urban areas and participation in rural nonfarm sectors has been one of key reasons explaining the declining agricultural growth in China, particularly since the late 1990s. Moreover, Christiaensen (2011) finds that the average farm size remains 0.6 hectare - no remarkable increase in farm size has been observed in China during the industrialisation process. The increase in part-time farming and rural wages will lead to a decline in the comparative advantage of agriculture unless there is no improvement in labour savings methods. It is noteworthy that China has maintained a net trade deficit in grains since 2006 (OECD and FAO 2013). Otsuka (2013) also predicts that the grain self-sufficiency ratio may decline in China unless the problems

of land constraints and farm income are solved. Consequently, China may become a major importer of grains in the future, which may result in a sharp increase in world food prices and trigger another food crisis.

2.4 Policy reforms for transformation of smallholder agriculture in the face of industrialisation and modernisation

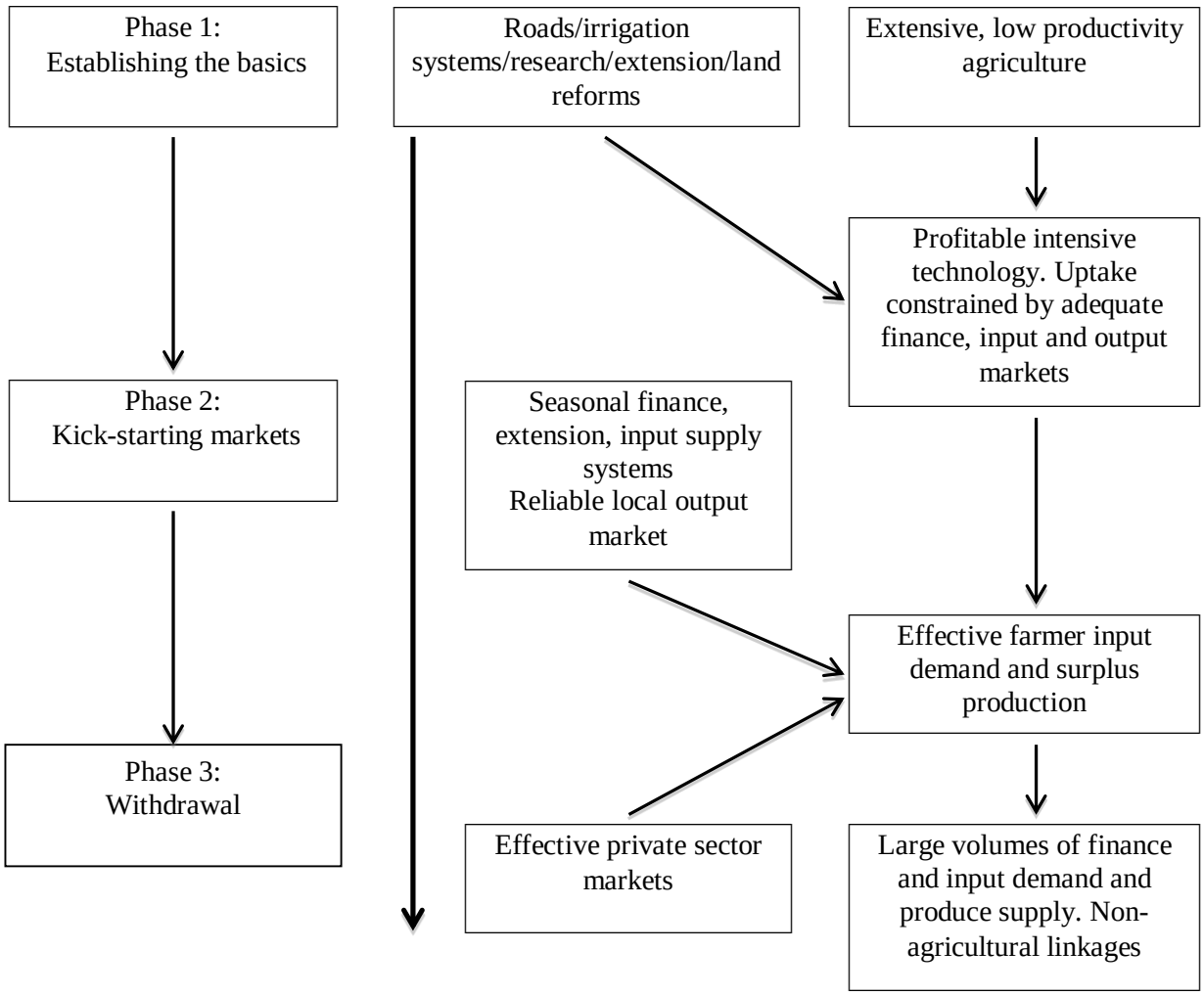
As the development of countries continues and incomes per capita rise, it is the normal historical experience for workers to leave agriculture to get nonfarm jobs, and for farms to consolidate and become larger and more mechanised. In addition, small farms that do remain either move to high-value production or become part-time (Hazell 2010). Hazell (2010) also argues that if this transition does not occur, farm incomes may fall seriously behind nonfarm incomes, consequently widening rural-urban income inequality.

The theoretical models and experience of agricultural transformation in land-poor countries show that smallholder agriculture plays a shrinking role in the process of industrialisation. In Asia, cereals, mainly rice, served as a leading growth sector during the green revolution in the 1960s to 1980s. However, as some Asian economies successfully industrialise, smallholder agriculture based on rice is becoming less relevant, and thus it is harder to avoid widening the income gaps between sectors and regions (Otsuka 2015). Moreover, Headey at al. (2010) find that the reverse transformation taking place in Asia could potentially result in a backlog of workers who may leave agriculture. In this context, this chapter argues that policy reforms for smallholder agriculture at the middle-income stage need to be designed to improve agricultural productivity through technical change and institutional innovation. In addition, the reforms need to support farmers to find higher-value opportunities in light of the increase in part-time farming, rising rural wage rates and income disparity.

There have been several studies that provide a policy framework supporting the agricultural transformation (Dorward et al. 2004; World Bank 2008; Anderson and Martin 2009; Thapa and Gaiha 2014; Hazell and Rahman 2014). Anderson and Martin (2009) show the declining comparative advantage of Asian agriculture and the application of protection measures at the high-income stage. However, they mainly concentrate on evaluating the effects of price and trade distortions in agriculture, and not the policy frameworks needed to support agricultural transformation. Dorward et al. (2004) review the institutional reforms and policies for pro-poor agricultural

growth, based on the summary of theoretical and empirical evidence. The authors argue that because the market failures change in the course of development, distinguishing policy phases in support of the agricultural sector is useful. Dorward et al. (2004) develop three policy phases to support smallholder agriculture (Figure 1). In Phase 1, the government plays a role in establishing the basics for improving food crop production, such as investments in agricultural research, irrigation infrastructure and land reforms for creating the conditions for pro-poor agricultural growth. This phase is characterised by extensive low-productivity agriculture in a low-income country.

Figure 2.6 **Policy phases in supporting agricultural transformation**

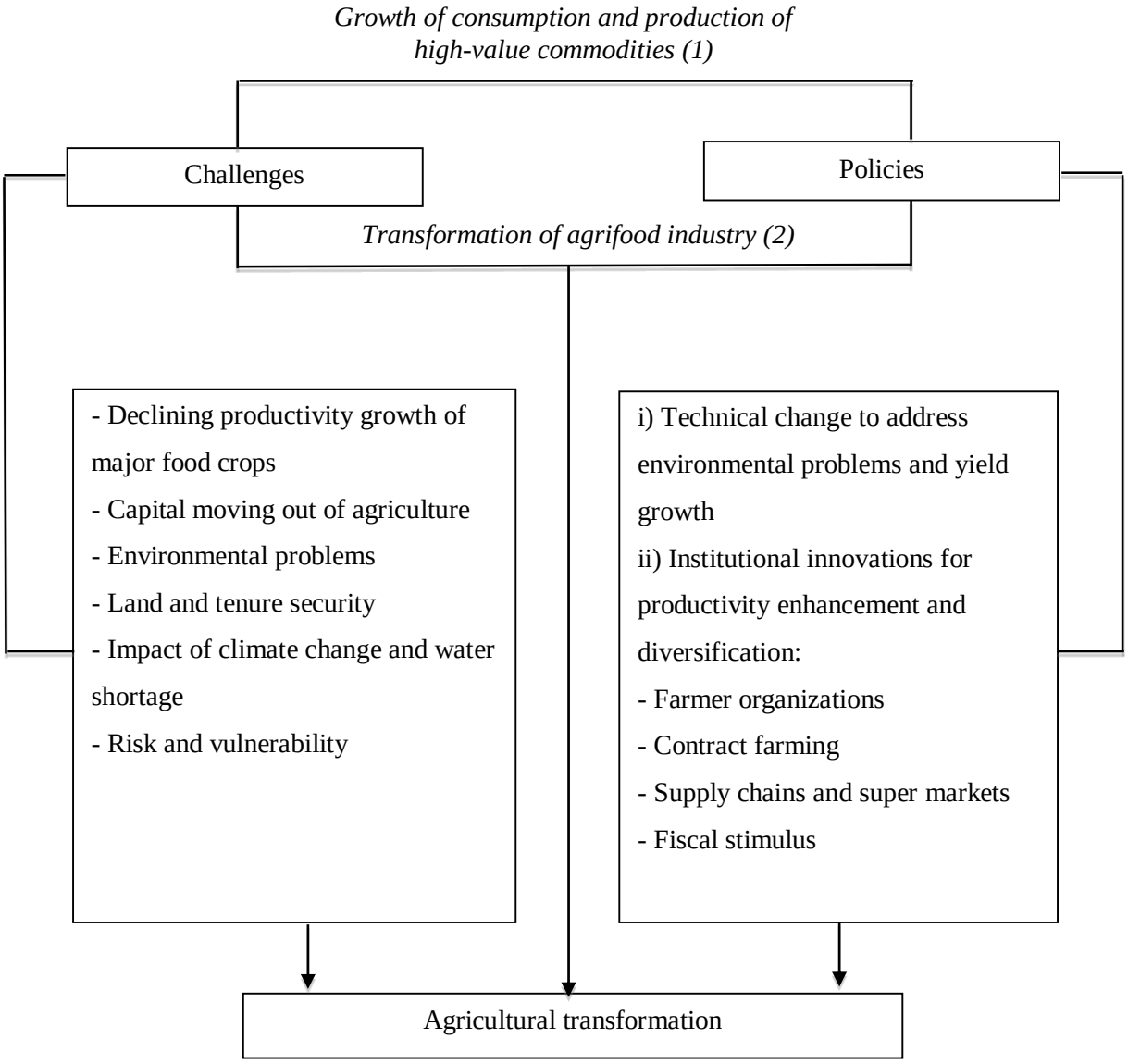


Source: Dorward et al. (2004)

However, the application of productivity-improved technical change is likely to be limited to small farms, with access to seasonal finance and markets once the basic conditions are in place. Thus, Dorward et al. (2004) suggest that the government should intervene in Phase 2 to facilitate farmers reduce transaction costs and risk when accessing seasonal finance and input markets. Furthermore, it is essential to invest in

institutional innovations that supply agricultural services, and in development of input supply systems and reliable output markets. When farm households adapt to new technologies and increase the transaction volumes of credit, input and outputs, transaction costs will decline. The government intervention should then be withdrawn and more attention paid to supporting the development of the rural nonfarm economy (Phase 3).

Figure 2.7 **Challenges and policy framework for smallholder agriculture in Asia**



Source: Developed from ideas and arguments of Thapa and Gaiha (2014)

The policy phases initiated by Dorward et al. (2004) have no strategies that deal with the emerging challenges for smallholder agriculture in middle-income countries like Vietnam and China. This policy framework emphasises institutional support for

labour-demanding technical changes in order to promote growth in poor rural areas. Regarding the agricultural sector in Asia and the Pacific, Thapa and Gaiha (2014) discuss new challenges facing agricultural transformation and suggest. The chapter reviews the ideas presented by Thapa and Gaiha (2014) and expresses these ideas in a policy framework in Figure 2.7.

Figure 2.7 introduces the policy framework for smallholder agriculture in Asia developed from Thapa and Gaiha (2014). It shows two recent transformations in Asia. The first transformation in agriculture is the growth of consumption and the production of high-value commodities - The increase in incomes has led to a shift in food consumption from grains and other staple crops to higher-value products. The second is the transformation of the agrifood industry - processing, wholesale, and retail. The participation of small farms in value chains and the supermarket revolution in the retail sector are born likely to have a substantial impact on agricultural production (Thapa and Gaiha 2014; Hazell and Rahman 2014).

Regarding challenges facing small farm, Thapa and Gaiha (2014) show that the decline in the productivity growth of major crops such as rice or wheat is one of the main concerns of policy makers in the Asian region. Consequently, diminishing returns in grain production result in capital moving out of agriculture. Hazell and Rahman (2014) also find that the displacement of cereal land for other crops or industrial development, and rising costs of production relative to the low price of cereals has made cereal production less profitable. In addition, degradation of the environment and land quality are also emerging challenges resulting from the intensive intensification of cereal production (e.g. three rice crop seasons per year). At the same time, smallholders in Asia and the Pacific must also cope with the negative impact of climate change, which may cause floods, and salt water intrusion threatening crop yield and the livelihoods of farmers (World Bank 2008). Intensive mono-crop systems such as rice system are causing deterioration of the soil and water (Ali and Byerlee 2002).

As regards land and tenure security, Thapa and Gaiha (2014) support equity-oriented land reforms, which seems in contradiction to the problems of small and scattered landholdings. Thapa and Gaiha use the argument developed by Lipton (2006), i.e. small farms tend to be more productive than large farms because of the inverse relationship between farm size and productivity. However, Otsuka et al. (2013) conclude that the agricultural sector in Asia will lose its comparative advantage in the process of industrialisation, and increasing

part-time farming and wage rates if land reforms fail to expand farm size and reduce land fragmentation. In order to deal with new challenges facing smallholders, Thapa and Gaiha (2014) develop a system of policies which include two components: technical changes and institutional innovations. However, these suggested policies mainly focus on maintaining and supporting small farms. The experience of the agricultural transformation in East Asian economies has revealed the importance of land reforms, crop diversification, the development of the rural nonfarm economy, input subsidies, increasing public spending in agricultural research, and rural infrastructure. Suphannachart and Warr (2011) find that public investment in agricultural research and development has a positive and significant impact on TFP growth. In addition, Haggblade et al. (2007) also find that more public spending on rural infrastructure reduces transaction costs and attracts more investment in agricultural production.

2.5 Concluding remarks

This chapter provides a review of both theoretical and empirical literature on agricultural transformation in a land-poor and labour-abundant country during industrialisation and rapidly economic structural change. In addition, it supports the development of the analytical framework in this current thesis. There are two key theoretical models that are examined. First, the Fei-Ranis dual economy model in a labour-abundant country is helpful for understanding the effect of economic structural transformation on the agricultural sector. The model implies that the transfer of labour from agriculture to industry causes a reduction of agricultural output if rural wages rise. Second, the Hayami-Ruttan model is examined. It allows technical changes and institutional innovations to be endogenous in the process of the agricultural transformation. These innovations are important in improving agricultural productivity and transforming the agricultural sector in light of rapidly economic structural change in rural areas.

In addition to theoretical models, the chapter discusses agricultural problems and the evolutionary processes of the agricultural sector in a land-poor country by reviewing the three agricultural problem model developed by Schultz (1978) and Hayami (2004 and 2007), and the evolutionary process of agricultural development in Asia by Otsuka (2013 and 2015). This discussion implies that in the face of rising rural wages and movement of farm labour into nonfarm sectors, the comparative advantage of agriculture will decline if there is no expansion of farm size and land consolidation in

those land-poor countries at the middle-income stage. Therefore, the policy framework emphasizes the development of nonfarm sectors, crop diversification, input support, and land reforms, which are also the research topics of the thesis. The remaining parts of the current thesis examine these themes empirically in the context of the Vietnamese economy. The literature review related to topics and answers to research questions are introduced in each key essay in the thesis.

Chapter 3

Agricultural reforms and structural transformation in Vietnam since economic reforms in 1986

"Vietnam needs to adopt the seemingly paradoxical stance of giving a high priority to raising agricultural productivity while recognizing that success can come only as agriculture declines as an employer of labour"

(World Bank 2000, pp. 12)

3.1 Introduction

Vietnam started its economic reforms in 1986, and has transformed from a central planning economy to market economy (Glewwe et al. 2004). Economic growth has brought about great achievements in poverty reduction and rising income. There have been many factors contributing to the economic success of Vietnam, and agricultural reform played an important role. Minot and Goletti (1998), Benjamin and Brandt (2004), and Dang et al. (2006) argue that agricultural reforms in the late 1980s contributed greatly to raising both food production and rural households' welfare. Further significant structural reform toward an open, market-oriented economy was introduced in the early 1990s with the emphasis of private sectors, foreign direct investment, manufacturing sectors and export-oriented trade. During the period 2000-2005, Vietnam's economic reform emphasised the liberalisation of investment and foreign trade. Since the joining the WTO in 2006, Vietnam has focused on macroeconomic stability, restructuring the state-owned enterprises, public spending and agriculture.

While past achievements in the agricultural sector are impressive, there are still great challenges ahead. Income disparity between regions and sectors has become an increasing concern since 2000 (World Bank 2014b). The rising inequality parallels the decline in agricultural growth (World Bank 2014b). In addition, Vietnam has been experiencing rapid industrialisation and rising wages, both affect the lives and livelihoods of millions of small farms (World Bank 2012). The developments of nonfarm sectors, an increase in part-time farming and environment degradation have

put more pressure on Vietnam's food security, with its emphasis on intensive rice production based on small and fragmented landholdings in the whole country.

This chapter surveys the evolution of agricultural reforms in Vietnam since 1986. It starts by examining a process of agrarian transformation that has swept through rural Vietnam since the mid-1980s, resulting in the replacement of collectivized production by household farming. A key theme of this chapter is the policy transition toward ensuring the comparative advantage of agriculture, food security, and structural changes. This analysis provides the policy setting for examining crop diversification, nonfarm participation, and land reforms in the ensuing chapters. It also aims to provide insight into smallholder Vietnamese farming in the face of industrialisation. It discusses the effects of *Doimoi* (economic reform) for agricultural production and structural changes, and outlines the development constraints, and current issues facing smallholder agriculture in Vietnam.

The structure of this chapter is as follows. Section 3.2 presents the overview of economic reforms, agricultural growth and structural transformation in rural Vietnam. Section 3.3 discusses changes in land policies. The 'rice first' policy in Vietnam's food security strategy is examined in section 3.4. Section 3.5 evaluates the emerging trends of the rural nonfarm economy. The next section evaluates current issues facing smallholder agriculture in Vietnam and suggests relevant strategies. The final provides concluding remarks on Vietnam's agricultural reforms.

3.2 An overview of agricultural reforms, and structural transformation

Agricultural cooperatives dominated production activities in rural areas after the Vietnam War, from 1975 to 1988. These cooperatives were responsible for providing raw material inputs, land, and machinery to farm households according to agricultural production plans. In addition, they also took responsibility for controlling market functions, and selling products to the state at controlled prices (Athukorala 2009). In 1980, agricultural cooperatives covered 65.6 per cent of farm households in rural Vietnam (Dieu 2006). However, this collective model failed to create working incentives for farm households (Kompas 2004). Consequently, agricultural production stagnated and the country had to import food during the late 1970s and 1980s. The period 1976-80 revealed a bad situation for agriculture and for the whole economy. Agricultural output grew at only 1.9 per cent annually - Vietnam imported 1.6 million tons of food per year (Cuc and Tiem 1996). The shortage of food resulted in increasing

concerns among policy makers about the efficiency of collectivized agriculture (Ravallion and van de Walle 2008).

As a result, in order to cope with increasing food insecurity, Directive 100 CT/TW, issued in 1981 by the Central Council of Secretaries of the Vietnam Communist Party, created great reforms in agricultural production. The government introduced a contract system for agriculture, the same as the household responsibility system in China in 1978. This improved and extended the contract system for groups of farmers in cooperatives. Food production thereby increased to 15 million tons and kept increasing by 640,000 tons each year (GSO 1987 and 1991). Food imports reduced to 1 million tons for the whole period 1981-1985 (Dieu 2006).

Although these agricultural reforms were successful in increasing food production in the early 1980s, the reform lost its momentum amid renewed efforts by politicians to enforce the collectivization of agriculture (Athukorala 2009). In 1986 and 1987, Vietnam had to import 700,000 tons of food each year to cope with famine (Cuc and Tiem 1996). Many did not obtain adequate outputs to pay duty for cooperatives (Dieu 2006). Collectivized agriculture was widely deemed a failure. Therefore, the situation required a new policy to cope with a new situation. The decision to abandon collectivization and central planning in favor of a market-based economy was officially made in 1986.

In 1986, Vietnam announced the reform policy named *Doimoi* at the Sixth Party Congress. It aimed to transform the Vietnamese economy from a command economy into a market-oriented system. The economic reforms were implemented over three interrelated stages. The first in the 1980s was a gradual reform to increase the efficiency in agricultural and industrial production. Then, from the late 1980s onward, the policy shifted from a planned economy toward a more market-driven economy. At that stage, state-owned enterprises were exposed to more market disciplines. Trade and investment regimes were gradually liberalised. The third stage was marked by extensive liberalisation of trade and investment which began in the early 2000s.

Table 3.1 **Major changes in agricultural policies, 1986-2013**

Year	Policy changes	Remarks
1988	Resolution 10 on the renovation of agricultural management	First key land policy to reallocate land from collectives to farm households
1993	Land Law	Land-use rights were guaranteed. The basic framework for the development of land markets; Land-use rights for agricultural households, which included five related rights: exchange, transfer, lease, inheritance and mortgage.
1998, 1999, and 2003	Land law was revised	The 1998 revision encouraged and facilitated the process of land allocation and registration by outlining procedures and designating responsibilities. The 1999 revision set out the conditions and procedures for the exchange, transfer, lease, inheritance and mortgage of land use rights. The 2003 Land Law raised the ceiling limits for the amount of land an agricultural household or individual could hold to three hectares for annual crops, and to five hectares in the case of the household or individual using a variety of lands
2008	Resolution 26 on agriculture, farmers and rural development	In light of the decline in agricultural growth, this Resolution recommended creating a "triangle pillars position" of policies on agriculture, farmers and rural development.
2013	Decision 899 on the approval of agricultural restructuring plan (ASP)	The ASP's core targets include: the promotion and maintenance of agricultural growth; increase in farmers' income and ensuring food security; an emphasis on green growth and sustainable development

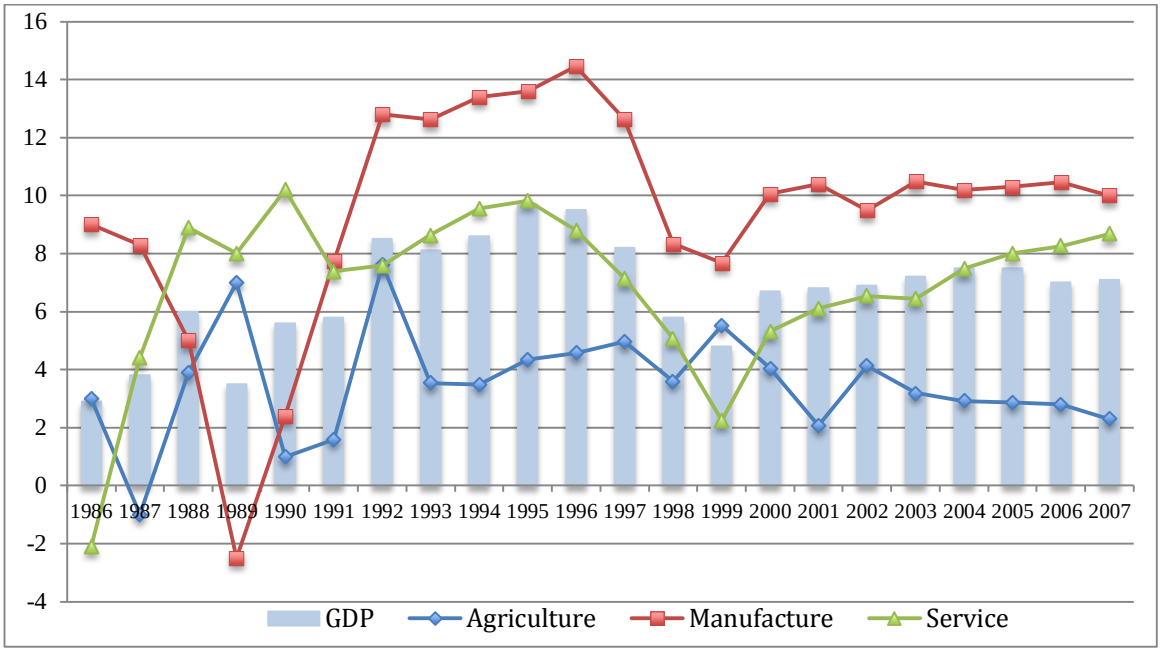
Source*:* Legal documents issued by the Vietnamese government.

The most significant policy in the reform process for agriculture began earlier (Dang et al. 2006). Agricultural reform milestones are summarized in Table 3.1. In 1988, Resolution 10 was issued to meet the urgent needs of agricultural development. Farm households had the right to use their agricultural land for 10 to 15 years, and were in full control of the production process. The Resolution actually decollectivized agriculture. The household became the primary producing entity instead of the cooperative. The Resolution encouraged farmers to invest in agricultural production. Farm household resources were mobilized. Farmers had taken the initiatives by adopting and exploiting existing technical advances and infrastructure in order to improve agricultural productivity (Dieu 2006).

The process of decollectivizing the agricultural system under Resolution 10 resulted in a boost in agricultural output and improved living standards for farmers (Kompas 2004). The paddy equivalent output increased by 26 percent, rice yields rose by 30 per cent from 1988 to 1992. Rice production reached 21.44 million tonnes in 1989 and 25 million tonnes in 1995. Vietnam started to export 1.4 million tonnes of rice in 1989 (Nguyen 2003). As a result, from a country running food shortage, Vietnam has become one of the leading rice exporters of the world (Fforde and Seneque 1995, p. 108; Glewwe et al. 2004).[12] The success of land reforms brought new opportunities for rural development, providing farm households with significant incomes and improving the living standard of farmers (Kerkvliet 2006).

[12]The overview of rice production will be discussed in details in Section 3.4 in this chapter.

Figure 3.1 **Growth rate in GDP and the main sectors, Vietnam 1986-2007 (per cent per year)**



Source*:* General Statistics Office (GSO), 2002, 2003, 2008, and 2009b, *The Statistical Yearbooks*, The Statistics Publishing House, Hanoi.

In addition to Resolution 10, the Land Law 1993 and the Decree 64 issued in 1993 also allocated agricultural land to farmers in long-term, and provided farmers with five rights of land use including the rights of transfer, exchange, lease, inheritance and mortgage. As a result, Kompas (2004) and Dang et al. (2006) show that land and market reforms in Vietnam induced farmers to work harder and provided more incentive to invest in land, in spite of the relatively modest growth of most inputs, and little or no technological change. The resulting surplus in agricultural production promoted the expansion of manufacturing sectors and urbanisation. Moreover, these trends were consolidated with the role of enterprise laws, foreign direct investment, and foreign trade. With significant agricultural and market institutional reforms, Vietnam became a middle-income country by 2010 (World Bank 2011a).

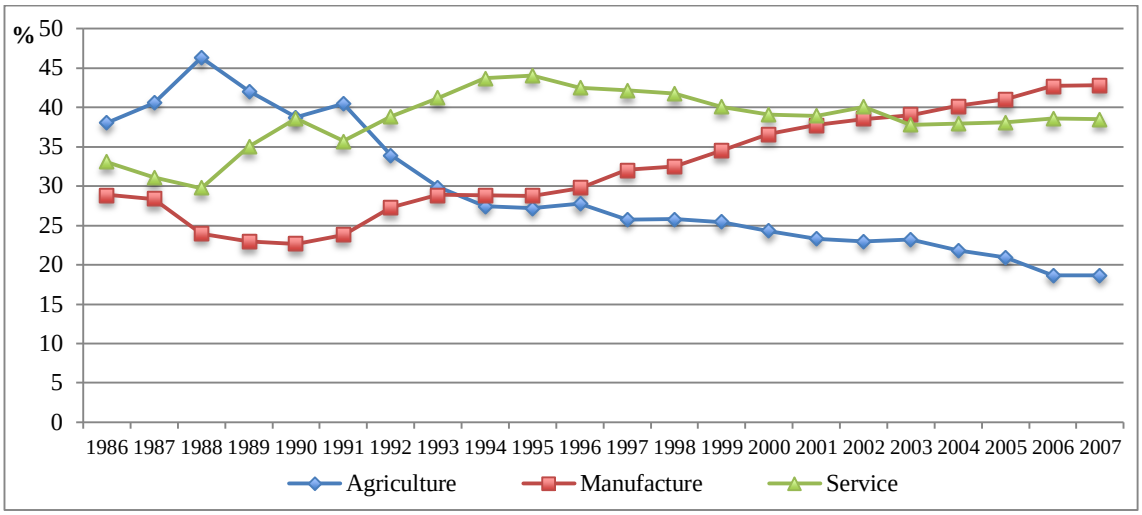
Although there was a fluctuation in Vietnam's growth rates, the GDP of the economy grew at nearly 7 per cent per annum from 1990 to 2007 (Figure 3.1). In the early reform period, annual GDP growth rates increased considerably, from 4.3 per cent in 1986-1989 to 7.3 per cent during 1990-1994. There were different trends of sectoral growth rates. Institutional reforms such as land and markets were the main sources of agricultural growth in the early reform period (Kompas 2004; Dang et al. 2006; Benjamin and

Brandt 2004). The agricultural growth facilitated the successful transformation of Vietnam's economy. As can be seen in Figure 3.1, agriculture was a stabilizing factor in economic growth over the whole period, particularly during the initial period of economic reform and the Asian financial crisis in the late 1990s. Since 1999, however, agricultural growth has shown a tendency to decline. It reduced to 3.7 per cent per year in the period 2000-2005 and down further to 2.3 per cent in 2007 (see Figure 3.1).

From their examination, Dang et al. (2006) find that the increase in input usage of land, labour and fertilizer explains the growth. However, input usage appears to be reaching its limit for generating more growth. Other studies of Vietnamese agriculture find that land fragmentation is one of main reasons for the reduction of agricultural growth as the incentives lost their impact (Hung et al. 2007; Kompas et al. 2012). Otsuka (2013) argues that the advantages of smallholder agriculture disappear if the wage rate increases. However, the extent of the decline in the comparative advantage of agriculture will be subject to the pace of farm size expansion and land consolidation. The World Bank (2006) shows that compared with other regional countries, land fragmentation and small landholding are the main contributors to Vietnam's lower productivity compared with regional countries. In addition to land constraints, rapid structural transformation is another of key reason for the declining trend of agricultural growth in Vietnam (World Bank, 2008).

As regards structural transformation in Vietnam since the *Doi Moi* in 1986, Figures 3.2 and 3.3 illustrate the trends of structural changes. The share of agriculture in GDP increased from 38.1 per cent in 1986 to 46.3 per cent in 1988, and then reduced continuously to approximately 18.7 per cent in 2007 (Figure 2.3). Similarly, the agricultural sector employed over 70 per cent of the labour force in 1990. The share of employment fell to 51.7 per cent in 2007, while the shares of employment in the manufacturing and service sectors increased from 11.6 and 15.8 per cent in 1990 to 30 and 18.3 per cent in 2007, respectively (Figure 2.4). Employment in the agricultural sector has declined rapidly since 2002.

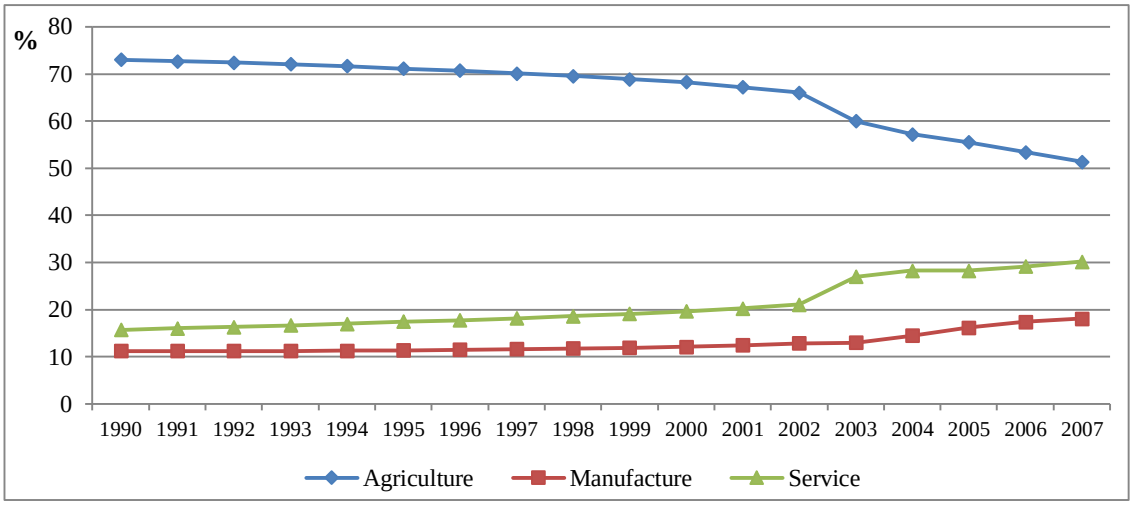
Figure **3.2 Shares of GDP by sectors, Vietnam, 1986-2007 (per cent)**



Source: General Statistics Office (GSO), 2002, 2006, 2008, 2009b and 2010.

The structural transformation reflects a common trend found in the industrialization process of developing countries in the past decades. The World Bank (2014b) concludes that Vietnam has undergone a fundamental structural transformation in the past 25 years with a shift of employment from agriculture to wage employment in manufacturing, construction and services. However, more than 60 per cent of the total labour force worked in the agricultural sector in 2007 (GSO 2012). In the latest GSO's agricultural census in 2011, there were over 10 million farm households in the whole country. Thus, the agricultural sector still plays an important role in the livelihood of millions of farm households.

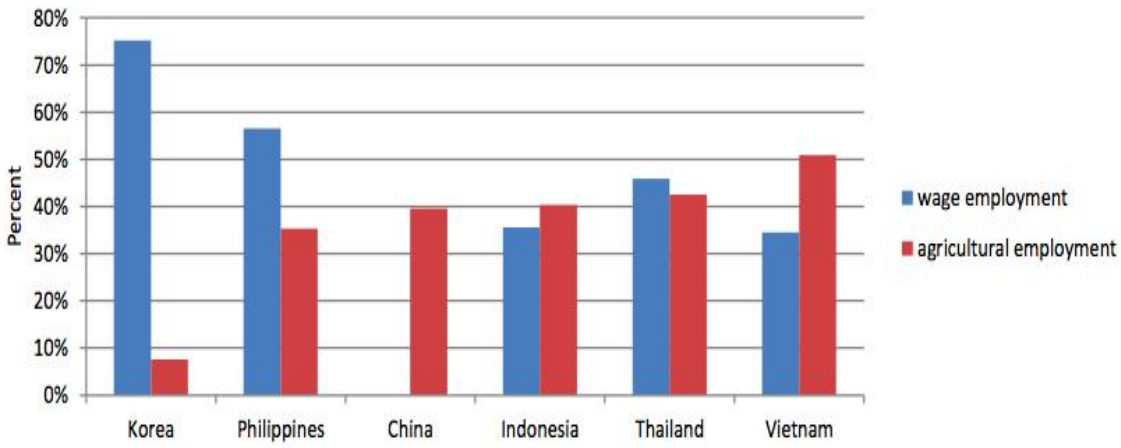
Figure 3.3 **Shares of employment by sectors, Vietnam, 1986-2007 (per cent)**



Source: General Statistics Office (GSO), 2002, 2006, 2008, 2009b and 2010.

Figure 3.4 shows employment trends in selected Asian countries. Despite the success of structural transformation in the past few decades, Vietnam seems to lag behind some neighbouring countries in terms of the trend of structural change. The share of the labour force in agriculture is still higher that other Asian countries and the share of workers in wage jobs remains lower. Therefore, driving up the speed of structural transformation is a key priority in Vietnam if the country is to catch up with its neighbouring economies.

Figure 3.4 **Employment trends in some Asian countries**



Source: World Bank (2014b, p. 36)

To sum up, economic reforms gained achievement in ensuring food security. Vietnam's agriculture, however, is coping with increasing challenges. There are more than 60 million people and 15.3 million households with approximately 32 million people of working age living in rural areas. Moreover, the rural population accounts for 76 per cent of the total (GSO 2012). Thus, the decline in agricultural growth threatens the sustainability of food security, livelihoods and poverty reduction in rural Vietnam. Given the high proportion of the population in Vietnam that continues to reside in rural areas, and the high population-to-land ratio, appropriate land management and labour allocation policies are important in improving the livelihood of millions of Vietnamese farmers (Scott 2009).

3.3 Land policy reforms

The objective of this section is to provide systematic information about the process of changes in the land tenure system in Vietnam since economic reforms in 1986. It traces

the major land issues facing farm households and policy makers by looking at changes in the land tenure system. The study then explores the land allocation process, and discusses the problems of small landholdings and land fragmentation.

3.3.1 Changes in the land tenure system

From 1986 to 1992, Vietnam mainly focused on the privatization of land use rights. In April 1988, Resolution 10 on the renovation of agricultural economic management was issued. Farm households replaced the dominant role of collectives as agricultural land was reallocated from collectives to farms. Land, however, still belonged to all people under the state's management. The state also assigned land use rights from collectives to farmers. This land policy gave farmers greater 'production rights', including the right to sell their products (Marsh et al. 2006). Decollectivization process was completed in 1992. Land use rights were finally allocated to farm households and were non-transferable, which resulted in posing constraints on the full liberalisation of agriculture and inefficient land use management (Le Cao Doan 1995). Therefore, the next land policy reform strengthened the development of the land-use rights market by issuance of a new land law in 1993.

As discussed earlier, the 1993 land law guaranteed long-term land use rights for farm households which included five related rights: exchange, transfer, and lease, inherit and mortgage. These rights were valid within the contracted period. Moreover, this law increased tenure security over the land allocated. Land users were granted a formal certificate of land-use rights. The long-term contract periods were 20 years for annual crops and 50 years for perennial crops, and the period could be extended. This law also set up a ceiling on the amount of land to be distributed to agricultural households. For annual crops, the limit was two hectares in the Central and Northern provinces and three hectares in the Southern provinces, and ten hectares for perennials.

The land law was revised in 1998, 1999 and 2003. The 1998 revision moved a step further toward ensuring the rights and obligations of farm households; strengthening land transactions; and registration. It also added the land-use right as a capital contribution for joint investments. The revised 1998 land law dictated that every transaction related to changes of land needs to be officially approved by local authorities. This includes reshaping land plots, changing the land tenure rights, using land as a mortgage at banks for borrowings, altering the land use duration, and subleasing land. The land law revision in 1999 showed the conditions and procedures for

the exchange, transfer, lease, inheritance and mortgage of land use rights. Land users can only transfer land use rights if they move to other places of residence to live, take up production or business activities, change to another occupation, or have no capacity to work. The land use right can only be transferred to households or individuals who have the demand for land use and have no land or a land area less than the land limit (Land law 1999).

The land law issued in 2003 provided comprehensive legal rules on land relations and improved land use management, such as land use planning, allocation of land, land lease, change in land use purposes, land resumption and land recalls, land use rights certificates, land markets, settlements of claims and disputes in terms of land. Furthermore, the law also increased the limits for the amount of land an agricultural household or individual can hold to three hectares for annual crops, and to five hectares in the case of the household or individual using a variety of lands. The limits applied for every area in the country. Farm households do not have to pay land fees if they directly use their lands to perform agricultural, forestry and fishery activities (Land law 2003).

3.3.2 Current land institutions

Land institutions related to the security of land tenure, access to land and the conversion of land use purpose, play an important role in enhancing investments and efficiency in agricultural production and the development of land markets (Deininger and Songqing 2003). They find that the success of economic development depends greatly on clear identification of asset ownership and invested capital. This section shows key points regarding land institutions in Vietnam under Land Law 2003.

First, land belongs to all people and the state plays a role as the owner's representative. The state of Vietnam implements its rights to decide legal land status relating to land use purposes, land reallocation, land lease, land price and land resumption. In addition, the state regulates benefits from land use by imposing land use fees, rental, and transfer and land use taxes. The state also has the right to grant the land-use rights to land users through allocating land, land lease and recognizing the legal status of the land-use rights. In the Land Law 2003, land-use rights include exchange, transfers, lease, inheritance and mortgage. The state grants a certificate of land use rights for each land user, which consists of different plots. If a farm household wants to exchange some of their plots, a new certificate of land use rights is reissued after land

transactions. Notably, land use rights are considered commodities in the land market. The state intervenes in that market through setting land prices, and controlling the registration of transactions of land use rights

Second, the Land Law 2003 states the terms of allocation and lease of agricultural land. The land leases for annual and perennial crops are 20 years and 50 years, respectively. In addition, the state also limits landholdings. For annual crops, the limit is set at three hectares for Southern provinces and two hectares for Northern provinces. When the terms of the land lease end, the state reallocates the agricultural land to households, and grants new certificates of land use rights. Finally, the government imposes restrictions on change of purpose, particularly paddy land. If farm households' wish to changing land use purpose from paddy to other crops, they must receive approval from local authorities at both the communal and district levels.

3.3.3 Land fragmentation

The first land policy reforms in the late 1980s have contributed to the success of the Vietnamese agriculture and lifted millions households out of poverty over the past decades (Dang et al. 2006). They have, however, resulted in a number of land issues, including small landholdings and land fragmentation. The most important principle of the land reallocation from cooperatives to households in the first wave of land reform was that land reallocation was to be based on egalitarian principle (Ravallion and van de Walle 2008; Hung et al. 2007). Scott (2009) shows that the egalitarian distribution of land was considered a necessity to avoid disputes and to curb the influx of rural migrants to the cities. Consequently, each household was reallocated some plots in different areas, based on the different qualities of the field plots, as well as access to water sources or other infrastructure. According to Resolution 10 in 1988, plots that were homogenous in quality were grouped into one land class within a village. If there was no consensus between farmers, a land class could be further divided into more subclasses. Based on this principle, land area under each class and subclass was allocated to each household. The land reallocation process has been remarkably equitable (Ravallion and van de Walle 2004). But this equality – along with the use of family size to determine the number of plots allocated – has resulted in serious land problems. Also, the process of demographical changes also led to increasing land fragmentation (Marsh et al. 2006).

Table 3.2 **Land fragmentation in Vietnam, 2010**

Regions	Number of operated plots (mean)	Number of operated plots (median)	Sum of home to plot distances (meters)
Northern lowlands	5.5	5	4,034
Northern highlands	5.5	5	9,602
Central highlands	5.4	3	6,066
Southern lowlands	3.7	3	2,828
Total	4.7	4	4,766

Source: Markussen et al. (2013)

In the whole country, there are estimated to be between 75 and 100 million parcels, an average of seven to eight plots per farm household (Vy 2002). Average rural farm households have 6.5 plots of land in the north and 3.4 plots in the south (World Bank 2006). There has been no official survey on land fragmentation in Vietnam in the whole country and there is no data on the number of plots per farm household in the agricultural censuses in 2006 and 2011. According to Markussen et al. (2013), the average distance from homes to paddy fields was 4.76 km. The average number of plots per household was 4.7 in 2010 (Table 3.2).

Concern about scattered land holdings has emerged since the late 1990s (MARD 2002; Research Institute of Agricultural Planning 2004). Land consolidation programs have been considered as a strategy to maintain food security and support rural industrialization. [13] The government issued Directive 10, a policy intended to encourage the plot exchange programs in 1998. According to this policy, farm households voluntarily transferred their land-use rights or exchanged their plots. Based on demand, local authorities required farmers to register for land consolidation and issued new land-use rights certificates. However, the effectiveness of this policy has been low due to increasing interest conflicts and transaction costs (Thinh 2009). Furthermore, in order to carry out the land consolidation programs successfully and balance all benefits and costs, all farmers were required to be involved in all stages of the program, which was time consuming and costly (Thinh 2009). Through the whole country, there were only nearly 700 communes in 20 provinces where plot exchange

[13]The reduction of land fragmentation is a key strategy in the Communist Party's Resolution No. 26-NQ/TW (2008) on agriculture, farmers and rural development in Vietnam. In this resolution, the government emphasised the role of land consolidation and the slow progress due to rising corruption and cumbersome procedure.

programs were implemented (MARD 2002). OECD (2015) also shows that in rural Vietnam, the process of land consolidation of crop production is at very early stages.

In addition, Hung et al. (2007) argue that the reduction of land fragmentation through the promotion of the voluntary exchange of plots between farmers is a narrow policy approach, compared to policies favouring the development of land markets such as enhancing land use rights and reducing restrictions on land transfers and transaction costs. Moreover, the plot exchange programs in rural Vietnam are based on some principles such as voluntarism, equity, transparency, and proactive participation of local authorities (Tran 2006). This method of land consolidation requires close coordination among a large number of households and plots. As a result, it takes time and efforts to achieve consent among all members. This process is likely to cause interest conflicts if land governance is weak (Palmer et al. 2009). This is one of the challenges facing voluntary land consolidation programs. It also explains the difficulties in land consolidation in rural Vietnam (Tran 2006). In addition, Marsh et al. (2006) show that land can be consolidated through plot transactions in the land markets. Nevertheless, the impact of land markets on the process of land consolidation is unclear. The market for the exchange of land use rights in Vietnam is still imperfect, despite the revisions of recent land law. Moreover, the government still controls agricultural land prices, and high transaction costs have restricted transactions in land markets (World Bank 2003 and 2006).

It has also been reported that many land transfers occurred illegally both before and after the 1993 Land Law (Do & Iyer 2003; Humphries 1999; Kerkvliet 2000; World Bank 2003). One main reason given for these illegal transactions is the costs associated with registering land use right transfers. Deininger and Songqing (2003) argue that the lack of a well-functioning credit market and appropriate safety nets in rural areas also affected the development of land use right markets. Ravallion and van de Walle (2004) state that a more active land rental market has not emerged since 1988. Similarly, Dang et al. (2006) conclude that land markets have failed to develop strongly, and high land rental rates may discourage investments by farmers. Furthermore, despite the improvement in land tenure security and increasing off-farm employment opportunities, farmers only rent out or sell their land if they are safe to rely on salaried jobs (Ravallion and van de Walle 2008). World Bank (2006) concluded that underdeveloped rural land markets pose obstacles for further productivity gains and labour mobility toward the higher nonfarm wage employment. Therefore, the problem of land fragmentation must be solved within the overall context of national policy. A

further land reform that encourages the development of land market is one possible a relevant strategy for reducing land fragmentation in Vietnam in the future.

3.3.4 Small landholdings

This thesis mainly focuses on land for annual crops. In 2011, the number of farm households using land for annual crops was nearly 10.3 million, accounting for 86.6 per cent of total households using agricultural production land in rural Vietnam. The number of households using under 1 hectare of land makes up 88.23 per cent of total households using land for annual crops. The average land area for annual crops per household was 0.62 hectare (GSO 2012). Farm sizes change throughout the country, but they are small and fragmented.

As regards paddy land, there are nearly 9.3 million households using paddy land, representing 90.29 per cent of total households producing annual crops and 77.6 per cent of total households using agricultural production land in 2011. On average, each farm household uses 0.44 hectares of paddy land. This area hardly changed in the period 2006-2011 (GSO 2012). As can be seen in Table 3.3, the majority of farm households have very small farms. Moreover, 85 per cent of total households using paddy land have a farm size of less than 1 hectare. Hazell and Rahman (2014) define smallholders as farms operating less than 2 hectares of land area, and using this definition, Vietnam is maintaining smallholder agriculture, particularly rice production with labour-intensive farming.

Table 3.3 **The structure of households by scale of use of land for paddy farming, 2006 and 2011**

	2006				2011			
	< 0.2 ha	From 0.2 to under 0.5 ha	From 0.5 to under 2 ha	2 ha and over	< 0.2 ha	From 0.2 to under 0.5 ha	From 0.5 to under2 ha	2 ha and over
Whole country	47.2	36.8	13.6	2.4	50.04	34.79	12.9	2.27
Red River Delta	63.2	34.8	2		64.84	33.19	1.94	0.03
North and Mountainous areas	49.75	36.45	13	0.8	58.12	33.48	7.94	0.46
North and Central Coast	54.25	39.7	6.05		53.43	39	7.36	0.21
Central Highlands	36.3	40.6	22	1.1	37.83	40.68	20.39	1.1
South East	16.1	42.6	37.8	3.5	12.37	40.06	42.01	5.56
Mekong River Delta	7.7	30.7	47.9	13.7	8.49	29.87	48.2	13.44

Source: GSO (2007 and 2012)

3.4 Food security and the 'rice first' policy in smallholder agriculture

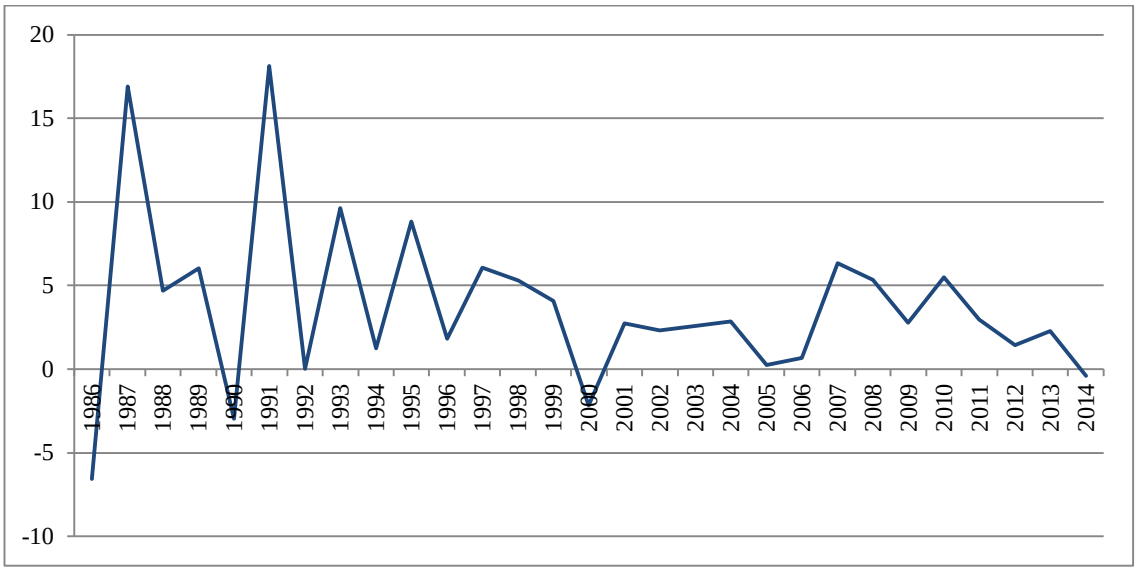
Food security has been one of the most important targets that concerned policy makers in Vietnam. Since the famines during 1970s and early 1980s, Vietnam has implemented many reforms to sustain rice self-sufficiency, achieved by explicitly controlling rice land and adopting the 'rice first' policy. Food security is directly related to land policy. In Vietnam, food security always means rice self-sufficiency,[14] and the Government of Vietnam issued policies to maintain rice-growing land aimed at firmly ensuring national food security.[15] Thus, Vietnam's food security policy is also directly linked to the 'rice first' policy.

Rice is the most important crop in Vietnam's agricultural production. Most of the production comes from family-operated small-scale farms. The rice growing area in 2011 was 4.1 million hectares, accounting for 43.77 per cent of total agricultural land and 65 per cent of annual cropping land (GSO 2012); and the number of rice-growing households was nearly 9.3 million, which represents 77.6 per cent of total households using agricultural production land and 86.7 per cent of total annual crop farm households. The paddy land area was only 0.44 ha per household on average in 2011 (GSO 2012). Rice output of farm households accounts for 75 per cent of total household annual crops in terms of quantity and over 78 per cent in value (Kompas et al. 2012).

[14] This view can be seen in Resolution 09/NQ-CQ on "Some policies and measures to promote distribution of agricultural products", issued by the Government of Vietnam on June the 15th, 2000.

[15] The issue of keeping paddy land, and restrictions on converting paddy land, has received great attention among Vietnam's policy makers and evidenced in a large variety of policies. The most important policy related to paddy land is Resolution 26/NQ/TW on agriculture, farmers and rural development, issued on August 5th, 2007. Resolution 26 states that proper land for rice cultivation must be maintained. In addition, Under Article 74 of 2003 Land Law, rice producers are prohibited from converting land use purposes without the permission of relevant government officials. The conversion of paddy land must be approved by land use planning regulations from communal level to provincial level. Other policies include Resolution 63 in 2009 on ensuring national food security, and Decree 42 (2012) on management and use of rice land.

Figure 3.5 **The growth rate of rice output in Vietnam, 1986-2014 (per cent)**

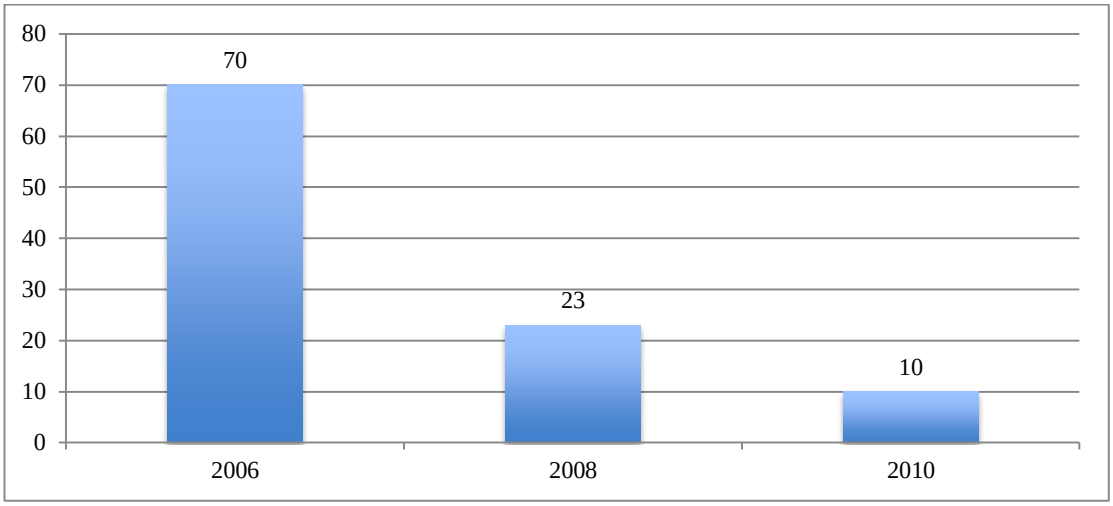


Source: Calculated from GSO (2002, 2006, 2008, 2014)

Since the economic reforms of 1986, food security policies have mainly focused on how to increase the supply of rice, particularly keeping paddy land stable and restricting their conversion to other crops and nonfarm activities. There is little doubt that the increase in rice output has been remarkable since the first wave of land reforms in the late 1980s and early 1990s (Kompas 2004). The growth rate of rice output shows an average annual increase of 3.64 per cent (Figure 3.5). After the main land reforms in 1988 and 1993, the average growth of rice output was 5.23 per cent in the period 1986-1999. However, since then the effect of the first wave of land reforms has been diminishing with an average growth rate in 2000-2014 of 2.25 per cent. It should be noted that for the country as a whole, there was a decline in the growth of rice output for 1986-2014.

The significant achievements in rice production have ensured national food security - Vietnam has sustained rice surpluses for export since 1988, at an average of about 10 per cent of total production per year. In 2011, Vietnam exported over 7 million tons of rice, with the total revenue of USD 3.7 billion (World Bank 2012). Despite large annual rice exports, many households still do not have physical, social or economic access to sufficient, safe and nutritious food to meet their dietary needs. Moreover, 20 per cent of Vietnamese children under five were underweight in 2007. Poor households are vulnerable to shocks and have become food insecure (FAO 2004).

Figure 3.6 **Margin proportion earned by rice farmers in the Mekong River Delta (per cent)**

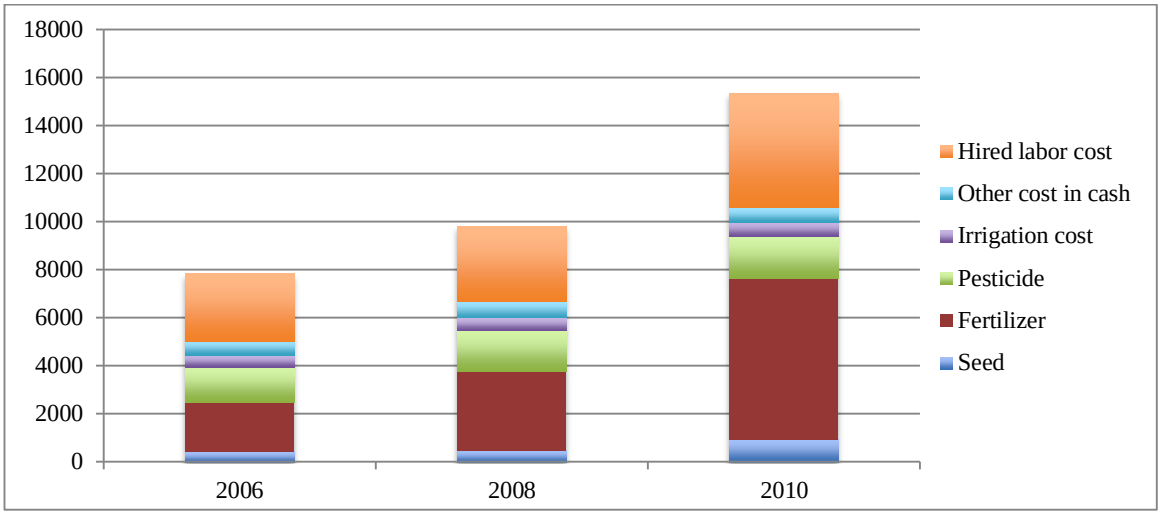


Source: Tran et al. (2013)

In addition, smallholder rice farmers are struggling to survive and are diversifying their livelihoods in light of low incomes and the increasing cost of rice production (Minot et al. 2006). Figure 3.6 shows the average margin proportion earned by rice farmers in the largest rice-growing region in Vietnam.[16] The margin proportion in rice production reduced from 70 per cent in 2006 to 10 per cent in 2010. One of the reasons for low margins had been the rapid increase in rice production costs. As can be seen in Figure 3.7, fertiliser and hired labour costs represent 46.5 and 33.1 per cent of total production cost for rice in 2010, respectively. World Bank (2012) shows that the rice policy has failed to produce a main income for rice growers, in spite of the fact that rice farmers spend most of their time and effort on rice production. The average share of rice income in total income only accounts for 20 per cent in farms of less than 0.5 hectare.

[16]According to Tran et al. (2013), the margin in rice production is calculated by taking farm-gate price minus production costs.

Figure 3.7 **Rice production costs in the Mekong River Delta (1000 VND per hectare)**



Source: FAO (2010)

Similarly, Table 3.4 shows that farmers with small landholdings in the Mekong River Delta earned little money from rice production. Income per capita per month from rice for households with farm size less than 2 hectares was below the official rural poverty line (VND 400,000 per capita monthly in 2009). In order to encourage farm households to produce rice, the government of Vietnam supported the rice sector by price support, procurement policies and input subsidies (World Bank 2012; Tran et al. 2013). These massive attempts to support the rice sector have put more pressure on state budgets in light of increasing fiscal stress.

The increasing share of hired labour cost in labour-intensive smallholder agriculture is one of challenges for rice farmers when rural wages increase, and small rice farms may respond to increasing fiscal stress by abandoning paddy fields. More recently, there has been an increasing trend to abandon paddy fields, particularly in small farms.[17] This emerging problem has concerned Vietnamese policy makers because it will threaten national food security. Taylor and Lybbert (2015) explains that idle remaining land when leaving farms is due to high costs of registering transfers and low profits in farm production. Up to now, there is no study on this trend. Otsuka (2013) shows that the comparative advantage of agriculture in East Asia countries has lost due to rapid

[17] In 2013, 42,785 families left over 6,882 hectares of fields untouched. Moreover, 3,407 families returned over 433 hectares of land to the local government. Some farmers state that the income they receive from growing rice has shrunk. A few hundred square meters of land can only provide them with an average of $2.37 to $3.79 a month.
(http://thediplomat.com/2013/12/vietnamese-rice-farmers-abandon-their-fields/; www.mard.gov.vn)

increases in the real rural wages over the past decades. In the case of Vietnam, Wiggins and Keats (2014) show that real rural wages increased by 55.37 per cent in the period 2005-2012. Consequently, labour-intensive farming will become very costly.

Table 3.4 **Farm household's monthly income per capita from different sources, Mekong River Delta, 2009 (1000 VND)**

Farm size		Total incomes	Rice income	Other crop incomes	Animal and aquatic incomes	Nonfarm incomes
<1 ha	Mean	849	151	84	82	533
	%	100	18	10	10	63
1- 2 ha	Mean	1165	284	72	359	449
	%	100	24	6	31	39
2.01 – 3 ha	Mean	1901	658	26	728	490
	%	100	35	1	38	26
>3 ha	Mean	1933	1296	10	88	540
	%	100	67	0	5	28
Total	Mean	1312	535	56	209	512
	%	100	41	4	16	39

Note: USD 1 = VND 21,000
Source: World Bank (2012)

Although small rice farms have been struggling because of low profits, these farms are locked into rice production by law.[18] Under the rice self-sufficiency policy approach, the Government encourages rice farmers to continue to produce rice. Public policy is still designed to achieve rice self-sufficiency rather than income growth in rural Vietnam (World Bank 2007). In addition, intensive rice production has threatened the long-term agricultural sustainability of Vietnam (Barton 2015). In recent years, rice farmers in the Mekong River Delta have produced three rice crops per year. Farmers, however, have gained little from the rice intensification, particularly in the Mekong River Delta. While input usage has increased rapidly, environmental degradation has become one of the biggest concerns in maintaining long-term rice productivity and quality (World Bank 2012). McPherson (2012) shows the pollution associated with the overuse of insecticides and pesticides has negatively affected the rice quality. The system of intensive rice production has resulted in environmental degradation. Thus, the "rice first" policy needs to be reconsidered in Vietnam's food security strategy.

[18] The article 38 of 2003 Land Law permits local governments to recover land without compensation if it is not being used for its designated purpose.

Despite the domination of rice and land policies that constrain rice farmers, crop diversity does exist in Vietnam.[19] Marsh et al. (2006) provide an overview of typical land use patterns, including specialised rice, rice and short-term crops such as vegetables, soybeans, other annual crops, and specialised non-rice crops. Marsh et al. (2006) find that higher returns from cropping patterns which covers crops such as potato, cabbage, tomato, squash, cucumber, beans and peas. Cropping patterns of food crops alone (rice, maize, cassava and sweet potato) give lower returns. In addition, the rotation of rice and other crops always gives a higher income than monoculture rice land. Minot et al. (2006) shows that in mountainous areas of Vietnam, households are highly dependent on rice for subsistence, and other cash crops for cash income. Ufer (2012) found the same evidence of crop diversity in north-western Vietnam. Rice comprised 11 per cent of total farm area and 8.5 per cent of expenditures, while maize was the main cash crop (71 per cent of farmed areas), the main source of income came from cash crops, accounting for 65 per cent of total household cash income.

Table 3.5 **Land use patterns in the Mekong River Delta, 1980-2008 (1000 ha)**

	1980	1990	2000	2008
Rice land	2238	2092	2067	1874
Other annual crops	92	130	135	178
Perennial crops	192	348	397	546
Aquaculture	6	145	229	531
All agricultural land	2522	2570	2599	2597
Rice as share of agricultural land (%)	89	81	80	72
Rice as share of all land (%)	80	72	65	55

Source*:* World Bank (2011b)

In the Mekong River Delta, farmers adopted crop rotation on paddy land - several crops or fish are grown in rotation with rice. As can be seen in Table 3.5, rice land reduced by 365,000 hectares from 1980 to 2014, while land for other annual crops nearly doubled in the same period in the Mekong River Delta, which is the largest rice growing region in Vietnam. Although there have been restrictions on the conversion of the land use purpose, many local authorities have gradually eased these restrictions and allowed farmers to diversify at a limited level.[20] However, rice land still represents 72

[19]See further evidence on the reduction of rice output when many farm households switch to other crops from http://www.bloomberg.com/news/2013-09-12/vietnam-s-rice-output-faces-slide-on-crop-switch-southeast-asia.html

[20] The Ministry of Agriculture and Rural Development of Vietnam has planned to convert 200,000 ha of paddy land into land for growing high value crops in the Mekong River Delta, the biggest rice-growing

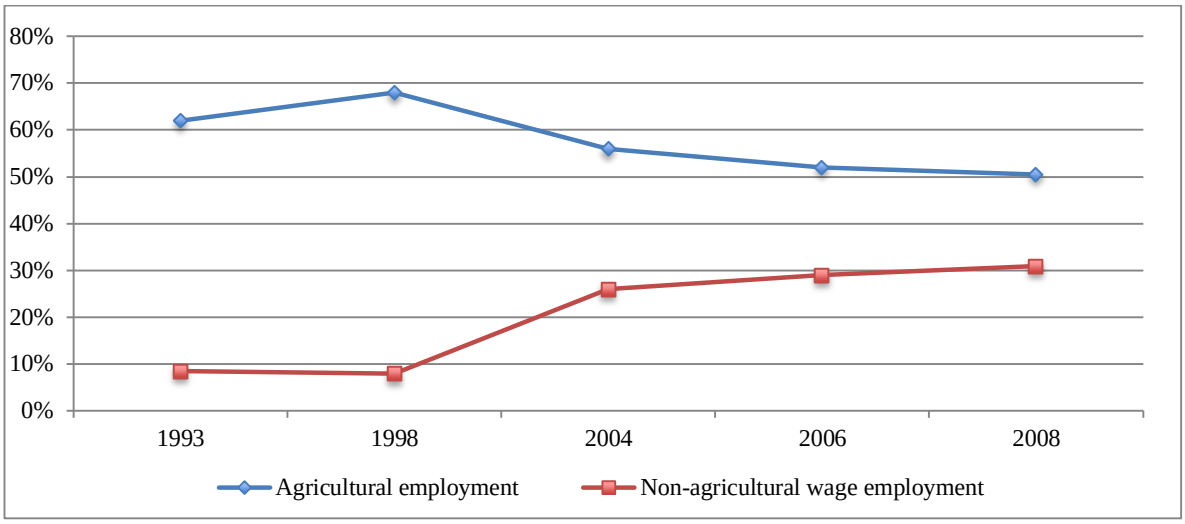
per cent of agricultural land in the region in 2008 (World Bank 2011b). Similarly, the FAO (2010) estimates that the paddy/fish rotation in the biggest rice-growing region in Vietnam has earned VND 40-45 million per hectare per year and a profit of VND 20-25 million per hectare compared with profit of VND 8-10 million per hectare from only rice production. At the same time, in the rice/vegetables rotation, households that grow crops after harvesting winter-spring paddy crop and before planting the summer-autumn paddy crop can earn an annual income of VND 30-70 million per hectare and profits of VND 15-40 million. As a result, there has been increasing debate on redesigning Vietnam's food security policies, such as easing restrictions on the conversion of crops, and permitting the reduction of paddy land.

3.5 The development of the rural nonfarm economy

There has been growing concern about the livelihood of rice farmers and the poor in rural Vietnam. One prominent and widely discussed policy is livelihood diversification into the nonfarm economy. The development of the rural nonfarm economy has become one of the most important factors in light of the declining trend in agricultural production in Vietnam. Van de Walle and Cratty (2004) find that the incidence of farm-only household decreased from 75 per cent to 52 per cent between 1993 and 1998. This means that the incidence of households that are involved in at least one nonfarm activity increased to make up nearly half of all rural households within this five-year period. World Bank (2006) highlights an increasing share of nonfarm activities in rural employment and household incomes, though the incidence of nonfarm employment greatly varies across the country.

region in Vietnam. In addition, other rice growing regions have also begun crop conversion (www.mard.gov.vn).

Figure 3.8 **Vietnam's employment shift from agriculture to non-agriculture**

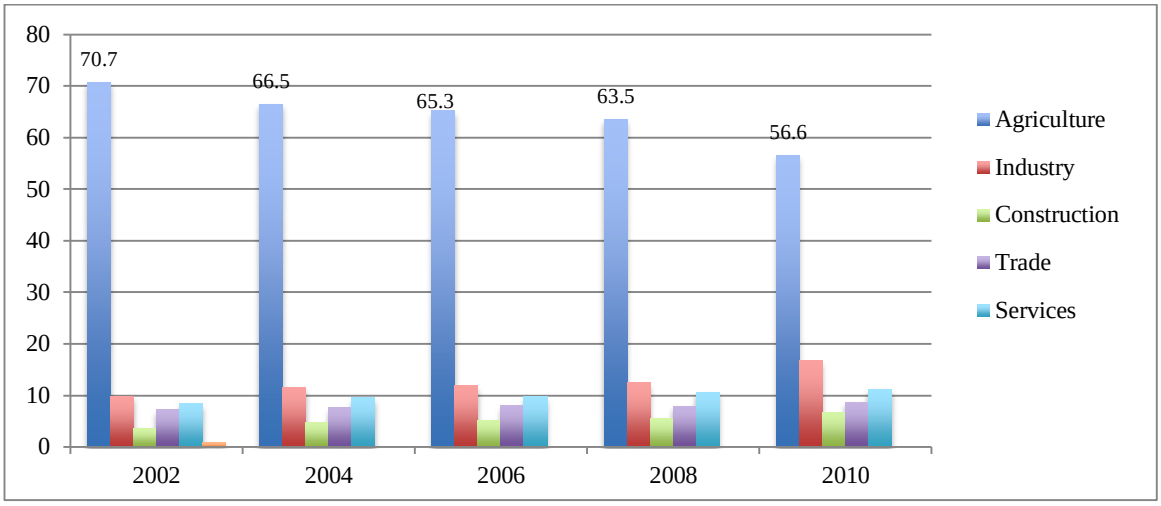


Source: World Bank (2014, p. 12)

As can be seen in Figure 3.8, the strong growth during the 1990s was associated with a substantial reduction in agricultural employment, driven by the dramatic decline in collective farming, and a jump in the share of workers in salaried jobs. Over half of Vietnam's workforce is now working outside of agriculture, and is increasingly focused on wage employment. The reallocation of labour from agriculture to wage employment appears to have slowed down in recent years as economic growth has decelerated. The initial rapid fall (1998 – 2006) was followed by a slowdown between 2006 and 2008. As will be shown below, many less well-educated workers, especially in rural areas, appear to have retained a foot in the agricultural sector during the recent economically difficult years.

Figure 3.9 depicts the employment structure of rural population who were 15 years old and over in the main job during 2002-2010. The share of agricultural employment reduced by 3.5 per cent per year. On average, there were 64.5 per cent of rural people working in the farm sector during the period 2002-2010. In addition, the high share of rural employment in the farm sector implies the typical characteristics of smallholder agriculture as labour-intensive farming (Hazel and Rahman 2014). The rural employment in non-agricultural sectors increased from 29.3 per cent in 2002 to 43.4 per cent in 2010. Generally, the rural employment structure in Vietnam changed significantly, indicating the development of the labour market in rural areas and the rural nonfarm economy (Dang et al. 2006).

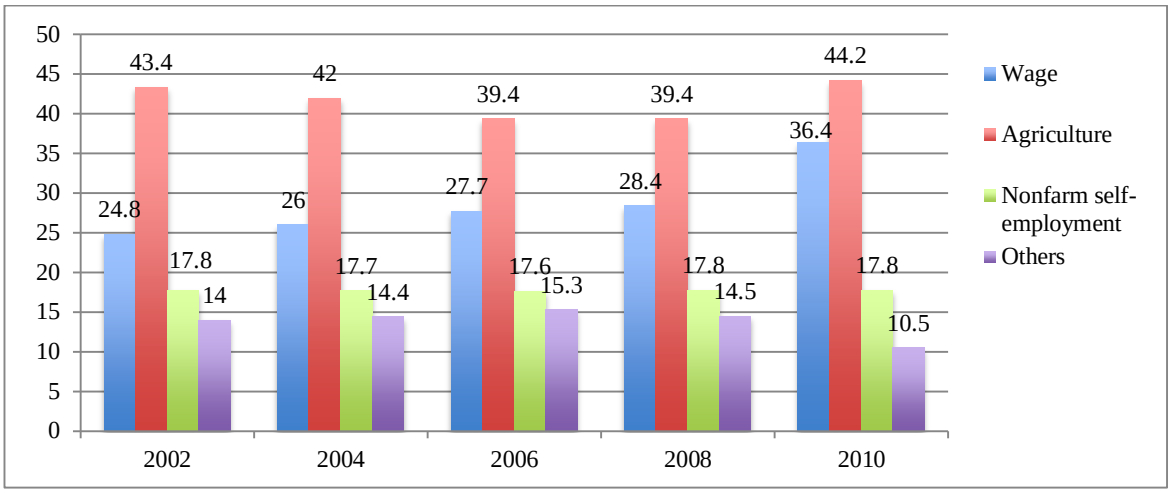
Figure 3.9 **Employment structure: rural population aged 15 years old and over in the main job, by economic sectors (per cent)**



Source: GSO (2010)

As regards income structure in rural Vietnam, the share of agricultural incomes decreased from 43.4 per cent in 2002 to 39.4 per cent in 2008, accompanied by an increased share of wage income gradually during 2002-2010 (Figure 3.10). However, the effect of the 2008 financial crisis has led to macroeconomic instability in Vietnam and the reduction of the manufacturing sector (World Bank 2012). As a result, the structural change in rural incomes has slow downed in recent years. Rural households have diversified their incomes by participating in nonfarm activities, and wage employment is playing a more important role in rural structural transformation. Despite the adverse impacts of macroeconomic turbulences on economic growth, agricultural diversification seems to be on-going in Vietnam. Nonfarm incomes have maintained an increasing trend in household incomes and mitigated the decline in agricultural incomes. Moreover, Haggblade et al. (2007) show that nonfarm incomes have made contribution to reduce the income gap between rural and urban areas in Asian countries.

Figure 3.10 **Structure of monthly income per capita in rural Vietnam (per cent)**



Source: GSO (2010)

Table 3.6 below further illustrates the development of the rural nonfarm economy by examining the growth of rural wages in Vietnam in the period 2005-2012. Wiggins and Keats (2014) surveyed selected Asian countries (including Vietnam) for this period. They found that there has been an increasing trend of rural wages in Asia. In the case of Vietnam, the average wages grew in real terms by 113 per cent. The average income of wage-workers in rural areas also increased by 34 per cent in the same period. The authors show that manufacturing growth and declining rural work force are main reasons for rising rural wages. Moreover, Table 3.6 shows that the wage rates in the agricultural sector increased along with the one in the industrial sector. As a result, according to the dualism economy model developed by Lewis (1954) and extended by Fei and Ranis (1964) in Chapter 2, the agricultural surplus to the industrial sector reduces further, because of the effect of the decline in the agricultural labour force on production, and the increase in food consumption from higher wages received by agricultural workers.

Table 3.6. The growth of rural wages in Vietnam, 2005-2012

	US$ real daily wages (constant 2010)			Changes in wages (%)	
	2005	2009	2012	2005-2009, 2009-2012	2005-2012
National, agriculture, forestry and fishing work, state sectors	4.05	6.29	8.63	55.37	113
Average income of wage worker in rural areas	3.92	4.69	5.26	20.12	34

Source: Wiggins and Keats (2014), *Rural wages in Asia*, Overseas Development Institute, London.

3.6 Current issues in Vietnam's agricultural development

When economic objectives are set for the agricultural development in a land-poor and labour-abundant country, they normally face three distinctly different problems: First is food security, then rising income gaps between sectors and regions, and finally the potential reduction agriculture's comparative advantage (Otsuka 2013). Otsuka (2013 and 2015) shows that affluent Asian economies and emerging Asian economies are about to face a loss in the comparative advantage of agriculture. The reason for this loss is the existence of labour-intensive smallholder agriculture in the midst of high and rising wages.

Like other East Asian countries, Vietnam is a land-poor and labour-abundant country. The success of the 'equity-oriented" first land reforms in the late 1980s and early 1990s has brought about significant changes in agricultural development (Marsh et al. 2006). However, the "equity-oriented" land reforms also resulted in the small-scale and fragmented farms, which is perceived to be the cause of present agricultural inefficiency (Hung et al. 2007; Kompas et al. 2012). The balance between equity and efficiency, between the 'rice first' policy and household welfare has resulted in three main issues in Vietnam's agricultural development in recent years.

Firstly, Vietnam maintains its "rice first" policy to ensure food self-sufficiency strategy. However, rice farmers with small landholdings have had to diversify their livelihoods because of low income from rice production. The government discourages rice growers to convert paddy land, and this enables Vietnam to maintain its capacity of food security and rice exports. This rice policy is in conflict with the desire of small farm households to diversify their output found in the relevant literature. Robison and Barry (1987) find that when farms are small and fragmented, households tend to be more diversified to stabilize their returns and reduce uncertainties. Similarly, Chavas and Di Falco (2012) show that small-scale farms tend to diversify to stabilize their returns for different crops. McPherson (2012) concludes that rice policy in Vietnam is inefficient and ineffective. The current policy of food self-sufficiency based on the control over land use is inefficient because land and other resources are locked into low-value uses. It is also ineffective because food insecurity, particularly as malnutrition approach, still exists for rice farmers.

Secondly, there is a conflict of objectives between food security policy and policy that promotes rural structural transformation, which requires the development of nonfarm

employment. The government maintains food security by encouraging agricultural production. However, increasing investments in local industries and manufacturing growth also encourages the development of the rural nonfarm economy and migration to urban areas and other sectors (Wiggins 2014; Haggblade et al. 2007). In Vietnam, rural structural transformation has been taking place since 1988. As a result, the labour movement into nonfarm sectors may reduce agricultural production. Although the relationship between the movement of labour into nonfarm activities and agricultural production is complex, the expansion of rural nonfarm economies and the increase in migration may concern policy makers in ensuring long-term food security in Vietnam in light of labour-intensive cultivation.

Finally, while agriculture's contribution to the economy reduced from 46.3 per cent in 1988 to less than 19 per cent in 2007, the share of labour employed in Vietnam's agricultural sector in 2007, declined from 73 per cent in 1990, and still stands at more than 50 per cent. Small-scale and highly fragmented landholdings depend on labour-intensive cultivation. Vietnam seems to follow the pattern of East Asian countries in its agricultural transformation, which has potentially resulted in a growing backlog of workers who will eventually need to exit the agricultural sector (Headey et al. 2010). The government's administrative land allocation was the main reason for the presence of land fragmentation in Vietnam's agriculture (Ravallion and van de Walle 2008).

However, as noted earlier, increasing trends of hired labour and rural wages as a result of demographical changes and wage growth in the manufacturing sector may reduce the comparative advantage of agriculture. As a result, Vietnam may transform its economic development policy from squeezing agriculture to supporting it. Farm households in rural Vietnam are likely to depend on highly protected and subsidized agriculture in the future. Therefore, the question of strategies of the development of smallholder agriculture in the presence of new conditions remains unanswered. Whether or not, and to which extent, the reduction of land fragmentation impacts on agricultural production and the shift of smallholder agriculture toward less labour-intensive farming remains questionable.

In order to solve the above-mentioned issues, the government of Vietnam can draw lessons from other countries in designing future agricultural development strategies. Scott (2009) argues that the primary benefits of land allocation in the late 1980s have been exploited. The country needs new sources of land reforms that boost agricultural

productivity and encourage less labour-intensive farming. Farm mechanization through land consolidation and concentration should be strengthened to increase food production at a reduced cost. In addition, Vietnam should change its approach of food security e.g. from rice self-sufficiency to farmer's incomes. Crop diversification is one solution increasing household income and ensuring food security. As the same time, Vietnam needs to strengthen agricultural mechanisation to facilitate labour transfer to off-farm employment, where it can better cope with rising real wages during the industrialisation process. It can apply labour saving innovations in agriculture. This can be achieved by substituting machines for labour inputs, or agricultural technical change (Hayami and Rutan 1985). Moreover, it helps to save more labour time for other activities. Finally, small farms are coping with increasing cost stress. Thus, input - supporting policies should be maintained to keep incentives for agricultural production and encourage farmers to stay in agriculture.

3.7 Concluding remarks

Over the past three decades, economic development of Vietnam has been characterised by a successful structural transformation from a predominantly agricultural and low-income economy to a middle-income and more structurally diversified one. Within this changing development process, agriculture has played a vital role to accommodate changes to the economy. During the first stage of agricultural reform (1986-1999), agriculture was liberalised from a central planning mechanism to a market economy. Three sets of policy blocks - decollectivization, price reforms and integration into the world market - were identified as factors contributing to Vietnam's economic development. The equity-oriented land reforms played a central role in this period. However, after 1999, agricultural growth declined. The growth rates of agricultural land and labour inputs decreased, especially in the 2000s. During this period, those institutional reforms related to land use rights were consolidated. In addition, rural structural changes took place rapidly with the development of the rural nonfarm economy and increasing migration to urban areas and other sectors. Although there has been a declining trend in agricultural growth in recent years, the Vietnamese economy is still squeezing its agricultural sector to support the development of other sectors by obtaining foreign exchange from exports, labour, land and other resources.

This chapter covers three sets of building blocks including food security or the "rice first" policy, the rural nonfarm economy, and land reforms. By developing arguments

from Otsuka (2013), it evaluates whether Vietnamese agriculture is likely to replicate problems that the East Asian countries experienced in agricultural development. Vietnam has retained a small-scale household based agriculture, in spite of the miracle in economic development.

The descriptive findings in this chapter show that despite significant reforms during the three past decades, restructuring Vietnam's smallholder agriculture is still one of major challenges facing policy makers. Vietnam's agricultural transformation appears to follow the path of East Asian economies. The analytical framework presented in Chapter 2 shows that Vietnam should implement land reforms by promoting the pattern of mechanization in agriculture. This is an innovation in light of rising rural wages and largely part-time farming. By saving farm labour inputs for other economic activities, household incomes can improve. In addition, the diversification in agricultural production and livelihoods also raises the income of small-scale farmers. Rice land designation policy should be changed in favour of crop diversification. These strategies ensure more efficient development paths for Vietnam and avoid failures in maintaining the comparative advantage of agriculture.

However, there has been no study discussing these issues systematically in Vietnam.[21] This thesis is the first attempt to contribute to the discussion on the effect of participation in the rural nonfarm economy and part-time farming on household production choices, the role of land reforms on labour allocation and economic diversity, crop diversification, and responses of family labour to increasing cost stress. It examines appropriate agricultural development strategies and policy reforms for smallholder agriculture in Vietnam. Further reforms and policy efforts are required to ensure the agricultural restructuring in current rural structural transformation period. These issues are discussed in the next chapters.

[21]The details of the literature review are presented in each key essay in the thesis (Chapters 4, 5 and 6).

Chapter 4

Crop diversification and economic performance of diversified farms*

"Economic growth and increasing incomes results in changes in food systems. With the growth of consumption and production of high value commodities, diversion of resources from the staple cereal sector to the production of commodities with higher income elasticities becomes important for maintaining incentives for the use of resources in the agricultural production and improving resilience for environmental changes. Thus, new patterns of product combination and resource use have to be developed, instead of intensive mono-crop systems. In addition, small farms respond to increasing cost stress by reducing farm labour or crop production. Therefore, further subsidies may often be necessary to make input purchases for improved technologies both profitable and affordable. This may be contrary to arguments dominating development policies on subsidies" (Policy proposition stated in Chapter 1)

4.1 Introduction

Since the beginning of economic reforms in 1986, food security policy has mainly focused on how to increase the supply of rice, particularly by keeping paddy land stable and through restrictions on converting to other crops and nonfarm activities.[22] Although agriculture is dominated by rice production, accounting for 65 per cent of annual cropping land (GSO 2007), a large number of rice farmers now grow other annual crops in conjunction with rice. Farmers have made adjustments to improve their livelihoods, even though the land designation policy, favouring rice, has remained in place (World Bank 2007; MARD 2009; Dao & Lewis 2013). Farm households in poor areas are converting some paddy land to other annual crops so that they can earn higher incomes (Minot et al. 2006). FAO (2012) suggests that diversifying production to include horticulture and higher value crops allows smallholders to broaden sources of food in local diets and to enter domestic markets for higher-value products. This is said to strengthen resilience to

* An earlier version of this chapter was presented at the 89th Annual Conference of Agricultural Economics Society at University of Warwick, United Kingdom.
http://ageconsearch.umn.edu/handle/204224

[22] Changes in land use purpose are only allowed, "within the existing physical planning framework adopted by central and local governments" (Vasavakul 2006, chapter 11, p.226).

economic and climate shocks. Because of the impact that climate change is likely to have on agricultural production, the need to consider diversified agricultural systems is ever more pressing (Lin 2011).

The Strategy of Agriculture and Rural Development (2011-2020), issued by the Vietnamese government in 2009, set specific objectives for self-sufficiency in food grain production along with the increased production of other nutritious crops, as well as encouragement of exports of vegetables and other annual crops, keeping in view domestic consumption demand changes, nutritional requirements, and the resilience of agricultural systems (MARD 2009). The reallocation of land away from paddy production and towards other crops conflicts with the current land designation policy. In Chapter 3, the evidence for crop diversification is presented in spite of the restrictions on the conversion of land use purpose in rural Vietnam. Although rice dominates and land policies constrain rice farmers, crop diversity does exist in Vietnam. This emphasis at the policy level shows the importance of determining the merits of crop diversification and economic performance of diversified farms at the household level. Chaplin (2000) defines crop diversification as a shift away from monoculture. Farms produce many crops that they could potentially use and sell at different times of the year. This chapter uses the definition of crop diversification given by Chaplin (2000).

Internationally, it has long been recognised that the economic performance of diversified farms is being increasingly influenced by output complementarity (Paul and Nehring 2005; Rahman 2009 and 2010). As a result, crop diversification may lead to cost reduction associated with multi-output production processes (Paul and Nehring, 2005). Several empirical studies find evidence of economies of scale and output complementarity in diversified farms (Chavas and Aliber 1993; Fernandez-Cornejo et al. 1992; Paul and Nehring 2005; Rahman 2010). While management expertise and technological advances tend to favour specialization, in contrast income uncertainty due to input and output price variability may favour diversification (Mafoua-Koukebene et al. 1996; Marsh et al. 2006; Chavas and Di Falco 2012).

The objective of this chapter is to examine the economic performance of diversified farms in rural Vietnam.[23] It seeks the evidence of scale economies, output complementarity and technical efficiency of small-scale production in a farming system characterised by a

[23]In this chapter, risks and uncertainties are ignored despite the fact that these are likely to influence jointness and crop diversification. The issues of risks and uncertainties are not the main focus in this chapter and will be explored in further research.

combination of cash-cropping and food crop production, particularly of rice. The study tests whether the dynamic process of change in integrated farming sub-systems can affect the potential for productivity gains and technical efficiency. It also analyses the economic performance of diversified farms by examining the response of households in adjusting output and input combinations in an environment of increasing cost stress. The substitutability between inputs can have an impact on the cost and efficiency of farm production (Paul et al. 2000). The analysis in this chapter mainly concentrates on rice-based farms. A framework of multi-output/multi-input production is used to estimate the elasticity of substitution and complementarity, as it cannot be estimated from direct cost functions. This also overcomes the common limitation of household surveys due to the lack of information on input prices. Notably, the following research questions are of interest:

a) Does crop diversification result in scale economies and output complementarity in agricultural production?

b) How does farm labour respond to increasing cost stress in multi-crop production?

c) How can technical efficiency be improved in a multi-output environment?

There has been little economic research on these questions. Most existing studies focus only on rice, instead of multi-output pattern.[24] This chapter contributes to the literature in several ways. Firstly, to the best of the author's knowledge, this research provides the first investigation of the economic performance of diversified farms in rural Vietnam. There have been no papers studying the evidence of diversification economies in agricultural production in Vietnam. To bridge this knowledge gap, this chapter uses the Vietnam Household Living Standard Survey 2006 (VHLSS) to answer the research questions. The investigation of the economic performance of diversified farm households provides a better understanding of household behaviour, which is important in designing and adjusting food security policy.

Secondly, the study also provides the first evidence of the elasticity of substitution and complementarity between inputs, with the implication for the response of farm labour to changes in other variables such as an increase in the costs of fertilizer, pesticide and capital. The input distance function improves the estimation of the elasticity of

[24] Papers that study the efficiency in rice production in Vietnam include Kompas et al. (2004, 2012); Vu (2012)

substitution in the context of multi-output and multi-input production technology (Grosskopf et al. 1995; Kumar, 2006). The Morishima elasticity of substitution is computed by applying the parameter estimates from the distance function. Blackorby and Russell (1989) convincingly argue that the Morishima elasticity is the more appropriate measure of substitutability when the production process has more than two inputs. The substitutability of farm inputs helps us to understand the resource allocation of farms facing increasing cost stress.

Finally, understanding technical efficiency enables us to uncover the factors that hinder the productivity growth of annual crop farming in Vietnam in light of declining trends of agricultural growth and rising abandonment of rice fields in many provinces in recent years.[25] The chapter also investigates whether or not further land reforms directed toward land consolidation may reduce technical inefficiency. The role of further land reforms in improving technical efficiency in Vietnamese rice production has been examined by Kompas (2004) and Kompas et al. (2012). The determinants of technical efficiency in a multi-crop environment are, however, open to question.

The chapter is organized as follows. Section 4.2 presents the literature review, which emphasises the measures of economic performance of diversified farms. In Section 4.3, the research methodology is introduced. The empirical model is presented in Section 4.4. This section highlights the methods in estimating the performance measures of diversified farms. It also describes the dataset and construction of variables. Section 4.5 reports and discusses the empirical results. The final section concludes and presents policy implications.

4.2 Literature review

Crop diversification is important for the growth and sustainability of agricultural production in developing countries (Ellis 1998). In a study of crop diversification in China, Van den Berge et al. (2007) found that given fragmented and small farm sizes, farm households who diversified into high-value vegetables and away from rice could improve their incomes. Similarly, the same evidence was found in the case of Sudan when crop diversification reduced income uncertainties (Guvele 2001). Many developing countries put a priority on shifting the cropping pattern from rice production to crop diversification, which aims at improving food security and nutrition, securing sources of income and

[25]See Chapter 3 for details about the evidence of abandoning paddy fields in rural Vietnam.

employment, the resilience of farming systems and environmental services (FAO 2012). Lin (2011) claims that crop diversification can improve resilience by buffering crop production from the increasing effect of climate change. Therefore, crop diversification can promote sustainable intensification in agricultural production.

4.2.1 Economies of diversification in agricultural production

Diversification can be found in agricultural production systems. Farm households can produce more than one output because they have the benefits from economies of scope, which result in positive externalities across the production processes. For example, crop rotation can enable farmers to control pest damages and improve farm incomes; waste from livestock can be used to improve land quality (Chavas and Aliber 1993; Paul and Nehring 2005).

Previous studies analysed the economies of diversification by using an input distance function (Rahman 2009 and 2010; Coelli and Fleming 2004; Irz and Thirtle 2004; Paul and Nehring 2005; Ramussen 2010; Ogundari 2013). These studies focused on examining the economies of scale, diversification and technical efficiency in diversified farms.[26] Coelli and Fleming (2004) introduced a measure of economies of diversification for Papua New Guinea farm households, who switched their crops from sweet potato production. The authors found weak evidence on diversification economies between subsistence food and both coffee and cash food production. In their study, they diverged from the standard approach in identifying the evidence of economies of scope by using an input distance function, instead of a cost function. The use of a cost function was irrelevant due to the lack of cost data and the unpriced nature of many inputs, and the imperfect land and labour markets. This is a common problem for survey data in many developing countries, and therefore, an input distance function is selected to study the economies of diversification.

Similarly, Rahman (2009 and 2010) found evidence of economies of scale and scope in Bangladesh's farm production using the input distance function. In Rahman (2010), the total output of crops increased by one per cent when the total inputs increased by only 0.89 percent. Similarly, Paul and Nehring (2005) provide an overview of the methods used to measure economic performance of US farms. In their study, they also find

[26]Scope economies are considered to exist if a particular firm can produce two or more output at a lower cost than two separate firms specializing in the production of the two individual output (Baumol et al. 1982).

evidence of significant economies of scale and output complementarity of the US's diversified farms. Rasmussen (2010) estimated the input distance function for Danish agricultural production. He found that the elasticity of input with respect to output was 0.62, which implies that one per cent increase in total outputs results in 0.62 per cent increase in the total inputs. These studies also found the existence of economies of scope in multiple output production, which implies that crop diversification results in cost savings in agricultural production.

In the study of Asia's agriculture, Barker et al. (1985) show that Asian farms have maintained different patterns to farms in developed countries, which remained specialized and small in scale. The authors argue that rice specialization in small farms in Asia is a puzzle, to the extent that small farms in other regions are often highly diversified. Kim et al. (2012) examined the economies of diversification with an application to South Korean farms. They concluded that diversification benefits were positive but not statistically significant in South Korean rice farms. Moreover, their study found positive and statistically significant complementarity effects, implying more incentives to diversify in non-rice activities, but fewer for rice farmers. These complementarity effects work against non-convexity effects, providing incentives for rice farmers to specialize in rice production. However, Kim et al. (2012) only find benefits of diversification for production patterns that exclude rice. The analysis fail to explain why farmers produce other crops including rice, and depends on the case by case evaluation.

In addition, South Korea's agriculture was highly protected, and in particular, supported income for rice farmers against rice imports (Honma and Hayami 2009). This reason explains the specialization in rice production of small farms in South Korea. Similarly, rice farmers in Vietnam receive huge support from policies (Tran et al. 2013). Procurement policies and the floor price policy, along with direct cash transfers to rice farmers, are popular policies to stimulate rice production.[27] As a result, rice farmers sell paddy to the government's enterprises based on procurement policy and rice floor price. In contrast, diversified households have to make their own decision on markets for cash crops, which are subject to the fluctuation of market prices.

[27] Resolution No. 63/NQ-CP (2009) on food security and floor price; Government Decisions on rice procurement policies such as Decision 993 (2010); fertiliser and seed subsidies, direct cash transfers of USD 50 per hectare to rice farmers in Resolution No. 42/ND-CP (2012).

Regarding the studies of farm performance in Vietnam, most quantitative analyses use input and output from rice farms (Kompas 2004; Kompas et al. 2012; Vu 2012), focusing exclusively on the rice-growing households, although most farm households in Vietnam also participate in other agricultural activities such as off-farm employment and annual crop production. Kim et al. (2012) argue that omitting other outputs creates a critical bias in the economic analysis of rice productivity if there are complementarities across multiple activities. This chapter, thus, provides new evidence of the efficiency response in multiple output environments and contributes to the debate on whether Vietnam should keep or reduce paddy land until 2020.[28] Moreover, it contributes to strengthening policies to enhance food security and nutritional status in Vietnam. The analysis also reveals a different pattern by only concentrating on small rice farms in Vietnam that diversified their annual crops in spite of the control of paddy land designation as shown in Chapter 3. In the case of Vietnam, it is important to determine the merit of crop diversification, particularly when the Vietnam government is keen on switching to other crops as a strategy for agricultural growth.

4.2.2 Input distance function and its applications in the literature

In order to capture the interactions between outputs and inputs, some studies use an input distance function that allows a multi-output and multi-input specialization of the technology. According to Paul and Nehring (2005), these relationships can be used to develop estimable distance functions, again with either an output or input orientation. Use of the distance function has an obvious advantage over the approach of production functions in that it allows for the possibility of multiple outputs and joint production (Kumbhakar et al. 2007). In fact, no specific behavioural goal is embedded in the distance function. Moreover, Kumbhakar et al. (2007) find that the stochastic production frontier can be estimated without the assumption of the separability of outputs and inputs when using the distance function approach.

The choice of the distance function is not new in the literature. The derivation of the input distance function and its properties can be found in many sources (Coelli et al. 1998; Fare and Primont 1995; Irz and Thirtle 2004; Kumbhakar and Lovell 2003; Lovell et al. 1994; Paul and Nehring 2005; Rahman 2009 and 2010; Brummer et al.

[28]The Government sets a target that by 2020 paddy land is kept at 3.8 million of hectare, and cutting paddy land which has resulted in increasing debate on this plan (http://english.vietnamnet.vn/fms/business/82250/vietnam-considers-cutting-rice-farming-area-down.html).

2006). The essential tool is the stochastic frontier approach proposed by Aigner et al. (1977) and the distance function, originally introduced by Shephard (1970). Over the years, this approach has been used by a number of authors to study agricultural productivity. Paul et al. (2000) were the first to use this approach to formally analyze the consequences of regulatory changes in the components of productivity change in agricultural production in New Zealand. They estimated a four-output, seven-input stochastic output distance function to analyze the impact of regulatory reforms on efficiency and adjustment of production processes on farms in the 1980s. Similarly, Newman and Matthews (2007) used an output distance function to measure and decompose the productivity growth of Irish agriculture between 1984 and 2000 for four principal farming systems. Irz and Thirtle (2004) analyzed the productivity performance for agriculture in Botswana in the period 1979–1996, using a two-output, six-input stochastic translog input distance function.

Moreover, several papers use input distance function to identify the determinants of technical efficiency in agricultural production. However, there is mixed evidence related to the effect of crop diversification on production efficiency in agriculture. Coelli and Fleming (2004) found that technical efficiency can significantly improve if households diversify their crops in Papua New Guinea. Similarly, Rahman (2009; 2010) and Ogundari (2013) also provided the same evidence in the case of Bangladesh and Nigeria, respectively. On the other hand, Llewelyn and Williams (1996) reached an opposite conclusion when crop diversification reduced technical efficiency in Indonesian crop production. In the case of Vietnam, there have been no papers studying the technical efficiency of diversified farms.

One of the advantages of the input distance function is that it can be used to calculate the elasticity of substitution. Grosskopf et al. (1995) firstly estimated the Morishima elasticity of substitution from the parameters of the input distance function in public economics. They argued that the advantage of the distance function over the cost function is that no information on input prices is required, nor is the maintained hypothesis of cost minimization required (Grosskopf et al. 1995). By using the evidence convincingly shown by Blackkorby and Russell (1989), the Morishima elasticity of substitution is the more appropriate measure of substitutability when the production process has more than two inputs. Furthermore, using this approach of the parametric distance function only requires data on outputs and inputs, while the dual methods based on the estimation of a cost function requires information on input

prices, which are often insufficiently developed in developing countries, particularly for land and labour (Irz and Thirtle 2004).

Similarly, Rahman (2010) adopts the approach of Paul and Nehring (2005), and uses the parameters of the estimated input distance function to measure the economic performance of farms in Bangladesh using cross-sectional data. Interestingly, in this paper, the Morishima elasticity of substitution is estimated. In addition, Rahman concludes that crop diversification improves technical efficiency in agricultural production in Bangladesh. The mean of technical efficiency in Rahman's paper is quite high, at 0.9. However, Rahman does not provide the constant output cross and own elasticity of shadow prices with respect to inputs when the author applied the methods of Grosskopf et al. (1995) and Kumar (2006). If Rahman uses the empirical approach developed by Kumar (2006) to calculate the Allen-Uzawa elasticity of substitution, this leads to theoretically inconsistent results due to the symmetric requirement of the Allen-Uzawa elasticity of substitution. This chapter further develops Rahman's (2010) estimation of the Morishima elasticity of substitution, as discussed in Grosskopf et al. (1995) and Kuma (2006).

4.3 Research methodology

4.3.1 Theoretical framework

The chapter focuses mainly on measuring economic performance of diversified farms. The scope of measures of economic performance in this study includes economies of scale, output complementarity, and elasticity of substitution between inputs in light of increasing cost stress in farm production in Vietnam. Bravo-Ureta et al. (2007) define technical efficiency as a measure of management ability at a given level of technology and a source of productivity growth including technical change. They show that the enhancement of the decision-making process can derive the gain in technical efficiency, which is influenced by social and economic conditions such as education and farm characteristics. In contrast, technical change involves investments in research and technology.

In order to answer the research questions of this chapter, a multiple output and input production technology is required. In the study conducted by Paul and Nehring (2005), the authors used both input and output distance functions to evaluate the economic performance of US farms. Both output and input distance functions are capable of

dealing with multi-output technologies. The output-based measure estimates technical efficiency in terms of proportional expansion of outputs, given input being held constant. Whereas, the input-based measure estimates technical efficiency in terms of the proportional savings in inputs, given outputs being held constant. These measures can be interpreted in terms of output enhancement and cost savings, respectively. In this chapter, an input-oriented stochastic distance function is analyzed, instead of an output oriented distance function, for two major reasons: (i) the input distance function is unambiguously interpreted in terms of cost saving - one of key interests in this chapter in light of the rising costs in agricultural production due to the high inflation of the past decade in Vietnam (World Bank, 2011); (ii) the input-based measure allows this study to answer the research question about how family labour behaves in response to increasing cost stress.

This study applies the input distance function developed by Paul and Nehring (2005) to measure the economic performance of diversified farms. Because there is no access to cost data due to the unpriced nature of many inputs in this study, which is unable to calculate economies of scope relative to a cost function. Thus, output complementarity is, instead, calculated by an input distance function. This problem of unpriced inputs may explain why studies on diversification economies in developing countries use the approach of input distance function, instead of cost function (Coelli and Fleming 2004 for Papua New Guinea; Rahman 2009 and 2010 for Bangladesh). At the same time, the choice of a stochastic distance function approach can allow the separation of the random noise from technical inefficiency effects that is ignored in the data envelopment analysis by Dao and Lewis (2013).[29] Several studies used the parameters of the estimated input distance function to estimate scale economies, technical efficiency and elasticity of substitution in diversified farms (Grosskopf et. al. 1995; Rahman 2010).

[29]Dao and Lewis (2013) also estimate the technical efficiency in rice-based crop diversification farms in Vietnam. However, they only apply non-parametric regression as a data envelopment analysis. Kumbhakar and Lovell (2003) show that non-parametric methods cannot provide the determinants of technical inefficiency in stochastic production function.

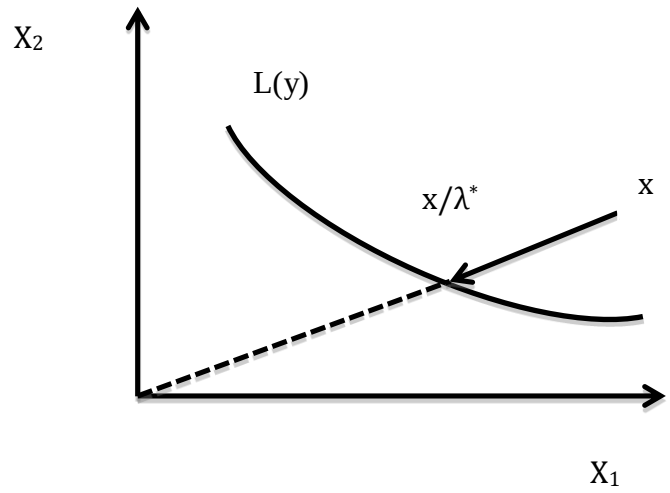


Figure 4.1 **Input distance function, over-utilization of X_1, reproduced from Grosskopf et al. (1995, p. 280)**

In the study of stochastic frontier analysis, Kumbhakar and Lovell (2003) introduce the overview of the input distance function, which was firstly introduced by Shephard (1970).[30] This function describes how much an input vector may be proportionally contracted with the output vector that is held fixed. This chapter uses the theoretical framework introduced by Kumbhakar and Lovell (2003), and Paul and Nehring (2005, p. 529). The input distance function *D(x,y)* is formally defined as:

$$D(x,y) = max\left\{\lambda; \lambda > 0, \frac{x}{\lambda} \in L(y)\right\} \quad (4.1)$$

$$L(y) = \{x \in R_+^N : x\}, \text{ } x \text{ can produce } y \quad (4.2)$$

where *x* is a scalar, *L(y)* is the set of input requirement *x*, which is used to produce the output vector *y*. Figure 5.1 below describes the input distance function. As can be seen in Figure 5.1, the input vector *x* is feasible for output *y*, but *y* can be produced with the radically contracted input vector (x/λ^*), and so $D(x, y) = \lambda^* > 1$. $D(x, y) = 1$ if and only if the input bundle is an element of the isoquant of *L(y)*. In addition, *D(x, y)* is non-decreasing, positively linear homogenous and concave in *x*, and increasing in *y*. Paul and Nehring (2005) show that the input distance function can provide the measure of technical efficiency because it allows for deviation (distance) from the frontier. Finally, there is a dual relationship between input distance function and cost function, which allow us to relate the derivatives of the input distance function to the cost function (Färe and Primon 1995).

[30]See further details of properties of input distance function in Kumbhakar and Lovell (2003).

According to Lovell et al. (1994), the imposition of a function form for *D(x, y)* cannot be directly estimated due to the unobserved value of the distance function. Lovell et al. (1994) thus suggest a way of solving this problem by exploiting the property of linear homogeneity of the input distance function as follows:

$$D(\rho x, y) = \rho D(x, y), \rho > 0 \quad (4.3)$$

Assuming that *x* is a vector of dimension *K* and $\rho = 1/x_1$, where x_1 denotes the (arbitrary chosen) first element of the input vector *x*, the Equation (4.3) is transformed in logarithmic form as:

$$lnD_i(x, y) = lnx_1 + lnD(x/x_1\ , y) \quad (4.4)$$

Lovell et al. (1994) also show that the logarithm of the distance function in the Equation (4.4) measures the deviation of an observation (*x*, *y*) from the deterministic border of the input requirement set *L(y)*, which is consist of two components according to the stochastic frontier literature. The first one describes random shocks and measurement errors. The second one corresponds to technical inefficiencies that are assumed to be stochastic and a non-negative random variable *u*. Conceptually the presence of inefficiencies can be evaluated by the distribution of management skills across the population of farm households using the same technology. These assumptions, thus, can be mathematically expressed as follows:

$$lnD(x, y) = u - v \quad (4.5)$$

Substituting Equation (4.5) into Equation (4.4) gives:

$$-lnx_1 = lnD(x/x_1, y) - u + v \quad (4.6)$$

4.3.2 Functional form

To empirically estimate the distance function, a functional form must be specified. I select the translog functional form used by previous studies (Lovell et al. 1994; Grosskopf et al. 1995; Coelli et al. 1998; Paul et al. 2000; Irz and Thirtle 2004; Paul and Nehring 2005; Rasmussen 2010; Rahman 2010). The translog is a flexible function and it has some advantages in that it allows the elasticity of scale to change for various farm sizes. In addition, a flexible technology also allows for substitution effects in the function, which supports the answer to the research questions related to substitutability between inputs (Paul et al. 2000).

The translog input distance function with *M* outputs, *N* inputs of the farm household *i* is given by:

$$lnD_i = \beta_0 + \sum_{n=1}^{N} \beta_n lnx_n + \frac{1}{2}\sum_{n=1}^{N}\sum_{k=1}^{N} \beta_{nk} lnx_n\, lnx_k + \sum_{m=1}^{M} \alpha_m lny_m + \frac{1}{2}\sum_{m=1}^{M}\sum_{l=1}^{M} \alpha_{ml} lny_m\, lny_l + \sum_{m=1}^{M}\sum_{n=1}^{N} \gamma_{mn} lny_m\, lnx_n \quad (4.7)$$

where D_i measures the distance from (x,y) to the production function and denotes the unobservable value of the distance function. As the input distance function is linear homogenous in inputs, the parameters in Equation (4.7) must satisfy the following regulatory restrictions:

$$\sum_n \beta_n = 1, \sum_k \beta_{nk} = 0, \sum_n \gamma_{mn} = 0 \ (m = 1, \dots, M)$$

$$\beta_{nk} = \beta_{kn} \ (N, K = 1, \dots, N);\ \alpha_{ml} = \alpha_{lm} \ (m, l = 1, \dots, M)$$

This chapter uses the approach of Lovell et al. (1994) and Coelli and Perelman (1999) in imposing these restrictions required for the homogeneity of degree of one in inputs ($\sum_{n=1}^{7} \beta_n = 1$) by normalizing the function by one of the input, similar to Equations (4.3) and (4.4). As a result, Equation (4.7) is expressed as follows:

$$ln(D_i/x_{1i}) = \beta_0 + \sum_{n=2}^{7} \beta_n lnx_n + \frac{1}{2}\sum_{n=2}^{7}\sum_{k=2}^{7} \beta_{nk} lnx_n\, lnx_k + \sum_{m=1}^{4} \alpha_m lny_m + \frac{1}{2}\sum_{m=1}^{4}\sum_{l=1}^{4} \alpha_{ml} lny_m\, lny_l + \sum_{m=1}^{4}\sum_{n=2}^{7} \gamma_{mn} lny_m\, lnx_n = \mathrm{lnD}(x^*, y) \quad (4.8)$$

where $x_{ni}^* = x_{ni}/x_{1i} (\forall n, i)$, only *n-1* inputs are not used for normalization. Substituting ln*D* with *u* and adding error term *v* to account for random noise, we end up with an estimating Equation (4.9). Substituting Equations (4.8) into (4.6), we have:

$$-lnx_1 = lnD(x_{ni}^*, y) - u + v \quad (4.9)$$

Paul and Nehring (2005) find that coefficient estimates from Equation (4.9) have opposite signs from those for a standard production or input requirement function. The authors introduce a method by reversing the signs of the equation in order to interpret

the measures from Equation (4.9) more similarly to those from the more familiar functions in the literature review:[31]

$$lnx_1 = -lnD(x^*_{ni}, y) - u + v \qquad (4.10)$$

Equation (4.10) is expressed as a stochastic distance function, which includes two error terms representing deviations from the frontier and random error. On the basis of a parameterisation of the distance function and distributional assumptions of error terms, Equation (4.10) can be estimated by the maximum likelihood methods, which have been extensively used in the stochastic frontier literature.[32]

4.4. Empirical implementation

4.4.1 The econometric specification

The empirical model in this chapter is developed from Equations (4.8) and (4.10). The frontier estimation is different from typical econometric models in which adding a normal error term allows the functions to be fitted with the data. Furthermore, it implies that a one-sided error term (u_i) should be appended to the function. When the function captures stochastic errors, the model is transferred into a stochastic production frontier perspective (initially developed by Aigner, Lovell and Schmidt (1977) for production functions). The estimation of a stochastic production frontier is widely used by maximum likelihood techniques, assumed that u_i are non-negative random variables independently distributed as truncation at zero of the normal distribution with unknown mean, M_i.

The production structure of annual crops in Vietnam is modelled using a multi-output multi-input stochastic distance function. One of the issues arises for implementing the distance function estimation is which of the inputs might be used as a normalizing factor. As Collie and Perelman (2000) argue, any input can be chosen and this should not present econometric problems because the results are invariant to this choice. However, there could still be economic reasons for selecting x_1. This analysis mainly focuses on rice-based annual crop farms, and in this study, all other inputs are represented relative to land as x_1. Using land as a normalizing variable in the input

[31]Paul et al. (2000), Paul and Nehring (2005), Rahman (2010), and Rasmussen (2010), they only reverse the signs of coefficient estimates from the $lnD(x^*, y, r)$. I follow the same step and keep the signs of the random statistical noise v and technical inefficiency u unchanged.
[32] See the summary of the stochastic frontier literature by Coelli et al. (1998).

distance function has been widely applied in studies in agricultural economics (Irz and Thirle 2004; Paul and Nehring 2005; Rahman 2010; Rasmussen 2010). This choice is consistent with the typical agricultural economics approach to production modelling in terms of yields, and inputs per acre. Different choices for the normalizing input variable (x_1), such as fertiliser, were tried with only a slight difference in results.

The empirical model is stated as follows:

$$-lnx_{1i} = \beta_0 + \sum_{n=2}^{7} \beta_n lnx_n^* + \frac{1}{2}\sum_{n=2}^{7}\sum_{k=2}^{7} \beta_{nk} lnx_n^* \, lnx_k^* + \sum_{m=1}^{4} \alpha_m lny_m + \frac{1}{2}\sum_{m=1}^{4}\sum_{l=1}^{4} \alpha_{ml} lny_m \, lny_l + \sum_{m=1}^{4}\sum_{n=2}^{7} \gamma_{mn} lny_m \, lnx_n^* + \sum_{k=1}^{8} \rho_k \, REG_k + v_i - u_i \quad (4.11)$$

And according to Battese and Coelli (1995), the parameter in the inefficiency distribution is expressed as $u_i = \mu_0 + \sum_{s=1}^{9} \mu_s \, M_{is} + \omega_i^*$, (4.11a)

where x_1 is land cultivated per farm as the normalizing input, v_i is the two-sided random error and u_i is the one-sided error in model (11), M in Equation (4.11a) introduces variables that represent farm household characteristics affecting technical inefficiencies. The model has added dummy variables that control for regional differences, REG_k. Model (4.11) includes seven production inputs (X), four outputs (Y) and nine variables of M_{is} in the technical inefficiencies model. There is no environmental condition in the model due to a lack of data that captures this variable. Thus, environmental conditions such as land quality and land characteristics are ignored in this chapter. Moreover, in Vietnam, the classification of irrigated land and non-irrigated land is only collected in surveys at the communal level. Regional differences are controlled by using regional dummies.

Equation (4.11a) estimates the determinants of technical inefficiency in annual crop farms. Efficiency is an important economic concept for the measurement of economic performance of a farm. From the one-sided error term u_i in Equation (4.11), the levels of technical efficiency can be estimated.[33] According to Kumbhakar and Lovel (2003),

[33] Technical efficiency (*TE*) refers to the ability to minimize input use in the production of a given output vector, or the ability to obtain maximum output from a given input vector (Kumbhakar and Lovell, 2003). In general, 0<*TE*<1, where *TE*=1 reflects that farms are producing on the frontier of

variance term is defined as $\delta^2 = \delta^2_v + \delta^2_u$ and $\gamma = \delta^2_u / (\delta^2_v + \delta^2_u)$. Using the approach of Coelli and Perelman (1999), the input distances are predicted as $D=E[exp(u)/e]$, where $e=v-u$. The technical scores of each farm are derived from the inverse of these input distances. The deviation of the technical efficiency measures from 1 indicates the percentage by which inputs of farm production would, in principle, have to decrease to reach the production frontier.

The impacts of determinants on the extent of a particular farm's efficiency, such as education and land fragmentation, are also be explored by including them as component of the M_{is} vector: the age of household head (M_1), the mean education of working-age men (M_2), the mean education of working age women (M_3), households that access to formal credit programs (M_4), the number of household members from 15 to 60 years old (M_5), dependency ratio (M_6), days of illness in a year (M_7), the number of plots that capture the impact of land fragmentation on technical inefficiency (M_8), and hours of non-farm wage participation (M_9).

4.4.2 Identification

As regards the endogeneity problem, there is criticism that the parameter estimates of the distance function may be affected by simultaneous equations bias (Atkinson et al. 1999). Atkinson et al. (1999) use instrumental variables to reduce the bias, even though they did not clearly specify the source of suspected simultaneous equations bias (Coelli, 2000). Atkinson et al. (1999) also argue that due to the ratios of inputs on the right-hand side of the estimating equation (in the case of an input distance function), there must be a simultaneous feedback problem because these input variables are assumed to be 'endogenous' variables.

However, Coelli (2000) clearly demonstrates that ordinary least squares provide the consistent estimates of the parameters of the input distance function under the assumption of cost minimizing behaviour. In fact (as Coelli (2000) shows), distance functions are no more subject to possible endogeneity criticisms than production functions. He further adds that when cost-minimising behaviour is a reasonable assumption, the input distance function has a clear advantage over the production function, due to an endogenous dependent variable and exogenous independent variables, while the production function has the converse. As a result, the use of distance functions is further strengthened (Coelli,

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production. Alternatively, $TE<1$ implies that farms are technically inefficient, which means that ($1-TE$) captures the proportional reduction in inputs, x that can be gained to produce output, y.

2000, p. 20–21). Therefore, this chapter inherits the analysis of consistent estimates in Coelli (2000) to develop the empirical model. Moreover, it also investigates the possibility of simultaneous equation bias in the estimation of the distance function (see Appendix A2). The OLS estimation results in consistent estimates of parameters under the cost minimizing assumption.

The estimates of parameters in the Equations (4.11) and (4.11a) are applied by using maximum likelihood estimation in a single state as shown in Coelli and Perelman (2000). STATA 13 is used to estimate the model, and the problem of zero values in the translog input distance function is solved by applying the approach of Paul et al. (2000).

4.4.3 The performance measures

There have been various measures of the production process that can be calculated as derivatives or elasticities from the estimated input distance function. The analysis applies the performance measures used by Paul and Nehring (2005) in the case of Vietnamese farm households. Rahman (2010) and Rasmussen (2010) also apply the same procedure in estimating the performance measures for farms in Bangladesh and Denmark, respectively. According to Paul and Nehring (2005), performance measures are desired from the overall output-input relationship. There are four measures including scale economies, output complementarity, elasticity of substitution between inputs and technical efficiency.

4.4.3.1 Scale economies

Baumol et al. (1982) developed the measurement of scale economies in multi-product firms. If the returns to scale are increasing, then the ray average cost is a decreasing function (where a proportional increase in outputs leads to a less than proportional increase in costs). Similarly, when returns to scale are decreasing, then the ray average cost is an increasing function (where a proportional increase in outputs leads to a more than proportional increase in cost).

Based on the above ideas, scale economies can be derived in farming production. The elasticity of the input distance function with respect to outputs and inputs has useful interpretations. Färe and Primont (1995) and Paul and Nehring (2005) find that the combination of the first-order input elasticities representing scale economies shows a positive correlation between productivity and input growth. Moreover, these studies

conclude that the relationship between input and output scale economy is defined as the sum of individual input elasticities and reflects how much overall input use must increase to support a 1 per cent increase in all outputs (which is the same as a cost function-based scale economy measure).

Based on the development in Paul and Nehring (2005) and Equation (4.11), the individual input elasticity summarizing the input expansion that is required for a 1 per cent increase in y_m is expressed as follows:

$$-\mathcal{E}_{D,y_m} = -\frac{\partial lnD}{\partial lny_m} = \frac{\partial lnx_1}{\partial lny_m} = \frac{\partial x_1}{\partial y_m}\frac{y_m}{x_1} = \mathcal{E}_{x,y_m} \tag{4.12}$$

The measure in Equation (4.12) can be considered as an "input share" of y_m that is relative to x_1. It is expected to be negative for all desirable outputs. Summarizing all elasticities in Equation (4.12) results in the measurement of scale economies can be shown by:

$$-\mathcal{E}_{D,y} = -\sum_m \frac{\partial lnD}{\partial lny_m} = \sum_m \frac{\partial lnx_1}{\partial lny_m} = \mathcal{E}_{x,y_m}$$
$$= \mathcal{E}_{x,y} \tag{4.12a}$$

Paul and Nehring (2005) indicate that the extent of scale economies (for proportional changes in all inputs) is implied by the shortfall of $\varepsilon_{x,y}$ from 1. Thus, $\varepsilon_{x,y}<1$ implies increasing return to scale, which means that output increases generate a less than proportionate input expansion (with proportional changes in all inputs). It should be noted that the measure of scale economies in Paul and Nehring (2005) is different from the traditional scale economies (SE>1 implies increasing returns to scale). Therefore, this chapter converts the measure of scale economies of Paul and Nehring (2005) to follow the traditional measure by using the formula: SE= (1/ $\varepsilon_{x,y}$). In this context, an increasing returns to scale corresponds to SE>1 ($\varepsilon_{x,y}<1$), while a decreasing return to scale corresponds to SE<1 ($\varepsilon_{x,y}>1$).

In addition, decomposing the first-order elasticities $\varepsilon_{x,ym}$ and $\varepsilon_{x,y}$ into the second-order effects captures changes in output composition as scale expands. This decomposition is implied by technological bias measures showing how the y_m input elasticity or the share $\varepsilon_{x,ym}$ reflects a change in another output. Thus, these measures provide insights into the output complementarity of the agricultural production system. Moreover, they

also provide insights into the competitive disadvantages faced by small farms in Vietnam and incentives to increase the scale of production.

4.4.3.2 Output complementarity and economies of scope

Willig (1979) developed the concept of scope economies in multiproduct firms. He finds that with economies of scope, joint production of two goods by one firm is less costly than combined costs of production of two firms. The reason for economies of scope, according to Willig (1979), comes from inputs that are shared and jointly utilized without complete congestion. This concept measures cost savings due to simultaneous production. Moreover, economies of scope arise from the presence of public inputs, which means that inputs purchased to produce certain products can be used to produce other products free of cost. Traditionally economies of scope are defined relative to a cost function (Baumol et al. 1982). A variable cost function is expressed as: *C=c(q,x,w)*, where q is a vector of outputs, x is a vector of inputs facing a vector of variable input prices, w. The function C satisfies the usual homogeneity, monotonicity and curvature properties (Chambers, 1988). The economies of scope exist between output *j and i* if $\partial^2 C/\partial q_i \partial q_j < 0, i \neq j$ (4.13)

Equation (4.13) implies that the addition of an extra unit of output *i* reduces the marginal cost of producing an extra unit of output *j*. However, this current study diverges from the standard method for two reasons. First, it uses an input distance function instead of a cost function. As shown in the theoretical framework section, there is no cost data due to the unpriced nature of inputs such as land, labour in the production system in Vietnam. Second, the choice of a stochastic input distance function approach allows the separation of the random noise from technical inefficiency, which is also one of key interests in this chapter. Therefore, it is unable to compute the economies of scope relative to a cost function from survey samples.

The chapter now defines output complementarity as a measure of 'economies of diversification' by using the approach of Paul and Nehring (2005). The output complementarity is not the same as the measure of scope elasticities in Equation (4.13) because its calculation is conditional upon the input mix being held fixed, whereas, the use of a cost function allows the input mix to be adjusted to obtain the minimum cost (Chavas and Aliber 1993). As shown by Paul and Nehring (2005) and equation (4.12), the increase in y_m as y_l increases can be represented by $\varepsilon_{y_m y_l} = \partial \varepsilon_{x,y_m}/\partial ln y_l$, where

$\mathcal{E}_{x,y_m}$ is a sum of all elasticities in Equation (4.12). If $\mathcal{E}_{y_m,y_l} < 0$, output jointness or complementarity is implied. As a result, economies of scope exist in farm production (Paul and Nehring 2005). In this case, input uses do not have to increase as much to expand y_m if the y_l level is greater. With output complementarity, the cost of adding the production of y_l to the production of y_m is smaller than the production of y_l alone. As a result, this elasticity is represented by the cross-output coefficient estimate α_{ml}, $\mathcal{E}_{y_m,y_l} = \alpha_{ml} = \mathcal{E}_{y_l,y_m}$.

If the complementarity between outputs is satisfied, an increase in one output expands the contribution of other outputs and thus performance improvement and cost savings. As regards cost-minimizing levels of inputs, the elasticity of D with respect to any input, x_n equals its cost share, s_n, that is: $\mathcal{E}_{x,x_n} = \partial lnD/\partial lnx_n = s_n$. This elasticity, thus, represents the relative importance of input x_n in the production process.

4.4.3.3 Elasticity of substitution

This section provides insights into the input contribution obtained from the input distance function using the duality property between the cost function and input distance function (Färe and Primont 1995). It also answers the second question: how households adjust inputs in small farms to respond to the increasing cost stress in multi-crop production. The elasticity of substitution can be estimated from cost functions. However, using the approach of cost functions requires input prices, which are missing in the household surveys in Vietnam (particularly land prices) due to incomplete markets (World Bank 2006; Le 2009).

In this chapter, the estimated parameters of the input distance function are used to calculate the Morishima elasticity of substitution (MES).[34] Blackorby and Russell (1989) convincingly argue that the Morishima elasticity of substitution is the more appropriate measure when there are more than two inputs in the production process. This chapter mainly focuses on the computation. The approach has been applied in several studies (Grosskopf et al. 1995 in public administration; Kumar 2006 in water management; Rahman 2009, 2010 in Bangladesh's agricultural production).

[34]The elasticity of substitution was originated from Hicks (1963). It is defined as the elasticity of the ratio of two inputs with respect to the ratio of their marginal products. Morishima (1967) introduced the measure of substitutability in the multi-input case written in Japanese. Later, Blackorby and Russel discovered and named the Morishima elasticity of substitution (MES). MES preserves the salient characteristics of the original Hicksian concept. See further details in Blackorby and Russel (1989) for an overview of MES.

Grosskopf et al. (1995, p. 281) claim that due to the complete description of the production technology, the parameters of the input distance function may be used to describe the characteristics of the frontier technology, including curvature, which captures the degree of substitutability along the surface technology. Hence, the indirect Morishima elasticity of substitution as denoted by Blackorby and Russel (1989) can be calculated as:

$$MES_{x,nk} = -\frac{dln\left[\frac{D_n(x,y)}{D_k(x,y)}\right]}{dln\left[\frac{x_n}{x_k}\right]} = x_n\left(\frac{D_{nk}(x,y)}{D_k(x,y)}\right) - x_n\left(\frac{D_{kk}(x,y)}{D_n(x,y)}\right) \quad (4.14)$$

where the subscripts in the input distance function indicates partial derivatives with respect to inputs, e.g. $D_{nn}(x,y)$ represents the second order derivative of the distance function with respect to x_n. Kumar (2006) notes that the first derivatives of the input distance function with respect to inputs obtain the normalized shadow price of that input due to the dual property between cost function and the input distance function. The first component of the definition, thus, can be considered as the ratio of the percentage change in the shadow prices resulting from a one per cent change in the ratio of inputs. This represents the change in relative marginal products and input prices needed to affect substitution under cost minimization. Grosskopf et al. (1995) suggest a simplified method to calculate the indirect Morishima elasticity as follow:

$$MES_{x,nk} = \mathcal{E}_{x,nk}(x,y) - \mathcal{E}_{,x,nn}(x,y) \quad (4.15)$$

where $\varepsilon_{x,nk}(x,y)$ and $\varepsilon_{x,nn}(x,y)$ are the constant output cross and own elasticity of shadow prices with respect to input. The first term gives information on whether pairs of inputs are net substitutes or net complements, and the second term is the own price elasticity of demand for the input. In addition, Kumar (2006) further adds that if $\varepsilon_{x,nk}(x,y)$ is greater than zero, net complements are implied. If $\varepsilon_{x,nk}(x,y)$ is less than zero, net substitutes are indicated. The indirect MES has opposite patterns to the direct one. In the case of indirect MES, if more input x_n were used for a given level of x_k, a higher value of MES suggests lower substitutability and the relative shadow price of x_n to x_k would increase substantially. Conversely, lower values reflect relative ease of substitution between the inputs. In this way, the indirect MES give information as to the feasibility of substitution. In addition, the Morishima elasticity is not symmetric, i.e. $MES_{x,nk}$ and $MES_{x,kn}$ are, in general, different (see Grosskopf et al. 1995; Paul et al. 2000; Kumar 2006).

Intuitively, the Morishima elasticity of substitution measures how an increase in the ratio of two inputs has an impact on the relative change in shadow prices of these inputs (Blackorby and Russell 1989). It implies that input *k* is a substitute for input *n* if an increase in the quantity of input *k* is associated with increases in the shadow price of input *n* relative to the shadow price of input *k*. Conversely, if input *k* is a complement for input *n*, the increase in quantity will result in the reduction of the shadow price of input *n*, which means that there is an increase in the quantity of input *n*. Thus, $MES_{x,nk}<0$ implies substitutability.

Using the parameters from the translog estimating Equation (4.11), $\varepsilon_{x,nk}(x,y)$ and $\varepsilon_{x,nn}(x,y)$ are obtained as follows:

$$\mathcal{E}_{x,nk}(x,y) = [\beta_{nk} + S_n S_k]/S_k \text{ if } n \neq k \text{ and } \mathcal{E}_{x,nn}(x,y) = [\beta_{nn} + S_n(S_n - 1)]/S_n \text{ if } n{=}n \quad (4.16)$$

where S_n is the first order derivative of the translog input distance function with respect to x_n as: $S_n = \partial lnD/\partial lnx_n = -\partial lnx_1/\partial lnx_n$ (4.17)

It should be noted that the elasticity of substitution (MES) is evaluated at the mean of the data using the parameter estimates of Equation (4.11). In this chapter, the substitution possibilities between family labour and other inputs are explored. In the past few years, there has been an increasing trend for farm households to abandon farms in rural Vietnam in light of rising cost stress (World Bank 2007 and 2011),[35] and thus this study investigates as to whether substitution possibilities could be explored.

4.4.4 Data

The data for the empirical analysis used are from VHLSS in 2006. This survey is nationally representative, and consists of questionnaires at both household and communal levels. There were 9,189 households in 2,216 communes surveyed in VHLSS 2006. This empirical analysis focuses on rice-based farms that mainly grow rice, starchy crops, vegetables and industrial annual crops. It should be noted that there are 4,824 farm households representing 52.49 per cent of total households in VHLSS 2006. For this study, rural rice-based annual cropping farms are selected - 3,059 rice farms accounting for an average 63.94 per cent of farms in the sample.

[35] Also, in 2013, 42,785 families left over 6,882 hectares of fields untouched in Vietnam. Moreover, 3,407 families returned over 433 hectares of land. Some farmers state that the income they receive from growing rice has shrunk (MARD 2014)

The main focus of this chapter is diversified farms and their economic performance. Thus, among 3059 rice farms, households producing at least one another annual crop are selected (this implies diversified farms). The sample used in this paper includes pure tenant households, and land rental households. This selection criterion results in a sample of 1,970 farm households, which may raise the issues of sample selectivity in the analysis. However, the scope of this study only concentrates on diversified farms to evaluate scale economies, output complementarity, and technical efficiency as measures of economic performance. Therefore, the issues of sample selection do not lead to any serious problems for the objective of this study.

In this chapter, there are four outputs including rice (y_1), vegetables (y_2), starchy outputs (y_3) and annual industrial outputs (y_4). Rice is measured in kilograms produced in the 12 months prior to the survey date. Other annual outputs are measured in value. There are 21 different crops classified as vegetables, starchy crops and industrial annual products in VHLSS.[36] Without aggregating crops, not possible is to estimate the model with the inclusion of these 21 annual crops and rice. Therefore, the valid way to aggregate these crops is through the value. In the literature, there are other researchers who face the same problem in the case of cash crops (Brümmer et al. 2006; Rahman 2009 and 2010; Rasmussen 2010). These studies use the aggregated value of all cash crops plus the quantity of food crop to estimate the input distance function.

There are seven inputs used in the Model (4.11) including x_1, a normalizing variable measured by the amount of area in hectares that farm households use for annual crops; x_2, family labour in hours; x_3, fertilizer in kilograms; x_4, pesticide; x_5, hired labour; x_6, hired capital;[37] x_7, seeds. There were a large number of observations that have zero value for the input variables x_5 (hired labour) and x_6 (hired capital). Morrison-Paul et al. (2000) show that some zeroes in the input variables make use of the translog form questionable - a typical fix for this is to substitute some minute amount of the variable to permit logs to be taken.

Table 4.1 describes the summary of statistics on the variables used in the analysis. In the inefficiency model, there are a number of variables representing farms'

[36] In the VHLSS 2006, vegetables include potatoes, water spinach, kohlrabi, cabbage, cauliflower, mustard greens of all kinds, fresh beans of all kinds, tomatoes, spiced herbs, and other vegetables, tubers and fruits. Starchy crops cover maize, sweet potatoes, cassava, manioc, and other starchy plants. Annual industrial crops include soybeans, peanuts, and sesame seeds. All crops are aggregated using the value of harvested output.

[37] Hired capital includes land rental or contracting, rental of assets, machinery, equipment and means of transport, and rental of cattle for ploughing per year.

characteristics that may affect technical efficiency. The age of the farm household head is included to control for demographic differences between farms. The level of education as a common technical efficiency shifter is also used in the model. All studies related to farm technical efficiency use education as a key variable. Kompas et al. (2004 and 2012) use years of schooling of the household head to capture the education effect in the model. This chapter evaluates the impact of education by decomposing between male and female education. Given the gender differences in educational levels, as well as the diversification of farm tasks by gender, this study uses the average education of adult females and males. Education is widely used as one of key determinants of technical efficiency in agricultural production.

As regards land policy, there are two key variables - land fragmentation and land certificate title. The number of plots measures land fragmentation. The chapter tests whether land consolidation results in improved technical efficiency. As discussed in the previous chapter, there are two sources to reduce land fragmentation: plot exchange programs and the development of land markets. The latter is the ratio of land under title to total land areas of farms. Marsh et al. (2006) show that allocating land titles has been a key land reform in Vietnam. It not only creates more incentives to invest in land, but also secures more credit in farm production, as without a land certificate, it is not easy to secure a loan from official banks. The final variable in the inefficiency model is the hours of participation in nonfarm activities. Farms with higher nonfarm hours may operate at lower level of technical efficiency.

It should be noted that the average farm size of multiple crop-growing households is small (0.41 hectare per farm) - 95% of farmers have land area less than one hectare. In light of the high land fragmentation in rural Vietnam (average 6.32 plots per farm in VHLSS 2006), diversification can be a method of reducing risk for small farms when their income from rice production is low. Chavas and Di Falco (2012) found that small-scale farms tend to diversify in order to stabilize the returns of different crops and reduce risk. In contrast, large farms focus on specialization.

Table 4.1 **Definitions, units of measurement and summary statistics for all variables in the empirical analysis**

Variables	Unit	Obs.	Mean	Std. Dev.
Output variables				
Rice (y_1)	Kg	1970	1876.68	2713.83
Vegetables (y_2)	1000VND	1970 (1550)	1012.54	3058.51
Starchy crops (y_3)	1000 VND	1970 (1445)	1217.06	3232.59
Annual industrial crops (y_4)	1000 VND	1970 (751)	477.83	2013.5
Input variables				
Land area cultivated (x_1)	Ha	1970	0.41	0.54
Family labour (x_2)	Hours	1970	2293.65	1616.68
Fertilisers (x_3)	kg	1970	525.93	717.59
Pesticides (x_4)	1000 VND	1970	359.74	1071.03
Labour hired (x_5)	1000 VND	1970	340.02	1184.20
Capital hired (x_6)	1000 VND	1970	546.40	968.83
Seeds (x_7)	1000 VND	1970	415.07	597.48
Farm specific variables				
Age of the household head	Years	1970	47.72	11.13
Mean education of working age men	Years	1970	4.08	2.17
Mean education of working age women	Years	1970	3.99	2.16
Household members, from 15 to 60	Persons	1970	3.02	1.20
Dependency ratio (%)	Per cent	1970	0.31	0.22
Days of illness	Days	1970	21.25	43.03
Number of plots	Plots	1970	6.32	4.26
Hours of nonfarm wage participation	Hours	1970	988.77	1519.42
Ratio of land with land use right certificates	%	1970	0.63	0.40

Note: The number of nonzero observations for each production activity is provided in parenthesis. Note that 1 USD=15,965 VND (Vietnamese currency) in 2006.

4.5 Empirical results

4.5.1 Crop diversification from the survey sample

As a direct measure of the degree of diversification, the Herfindahl index (*HI*), (widely used in literature)[38] is examined. This index is defined as the sum of the squares of the acreage, or revenue proportion of each crop in total cropped area/revenue (Brümmer et al. 2006). This chapter applies the approach of Brümmer et al. (2006) by using the

[38] In-applied agricultural economics, the Herfindahl index has been used by Llewelyn and Williams (1996); Brummer et al. (2006); Rahman (2010); Ogundari (2013).

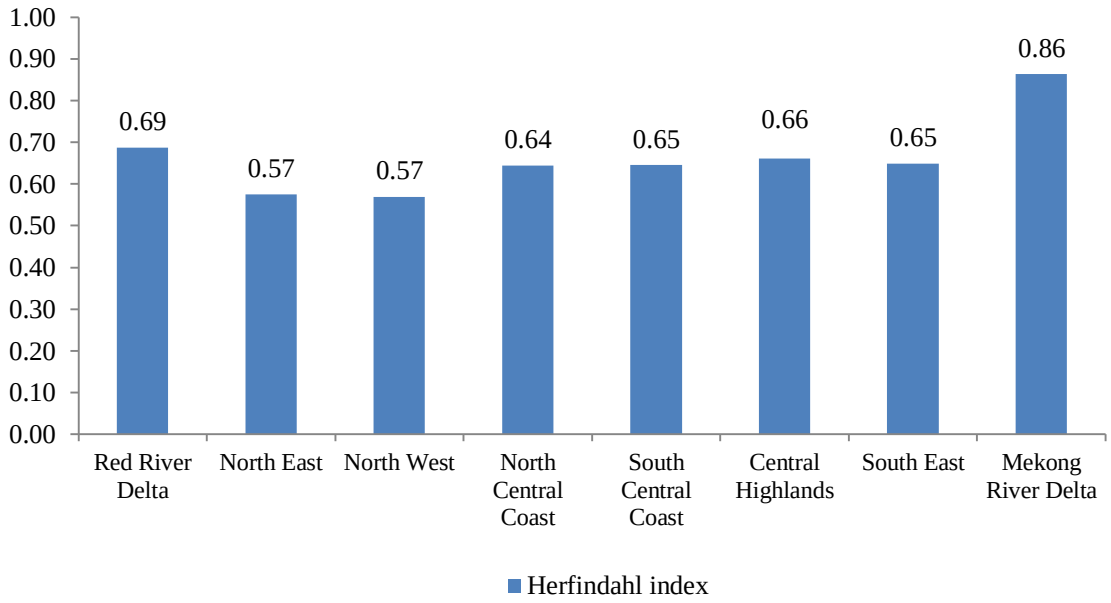
revenues of annual crops of a farm to estimate *HI*. The detailed formula of the *HI* applied in this chapter is described as follows:

$$HI = \sum_{i=1}^{N} \left(\frac{Y_i}{\sum_{i=1}^{n} Y_i} \right)^2, 0 \leq HI \leq 1,$$

where Y_i represents the revenue share occupied by the *ith* crop in total revenue *Y* and *N* is the number of crops of a farm. The zero value reflects perfect diversification and one reflects perfect specialization (only one crop).

Figure 4.2 below describes the annual crop diversification index by regions in Vietnam. The sample mean of the Herfindahl index is 0.75. The Mekong River Delta, the centre of rice production in Vietnam, has the highest Herfindahl index. Conversely, crop diversification mainly occurs in northern regions. Households in the North West region produce a wide variety of crops than other regions, and the Herfindahl index of 0.57. Robison and Barry (1987) concluded that when farms are small, households tend to be more diversified, stabilise their returns and reduce uncertainties.

Figure 4.2 **Annual crop diversification index by regions***

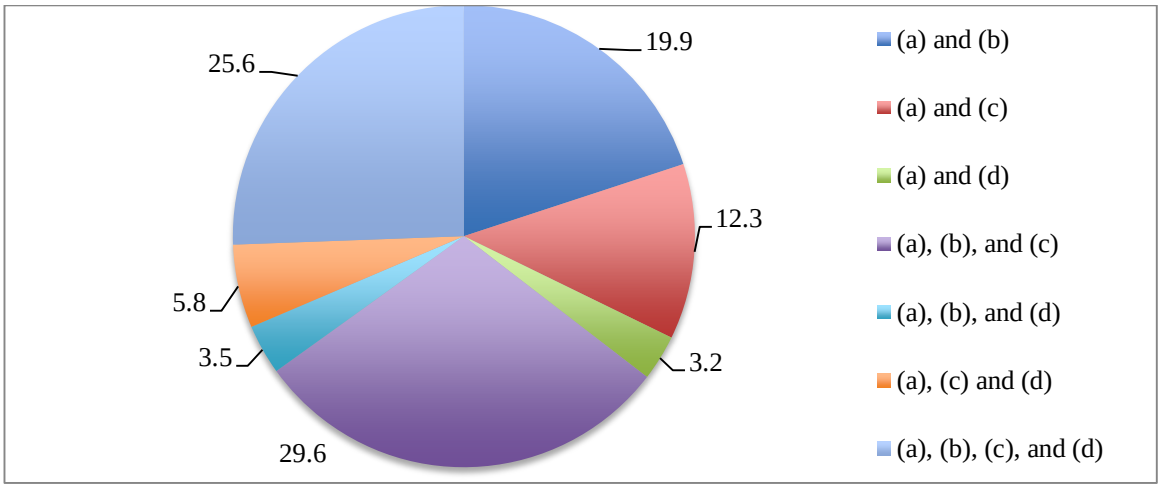


Note: *The sample includes households that produce only rice and households produce rice and other annual crops.
Source: calculated from VHLSS 2006.

For rice-based farm households in the sample (1,970 households), that grow vegetables, account for 78.68 per cent. The number of households that produce starchy crops represents 73.35 per cent of total households - this reflects an increasing trend of crop switching. There are only 38.12 per cent of households growing annual industrial

crops. According to VHLSS 2006, among rice farmers, there are 70.2 per cent of households that diversify their crops. There are 29.8 per cent of households that only produce rice.

Figure 4.3 **Land use patterns of rice growing households from surveyed sample**



Notes: (a) = rice; (b) = vegetables; (c) = starchy crops; (d) = Annual industrial crops
Source: calculated from VHLSS 2006.

According to the GSO (2012), the whole country has 6.44 million of hectares for annual crops, of which paddy land accounts for 63.97 per cent (4.12 million of hectares). Marsh et al. (2006) provide an overview of land use patterns in Vietnam. Under the 1993 Land Law, farm households have both rights and responsibilities in using land, as stated in the policies associated with land use rights. However, land related changes such as changes in land use purposes stated in the land use right certificates, or reshaping plots, are officially registered with local authorities, which may arise transaction costs during the registration. There are different land use patterns in the VHLSS 2006. This chapter compiles the land use patterns for different crops produced by farm households as follows: (a) rice, (b) vegetables, (c) starchy crops, and (d) annual industrial crops. Based on these crops, land use patterns are divided into seven categories. As can be seen in Figure 4.3, the number of households producing rice, vegetables and starchy crops represents 29.6 per cent, while 25.6 per cent of farms grow all crops. The number of farms growing both rice-vegetables and rice-starchy crops accounts for 19.9 per cent and 12.3 per cent, respectively. It should be noted that all crops were produced over the 12 months prior the survey date.

4.5.2 Tests of hypotheses for model selection

Table 4.2 provides the results of hypothesis tests. It provides the results of the likelihood ratio tests, which compare the likelihood function under the null and alternative hypothesis.[39] There are five hypothesis tests, summarized in Table 4.2 below. Firstly, testing the selection of a right functional form, the log likelihood specification test rejects the Cobb-Douglas specification in favour of a translog production function. Secondly, it tests whether the inefficiency term *u* is non-stochastic and equal to zero. In this context, the deviation from the frontier of the input requirement set is solely explained by random shocks and the input distance function can be estimated by the ordinary least squares method. The log likelihood ratio test at 5% significant level rejects the null hypothesis. As a result, this indicates that significant technical inefficiencies exist in Vietnam's agriculture.

Table 4.2 **Tests of hypotheses**

Name of tests	Null hypothesis	Likelihood ratio ($\chi^{2\text{-}}_{\text{calculated}}$)	$\chi^{2\text{-}}_{\text{critical}}$ (0.95)	Decision
1. Functional form (Translog vs Cobb-Douglass)	H_0: $\beta_{nk}=\alpha_{ml}=\gamma_{mn}=0$ for all n, k, m and l	1092.71	73.31	Reject H_0 (selected TL)
2. No inefficiency effect	H_0: $\gamma=\eta_0=\eta_1=\eta_2=\eta_3=\eta_4=\eta_5=\eta_6=\eta_7=\eta_8=\eta_9=0$	41.39	3.84	Reject H_0
3. Farm specific effects do not affect technical inefficiencies	H_0: $\eta_0=\eta_1=\eta_2=\eta_3=\eta_4=\eta_5=\eta_6=\eta_7=0$	76.48	15.51	Reject H_0
4. Input-output separability	H_0: all $\gamma_{mn}=0$ for all m and n	97.36	36.42	Reject H_0
5. Returns to scale (scale economy if $\varepsilon_{x,y}<1$)	H_0: $(\Sigma\alpha_m)=1$ for all m	11.39	3.84	Reject H_0 (scale economy exists)

Source: calculated from VHLSS 2006.

[39] The analysis calculates the statistic $LR=-2(\ln LH(H_0) - \ln LH(H_1)$ where LH(.) is defined as the likelihood function, H_0 the null hypothesis and H_1 the alternative hypothesis. Thus, under the null hypothesis, the statistic LR follows a chi-squared distribution with a number of degrees of freedom equal to the number of restrictions. Steps introduced in Wooldridge (2012) are applied.

Next, I test whether the variables in the technical inefficiency model are statistically significant. The null hypothesis is rejected at the 5 per cent level, implying that the distribution of inefficiencies is not the same across individual households and is subject to the variable of vector M_i in Equation (11a). This result is consistent with the efficiency model introduced by Battese and Coelli (1995). Next, the hypothesis of input-output separability is tested. This test is done by following the steps of Irz and Thirtle (2004). This hypothesis test is defined mathematically by equating all cross-terms between outputs and inputs (γ_{mn}) to zero. The null hypothesis is strongly rejected, which indicates that it is impossible to aggregate consistently the two outputs into a single index. As the same time, this result shows why the input distance function is more appropriate than a stochastic frontier production function, which requires the aggregation of all outputs before estimation. The final test introduced in Table 4.2 is the presence of returns to scale in annual crop production in the context of multi-output technology. This study also tests the summary of all regulatory restrictions of all α_m that are equal to one. The null hypothesis is also rejected in favour of the existence of the scale economy.

Table 4.3 **Monotonicity condition check**

Inputs $\{\partial lnD/\partial x_n \geq 0\}$ for every input	Value	Outcome	Outputs $\{\partial lnD/\partial y_m \leq 0\}$ for every output	Value	Outcome
Family labour	0.019	Fulfilled	Rice	-0.078	Fulfilled
Fertiliser	0.029	Fulfilled	Vegetables	-0.007	Fulfilled
Pesticide	0.011	Fulfilled	Starchy crops	-0.037	Fulfilled
Labour hired	0.009	Fulfilled	Annual industrial	-0.062	Fulfilled
Capital hired	0.005	Fulfilled	crops		
Seeds	0.021	Fulfilled			

Source: calculated from VHLSS 2006.

In this chapter, the monotonicity condition is tested, which shows that the input distance function is non-decreasing in inputs (i.e. $\{\partial lnD/\partial x_n \geq 0\}$) and non-increasing in outputs (i.e. $\{\partial lnD/\partial y_m \leq 0\}$) (Hailu and Veeman, 2000). The fulfilling curvature property (i.e. concave in x_n and quasi-concave in y_m), in accordance with production theory, can be checked by examining the Hessian matrix of the second-order partial differentials of the distance function with respect to outputs and inputs. Monotonicity conditions are not violated if the elasticities of inputs are positive and elasticities of

outputs are negative. At all data points, the estimated input distance function is concave for inputs and quasi-concave for outputs. As can be seen in the Table 4.3, monotonicity condition is satisfied for all inputs and outputs. The signs of the coefficients of the first order terms of inputs and output are consistent with theory.

4.5.3 Measures of economic performance

This section begins by examining the elasticities of inputs and outputs at the sample mean. The elasticities are derived from the estimation of Equation (4.11).[40] All the variables are mean differenced prior to estimation so that elasticities of the input distance function estimated at the sample mean are considered as first order coefficients. Table 4.4 introduces the elasticities of input distance function at the average values of the variables. As can be seen in the Table 4.4, the signs on the first order coefficients of outputs and inputs are consistent with prior expectations. The values in Table 4.4 as expected, are negative and statistically significant ($\varepsilon_{D,y_m} = -\varepsilon_{x_1,y_m}$). The elasticity with respect to rice (ε_{D,y_m}) is -0.606, the largest compared with other outputs. These results also indicate that the cost elasticity of rice output is larger than the corresponding elasticity of other annual crops. Furthermore, all output elasticities are significantly different from zero, which implies that an increase in the production of any of these outputs will increase costs substantially. The cost elasticity of rice is 0.606, implying that one per cent increase in rice output results in an increase in cost by 0.606 per cent. This estimated parameter, thus, reflects the dominance of rice production in the Vietnamese agriculture.

The evidence of scale economies is also presented in Table 4.4. The presented measures show significant scale economies (*SE*=1.075) for input-oriented specification (*SE*>1 or ($\varepsilon_{x,y}<1$) indicates scale economies).[41] This implies that when total inputs increase by 1 per cent, total outputs of production increase by 1.075 per cent, suggesting increasing returns to scale. Similarly, $\varepsilon_{x,y}$=0.93 implies that when total outputs increase by 1 per cent, total costs of production only rise by 0.93 per cent. This evidence is interesting because other studies using the input distance function share the same findings for crop

[40]The full estimated results of the input distance function are presented in the Appendix. 55% of the coefficients in the distance function are statistically significant. In this chapter, I only report the elasticities computed from the coefficients and the average values of the variables in the data. See further details about the estimated method in Grosskopf et al. (1995, pp. 293).

[41]Paul and Nehring (2005) find that the estimated scale economies are lower when off-farm income as another output is included, which reflects the increasing prevalence of off-farm incomes for small landholding farm households combats their scale disadvantages from only farming activities. I also find a similar result but the estimate is insignificant so I do not report in this chapter.

farms (Paul and Nehring 2005, $\varepsilon_{x,y}$=0.653 for the US; Rahman 2010, $\varepsilon_{x,y}$=0.45 for Bangladesh; Rasmussen 2010, $\varepsilon_{x,y}$=0.723 for Denmark). Ogundari and Brümmer (2010) also found evidence of increasing returns to scale in cassava production in Nigeria using the output distance function. Using the US farm data, Chavas and Aliber (1993) had the same evidence of economies of scale in small farms.

Table 4.4 **Elasticities of input distance function at sample means (first order components)**

Variables	Symbol	Value[a]	*t*-ratio
Output elasticities			
Scale economy ($1/\varepsilon_{x,y}$)	SE	1.075	
Summaries of all output elasticities	$\varepsilon_{x,y}$	0.93	
Rice	$\varepsilon_{x,y1}$	0.606***	23.08
Vegetables	$\varepsilon_{x,y2}$	0.024 ***	3.35
Starchy crops	$\varepsilon_{x,y3}$	0.217***	5.65
Annual industrial crops	$\varepsilon_{x,y4}$	0.083*	1.88
Input elasticities			
Family labour	$\varepsilon_{x,x2}$	-0.165***	-7.74
Fertilizer	$\varepsilon_{x,x3}$	-0.204***	-7.09
Pesticides	$\varepsilon_{x,x4}$	-0.068***	-2.88
Seeds	$\varepsilon_{x,x5}$	-0.089***	-5.00
Capital hired	$\varepsilon_{x,x6}$	-0.028***	-3.90
Labour hired	$\varepsilon_{x,x7}$	-0.126***	-6.11
Land	$\varepsilon_{x,x1}$	-0.320	
Output complementarity			
Rice and vegetables	$\varepsilon_{x,y12}$	-0.011***	-3.65
Rice and starchy crops	$\varepsilon_{x,y13}$	-0.019***	-6.93
Rice and annual industrial crops	$\varepsilon_{x,y14}$	-0.023***	-5.10
Vegetables and starchy crops	$\varepsilon_{x,y23}$	-0.003**	-2.44
Vegetables and annual industrial crops	$\varepsilon_{x,y23}$	-0.0003	-0.48
Starchy crops and annual industrial crops	$\varepsilon_{x,y34}$	-0.0004	-0.53

Notes: [a] evaluated at the means of the data using the parameter estimates of Equation (4.11); The elasticity of land is computed by taking the difference between 1 and the sum of the coefficients of all other inputs.

However, studies that use other methods provide mixed results. When Vu (2012) applies the approach of data envelopment analysis, he concludes that the majority of rice farms are operating with increasing returns to scale in Vietnam. This finding suggests that a large number of rice farms in Vietnam should increase their scale of operations to gain scale efficiency. There has been no study on returns to scale in the context of multi-output farms in Vietnam. Conversely, Wadud and White (2000) with Rahman (2010) found the opposite, when they supported the decreasing returns to

scale in Bangladesh agriculture. However, Wadud and White (2000) focused on rice or a single crop, rather than multi-output and multi-input technology. Therefore, the results shown in the literature are largely subject to selected methods to measure the scale economies and the context of multi-or single output.

Similarly, the first order conditions of the input distance function with respect to inputs are equal to cost shares and imply the importance of inputs in annual crop production. As can be seen in Table 4.4, all elasticities are statistically significant at one per cent level. Land has the largest elasticity with the value of 0.32, which means that the cost of land represents 32 per cent of total cost at the sample mean.[42] The family labour cost accounts for 16.3% of total production costs, reflecting the importance of family labour in the production process. It should be noted that the markets for land and labour in developing countries are not sufficiently developed.[43] As a result, there is a lack of information on land prices or family labour input in the household data surveys, which cannot provide the information on the cost shares of land and family labour (Kumar 2006).

To further investigate the implications of the estimated parameters of output complementarity, ε_{x,y_m,y_l} is estimated. As can be seen in Table 4.4, there is a complementarity between rice and other crops. For instance, estimated coefficient between rice and starchy crop is 0.019, which implies that a 1 per cent increase in rice output will reduce the marginal utilization of inputs for producing starchy outputs by 0.019 per cent. In addition, these coefficients are statistically significant, and therefore does not support the rejection of the null hypothesis of no output complementarity at any normal level of significance. There is no evidence of output complementarity across the combinations of vegetables and annual industrial crops, or starchy crops and annual industrial crops. However, there may be potential clashes with resource allocation requirements, such as land and labour.

As a result, this finding indicates that significant output complementarity exists in farming systems comprising rice production and other crops which implies the potential presence of economies of scope in crop diversification. Paul and Nehring

[42]Due to regulatory restrictions, $\sum_n \beta_n = 1$ in Equation (11), the elasticity of land is computed by taking the difference between 1 and the sum of the coefficients of all other inputs. Thus, the significant level cannot be reported in Table 4.4.

[43]Many studies find that perfect labour and land markets are rarely found in developing countries (Benjamin 1992; Urdy 1996; Jolliffe 2004). Le (2010) also rejected the perfect market assumptions in the sample of Vietnamese farmers. World Bank (2006) has the same conclusion for land market in Vietnam when the government controls land prices and ownership.

(2005) show that if the evidence of economies of scope is found, average costs for a farm household in producing more than two outputs are lower and cost savings from the by-products in the production process. Increasing the production of other annual products reduces the input share of rice. Inputs of rice production are also used for other cash cropping such as family labour and land. Farm households appears to adapt strategies by combining cash cropping with rice production.

Furthermore, farm households still retain significant subsistence rice production while increasing cash cropping activities which rely on households' farm labour, farming methods and land. Small farms in the sample may adjust their production by making productive use of family labour surplus in slack seasons, and avoiding the bottlenecks in the labour utilization. The evidence of output complementarity is also explained by labour combination in different and between seasons. When small farms diversify their livelihoods into vegetables, starchy crops or annual industrial crops, they have many opportunities to make decisions on different activities that complement each other, given the seasonal nature of their labour demand throughout the year. There have been no studies on crop diversification in Vietnam, thus, this result cannot be verified and compared. Similar results are found in Rahman (2010) for Bangladesh's agricultural production and Ogundari and Brümmer (2011) for cassava and other crops in Nigeria.

4.5.4 Elasticity of substitution and complementarity

The estimated coefficients from the distance function can be also used to derive the cross and own price elasticities, which aim to answer the second question in this chapter. In this section, $\varepsilon_{x,nk}(x,y)$ and $\varepsilon_{x,nn}(x,y)$ are computed using the method in Equation (4.15). Grosskopf et al. (1995) also introduced the formula that is the same as Equation (4.15), but the author ignores the output cross and own elasticity of shadow prices with respect to inputs. Similarly, Rahman (2010) used the approach of Grosskopf et al. (1995) and Kumar (2006) to calculate $\varepsilon_{x,nk}(x,y)$ and $\varepsilon_{x,nn}(x,y)$. In this chapter, the approach of Grosskopf et al. (1995) is extended by introducing further information on the output cross and own elasticity of shadow prices with respect to inputs. It shout be noted that these are indirect elasticities. A higher value means less responsiveness.

Moreover, if $\varepsilon_{x,nk}(x,y)$ is less than zero, net substitutes are implied. Conversely, when $\varepsilon_{x,nk}(x,y)$ is greater than zero, net complements are indicated (Grosskopf et al. 1995). The substitutability between inputs implies that as the shadow price (or cost share) of

an input increases, farm households employ more of another input. In contrast, the complementarity between two inputs means that as the shadow price of an input increases, farmers employ less of another input (Kumar 2006; Rahman 2010).

As can be seen in Table 4.5, among the cross elasticity between inputs, family labour appears to be complementary to all other inputs, except hired labour, (hired labour can be a substitute for family labour). The complementarity between family labour and fertiliser, pesticides, capital and seeds implies that if the shadow prices of fertilisers, pesticides, seeds and capital increase, there is a reduction of family labour supply.[44] If fertiliser prices increase, there will be a reduction in fertiliser demand. Therefore, the increasing burden of high costs results in increasing inefficiency in crop production. Consequently household members seek off-farm opportunities to smooth income and consumption in light of the uncertainties of farm incomes (Reardon et al. 2001).

Table 4.5 **Mean of output cross, and own indirect elasticity of shadow prices with respect to inputs (ε_{ij}), Vietnam**

	Labour	Fertilizer	Pesticide	Hired labour	Capital	Seeds
Labour	-1.112	0.288	0.120	-0.312	0.471	0.230
	(-16.17)	(4.02)	(0.95)	(-3.05)	(4.03)	(2.68)
Fertiliser	0.352	-0.901	0.337	0.362	0.014	-0.009
	(3.97)	(-8.02)	(1.74)	(2.52)	(0.09)	(-0.07)
Pesticide	0.051	0.116	-0.589	-0.348	0.004	0.221
	(0.95)	(1.74)	(-3.55)	(-3.60)	(0.05)	(2.68)
Hired labour	-0.057	0.053	-0.149	-0.217	0.066	-0.073
	(-3.05)	(2.52)	(-3.60)	(-1.67)	(1.89)	(-2.74)
Capital	0.079	0.002	0.002	0.061	-1.438	0.048
	(4.03)	(0.09)	(0.05)	(1.89)	(-12.07)	(1.61)
Seeds	0.204	-0.004	0.462	-0.355	0.250	-0.848
	(2.68)	(-0.05)	(2.68)	(-2.74)	(1.61)	(-6.53)

Notes: t-values are in parentheses; evaluated at the mean of the data using parameter estimates from Equation (4.11).
Source: calculated from VHLSS 2006.

Interestingly, using elasticity of substitution provides one answer to the question as to why farmers have left their fields in rural Vietnam. For this reason, the Vietnam government should change its approach to designing food security policies. Instead of

[44]Kumar (2006) shows that the absolute shadow price reflects the actual proportion of inputs used by an inefficient producer. Hence, the shadow price means the cost share of an input. He also assumed that the observed price of one input is equal to its shadow price. Similarly, Rahman (2010, p.335) applies the same method used in Kumar (2006) to compute elasticities in Bangladesh agricultural production. In this current paper, we use the same approach to analyse the elasticities between inputs.

only focusing on rice price policy and subsidies to state owned enterprises in food industries and rice exports (Kompas et al. 2012), the government should note that the reduction of costs of production such as fertiliser, pesticides, seeds and hired capital also plays a vital role in creating more incentives for farmers to stay and invest in agricultural production. In addition, increasing cost stress contributes to the reallocation of household resources by reducing the investment in agriculture.

The elasticity of substitution between family labour and hired labour is also of interest. In light of rising landlessness in Vietnam, the substitutability between family labour and hired labour also has policy implications. In 2004, the landlessness rate in Vietnam was 13.55 per cent, which led to increasing social stratification in rural areas; more farm households hired labour for farming activities and participated in off-farm jobs (Akram-Lodhi 2005; Ravallion and van de Walle 2006). In this chapter, increasing cost stress and social stratification in rural areas also contribute to labour allocation in farm households in rural Vietnam.

Table 4.5 also provides evidence of net substitutes between family labour and hired labour, which implies that the increase in farm labour supply depends on the shadow price of hired labour, as well as other inputs. As the shadow price of hired labour rises, households increase the family labour supply. Conversely, households reduce family labour required for farming activities. The reduction of demand for hired labour as a result of increasing rural wages results in the reduction of the shadow price of family labour. Conversely, if more family labour participates in off-farm jobs, the shadow price of hired labour will go down. As the degree of substitutability between family and hired labour increases, farm operators can more easily hire replacement workers on the farm. The family labour can then allocate more hours to off-farm activities or migrate to urban areas (D'Antoni et al. 2014). This can result in increasing inequality and social stratification within rural areas as shown by Akram-Lodhi (2005). Furthermore, the complementarity between hired labour and capital implies the labour-intensive dominance in small farms in Vietnam.

As regards the relationship between fertiliser and family labour, an increase in the shadow price of fertiliser reduces family farm labour supply. In other words, an increase in fertiliser price results in the reduction of the demand for fertiliser consumption. Then the reduction of fertiliser quantities leads to a rise in the shadow price of family labour due to the complementarity between these inputs. As a result, there is a reduction of

demand for family labour. Gilbert (2014) finds that fertiliser subsidy programs have positive impacts on the probability of a household's demand for agricultural labour. In Vietnam, the government provides domestic fertiliser producers with preferential treatments aimed at reducing fertiliser prices, such as subsiding input materials in fertiliser production.[45] Similarly, the reduction of the cost share of fertiliser enables farm households to relax credit constraints and increase labour demand for hired and family labour.

Table 4.6 **The indirect Morishima elasticity of substitution**

	Labour	Fertilizer	Pesticide	Hired labour	Capital	Seeds
Labour		1.189	0.709	-0.251	1.909	1.078
		(7.58)	(3.43)	(-1.29)	(11.36)	(6.30)
Fertiliser	1.465		0.926	0.579	1.452	0.841
	(11.63)		(2.85)	(3.48)	(6.71)	(4.16)
Pesticide	1.163	1.016		-0.131	1.443	1.069
	(13.14)	(6.25)		(-0.87)	(8.33)	(6.37)
Hired labour	-1.180	0.954	0.439		1.504	0.775
	(-15.10)	(8.16)	(2.47)		(11.81)	(5.71)
Capital	1.192	0.903	0.591	0.279		0.896
	(17.28)	(8.00)	(3.28)	(2.15)		(6.94)
Seeds	1.316	0.896	1.051	-0.138	1.689	
	(11.57)	(5.45)	(3.95)	(-0.82)	(8.09)	

Notes: t-values are in parentheses; evaluated at the means of the data using parameters estimates of Equation (4.11).
Source: calculated from VHLSS 2006.

The indirect Morishima elasticity of substitution is computed from the input distance function and is presented in Tables 4.6.[46] The Morishima elasticities of substitution are not symmetric. These results are consistent with Table 4.5. There is a complementarity between family labour and other inputs, except hired labour. This implies that an increase in shadow prices (or cost shares) of fertiliser, pesticides and capital to family labour would increase substantially, mitigating the cost savings of such a substitution. Hence, in this case, the Morishima elasticity of substitution provides this chapter with information on the feasibility of substitutions. In the relationship between family labour and hired labour, the Morishima elasticity of substitution suggests substitutability and the relative shadow price of hired labour to family labour would increase, not mitigating the cost savings of such substitutions. Overall, the estimated elasticities indicate that family labour can be relatively easily substituted for hired labour. If more hired labour

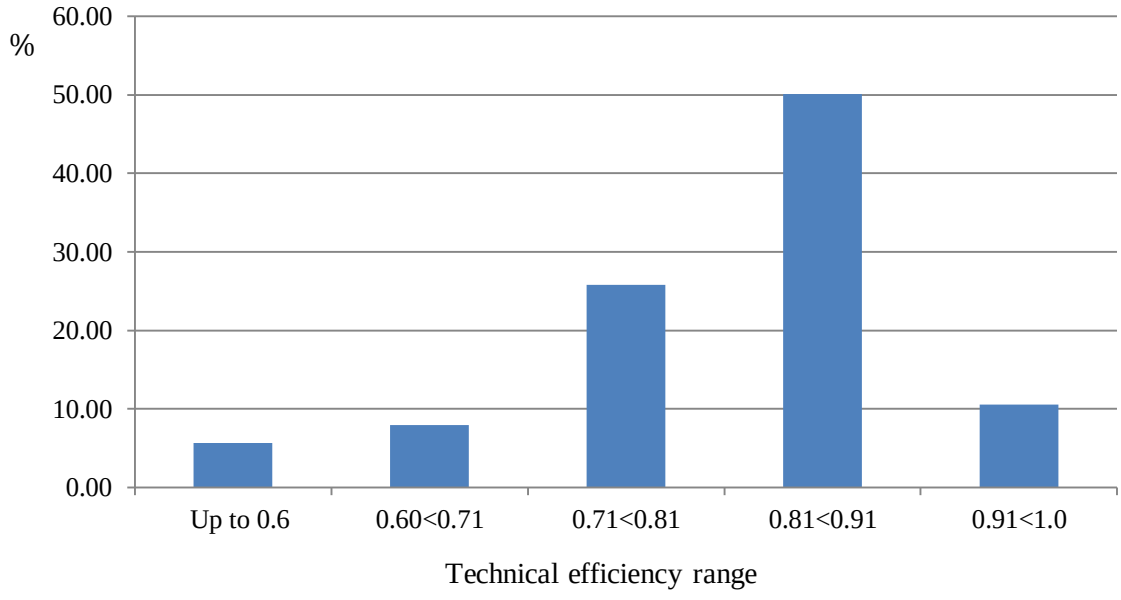
[45]See further fertiliser subsidy in Vietnam (http://vietnamnews.vn/economy/221084/fertiliser-subsidies-not-helping-farmers.html).
[46] See further procedures about how to calculate elasticities in Grosskopf et al. (1995, p. 293).

were employed for a given level of family labour, a negative and small MES between hired and family labour suggests substitutability and the relative shadow price of hired labour to family labour would reduce substantially, resulting in the cost savings of such a substitution.

4.5.5 Technical efficiency

Prior studies mainly focused on technical efficiency in rice production in Vietnam. Dao and Lewis (2013) found that the mean of technical efficiency for rice-based multiple crop farms in four provinces in northern Vietnam was 0.83. In this chapter, the mean technical efficiency is 0.813, which implies that the average farm households could, in principle, reduce further 18.7 per cent of inputs to produce given crops or increase outputs by 18.7 per cent at given inputs (Table 4.7). This also indicates that an opportunity may exist to expand crop outputs without using more inputs, or with the application of improved production technology. As can be seen in Figure 4.4, there is a wide range of production inefficiency of farm households ranging from 21 per cent to 96 per cent in multiple-crop farming. The mean technical efficiency of multiple crop farming is higher than other estimates of studies focusing only on rice. Kompas et al. (2012) and Vu (2012) estimate the mean technical efficiency to be 0.77 and 0.78 respectively. This finding indicates that technical efficiency is higher in crop diversity than single rice production.

Figure 4.4 **Distribution of technical efficiency indices**



Source: Calculated from VHLSS 2006.

Table 4.7 **Technical efficiency in annual crop production in Vietnam, VHLSS 2006**

Variables	Percentage of households (%)
Efficiency level (%)	
Up to 60	5.69
61-70	7.92
71-80	25.79
81-90	50.10
More than 90	10.51
Mean efficiency level	0.813
Standard deviation	0.101
Minimum	0.219
Maximum	0.961
Number of observations	1970

Source: Calculated from VHLSS 2006.

As regards the determinants of technical inefficiency in multiple crops farming, Table 4.8 provides the effects of farm characteristics on technical inefficiency. Education plays a vital role in reducing technical inefficiency, particularly the education of women. The level of impact on the reduction of technical inefficiency of female education is two times higher than that of male education. This also reflects the role of women in improving technical efficiency and farm production. In light of more opportunities in off-farm jobs and men's migration to cities, women in rural areas have become a key labour force (GSO 2009a). This result is consistent with the finding of Rahman (2010), who emphasizes the role of women in Bangladesh agriculture. The significant role of education in reducing technical inefficiency in Vietnam is also studied by Kompas et al. (2012). Also, household size at working ages significantly improves technical efficiency. Households who diversify their crops have small and fragmented landholdings. As a result, the application of mechanization in farming activities is hindered. Mafoua-Koukebe et al. (1996) indicate that when production is labour intensive, farms tend to be more diversified. A larger supply of family labour of working age, thus, reduces technical inefficiency in crop production.

The effect of land fragmentation on agricultural efficiency is captured in the technical inefficiency model. The number of plots is used instead of the Simpson index.[47] This result is consistent with the conclusions of previous studies (Hung et al. 2007; Kompas

[47]The coefficient of the Simpson index is not statistically significant even though it shows a positive sign.

et al. 2012). It means that the reduction of land fragmentation improve technical efficiency. One of the interesting findings here is the effect of land use right certificates on technical efficiency. If farms have titled land, there are more incentives to invest and provide a source of collateral for loans. The empirical result shows that farm households with a higher (and proper) ratio of land and holding land use right certificates, are more efficient. This result is the same as the recent findings of Kompas et al. (2012) and Vu (2012).

Table 4.8 **Technical inefficiency model**

	Parameters	Coefficients	*t value*
Age of the household head	η_1	0.001	0.20
		(0.005)	
Mean education of working age men	η_2	-0.07***	-2.67
		(0.026)	
Mean education of working age women	η_3	-0.141***	-5.42
		(0.025)	
Household members, from 15 to 60 years old	η_4	0.398***	6.63
		(0.06)	
Dependency ratio (per cent)	η_5	0.643**	2.22
		(0.289)	
Days of illness	η_6	0.001	0.51
		(0.001)	
Number of plots	η_7	0.021*	1.96
		(0.011)	
Hours of nonfarm wages	η_8	-0.0002***	-4.19
		(0.0004)	
Ratio of land with land use right certificates	η_9	-0.203*	-1.66
		(0.122)	
Constant	η_0	-3.107***	-7.20
		(0.432)	
Number of observations		1970	

Notes: ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively; Standard errors are in parentheses.
Source: calculated from VHLSS 2006.

4.6 Concluding remarks

This chapter has reported on the analysis of economies of scale, output complementarity and technical efficiency in the farming system comprising cropping activities of food and other annual cash crops in rural Vietnam. It further provides information on the responses of small-scale farm households to increasing cost stress in multi-crop production. Scale economies and output complementarity were found in multiple crop

production. The elasticity of output with respect to total inputs is 1.075, which implies that when total inputs increase by 1 per cent, total outputs of production increase by 1.075 per cent. Similarly, when total output increases by 1 per cent, total costs of production rise by only 0.93 per cent. This finding reveals that slightly increasing returns to scale are evident in Vietnamese multiple crop production. An increase in rice production reduces the marginal utilization of inputs for producing other crops. Moreover, crop combination results in cost savings in the production process. Thus, output complementarity is found between rice as subsistence production, and other crops. This finding implies the potential presence of economies of scope, which has important implications on economic performance.

Results also show that households with smallholder production substantially respond to cost stress in multiple crop environment. Family labour use and other inputs such as fertilisers, pesticides and capital are complementary, which means that farm labour use falls when the prices of these inputs increase. This finding contributes to the literature on the push factors of labour allocation in smallholder farms. Since fertilizers, pesticides and seeds account for the largest share of total production costs, policies that lead to more incentives to invest in crop faming activities should focus on the reduction of input costs. The government should spend more resources on reducing prices of fertilisers, pesticides and hiring capital for farmers. The evidence of elasticity of substitution between farm labour and fertilisers and pesticides indicates that subsidy programs on fertilisers and pesticides can have a positive effect on the probability that a household demands family labour, which can reduce the increasing trend of abandoning of agricultural production in rural Vietnam.

However, any adjustment of the cost structure also impacts on rural labour market when more farmers have worked for farm wages (Akram-Lodhi 2005). The result shows that there is substitution between family labour and hired labour. With the increasing participation in nonfarm activities by smallholders, the reliance on hired labour is more important for producers. The farm household can allocate more hours to off-farm work by hiring replacement workers on the farm. Therefore, it would be expected that a large increase in government input subsidy would have a significant impact on the flow of labour into farming activities, mainly on the reduction of demand for hired labour. Warr and Yusuf (2014) find that in Indonesia, input subsidies such as for fertiliser have a large and positive impact on unskilled wages.

Another finding is the existence of substantial technical inefficiency in multiple-crop farming, this implying that there may be opportunities to expand crop output by 18.7 per cent without resort to greater uses of inputs or improved technologies in farm production. There were seven variables which significantly affect technical inefficiency. The improvement of education, particularly for women, and the reduction of the dependency ratio both contribute to improving technical efficiency. Furthermore, land reforms directed toward the reduction of land fragmentation and improvement of proper land rights should be strengthened to improve efficiency.

The policy implication of this research is that priority should be given the design of policies to promote crop diversification for small farms, which is found to improve productivity through scale economies, output complementarity and technical efficiency improvement. Although the Vietnamese government appears to give priority to rice self-sufficiency policies rather than the income of farmers, Kompas et al. (2012) conclude that the mandate to grow rice in all provinces, at least in terms of defined efficiency criteria, is not appropriate. The recent thrust of the Vietnamese government to promote diversification in the Strategy of Agriculture and Rural Development (2011-2020) is a step in a right direction. Therefore, crop diversity should be expanded to improve the income of farm households. As part of an FAO nutrition-sensitive food systems approach, crop diversification improves the nutritional health status of low-income households through the increased production of nutrient-rich foods for direct consumption and generation of the income needed to procure the amount and variety of food that families need (FAO 2012). There are some issues that need to be further developed in future research. This chapter focuses only on annual cropping activities. It would be useful to investigate the patterns of diversification involving off-farm activities. In addition, sources of economies of diversification are also ignored in this study. This issue should be further studied in the future.

Appendices of Chapter 4

Appendix 4.1 **First derivative and second derivative of the input distance function**

After the estimation of Equation (4.11) in Section 4.4 in this chapter, we have the following expression:

$$-lnx_{1i} = \beta_0 + \sum_{n=2}^{7}\beta_n lnx_n^* + \frac{1}{2}\sum_{n=2}^{7}\sum_{k=2}^{7}\beta_{nk} lnx_n^* lnx_k^* + \sum_{m=1}^{4}\alpha_m lny_m + \frac{1}{2}\sum_{m=1}^{4}\sum_{l=1}^{4}\alpha_{ml} lny_m lny_l + \sum_{m=1}^{4}\sum_{n=2}^{7}\gamma_{mn} lny_m lnx_n^* + \sum_{k=1}^{8}\rho_k REG_k + \hat{v} - \hat{u} \qquad 4.A1$$

Replacing $\hat{v} - \hat{u}$ with *–lnD* provides:

$$-lnx_{1i} = \beta_0 + \sum_{n=2}^{7}\beta_n lnx_n^* + \frac{1}{2}\sum_{n=2}^{7}\sum_{k=2}^{7}\beta_{nk} lnx_n^* lnx_k^* + \sum_{m=1}^{4}\alpha_m lny_m + \frac{1}{2}\sum_{m=1}^{4}\sum_{l=1}^{4}\alpha_{ml} lny_m lny_l + \sum_{m=1}^{4}\sum_{n=2}^{7}\gamma_{mn} lny_m lnx_n^* + \sum_{k=1}^{8}\rho_k REG_k - \ln D \qquad 4.A2$$

Rearranging (4.A2) gives:

$$lnD = \beta_0 + \sum_{n=2}^{7}\beta_n lnx_n^* + \frac{1}{2}\sum_{n=2}^{7}\sum_{k=2}^{7}\beta_{nk} lnx_n^* lnx_k^* + \sum_{m=1}^{4}\alpha_m lny_m + \frac{1}{2}\sum_{m=1}^{4}\sum_{l=1}^{4}\alpha_{ml} lny_m lny_l + \sum_{m=1}^{4}\sum_{n=2}^{7}\gamma_{mn} lny_m lnx_n^* + \sum_{k=1}^{8}\rho_k REG_k + \ln x_{1i} \qquad 4.A3$$

From Equation (4.A3), taking the first partial derivative with respect to output y_m gives:

$$\frac{\partial lnD}{\partial lny_m} = \alpha_m + \sum_{l=1}^{4}\alpha_{ml} lny_l + \sum_{m=1}^{4}\sum_{n=2}^{7}\gamma_{mn} lnx_n^* = \varepsilon_{D,y_m} \qquad 4.A4$$

Also, from Equation (4.A3), taking the second partial derivatives with respect to output y_n gives:

$$\frac{\partial lnD}{\partial lny_m lny_l} = \alpha_{ml} = \varepsilon_{y_m,y_l} \qquad 4.A5$$

Appendix 4.2 **Investigating the possibility of simultaneous equation bias in the estimation of the distance function**

Using the approach of Collie (2000), the possibility of simultaneous bias is investigated by examining whether there is a simultaneous feedback problem if the ratio of two inputs appears on the right hand side of an input distance function. A translog input distance function with *M* outputs and *N* inputs of the farm household *i* is given by:

$$lnD_i = \beta_0 + \sum_{n=1}^{N} \beta_n lnx_n + \frac{1}{2}\sum_{n=1}^{N}\sum_{k=1}^{N} \beta_{nk} lnx_n\, lnx_k + \sum_{m=1}^{M} \alpha_m lny_m + \frac{1}{2}\sum_{m=1}^{M}\sum_{l=1}^{M} \alpha_{ml} lny_m\, lny_l + \sum_{m=1}^{M}\sum_{n=1}^{N} \gamma_{mn} lny_m\, lnx_n \qquad 4.A6$$

where D_i measures the radical distance from (x,y) to the production function. By imposing the homogeneity restrictions, the following equation is expressed as:

$$-lnx_N = \beta_0 + \sum_{n=1}^{N-1} \beta_n (lnx_n - lnx_N) + \frac{1}{2}\sum_{n=1}^{N-1}\sum_{k=1}^{N-1} \beta_{nk} (lnx_n - lnx_N)(lnx_k - lnx_N) + \sum_{m=1}^{M} \alpha_m lny_m + \frac{1}{2}\sum_{m=1}^{M}\sum_{l=1}^{M} \alpha_{ml} lny_m\, lny_l + \sum_{m=1}^{M}\sum_{n=1}^{N} \gamma_{mn} lny_m\, (lnx_n - lnx_N) - \ln D \qquad 4.A7$$

The input distance function is homogenous to the degree of one in inputs. Färe and Primont (1995) introduce the duality between cost and input distance function. Under the condition of cost minimization and using Shephard's lemma, as stated in Färe and Primont (1995), the duality is expressed as: $C(w,y)=Min\ \{wx: D(x,y) \geq 1\}$ where x is a vector of input prices. It is easy to relate the derivatives of the input distance function to the cost function. The derivative of the input distance function with respect to a particular input n is expressed as:

$$\frac{\partial D(x^*(w,y),y)}{\partial x_n} = \frac{w_n}{C(x,y)} = r_n^*(x,y) \qquad 4.A8$$

where r_n^* is the cost-deflated shadow price of input *n*.

This is more conveniently expressed in terms of log derivative of the distance function as:

$$\mathcal{E}_{D,x_n} = \frac{\partial lnD}{\partial lnx_n} = \frac{w_n x_n^*(w,y)}{C(x,y)} = S_n \qquad 4.A9$$

The expression (4.A9) denotes that the log derivative of the input distance function with respect to input n is equal to its cost share S_n, which shows the relative importance of that input in the production (Färe and Primont 1995).

Based on the result of Equation (4.A9), from Equation (4.A7), we obtain:

$$\frac{\partial lnD}{\partial lnx_n} = \frac{w_n x_n^*(w,y)}{C(x,y)} \; and \frac{\partial lnD}{\partial lnx_n} = \frac{w_N x_N^*(w,y)}{C(x,y)} \qquad 4.A10$$

From Equation (4.A7), the first partial derivatives are equal to:

$$\frac{\partial lnD}{\partial lnx_n} = \beta_n + \sum_{l=1}^{N} \beta_{nk} \, (lnx_k - lnx_N) + \sum_{m=1}^{M} \gamma_{mn} \, lny_m, n = 1,2, \dots, N-1 \qquad 4.A11$$

and

$$\frac{\partial lnD}{\partial lnx_n} = \beta_n + \sum_{l=1}^{N} \beta_{nk} \, (lnx_k - lnx_N) - \sum_{n=1}^{N-1} \sum_{m=1}^{M} \gamma_{mn} \, lny_m \qquad 4.A12$$

Substituting Equations (4.A11) and (4.A12) into (4.A10), we obtain:

$$\frac{\partial lnD}{\partial lnx_n} = \frac{w_n x_n^*(w,y)}{C(x,y)} = \beta_n + \sum_{l=1}^{N} \beta_{nk} \, (lnx_k - lnx_N) - \sum_{n=1}^{N-1} \sum_{m=1}^{M} \gamma_{mn} \, lny_m$$

and

$$\frac{\partial lnD}{\partial lnx_N} = \frac{w_N x_N^*(w,y)}{C(x,y)} = 1 - \sum_{n}^{N-1} \beta_n - \sum_{n-1}^{N-1} \sum_{k=1}^{N-1} \beta_{nk} \, (lnx_k - lnx_N) - \sum_{n=1}^{N-1} \sum_{m=1}^{M} \gamma_{mn} \, lny_m$$

The ratio of these above two partial derivatives provides:

$$\frac{w_n x_n^*(w,y)}{w_N x_N^*(w,y)} = \frac{\beta_n + \sum_{k=1}^{N} \beta_{nk} \, (lnx_k - lnx_N) + \sum_{m=1}^{M} \gamma_{mn} \, lny_m}{1 - \sum_{n}^{N-1} \beta_n - \sum_{n-1}^{N-1} \sum_{k=1}^{N-1} \beta_{nk} \, (lnx_k - lnx_N) - \sum_{n=1}^{N-1} \sum_{m=1}^{M} \gamma_{mn} \, lny_m} \qquad 4.A13$$

By using the approach of Coelli (2000), this study adds two terms, *R* and *E*, to capture allocative mistakes. The term *R* is constant across farms and allows for possible systematic allocative mistakes in the agriculture such as regulatory constraints that

influence all firms. The term *E* denotes an error term that changes from farms to farms and captures the difference in allocative mistakes between farms. Equation (4.A13) is now expressed as:

$$\frac{w_n x_n^*(w,y)}{w_N x_N^*(w,y)} = \frac{\beta_n + \sum_{k=1}^{N} \beta_{nk} \left(lnx_k - lnx_N\right) + \sum_{m=1}^{M} \gamma_{mn}\, lny_m}{1 - \sum_{n}^{N-1} \beta_n - \sum_{n-1}^{N-1} \sum_{k=1}^{N-1} \beta_{nk} \left(lnx_k - lnx_N\right) - \sum_{n=1}^{N-1} \sum_{m=1}^{M} \gamma_{mn}\, lny_m} RE \qquad 4.\ A14$$

Taking logs of Equation (4.A14), we have:

$$lnw_n + lnx_n - lnw_N - lnx_N = a + e \qquad 4.\ A15$$

where:

$$a = \log\left(\frac{\beta_n + \sum_{k=1}^{N} \beta_{nk} \left(lnx_k - lnx_N\right) + \sum_{m=1}^{M} \gamma_{mn}\, lny_m}{1 - \sum_{n}^{N-1} \beta_n - \sum_{n-1}^{N-1} \sum_{k=1}^{N-1} \beta_{nk} \left(lnx_k - lnx_N\right) - \sum_{n=1}^{N-1} \sum_{m=1}^{M} \gamma_{mn}\, lny_m}\right),$$

$$e = \log(E)$$

From (4.A7) and (4.A15), we have a system of structural equations as follows:

$$-lnx_N = \beta_0 + \sum_{n=1}^{N-1} \beta_n (lnx_n - lnx_N) + \frac{1}{2} \sum_{n=1}^{N-1} \sum_{k=1}^{N-1} \beta_{nk} (lnx_n - lnx_N)\,(lnx_k - lnx_N) + \sum_{m=1}^{M} \alpha_m lny_m + \frac{1}{2} \sum_{m=1}^{M} \sum_{l=1}^{M} \alpha_{ml} lny_m\, lny_l + \sum_{m=1}^{M} \sum_{n=1}^{N} \gamma_{mn} lny_m\,(lnx_n - lnx_N) - \ln D_i \qquad 4.\ A16$$

$$(lnx_n - lnx_N) = a + (lnw_N - lnw_n) + e \qquad 4.\ A17$$

In order to investigate the possibility of simultaneous bias in the estimation of (4.A16), the reduced form equations for two endogenous variable, x_n and x_N, are desired. By substituting Equation (4.A17) into (4.A16), we obtain:

$$lnx_N = -\beta_0 - \sum_{n=1}^{N-1} \beta_n (a + lnw_N - lnw_n + e) + \frac{1}{2} \sum_{n=1}^{N-1} \sum_{k=1}^{N-1} \beta_{nk}\,(a + lnw_N - lnw_n + e)^2 - \sum_{m=1}^{M} \alpha_m lny_m - \frac{1}{2} \sum_{m=1}^{M} \sum_{l=1}^{M} \alpha_{ml} lny_m\, lny_l - \sum_{m=1}^{M} \sum_{n=1}^{N} \gamma_{mn} lny_m\,(a + lnw_N - lnw_n + e) + \ln D_i$$

Then, this above equation is substituted into (4.A17). As a result, the reduced form equation as follows:

$$nx_n = a + (lnw_N - lnw_n) + e - \beta_0 - \sum_{n=1}^{N-1} \beta_n (a + lnw_N - lnw_n + e) + \frac{1}{2} \sum_{n=1}^{N-1} \sum_{k=1}^{N-1} \beta_{nk} (a + lnw_N - lnw_n + e)^2 - \sum_{m=1}^{M} \alpha_m lny_m - \frac{1}{2} \sum_{m=1}^{M} \sum_{l=1}^{M} \alpha_{ml} lny_m \, lny_l - \sum_{m=1}^{M} \sum_{n=1}^{N} \gamma_{mn} lny_m (a + lnw_N - lnw_n + e) + \ln D_i$$

So:

$$(lnx_n - lnx_N) = a + (lnw_N - lnw_n) + e - \beta_0 - \sum_{n=1}^{N-1} \beta_n (a + lnw_N - lnw_n + e) + \frac{1}{2} \sum_{n=1}^{N-1} \sum_{k=1}^{N-1} \beta_{nk} (a + lnw_N - lnw_n + e)^2 - \sum_{m=1}^{M} \alpha_m lny_m - \frac{1}{2} \sum_{m=1}^{M} \sum_{l=1}^{M} \alpha_{ml} lny_m \, lny_l - \sum_{m=1}^{M} \sum_{n=1}^{N} \gamma_{mn} lny_m (a + lnw_N - lnw_n + e)$$

The ratio of any two inputs does not contain the error term *lnD*. As a result, OLS estimation (4.A16) results in consistent estimates of parameters under the cost minimizing assumption.

Appendix 4.3 **Parameter estimates of the stochastic input distance function including inefficiency effects**

Variables	Parameters	Coefficients	SE	*t value*
Production variables				
ln(labour/land)	β_2	-0.235	0.142	-1.66
ln(fertiliser/land)	β_3	-0.253	0.193	-1.31
ln(pesticide/land)	β_4	-0.277	0.125	-2.22
ln(hired labour/land)	β_5	-0.095	0.038	-0.99
ln(capital/land	β_6	-0.145	0.047	-3.10
ln(seeds/land)	β_7	-0.074	0.189	-0.39
1/2 ln(labour/land)^2	β_{22}	-0.046	0.011	-4.03
1/2 ln(fertiliser/land)^2	β_{33}	-0.021	0.023	-0.93
1/2 ln(pesticide/land)^2	β_{44}	0.024	0.012	2.06
1/2 ln(hired labour/land)^2	β_{55}	0.036	0.004	9.1
1/2 ln(capital/land)^2	β_{66}	-0.013	0.003	-3.91
1/2 ln(seeds/land)^2	β_{77}	0.001	0.019	0.05
ln(labour/land)*ln(fertiliser/land)	β_{23}	0.025	0.015	1.72
ln(labour/land)*ln(pesticide/land)	β_{24}	-0.003	0.009	-0.35
ln(labour/land)* ln(hired labour/land)	β_{25}	-0.014	0.003	-4.66
ln(labour/land)* ln(capital/land)	β_{26}	0.009	0.003	2.62
ln(labour/land)* ln(seeds/land)	β_{27}	0.010	0.013	0.76
ln(fertiliser/land)* ln(pesticide/land)	β_{34}	0.009	0.014	0.69
ln(fertiliser/land)* ln(hired labour/land)	β_{35}	0.005	0.004	1.1
ln(fertiliser/land)* ln(capital/land)	β_{36}	-0.005	0.005	-1.17
ln(fertiliser/land)* ln(seeds/land)	β_{37}	-0.031	0.019	-1.66
ln(pesticide/land)* ln(hired labour/land)	β_{45}	-0.013	0.003	-4.32
ln(pesticide/land)* ln(capital/land)	β_{46}	-0.002	0.003	-0.62
ln(pesticide/land)* ln(seeds/land)	β_{47}	0.022	0.012	1.84
ln(hired labour/land)* ln(capital/land)	β_{56}	0.001	0.001	1.03
ln(hired labour/land)* ln(seeds/land)	β_{57}	-0.015	0.004	-3.86
ln(capital/land)* ln(seeds/land)	β_{67}	0.003	0.004	0.67
ln(labour/land) * ln(rice output)	γ_{21}	0.037	0.011	3.46
ln(labour/land)* ln(vegetables)	γ_{22}	0.001	0.003	0.33
ln(labour/land)*ln(starchy output)	γ_{23}	-0.005	0.003	-1.91
ln(labour/land)* ln(annual industrial output)	γ_{24}	-0.010	0.004	-2.87
ln(fertiliser/land)* ln(rice output)	γ_{31}	-0.046	0.018	-2.56
ln(fertiliser/land)* ln(vegetables)	γ_{32}	0.002	0.005	0.44
ln(fertiliser/land)*ln(starchy output)	γ_{33}	-0.003	0.004	-0.74
ln(fertiliser/land)*ln(annual industrial output)	γ_{34}	-0.004	0.005	-0.73
ln(pesticide/land) * ln(rice output)	γ_{41}	0.009	0.010	0.85

ln(pesticide/land) * ln(vegetables)	γ_{42}	0.005	0.003	1.57
ln(pesticide/land)*ln(starchy output)	γ_{43}	-0.003	0.003	-1.09
ln(pesticide/land)*ln(annual industrial output)	γ_{44}	0.000	0.003	0.1
ln(hired labour/land)* ln(rice output)	γ_{51}	0.008	0.004	2.15
ln(hired labour/land)* ln(vegetables)	γ_{52}	0.001	0.001	0.68
ln(hired labour/land)*ln(starchy output)	γ_{53}	0.002	0.001	3.14
ln(hired labour/land)*ln(annual industrial output)	γ_{54}	-0.002	0.001	-1.71
ln(capital/land)* ln(rice output)	γ_{61}	0.016	0.004	3.94
ln(capital/land)* ln(vegetables)	γ_{62}	-0.001	0.001	-0.56
ln(capital/land)*ln(starchy output)	γ_{63}	0.001	0.001	1.13
ln(capital/land)*ln(annual industrial output)	γ_{64}	-0.001	0.001	-0.79
ln(seeds/land) * ln(rice output)	γ_{71}	-0.002	0.015	-0.14
ln(seeds/land) * ln(vegetables)	γ_{72}	-0.005	0.004	-1.16
ln(seeds/land)*ln(starchy output)	γ_{73}	-0.004	0.004	-1.15
ln(seeds/land)*ln(annual industrial output)	γ_{74}	0.007	0.005	1.37
ln(rice output)	α_1	0.191	0.189	1.91
ln(vegetables)	α_2	0.025	0.049	0.5
ln(starchy output)	α_3	0.218	0.041	5.35
ln(annual industrial output)	α_4	0.196	0.056	3.47
1/2 ln(rice output)^2	α_{11}	0.105	0.017	6.1
1/2 ln(vegetables)^2	α_{22}	0.019	0.002	7.65
1/2 ln(starchy output)^2	α_{33}	0.019	0.002	9.23
1/2 ln(annual industrial output)^2	α_{44}	0.040	0.005	8.79
ln(rice output)* ln(vegetables)	α_{12}	-0.011	0.0037	-2.84
ln(rice output)*ln(starchy output)	α_{13}	-0.019	0.003	-6.05
ln(rice output)*ln(annual industrial output)	α_{14}	-0.023	0.004	-5.34
ln(vegetables)*ln(starchy output)	α_{23}	-0.003	0.009	-2.49
ln(vegetables)*ln(annual industrial output)	α_{24}	-0.0003	0.0008	-0.48
ln(starchy output)*ln(annual industrial output)	α_{34}	-0.0004	0.0007	-0.53
Region				
North East	ρ_1	0.058	0.018	3.18
North West	ρ_2	0.021	0.031	0.66
North Central Coast	ρ_3	0.113	0.019	5.96
South Central Coast	ρ_4	-0.016	0.026	-0.61
Central Highlands	ρ_5	0.345	0.042	8.15
South East	ρ_6	0.445	0.053	8.45
Mekong River Delta	ρ_7	0.138	0.040	3.48
Constant	β_0	0.306	1.344	0.23
Inefficiency effects function				
Age of the household head	η_1	0.001	0.005	0.2

Mean education of working age men	η_2	-0.070	0.026	-2.67
Mean education of working age women	η_3	-0.141	0.026	-5.42
Household members, from 15 to 60 years old	η_4	0.398	0.06	6.63
Dependency ratio (%)	η_5	0.643	0.289	2.22
Days of illness	η_6	0.001	0.001	0.51
Number of plots	η_7	0.021	0.011	1.96
Hours of nonfarm wages	η_8	-0.0002	0.000	-4.19
Ratio of land with land use right certificates	η_9	-0.203	0.122	-1.66
Constant	η_0	-3.107	0.432	-7.20
N		1970		

Source: calculated from VHLSS 2006.

Chapter 5

Impacts of nonfarm participation on household production choices in smallholder agriculture

"In land-poor countries at the middle-income stage, as the economy develops and wages are rising rapidly, low income from grain production causes the consequent move by farmers into nonfarm sectors as a mean of improving household income, thereby increasing part-time farming and resulting in a decline in food production. Policies that keep food production stable seem to place food self-sufficiency in conflict with goals of improved household welfare and rural structural transformation."(Policy proposition stated in Chapter 1)

5.1 Introduction

Agriculture has traditionally been perceived as the engine of rural growth in Asia. Nonfarm activities, however, have assumed an increasingly important role (Mishra and Goodwin 1997; Lanjouw and Lanjouw 2001; Haggblade et al. 2007; Hazell and Rahman 2014). The widely quoted empirical evidence for developing countries shows that the rural nonfarm economy in Asia accounts for 30 per cent of full-time rural employment and 50 per cent of incomes (Hazell and Rahman 2014, p. 485). In contrast, in China, 62 per cent of the rural labour force was working off the farm in 2008, i.e. equivalent to 310 million members of the rural labour force were fully or partially in off-farm activities (Huang et al. 2012). Similarly, in Vietnam, the percentage of households that were involved in at least one nonfarm activity increased from 25% to nearly 50% of rural households between 1993 and 1998 (Van de Walle and Cratty 2004). In Vietnam, rice farms with less than 0.5 hectares account for 85 per cent of total rice farms (GSO 2012).

As economic growth proceeds in developing countries, along with an outflow of resources from farm sectors, questions about the role that nonfarm sectors plays in developing countries will grow more controversial and draw the attention of policy makers. One of these questions is whether or not food production and crop incomes will decline, potentially threatening food security as labour and resources move away from farms. Policy makers face the dual task of facilitating food security and the promotion of economic structural transformation. Policies that keep agricultural

production stable seem to place food self-sufficiency into conflict with the goals of improvement of household welfare and rural structural transformation. There are underlying needs to be identified if we are to understand farmers' decision-making and the drivers of choice between remaining on the farm or participation in nonfarm activities, and between investing in farm production and hiring labour.

Although the participation of household labour into nonfarm activities is a primary feature of the economic structural transformation process (Thirlwall 2006; Haggblade et al. 2007), the potential impacts of this process on agriculture can be quite complex. Economic theories show ambiguous predictions in terms of the magnitude or signs of the effects (Taylor and Lybbert 2015). Moreover, econometric models are not simple because covariates are likely to affect both nonfarm participation and agricultural production (Taylor and Feldman 2010). If farm households cannot substitute for nonfarm labour due to liquidity constraints or an incomplete labour market in rural areas, labour movement into nonfarm activities could result in the reduction of agricultural production. Alternatively, farm households can apply less labour-intensive farming or reorganize agricultural production by increasing family labour in order to keep output stable. In addition, households can spend nonfarm income on relaxing the constraints on agricultural production, such as investing in capital or hiring more labour. Thus, the possible impacts of nonfarm participation on agricultural production are theoretically indeterminate (Haggblade et al. 2007). Taylor and Lybbert (2015) show that whether or not the movement of workers out of agriculture without losing crop production is an empirical question that researchers and policy makers are still trying to answer.

This chapter aims to answer the following question: What choices of agricultural production do small farms make when household members participate in nonfarm activities and part-time farming increases? Moreover, the chapter investigates whether or not nonfarm activities of farm households are complementary to agricultural production. The impact of nonfarm participation on agricultural outcomes is complex and cannot be signed *a priori*, this chapter, thus, uses different techniques such as first difference, instrumental variables and matching technique to check the consistency of the empirical results. To implement this objective, this analysis employs a national dataset - the Vietnamese Household Living Standard Surveys 2004 and 2006. Complementarity implies that nonfarm participation provides non-labour inputs, credit and capital to farm households, which can be used to improve agricultural productivity. Rivalry or competition implies that nonfarm participation withdraws resources from farms, and thus

reduces agricultural production.

Little economic research has been conducted on the research question. There have been a few papers that examine the impact of nonfarm participation on agricultural production in rural Vietnam (Stampini and David 2009; De Brauw 2010). Stampini and David (2009) find evidence for relaxing credit constraints to farming. Their study, however, only focuses on crop expenses and ignores rice production, farm revenue and regional differences. Using the same data source in the 1990s as Stampini and David (2009), De Brauw (2010) shows an increase in seasonal migrants resulted in a move out of rice production and reduced the demand for agricultural inputs in the early stage of agricultural reform. Nevertheless, seasonal migration only accounted for a small number of their households in the sample.[48] Moreover, this study does not capture the whole picture of the rural nonfarm economy, which plays in increasing role in structural change and household welfare in rural Vietnam. As a result, no study has systematically addressed the impact of nonfarm participation on household production choices at the household level. This chapter closes this knowledge gap by using a panel dataset from the VHLSS 2004 and 2006. It takes the literature one step further by examining the evidence of relaxing credit constraints on small farms, the effects of different measures of nonfarm participation on rice production and farm revenue in the whole country, and in different regions.

This study is important for a number of reasons. First, to the best of the author's knowledge, it offers the first systematically economic assessment of the impacts of labour movement into rural nonfarm sectors on household production choices in light of the increasing importance of the nonfarm economy in Vietnam. Second, it focuses on not only seasonal migration, but also the rural nonfarm economy more broadly. In the literature, there is no study on the effect of part-time farming on agricultural production. Although farm households sometimes participate in temporary migration from rural areas to cities, most of their activities are in the rural nonfarm economy (Haggblade et al. 2007; Van de Walle and Cratty 2004). Third, one challenge facing policy makers in Vietnam is the trade-off between the rise in the welfare of farm households, and food security, particularly rice self-sufficiency. Policy makers are concerned about the conflict between these two objectives of the rural structural transformation. This study investigates whether or not does, in fact, the conflict exist. Evidence of a move away from farming, or a

[48] De Brauw (2010) used the Vietnam Living Standard Survey in 1992-1993 and 1997-1998. The number of households that had seasonal migration increased from 65 households in 1993 to 369 households in 1998.

complement to farming, can support policy makers in designing policies related to labour mobility, credit, insurance, and food security.

The remainder of this chapter is organized as follows. The literature review is analysed in Section 5.2, which shows the gap in the current literature on the effects of nonfarm participation on household production choices in smallholder agriculture. Section 5.3 describes methodologies used to answer the research question. The dataset and the variables are presented in Section 5.4. Estimation results are introduced in Section 5.5. Section 5.6 concludes, and outlines policy implications and suggestions for further research.

5.2 Literature review

5.2.1 Definitions

Following convention, this chapter uses the definition of nonfarm employment initiated by Haggblade et al. (2007 and 2010) and Hazell and Rahman (2014). It defines nonfarm employment to include all economic activities other than the production of primary agricultural commodities. Nonfarm activities, thus, include mining, manufacturing, utilities, construction, commerce, transport, and the full gamut of financial, personal, and government services. Workers in agro processing such as the transformation of raw agricultural products by milling, packaging, bulking, or transporting form a key component of the rural nonfarm employment. Nonfarm employment covers both the rural nonfarm economy and seasonal migration. Hoang et al. (2014) show that nonfarm employment in rural Vietnam takes place predominantly in local communities. As a result, the scope of nonfarm employment in this chapter is broader than that of seasonal migration. Seasonal migration is defined by the number of seasonal migrants, who left their household for work during the past 12 months (De Brauw 2010).

5.2.2 Literature on the effect of nonfarm participation on agricultural production

The existing empirical literature on the linkages at the household level between nonfarm participation and agricultural production is limited and inconclusive. Most studies focus on the impact of the agricultural sector on rural nonfarm activities and economic growth. In development economics, agricultural linkage growth is classified

into four categories: production, consumption, factor market and productivity linkages (Thirlwall 2006; Johnson 2000; Haggblade et al. 2007, Hazell and Rahman 2014). For example, Trung (2000) finds that growth in Vietnam's rice production during the 1990s generated the development of the rural nonfarm economy in favourable agricultural regions.

However, reverse linkages from nonfarm to farm have received growing interest in the literature, despite mixed evidence. The positive impact of nonfarm incomes on agricultural production has been noted in several studies (Collier and Lai 1986; Evans and Ngau 1991; Savadogo et al. 1994; Oseni and Winters 2009). Collier and Lai (1986) find that in Kenya, crop output is positively associated with non-crop incomes and liquid assets for smallholder agriculture. Evans and Ngau (1991) also conclude that farmers with nonfarm incomes are more likely to grow coffee (more profitable), rather than maize for subsistence in Kenya. At the same time, Savadogo et al. (1994) demonstrate that incomes from nonfarm activities enables farmers in Burkina Faso to invest in animal traction packages. In a qualitative analysis, Reardon et al. (1994) argue that with a buffer of cash from nonfarm activities, farmers are willing to move from "safety first" food cropping to risky cash crops.

In addition to positive impacts, empirical evidence on negative effects can be found in the literature. Taylor and Lybbert (2015) show that small farmers face many different kinds of production constraints that restrict their capacity and willingness to increase agricultural production, and shift into higher value crop activities. For example, high production risks and lack of crop insurance make farmers unwilling to invest in agriculture. Similarly, Holden et al. (2004) find that in Ethiopia, participation in rural nonfarm activities result in a drop in agricultural productivity due to increased soil erosion and land degradation. A more recent study using Albanian household survey data 2005 (Kilic et al. 2009) shows that rural households utilised their nonfarm incomes not to invest in time-saving farming and farm capital, but to move out of crop production. In the case of Hungary, Rizov and Swinnen (2004) found evidence of a move away from farming when rural households participate in nonfarm activities. They found that nonfarm incomes reduce the probability of engagement in agriculture. Similarly, De Brauw (2010) studies the impact of seasonal migration on agricultural production in Vietnam. The author concludes that seasonal migration results in the reduction of rice outputs and less use of farm inputs. He also finds evidence of a shift from labour to land-intensive farming.

As regards the role of nonfarm participation in relaxing the liquid constraints facing farm households, studies in developing countries show the same picture of the impact. Oseni and Winters (2009) find that farmers in rural Nigeria utilise their nonfarm incomes to relax credit constraints by spending on crop expenses and payments for hired labour and inorganic fertilizers. Ellis and Freeman (2004) investigate the impact in four countries: Uganda, Kenya, Tanzania and Malawi. The authors conclude that nonfarm incomes result in improving land productivity in these countries by relaxing cash constraints so farmers can purchase inputs.

The picture is often the same when nonfarm labour and incomes are disaggregated in migration and remittances, which have a conceptually similar role. Although theoretically migration could affect agricultural production, there have been few studies examining the direct relationship between migration and agricultural production (Rozelle et al. 1999; Taylor et al. 2003; Li et al. 2013; Tuladha et al. 2014). These studies find that migration distorts on-farm operations in the short-run when labour leaves. However, remittances can reduce negative impacts by investing in capital intensive and profitable cash crop production. For example, Rozelle et al. (1999) find that in northeast China, migration is negatively associated with maize yields, but migrant remittances more than make up for the presumed lost-labour effect. As a result, maize yields are higher for migrant households than for non-migrant households. Tuladha et al. (2014) study the effect of migration and remittances on Nepal's agricultural yields using the new economics of labour migration theory framework. They show that migration negatively affects agricultural yields, and remittances are not used to invest in agricultural capital goods and inputs. These contrasting estimates between countries indicate that the impact of migration and remittances should, thus, be studied in context.

To sum up, three overarching points arise from the above studies. Firstly, while most studies on Vietnam concentrate on the impact of migration or nonfarm participation on poverty and household expenditure (Nguyen 2008; Hoang et al. 2014; Nguyen et al. 2011; Nguyen and Mont 2012), few papers measure the effect of nonfarm participation on agricultural production. Most papers study the drivers or determinants of migration and remittances in Vietnam (Niimi et al. 2009; Phan 2012; Nguyen et al. 2015; Coxhead et al. 2015). De Brauw (2010) investigates the impact of seasonal migration on agricultural production using the VHLSS 1993 and 1998. He shows that seasonal migration can result in a move out of rice production in rural Vietnam. Rice outputs in Vietnam increased steadily in the 1990s despite the increasing trends of labour

movement out of agriculture and rural areas (Dang et al. 2006). Brennan et al. (2012) using the general equilibrium model also find a slight decrease in feed output in Vietnamese agriculture, as a result of rural-urban migration.

Second, although migration has become the dominant form of nonfarm activities in developing countries, the rural nonfarm economy has absorbed a large number of farm workers (Haggblade et al. 2007; Hazell and Rahman 2014). Rozell et al. (1999) use the number of migrants and remittances to test the new economics of labour migration theory (NELM). However, return migration, unregistered migration, and migration history are rarely surveyed in household living standard datasets in Vietnam, with the exception of seasonal migration. La and Leung (2012) show that over the period 2002-2006, the number of households receiving remittances accounted for over 80 per cent on average in rural areas of Vietnam (from VHLSS 2002, 2004 and 2006 surveys).[49] Nevertheless, these VHLSS surveys cannot provide the migration history needed to capture information on those non-household members who send remittances to local communities. There is also no information on the number of households receiving remittances from households' migrants. Nguyen et al. (2015) show that it is unlikely to link the migrants with their original households so that the effect of remittances on household welfare cannot be evaluated. Therefore, in the case of Vietnam, it is not possible to examine the impact of migration and remittances simultaneously in the framework of NELM model, which requires instrumental variables for both migration and remittances.

Third, the impact of nonfarm participation on agricultural production is complicated by the fact that the participation of farm labour and capital in the nonfarm economy constrains resource allocation in agricultural production, particularly in crop and livestock sectors as presented by Haggblade et al. (2007). Moreover, there are barriers that affect the participation in nonfarm activities. For example, for poorer households that decide to participate in nonfarm activities, diversion of labour to other activities can result in the stagnation of or reduction in their own farm productivity (Ellis and Freeman 2004). Similarly, shifts of labour from farm to nonfarm employment can sometimes lead to farm production inefficiency (Chavas et al. 2005). In addition, this mixed evidence indicates that the impact of nonfarm participation depends a good deal

[49] According to the questionnaire from VHLSS 2004 and 2006 surveys, remittances are income from people who are not household members. Therefore, they are not considered as nonfarm income0 of rural households. This chapter uses the definition of nonfarm incomes in Hazell and Rahman (2014).

on the context of each country.

This study contributes to the literature by concentrating on the nexus between nonfarm participation and household production choices. It traces the complex linkages that exist among nonfarm participation and agricultural production by using different methods to validate the consistency of the empirical results. It further explores whether or not participation in nonfarm activities relaxes credit or cash constraints in rural Vietnam. Furthermore, it decomposes the effect of nonfarm participation on production choices into regional differences (i.e. north and south). The differences in constraints on land may affect household's decisions on production choices, such as: the reduction of rice production; a switch to other crops; substitution between hired labour and family labour; investing in mechanization; and less labour-farming cultivation (Otsuka et al. 2013b).

5.2.3 Literature on the determinants of rural nonfarm employment and incomes

In developing countries, rural livelihood strategy is a driver of poverty reduction and food security (Ellis 2000; Barrett et al. 2001; Winter et al. 2001; Thirlwall 2006). The role of the rural nonfarm economy is increasing and has become an important source of income for rural households in their livelihood diversification. Lanjouw and Lanjouw (2001) claim that nonfarm employment provides economic security for those members of society who may have restricted access to farm employment. Similarly, Reardon et al. (1994) find that in rural economies, participation in rural nonfarm employment facilitates liquidity constraints facing households in light of financial market imperfections. The function of the rural nonfarm economy is as a safety net for households facing income shocks and protecting their assets.

As regards the identification of the determinants of rural income diversification, Ellis (1998 and 2000) shows that the determinants of rural income diversification are necessity and choice, which are the same as the push and pull factors of migration. The author finds that asset categories and their structure determine the choice of livelihoods. These categories include natural capital such as land, physical capital, human capital, financial capital and social capital. Barrett et al. (2001) argue that the diverse mix of assets available to households typically produces a wide range of different asset allocation choices. These papers argue that asset structure plays an important role in the choice of livelihood diversification in rural areas.

Similarly, Haggblade et al. (2007) show that the motives of rural households for diversification differ significantly across settings and income groups. This suggests an important distinction between diversification driven mainly by "pull" factors for accumulation objectives and "push" factors for cope with shock and escape from low growth in agriculture. The coping literature examines how rural households in low-potential and risky environments adapt by deploying household resources to a range of farm and nonfarm activities (Rosenzweig and Stark 1989). The discussion of 'pull' and 'push' factors is found in many research papers investigating patterns of household income diversification in developing countries (Evans and Ngau 1991; Readon et al. 1994; Ellis 2000; Barrett et al. 2001; Ellis and Freeman 2004; Lanjouw, Quizon and Sparrow 2001). Many rural households turn to a more diversified portfolio of activities due to increasing risks to their livelihood in farm activities (Ellis 1999 and 2000).

In addition to these studies, there is an additional area of investigation that traces the development of the rural nonfarm economy. Several studies emphasise the role of infrastructure in rural areas (Haggblade et al. 2007; Renkow 2007; Lokshin and Yemtsov 2005). These studies find that the improvement in infrastructure facilitates nonfarm opportunities. Moreover, as seen in Indonesia, the expansion of electricity results in employment in exported-oriented sectors and in a wide range of nonfarm employment opportunities (Gibson and Olivia 2010).

5.3 Research methodology

5.3.1 Theoretical model

The agricultural household model (AHM) developed by Singh, Squire and Strauss (1986) is selected. Unlike neoclassical economic theory, which focuses either consumer or producer theory, AHM integrates consumption, production, exchange and labour supply decisions simultaneously. In the case of complete markets, AHM predicts that production decisions can be separable from consumption, which means that the participation in off-farm employment is independent of farm production choices. Conversely, incomplete markets result in non-separable model, which predicts that production decision is interrelated with consumption and depends on preferences and endowments. As a result, agricultural production may be affected if farm labour moves to the nonfarm sector in the case of non-separable model. Many studies show that perfect labour and land markets are rarely found in developing countries

(Benjamin 1992; Urdy 1996; Jollife 2004). In the case of Vietnam, Le (2009 and 2010) also rejected the hypothesis of complete markets when he estimated the labour supply function in rural Vietnam using household survey data. World Bank (2006) reaches the same conclusion on land market in Vietnam. Hence, a non-separable model is relevant in the context of Vietnam, which implies that structural change is likely to affect agricultural production.

Another theory related to the household model, which is also widely used, is the new economics of labour migration by Stark and Bloom (1985). Family members who move to nonfarm sectors can provide the family with capital needed to raise agricultural productivity (Taylor and Lybbert 2015). If it is not possible to compensate the loss of family labour due to migration or nonfarm activities in an imperfect market, a decrease in production, or a move away from labour intensive farming or the use of labour savings technology can occur. If the negative labour impact is bigger than the beneficial impact of relaxing credit constraints, then there will be a negative effect of migration on agricultural production (Rozelle et al. 1999). Therefore, when a household operating in imperfect markets decides to send out a migrant, the decision can either exacerbate or alleviate constraints on agricultural production. In the NELM theory, remittances play a key role in identifying the impact of migration (Rozelle et al. 1999). The NELM also postulates that increased remittances may relax rural households' financial constraints and increase investment in new farming technologies (Stark and Bloom 1985). In Section 5.2, the chapter argues that the NELM framework is unlikely to apply in the case of Vietnam due to data constraints on migration and remittances and instruments for both variables, which requires both migration and remittances to be simultaneously used in the model.

By using the approach developed by Taylor et al. (2003), the theoretical model starts by considering a farm household whose goal is to maximize output *(Q)* under given resource constraints *(RC)*. They face credit constraints and must cope with imperfect markets in rural areas. Suppose that a household may invest its fixed resource *RC* (land or family labour) to produce in either low productivity (e.g. grain) or high productivity activity (e.g. cash crops or manufacturing), s_i for i=0,1, respectively. There are household characteristics Z_x that shape productivity in each activity. It is assumed that at the relative price (P_1/P_0), the household will specialize in the high productivity activity, leading to an output function: $Q^*=f_1(RC, Z_x)$ (5.1)

Assume that $c(RC_1)$ is defined as the cost of, or barrier to, adopting the high productivity technology and K denotes the household's credit available to invest in high productivity activity. In the case of a risk constraint, $c(RC_1)$ denotes as a measure of risk related to high productivity activity and K is thus be the maximum risk that the household is willing to accept. The household may face a market constraint on its investment on a high productivity activity such that $c(RC_1) \leq K$, $c'(RC_1) > 0$. In order to relax credit constraints or risk constraints, the household may participate in nonfarm activities from family members (L_n). Hence, the theoretical framework assumes that $K=f(L_n)$ (5.2)

In addition, the constrained resource allocation to the high productivity activity is: $RC^c = \phi(K)$, where $\phi'(K)>0$. Constrained output under high productivity activity is: $Q_1^c = f_1(RC_{c_1}, Z_x)$ and under low productivity activity: $Q_1^c = f_1(RC - RC_{c_1}, Z_x)$. As a result, the constrained output per unit of RC is followed by: $q^c = (Q_1^c + Q_0^c/RC)$ where $q^c < q$, q defines the unconstrained output. In Equation (5.2), the sign of f_{L_n} is indeterminate. Consequently, the effect of nonfarm participation on agricultural production is ambiguous. However, Taylor et al. (2003) point out that if capital, risk or human capital constraints are binding, the impact of nonfarm participation is not likely to be zero. When the findings show positive impacts, this implies that nonfarm participation complements agricultural production by relaxing credit or risk constraints. Conversely, negative impacts mean that increased nonfarm activities exacerbate labour shortages or represent a move away from farming.

The household maximises utility $u(c, S, \varepsilon)$ that is subject to a budget constraint and a time allocation constraint. In the utility function, c denotes consumption; S represents leisure, and ε captures other factors. The household can obtain income through agricultural production and nonfarm activities. The household produces farm outputs using the constrained equation: $Q_a = f_a(RC_c, Z_x, \psi)$, where ψ is other factors that affect output. Because $RC^c = \phi(K)$ and $K = f(L_n)$, the output function can be rewritten as:

$$Q_a = f_a(L_a, L_n, A, X, Z_x, \psi) \quad (5.3)$$

where L_a is agricultural labour; A is fixed land area in the short run; and X represents inputs. Normalising the price of agricultural product to one, the agricultural profit is expressed as:

$$\pi = f_a(L_a, L_n, A, X, Z_x, \psi) - p_x X \quad (5.4)$$

where p_x is a vector of input prices; π and represents farm profits.

The household faces a time allocation constraint that is binding:

$$\overline{L} = L_a + L_n + S \quad (5.5)$$

The household will thus maximize the full incomes:

$$I = f_a(L_a, L_n, A, X, Z_x, \Psi) \quad (5.6)$$

where w_s is the shadow wage implicitly identified by the household labour equilibrium. The above utility maximization problem can be solved maximizing the utility function $u(c,S,\varepsilon)$ subject to Equations (5.5) and (5.6). Solving the full model provides the equilibrium output as follows: $Y^* = Y(L_n, p_x, A, Z_x, \Psi)$ (5.7)

The main interest in this chapter is the impact of nonfarm participation on agricultural measures($\partial Y_i / \partial L_n$). De Janvry et al. (1991) and Wang et al. (2014) show that if the nonfarm constraint does not bind and no constraint on nonfarm participation exists, the net impact will be zero. Conversely, in the absence of perfect markets as shown by Le (2009) and World Bank (2006) in Vietnam, assuming that nonfarm employment constraints are binding, nonfarm participation may affect agricultural production. In addition, the impact of nonfarm participation on demand for inputs may be different from zero. Without a credit or insurance market, nonfarm participation enables farm households to relax constraints by providing nonfarm incomes. As a result, agricultural production can be improved. This effect, however, may not be positive if farmers cope with imperfect markets. The participation in nonfarm activities may exacerbate labour constraints by competing for farm labour. In addition, farm households could use nonfarm incomes to purchase inputs and invest in capital for long-term development (Taylor and Feldman 2010).

5.3.2 Empirical model

The objective of the empirical model is to answer the research question how labour movement from farm to nonfarm activities affects household production choices. The empirical models are derived from the agricultural household model described in Section 5.3.1. In order to control for household heterogeneity and better study the dynamics of labour movement overtime, the analysis takes advantage of the longitudinal feature of the VHLSS. A general two-way linear panel data model is expressed as follows:

$$\Delta lnY_{icr} = \sum_{x=1}^{N} \alpha_x \Delta lnX_{icr} + \alpha_{L_n} \Delta L_n + \sum_{z=1}^{K} \alpha_z Z_{icr} + \sum_{a=1}^{M} \alpha_a A_{icr} + \alpha_r R_{cr} + \Delta\varepsilon_{icr} \quad (5.8)$$

where *i* denotes households; *c* denotes communes; *r* indexes regions; *Y* measures agricultural outputs, agricultural revenue or non-rice agricultural revenue; *X* is a vector of inputs in farm production; L_n represents a measure of nonfarm participation including the number of household members participating in nonfarm activities, or share of household's working hours in nonfarm activities; *Z* is a variable related to household characteristics such as demographics, education, assets; *A* references other factors that affect agricultural production such as the share of land that is titled; and *R* controls communal and regional characteristics. Given the short panel with only two time periods, the model is specified in differences to remove household and regional fixed effects.

The empirical results from Equation (5.8) help to evaluate the effects of nonfarm participation on rice production, agricultural and non-rice agricultural revenue, and household expenditure. The expressions in Equation (5.8), however, do not show the role of nonfarm participation in relaxing the liquidity constraints facing farm households, as analyzed in the theoretical section. By using the approach of Oseni and Winter (2009), the additional model focuses on the effects of nonfarm participation on crop expenses for farm households in rural Vietnam. The dependent variables include input costs, hired labour and capital, and other expenses. All independent variables are the same as the variables in Equations (5.8), but without *X*, a vector of inputs. The relationship is mathematically expressed as follows:

$$\Delta lnX_{icr} = \mu_{L_n} \Delta L_n + \sum_{z=1}^{K} \mu_z Z_{icr} + \sum_{a=1}^{M} \mu_a A_{icr} + \mu_r R_{cr} + \Delta v_{icr} \quad (5.9)$$

where *X* measures crop expenses; L_n is a measure of nonfarm participation; *Z* includes household characteristics; *A* represents other factors that may affect crop expenses; and *R* controls regional effects. The null hypothesis associated with the hypothesis that there is evidence of relaxing liquidity constraints facing farm households is that: $\mu_{L_n} = 0$

5.3.3 Identification

The estimation of all equations is challenging because the participation in nonfarm activities is not a random process. Furthermore, unobservable heterogeneity that affects decisions on nonfarm participation may also affect agricultural outcomes. Thus, if all equations are estimated using the first differenced model, the coefficient estimates of

interested variables are likely to be biased, in spite of the elimination of unobserved fixed effects (such as ability or entrepreneurship of farm households and other regional fixed effects) when using the first difference method. There are two problems that may arise from including omitted variables and reverse causality (Wooldridge 2012). In order to solve the bias problems, this chapter uses different approaches, including first difference, two stage least squares, and matching technique. Each method has its own advantages and disadvantages. If the empirical results show the same sign and significance, then it can be concluded that there is consistency of the effects.

Instrumental variable approach: controlling for unobserved time-varying shocks and reverse causality

Although unobserved fixed effects are eliminated from the first difference method, unobservable heterogeneity effects that change over time may drive the omitted variable problem. For example, adverse price shocks may have a negative impact on agricultural production. However, the shock might be expected to produce a negative bias on the coefficient of nonfarm labour. Hertz (2007) finds that risk aversion may divert labour and capital to nonfarm employment, resulting in a negative bias. When there is a correlation between seasonal migration and improved transport network access overtime, then positive bias can be expected (De Brauw 2010). Hence, it is not easy to determine the sign of the bias. In addition, reverse causality may cause a simultaneous bias. The condition of agricultural production may influence the probability of nonfarm participation. Low agricultural income is likely to encourage farm households to leave, and seek better opportunities and select nonfarm jobs to secure their livelihood (Barrett et al. 2001). Therefore, in order to reduce the problems of omitted variables and reverse causality, an instrument variable framework is used to estimate interested coefficients consistently.

This chapter estimates Equations (5.8) and (5.9) using the two-stage least squares (2SLS). Instrument variables are correlated with nonfarm variables, but are not correlated with agricultural production (such as outputs or inputs), except through their effect on nonfarm participation. Nonfarm networks are selected as an instrument variable for the equations.

The first-stage equation is expressed as follows:

$$\Delta L_{nicr} = \rho_m M_{cr,t-1} + \sum_{z=1}^{K} \rho_z Z_{icr} + \sum_{a=1}^{M} \rho_a A_{icr} + \rho_r R_{cr} + \Delta\theta_{icr}^{L_n} \qquad (5.10)$$

where *i* denotes households; *c* denotes communes; *r* indexes region; L_{nicr} represents a measure of nonfarm participation; $M_{cr,t-1}$ is the lagged commune-level nonfarm networks, which measures the share of people working in nonfarm activities over the past 12 months at the communal level (taken from the communal surveys in 2004);[50] Z includes household characteristics, other variables are the same as Equations (5.8) and (5.9). $M_{cr,t-1}$ measures nonfarm networks as an instrumental variable in the first-stage equation. It should be noted that there are two different surveys at the household and communal levels in 2004 and 2006.

In previous studies, nonfarm networks, or contacts with people in communities who have previously participated in nonfarm activities, are widely used.[51] In both empirical and theoretical studies, nonfarm networks have been found to be among the most important factors driving nonfarm participation (Taylor and Martin 2001). Hoang et al. (2014) exploit this instrument to study the impact of nonfarm participation on poverty and expenditure in Vietnam. Similarly, Kajisa (2007) also emphasises the role of nonfarm networks in supporting household members to be employed in nonfarm activities. Members who have already participated in nonfarm sectors will reduce some costs related to the search for work in nonfarm employment, due to the sharing of information on jobs in other regions with their relatives and neighbours.

In the context of Vietnam, having nonfarm networks gives farm households more connections and access to nonfarm employment, particularly the connections between fellow villagers or fellow countrymen (Hoang et al. 2014). In addition, Oseni and Winter (2009) argue that the effect of nonfarm networks on crop expenses only occurs via its impact on nonfarm participation. Therefore, nonfarm networks can be seen as a good choice for this analysis. In this study, nonfarm networks are constructed by exploiting the unique feature of nonfarm activities from the survey of 2,216 communes in all provinces in Vietnam. The variable ($M_{cr,t-1}$) is collected from the commune level survey in 2004 that accompanies the household surveys. It measures the share of people working in nonfarm sectors in relation to the total number working in the commune. Furthermore, this study also accounts for the direct effect of economic shocks on nonfarm networks and agricultural production simultaneously by including

[50] The communal surveys were independently carried out with household surveys. In Vietnam, the administrative system is structured from highest to lowest level as follows: province (or city), district, commune, and village.

[51] See also Rozelle et al, 1999; Taylor et al, 2003; Li et al. 2013; Kajisa 2007; Tuladhar et al. 2014; Kilic et al. 2009; Oseni and Winter 2009; De Brauw 2010. These papers also use nonfarm networks as instrumental variables for migration or nonfarm participation.

some commune-level infrastructure variables such as transport, markets, irrigated land and regional dummies.

Matching decomposition method

The purpose of this section is to check the OLS first difference and 2SLS results with an impact evaluation method called the matching technique. It should be noted that matching technique only complements estimated methods to examine the consistency of a multivariate regression. In addition, the matching also solves the selection bias (Khandker et al. 2010). However, this chapter cannot correct for selection into rice production by using multivariate regressions.[52] In the case of agricultural revenue, selectivity bias does not exist because the panel of rural households that reported farm revenue in both dataset is constructed.

In order to implement the objectives of this section, the chapter applies a matching decomposition method proposed by Nopo (2008), who developed the standard Blinder-Oaxaca decomposition to explain gender wage differences. According to Nopo (2008), this method extends and solves two problems in the Blinder-Oaxaca decomposition. First, it is a fully nonparametric matching technique, as it does not require estimating regression models of agricultural production. Second, Nopo's matching method does not make the out-of-support assumption because the counterfactual means of agricultural production are simulated only for the common support. Thus, this method applies an exact covariate matching procedure, which chooses two sub-samples of farm and nonfarm households with comparable characteristics to construct the counterfactual groups. Matching results solely depend on households who are comparable in terms of observable characteristics of agricultural production, which is one of disadvantages of this method. Note that the results of the matching technique are only used to further validate the previous empirical results. In the case of multivariate regression, unmatched farm and nonfarm households also contribute to the estimated parameters.

Assume that H represents the indicators of agricultural production (output, revenue, and inputs), and Z measures household characteristics, which determine agricultural production. In addition, assume $g^{nf}(z) = E(H/Z = z, nf)$ denotes the mean of

[52] There is no valid instrument that correlates with the decision to produce rice, but does not affect the amounts produced. This problem is also ignored in previous studies in the literature due to difficulties in identifying exclusion restrictions.

indicators of agricultural production for nonfarm groups of households with characteristics z. For farm groups, $g^f(z) = E(H/Z = z, f)$ is defined in a similar manner. Thus, the average nonfarm-farm gaps of indicators of agricultural production are expressed as:

$$\Delta = E(H/nf) - E(H/f)$$

By using the approach of Nopo (2008) and the algorithm involving four steps introduced by Mussa (2014), this chapter performs the matching procedure based on observed characteristics as below:

* Step 1: Select a household in the sample that participated in nonfarm activities in 2006.

* Step 2: Select all households from the sub-sample of farm households who have the same characteristics as the households in Step 1. These households did not participate in nonfarm activities in 2006. Keep these selected observations.

* Step 3: From selected households in Step 2, establish a synthetic household that matches the household in Step 1. Compute the counterfactual means of agricultural production including output, revenue and inputs of nonfarm households selected in Step 1 as the weighted average level of farm households selected in Step 2.

* Step 4: Compute D by using the change between actual and the new synthetic indicators of agricultural production and the "match" dummy variable coded as 1 if farm and nonfarm households are matched.

This chapter uses the "push" and "pull" factors of decision making on nonfarm participation of farm households as matching variables.[53] First, it considers farm characteristics, including land for annual crops in 2004 and 2006 at different quartiles, and input uses in 2004. Second are dummy variables on educational levels of the household head such as no education, primary education, and secondary education in 2004. Third, a dummy variable for nonfarm participation of household members in 2004 is also considered. Finally, the value of household assets including farm and nonfarm assets are classified in four categories, corresponding to different quartiles in 2004. Bezu et al (2012) find that initial household asset holdings and education are

[53] See further details in Haggblade et al. (2007) about the determinants of nonfarm participation of farm households in developing countries.

important factors for a transition into nonfarm employment and high-return rural nonfarm employment. It should be noted that this procedure controls for the same amount of land and assets in 2006. These variables may not necessarily be the same as in 2004. The only difference between the two matched groups of households is participation in nonfarm activities in 2006. Note that, this method only focuses on the change in agricultural production in the period 2004 and 2006.

5.4 Survey sample data and trends of agricultural production and nonfarm activities

5.4.1 Data and variables

As in the previous chapter, the Vietnam Household Living Standard Surveys of 2004 and 2006 are used for empirical analysis. These surveys are nationally representative, and consist of questionnaires at both the household and communal levels. The Vietnamese General Statistics Office has undertaken these surveys with technical support from the World Bank and UNDP since 1992/1993. VHLSSs provide rich information on household and commune characteristics such as demography, education, health, employment, land, assets, income and expenditure. The commune survey covers information on infrastructure and institution at the communal level. The cluster-sampling technique is used to represent the entire country. The communal surveys provide further information on living conditions and communal characteristics such as infrastructure, businesses, number of people participating in nonfarm activities in the commune, and other measures.

The VHLSS surveys use a multi-stage, randomized cluster design to survey 2,216 communes of all provinces in each VHLSS 2004 and 2006. These surveys cover 9,188 and 9,189 households, respectively. Fifty per cent of households in VHLSS 2004 were reinterviewed in the VHLSS 2006. In total, 3,224 rural households were included in both surveys after accounting for missing data. In order to answer the research question, the panel of 2,801 rural households that reported farm income in both datasets is constructed. The total sample size is 5,602 observations.

There are a few limitations of the datasets. First, the surveys do not track migration history. Nguyen et al. (2011) estimate that the number of households who sent out working migrants totals 295, accounting for 7 per cent of households in the panel

sample.[54] There is no information on migration history before 2004. As a result, it is not possible to identify the percentage of migrant households, who received remittances. These constraints hinder the analysis of the insights of NELM theory. In the VHLSS surveys, more than 80 per cent of rural households received remittances sent from non-household members (Nguyen and Mont 2012). Similarly, using from VHLSS 2004 and 2006 in rural Vietnam, La and Leung (2012) also find that the percentage of households receiving remittances were 84.1 and 87.8, respectively.

Second, the information on prices of crops and input is also not tracked. Rice prices are not available in either the communal or the household surveys. In order to control the price effect in the model of rice production, a common practice is to calculate unit values by dividing revenues from the sales of outputs by the corresponding quantities, and use these as a direct substitute for market prices. In this chapter, unit values of rice are used to measure rice prices. Nevertheless, Deaton (1997) argues that using unit values as market prices results in problems such as differences in price and the quality of outputs, along with measurement errors in both the quantity and sales data. Therefore, unit values are not perfect measures of rice price. Finally, the VHLSS surveys only cover registered households. The unregistered households such as rural migrants are excluded. Given that, these limitations do not impose any serious issue for the objective of this study.

Dependent variables

The regression analysis in this chapter uses various dependent variables to explore the impact of nonfarm participation on household production choices. First, the quantity of rice output is selected to evaluate rice production. Rice output accounts for more than 72 per cent of total annual crops in terms of quantity, and 76 per cent in terms of value. In the VHLSS surveys, there are more than 20 different annual crops. Second, agricultural and non-rice agricultural revenues are also selected. VHLSS surveys provide revenues for each crop, which is useful when calculating total farm revenue and non-rice farm revenue. As rice represents a large share of total farm revenue, I now disaggregate farm production into rice and others. In addition to the effects on agricultural production, the effect of nonfarm activities on household welfare is also

[54] Hoang et al. (2014) also find that only 6 per cent of household members were seasonal migrants in VHLSSs in 2004, 2006, and 2008.

explored. Although farm households tend to diversify their livelihoods, crop incomes represent more than 68 per cent of agricultural incomes.[55]

Finally, crop expenses consist of input costs, hired labour, and hired capital. Many inputs like fertiliser, pesticides, seeds, hired labour and capital are measured in terms of value, and were aggregated at the farm level. This study only examines at expenditure on inputs because the information on the quantity of inputs is missing, or incomplete and difficult to compare. As regards hired labour, VHLSS surveys only obtain the value, not the number, of person days. The equations of dependent variables as different types of crop expenses can provide the evidence of overcoming liquidity constraints in farm production.

Independent variables

There are 38 per cent of households working only on the farm (full-time farming) and 62 per cent of farm households with at least one member working on nonfarm activities (part-time farming). Of this 62 per cent, 58.6 per cent reported nonfarm incomes from their family members who participated in nonfarm activities. Thus, the key variables of interest are nonfarm participation measured by the number of household members participating in nonfarm activities and the share of hours working in nonfarm sectors.

In this analysis, nonfarm labour includes rural nonfarm labour and seasonal migrants as defined by Haggbalde et al. (2007). The number of household members participating in nonfarm activities measures the variable of rural nonfarm labour. The employment classification (nonfarm wages and nonfarm self-employment) is carried out by considering the most time-consuming job. Similarly, a seasonal migrant is broadly defined as a person who has been absent from home for a minimum of one month and a maximum of 11 months. Many nonfarm businesses operate according to the rhythms set by agricultural season. Seasonal migrants are still considered household members according to the definition in Section 3.1 in this chapter. It should be noted that nonfarm employment in rural Vietnam takes place predominantly in local communities.

In the VHLSS 2004 and 2006 surveys, the share of households leaving for seasonal migration accounts for 4.13 and 4.64 per cent of rural households, respectively. Furthermore, the proportion of seasonal migration households among all nonfarm households represents 5.15 and 10.25 per cent in the two surveys, respectively. The

[55] When taking the log of dependent variables, I add an arbitrary constant of "1" to variables with zero value to avoid creating missing values.

VHLSS 2004 and 2006 surveys have an attractive feature that provides key detailed information on employment of household members aged above 15 years.[56] From this information, the chapter compiles the household data on the amount of labour allocated to each of the following two main activities: (a) farm, (b) nonfarm. In the VHLSS surveys, nonfarm employment is divided into nonfarm wage and self-nonfarm employment. The model also controls differences in demographics, human capital and physical capital across farm households. Demographical characteristics hypothesized to affect the model include the number of household members of working age according to Vietnamese Labour Law (from 15 to 60 years old) and the ratio of dependents measured in percent. Singh at al. (1986) show that the demographic composition of the household may affect the participation in nonfarm activities if labour markets are imperfect.

To account for human and physical capital, the measures of education and assets in all equations are included. Given differences in educational levels between males and females, as well as the diversification of farm tasks by gender, the average education of working age males and females are added to the model. The measure of education at working age reduces the bias problem of these variables. The physical assets consist of the value of farm assets and nonfarm assets. All values are deflated to January 2004 prices. Moreover, communal and regional characteristics are also controlled such as infrastructure, markets and the share of irrigated land at the communal level, and eight regional dummies. These variables are not differenced. The model also controls covariate shocks such as the number of disasters in the commune. This variable is collected from the commune level survey. In addition, remittances from non-household members and public transfers such as pensions and other social insurance are captured in the model. These values are deflated to January 2004 prices.

5.4.2 Agricultural production from survey samples

Rice is the most common crop growing in all provinces in Vietnam, representing 65.4 per cent of farm households in rural Vietnam. Table 5.1 below summarises the measures of agricultural production from VHLSS 2004 and 2006. The average rice production increases from 3436.03 kg in 2004 to 3698.5 kg in 2006. Rice output of the households

[56] In the VHLSS 2004 and 2006 questionnaire, Section 4A – Employment status is asked. The sample used in this analysis includes individuals aged above 15 years old. The lower age limit of 15 years old is chosen because we follow the classification of GSO (2010). More than 90% of the rural population aged 15 years old has had lower secondary as their highest educational level. As the same time, the survey showed that those who had no work, or could not find a job, or did not know how and where to find a job, ranging from 1 to 2% in the VHLSSs. This chapter also includes household members over 65 year's old accounting for seven per cent of the economically active labour participation.

in the panel sample of 2802 farms represents more than 75 per cent of the total annual crops in terms of quantity, and over 78 per cent in terms of value. Among households that report farm income, there is evidence of crop diversification.

Table 5.1 **Characteristics of agricultural production measures, 2004 and 2006, Vietnam**

Variables	2004		2006	
	Number of observations	Mean (Std.dev.)	Number of observations	Mean (Std.dev.)
* *Agricultural output*				
Paddy (kg)	2190	3436.03 (6077.15)	1900	3698.55 (7491.96)
Agricultural revenue (1000 VND)	2801	11924.05 (33520.01)	2801	15174.1 (51255.48)
Agricultural revenue without rice (1000 VND)	2486	5633.66 (3030.96)	2479	6657.62 (40960.63)
Crop incomes (1000 VND)	2634	6622.38 (12059.89)	2625	7238,71 (14861.79)
* *Agricultural inputs*				
Fertiliser (1000 VND)	2572	1517.72 (2573.35)	2544	1843.28 (3278.35)
Pesticide (1000 VND)	2333	449.95 (1109.64)	2311	489.89 (1346.82)
Seeds (1000 VND)	2368	368.38 (612.05)	2302	366.33 (626.81)
On farm family hours	2369	2465.78 (1798.27)	2317	2406.15 (1786.69)
Paddy land (m^2)	2190	7087.64 (11356.51)	2109	7266.80 (13494.87)
Total annual land (m^2)	2771	7989.23 (11356.51)	2683	8592.38 (18843.15)
Hired labour (1000 VND)	1253	976.51 (3856.67)	1244	1137.48 (3266.38)
Hired capital (1000 VND)	1786	692.84 (1642.4)	1757	748.36 (1299.22)

Notes: Standard deviations are in parentheses. All summary statistics are conditional on positive values and deflated to January 2004 prices; 1 USD=15,965 VND (2006).
Source: calculated from VHLSS 2004 and 2006.

As can be seen in Table 5.1, the proportion of rice revenue reduced from an average of 42.3 per cent in 2004 to 39.3 per cent in 2006. This compares with an average of 70 per cent of agricultural revenue in the period 1993-1998 (Dang et al. 2006). Agricultural revenue can be obtained from rice, other annual crops, fruit, livestock, perennial and

industrial crops, and aquaculture products. Thus, farms in rural Vietnam have been switching from specialized to diversified farming as rice income tends to fall and other sources of incomes such as cash crops and livestock tend to increase.

Table 5.2 **Changes in farm outputs and inputs between 2004 and 2006, rural Vietnam**

Variables	Farm households (full-time farming)	Non-farm households* (part-time farming)	All households
Change in paddy production (kg)	392.60 (4392.57) *547*	95.90 (3538.81) *1298*	180.65 (3803.46) *1845*
Change in agricultural revenue (1000 VND)	1512.02 (15494.46) *819*	940.22 (13295.95) *1983*	1099.34 (13941.90) *2802*
Change in agricultural revenue without rice (1000 VND)	1688.00 (21055.45) *748*	734.99 (10106.97) *1618*	1020.17 (14293.43) *2366*
Change in paddy land (m^2)	609.61 (7928.56) *626*	-29.00 (6210.20) *1423*	155.94 (6757.23) *2049*
Change in farm hours	-44.02 (1998.73) *690*	-167.50 (1709.71) *1416*	-129.09 (1805.03) *2106*
Change in fertiliser (1000 VND)	369.68 (2189.41) *760*	289.27 (1873.34) *1716*	312.68 (1970.51) *2476*
Change in seeds (1000 VND)	-19.21 (405.58) *695*	-8.83 (479.83) *1539*	-11.88 (459.17) *2234*
Changes in hired labour (1000 VND)	13.78 (1593.84) *790*	88.07 (1361.95) *1768*	66.31 (1433.85) *2558*
Change in hired capital (1000 VND)	-22.16 (1325.84) *790*	36.57 (1423.94) *1768*	19.37 (1395.93) *2558*
Change in livestock expenditure (1000 VND)	368.78 (8108.35) *819*	377.36 (9201.35) *1983*	374.97 (8909.27) *2802*

Notes: All means are conditional on mean being larger than zero; standard deviations are in parentheses; number of observations is in italics. All values are deflated to January 2004 prices; 1 USD=15,965 VND (2006); * Nonfarm households are defined as having at least one family member who participates in nonfarm activities (Haggblade et al. 2007);
Source: calculated from VHLSS 2004 and 2006.

Table 5.2 provides information on changes in rice production and inputs between 2004 and 2006. When this chapter compares the change in paddy production between two years, 2004 and 2006, in households that increased their participation in nonfarm activities, it can be noted that there are small but noticeable differences in summary statistics. Agricultural output among nonfarm households grew somewhat more slowly than that of farm households. When potential negative effects of labour movement into nonfarm activities are offset by the increased use of capital financed from nonfarm incomes, differences in paddy production between two groups of households may not be apparent in the descriptive statistics.

In addition, nonfarm households also appear to have reduced paddy land, which is opposite to the increasing trend for farm households. As the same time, nonfarm households decreased the farm labour input more than farm households, and used more capital and hired labour, while on average farm households appear to have decreased the amount of hired capital. However, these descriptive statistics do not account for inherent differences between farm and nonfarm households. The empirical analysis also control regional differences. All input and output variables are expressed in logarithms to minimize the impact of outliers.

5.4.3 Trends of nonfarm activities and income diversification in Vietnam from survey samples

Although agricultural production plays an important role and is undertaken by most households in rural Vietnam, many farm households augment incomes with a wide array of other productive activities such as wage labour within, or near local communities, or by migrating. Table 5.3 shows the percentage of nonfarm employment of rural individuals by industry and sector for the period 2004-2006. As can be seen in the table, rural households participated in diverse types of industries: Manufacturing, construction and trading were the main industries, accounting for over 65 per cent of employment in the nonfarm sector. Similarly, nonfarm wage employment was made mainly of nonfarm work, representing more than 67 per cent of nonfarm employment. In 2006, nonfarm self-employment (including household business) constituted approximately 32.3 per cent of total nonfarm employment.

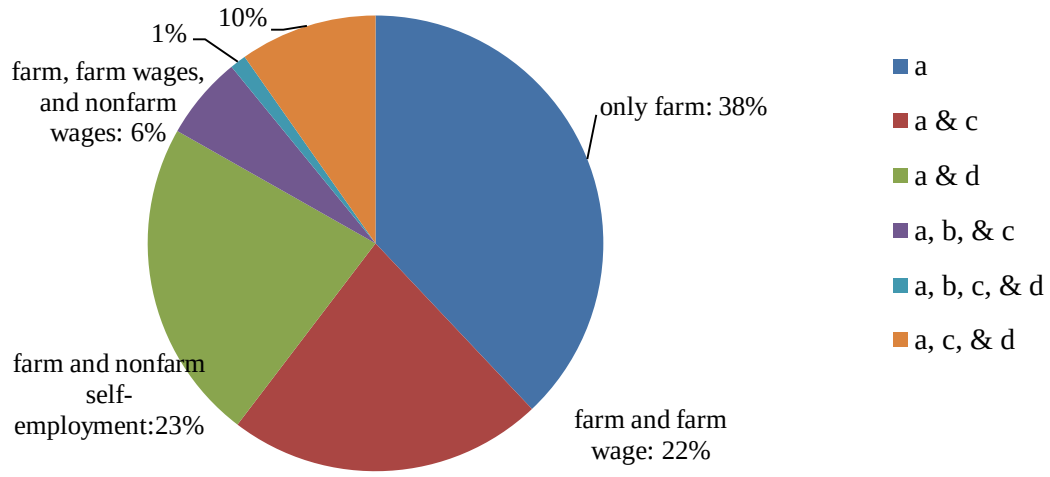
Table 5.3 **Percentage of rural individuals in nonfarm activities**

Variable	2004	2006
** By industries*		
Mining	2.20	2.11
Manufacturing	30.26	31.80
Construction	16.53	15.74
Finance and real estate	0.34	0.31
Government administration	5.61	5.68
Education, culture and science	9.11	8.23
Hotel, administration and services	4.67	4.37
Trading	20.27	22.10
Utility (electricity and water)	0.39	0.46
Transport and communication	5.97	4.62
Others	4.63	4.57
** By sectors*		
Wage employment	68.46	67.67
Self-employment	31.54	32.33

Source: calculated from VHLSS 2004 and 2006.

In this chapter, the household-level data are compiled using the amount of labour allocated to each of the following activities: (*a*) only farm, (*b*) farm wages, (*c*) nonfarm wages, (*d*) nonfarm self-employment. Based on these activities, Figure 5.1 introduces the patterns of labour allocation of a rural household, on average. Households relying only on farm work accounted for 38 per cent of the total, while households that combined own-farming with nonfarm wage work and nonfarm self-employment accounted for 22 and 23 per cent, respectively. Yet, nonfarm labour is clearly important for agricultural households: 62 per cent of households had one or more family members that were engaged in nonfarm activities (including (b), (c), or (d) in Figure 5.1).

Figure 5.1 **Trends of part-time farming in rural areas**



Notes: (a): farm; (b) farm wages; (c) nonfarm wages; (d) nonfarm self-employment
Source: calculated from VHLSS 2004 and 2006.

As found in many nonfarm studies, nonfarm labour in Vietnam tends to be younger and better educated than farm labour (Table 5.4). Family members have to divide their time between farming and nonfarm activities or spend all their time on nonfarm activities. Thus, part-time farming is one of the channels through which labour is moving out of agriculture (Weiss 1996). The younger and better-educated individuals may sustain success in nonfarm opportunities. It is, however, likely that farm households cannot leave agriculture entirely. As a result, household labour availability for nonfarm jobs is restricted. Furthermore, decisions regarding nonfarm participation may be constrained in regions with thin local job markets, or lack of funds or credit, to start nonfarm self-employment activities. If local nonfarm markets are not available, farmers have to migrate seasonally or permanently. In the panel data, there is more than one family member working in nonfarm activities, which are considered as the most time consuming jobs. Thus, agricultural production may be affected due to the reduction of farm labour and cash constraints.

Table 5.4 **Human capital statistics for household members between sectors, Vietnam, 2004 and 2006**

Variables (mean)	2004			2006		
	Nonfarm wages	Nonfarm self-employment	Farm	Nonfarm wages	Nonfarm self-employment	Farm
Male (%)	58.54	44.57	45.24	60.93	44.11	40.73
Education (years)	6.76	6.9	5.87	6.9	6.98	5.98
Experience (years)	17.88	21.75	22.11	21.52	27.66	28.09
Age	30.45	34.47	33.78	34.42	40.65	42.05
Share of working individuals (%)	35.45	17.9	46.65	41.21	21.8	37

Notes: Means in this table are calculated at the individual level. Education is measured by the number of years of school completed. Experience is measured by the formula: age minus years in school minus six (Mincer 1974).
Source*:* calculated from VHLSS 2004 and 2006.

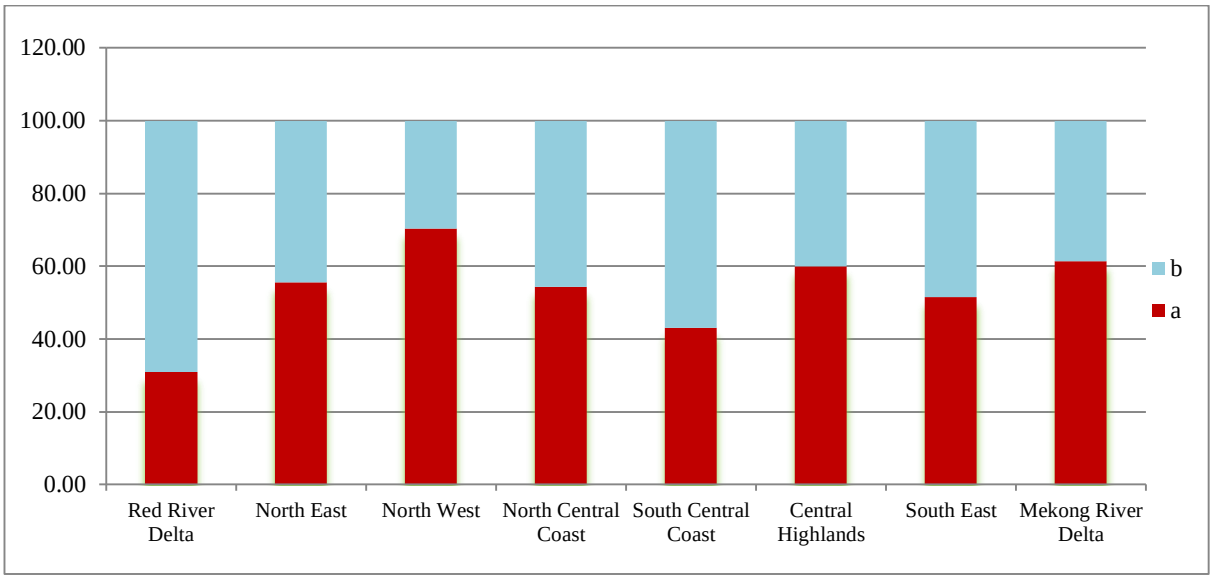
In addition to the need of further land reforms, there has been a structural change in rural Vietnam. An increasing number of households have abandoned agriculture or reduced agricultural production, and take part in the rural nonfarm economy. Figure 5.2 depicts the participation rate in nonfarm activities by farm households in eight regions in Vietnam. Regions in northern Vietnam suffer from higher land fragmentation than ones in the South. The Simpson index for the Red River Delta is 0.6, three times higher than the Simpson index for the Mekong River Delta. Interestingly, nearly 70 per cent of farm households in the Red River Delta have at least one member working in nonfarm activities, whereas, only 40 per cent of farm households in the South have extra nonfarm jobs. However, Figure 5.2 shows that farm households tend to diversify their incomes in light of increasing uncertainties in agricultural production.

While there are variations across regions, this study focuses on two regions: Northern Vietnam and Southern Vietnam.[57] Glewwe et al. (2004), and Minot and Goletti (1998) show the differences in agricultural production between these two regions. The Mekong River Delta is the largest rice-producing region in Vietnam - more than 50 per

[57] The North of Vietnam includes the Red River Delta, North East, North West and North Central Coast. The South of Vietnam consists of the Mekong River Delta, Central Highlands, South East and South Central Coast according to VHLSSs.

cent of rice output and more than 90 per cent of rice exports from this region (Pham et al. 2015). It should be noted that in 2006 rice land accounted for 82.58 per cent and 68.4 per cent of total agricultural land in the Red River Delta and Mekong River Delta, respectively (VHLSS 2006).

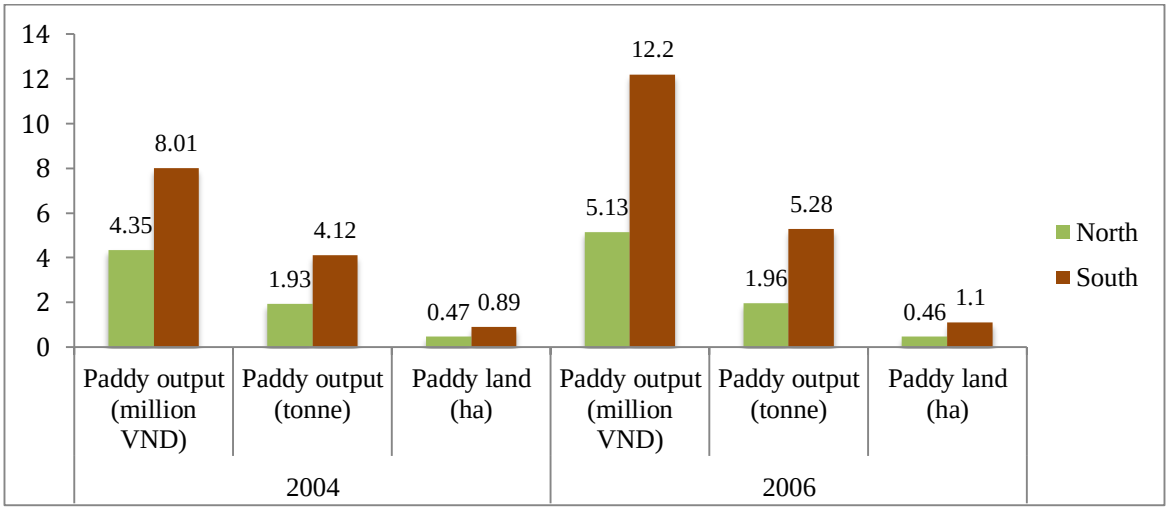
Figure 5.2 **The structure of two groups of households by regions from the VHLSS 2004-2006**



Notes: (a) Households working only on the farm; (b) Households with at least one member working in nonfarm activities;
Source: calculated from VHLSS 2004 and 2006.

In contrast, farm households in the North of Vietnam are smallholders and tend to diversify their livelihoods into nonfarm sectors (Minot 2006). Average rural farm households have 6.5 plots of land in the north and 3.4 plots in the south (World Bank 2006). As depicted in Figure 5.3 using the sample, the average paddy output per tonne and land of a farm household in the South are nearly three times higher than the ones in the North. Therefore, the impact of nonfarm participation on agricultural production is likely to be different.

Figure 5.3 **Differences in rice production of a farm household, North and South Vietnam**



Source: Author's calculation using VHLSS 2004 and 2006.

Table 5.5 below provides the information on incomes by farm size in the period 2004 - 2006. Clearly, households with smaller farm sizes are more engaged in nonfarm activities. In the survey sample, more than 60 per cent of rural households have a farm size that is less than 0.5 hectare. Nonfarm income represents the largest share of off-farm income of rural household in Vietnam. The share of total household income derived from nonfarm activities falls with farm size. In addition, among off-farm-incomes, nonfarm incomes are far much higher than agricultural wages. All categories of off-farm activities are relatively more important for households with fewer land assets. Thus, the ability to participate in nonfarm activities is fundamental for the land-poor. Many households with small farm sizes are more engaged to off-farm activities. Small landholding households have diversified their livelihoods in light of increasing costs of inputs and the declining trend of rice prices.

Table 5.5 **Sources of income in rural Vietnam by farm sizes, 2004-2006**

	<0.5 ha	0.5-1 ha	1-2ha	2-3ha	>3ha
Share in total incomes (%)					
Total farm incomes	35.33	62.12	71.39	76.53	78.72
Total off-farm incomes[58]	64.65	37.87	28.61	23.47	21.28
Nonfarm incomes	47.63	25.52	18.56	15.20	14.63
Nonfarm wages	29.93	16.92	12.91	9.78	9.77
Self-nonfarm incomes	17.67	8.59	5.64	5.42	4.86
Agricultural wages	1.70	0.77	0.81	0.41	0.12
Remittances	9.12	7.19	5.75	4.62	3.32
Public transfers	4.08	2.65	1.99	1.94	1.74
Others	2.15	1.74	1.49	1.30	1.47
Number of households (%)	61.44	17.17	11.84	4.64	4.91

Note: All incomes deflated to January 2004 prices
Source: Calculated from VHLSS panel data 2004-2006

Similarly, Table 5.6 provides information on sources of incomes by quintiles of real per capital expenditure in the period 2004-2006. For the middle and richest groups, off-farm incomes are more important than farm incomes. The richer the household is, the higher the share of nonfarm income. These results are consistent with the findings of previous studies shown in the literature review. For the poor groups in the sample, farming is the main activity. Agriculture emerges as the driving factor in determining the evolution of expenditure in poor groups. Nonfarm incomes only represent 28.29 per cent of the total income of the poorest households. Clearly, there is upward mobility in labour markets in rural Vietnam. When household incomes improve, households tend to move toward nonfarm activities. Haggblade et al. (2007) show that there are barriers for poor households to enter nonfarm activities due to constraints of education and assets. However, in the context of rural Vietnam, nonfarm employment contributes to improving the livelihoods of these households. Small farm sizes, land fragmentation and

[58] According to the questionnaire from VHLSS of 2004 and 2006, remittances are incomes from people who are not household members. Therefore, they are not considered as nonfarm incomes for rural households. Other incomes in this paper are income from education, health, and others from section 4D2 of the questionnaire. Nonfarm incomes are incomes that are collected from section 4A-Employment and section 4C2 respectively. The sum of all income except farm income is off-farm income. The VHLSS also collected information on the income obtained from nonfarm activities. Public transfers consist of income as pension, social insurance and unearned transfers received by households. Nonfarm incomes include wages from household members who migrated to other provinces and cities to work. Farm incomes include net income (total production value minus expenditures) from crops, livestock, forestry, and aquaculture.

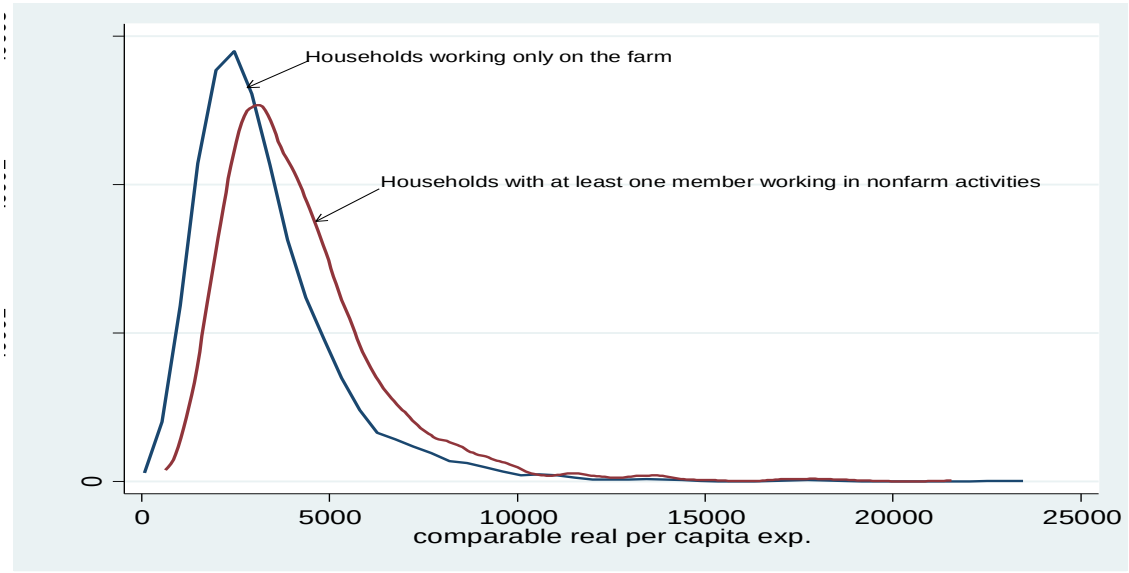
increasing costs of production are one of arguments explaining the "push" factor for the participation into nonfarm activities in rural Vietnam (Pham et al. 2010).

Table 5.6 **Sources of income in rural Vietnam, by quintile – real per capital expenditure, 2004-2006**

	Poorest	Poor-mid	Middle	Middle-upper	Richest
Share in total income (%)					
Total farm incomes	59.85	50.90	47.86	39.23	29.08
Total off-farm incomes	40.14	49.05	52.14	60.75	70.92
Nonfarm incomes	28.39	37.73	38.48	42.94	44.17
Nonfarm wages	23.79	24.24	22.07	24.08	25.11
Self-nonfarm incomes	4.59	13.44	16.40	18.84	19.06
Agricultural wages	2.24	1.25	0.70	1.03	0.84
Remittances	5.08	6.12	7.84	10.10	16.86
Public transfers	2.58	2.66	3.56	4.41	4.92
Others	1.87	1.34	1.57	2.29	4.13
Number of household (%)	22.69	24.24	23.44	19.88	9.74

Note: All incomes deflated to January 2004 prices
Source: Calculated from VHLSS panel data 2004-2006.

Figure 5.4 **The density function of real per capita expenditure of two groups of households**



Note: All expenditures deflated to January 2004 prices
Source*:* calculated from VHLSS 2004 and 2006.

Several studies have shown that participation in the rural nonfarm economy is positively correlated to household welfare (Haggbalde et al. 2007; Lanjouw and Lanjouw 2001). However, studies of the determinants of nonfarm participation indicate that rich households have better access to remunerative nonfarm activities (de Janvry & Sadoulet 2001). In the context of rural Vietnam, households with at least one member in a nonfarm activity have higher expenditure than ones with only farming activities (Figure 5.4).

5.5 Empirical results

This section provides the empirical results of the effect of nonfarm labour on household production choices in rural Vietnam. A series of regressions use first difference, and 2SLS with first difference. This section only reports the results of each method and evaluates the consistency of the empirical results. As regards the 2SLS method, two different groups of equations are estimated. All tests related to instrumental variables are also provided. The following analysis is carried out for the whole sample. Due to differences in agricultural production between Northern and Southern Vietnam, regional results are also introduced in this section. For brevity, full regression tables are presented in the Appendix of this chapter.

5.5.1 Results of first-stage regression

The first-stage results for the instrumented measures of nonfarm participation, reported in Table 5.7, are estimated using the first difference method. Using the communal surveys in 2004, the share of people working in nonfarm activities over the past 12 months measures the lagged nonfarm networks. As can be seen in Table 5.7, the coefficients of the instrumental variable is positive and statistically significant, which implies that the increase in the share of nonfarm networks at the communal level leads to an increase in the nonfarm participation of household members. The cluster corrected *F*-statistics testing the hypothesis that the coefficients on the instrument are zero exceed Stock and Yogo critical values for weak instruments. This chapter also considers a value of *F*-statistic above 10 from the test of joint significance of the instruments in the first-stage regression as essential to state that instruments are sufficiently strong.

Columns (2) and (4) are estimated without agricultural variables such as production inputs and unit values of rice as proxy of rice price. However, results are still consistent.

The results do not depend on whether or not agricultural variables are used in the sample. The lagged nonfarm network at communal level measured by the number of people participating in nonfarm activities in the commune (obtained from the commune level survey in 2004) identifies the nonfarm labour equation.

Table 5.7 **Results of first stage regression (2SLS)**

	Change in number of individuals in nonfarm activities		Change in the share of hours working in nonfarm activities	
Independent variables	(1)	(2)	(3)	(4)
Lagged nonfarm network at commune level, 2004	0.291*** (0.006)	0.291*** (0.006)	0.062*** (0.002)	0.062*** (0.002)
Agricultural variables (differenced)	Included		Included	
Household characteristics (differenced)	Included	Included	Included	Included
Commune characteristics	Included	Included	Included	Included
Regional dummies?	Yes	Yes	Yes	Yes
R^2	0.454	0.452	0.292	0.288
Number of observations	2801		2801	

Notes: Columns (1) and (3) refer to annual crop production; Columns (2) and (4) refer to crop expenses; Standard errors are robust through cluster option and in parentheses; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively; Full details of the estimation are presented in Appendix 5.3 in the Appendices of the chapter.

5.5.2 The effect of participation in nonfarm activities on rice production

Asian countries have undergone a rapid economic structural transformation in light of rising rural wages, (as described in Chapter 3). As a result, increasing part-time farming and the rural nonfarm economy may reduce rice production in a country characterized by small and fragmented landholdings. The existing empirical evidence in the literature, reviewed in Section 5.3, suggests that nonfarm participation may distort on-farm operations in the short-run and nonfarm incomes can reduce the negative impacts by investing in capital intensive and profitable cash crop production in developing countries. In Asia, agricultural production has been dominated by labour-intensive cultivation-based small farms, mainly relying on family labour (Hazell and Rahman 2014). In the case of the absence of efficient labour market and credit constraints, labour movement is likely to affect agriculture. This section mainly explores the effect of nonfarm participation on rice production in rural Vietnam.

Table 5.8 **The effects of nonfarm participation on rice output in rural Vietnam, 2004-2006**

Explanatory variables	Dependent variable: Rice output					
	The whole country		North		South	
	FD-OLS	FD-2SLS	FD-OLS	FD-2SLS	FD-OLS	FD-2SLS
1. Panel A						
Change in number of individuals in nonfarm activities	-0.001 (0.006)	-0.027** (0.011)	-0.004 (0.007)	-0.031** (0.014)	-0.007 (0.014)	-0.020 (0.02)
Tests of instruments						
DWH F-test, p-value		0.0041		0.004		0.296
F-statistics, excluded instruments		500.8		251.04		267.34
R^2	0.317	0.313	0.330	0.323	0.321	0.320
2. Panel B						
Changes in the share of hours working in nonfarm activities	-0.003 (0.015)	-0.128** (0.053)	-0.021 (0.024)	-0.163** (0.072)	-0.004 (0.026)	-0.082 (0.081)
Tests of instruments						
DWH F test, p-value		0.0035		0.0042		0.221
F statistics, excluded instruments		361.77		205.76		186.11
R^2	0.317	0.307	0.330	0.313	0.321	0.317
Number of observations	2801	2801	1649	1649	1152	1152

Notes: FD means first difference; Standard errors are robust through cluster option and in parentheses; Dependent variables are expressed in the log; All regional, household and communal variables, and rice price are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure as discussed in Section 5.3; ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively. Full details of the estimation are presented in Appendices A5.4-5.9 in the Appendices of the chapter.

Table 5.8 shows the results of OLS and 2SLS estimates of two separated equations on rice output. OLS estimation shows a statistically insignificant effect. However, the estimated coefficients with 2SLS for rice output find that an additional family member participating in nonfarm activities shows a negative and significant effect on rice production. According to Panel A, an additional household member working in the nonfarm sector reduces the household rice output by around 3 per cent between the period 2004 and 2006. As mean rice output in the sample is around 3561.9 kg per farm household per year, this result implies that a household may lose around 106.9 kg of rice. Although there is clear evidence of structural change in rural areas, the magnitude of impact on paddy production is small, illustrating weak evidence of the impact of labour movement into nonfarm

activities on paddy output. In Panel B, the measure of changes in the share of hours working in the nonfarm economy is selected. The 2SLS estimations find that a 10 per cent increase in the share of hours that family members work in nonfarm sectors reduces rice output by 1.28 per cent between 2004 and 2006. This finding is also consistent with Brennan et al. (2012) when authors used the Vietnam Agricultural Sector model to explore the impact of rural-urban migration on Vietnamese agriculture.

The effects of nonfarm participation are further decomposed into regional differences (Table 5.8). In the north, an additional family member in the nonfarm sector reduces paddy output by 3.1 per cent; and a 10 per cent increase in the share of working hours in nonfarm activities results in a reduction of 1.63 per cent in rice output. In contrast, in the south, there is no effect of labour movement into the nonfarm economy on rice production. One possible reason for this is that rice production is more labour-intensive in the north than in the south. Pingali et al. (1998) find that in 1995, farm households had on average 246 labour days per hectare per person in the Red River Delta versus 96 days in the Mekong River Delta. Similarly, there are significant differences in total on-farm working hours per household per year in the panel sample between regions. Thus, the reduction of on-farm family members may lead to a decrease in rice production in the north. The effects on agricultural inputs presented in the next section provide further explanation of this difference.

More interestingly, the magnitude of reduction in paddy output is smaller when compared with the previous study by De Brauw (2010) on seasonal migration. The impact on paddy production is consistent with other studies that found a decline of paddy output. De Brauw (2010) also finds that in Vietnam, an additional seasonal migrant is associated with between 29 - 39 per cent less rice production. This is a huge decline. In this study, if the participation in rural nonfarm activities and part-time farming are captured, the adverse impact on rice production is less severe. Moreover, the decline in rice output only occurs in the north, which has more land constraints to cope with than the south. These findings emphasize the importance of the development of the rural nonfarm economy in Vietnam's rural structural transformation.

5.5.3 The effect of nonfarm activities on agricultural revenue

One question is whether or not aggregate production or agricultural revenue in Vietnam has changed as a result of rapid rural transformation. If agricultural revenue reduces due to the participation in nonfarm activities by household members, households may move

away from agriculture. On the other hand, if there is no impact, or an increase in agricultural revenue, this implies that farmers may diversify their livelihoods, or crop mix to cope with the reduction of farm labour. Therefore, this section explores the impact of nonfarm participation on aggregate agricultural production measured by agricultural revenue.

As can be seen in Table 5.9, OLS estimations find a statistically insignificant impact on agricultural revenue in both Panels A and B. However, 2SLS estimations show statistically significant effects in the whole country, and the north samples. In Panel A of 2SLS, an additional family member in the nonfarm sector results in a reduction of agricultural revenue in the whole country by 4.8 per cent, and in the north by 5.3 per cent. As the mean agricultural revenue in the whole sample is around VND 15.17 million per year, this estimation implies that for the whole sample households lose around nearly VND 728,400 of their agricultural revenue due to labour movement into nonfarm activities. Similarly, the 2SLS estimations find that a 10 per cent increase in the share of hours that family members working in the nonfarm economy reduce total agricultural revenue in the whole country and the north sample by 2.24 per cent and 2.8 per cent between 2004 and 2006, respectively. Moreover, the different impacts between OLS and 2SLS show that the effects are statistically significant among farm households who keep nonfarm network availability. In addition, for the south sample, there is no impact of nonfarm participation on total farm revenue. One possible reason is that the impact of nonfarm participation on rice production in the south is economically no different from zero.

As regards non-rice agricultural revenue, the analysis show no evidence of a statistically significant effect of nonfarm participation on non-rice agricultural revenue in the whole sample and all regions - this suggests that some households are retaining their crop mix in response to nonfarm participation. Despite the statistical evidence, the effect of participation of family members in nonfarm activities on rice output is not strong - households appear to maintain and change to other crops. This explains why the effects of nonfarm participation are economically no different to zero. This empirical result is also consistent with the finding of previous study on seasonal migration in Vietnam (De Brauw 2010), which provides the evidence of growing more of crops other than rice in the north of Vietnam.

To sum up, in spite of the small decreasing amount compared to total agricultural revenue, the estimated coefficients of nonfarm variables are negative in all regions,

which implies that using the north sample farm households may shift out of agriculture as they begin to work in nonfarm activities. However, the empirical evidence shows that there is no impact on non-rice agricultural revenue. Therefore, it can be concluded that nonfarm participation in smallholder agriculture appears to be only substituted for rice production in the north of Vietnam, not in the south. Smallholder agriculture in the north is losing its comparative advantage. The significant impacts only occur among households that respond to nonfarm networks. This conclusion seems to contradict the target of the 'rice first' policy that keeps farm households continuing rice production.

Chapter 3 presents a system of supporting policies to encourage rice farmers to stay in agriculture and produce rice in Vietnam. However, the increasing trend of part-time farming and the expansion of the rural nonfarm economy is not complementary to rice production, particularly in the north of Vietnam. Hazell and Rahman (2014) and Wiggin et al. (2010) conclude that agriculture and the rural nonfarm economy are more complementary than is competition. This study shows that the complementary or competitive condition depends on the context in each country and region, in which land constraints play an important role. There are several possible explanations for the lack of impact on non-rice agricultural revenue in all regions. Nonfarm participation may enable farm households to overcome liquidity constraints in producing other more valued crops. Households can substitute family labour by spending on hired labour and capital. Furthermore, households may choose to leave labour-intensive producing rice to produce less labour-intensive crops. The next section examines household behaviour related to input usage when farm households participate in nonfarm activities.

Table 5.9 **The effects of nonfarm participation on agricultural, and non-rice agricultural revenue in rural Vietnam, 2004 and 2006**

Explanatory variables	Dependent variable: Total agricultural revenue						Dependent variable: Total non-rice agricultural revenue					
	The whole country		North		South		The whole country		North		South	
	FD-OLS	FD-2SLS	FD-OLS	FD-2SLS	FD-OLS	FD-2SLS	FD-OLS	FD-2SLS	FD-OLS	FD-2SLS	FD-OLS	FD-2SLS
1. Panel A												
Change in number of individuals in nonfarm activities	-0.013 (0.01)	-0.048*** (0.017)	-0.009 (0.009)	-0.053*** (0.016)	-0.014 (0.02)	-0.04 (0.036)	-0.014 (0.017)	-0.051 (0.032)	-0.019 (0.018)	-0.044 (0.035)	-0.01 (0.043)	-0.097 (0.065)
Tests of instruments												
DWH F test, p-value		0.012		0.0009		0.338		0.146		0.403		0.119
F statistics, excluded instruments		502.21		252.77		267.09		413.06		229.4		202.17
R^2	0.512	0.510	0.584	0.578	0.474	0.476	0.232	0.23	0.274	0.273	0.205	0.199
2. Panel B												
Changes in the share of hours working in nonfarm activities	-0.053 (0.034)	-0.224*** (0.08)	-0.018 (0.034)	-0.280*** (0.083)	-0.074 (0.058)	-0.166 (0.146)	-0.062 (0.059)	-0.236 (0.15)	-0.027 (0.063)	-0.230 (0.182)	-0.105 (0.113)	-0.389 (0.255)
Tests of instruments												
DWH F test, p-value		0.021		0.0017		0.473		0.176		0.246		0.236
F statistics, excluded instruments		361.86		206.32		186.93		319.07		192.99		155.16
R^2	0.512	0.507	0.584	0.566	0.475	0.476	0.232	0.229	0.274	0.270	0.206	0.199
Number of observations	2801	2801	1649	1649	1152	1152	2365	2365	1593	1530	835	835

Notes: FD means first difference; Standard errors are robust through cluster option and in parentheses; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure as discussed in Section 5.3; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively. Full details of the estimation are presented in Appendix 5.4-5.9 in the Appendices of the chapter.

5.5.4 The effect of nonfarm participation on agricultural inputs

The two previous sections explore the short-run impact when family members of farm households engage in nonfarm activities. In the case of smallholder agriculture with labour-intensive farming, labour movement or an increase in the household's working hours in nonfarm activities have negative impacts on agricultural production. However, small farms are likely to adapt to the shortage of farm labour and hours by investing in agricultural assets, and inputs, changing to less labour-intensive farming, spending cash on other crops or labour-saving inputs (Hazel and Rahman, 2014). Therefore, in the medium and long run, farm households can maintain or increase crop production. If there is no evidence of relaxing liquidity constraints, farm households move away from farming production (Taylor et al. 2003).

This section introduces two types of method that are similar to the tables in the previous sections. Table 5.10 presents the empirical results of changes in the number of individuals participating in nonfarm activities on agricultural expenditure. It only examines statistically significant coefficients, and finds evidence of the reduction in crop expenses in the north as a result of nonfarm participation. Moreover, expenditure on fertilisers, which accounts for nearly 40 per cent of the total cost of production, also decrease for the north sample in both OLS and 2SLS as a result of labour movement in nonfarm activities. This finding is consistent with the reduction in rice output and farm incomes of households in the north. There is no evidence of statistically significant effects for nonfarm participation on crop inputs for households in the south.

Regarding the effect of nonfarm participation on livestock expenditures, the point estimates are negative for the whole and the south samples in OLS and 2SLS estimations. An additional household member engaged in nonfarm activities results in the reduction of expenditures on livestock by 9.2 per cent for the whole sample, and 25.7 per cent for the south sample. Although the point estimates for the impact of nonfarm participation on livestock expenses are negative and large in the south, they are only statistically significant in 2SLS, which implies that the impacts on livestock spending are large among households likely to respond to the availability of nonfarm networks. In the case of households in the north, the effects on livestock expenses are economically no different to zero. Northern households still keep or switch to livestock sectors, instead of crop production.

Table 5.10 The effects of changes in number of individuals participating in nonfarm activities on agricultural inputs in rural Vietnam, 2004 and 2006

Agricultural inputs as dependent variables	FD-OLS			FD-2SLS		
	The country	North	South	The country	North	South
Crop expenditures	-0.008	-0.000	-0.018	-0.023	-0.007	-0.064
	(0.016)	(0.014)	(0.029)	(0.027)	(0.028)	(0.051)
Livestock expenditures	-0.017	0.026	-0.071	-0.092**	0.024	-0.257***
	(0.021)	(0.027)	(0.044)	(0.038)	(0.039)	(0.068)
Pesticides	0.008	0.033*	-0.026	0.005	0.027	-0.032
	(0.018)	(0.019)	(0.03)	(0.027)	(0.035)	(0.044)
Fertilizer	-0.021	0.005	-0.085	-0.03	-0.028*	-0.017
	(0.016)	(0.015)	(0.114)	(0.024)	(0.015)	(0.033)
Seeds	-0.03*	0.004	-0.014	-0.047**	0.03	-0.016
	(0.016)	(0.015)	(0.065)	(0.022)	(0.027)	(0.024)
Hired labour	0.001	-0.002	0.095***	0.008	-0.001	0.103**
	(0.01)	(0.008)	(0.034)	(0.017)	(0.017)	(0.042)
Hired capital	-0.014	-0.012	0.016	-0.017	-0.022	0.01
	(0.012)	(0.015)	(0.016)	(0.018)	(0.023)	(0.027)
Farm hours	-0.119***	-0.127***	-0.109***	-0.108***	-0.091***	-0.125***
	(0.011)	(0.023)	(0.023)	(0.025)	(0.034)	(0.033)
Agricultural service	-0.005	-0.006	-0.004	-0.005	-0.006	-0.002
	(0.004)	(0.004)	(0.007)	(0.003)	(0.004)	(0.005)

Notes: FD means first difference; Standard errors are robust through cluster option and in parentheses; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure as discussed in Section 5.3; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

This chapter also finds the evidence of relaxing liquidity constraints on crop production by allowing farm households to increase spending on the value of hired labour. The point estimates are all positive, which suggests that households in the south increase their spending on the value of hired labour. Table 5.10 shows that an additional family member working in the nonfarm economy results in an increase in the value of hired labour by 10.3 per cent in the 2SLS estimation. Thus, the substitution of hired labour for family labour may explain the evidence of small impacts of nonfarm participation on rice production and farm revenue for households in the south. These findings are robust with the results related to rice production associated with labour movement into nonfarm sectors in the chapter. The analysis also rejects the hypothesis investing in capital from farm households, as all estimated coefficients on hired capital are statistically insignificant. However, they do show

positive signs and an increasing trend, which can affect long-term production toward less labour intensive farming or labour-saving methods.

In addition, the estimates in Table 5.10 shows that one additional household member associated with nonfarm activities reduces the total number of farm households by over 10 per cent for both OLS and 2SLS, on average. Nevertheless, this reduction does not come at the expense of farm and non-rice farm revenue because the impact of nonfarm participation on non-rice farm revenue is statistically insignificant. These outcomes may arise while a labour surplus still exists in rural areas. Table 5.11 shows a similar pattern of impact when nonfarm participation is measured by the share of hours working on nonfarm activities.

Table 5.11 **Changes in the share of hours working in nonfarm activities on agricultural inputs, rural Vietnam, 2004 and 2006**

Agricultural inputs as dependent variables	FD-OLS			FD-2SLS		
	The country	North	South	The country	North	South
Crop expenditure	-0.069	-0.036	-0.104	-0.101	-0.094	-0.251
	(0.046)	(0.057)	(0.072)	(0.119)	(0.139)	(0.197)
Livestock expenditure	-0.238***	-0.112	-0.371***	-0.411**	0.117	-1.002***
	(0.06)	(0.069)	(0.130)	(0.165)	(0.193)	(0.256)
Pesticides	0.026	0.112**	-0.068	0.024	0.131	-0.119
	(0.054)	(0.05)	(0.081)	(0.121)	(0.174)	(0.174)
Fertiliser	-0.085*	-0.044*	-0.048	-0.136	-0.114*	-0.049
	(0.049)	(0.055)	(0.084)	(0.11)	(0.058)	(0.131)
Seeds	-0.075	0.014	-0.039	-0.209**	0.142	-0.021
	(0.047)	(0.055)	(0.069)	(0.096)	(0.135)	(0.023)
Hired labour	0.026	-0.005	0.104***	0.032	-0.003	0.409**
	(0.029)	(0.03)	(0.029)	(0.077)	(0.082)	(0.167)
Hired capital	-0.038	-0.042	0.037	-0.08	-0.109	0.044
	(0.037)	(0.043)	(0.049)	(0.079)	(0.114)	(0.107)
Farm hours	-0.791***	-0.897***	-0.688***	-0.473***	-0.447***	-0.471***
	(0.042)	(0.071)	(0.072)	(0.1)	(0.152)	(0.126)
Agricultural services	-0.009	-0.024	0.005	-0.02	-0.031	-0.008
	(0.012)	(0.017)	(0.014)	(0.014)	(0.021)	(0.02)

Notes: FD means first difference; Standard errors are robust through cluster option and in parentheses; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure (as discussed in Section 5.3); *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

5.5.5 The effect of nonfarm activities on rural household welfare

Most studies in Vietnam focus on the effect of nonfarm participation on poverty reduction and household expenditure (Van de Walle and Cratty 2004; Hoang et al. 2014). They conclude that nonfarm participation contributes to poverty reduction and an increase in household expenditure. However, no studies examine regional differences. Although the focus of this section is not new to the literature, its purpose is to verify previous findings, and contribute to the study of regional differences, and thus providing further understanding of household behaviour in spending nonfarm incomes on agricultural production.

Table 5.12 The effects of nonfarm participation on household welfare in rural Vietnam, 2004 and 2006

Explanatory variables	Dependent variables: Change in log of household's total real expenditure					
	The whole country		North		South	
	FD-OLS	FD-2SLS	FD-OLS	FD-2SLS	FD-OLS	FD-2SLS
1. Panel A						
Change in number of individuals in nonfarm activities	0.038*** (0.006)	0.054*** (0.014)	0.045** (0.008)	0.048*** (0.018)	0.03*** (0.008)	0.063*** (0.022)
Tests of instruments						
DWH F test, *p-value*		0.127		0.824		0.055
F statistics, excluded instruments		502.21		252.77		267.09
R^2	0.201	0.199	0.230	0.23	0.180	0.172
2. Panel B						
Changes in the share of hours working in nonfarm activities	0.089*** (0.02)	0.252*** (0.063)	0.118*** (0.027)	0.249*** (0.092)	0.056*** (0.027)	0.262*** (0.091)
Tests of instruments						
DWH F test, *p-value*		0.004		0.109		0.0092
F statistics, excluded instruments		361.86		206.32		186.93
R^2	0.197	0.181	0.225	0.219	0.176	0.148
Number of observations	2801	2801	1649	1649	1152	1152

Notes: FD means first difference; Standard errors are robust through cluster option and in parentheses; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure as discussed in Section 5.3; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively. See the appendix for full estimation.

As can be seen in Table 5.12, both OLS and 2SLS estimations find statistically significant effects of nonfarm participation on household expenditure in all regions. Using 2SLS method, this study finds that an additional family member participating in nonfarm activities increases household expenditure in the north and south by 4.8 per cent and 6.3 per cent, respectively. A similar pattern can be seen by using changes in the share of working hours in nonfarm activities. Households in the north sample appear to spend nonfarm incomes on consumption smoothing, whereas, in the south sample, nonfarm incomes not only smooth consumption, but also play a role in relaxing liquidity constraints on agricultural inputs, particularly the value of hired labour and capital. These findings emphasise rural diversification as an important strategy in improving household welfare and boosting agricultural production by absorbing any labour surplus and moving to less labour-intensive farming. However, this only occurs in regions that have fewer constraints on small and highly fragmented landholdings.

One question that has not been answered yet is why farmers in the north behave differently to those in the south. In this chapter, I argue that the differences in land constraints between two regions may explain the different effects of nonfarm participation on agricultural production. Otsuka et al. (2013) find that an increase in real wages, along with the absorption of labour into the nonfarm economy, has resulted in the substitution of labour by machines in agriculture. However, this process is less successful in a country that is constrained by small and fragmented landholdings. Household farm sizes in the north are, on average, smaller and more fragmented than in the south. Interestingly, Wiggins and Keats (2014) show that real wages in rural Vietnam increased by 55.37 per cent in the period 2005-2012. The increase in costs of hired labour in light of small and fragmented landholdings pushed rice farmers in the north to abandon or reduce rice production, or switch to other crops that require less labour-intensive farming (e.g. starchy crops, vegetables and annual industrial crops). Moreover, increasing costs of rice production consequently squeeze farm profits. In contrast, households in the south face fewer constraints on land so they are able to spend nonfarm income on hired labour, and thus apply less labour-intensive farming.

5.5.6 Further test of the consistency of empirical results using the matching technique

In order to validate the previous empirical results, this chapter also adopts a matching approach taken from labour market literature. As introduced in Section 5.3, the results

of this approach are obtained from statistical twin pairs of matched farm and nonfarm households. By applying the procedures outlined in Section 5.3, the common support includes 2,047 households out of a total of 2,801. Note that the focus is restricted to changes in agricultural production including rice production, farm revenue and crop expenditures, which is consistent with dependent variables in the previous sections.

Table 5.13 **The effects of nonfarm participation on rice production, farm revenue and household expenditures using the matching method, 2004 and 2006**

Dependent variables	Matching valued at means		
	The country	North	South
Paddy output	-0.038* (0.021)	-0.051* (0.027)	-0.084 (0.059)
Total agricultural revenue	-0.113*** (0.031)	-0.111*** (0.034)	-0.095 (0.038)
Total non-rice agricultural revenue	-0.044 (0.022)	-0.093* (0.049)	-0.006 (0.089)
Total real expenditure	0.097*** (0.02)	0.075*** (0.024)	0.126*** (0.035)

Notes: Standard errors are in parentheses; *, **, *** indicate that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

Tables 5.13 and 5.14 show the differences of agricultural outcomes valued at the means using the matching method. The empirical differences shown in these tables validate the findings of the OLS and 2SLS estimates. Thus, the results confirm the consistency about the sign and statistical significance of interested variables. The matching method finds statistically significant evidence of the effect of nonfarm participation on rice production. However, the significant impact appears to occur in the north of Vietnam (this is similar to the previous analysis). A similar pattern is also seen in the case of farm, non-rice agricultural revenue, and total real household expenditures. In the case of crop expenditures (presented in Table 5.14), matching results also find evidence of labour substitution and investments in less-labour intensive farming for rural households in the South, which would suggest that nonfarm participation is associated with higher expenditures on hired labour by 20.8 per cent and on capital by 7.5 per cent.

Table 5.14 **The effects of nonfarm participation on agricultural inputs using matching method, 2004 and 2006**

Dependent variables: Agricultural inputs	Matching valued at means		
	The country	North	South
Crop expenditure	-0.055 (0.037)	-0.116*** (0.04)	0.029 (0.077)
Livestock expenditure	0.064 (0.055)	0.036 (0.054)	0.079 (0.124)
Pesticides	0.073 (0.048)	0.075 (0.054)	0.076 (0.095)
Fertiliser	-0.071* (0.04)	-0.115*** (0.044)	-0.014 (0.081)
Seeds	-0.063* (0.036)	-0.06 (0.044)	-0.09 (0.065)
Value of hired labour	0.053* (0.028)	-0.045* (0.023)	0.208*** (0.068)
Value of hired capital	-0.011 (0.035)	-0.054 (0.041)	0.075* (0.065)
Farm hours	-0.089** (0.04)	-0.147* (0.077)	-0.125* (0.071)
Agricultural services	0.002 (0.008)	0.012* (0.007)	-0.02 (0.018)

Notes: Standard errors are in parentheses; *, **, *** indicate that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

5.6 Conclusions

The government currently gives priority to boosting the structural transformation, where labour and resources are reallocated from the agricultural sector to other sectors, where they can be used more productively and raise national productivity (Warr 2009). In addition, the government implement policies to ensure national food security, particularly rice self-sufficiency. However, these objectives appear to be in conflict. The movement of resources out of agriculture may reduce agricultural production and threaten sustained food security. In contrast, maintaining current rice self-sufficiency policy may slow down the process of structural changes and affect household welfare.

Given that there are few studies focusing on the linkages between farm and nonfarm sectors, and the complexity of the relationship between nonfarm participation and agricultural production, this study attempts to investigate the effect of labour movement into nonfarm activities and part-time farming on household production choices in rural Vietnam. By using a panel sample of farm households in VHLSS 2004

and 2006 surveys, the study offers a systematic approach to studying nonfarm impacts on household behaviour in agricultural production. It applies different methods, including OLS, 2SLS, and uses the matching technique to verify the consistency of the empirical results. The 2SLS estimation method uses nonfarm networks as instruments to identify the model.

There are three equations used in the estimations. The first equation investigates the impact of nonfarm participation on rice production (the most important annual crop in Vietnam). Second, the model of agricultural revenue and non-rice agricultural revenue provides evidence of a nonfarm impact on aggregate production. Third, the crop expense model looks for evidence of the relaxation of liquidity constraints on farm production. Finally, the effect of nonfarm participation on household expenditure is also examined in order to further understand household behaviour in spending nonfarm income.

The analysis in this chapter indicates that in rural Vietnam, nonfarm participation have higher returns than farming. It also contributes to improving household welfare. The analysis finds evidence that labour movement to nonfarm sectors reduces rice production. Moreover, aggregate agricultural production also declines significantly, and there are negative effects of labour movement into nonfarm activities on farm revenue. These findings suggest that, regardless of the level of agricultural market integration of farm households, nonfarm employment is more of a substitute than a complement to rice production. However, these conclusions are limited to the north of Vietnam. The chapter finds no evidence of the effects of nonfarm participation on non-rice agricultural revenue and livestock expenditure. That is, households that participate in nonfarm sectors in the north have readjusted their production structure by investing in livestock sectors and alternate crops that require less labour. The government has designed policies to encourage farmers to maintain and increase rice production. However, rice farmers are struggling to survive.

Similarly, labour movement into nonfarm activities has induced rice farmers in the south to maintain rice production by hiring more labour to substitute for family labour during the periods of peak labour demand, and by investing in more capital to facilitate less labour-intensive farming. This study finds that nonfarm incomes partially compensate for the labour reallocation effect by enabling more spending on hired labour and capital. This finding provides evidence that nonfarm incomes relax the

liquidity constraints on expanding crop production through purchased inputs, at least in the short run.

While the decline in agricultural revenue in the north suggests some level of substitution between farm and nonfarm income generation strategies, the stability in rice production at the national level, despite rapid rural structural change, brings welcome news to policy makers and their concern for food production in rural Vietnam over the decades. However, agriculture in the north is losing its comparative advantage as farm households reduce their investments in agriculture. The increasing trend in the north of abandoning paddy fields has raised concerns about agricultural production in the region. The findings of this study indicate that Vietnam should change its approach toward food security, particularly its rice self-sufficiency policy: food self-sufficiency does not imply food security (Warr 2014). Rice farmers with small and fragmented landholdings are struggling to survive and have to diversify. The abandonment of paddy fields in the north has caused the waste of scare resources because the current rice policy has blocked paddy land for conversion. As a result, the opportunity cost of rice production has increased in recent years.

Moreover, the difference in the empirical results between regions show that small and highly fragmented landholdings have become one of the largest constraints for agricultural development in Vietnam. World Bank (2006) shows that this problem is particularly severe in the north, where the average rural farm households has 6.5 plot of land, compared to the south, with an average close to 3.4 plots per household. If land constraints cannot be solved, agricultural production in the south may lose its comparative advantage in the future in light of increasing nonfarm employment and real rural wages. Warr (2014) shows that the most effective way to deal with food insecurity is to raise agricultural productivity. In this way, the conflict faced in carrying out the dual task of facilitating food security, and the promotion of economic structural transformation can be resolved by improving agricultural productivity through mechanization or less labour-intensive farming, this only be achieved by larger and less fragmented landholdings.

In Chapter 2, it was shown that land reforms are necessary for labour savings technologies and less labour-intensive farming. Constraints on land market, small landholding and land fragmentation are hindering farm households from investing more capital in farming. Thus, institutional reforms of land markets are important

because they break the vicious circle that traps small farmers when they apply more capital and mechanisation (Otsuka 2013). Rice production will be significantly reduced in the long run if progress in land reforms is slow. Therefore, land reform directed towards land consolidation is further investigated to verify these arguments.

In addition to land reforms, credit reforms and the encouragement of informal credit institutions could support farm households by relaxing their liquidity constraints and thus promoting investment in farm production in response to increasing labour movement out of farming. At the same time, the development of insurance markets in rural areas is also important in reducing risks in farming and encouraging investment in agriculture. If these reforms are successful, nonfarm incomes can be invested in expanding nonfarm activities and facilitating sustainable rural transformation. These topics will be areas for future research. This chapter offers some further policy implications. Given the role of the nonfarm economy in improving household welfare and having little effect on rice production, government should stimulate the development of the rural nonfarm economy.

While the present estimations indicate that nonfarm participation represents a move away from agriculture, this argument should be taken with care. A better picture of the situation requires further research in order to understand the behaviour of the remaining members in a family related to farm production (e.g. incentives to work less or more). Also, further research is needed to find the regional specific attributes that affect the impact. For example, the expansion of remittances from non-household members may conceivably crowd out existing rural nonfarm incomes from current household members, and thus reduce incentives to work. Notably, Becker (1974) and Barro (1974) argue that an increase in public transfers could also crowd out existing private transfers. All these arguments may contribute to the reduction of farm labour supply and nonfarm incomes. Although the coefficients of remittances and pubic transfers on farm labour supply are statistically insignificant in this study, the crowding out effects should be further investigated in future research. In addition, in the future, the long-term and permanent migration section, particularly the migration history needed to capture information on those non-household members who send remittances to local communities, should be surveyed in household living standard datasets in Vietnam. In this case, it is possible to evaluate the impact of migration and remittances on agricultural production simultaneously in the framework of NELM model.

Appendices of Chapter 5

Appendix 5.1 **Rural household characteristics by farm and nonfarm involvement status in Vietnam, 2004 and 2006**

	2004			2006		
Variable	Farm	Nonfarm	All	Farm	Nonfarm	All
Number of nonfarm labour	0	1.96	1.43	0	1.94	1.41
Nonfarm income (1000 VND)	0	9974.65	6220.1	0	12170.64	7571.47
Household size, people	4.25	4.58	4.46	4.08	4.53	4.36
Household members, 15 to 60 years	2.63	2.94	2.83	2.34	2.98	2.74
Dependency ratio (%)	0.39	0.35	0.36	0.43	0.33	0.37
Ethnic status of the head, 1 for majority	0.75	0.91	0.85	0.75	0.90	0.84
Age of the head of household, years	49.43	47.78	48.40	50.90	48.35	49.31
Marital status of the head, 1 for married	0.84	0.84	0.84	0.82	0.86	0.84
Mean education of working age men	3.30	4.14	3.85	3.45	4.16	3.91
Mean education of working age women	3.32	3.83	3.65	3.44	3.92	3.75
Head of household has primary education (dummy)	0.26	0.25	0.26	0.29	0.24	0.26
Head of household has lower secondary education (dummy)	0.31	0.36	0.34	0.29	0.39	0.35
Head of household has upper secondary education (dummy)	0.05	0.12	0.09	0.05	0.12	0.09
Head of household has university education (dummy)	0.01	0.02	0.01	0.00	0.02	0.01
Farm assets (1000 VND)	18275.2	16880.1	17416.5	20569.9	19120.9	19706.7
Nonfarm assets (1000 VND)	5516.0	9239.7	8025.7	5573.9	12494.6	10305.2
Non-productive assets (1000 VND)	2220.9	3145.6	2980.3	681.5	1993.7	1738.4
Income sources (%)						
Agriculture	78.74	38.16	53.44	75.40	35.41	50.62
Agricultural wages	0.00	3.90	2.44	0.00	2.99	1.85
Non-agricultural wages	0.00	27.44	17.09	0.00	30.80	19.00
Self-nonfarm incomes	0.00	18.44	11.49	0.00	18.76	11.71
Remittances	12.51	7.56	9.42	15.08	7.40	10.32
Transfers	6.75	3.38	4.67	7.23	3.36	4.82
Others	2.00	1.12	1.46	2.29	1.29	1.68

Notes: All summary statistics are conditional on positive values and deflated to January 2004 prices.
Source*:* calculated from VHLSS 2004 and 2006.

Appendix 5.2 **Summary statistics from panel sample**

Variables	Mean	Std. Dev.	Min	Max
Paddy (kg)	3561.94	6793	30	169128
Annual industrial products (kg)	181.43	344.82	1	6767
Starchy products (kg)	2051.16	6479.39	3	125000
Vegetables (kg)	507.94	1313.12	3	25200
Farm revenue (1000 VND)	10272.99	17405.56	16.59	532808.3
Seeds (1000 VND)	367.35	619.48	1.61	12168.2
Fertiliser (1000 VND)	1683.48	2957.61	4.03	58201.1
Pesticides (1000 VND)	469.72	1235.7	1.84	22322.1
Hired labour (1000 VND)	1058.1	3569.9	8.05	119792.6
Hired capital (1000 VND)	720.9	1479.03	9.66	42404.5
Annual land (m^2)	5129.83	7862.37	20	145800
Number of land plots titled	2.69	4.6	0	166
Farm hours (hours)	2437.1	1793.83	5	17420
Unit values of rice (1000 VND)	2.48	0.235	1.35	3.5
Household members, from 15 to 60 (years old)	2.78	1.3	0	10
Dependency ratio	0.37	0.24	0	1
Mean education of working age men (years)	3.88	2.32	0	16
Mean education of working age women (years)	3.7	2.37	0	16
Remittances (1000 VND)	2546.21	8354.1	6.45	241984.3
Transfers (1000 VND)	4214.3	5271.03	2.42	74890.3
Disasters in commune	1.34	1.27	0	7
Farm assets (1000 VND)	18186.5	58456.95	8.05	1862755
Nonfarm assets (1000 VND)	8862.2	40099.08	18.44	921744.1
Access to asphalt road	0.62	0.48	0	1
Having markets in commune	0.58	0.49	0	1
Land area irrigated in commune (%)	61.27	31.16	0.5	100
Number of household members who were born or had lived in urban areas	0.042	0.29	0	7
Number of people in commune participating in nonfarm activities	244.22	552.37	0	8414

Notes: All values and deflated to January 2004 prices. Hired capital includes land rental, rental of machinery, equipment, means of transport, and cattle for ploughing; 1 USD=15,965 VND (2006)
Source*:* calculated from VHLSS 2004 and 2006.

Appendix 5.3 **First stage regression**

	Change in number of individuals in nonfarm activities		Change in the share of hours working in nonfarm activities	
	(1)	(2)	(3)	(4)
Lagged nonfarm network at commune level, 2004	0.291***	0.291***	0.062***	0.062***
	(0.006)	(0.006)	(0.002)	(0.002)
Agricultural variables (differenced)				
Logarithm, annual land	0.02	0.007	-0.001	-0.005
	(0.042)	(0.037)	(0.015)	(0.012)
Number of land plots titled	0.001	0.000	0.002	0.002
	(0.002)	(0.002)	(0.001)	(0.001)
Logarithm, seed costs	-0.026		-0.002	
	(0.022)		(0.009)	
Logarithm, fertiliser costs	-0.013		-0.009	
	(0.024)		(0.01)	
Logarithm, pesticide costs	0.026		0.013	
	(0.021)		(0.009)	
Logarithm, value of hired labour	-0.004		-0.011	
	(0.033)		(0.011)	
Logarithm, value of hired capital	-0.014		-0.003	
	0.028)		(0.009)	
Logarithm, farm hours	-0.154***	-0.155***	-0.144***	-0.143***
	(0.018)	(0.019)	(0.008)	(0.008)
Household characteristics (differenced)				
Household members, from 15 to 60 years old	0.347***	0.345***	0.036***	0.035***
	(0.032)	(0.032)	(0.008)	(0.008)
Dependency ratio	0.669***	0.662***	0.018	0.021***
	(0.139)	(0.137)	(0.035)	(0.036)
Mean education of working age men	-0.002	-0.002	0.003	0.003
	(0.017)	(0.017)	(0.006)	(0.006)
Mean education of working age women	-0.009	-0.01	0.000	-0.000
	(0.015)	(0.015)	(0.005)	(0.005)
Logarithm, remittances	-0.011*	-0.011*	-0.006*	-0.006*
	(0.006)	(0.006)	(0.003)	(0.003)
Logarithm, transfers	0.025	0.026	-0.015	-0.012
	(0.05)	(0.05)	(0.017)	(0.016)
Disasters in commune	0.004	0.003	0.000	0.002
	(0.008)	(0.008)	(0.003)	(0.004)
Logarithm, farm assets	0.013	0.013	-0.003	-0.002
	(0.018)	(0.018)	(0.005)	(0.006)
Logarithm, nonfarm assets	0.01	0.011	0.004	0.004
	(0.03)	(0.03)	(0.028)	(0.01)
Commune characteristics	Included	Included	Included	Included
Regional dummies	Yes	Yes	Yes	Yes
Number of observations	2801	2801	2801	2801
R^2	0.454	0.452	0.292	0.288
F statistics, instruments	1127.08	1200.05	368.01	328.44

Notes: Columns (1) and (3) refer to rice production, agricultural income and total real household expenditure; Columns (2) and (4) refer to crop expenses; Standard errors are robust through cluster option; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

Appendix 5.4 **Effect of changes in nonfarm individuals on agricultural production using OLS estimates in rural Vietnam**

Explanatory variables	Paddy output	Agricultural revenue	Non-rice agricultural revenue
Change in number of individuals in nonfarm activities	-0.001	-0.013	-0.014
	(0.006)	(0.01)	(0.017)
Agricultural variables (differenced)			
Logarithm, annual land	0.144***	0.157***	0.211***
	(0.025)	(0.034)	(0.043)
Number of land plots titled	0.003**	-0.001	0.001
	(0.001)	(0.002)	(0.003)
Logarithm, seed costs	0.131***	0.113***	0.105***
	(0.017)	(0.015)	(0.03)
Logarithm, fertiliser costs	0.073***	0.478***	0.439***
	(0.011)	(0.026)	(0.037)
Logarithm, pesticide costs	0.047***	0.064***	0.077***
	(0.007)	(0.016)	(0.028)
Logarithm, value of hired labour	0.025**	0.059***	0.02*
	(0.012)	(0.017)	(0.048)
Logarithm, value of hired capital	0.127***	0.071***	0.013
	(0.017)	(0.011)	(0.026)
Logarithm, farm hours	0.003	0.041*	0.051*
	(0.009)	(0.02)	(0.029)
Logarithm, rice price (measured by unit value)	0.067***	0.057**	-0.152**
	(0.010)	(0.026)	(0.066)
Household characteristics (differenced)			
Household members, from 15 to 60 years old	0.015*	0.003	0.033
	(0.011)	(0.018)	(0.03)
Dependency ratio	-0.016	0.012	0.097
	(0.068)	(0.078)	(0.167)
Mean education of working age men	0.001	0.011	0.027
	(0.005)	(0.041)	(0.017)
Mean education of working age women	-0.003	0.003	0.019
	(0.005)	(0.008)	(0.016)
Logarithm, remittances	-0.003	0.003	0.016
	(0.003)	(0.006)	(0.01)
Logarithm, transfers	-0.016	-0.028	-0.057
	(0.013)	(0.03)	(0.056)
Disasters in commune	-0.008	0.002**	0.006
	(0.006)	(0.008)	(0.015)
Logarithm, farm assets	0.001	0.03	0.048**
	(0.008)	(0.018)	(0.023)
Logarithm, nonfarm assets	-0.001	0.004	0.026
	(0.012)	(0.012)	(0.035)
Communal characteristics	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Number of observations	2801	2801	2365
R^2	0.317	0.512	0.232

Notes: Standard errors are robust through cluster option; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure (as discussed in Section 5.3); *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

Appendix 5.5 **Effect of changes in nonfarm individuals on agricultural production using OLS estimates: northern Vietnam**

Explanatory variables	Paddy output	Agricultural revenue	Non-rice agricultural revenue
Change in number of individuals in nonfarm activities	-0.004	-0.009	-0.019
	(0.007)	(0.009)	(0.018)
Agricultural variables (differenced)			
Logarithm, annual land	0.158***	0.172***	0.202***
	(0.031)	(0.029)	(0.04)
Number of land plots titled	0.005**	0.002	0.006***
	(0.002)	(0.002)	(0.002)
Logarithm, seed costs	0.111***	0.161***	0.206***
	(0.015)	(0.022)	(0.035)
Logarithm, fertilizer costs	0.088***	0.427***	0.413***
	(0.013)	(0.03)	(0.043)
Logarithm, pesticide costs	0.047***	0.037***	0.081***
	(0.013)	(0.012)	(0.026)
Logarithm, value of hired labour	0.03*	0.054***	0.031
	(0.015)	(0.02)	(0.058)
Logarithm, value of hired capital	0.121***	0.069***	0.004
	(0.019)	(0.009)	(0.035)
Logarithm, farm hours	-0.002	0.029	0.022
	(0.013)	(0.018)	(0.03)
Logarithm, rice price (measured by unit value)	0.064***	0.038	-0.262***
	(0.013)	(0.034)	(0.058)
Household characteristics (differenced)			
Household members, from 15 to 60 years old	0.034**	0.024**	0.08***
	(0.016)	(0.011)	(0.026)
Dependency ratio	0.069	-0.051	0.246
	(0.096)	(0.082)	(0.184)
Mean education of working age men	-0.009	-0.01	0.001
	(0.008)	(0.009)	(0.02)
Mean education of working age women	-0.015**	-0.011	0.001
	(0.007)	(0.008)	(0.019)
Logarithm, remittances	-0.003	-0.000	0.005
	(0.004)	(0.003)	(0.008)
Logarithm, transfers	-0.024	-0.02	-0.08
	(0.017)	(0.034)	(0.067)
Disasters in commune	-0.009	0.011**	0.004*
	(0.007)	(0.007)	(0.015)
Logarithm, farm assets	0.007	0.043***	0.091***
	(0.01)	(0.013)	(0.026)
Logarithm, nonfarm assets	-0.022	0.009	0.038*
	(0.016)	(0.01)	(0.022)
Communal characteristics	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Number of observations	1649	1649	1593
R^2	0.330	0.584	0.274

Notes: Standard errors are robust through cluster option; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure (as discussed in Section 5.3); ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

Appendix 5.6 **Effect of changes in nonfarm individuals on agricultural production using OLS estimates: southern Vietnam**

Explanatory variables	Paddy output	Agricultural revenue	Non-rice agricultural revenue
Change in number of individuals in nonfarm activities	-0.007	-0.014	-0.01
	(0.014)	(0.02)	(0.043)
Agricultural variables (differenced)			
Logarithm, annual land	0.129***	0.133*	0.210**
	(0.034)	(0.07)	(0.093)
Number of land plots titled	0.001***	-0.004**	-0.005*
	(0.000)	(0.001)	(0.002)
Logarithm, seed costs	0.153***	0.063*	-0.058
	(0.036)	(0.033)	(0.059)
Logarithm, fertiliser costs	0.08***	0.516***	0.475***
	(0.022)	(0.039)	(0.071)
Logarithm, pesticide costs	0.067***	0.084***	0.058
	(0.013)	(0.027)	(0.044)
Logarithm, value of hired labour	0.021*	0.054**	0.01
	(0.022)	(0.025)	(0.053)
Logarithm, value of hired capital	0.113***	0.086***	0.034
	(0.024)	(0.019)	(0.048)
Logarithm, farm hours	0.009	0.057*	0.097*
	(0.013)	(0.031)	(0.05)
Logarithm, rice price (measured by unit value)	0.072***	0.077	0.015
	(0.026)	(0.059)	(0.192)
Household characteristics (differenced)			
Household members, from 15 to 60 years old	-0.009**	-0.024	-0.039
	(0.012)	(0.041)	(0.073)
Dependency ratio	-0.081	0.093	-0.157
	(0.081)	(0.22)	(0.347)
Mean education of working age men	0.013*	0.04*	0.071**
	(0.007)	(0.022)	(0.034)
Mean education of working age women	0.011	0.023**	0.051*
	(0.008)	(0.016)	(0.027)
Logarithm, remittances	-0.008	0.008	0.025
	(0.007)	(0.012)	(0.022)
Logarithm, transfers	-0.008	-0.031	-0.04
	(0.022)	(0.088)	(0.131)
Disasters in commune	0.000	-0.01	-0.004
	(0.008)	(0.014)	(0.022)
Logarithm, farm assets	-0.017	0.015	0.002
	(0.013)	(0.031)	(0.039)
Logarithm, nonfarm assets	0.035	-0.006	-0.004
	(0.021)	(0.034)	(0.095)
Communal characteristics	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Number of observations	1152	1152	835
R^2	0.321	0.474	0.206

Notes: Standard errors are robust through cluster option; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure (as discussed in Section 5.3); ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

Appendix 5.7 **Effect of changes in nonfarm individuals on agricultural production using 2SLS estimates: rural Vietnam**

Explanatory variables	Paddy output	Agricultural revenue	Non-rice agricultural revenue
Change in number of individuals in nonfarm activities	-0.027**	-0.048***	-0.051
	(0.011)	(0.017)	(0.032)
Agricultural variables (differenced)			
Logarithm, annual land	0.145***	0.157**	0.21***
	(0.019)	(0.026)	(0.039)
Number of land plots titled	0.003*	-0.000	0.002
	(0.002)	(0.002)	(0.003)
Logarithm, seed costs	0.128***	0.111***	0.103***
	(0.015)	(0.018)	(0.032)
Logarithm, fertiliser costs	0.072***	0.479***	0.443***
	(0.012)	(0.028)	(0.038)
Logarithm, pesticide costs	0.049***	0.065***	0.077***
	(0.01)	(0.015)	(0.026)
Logarithm, value of hired labour	0.026*	0.059***	0.02
	(0.014)	(0.016)	(0.04)
Logarithm, value of hired capital	0.125***	0.07***	0.014
	(0.014)	(0.013)	(0.032)
Logarithm, farm hours	-0.003	0.031*	0.041
	(0.01)	(0.018)	(0.031)
Logarithm, rice price (measured by unit value)	0.065***	0.062	-0.146
	(0.010)	(0.032)	(0.095)
Household characteristics (differenced)			
Household members, from 15 to 60 years old	0.029***	0.022	0.052
	(0.011)	(0.02)	(0.032)
Dependency ratio	0.038	0.061	0.158
	(0.053)	(0.079)	(0.152)
Mean education of working age men	0.001	0.012	0.028
	(0.006)	(0.009)	(0.018)
Mean education of working age women	-0.004	0.003	0.018
	(0.005)	(0.008)	(0.018)
Logarithm, remittances	-0.004	0.003	0.016
	(0.003)	(0.005)	(0.012)
Logarithm, transfers	-0.014	-0.024	-0.053
	(0.014)	(0.039)	(0.068)
Disasters in commune	-0.009*	0.001	0.005
	(0.005)	(0.007)	(0.013)
Logarithm, farm assets	0.002	0.03	0.046*
	(0.009)	(0.018)	(0.028)
Logarithm, nonfarm assets	-0.000	0.007	0.027
	(0.012)	(0.012)	(0.042)
Communal characteristics	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Number of observations	2801	2801	2365
R^2	0.313	0.510	0.23

Notes: Standard errors are robust through cluster option; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure (as discussed in Section 5.3); *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

Appendix 5.8 **Effect of changes in nonfarm individuals on agricultural production using 2SLS estimates: northern Vietnam**

Explanatory variables	Paddy output	Agricultural revenue	Non-rice agricultural revenue
Change in number of individuals in nonfarm activities	-0.031**	-0.053***	-0.044
	(0.014)	(0.016)	(0.035)
Agricultural variables (differenced)			
Logarithm, annual land	0.159***	0.173***	0.202***
	(0.023)	(0.025)	(0.041)
Number of land plots titled	0.005**	0.003	0.007**
	(0.002)	(0.002)	(0.003)
Logarithm, seed costs	0.111***	0.162***	0.208***
	(0.016)	(0.017)	(0.036)
Logarithm, fertiliser costs	0.088***	0.427***	0.413***
	(0.017)	(0.029)	(0.043)
Logarithm, pesticide costs	0.049***	0.04***	0.082***
	(0.013)	(0.013)	(0.027)
Logarithm, value of hired labour	0.029	0.054**	0.029
	(0.022)	(0.021)	(0.056)
Logarithm, value of hired capital	0.119***	0.067***	0.004
	(0.016)	(0.013)	(0.033)
Logarithm, farm hours	-0.011	0.019	0.016
	(0.013)	(0.017)	(0.033)
Logarithm, rice price (measured by unit value)	0.062***	0.042	-0.261***
	(0.011)	(0.034)	(0.090)
Household characteristics (differenced)			
Household members, from 15 to 60 years old	0.05***	0.045***	0.09***
	(0.014)	(0.015)	(0.031)
Dependency ratio	0.114	0.005	0.276
	(0.074)	(0.08)	(0.17)
Mean education of working age men	-0.009	-0.01	0.001
	(0.008)	(0.009)	(0.018)
Mean education of working age women	-0.016**	-0.012*	0.000
	(0.007)	(0.008)	(0.017)
Logarithm, remittances	0.002	-0.001	0.005
	(0.005)	(0.005)	(0.011)
Logarithm, transfers	-0.019	-0.015	-0.078
	(0.019)	(0.03)	(0.06)
Disasters in commune	-0.011	0.009	0.003
	(0.007)	(0.08)	(0.016)
Logarithm, farm assets	0.006	0.041***	0.089***
	(0.013)	(0.014)	(0.032)
Logarithm, nonfarm assets	-0.023	0.01	0.039
	(0.014)	(0.011)	(0.03)
Communal characteristics	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Number of observations	1649	1649	1530
R^2	0.323	0.578	0.273

Notes: Standard errors are robust through cluster option; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure (as discussed in Section 5.3); ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

Appendix 5.9 **Effect of changes in nonfarm individuals on agricultural production using 2SLS estimates: southern Vietnam**

Explanatory variables	Paddy output	Agricultural revenue	Non-rice agricultural revenue
Change in number of individuals in nonfarm activities	-0.02	-0.04	-0.097
	(0.02)	(0.036)	(0.065)
Agricultural variables (differenced)			
Logarithm, annual land	0.105***	0.133**	0.212**
	(0.033)	(0.057)	(0.084)
Number of land plots titled	0.002	-0.004*	-0.004
	(0.002)	(0.002)	(0.003)
Logarithm, seed costs	0.156***	0.059***	-0.073
	(0.029)	(0.036)	(0.055)
Logarithm, fertiliser costs	0.061***	0.518	0.478***
	(0.016)	(0.042)	(0.06)
Logarithm, pesticide costs	0.049***	0.083	0.056
	(0.015)	(0.028)	(0.047)
Logarithm, value of hired labour	0.028	0.055*	0.013*
	(0.019)	(0.022)	(0.055)
Logarithm, value of hired capital	0.131***	0.086	0.039
	(0.024)	(0.024)	(0.066)
Logarithm, farm hours	0.005	0.048	0.077
	(0.014)	(0.035)	(0.058)
Logarithm, rice price (measured by unit value)	0.074***	0.083	-0.043
	(0.021)	(0.059	(0.215)
Household characteristics (differenced)			
Household members, from 15 to 60 years old	-0.002**	-0.009	0.011
	(0.016)	(0.042)	(0.066)
Dependency ratio	-0.073	0.139	-0.009
	(0.072)	(0.153)	(0.285)
Mean education of working age men	0.011	0.042	0.073**
	(0.009)	(0.019)	(0.037)
Mean education of working age women	0.014*	0.022**	0.046
	(0.008)	(0.018)	(0.037)
Logarithm, remittances	-0.009**	0.008	0.024
	(0.005)	(0.01)	(0.023)
Logarithm, transfers	-0.004	-0.028	-0.032
	(0.025)	(0.092)	(0.137)
Disasters in commune	-0.007	-0.01	-0.004
	(0.008)	(0.014)	(0.023)
Logarithm, farm assets	-0.005	0.017	0.002
	(0.012)	(0.034)	(0.048)
Logarithm, nonfarm assets	0.028	-0.000	-0.000
	(0.019)	(0.024)	(0.092)
Communal characteristics	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Number of observations	1152	1152	835
R^2	0.320	0.476	0.199

Notes: Standard errors are robust through cluster option; Dependent variables are expressed in the log; All regional, household and communal variables are included in the models in each panel; All models differenced to remove unobserved fixed effects and estimated using instrument variables with IV-GMM procedure (as discussed in section 5.3); ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

Chapter 6

The effect of land fragmentation on labour allocation and the economic diversity of farm households*

"In the face of industrialization and increasing rural wages, technical changes and institutional innovations are key strategies to improve agricultural productivity and prevent the comparative advantage of agriculture from declining. Land reforms directed toward land consolidation, which results in increasing labour-saving farming and more mechanization, are important strategies in the long term during the transitional period form middle-income stage to high-income stage" (Policy proposition stated in Chapter 1)

6.1 Introduction

The development experience shows that the economic success of countries is accompanied by agricultural growth and economic structural change, where labour and resources are reallocated from the agricultural sector toward other sectors where they can be used more productively (Lewis 1954; Perkin et al. 2006; Warr 2009). Johnson (2000) notes that given the fixity of land, increasing the productivity of agriculture is necessary for both poverty reduction and the development of the nonfarm sectors. Many classical models analyse the role of agricultural productivity growth in releasing labour from agriculture and in generating demand for the output of nonfarm sectors (Johnson 2000; Haggblade et al. 2007). This raises the question as to whether Vietnam can release labour from agriculture in a way that improves productivity and brings about gradual changes in farm sizes, and the adoption of mechanized labour savings methods, rather than relying on potentially distorting subsidies, which prevent a further rapid widening of the gap between rural and urban areas.

Land reform through the reduction of land fragmentation (land consolidation) [59] is a determinant of the ease with which this objective can be achieved. Land consolidation

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[59]Land fragmentation is defined as the existence of a number of spatially separate plots of land, which are farmed as single units (McPherson 1982). Land consolidation is defined as an exchange of the land ownership and location of spatially scattered plots of farms to establish new landholdings with fewer plots (Oldenburg 1990, p. 183). In this chapter, land consolidation is considered a public policy, which is designed to address the problem of land fragmentation.

can facilitate the creation of competitive agricultural production arrangements by enabling farmers to have farms with fewer parcels that are larger and better shaped, and to expand the size of their holdings (Blarel 1992). The governments of many developing countries emphasise the role of research, public investments and credit programs in agriculture, as well as the promotion of mechanisation in order to improve productivity and poverty reduction. However, these policies may be hindered if the land holdings of households are too scattered and small (McPherson 1982). The analysis in Chapter 2 shows that small and fragmented landholdings result in a decline in the comparative advantage of agriculture in the face of rising rural wages. Thus, land reforms involving land consolidation programs play a vital role in agricultural productivity growth, and in increasing the application of less labour-intensive farming.

Several studies of agricultural growth show that the reduction of land fragmentation results in productivity gains in agriculture (Blarel et al. 1992; Wan and Cheng 2001; Hung et al. 2007; Kompas et al. 2012). As a result, land consolidation has policy relevance for governments in promoting agricultural productivity. Tan et al. (2008) conclude that land consolidation may release more labour for other sectors of the Chinese economy. Wan and Cheng (2001) reach the same conclusion for the Chinese farm households. These studies found evidence that land reforms such as land consolidation can facilitate structural transformation and agricultural productivity growth. If these findings are accurate, land consolidation not only improves agricultural productivity, but also reduces agricultural surplus of labour- one of the challenges facing Vietnam.

Policy makers in Vietnam are aware of these issues and have tried to address them through increasing land consolidation programs since 1998. The question is, however, whether or not this policy really works, and whether land consolidation may also foster labour allocation and economic diversification. This chapter examines whether the application of land consolidation reduces labour supply and induces labour reallocation in farm households. An understanding whether land reforms have had the desired impact, and the magnitude of any effects in shifting labour out of agriculture and bringing about rural transformation, is important in light of rising rural-urban inequality, and the need to enhance agricultural productivity in Vietnam.

The overall objective of this paper is, therefore, to test the validity of the above-mentioned areas in rural Vietnam, with a concentration on the role of land policies in facilitating the structural transformation. McCaig and Pavcnik (2013) show that no

study formally examines the impact of agricultural productivity growth on the "labour push" explanation for the observed movement of labour out of agriculture in Vietnam. In this chapter, land consolidation is used as a measure of agricultural technical change. The concept of technical change is discussed in Chapter 2.[60] The study also tests whether land consolidation is considered a factor-biased technical change, or a Hicks-neutral technical change. If land consolidation reduces farm labour, then factor-biased technical change should be considered. Conversely, if land consolidation increases farm labour, the Hicks neutral technical change should be selected. This argument is important in supporting the development of empirical models such as selection of functional forms related to land fragmentation.

To carry out the empirical tests, this chapter first develops a model for studying the effect of agricultural development through land consolidation. As discussed in Chapter 2, there is no unanimity in the theoretical literature on the effect of land reforms on labour allocation in a land-poor and labour-abundant country. The chapter expands a theoretical model developed by Jia and Petrick (2013) by capturing the land consolidation parameter that measures the efficiency of labour uses on the farm plot, and the ability to apply it to mechanisation in both rice production and factor-biased technical change. The theoretical model, thus, predicts that the effect of agricultural technical change through land consolidation on labour allocation depends on the factor biased technical change.

The chapter employs a panel data set of the Vietnam Household Living Standard Survey in 2004 and 2006 to explore the impact of land fragmentation on labour movements (via migration of nonfarm employment) out of agriculture and diversification. The empirical strategy includes using different methods to verify the consistency of the results, such as first difference; the double hurdle model; and the model of sample selection correction. There are two systems of equations, including the impact of land consolidation on nonfarm and farm outcomes.

This study contributes to the literature in several ways. First, this is apparently the first paper examining the joint treatment of two issues that have previously been treated separately: the effect of land consolidation on farm, nonfarm employment and incomes. Land consolidation has two separate effects: a direct agricultural productivity

[60] Technical change is defined as any change in production coefficients resulting from the purposeful resource-using activity directed to the development of new knowledge embodied in designs, materials, or organizations (Hayami and Ruttan 1985, p. 86).

effect that is the main focus of much of the empirical literature, and an indirect labour allocation effect that is the main interest of this study. Second, many studies in the literature focus on the impacts of land fragmentation on agricultural productivity, crop inputs and crop diversification, but this study discusses the linkages between land fragmentation and labour allocation, and economic diversity of farm households. Next, there is a further contribution to the current literature by taking into account the potential spillover effect of land consolidation as a "push" factor in the determinants of nonfarm employment and incomes after controlling human capital assets and locational factors. Finally, it provides a theoretical framework of linkages between agricultural technical change and labour allocation ignored in the earlier literature.

The rest of this chapter is organized as follows: Section 6.2 covers the literature review and summarizes previous studies which support the discussion of variables in the model. Section 6.3 introduces the theoretical framework and empirical methodologies. Section 6.4 analyses the data and variables. Section 6.5 describes the empirical results. Finally, conclusions are presented with a summary of the main findings.

6.2 Literature review

6.2.1 Agricultural growth, household labour allocation and structural transformation

Considering the determinants of labour allocation, to date, there are three strands of thoughts that trace this process. The first strand, focuses on the role of infrastructure and locational factors, and holds the views that labour moves toward the rural nonfarm economy in those areas where infrastructure is well developed (Haggblade et al. 2007; Isgut 2004). The second strand emphasises the importance of human capital and physical assets, which are well asserted in all studies related to the nonfarm sector (Fafchamps and Quisumbing 1999; Haggblade et al. 2007; Kijima and Lanjouw 2005). The final strand is the role of agricultural growth linkages, which emphasise that agricultural development resulting from technological advances, could spur the development of the nonfarm sector through many forward and backward linkages (Johnson 2000; Haggblade et al. 2007).

While many studies evaluate the effects of infrastructure and locational factors, human capital, and physical assets on poverty reduction, the third strand has not been explored

deeply. The agricultural growth linkage hypothesis postulates that modern agricultural technology propels the development of the nonfarm economy through production and consumption linkages (Haggblade et al. 2007). On the production side, improved agricultural technologies and land reallocation, which allows more mechanisation, may spur the birth and development of industries and service-related support to the agricultural sector. In addition, it releases rural workers to participate in nonfarm activities. On the consumption side, any increase in farm income brought about by increased agricultural productivity stimulates the consumption of locally produced nonfarm goods and services (Haggblade et al. 2007).

There is a long tradition in economics of studying this third strand. Schultz (1953) held the view that an agricultural surplus is a necessary condition for a country to start the development process and structural transformation. However, the view that agricultural productivity can support rural transformation has been challenged by many studies, which argue that high agricultural productivity can retard industrial growth as labour reallocates towards the comparative advantage sector (Field, 1978). Matsuyama (1992), for example, indicates that the growth of agricultural productivity can slow down structural change in open economies because labour reallocates toward the agricultural sector, which consequently reduces the size of the non-agricultural sector. In his model, there is only one type of labour, thus technical change is, by definition, Hicks-neutral. So, a new prediction emerges: when technical change is strongly labour savings, an increase in agricultural productivity leads to labour changes, even in open economies.

Similarly, Foster and Rosenzweig (2004 and 2008) find that growth of income from the nonfarm sector in rural India has been substantial and the primary source of this growth is not predicated on the expansion of agricultural growth. However, Johnson (2000) emphasises that increasing the productivity of agriculture is essential for both poverty reduction and the development of the non-agricultural sector. Although there have been many theoretical studies, empirical evidence testing these linkages is still rare, particularly using household survey data.

One that is close to this paper is the research of Foster and Rosenzweig (2004 and 2008) in rural India. The authors investigate the effect of agricultural growth as a result of the adoption of high yielding varieties (HYV) on economic diversification and income growth. They also verify the strong conclusion of Johnson (2000) that an increase in agricultural productivity leads to the development of non-agricultural sectors. Foster and

Rosenzweig (2004 and 2008) find evidence of the opposite: the substantial expansion of the nonfarm sector in India is not a result of from the growth of agricultural productivity. In this study, the theoretical model predicts that if the technical change is Hicks-neutral, an increase in farm productivity leads to greater farm labour intensity. Thus, the conclusion of Foster and Rosenzweig is consistent with the predictions in the theoretical studies, if they assume a Hicks-neutral technical change in their model.

6.2.2 The role of the reduction of land fragmentation in fostering income diversification, agricultural productivity, and nonfarm development

As regards the impact of land fragmentation on labour allocation and income diversification, there is a missing link in the literature. The main focus of the literature is the linkage between land fragmentation, farm sizes and farm productivity (or farm output). Many studies show that small and fragmented farm size hampers technology application, leading to more farm labour and higher costs for farming production, this in turn reduces productivity in agricultural production (Hung et al. 2004; Blarel et al. 1992; Bentley 1987). Similarly, McPherson (1982) and Bentley (1987) find that land fragmentation keeps labour on farms and increases farming labour supply. Wan and Cheng (2001) find that there is a significant impact of land fragmentation on agricultural production, which implies that the exogenous addition of one plot results in a reduction of annual crop output by 2 to 10 percentage points. Similarly, the analysis using a stochastic production frontier method shows a negative impact of land fragmentation on agricultural productivity in Bangladesh (Rahman and Rahman 2008).

In addition, the theory of inverse farm size and productivity is less effective if the effect of land fragmentation is controlled (Niroula and Thapa 2005). The authors claim that when landholdings are scattered, the increased costs not only undermine efficiency, but also result in unsuitable land utilization due to the adoption of selective and extractive strategies. Moreover, land fragmentation contributes to a weakening of the economic competitiveness of farm households, due to the increased costs of labour and other inputs (Tan et al. 2008).

There has been no study analysing the impact of land consolidation on economic diversification of farm households. In addition, studies in the literature do not provide a theoretical framework for their analysis related to the impact of land consolidation or agricultural technical change on labour allocation in a farm household. Jia and Petrick

(2013) show that the effect of scattered landholdings on the marginal product of labour and labour allocation is theoretically undetermined, despite the positive relationship between land consolidation and productivity. They also conclude that land consolidation makes on-farm work more attractive and thus decreases the off-farm labour supply in the case of China. However, the impact of land-consolidated policies on off-farm labour supply is statistically insignificant. Tan et al. (2008) state that fragmented landholdings cause higher labour costs in Chinese agricultural production. Wan and Cheng (2001) also find that more liberal land policies in China allowing land consolidation may reduce surplus labour in agricultural production.

In addition, previous studies have found that the reduction of land fragmentation improves agricultural technical efficiency (Hung et al. 2007; Rahman 2009). Similarly, McPherson (1982) finds that land fragmentation hinders any improvement in agricultural productivity. Given the continued decline in cultivated area, diminishing productivity, the prevalence of a labour surplus and continued increases in the costs of production, rural households' profitability in rice production is decreasing. Moreover, Wan and Cheng (2001) find that land fragmentation often results in problems of increased labour time, land losses, need for fencing, increasing transportation costs and restrictions to human, and machinery and irrigation access. Hence, the limit of technological application is likely a main disadvantage of land fragmentation.

In the case of Vietnam, previous studies mainly concentrate on the effect of land fragmentation on agricultural production. Markussen et al. (2013) provide a detailed analysis of inter and intra farmland fragmentation in Vietnam. They used a different sample – the Vietnam Access to Resources Household Survey of 12 provinces (VARHS) in 2008. They find that consolidating land has facilitated some types of mechanisation in farming activities, and greater agricultural productivity. Thus, land consolidation has the potential to increase agricultural output. Similarly, Hung et al. (2007) reach the same conclusion that less fragmented land holdings result in increased crop productivity. Kompas (2004) and Kompas et al. (2012), using farm survey data and VHLSS 2004, find that the reduction of land fragmentation improves technical efficiency in rice production in Vietnam. However, there has been no study on the impact of land fragmentation on labour allocation and the economic diversification of farm households in Vietnam. Moreover, previous studies do not investigate the mechanisms of labour allocation, and in particular the theoretical framework for this

allocation. This present study fills the gap by examining the impact of land fragmentation systematically, and by focusing on both nonfarm and farm outcomes.

6.3 Methodology

6.3.1 Theoretical framework

In order to characterise the process of labour allocation and economic diversification of farm households by land consolidation, this chapter develops a simple theoretical framework for investigating the impact of agricultural technical change on the marginal product of on-farm labour, and on labour allocation. The reduction of land fragmentation is hypothesised as an agricultural technical change, involves the rearrangement of plots and farming methods. Hayami and Ruttan (1985) emphasise that agricultural technical change is also linked to the development of new designs and organisations in agricultural production.

In Jia and Petrick (2013), the authors also develop a theoretical model and conclude that the effect of land fragmentation on agricultural productivity is theoretically determined. However, the effect of land fragmentation on labour allocation is theoretically undetermined. This chapter argues that the impact of land fragmentation on labour allocation can be theoretically determined. Instead of measuring the variable of land fragmentation directly, it begins by exploring the effects of agricultural development as a measure of agricultural technical change from Hayami and Ruttan (1985), which captures the process of land consolidation. This is a new approach in creating a theoretical framework to evaluate the relationship between land reforms and rural structural transformation. In addition, the model considers rural households who derive their livelihoods from agricultural production.

6.3.1.1 Theoretical research on the impact of agricultural technical change on labour allocation of farm households

As shown by both theoretical and empirical evidence, there is mixed evidence of the effect of agricultural technical change on labour use and allocation in the household. This is the main focus of this paper. In microeconomic perspectives, the marginal product of farm labour is a key factor influencing the labour allocation process. The chapter starts an output function $Y(L, A, \theta)$, where L denotes labour, A is a vector of other factors of production, and θ is a vector of technologies. Acemoglu (2010) shows

that technology is strongly labour savings if an increase in θ reduces the marginal product of labour.

Because the focus is on labour reallocation due to the impacts of agricultural technical changes, the model considers two kinds of production function: Cobb-Douglas, and CES, *y=f(L,A),* (this is the same type of model used by Benjamin (1995) and Urdy (1996)). The technical parameter in the function is introduced to evaluate its impacts on the marginal product of farm labour, $y=\alpha_1 f(L,A)$ (Hicks-neutral technical change), $y=f(\alpha_2 L,A)$ (labour augmenting technical change like the approach of Jia and Petrick (2013)), and $y=f(L,\alpha_3 A)$ (land augmenting technical change). McMillan et al. (1989) use the same approach, with α defined as the effort of farmers due to institutional reforms and αL is measured as efficiency units. This model is Hicks factor-biased labour augmenting.

This chapter starts the CES production function, which is based on the specification developed by Acemoglu (2010) and Bustos et al. (2013), the model extends the production function as follows:[61]

$$Y = \alpha_1 \left[\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}} + (1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \qquad (6.1)$$

where Y denotes the production of agricultural product. There are two input factors, labour (L) and land (A); α_1 represents Hicks-neutral technical changes; α_2 labour augmenting technical changes; and α_3 is land or capital augmenting technical changes. The parameter α_2 is the same approach used by Jia and Petrick (2013). The share parameter$\gamma \in (0,1)$ and the parameter σ measure the elasticity of substitution between labour and land. If $\frac{\sigma-1}{\sigma}$ approaches to zero, it results in the Cobb-Douglass production function.

Marginal product of labour (*MPL*) is measured by differentiating the agricultural production function (Equation 6.1) with respect to labour:

$$MPL = \frac{\partial Y}{\partial L}$$

[61] The main development of my model compared with that used by Acemoglu (2010) and Bustos et al. (2013) is the introduction of an agricultural technical parameter. In addition, I analyse the cases of technical change using details that have been ignored in previous studies. I also develop further the condition of labour savings as described in Acemoglu (2010). Technology is strongly labour savings if technological change reduces the farm marginal product of labour. This condition only holds if there is a low enough elasticity of substitution, as shown in Equation (6.5).

$$MPL = \alpha_1 \left[\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}} + (1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}-1} \gamma L^{\frac{\sigma}{\sigma-1}-1} \alpha_2^{\frac{\sigma-1}{\sigma}}$$

Set $\omega = [\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}} + (1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}]$

Then I have: $MPL = \alpha_1 [\omega]^{\frac{\sigma}{\sigma-1}-1} \gamma L^{\frac{\sigma}{\sigma-1}-1} \alpha_2^{\frac{\sigma-1}{\sigma}}$

The ratio of marginal product of land to marginal product of labour is:

$$\frac{MPA}{MPL} = \frac{1-\gamma}{\gamma}\left(\frac{\alpha_3}{\alpha_2}\right)^{\frac{\sigma-1}{\sigma}}\left(\frac{A}{L}\right)^{\frac{1}{\sigma}} \qquad (6.2)$$

Therefore, if labour and land are complements in agricultural production ($\sigma<1$), then labour augmenting technology which increases in α_2, will raise the marginal product of land relative to labour. Similarly, technical change is labour savings if it decreases the *MPL*. The model now evaluates the impact of agricultural technical changes on the farm marginal product of labour and labour allocation in the household, under two types of technical change. This chapter mainly focuses on Hicks-neutral technical change and labour augmenting technical change, both of which are relevant to Vietnamese context.

Hicks neutral technical change[62]

This study extends the approach of Jia and Petrick (2013) by introducing the case of Hicks neutral technical change. This is the same type of functional form developed by Lau and Yotopolous (1971) in their discussion of technical efficiency. The Cobb-Douglas production function has been used extensively in the literature and has the property of Hicks neutral technical change with a unity elasticity of substitution. Thus, under the Cobb-Douglas production function, productivity is always Hicks neutral, i.e. improvements in productivity do not affect the relative marginal products of land and labour and so do not alter the relative allocations of the factors (Acemoglu 2010; Raval 2011). In case of the Cobb-Douglas production function, the increase in agricultural productivity has a positive impact on the *MPL* and thus slows down the process of labour transformation.

[62] The technical progress is classified as Hicks neutral if the ratio of marginal products remains unchanged for a given factor input ratio (Hicks 1963).

Using the assumption of Hicks neutral technical change, agricultural technical change affects production processes rather than a particular input. It adds to the production process through its effects on productive efficiency (Wan and Cheng, 2001). The increase in α_1 toward unity means greater productivity, and this results in an increase in the farm marginal product of labour, because: $\frac{\partial MPL}{\partial \alpha_1} > 0$. As a result, less farm labour is released to other sectors.

If Hicks-neutral technical change is applied in agricultural production, then $\frac{\partial MPL}{\partial \alpha_1} > 0$, and I have:

$$\frac{\partial MPL}{\partial \alpha_1} = \left[\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}} + (1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}-1} \gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}-1}\alpha_2 > 0$$

where $\gamma \in (0,1)$, and $\alpha_2>0$, $\alpha_3>0$; L and A are positive.

Labour augmenting technical change

The impact of agricultural technical change depends on the elasticity of substitution. If the elasticity of substitution meets the conditions in Equation (6.3), labour augmenting technical change is strongly labour savings (Acemoglu 2010). Benjamin (1995) shows that if the elasticity of substitution is low enough, and labour's share is high enough, factors that improve productivity (such as better land quality) could decrease labour uses. This would happen because less labour (L) is required to achieve the optimal amount of effective labour ($\alpha_2 L$).

In the case of labour augmenting technical change, the expression: $\frac{\partial MPL}{\partial \alpha_2} < 0$ if and only if the condition in Equation (6.3) is satisfied, or the elasticity of substitution is low enough.[63] Thus, we have:

$$\frac{\partial MPL}{\partial \alpha_2} = \alpha_1\omega^{\frac{\sigma}{\sigma-1}-1}\gamma L^{\frac{\sigma-1}{\sigma}-1}\alpha_2^{\frac{\sigma-1}{\sigma}-1}\frac{\sigma-1}{\sigma} + \alpha_1\omega^{\frac{\sigma}{\sigma-1}-2}\left(\frac{\sigma}{\sigma-1}-1\right)\gamma L^{\frac{\sigma-1}{\sigma}}\alpha_2^{\frac{\sigma-1}{\sigma}-1}\frac{\sigma-1}{\sigma}\gamma L^{\frac{\sigma-1}{\sigma}-1}\alpha_2^{\frac{\sigma-1}{\sigma}}$$

$$\frac{\partial MPL}{\partial \alpha_2} = \alpha_1\omega^{\frac{1}{\sigma-1}}\gamma L^{\frac{-1}{\sigma}}\alpha_2^{\frac{-1}{\sigma}}\frac{\sigma-1}{\sigma}\left[1 + \frac{1}{\sigma-1}\omega^{-1}\gamma(\alpha_{2L})^{\frac{\sigma-1}{\sigma}}\right]$$

where $\omega = [\,\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}} + (1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}]$

[63]See Appendix 6.1 for further mathematical proof.

If σ<1 and $\frac{\sigma-1}{\sigma} < 0$, then $\frac{\partial MPL}{\partial \alpha_2} < 0$ if and only if $\left[1 + \frac{1}{\sigma-1}\omega^{-1}\gamma(\alpha_{2L})^{\frac{\sigma-1}{\sigma}}\right] > 0$. This condition only holds when σ satisfies the condition in Equation (6.3) as follows:

$$\sigma < \frac{(1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}}{\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}} + (1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}} < 1 \qquad (6.3)$$

Empirical predictions

The theoretical framework predicts that a Hick-neutral increase in agricultural productivity slows the labour allocation toward nonfarm sectors. However, if the condition in Equation (6.3) is satisfied, then technical change is strongly labour savings, and there will be a reduction of labour demand in farm production. Hence, the predictions of the theoretical model show that the impacts of agricultural productivity on labour allocation are subject to the factor-biased technical change. As a result, the effect of land fragmentation on labour allocation can be theoretically determined.

In this chapter, the prediction of the theoretical framework is tested by investigating the impact of the reduction of land fragmentation on nonfarm and farm outcomes, such as labour supply and profits. To hypothesise the effects of different agricultural technical changes on household's labour allocation, a model based on Jia and Petrick (2013) is developed.[64] In Jia and Petrick (2013), an exogenous land consolidation parameter $\alpha \in (0,1)$ is introduced. This parameter captures the efficiency of labour use on the plot. If α is closer to unity, the farmer spends more time on farming activities. Conversely, if α is closer to 0, more time is spent on travelling due to scattered plots and the distance from home to plots, or on other unproductive activities such as difficulties in water management and mechanisation of agricultural production (Blarel et al. 1992; Tan et al. 2008; Wan and Cheng, 2001; Hung et al. 2007). The negative effects of land fragmentation on productivity are analysed deeply in the literature review of this paper. Because of land fragmentation problems, there is a reduction in the productive labour used in agricultural production. Jia and Petrick (2013) introduce the production function, $Y = f(\alpha L, X)$, where αL is the level of effective labour.

[64] The main development of the model compared with that used by Jia and Petrick (2013) are the arguments and discussion related to production functional forms and elasticity of substitution, which can determine the effects of land fragmentation on the marginal product of farm labour. In addition, it further develops the labour optimization problem under an imperfect land market.

Nevertheless, Jia and Petrick (2013) argue that the impact of land fragmentation on the marginal product of labour is theoretically undetermined when taking the partial derivative of the labour augmenting production function with respect to farm labour, *L*. This study provides a different view. Based on the framework of the level of effective on-plot labour in the presence of land fragmentation, the effects of land fragmentation on the marginal product of farm labour can be determined by showing a clear production function and with the assumptions of the elasticity of substitution, and of technical changes.[65] I extend the model by capturing the land consolidation parameter α. All cases, including Hicks neutral, labour augmenting and land augmenting technical change, have the same property that is, more land consolidation leads to more agricultural output. What differs between the models is the way in which the relative marginal products of land and labour are affected, and these in turn affect the labour allocation in the household.

As shown in many studies, land consolidation enables farmers to mechanise and save time. Therefore, this technology is characterised as labour-augmenting technical change. Wan and Cheng (2001) test the non-neutral effects of land fragmentation. They are unable to reject the hypothesis of non-neutral effects. The impacts on labour allocation depend on the elasticity of substitution between labour and land. If land and labour are complementary and meet the condition of equation (5), then land consolidation is expected to reduce labour intensity in agricultural production, and more labour allocation toward nonfarm activities.[66] However, if the complementarity between land and labour is weak, the prediction is opposite. Before testing the predictions, the chapter develops the framework for empirical studies and model specifications in the next section. When the empirical evidence shows that policies toward more land consolidation will release farm labour to other sectors and reduce labour intensity, it can be concluded that Hicks non-neutral technical change plays an important role in the relationship between the growth of agricultural technical change and the economic diversification of farm households in rural Vietnam.

[65] The idea of the elasticity of substitution originated from Hicks (1963) in "The Theory of Wages". Elasticity of substitution is defined as the elasticity of the ratio of two inputs to a production function, with respect to the ratio of their marginal products. It measures how easy it is to substitute one input for another.

[66] See Acemoglu (2010) for further discussion about labour savings.

6.3.1.2 Model framework for the impact of land fragmentation on labour allocation and economic diversification

This chapter begins by presenting a theoretical framework for a farm household's optimal labour allocation to main activities. I extend the approach of Jolliffe (2004)[67] and consider the household's resource allocation problem as:

$$\underset{L_{a,t},\, A_{k,t}}{\text{Max}}\; U[\bar{L}]\left(X_{h,t}\right) - \sum_a L_{a,t}\,, \sum_a Y_a(L_a\,, A_{k,t}, \alpha_t, X_t, LF, \varepsilon_{a,t})] \qquad (6.4)$$

subject to $\bar{L} \geq \sum_a L_a, L_a \geq 0, A = \sum_k A_k = \bar{A}\,, a = f(farm), nf(nonfarm)$

Here *U(.)* is the farm utility function in the period *t* over leisure ($\bar{L}(X_h) - \sum_a L_a$), and restricted profits (income minus cost of inputs). The restricted profits are a sum of profits from two activities: farm (*f*) and nonfarm (*nf*). Profits from these two activities are a function of household endowments such as assets, education and access to infrastructure, *X*, household labour supply, L_a, allocated to farm and nonfarm activities. A_k is the land use of different annual crops, and is constrained by the total endowment of land, along with locational factors such as infrastructure conditions, *LF*. Household labour supply depends on household characteristics, X_h. The number of plots, or the Simpson index, measures the land consolidation parameter, α_t. Random shocks to production are defined as ε_a.

If labour and land markets are perfect, then Equation (6.4) leads to a separable decision between production and preferences (Singh, Squire, and Strauss 1986). The marginal product of farm and nonfarm activities equates market wages exogenously. However, many studies show that perfect labour and land markets are rarely found in developing countries (Benjamin 1992; Urdy 1996; Jolliffe 2004). Le (2009) also rejected the perfect market assumption in the sample of Vietnamese farmers when he estimated the labour supply function in rural Vietnam. The land markets also have the same pattern (World Bank 2006). Therefore, in the case of incomplete labour and land markets, de Janvry et al. (1991), and Skoufias (1994) show that household labour is allocated such that the marginal product of labour is equal to endogenous shadow cost of labour, *w**.

[67] Jolliffe (2004) uses the same model to measure the effects of education on labour allocation, and profits in farm and off-farm activities in Ghana. The main development of my model compared with that used by Jolliffe (2004) is the introduction of land fragmentation by adding more land consolidation parameters such as the Simpson index or the log of plots.

The household labour supply can be formed by identifying the factors that affect *w** in the case of utility maximization.

We have:

$$\frac{\partial Y_{a,t}(L_{a,t}, A_{k,t}, \alpha, X_t, LF_t, \varepsilon_{a,t}}{\partial L_{a,t}} = w_t^* \quad (6.5)$$

The allocation of family labour to farm and nonfarm activities thus depends, through *w**, on household characteristics and other factors that affect profits (de Janvry et al. 1991). The reduced form of household labour supply into farm and nonfarm activities is as follows:[68]

$$L_a = f\big(X_t, A_{k,t}, \alpha_t, LF_t, \varepsilon_{a,t}\big) a = f, nf \quad (6.6)$$

Substituting equation (6.6) into farm and nonfarm profit functions, we have:

$$Y_{a,t} = f\big(L_a^*(X_t, A_{k,t}, \alpha_t, LF_t, \varepsilon_{a,t}\big), X_t, A_{k,t}, \alpha_t, LF_t, \varepsilon_{a,t}) \quad (6.7)$$

and

$$Y_{a,t} = f(X_t, A_{k,t}, \alpha_t, LF_t, \varepsilon_{a,t}) \quad (6.8)$$

The addition of the profit function from each activity into a single household profit function yields:

$$Y_t = f\big(L_a^*(X_t, A_{k,t}, \alpha_t, LF_t, \varepsilon_{a,t}\big), X_t, A_{k,t}, \alpha_t, LF_t, \varepsilon_{a,t}) \quad (6.9)$$

Therefore, Equation (6.6) measures the extent to which land fragmentation affects labour allocation between farm and nonfarm activities. Similarly, Equation (6.8) measures the direct effect of land fragmentation on farm and nonfarm income. These equations thus guide the framework for econometric specification.

[68] X_t includes household characteristics, X_h. Benjamin (1992) shows that if X_h can have a significant impact on sectoral choice, then this finding can provide evidence of an incomplete labour market and the separable assumption can be rejected.

6.3.2 Empirical models

The purpose of empirical models is to address the issue of whether agricultural technical change, resulting from the reduction of land fragmentation, actually leads to labour allocation and economic diversity in farm households in rural Vietnam. This study design allows us to examine whether exogenous shocks to crop productivity lead to changes in labour allocation and the economic diversification of a farm household. This step permits us to characterise the factor biased technical change (as shown by Wan and Cheng (2001)). Previous studies show the role of the reduction of land fragmentation on farm productivity and the improvement of technical efficiency. This section studies the effect of land fragmentation on labour allocation and economic diversification, including the participation in the rural nonfarm economy in Vietnam, and the importance of land consolidation to the allocation of labour into a higher return activity.

For this purpose, the study first estimates two reduced forms of farm and nonfarm labour supplies from Equation (6.6), and farm and nonfarm profits from equation (6.8). Next, it considers the effect of land fragmentation on the agricultural productivity and labour intensity in farm and nonfarm activities. This paper uses different methods to measure the extent of the reduction of land fragmentation on labour allocation, and test the prediction that this change is characterised as labour-augmenting technical change.

Based on Equations (6.6) and (6.8), the dependent variables are estimated by using the same set of independent variables, which control incentives and constraints affecting the participation in farm and nonfarm activities (Reardon et al. 1992). It has reduced form equations as follows:

$$L_{it,a} = \beta_0 + \beta_1 S_{it} + \beta_2 X_{it} + \beta_3 A_{it} + \beta_4 LF_{it} + \beta_5 R_k + \beta_6 T + \varepsilon_{it,a}, a = nf, f \quad (6.10)$$

and

$$Y_{it,a} = \lambda_0 + \lambda_1 S_{it} + \lambda_2 X_{it} + \lambda_3 A_{it} + \lambda_4 LF_{it} + \lambda_5 R_k + \lambda_6 T + \varepsilon_{it,a} \quad (6.11)$$

and the effect of land consolidation on agricultural productivity and factor intensity in farm and nonfarm activities is captured by the following reduced form equation:

$$P_{it,a} = \delta_0 + \delta_1 S_{it} + \delta_2 X_{it} + \delta_3 A_{it} + \delta_4 LF_{it} + \delta_5 R_k + \delta_6 T + \varepsilon_{it,a} \quad (6.12)$$

where L_a and Y_a represent the farm, nonfarm labour supply and profits, respectively, and P_{it} is defined as either (i) agricultural output per ha; or (ii) the number of individuals in the household who derive their main income from farm or nonfarm activity, a represents farm and nonfarm outcomes; S_{it} is a vector of variables capturing land fragmentation which includes the Simpson index or the number of plots. The direct effect of land fragmentation on farm and nonfarm labour supplies, and farm and nonfarm profits, is β_1. The hypothesis of the coefficient β_1 is positive in case of the estimation of the farm labour supply function, and negative if the reduced form is nonfarm labour supply function.

A similar pattern is applied for the profit functions. If these hypotheses cannot be rejected, it can be argued that the impact of agricultural technical change through land consolidation is subject to the factor biased technical changes. Thus, the variable of interest in this study is S_{it}. The model also controls other variables that can affect farm and nonfarm labour supply and profits, - these include household characteristics, X_{it} (education, demographics and social networks of household members); total land area of annual crops,[69] A_{it}; locational factors, LF_{it} (infrastructure, business environments);[70] regional dummies, R_k; and year dummies, T. The error term ε_{it} includes two components: the first one is unobserved time-constant heterogeneity η_i, which affects outcomes such as land quality, farm household's management ability, and degree of risk aversion. The second one is unobserved time-varying factors that impact dependent variables such as health shocks.

The chapter investigates how land consolidation relates to changes in farm production, and labour allocation between farm and nonfarm activities in Equations (6.10), (6.11), and (6.12). In the first section on estimation strategies, the chapter shows estimates of equations related to nonfarm outcomes including nonfarm labour supply, nonfarm profits and number of individuals in nonfarm activities. In the second section, different equations related to farm results are introduced, including farm labour supply and profits, farm output per hectare, and share of farm employment.

[69] World Bank (2006) show that land fragmentation mainly focuses on annual crops.

[70] Isgut (2004) emphasises the importance of location factors (such as infrastructure and business environment) on nonfarm income and employment in Honduras. Isgut shows that locational factors play a very important role in moving toward nonfarm activities. The importance of human capital and infrastructure is analysed in the section of literature review in this chapter.

6.4 Controlling the bias in econometric models

6.4.1 Controlling for unobserved heterogeneity η_i

The estimation of Equations (6.10), (6.11) and (6.12) pose some econometric challenges. A potential problem may arise from the effect of unobserved heterogeneity η_i, which can cause a biased estimation of the models (due to omitted variable bias). Therefore, controlling η_i is necessary in order to get consistent estimates. In addition, a vector of exogenous household and communal characteristics is used.[71] Equations (10), (11) and (12) can be estimated using a fixed effect model. First difference is applied to control the unobserved heterogeneity η_i.

Alternatively, the model needs to capture the efficiency gain by using a random effect model. Due to the low variation of the measure of land fragmentation, an approach proposed by Mundlak (1978) and expanded by Chamberlain (1984) is applied. This method allows unobserved heterogeneity to be correlated with independent variables. In the correlated random effect model, $\overline{X_h}$ is denoted as the mean of time varying independent variables in the models. Using the approach of Mundlak (1978), let unobserved heterogeneity $\eta_i = \overline{X_h}\gamma + \mu_h$, where γ is a vector of coefficients capturing possible correlation between η_i and household characteristics and μ_h is an error term that is not correlated with $\overline{X_h}$. I substitute $\varepsilon_{it,a} = \eta_i + \tau_{it,a}$ and $\eta_i = \overline{X_h}\gamma + \mu_h$ into equations (6.10), (6.11), and (6.12) to yield the Mundlak specifications[72] as follows:

$$L_{it,a} = \beta_0 + \beta_1 S_{it} + \beta_2 X_{it} + \beta_3 A_{it} + \beta_4 LF_{it} + \beta_5 R_k + \beta_6 T + \beta_7 \overline{X_h} + \omega_{it,a} \qquad (6.10')$$

$$Y_{it,a} = \lambda_0 + \lambda_1 S_{it} + \lambda_2 X_{it} + \lambda_3 A_{it} + \lambda_4 LF_{it} + \lambda_5 R_k + \lambda_6 T + \lambda_7 \overline{X_h} + \omega_{it,a} \qquad (6.11')$$

$$P_{it,a} = \delta_0 + \delta_1 S_{it} + \delta_2 X_{it} + \delta_3 A_{it} + \delta_4 LF_{it} + \delta_5 R_k + \delta_6 T + \delta_7 \overline{X_h} + \omega_{it,a} \qquad (6.12')$$

where $\omega_{it,a} = \tau_{it,a} + \mu_h$

6.4.2 Controlling for unobserved shocks

One of problems, which may arise even after controlling the correlation between S_{it} (measures of land fragmentation) and η_i, is the correlation between S_{it} and unobservable time-varying variables. Land fragmentations measured by the Simpson index and log of

[71] Van de Walle and Cratty (2004) also used exogenous variables to reduce the potentials of biased estimates in their study on the role of nonfarm economy on poverty reduction in Vietnam.
[72] For more on the correlated random effects model, see Wooldridge (2012).

plots are assumed to be exogenous, and thus serve as their own instruments, due to the restrictions of the Vietnamese land markets.[73] In addition, land markets are imperfect for both sales and rental markets, as a result of uncertainties related to land institutions and restrictions. Therefore, land fragmentation is assumed to be exogenous in the models. All prior studies assume independence between land fragmentation and unobserved time-varying variables. According to the VHLSS surveys, 67.3 per cent of plots have land-use right certificates. Only 4.03 per cent of plots were exchanged through the land rental market. Thus, rural households cannot reduce scattered land holdings by land markets.

However, the assumption of independence between land fragmentation and unobserved shocks may be strong. Therefore, land fragmentation is likely to be correlated with unobserved time-varying factors that affect farm and nonfarm. As discussed earlier, land consolidation from the data is attributed by plot exchange, not by land markets. The land consolidation programs are implemented by voluntary plot exchange and reallocation with comprehensive planning. Tran (2006) finds that voluntary plot exchange is carried out at the household level and the scope, and the effect, of this program is low. This method of land consolidation requires close coordination among a large number of households and plots. As a result, it takes time and effort to achieve consent among all members. This is one of challenges facing voluntary land consolidation programs, and is one reason for the difficulties facing land consolidation in rural Vietnam (Tran 2006). Thus, the reduction of land fragmentation represents a decision made by local authorities and related households, rather than a household decision.

In addition, the control of the correlation between land fragmentation and unobserved shocks requires an instrumental variable. This instrumental variable is correlated with a potentially endogenous variable, but not correlated with unobserved shocks in the structural models. I experimented with a range of instrumental variables such as number of land use right certificates transferred in the commune, communal population density, and area of annual crop land titled by certificates of land-use right in the commune.[74] However,

[73] Chapter 3 discusses in detail the problems of land markets and history of land fragmentation in Vietnam in details. Farmland was reallocated to households by the egalitarian principle during the process of decollectivizing the agricultural system. In this chapter, log of plots is used as another measure of land fragmentation, which is similar to previous studies (Jia and Petrick 2013; Wan and Cheng 2001; Hung et al. 2007).

[74] In the communal surveys, Section 4 covers agriculture and land types. However, it does not provide information related to land consolidation programs. In Vietnam, land ownership does not exist. Local government issues a certificate of land use right for all plots which households use. On this certificate, it shows the information on the number of plots, area, and location for each plot (Land Law 2003).

the results are not useful due to a lack of suitable instruments. Ma et al. (2013) study the effect of perceived land tenure security on land investments. The authors used instrumental variables that are correlated with perceived land tenure such as opinions about policy. A good instrumental variable is linked to land governance or the perception of households of the benefits of land fragmentation; these are ignored in household surveys designed by the World Bank. This is the reason why all previous studies of the problem of land fragmentation have assumed that it is exogenous, (see Jia and Petrick 2013; Rahman and Rahman 2008; Markussen et al. 2013).

This chapter further tests the exogenous condition of land fragmentation by applying the control function approach to solve the problem. The control function is implemented by taking the residuals from a reduced form model of land fragmentation. These residuals are included in the labour supply and profit functions as a covariate. The significance of the coefficients on the residuals will test and control for the correlation between land fragmentation and unobserved shocks (Papke and Wooldridge 2008). In order to apply the control function, the first step is to model the reduced form for land fragmentation by using the first difference and Tobit models for the correlated random effect models. The instrumental variable is the number of land use right certificates transferred in the commune in the past year. Although the coefficient of this instrumental variable is significant, the coefficient of residuals on the structural farm and nonfarm equations is statistically insignificant, which indicates that the land fragmentation is not endogenous in both the farm and nonfarm outcome equations.[75]

6.4.3 Controlling the sample selection bias to examine the effect of land fragmentation on nonfarm outcomes

In order to control the unobserved heterogeneity η_i, correlated random effects (CRE), as adopted by Mundlak (1978), can be applied. Although the model can control for the unobserved heterogeneity η_i, it faces a sample selection bias in nonfarm models due to the incidental truncation of the nonfarm labour participation (Cunguara et al. 2011). Wooldridge (2012) argues that the problem of sample selection bias needs to be tested. Because of the change in a household's selection status overtime, the within-estimator aimed at eliminating the unobserved time-constant heterogeneity cannot be applied due to changes in household composition overtime by the group of selected households. In order to solve both problems - sample selection and η_i, this study uses the estimating

[75] See the Appendix A8 for the test using control function.

procedure introduced by Wooldridge (1995), who developed the level equation to obtain consistent estimations using a pooled method by parameterizing the conditional expectations. The model first obtains the inverse Mills ratio from a reduced form selection probit equation as follows:

$$s_{it} = 1[x_i\gamma_{t2} + \varepsilon_{it} > 0]$$

where *s* is a dummy variable, equal to one for households with a positive nonfarm labour supply or profits and zero otherwise; $x_i = (x_{it}, \bar{x})$ is consist with the value of an independent variable for household *i* in period *t* and its mean value for household *i* across periods of time. I use the approach of Mundlak (1978) to control for household fixed effects of the selection equation. The independent variables are shown in Equations (6.10'), (6.11') and (6.12'). The Wooldridge (1995) estimator requires, at least, a time-varying variable, and this affects selection, but not the level equation. Note that the two-step estimation could be unreliable in the absence of exclusion restriction (Wooldridge 2012).

Next, time periods are pooled together and the data set is treated as a cross section. The pooling of all panel observations is a shortcoming of this approach, but it is, unfortunately, the only option in this case. The model includes the inverse Mills ratio, computed from the participation equation, as an additional variable to control sample selection bias. However, there are some exclusion restrictions related to the models of nonfarm outcomes. I include at least one time-varying variable in the selection equation that does not affect nonfarm labour supply and incomes. In this case, unearned incomes from Gupta and Smith (2002) is used in the participation equation, but not in the nonfarm labour supply and income.

6.5 Functional forms

6.5.1 The effect of land fragmentation on nonfarm outcomes: nonfarm labour supply and nonfarm profits

The chapter now turns to the question of whether the move toward nonfarm activities increased due to the impact of land fragmentation. There are two equations for three outcomes, including nonfarm labour supply measured by the number of hours spent by

household members on nonfarm work, and nonfarm profits.[76] As mentioned earlier, one of the challenges associated with estimating nonfarm labour supply and nonfarm profits is that a large proportion of the households in the sample do not participate into nonfarm activities. It seems plausible that Wooldridge (1995) is appropriate.

However, the exclusion restriction is not easy to accept on *priori* grounds. Van de Walle and Cratty (2004) argue that given the imperfect markets in rural Vietnam (e.g.land markets) such an exclusion restriction seems far-fetched. Therefore, the study uses another method, which does not require imposing exclusion restrictions. The method is called the double hurdle model (DHM) for nonfarm labour supply and profits. It follows recent studies related to nonfarm participation and income (e.g. Matshe and Young (2004), Atamanov and Van den Berge (2012)) by applying the same approach. The two-step double hurdle model developed by Cragg (1971) is chosen in this case to estimate censored dependent variables. This model is more flexible than the Tobit model because it takes into account of the possibility that the factors affecting the participation in farm activities and factors affecting the level of farm labour supply and profits may be different. In hurdle 1, farm households decide whether or not to participate into farm activities, and if household members agree to take part, then hurdle 2 takes into consideration the amount of profits earned by household. The maximum likelihood estimator in the first hurdle can be obtained by using a Probit regression. The maximum likelihood estimator for hurdle 2 can then be estimated using a truncated normal regression model. The test to choose between the Tobit model and double hurdle model is implemented by using a likelihood ratio test.

6.5.2 The effect of land fragmentation on farm outcomes: productivity, labour supply, profits, and the number of individuals in farming activities

This section consolidates the findings in the literature related to the consequences of land fragmentation. The effect of land fragmentation on four farm outcomes is further investigated in order to answer the question of whether more people move off the farm as a result of policies related to the reduction of land fragmentation. Firstly, farm productivity change is measured as the farm annual crop output per hectare. The second is farm labour supply measured by working hours spent by household members

[76] Nonfarm profits are the aggregate of nonfarm wages and profits of self-nonfarm employment of farm households.

on farming activities. The third outcome is farm profits.[77] The final one is the number of individuals in farm employment in the household. The impact of land fragmentation on farm outcomes can be estimated using different methods. Initial characteristics of households, land and communes are controlled. The use of the initial period (and thus pre-determined) variables may eliminate the potential endogeneity of the some household characteristics. Moreover, it may also mitigate the simultaneity problem caused by some unobservable variables. This method removes unobserved heterogeneity η_i such as land quality, management skills or ability.

6.6 Data

As in the previous chapters, this study uses the VHLSS 2004 and 2006 surveys for empirical analysis. To concentrate on labour allocation of rural households in the full sample, this chapter follows the approach taken by Jolliffe (2004) by selecting farm households with at least one member who describes the main job as farming, and which has positive farm profits. In addition, households with no rice crop outputs and land were excluded from the analysis (the number of excluded households is 2179). It should be noted that this chapter only focuses on rice farms. World Bank (2006) and Marsh et al. (2006) show that land fragmentation mainly occurs in rice production in Vietnam. The sample of panel data used in this study thus includes pure tenant households, and land rental households. As regards attrition bias resulting from households leaving the panel in different waves, there are 2,289 households sampled in the second wave, 2,032 of those households had been sampled in the first wave. Thus, a balanced panel of 2014 households was established by removing households with missing data and apparent enumerator errors and available for only one time period; this results in 4,028 households over the two waves of the survey.

Table 6.1 provides the information on the summary statistics of variables used in the models. Farm profits are measured by the difference between the total revenue of annual crops and their costs in a year. The measure of rice output is the quantity harvested during the previous 12 months. To better compare the profits and value of assets of households between two years, these values were deflated to January 2000 prices as the base year. The deflators used in this paper are collected from GSO (2010).

[77] Farm profits are the difference between total revenue and costs of annual crop production. Farm profits are equal to zero if total costs are greater than total revenue.

Table 6.1 **Summary statistics of variables in the model**

Variable	Mean	Std. Dev.
Farm outcomes (dependent variables)		
Farm profits/ha/year, 1000 VND	34879.69	96583.81
Rice output/ha, tons/ha	5.6	4.3
Farm hours (total number of hours per year)	2446.90	1822.19
Share of individuals in farm activities of the household (%)	33.8	0.34
Nonfarm outcomes (dependent variables)		
Nonfarm profits, 1000 VND	6833.25	11266.63
Nonfarm hours (total number of hours per year)	1573.37	2034.10
Share of individuals in nonfarm activities of the household (%)	29.4	0.41
Explanatory variables		
Simpson index (a measure of land fragmentation)	0.54	0.25
Household characteristics		
Land, ha	0.51	0.76
Age of the head of household, years	46.96	14.40
Age of the head of household squared, years	2412.45	1372.62
Gender of the head of household, 1 for male	0.59	0.49
Marital status of the head, 1 for married	0.83	0.37
Ethnic status of the head, 1 for majority	0.81	0.39
Household members, from 15 to 60 years old, people	2.75	1.32
Dependency ratio (%)	0.33	0.23
Value of assets, 1000 VND	10,880.29	40,606.4
Education		
Mean education of working age men (from 15 to 60, years)	3.85	2.40
Mean education of working age women (from 15 to 60, years)	3.66	2.38
Head of household has primary education	0.25	0.43
Head of household has lower secondary education	0.38	0.49
Head of household has university education	0.01	0.09
Days of illness	19.52	43.81
Participation into nonfarm activities		
Having member working in state economic sector	0.098	0.297
Having member working in private economic sector	0.052	0.224
Having member working on household's own business	0.850	0.357
Locational factors		
Access to asphalt road	0.60	0.49
Access to electricity	0.85	0.35
Access to post office	0.77	0.42
Access to extension	0.49	0.24
Inland delta areas	0.58	0.49
Remote areas	0.15	0.36
Having business units in commune	0.62	0.48
Having craft villages in commune	0.14	0.34
Disasters in commune	1.16	1.25
Having employment programs in commune	0.24	0.43
Having infrastructure programs in commune	0.42	0.49
Having educational and vocational programs in commune	0.14	0.34

6.6.1 Measurement of land fragmentation

The independent variable of land fragmentation is of key interest in this chapter. Thus, a measurement of land fragmentation is necessary to provide a relatively complete picture of fragmented land holdings of rural households, and then for use in policy analysis. The present chapter uses the Simpson index to measure land fragmentation. This approach has been used by a number of studies.[78] According to Blarel et al. (1992), the Simpson index is defined as:

$$SI = 1 - \sum_{i=1}^{n} a_i^2 \Big/ \left(\sum_{i=1}^{n} a_i\right)^2$$

where a is the area of each plot, and n is the number of plots. SI lies between zero and one, with a higher value if the Simpson index (SI) shows a larger degree of land fragmentation. The average plot area, the distribution of plot area and the number of plots form the Simpson index. However, this index does not capture the average distance from home to the plots – i.e. it ignores the spatial distribution of plots. This is a limitation of the data. Unfortunately, there is no section on spatial distribution in the VHLSS surveys. The Simpson index has been used in previous studies on land fragmentation in Vietnam (Kompas et al. 2012; Hung et al. 2007, Makussen et al. 2013), which can be compared with the results in this study. In this chapter, both the Simpson index and plots are used as measures of land fragmentation.

6.6.2 Evidence of land fragmentation

This section explores whether land consolidation occurred and, if so, whether the process was driven by the land market in Vietnam. Table 6.2 provides statistics of land fragmentation in Vietnam using the VHLSS 2004 and 2006. As can be seen in the table, there is a reduction in the degree of land fragmentation. All indicators show consistently the tendency to land consolidation. The reduction of the Simpson index means that more plots are consolidated. Meanwhile, the farm sizes also increase. Thus, land consolidation and accumulation take place at the same time.[79] The analysis in Chapter 3 shows that land can be consolidated through plot exchange or through transactions in the land

[78] Studies applying the Simpson index as the measurement of land fragmentation include Blarel et al, 1992; Tan et al. 2008; Hung et al. 2007.

[79] The reduction of plots can eliminate the barriers between plots and irrigation systems. Due to the lack of data on land barriers and irrigation systems, this chapter cannot provide evidence on this argument.

markets.[80] Chapter 3 also presents the reasons for slow progress in land consolidation in rural Vietnam.

Table 6.2 **Land fragmentation in Vietnam, 2004-2006**

Indicators	2004	2006	Panel
Farm size (ha)			
Mean	0.45	0.48	0.47
Median	0.27	0.28	0.27
Average size of plot (m^2)			
Mean	1112.1	1530.7	1326.2
Median	437.5	540.0	494.3
Plots			
Mean	6.0	5.2	5.6
Median	5.0	4.0	5.0
Simpson index	***Percentage of households (%)***		
0-0.2	10.18	13.70	11.94
0.2-0.4	13.70	13.31	13.51
0.4-0.6	25.67	27.46	26.56
0.6-0.8	34.46	33.57	34.01
0.8-1.0	15.99	11.97	13.98
Number of households	*2014*	*2014*	*4028*

Source: Calculated from VHLSS 2004 and 2006

In order to gain an insight into the change in land fragmentation in rural Vietnam, the correlation between land fragmentation and farm sizes is explored. If the relationship is uncorrelated, or very weakly correlated, the change in land fragmentation is likely to be driven by factors such as plot exchange. Conversely, if scattered landholdings and farm sizes are negatively correlated, or become less positively related, land markets can drive land consolidation. In order to measure the relationship between land fragmentation and farm size, the Spearman's rank correlation coefficient used.[81] The Spearman coefficient is selected because it has many advantages in terms of the distributional nonparametric method (Kozak et al. 2012). The Spearman rank correlation is estimated by the following expression:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

,

[80]See further details of land fragmentation in Vietnam in Section 3.3 in Chapter 3 of this thesis.
[81] In Stata13, the Spearman's rank correlation coefficient can be calculated by using the command *spearman*. See Kozak et al. (2012) for further discussion of the Spearman's rank correlation coefficients in agricultural research.

where d_i is the difference between the rank of corresponding variables, and n is the number of pairs of values.

Table 6.3 **The Spearman correlation coefficient between land fragmentation and farm sizes**

Pair of variables	2004	2006
Number of plots-farm size	0.1748 (0.000)	0.2117 (0.000)
Plot size-farm size	0.6345 (0.000)	0.610 (0.000)
Simpson index-farm size	0.0937 (0.000)	0.0449 (0.044)

Notes: Number in parenthesis is *p value* of the test H_0: two variables are independent
Source: Calculated from VHLSS 2004 and 2006

Table 6.3 shows the Spearman correlation coefficients between land fragmentation and farm sizes in annual crop production in Vietnam using the VHLSS data in 2004 and 2006. As can be seen from the table, the process of land consolidation is unlikely to be driven by the land market. If farm households consolidate plots that are close to their existing plots, there would be an opposite direction between farm sizes and land fragmentation. This means that the Spearman correlation coefficient would be negative, or less positive overtime. The statistics from Table 6.3 provide evidence that the correlation between scattered land holdings is weak (the coefficient is less than 0.5). As a result, land consolidation in surveyed years should be attributed to plot exchange rather than to the land market.

From the survey data from 2004 to 2006, there is no evidence that the emerging land markets support land consolidation. Farm households may have not realised the negative effects of land fragmentation on agricultural production. In other words, the costs of severe scattered land holdings is unlikely to outweigh the expense of consolidating annual plots located next to their plots. Therefore, in this chapter, land consolidation is assumed to be exogenously driven, thus reflecting imperfect functions of the land market, or credit constraints in land consolidation.

6.7 Empirical results

The purpose of this section is to describe the empirical results for the relationship between changes in land fragmentation and economic diversification. It answers the question of whether policies related to land consolidation would lead to more economic diversity (including the growth of farm and nonfarm incomes and labour supplies). It

also provides the result for farm outputs and profits, which confirm further the evidence of agricultural productivity growth as a result of the reduction of land fragmentation. Unlike earlier studies, this study does not estimate the production function. Deaton (1997) points out that the most concern in the estimation of production function is the endogeneity of inputs, and in order to solve the problem of endogeneity, other researchers instrumented inputs (Jacoby 1993; Barrett et al. 2008). Hence, the common factors that determine both the outputs and the farm profits, are used.

6.7.1 Nonfarm outcomes: nonfarm labour supply and nonfarm profits

This section provides the empirical results of the effect of land fragmentation on nonfarm outcomes, including nonfarm labour supply and nonfarm profits. The purpose of this section is to answer whether or not an exogenous shocks to agricultural productivity leads to an economic diversity into nonfarm activities of a farm household. It follows different specifications in order to check the consistency of the impact. Table 6.4 indicates the effect of land fragmentation on nonfarm outcomes without selection corrections. As can be seen in the table, all estimated coefficients have negative signs in both methods. This finding means that the reduction of land fragmentation results in an increase in nonfarm labour supply and nonfarm profits.

Column (1) and (3) in Table 6.4 present the results of double hurdle model of the level equation. The selection equation for hurdle 1 is introduced in the Appendix. For robustness, the likelihood ratio test (LR) is carried out to determine whether the double hurdle model fits the model of factors affecting nonfarm labour supply and profits better than the Tobit estimation. Like Matshe and Young (2004), all the Tobit models can be rejected in favour of the double hurdle model at 5 per cent significant level. This chapter provides the estimates in both cases with and without the specification of Mundlak (1978) approach and tests the Mundlak fixed effects for nonfarm supply and profits. The double hurdle model is estimated by correlated random effects, which control for Mundlak fixed effects.

Table 6.4 **The effect of land fragmentation on nonfarm outcomes without selection correction using double hurdle model and first difference**

	Dependent variables			
	Nonfarm labour supply		Nonfarm profits	
Explanatory variables	Hurdle 2 (1)	FD (2)	Hurdle 2 (3)	FD (4)
Panel A				
Simpson index	-0.120*	-0.646*	-0.307***	-0.233
	(0.063)	(0.344)	(0.096)	(0.408)
Mundlak fixed effect test, χ^2 and *p_value*	12.58		65.87	
	(0.1697)		(0.000)	
Household characteristics	Yes	Yes	Yes	Yes
Human capital	Yes	Yes	Yes	Yes
Household assets and credits	Yes	Yes	Yes	Yes
Locational characteristics	Yes	Yes	Yes	Yes
Participation in economic sectors	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Number of observations	2008	2014	2008	2014
Panel B				
Log of plots	-0.026	-0.324**	-0.154***	-0.225
	(0.027)	(0.143)	(0.038)	(0.168)
Mundlak fixed effect test, χ^2 and *p_value*	12.51		64.64	
	(0.1863)		(0.000)	
Household characteristics	Yes	Yes	Yes	Yes
Human capital	Yes	Yes	Yes	Yes
Household assets and credits	Yes	Yes	Yes	Yes
Locational characteristics	Yes	Yes	Yes	Yes
Participation in economic sectors	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Number of observations	2008	2014	2008	2014

Notes: FD is first difference method; Standard errors (SE) are robust through the *cluster* option and in the parentheses. DHM standard errors are bootstrapped with 500 replications. DHM is double hurdle model (I only report hurdle 2 of the level equation; hurdle 1 is in the Appendix); All dependent variables are expressed in the log; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively; The double hurdle model specification follows the Mundlak (1978) approach; (The full set of parameter estimates are presented in Appendices 6.5, 6.6, and 6.7 of the chapter).
Source: Calculated from VHLSS 2004 and 2006

Nonfarm self-employment profits and nonfarm wages are aggregated, which results in the estimation of censored variables becoming less severe when merging two types of nonfarm activities. The null hypothesis of the fixed effect test for nonfarm profits is rejected at the 5 per cent significance level. Using the log of plots as a measure of land fragmentation in Panel B, Columns (2) and (4) in Table 6.4 shows that land fragmentation tends to have negative effects on nonfarm labour supply and nonfarm profits. In Panel A, the Simpson index is statistically significant at the 5 per cent

significance level. Although specifications have the same trends of estimated coefficients and indicate that policies toward more consolidated land holdings may release more agricultural labour surplus, these equations also may suffer from a selection bias. Therefore, in the next section, the effect of land consolidation on nonfarm outcomes with selection corrections is examined.

Table 6.5 **The effect of land fragmentation on nonfarm outcomes with selection correction using the approach of Wooldridge (1995)**

	Dependent variables	
Explanatory variables	Nonfarm labour supply	Nonfarm profits
Panel A		
Simpson index	-0.122*	-0.297***
	(0.063)	(0.080)
Mundlak fixed effect test, F(9,1956), *p-value*	1.31 (0.2282)	2.96 (0.0017)
Sample selection bias test, F(2,1956), *p-value*	0.60 (0.548)	4.44 (0.012)
Household characteristics	Yes	Yes
Human capital	Yes	Yes
Household assets and credits	Yes	Yes
Locational characteristics	Yes	Yes
Participation in economic sectors	Yes	Yes
Regional dummies	Yes	Yes
Number of observations	2008	2008
Panel B		
Log of plots	-0.023	-0.143***
	(0.027)	(0.037)
Mundlak fixed effect test, F(9,1956), *p-value*	1.28 (0.2434)	2.79 (0.003)
Sample selection bias test, F(2,1956), *p-value*	0.57 (0.564)	4.67 (0.0094)
Household characteristics	Yes	Yes
Human capital	Yes	Yes
Household assets and credits	Yes	Yes
Locational characteristics	Yes	Yes
Participation in economic sectors	Yes	Yes
Regional dummies	Yes	Yes
Number of observations	2008	2008

Notes: Standard errors (SE) are robust through the *cluster* option and in the parentheses; All dependent variables are expressed in the log; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively;
The model specification follows the Mundlak (1978) approach (Mundlak fixed effect test for nonfarm labour supply and nonfarm profits and sample selection bias test for nonfarm labour supply and profits at 5% significant level, respectively); (The full set of parameter estimates are presented in Appendices 6.8 of the chapter).
Source: Calculated from VHLSS 2004 and 2006

Table 6.5 shows the effect of land consolidation on nonfarm outcomes with the correction of sample selection bias. To control the sample selection, the chapter estimates (6.10), (6.11) and (6.12) with pooled data. The tests for sample selection bias and fixed effects are obtained by employing an *F*-test. The results reveal that both nonfarm labour supply and profits suffer from sample selection bias at the 5 per cent significance level. Thus, the approach of controlling sample selection bias is demanding. As a result, using the method of Wooldridge (1995) results in the same conclusion, i.e. more land consolidation may release more labour to nonfarm sectors in the future. All the coefficients of the Simpson index and log of plots in equations are significant and have the same sign. The increase in agricultural productivity as a result of land consolidation leads to an increase in farm households' income, combined with non-homothetic preferences, will generate the demand for non-agricultural goods and services. Consequently, this process will pull farm labour to nonfarm sectors.

6.7.2 Farm outcomes: productivity, labour supply and farm profits

This section examines the impact of land fragmentation on farm labour supply and profits. In order to investigate the relationship, equations (6.10), (6.11) and (6.12) using first difference are estimated. The main explanatory variable of interest is the Simpson index and log of plots. Table 6.6 provides estimated results with four farm outcomes as dependent variables. Panel A presents the Simpson index, and Panel B captures the log of plots. All four dependent variables are estimated on the same set of explanatory variables in Equations (6.10) and (6.11) using the panel data method to control for the fixed unobserved heterogeneity. The log of plots and Simpson index are used to measure land fragmentation. Household characteristics are controlled for, e.g. education of adults, assets, participation into different nonfarm activities and demographic information on farm households. In addition, location factors such as business environment related to infrastructure, and regional characteristics are also controlled.

As can be seen in the Table 6.6, the estimated coefficients show that the reduction of land fragmentation (land consolidation) results in a reduction in farm labour supply and the number of individuals working in farming activities. Farmers with more fragmented land holdings switch to more labour-intensive farming. Based on the first difference method, 1 per cent fall in the number of plots still decreases the farm labour supply by 0.36 per cent. Furthermore, if land fragmentation is reduced by 1 per cent, farm profits per hectare and farm output per hectare increase by 0.12 per cent and 0.055 per cent,

respectively. The mean farm labour hours of a household is around 2,446 hours per year (see Table 6.1). The estimated result implies that farm labour supply reduces by around 3.6 per cent when the number of plots reduce by 10 per cent, which corresponds to the reduction of 88.2 hours per year. Similarly, the farm labour hours reduce by 129 hours in the case of the Simpson index. As a result, the reduction of land fragmentation results in a decline in farm labour intensity in rice production in Vietnam. This finding is consistent with previous studies in China such as Wan and Cheng (2001) and Tan et al. (2006 and 2008). For example, Tan et al (2006) find that in China, incomes from off-farm employment and land rental markets are associated with lower land fragmentation.

Table 6.6 **The effect of land fragmentation on farm outcomes using first difference**

	Dependent variables: Farm outcomes			
	Number of individuals in farming activities	Farm labour supply	Farm profits per ha	Farm output per ha
Panel A				
Simpson index	0.200*	0.533*	-0.109	-0.092***
	(0.097)	(0.315)	(0.082)	(0.019)
Household characteristics	Yes	Yes	Yes	Yes
Human capital	Yes	Yes	Yes	Yes
Household assets and credits	Yes	Yes	Yes	Yes
Locational characteristics	Yes	Yes	Yes	Yes
Participation in economic sectors	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Panel B				
Log of plots	0.051	0.355***	-0.115***	-0.055***
	(0.041)	(0.129)	(0.031)	(0.007)
Household characteristics	Yes	Yes	Yes	Yes
Human capital	Yes	Yes	Yes	Yes
Household assets and credits	Yes	Yes	Yes	Yes
Locational characteristics	Yes	Yes	Yes	Yes
Participation in economic sectors	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Number of observations	2014	2014	2014	2014

Notes: Standard errors (SE) are robust through the *cluster* option and in the parentheses; All dependent variables are expressed as logs, except number of individuals in farming activities; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively; (see Appendices A6.3 and A6.4 for full estimation).
Source: Calculated from VHLSS 2004 and 2006

Similarly, the decline in land fragmentation improves farm productivity, which then reduces the labour intensity in agriculture. The advantage of land consolidation is to save

labour time, and thus allow saving labour. As a result, this finding supports the characterisation of the expansion of land consolidation as a non-Hicks neutral technical change, which is consistent with the hypothesis of non-neutral effects in Wan and Cheng (2001). Both measures of land fragmentation have the same effect on farm outcomes.

To sum up, the estimates of farm outcomes indicate that moving land consolidation increases farm incomes. When the fixed effect is controlled, the estimates show that an increase in land consolidation reduces labour intensity and farm labour supply, and improves nonfarm profits and nonfarm labour supply. There is a linkage between the agricultural development and the rural nonfarm economy. Regression results show that the reduction of land fragmentation improves productivity, which then increases the probability of increasing nonfarm incomes. Agricultural technical change leads to increases in nonfarm incomes, which means that investments in agricultural technical changes have a positive outcome.

6.7.3 Robustness to controlling for market wages

Another potential concern is that results might be driven by the evolution of market wages in the nonfarm sectors, and not by technical change. For example, an increase in the wage in nonfarm sectors could induce an expansion of employment in these sectors. To address this concern, this study adds the variable of hour wages (W) into the following equation[82]:

$$\Delta L_{it,a} = \beta_1 \Delta S_{it} + \beta_2 W_{it-1} + \beta_3 X_{it-1} + \beta_4 A_{it-1} + \beta_5 LF_{it-1} + \beta_6 R_k + \Delta\varepsilon_{it,a}, a = nf, f$$

The equation, including hourly wages, is the same Equation (6.10), except that hourly wages in the initial period ($W_{i,t-1}$) are controlled. As can be seen in Table 6.7, the reduction of land fragmentation leads to the reduction of farm labour supply, and an increase in nonfarm labour supply, after controlling hourly wages. Using hourly wages in the initial period reduces the endogeneity problem of this variable in the regression. The result obtained using data from VHLSS surveys is consistent. I also test the effect of hourly wages on nonfarm labour supply and the result is still consistent, as with the case without hourly wages.

[82] Mean hourly real wages (thousand VND) for farm households who have at least one member participating in nonfarm employment are 2.75. Wages are deflated to January 2000 prices. This mean is much lower compared with 4.56 for the whole sample.

Table 6.7 **Determinants of farm and nonfarm labour supply using first difference method and controlling hour wages**

Variables	Farm labour supply		Nonfarm labour supply	
	Coef.	Standard error	Coef.	Standard error
Simpson index	0.531*	0.314	-0.362	0.319
Hour wages	-0.313**	0.133	1.716***	0.091
Annual crop land	0.035	0.049	-0.093*	0.052
Age	-0.049***	0.006	-0.030***	0.005
Household members, from 15 to 60 years old, people	0.316***	0.076	0.327***	0.072
Dependency ratio (%)	4.382***	0.370	1.098***	0.346
Mean education of working age men	0.178***	0.036	0.163***	0.034
Mean education of working age women	0.062*	0.034	0.085**	0.034
Access to formal credit	-0.024	0.155	0.067	0.154
Log of assets	-0.030	0.022	0.005	0.022
Access to asphalt road	0.419**	0.167	0.388**	0.167
Access to electricity	0.107	0.199	-0.193	0.197
Access to post office	-0.348*	0.205	0.097	0.212
Access to extension	-0.283	0.359	-0.262	0.359
Having business units in commune	0.162	0.176	0.316*	0.178
Having craft villages in commune	-0.438*	0.249	0.474*	0.251
Disasters in commune	0.082	0.069	-0.037	0.068
Having employment programs in commune	-0.073	0.192	-0.125	0.192
Having infrastructure programs in commune	-0.029	0.158	-0.046	0.157
Having educational and vocational programs	-0.505**	0.210	-0.110	0.202
Having member working in state economic sector	-0.480	0.329	0.592*	0.308
Having member working in private economic sector	-0.146	0.424	0.692*	0.380
Having member working on household's own business	-1.280***	0.184	-0.609***	0.207
Regions	Yes		Yes	
Constant	4.593***	0.568	3.222***	0.570
N	2014		2014	
R^2	0.172		0.246	

Notes: Standard errors are robust; the dependent variables are expressed as logs; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.

6.8 Concluding remarks

Economic growth in developing countries is accompanied by the movement of farm labour out of agriculture. It is widely recognized that improving agricultural productivity leads to rising rural income, and poverty reduction (Warr 2006). Although Vietnam is one of the leading rice exporters in the world, rice farmers are being kept in low income (Chapter 3). In addition, rice consumption is falling in nearly all of Asia, and plus the expansion of rice output and exports in some countries (Timmer 2013). Therefore, it is no surprise that increased attention has been given in recent years by development institutions (such as the World Bank, ADB and governments) to the potential for expansion of the rural nonfarm economy as a source of income growth and poverty reduction, as well as economic diversification. Better appreciation of how factors such as land reforms affect the direction and pace of rural transformation and productivity is critical to the investigation of the underlying dynamics and to support public policy formations. However, empirical studies in this area are still lacking.

This chapter hypothesises that land reform through the reduction of land fragmentation is a determinant of the ease with which this question can be answered. In addition, this chapter also tests the hypothesis that the impacts of agricultural productivity growth on economic diversification depend on the factor bias of technical change. Theoretically, using this assumption of technical change results in the conclusion that the increase in agricultural productivity slows the rural structure transformation. Conversely, if the technical change is factor-biased, opposite conclusions can be drawn.

By expanding the theoretical framework of Jia and Petrick (2013), Acemoglu (2010) and arguments in Foster and Rosenzweig (2004 and 2008), this chapter develops the theoretical analysis using the Cobb-Douglas and CES production functions, with different assumptions on technical changes. Based on theoretical analysis, if a technical change is Hicks-neutral, it leads to more on-farm labour supply. Conversely, if technical change is labour saving and the elasticity of substitution is low enough, then it can reduce farm labour supply and release more labour to other sectors. The chapter tests these theoretical predictions by developing an empirical analysis of the impact of land consolidation on nonfarm and farm outcomes.

The study uses the method of panel data and the correlated random effect model to control the unobserved heterogeneity and sample selection bias. It finds that the

reduction of land fragmentation decreases farm labour supply, labour intensity and improve farm profits and productivity. If land fragmentation declines by 1 per cent, farm labour supply decreases by 0.36 per cent. Farm profits and productivity per hectare increase by 0.12 per cent and 0.055 per cent, respectively. Similarly, land consolidation may release more farm labour to nonfarm sectors, and increase nonfarm profits. The empirical evidence also shows that factor biased technical change plays an important role in explaining the effect of agricultural productivity on economic diversification and income in Vietnam. Therefore, these results are consistent with the theoretical prediction that the application of labour savings agricultural technical changes reduces labour demand and induces labour reallocation in farm households.

The chapter also points to a linkage between the farm and nonfarm sector. The productivity improvement in the farm sector will promote the development of the nonfarm economy and economic diversification of rural households. Evidence provided in the chapter indicates that land consolidation is an appropriate public policy in light of declining agricultural growth in Vietnam. The issues of land use have become an important threshold that Vietnam needs to reform despite increasing public investment in agriculture in recent years. As Warr (2009) concludes, these released resources are used more productively in other sectors and improve the productivity of the country. In addition, the expansion of and land intuitions related to develop land markets, such as land ownership rights and the promotion of land rental markets, are key factors in the next reforms if Vietnam is to accelerate the land consolidation process. Consolidation is mainly implemented through plot exchange and much depends greatly on the quality of land governance.

Otsuka (2013) finds that in the economic development in Asia, in order to reduce labour costs due to rising rural wages, larger farm size with less fragmentation needs to be promoted, along with mechanisation. The consolidation of parcels of land is needed to promote large mechanization and maintain the comparative advantage in agriculture. The reduction of land fragmentation will create more incentives to apply mechanisation in farming production and improve productivity. As a result, it may release more labour to other sectors of the economy. As Vietnam appears to have a labour surplus, the real benefits to farm households from land consolidation may not be apparent until the real opportunity cost of farm labour begins to rise. However, this opportunity cost is affected by factors such as the availability of employment opportunities for the family members, wage rates, the level of education, and the time of year and seasons. Thus, the creation of

off-farm jobs and labour allocation to other sectors will be a key policy framework for Vietnam's agricultural and rural development.

In addition, education, and locational factors also play an important role in boosting the participation into nonfarm activities of farm households. Although they are only control variables, the coefficients are consistent with the findings in the literature review related to the determinants of economic diversification. Therefore, the reduction of land fragmentation is a necessary condition, while the improvement of education and locational factors are sufficient conditions that households can diversify their livelihoods. However, this conclusion should be further tested in future research.

While the empirical results indicate that land consolidation encourages labour allocation and results in the diversification of economic activities of farm households, that argument should be taken with cautions. It is necessary for future research to capture the changes of prices of goods and sources of migration. In addition, the effect of uncertainties such ash shocks and risks on smallholder decision-making is also neglected. These factors play an important role in households' behaviour in smoothing income and consumption. Thus, future research should capture both shocks and risk to understand more about labour allocation and economic diversification of farm households. In addition, the analysis examines a sample of continuously existing farms, operated either full-time or part-time. Farm exits are not considered. Improved opportunities to consolidate farm land due to better functioning land markets may convince some of the least productive farmers to give up farming altogether, and earn their living fully from nonfarm sources. This process may well increase the number of urban job seekers, and may lead to increasing specialization and differentiation within the pool of Vietnamese rural households.

Appendices of Chapter 6

Appendix 6.1 **Mathematical proof of theoretical research in Section 6.3.1**

The expression must satisfy the condition $\left[1+\frac{1}{\sigma-1}\omega^{-1}\gamma(\alpha_{2L})^{\frac{\sigma-1}{\sigma}}\right]>0$ if we expect $\frac{\partial MPL}{\partial \alpha_2}<0$ in the case of σ<1 (labour and land are complements in agricultural production). In order to have $\left[1+\frac{1}{\sigma-1}\omega^{-1}\gamma(\alpha_{2L})^{\frac{\sigma-1}{\sigma}}\right]>0$, we have:

$1>-\frac{1}{\sigma-1}\omega^{-1}\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}}$ where: $\omega=[\,\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}}+(1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}]$

$-\omega^{-1}\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}}<-(1-\sigma)\rightarrow\sigma<1-\omega^{-1}\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}}$

We have:

$$\sigma<1-\frac{\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}}}{\omega}$$

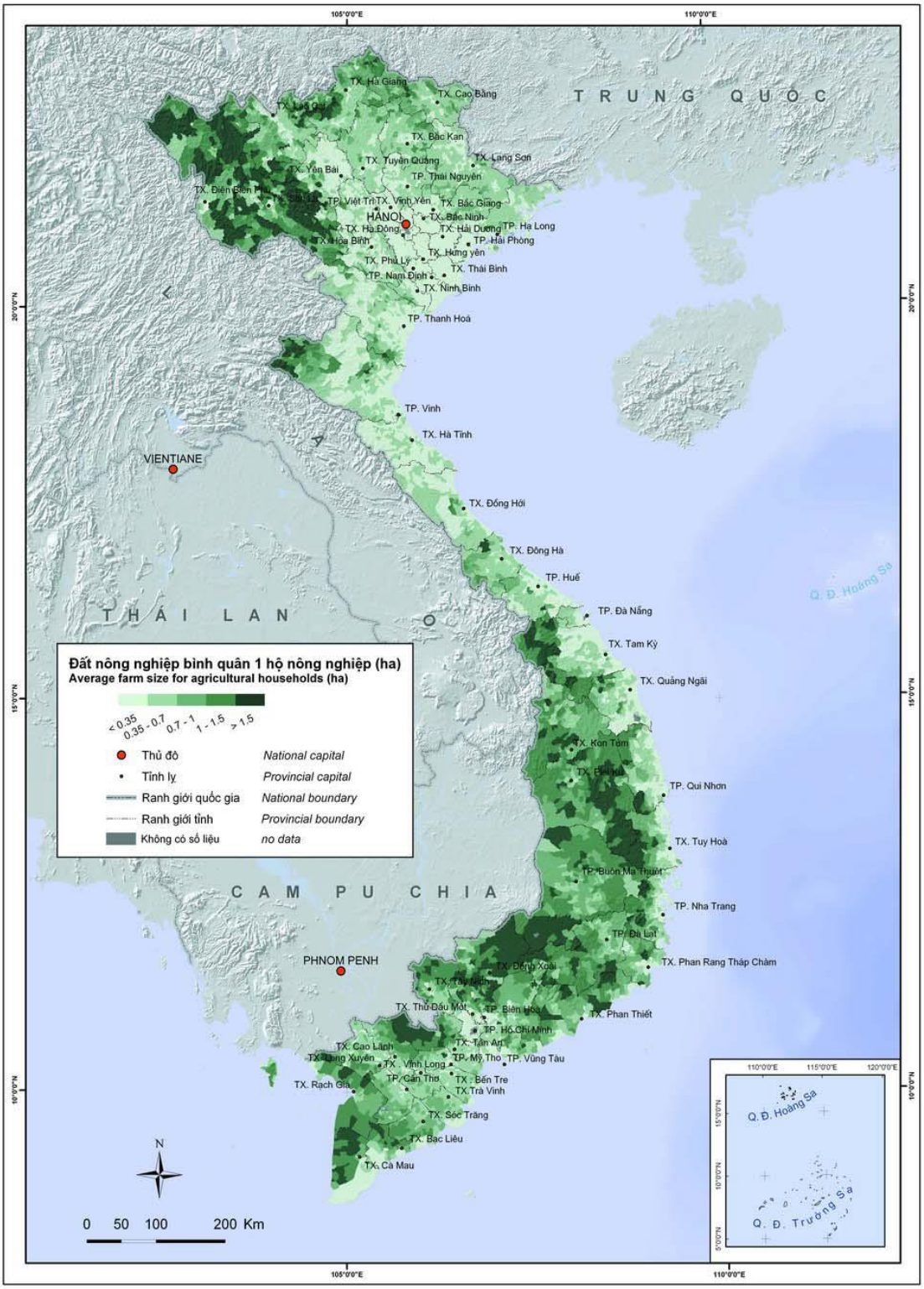
$$\sigma<1-\frac{\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}}}{\left[\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}}+(1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}\right]}=\frac{(1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}}{\left[\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}}+(1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}\right]}$$

As a result, $\frac{\partial MPL}{\partial \alpha_2}<0$ if and only if:

$$\sigma<\frac{(1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}}{\gamma(\alpha_2 L)^{\frac{\sigma-1}{\sigma}}+(1-\gamma)(\alpha_3 A)^{\frac{\sigma-1}{\sigma}}}<1$$

If the elasticity of substitution fails to satisfy the condition of Equation (6.3) in Chapter 6, and is less than one, labour augmenting technical change is not strong labour savings. Hence, an increase in α_2 will have a positive impact on the farm marginal product of labour, $\frac{\partial MPL}{\partial \alpha_2}>0$.

Appendix 6.2 **Average farm size for agricultural household (ha)**



Source: GSO (2007)

Appendix 6.3 **The effects of land fragmentation on farm outcomes, using the first difference method-log of plots**

	Farm labour supply	Farm profits	Farm output	Number of individuals in farming activities
Log of plots	0.355***	-0.115***	-0.055***	0.051
Annual crop land	0.048	0.194***	-0.022***	-0.016
Age	-0.047***	-0.003**	0.000	-0.007***
Household members, from 15 to 60 years old, people	0.260***	-0.020	0.003	0.010
Dependency ratio (%)	4.408***	-0.080	-0.016	0.358***
Mean education of working age men	0.180***	0.005	0.003	0.024**
Mean education of working age women	0.065*	0.015*	0.002	0.008
Access to formal credit	-0.012	0.048	0.008	-0.027
Log of assets	-0.025	-0.016***	0.002	0.003
Access to asphalt road	0.407**	-0.032	-0.001	-0.039
Access to electricity	0.111	-0.025	-0.002	-0.070
Access to post office	-0.341*	0.057	-0.010	0.057
Access to extension	-0.233	0.027	0.003	-0.013
Having business units in commune	0.172	-0.016	0.001	-0.123**
Having craft villages in commune	-0.452*	-0.051	-0.003	0.000
Disasters in commune	0.088	-0.027*	0.005	0.022
Having employment programs in commune	-0.101	-0.037	-0.007	0.084
Having infrastructure programs in commune	-0.049	-0.051	0.002	0.017
Having educational and vocational programs	-0.524**	0.033	-0.025*	-0.058
Having member working in state economic sector	-0.890***	-0.105	0.001	-0.054
Having member working in private economic sector	-0.463	-0.051	-0.021	-0.007
Having member working on household's own business	-1.139***	-0.118***	0.005	-0.540***
North East	-0.293	-0.011	-0.001	-0.058
North West	0.768*	-0.482***	-0.004	0.249
North Central Coast	0.066	0.075*	0.001	-0.076
South Central Coast	0.326	0.024	-0.016	-0.176**
Central Highlands	0.356	-0.128	-0.022	0.251
South East	0.537	-0.095	-0.028	0.156
Mekong River Delta	0.467*	-0.038	0.001	0.125
Constant	4.346***	-0.231	0.131***	0.793***
N	2014	1937	2014	2014
R^2	0.171	0.095	0.067	0.073

Notes: Standard errors are robust through the *cluster* option; All dependent variables are expressed as log change; ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively;
Source: Calculated from VHLSS 2004 and 2006.

Appendix 6.4 **The effects of land fragmentation on farm outcomes using the first difference method-the Simpson index**

	Farm labour supply	Farm profits	Farm output	No of individuals in farming activities
Simpson index	0.533*	-0.109	-0.092***	0.200**
Annual crop land	0.049	0.189***	-0.022***	-0.012
Age	-0.048***	-0.003**	0.000	-0.007***
Household members, from 15 to 60 years old, people	0.266***	-0.021	0.002	0.010
Dependency ratio (%)	4.423***	-0.086	-0.018	0.356***
Mean education of working age men	0.174***	0.007	0.004*	0.023**
Mean education of working age women	0.063*	0.016**	0.002	0.008
Access to formal credit	-0.020	0.050	0.009	-0.027
Log of assets	-0.025	-0.016***	0.002	0.003
Access to asphalt road	0.422**	-0.035	-0.003	-0.034
Access to electricity	0.125	-0.032	-0.003	-0.074
Access to post office	-0.353*	0.062	-0.009	0.058
Access to extension	-0.247	0.031	0.005	-0.015
Having business units in commune	0.152	-0.009	0.004	-0.126**
Having craft villages in commune	-0.468*	-0.047	-0.001	-0.002
Disasters in commune	0.088	-0.026*	0.005	0.023
Having employment programs in commune	-0.077	-0.045	-0.010	0.087
Having infrastructure programs in commune	-0.033	-0.058*	-0.001	0.017
Having educational and vocational programs	-0.518**	0.031	-0.026**	-0.057
Having member working in state economic sector	-0.877***	-0.107*	-0.002	-0.051
Having member working in private economic sector	-0.477	-0.049	-0.019	-0.006
Having member working on household's own business	-1.129***	-0.122***	0.004	-0.539***
North East	-0.222	-0.034	-0.012	-0.049
North West	0.807**	-0.492***	-0.009	0.248
North Central Coast	0.075	0.073*	-0.001	-0.075
South Central Coast	0.315	0.024	-0.014	-0.183**
Central Highlands	0.294	-0.112	-0.012	0.233
South East	0.550	-0.093	-0.030	0.158
Mekong River Delta	0.463*	-0.028	0.002	0.127
Constant	4.280***	-0.175	0.142***	0.772***
N	2014	1937	2014	2014
R^2	**0.17**	**0.087**	**0.053**	**0.074**

Notes: Standard errors are robust through the *cluster* option; All dependent variables are expressed as log change; ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively;

Source: Calculated from VHLSS 2004 and 2006

Appendix 6.5 **The effects of land fragmentation on nonfarm outcomes without selection correction using first difference method-the Simson index**

Independent variables	Nonfarm labour supply	Nonfarm profits
Simpson index	-0.646*	-0.233
Annual crop land	-0.056	0.105
Age	-0.030***	-0.023***
Household members, from 15 to 60 years old, people	0.323***	0.076
Dependency ratio (%)	1.565***	1.587***
Mean education of working age men	0.236***	0.113**
Mean education of working age women	0.141***	0.120**
Access to formal credit	0.061	0.132
Log of assets	-0.009	0.000
Access to asphalt road	0.531***	0.099
Access to electricity	-0.264	0.253
Access to post office	-0.012	0.073
Access to extension	-0.337	-0.275
Having business units in commune	0.527***	0.507**
Having craft villages in commune	0.064	-0.683**
Disasters in commune	-0.052	-0.118
Having employment programs in commune	-0.023	0.232
Having infrastructure programs in commune	-0.109	0.065
Having educational and vocational programs	-0.216	-0.421
Having member working in state economic sector	-0.239	-2.005***
Having member working in private economic sector	-0.506	-2.910***
Having member working on household's own business	-0.275	-0.594**
North East	-1.042***	0.009
North West	-0.633	0.811
North Central Coast	-0.899***	0.010
South Central Coast	0.469	1.226***
Central Highlands	-0.425	0.325
South East	-0.519	0.228
Mekong River Delta	-0.684**	0.479
Constant	2.729***	-0.077
N	2014	2014
R^2	0.102	0.07

Notes: The first difference method is used; Standard errors are robust through the *cluster* option; All dependent variables are expressed as the log change; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively;
Source: Calculated from VHLSS 2004 and 2006

Appendix 6.6 **The effects of land fragmentation on nonfarm outcomes without selection correction using first difference-log of plots**

Independent variables	Nonfarm labour supply	Nonfarm profits
Log of plots	-0.324**	-0.225
Annual crop land	-0.051	0.103
Age	-0.031***	-0.023***
Household members, from 15 to 60 years old, people	0.326***	0.080
Dependency ratio (%)	1.574***	1.600***
Mean education of working age men	0.230***	0.109**
Mean education of working age women	0.139***	0.118**
Access to formal credit	0.056	0.127
Log of assets	-0.009	0.001
Access to asphalt road	0.548***	0.107
Access to electricity	-0.259	0.266
Access to post office	-0.020	0.062
Access to extension	-0.349	-0.283
Having business units in commune	0.508***	0.494**
Having craft villages in commune	0.049	-0.693**
Disasters in commune	-0.051	-0.120
Having employment programs in commune	-0.001	0.248
Having infrastructure programs in commune	-0.097	0.077
Having educational and vocational programs	-0.210	-0.417
Having member working in state economic sector	-0.225	-1.999***
Having member working in private economic sector	-0.514	-2.921***
Having member working on household's own business	-0.267	-0.588**
North East	-0.979***	0.055
North West	-0.605	0.841*
North Central Coast	-0.893***	0.017
South Central Coast	0.451	1.224***
Central Highlands	-0.493	0.294
South East	-0.507	0.236
Mekong River Delta	-0.685**	0.474
Constant	2.655***	-0.108
N	2014	2014
R^2	0.103	0.07

Notes: The first difference method is used; Standard errors are robust through the *cluster* option; All dependent variables are expressed as the log change; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively;
Source: Calculated from VHLSS 2004 and 2006

Appendix 6.7 **The effects of land fragmentation on nonfarm outcomes using double hurdle model**

	Hurdle 1 *(using probit)*	
Variables	Probability of participating in nonfarm activities	
Simpson index	*0.043*	
Log of plots		*-0.041*
Annual crop land	-0.016	-0.012
Age of the head of household, years	0.011	0.011
Age of the head of household squared, years	0.000	0.000
Gender of the head of household, 1 for male	-0.111**	-0.111**
Marital status of the head, 1 for married	-0.178**	-0.178**
Ethnic status of the head, 1 for majority	0.343***	0.343***
Household members, from 15 to 60 years old, people	0.282***	0.282***
Dependency ratio (%)	0.201	0.202
Mean education of working age men	0.034	0.034
Mean education of working age women	0.029	0.028
Head of household has primary education	0.084	0.084
Head of household has lower secondary education	0.064	0.066
Head of household has university education	0.765*	0.766*
Access to formal credit	-0.011	-0.009
Log of assets	0.011	0.011
Days of illness	-0.001	-0.001
Having member working in state economic sector	1.698***	1.697***
Having member working in private economic sector	1.786***	1.788***
Having member working on household's own business	0.175**	0.176**
Access to asphalt road	0.135**	0.133**
Access to electricity	-0.389***	-0.386***
Access to post office	-0.156**	-0.152**
Access to extension	-0.179*	-0.180*
Inland delta areas	0.315***	0.313***
Remote areas	-0.291***	-0.296***
Having business units in commune	0.09	0.091
Having craft villages in commune	0.372***	0.366***
Disasters in commune	-0.021	-0.021
Having employment programs in commune	0.113*	0.114*
Having infrastructure programs in commune	0.117**	0.118**
Having educational and vocational programs	0.07	0.071
Year 2006	0.408***	0.397***
North East	-0.339***	-0.336***
North West	-0.428***	-0.424***
North Central Coast	-0.521***	-0.521***
South Central Coast	-0.157*	-0.171*
Central Highlands	-0.292**	-0.318**
South East	-0.489***	-0.531***

Mekong River Delta		-0.698***	-0.751***
Constant		-1.135***	-1.130***
Pseudo R^2		0.2765	0.2766
Mundlak fixed effects		Yes	Yes
Number of observations		4028	4028

			Hurdle 2 (*using truncreg)*	
Variables	Nonfarm labour supply	Nonfarm profits	Nonfarm labour supply	Nonfarm profits
Simpson index			*-0.120**	*-0.291****
Log of plots	*-0.026*	*-0.154****		
Annual crop land (ha)	-0.001	-0.053***	0.012	0.000
Age of the head of household, years	-0.018	-0.022	-0.018	-0.028
Age of the head of household squared, years	0.000	0.000	0.000	0.000*
Gender of the head of household, 1 for male	0.002	-0.007	0.002	-0.008
Marital status of the head, 1 for married	-0.006	0.151**	-0.004	0.148*
Ethnic status of the head, 1 for majority	0.129**	0.438***	0.132**	0.441***
Household members, from 15 to 60 years old	0.193***	0.231***	0.195***	0.224***
Dependency ratio (%)	0.371**	0.863***	0.373**	1.005***
Mean education of working age men (years)	-0.009	0.066***	-0.011	0.004
Mean education of working age women	0.004	0.040***	0.003	0.037
Head of household has primary education	0.038	0.138**	0.037	0.145***
Head of household has lower secondary education	0.017	0.103**	0.016	0.099**
Head of household has university education	-0.131	0.011	-0.137	-0.011
Access to formal credit	-0.028	0.029	-0.028	0.031
Log of assets	-0.005	-0.002	-0.005	-0.009
Days of illness	0.000	0.000	0.000	0.000
Having member working in state sector	0.237***	0.488***	0.235***	0.480***
Having member working in private sector	0.238***	0.290***	0.240***	0.301***
Having member working on their own business	-0.062	-0.077	-0.063*	-0.081**
Access to asphalt road	0.039	0.040	0.040	0.043
Access to electricity	-0.043	-0.024	-0.045	-0.043
Access to post office	-0.038	-0.134***	-0.035	-0.132**
Access to extension	-0.020	-0.057	-0.021	-0.061
Inland delta areas	0.029	0.054	0.031	0.065
Remote areas	-0.033	-0.131	-0.035	-0.118
Having business units in commune	0.063*	0.146***	0.065*	0.154***
Having craft villages in commune	0.050	0.093*	0.048	0.101*
Disasters in commune	-0.003	-0.020	-0.002	-0.015

Having employment programs in commune	-0.023	0.015	-0.025	0.004
Having infrastructure programs in commune	0.002	-0.059	0.003	-0.062
Having educational and vocational programs	-0.033	-0.102*	-0.036	-0.109*
Year 2006	0.200***	0.034	0.200***	0.062***
North East	-0.055	-0.175**	-0.059	-0.191**
North West	-0.280***	-0.250*	-0.287***	-0.282*
North Central Coast	-0.196***	-0.396***	-0.195***	-0.393***
South Central Coast	-0.055	0.095	-0.059	0.108
Central Highlands	-0.015	-0.486**	-0.031	-0.471***
South East	0.023	0.276***	0.004	0.304***
Mekong River Delta	-0.195***	0.015	-0.210***	0.086
Constant	7.766***	8.338***	7.805***	8.596***
N	2008	2008	2008	2008
Mundlak fixed effects	Yes	Yes	Yes	Yes

Notes: Standard errors are robust through the *cluster* option; All dependent variables are expressed as the log change; ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively;
Source: Calculated from VHLSS 2004 and 2006.

Appendix 6.8 **The effect of land fragmentation on nonfarm outcomes using Wooldridge (1995)**

Independent variables	Nonfarm labour supply	Nonfarm profits	Nonfarm labour supply	Nonfarm profits
Simpson index	*-0.122**	*-0.297****		
Log of plots			*-0.023*	*-0.143****
Annual crop land	0.014	0.006	0.011	0.008
Age of the head of household, years	-0.017	-0.025	-0.017	-0.025
Age of the head of household squared, years	0.000	0.000	0.000	0.000
Gender of the head of household, 1 for male	0.006	0.007	0.007	0.008
Marital status of the head, 1 for married	0.002	0.170***	0.001	0.170***
Ethnic status of the head, 1 for majority	0.118**	0.386***	0.116**	0.379***
Household members, from 15 to 60 years old, people	0.186***	0.194***	0.185***	0.190***
Dependency ratio (%)	0.372*	0.997***	0.371*	0.988***
Mean education of working age men	-0.014	-0.003	-0.011	0.003
Mean education of working age women	0.001	0.030	0.002	0.031
Head of household has primary education	0.035	0.138***	0.036	0.142***
Head of household has lower secondary education	0.013	0.090*	0.015	0.095**
Head of household has university education	-0.144	-0.034	-0.141	-0.034
Access to formal credit	-0.026	0.035	-0.026	0.038
Log of assets	-0.006	-0.010	-0.006	-0.010
Days of illness	0.000	0.000	0.000	0.001
Having member working in state economic sector	0.193***	0.332***	0.197***	0.331***
Having member working in private economic sector	0.205***	0.179***	0.204***	0.167**
Having member working on household's own business	-0.062	-0.074	-0.060	-0.069
Access to asphalt road	0.036	0.031	0.036	0.027
Access to electricity	-0.034	-0.007	-0.033	0.003
Access to post office	-0.030	-0.106*	-0.033	-0.103*
Access to extension	-0.016	-0.042	-0.015	-0.036
Inland delta areas	0.021	0.026	0.019	0.017
Remote areas	-0.023	-0.080	-0.018	-0.072
Having business units in commune	0.062*	0.141***	0.061*	0.144***
Having craft villages in commune	0.037	0.062	0.039	0.050
Disasters in commune	-0.002	-0.013	-0.002	-0.013
Having employment programs in commune	-0.029	-0.010	-0.027	-0.005
Having infrastructure programs in commune	0.001	-0.070*	0.001	-0.069*
Having educational and vocational programs	-0.036	-0.109*	-0.034	-0.107*
Inverse Mill ratio (2004)	-0.059	-0.164*	-0.057	-0.177*
Inverse Mill ratio (2006)	-0.090	-0.360***	-0.087	-0.371***
Year 2006	0.204***	0.124**	0.203***	0.095

North East	-0.048	-0.153**	-0.044	-0.130*
North West	-0.275***	-0.239*	-0.265***	-0.188
North Central Coast	-0.180***	-0.338***	-0.181***	-0.335***
South Central Coast	-0.056	0.114*	-0.051	0.100
Central Highlands	-0.022	-0.438**	0.001	-0.412**
South East	0.021	0.365***	0.043	0.350***
Mekong River Delta	-0.187***	0.165**	-0.166***	0.141*
Constant	7.863***	8.789***	7.856***	8.736***
R^2	0.249	0.312	0.248	0.314
Mundlak fixed effects	Yes	Yes	Yes	Yes

Notes: All dependent variables are expressed as the log change; *, **, *** indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively;
Source: Calculated from VHLSS 2004 and 2006.

Appendix 6.9 **Factors influencing the land fragmentation of a farm household, using first difference**

Independent variables	Log of plots		Simpson index	
	Coef.	P value	Coef.	P value
Annual crop land	-0.036***	0.000	-0.025***	0.000
Age	0.000	0.711	0.000	0.683
Household members, from 15 to 60 years old, people	0.022*	0.077	0.005	0.320
Dependency ratio (%)	0.096	0.118	0.035	0.188
Mean education of working age men	-0.014**	0.037	0.002	0.439
Mean education of working age women	-0.010*	0.080	-0.002	0.382
Access to formal credit	-0.031	0.250	-0.006	0.560
Log of assets	0.007*	0.078	0.004**	0.028
Access to asphalt road	0.020	0.494	-0.016	0.193
Access to electricity	0.084**	0.010	0.037***	0.008
Access to post office	-0.078**	0.025	-0.026*	0.089
Access to extension	-0.048	0.452	-0.003	0.905
Having business units in commune	-0.059**	0.042	-0.001	0.969
Having craft villages in commune	-0.040	0.317	0.002	0.905
Disasters in commune	-0.021*	0.055	-0.013***	0.006
Having employment programs in commune	0.059*	0.071	-0.003	0.809
Having infrastructure programs in commune	0.058**	0.034	0.012	0.289
Having educational and vocational programs	0.019	0.599	0.000	0.975
Having member working in state economic sector	0.011	0.814	-0.016	0.431
Having member working in private economic sector	-0.067	0.329	-0.022	0.372
Having member working on household's own business	0.031	0.377	0.002	0.896
North East	0.209***	0.000	0.008	0.649
North West	0.162**	0.019	0.041	0.146
North Central Coast	0.043	0.270	0.011	0.517
South Central Coast	0.046	0.349	0.048***	0.010
Central Highlands	-0.039	0.585	0.083***	0.009
South East	0.068	0.408	0.012	0.716
Mekong River Delta	-0.014	0.757	-0.009	0.666
Transfer of land use right certificates in the commune	-0.015***	0.008	-0.006**	0.011
Constant	-0.062	0.562	0.086*	0.058
N	2014		2014	
R^2	0.077		0.052	

Notes: Standard errors are robust through the *cluster* option; All dependent variables are expressed as the log change; ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively.
Source: Calculated from VHLSS 2004 and 2006.

Appendix 6.10 **Testing the endogeneity of land fragmentation, using the control function**

Independent variables	Farm labour supply			
	Coef.	SE	Coef.	SE
Log of plots	*-0.393*	*2.137*		
Residual of log of plots	0.751	2.138		
Simpson index			*-0.982*	*5.349*
Residual of Simpson index			1.520	5.358
Annual crop land	0.021	0.092	0.010	0.144
Age	-0.048***	0.006	-0.047***	0.006
Household members, from 15 to 60 years old, people	0.277***	0.087	0.274***	0.078
Dependency ratio (%)	4.478***	0.425	4.475***	0.416
Mean education of working age men	0.169***	0.046	0.177***	0.038
Mean education of working age women	0.057	0.041	0.059	0.036
Access to formal credit	-0.036	0.169	-0.030	0.159
Log of assets	-0.020	0.026	-0.019	0.029
Access to asphalt road	0.421**	0.172	0.397**	0.190
Access to electricity	0.190	0.306	0.193	0.320
Access to post office	-0.393	0.256	-0.388	0.242
Access to extension	-0.260	0.368	-0.245	0.361
Having business units in commune	0.132	0.206	0.154	0.177
Having craft villages in commune	-0.485*	0.268	-0.467*	0.251
Disasters in commune	0.074	0.082	0.069	0.098
Having employment programs in commune	-0.049	0.239	-0.075	0.192
Having infrastructure programs in commune	0.004	0.222	-0.006	0.185
Having educational and vocational programs	-0.511**	0.212	-0.518**	0.209
Having member working in state economic sector	-0.881***	0.283	-0.902***	0.297
Having member working in private economic sector	-0.522	0.431	-0.518	0.422
Having member working on household's own business	-1.116***	0.184	-1.126***	0.173
North East	-0.132	0.528	-0.206	0.258
North West	0.908	0.571	0.885*	0.490
North Central Coast	0.096	0.252	0.089	0.243
South Central Coast	0.351	0.294	0.381	0.365
Central Highlands	0.306	0.472	0.403	0.593
South East	0.564	0.402	0.549	0.399
Mekong River Delta	0.436	0.276	0.433	0.282
Constant	4.313***	0.570	4.421***	0.737
N	2014		2014	
R^2	0.172		0.17	

Notes: Standard errors are robust through the *cluster* option; All dependent variables are expressed as the log change; ∗, ∗∗, ∗∗∗ indicates that the corresponding coefficients are significant at the 10%, 5%, and 1% levels, respectively;
Source: Calculated from VHLSS 2004 and 2006.

Chapter 7

Conclusions and policy implications

7.1 Main findings

Although there have been major land policy reforms in Vietnam, small farms continue to dominate. Farms less than one hectare account for more than 85 per cent of the country's total 10 million farm households (GSO 2012). In the new setting of industrialisation process and income growth, the 'rice first' policy and the place of smallholder agriculture have recently been raised by policy makers in the discussion on reforming agricultural policies. There has so far been no definitive policy resolution of the optimal structure of Vietnam's smallholder agriculture. The balance between efficiency and equity, between lowering production costs and raising prices, is a challenge for policy makers. As stated in Chapter 1, the objective of the thesis is to contribute to designing appropriate agricultural development strategies for Vietnam, based on empirical analysis at the farm household level. The thesis mainly focuses on the following four policy issues: crop diversification; the development of the rural nonfarm economy; land reforms directed towards land consolidation; and input supporting policy for small farms.

The study contains seven chapters. All except Chapters 1 and 7 are written as one consistent theme essay on the transformation of smallholder agriculture. The research questions are addressed in three analytical core chapters, 4 to 6. Chapter 2 reviews relevant theories and experience of the agricultural transformation in some Asian countries in order to establish the stage for the ensuing analysis. I first review the Fei-Ranis growth model of a labour-abundant economy for investigating the effect of structural change on agriculture. Chapter 2 shows that the dual economy model does not provide any insights into what happens on a micro-level that would enable people to move up economically by participating in off-farm employment. I then present the theory of induced technical change and institutional innovations by Hayami and Ruttan (1985). Next, there is further more discussion on the agricultural problems of land-poor countries, and the experience of some East Asian countries during agricultural transformation. These discussions on both theories, and development experience, imply that the comparative advantage of smallholder agriculture is declining in the face of rising rural wages and the movement of labour to nonfarm sectors. In addition, small-farm led agricultural growth based on cereal production is becoming less

relevant, and less able to avoid a widening income gap. In the final section, the chapter discusses the analytical framework of policy reforms aimed at strengthening technical changes and institutional innovations to improve agricultural productivity and household incomes.

Chapter 3 provides an overview of Vietnam's agricultural reforms and structural transformation since 1986. The descriptive findings in this chapter show that although agriculture's share of Vietnam's GDP has now shrunk to below 20 per cent, farming still offers a livelihood for two-thirds of the country's population and employs more than 50 per cent of Vietnam's total workforce. Despite the successful story of food self-sufficiency over the past decades, Vietnam's agricultural transformation has been following the path same as other East Asian economies. First, a prominent characteristic of rice production in Vietnam is that it is carried out by a large number of rice farmers, who have tiny and fragmented farms, and labour-intensive farming in light of rising rural wages. The average farm sizes per household have shown virtually no increase during this period of fast structural transformation. Second, Vietnam maintains its "rice first" policy to ensure food self-sufficiency. Rice farmers have an economic incentive to diversify their livelihoods because of the low income from rice production. They are prevented from doing so by legal restrictions on land reallocation away from rice production. This rice policy is in conflict with the desire of small farm households to diversify their output. Finally, there is a conflict of objectives between food security policy, and policy that promotes rural structural transformation, which requires the development of off-farm employment. The expansion of rural nonfarm economies and the increase in part-time farming, is a concern for policy makers in ensuring long-term food security in Vietnam.

Chapter 4, 5, and 6 provide the analytical core of the thesis. Table 7.1 summarises the research questions and the answers in each core chapter. Chapter 4 explores the merits of crop diversification. Specifically, it measures the performance of diversified farms and response of farm households to increasing cost stress using a stochastic input distance function approach. Chapter 5 examines the effects of labour movement into nonfarm activities on rural household production choices. The analysis uses panel data for Vietnam from 2004 to 2006 and different methods (including the OLS first difference, 2SLS first difference and matching techniques) to verify the consistency of the empirical results. Chapter 6 investigates the impacts of land fragmentation on the economic diversity of farm households. To develop the empirical analysis, a model is presented in which the estimated impact of land fragmentation on economic diversification allows for non-neutral technical change.

Table 7.1 **Summary of research questions and main findings in Chapter 4, 5 and 6**

Research questions	Main findings
Chapter 4 - *Does crop diversification result in scale economies and output complementarity in agricultural production?*	- Scale economies were found in multiple crop production. The elasticity of output with respect to total inputs is 1.075, implying that when total inputs increase by 1 per cent, total outputs of production increase by 1.075 per cent. Equivalently, when total outputs increase by 1 per cent, total costs of production rise by only 0.93 per cent. This finding reveals that slightly increasing returns to scale are evident in Vietnam's multiple crop production. In addition, the increase in rice production reduces the marginal utilization of inputs for producing other crops. As a result, crop combinations result in cost savings in the production process. Thus, significant output complementarity is found between rice production and other crops. This finding also implies the potential presence of economies of scope, which has important economic performance implications.
- *How can technical efficiency be improved in a multi-output environment?*	- Another finding is that there is substantial technical inefficiency in multiple-crop farming implying opportunities to expand crop output by 18.7 per cent without greater use of inputs or improved technologies in farm production. The mean technical efficiency of multiple crop farming is higher than other estimates of previous studies focusing on only rice The improvement of education, particularly for women and the reduction of the dependency ratio contribute to improving technical efficiency. The estimated result shows that the impact of women's education on technical efficiency is much greater than the impact of men's education. Furthermore, land reforms aimed at the reduction of land fragmentation and proper land rights contribute to improving technical efficiency. Finally, the participation in nonfarm employment of family members also improves technical efficiency in multi-output production.
- *How does farm labour respond to increasing cost stress in multi-crop production?*	- Results also show that households with smallholder production respond to rising cost stress in multiple crop environments. Family labour and other inputs such as fertilisers, pesticides and capital are complementary, which means that farm labour usage falls when the prices of these inputs increase. This finding contributes to the literature on the 'push' factors of labour allocation in smallholder farms. The result also shows that there is substitution between family labour and hired labour. Farm households can allocate more hours to nonfarm work by hiring replacement workers on the farm.

Table 7.1 **Continued**

Research questions	Main findings
Chapter 5 *- What choices of agricultural production do small farms make when household members participate in nonfarm activities and part-time farming increases? Are nonfarm activities of farm households complementary to agricultural production?*	- In rural Vietnam, nonfarm participation has higher returns than farming and contributes to improving household welfare. The analysis finds evidence that labour movement to nonfarm sectors reduces rice production. Moreover, aggregate agricultural production declines significantly and there are negative effects on farm revenue of labour movement into nonfarm activities. These findings suggest that regardless of the level of agricultural market integration of farm households, labour movement into nonfarm activities reduces rice production. Nonfarm employment is complementary to agricultural production. However, these conclusions are limited in the north of Vietnam, and not to the south. - The chapter finds no evidence of the effects of nonfarm participation on non-rice agricultural revenue and livestock expenditure. As a result, households that participate in nonfarm sectors in the north have readjusted their production structure by investing in livestock sectors and other crops that require less labour. Rice farmers are struggling to survive in rice production. Similarly, in the face of increasing nonfarm participation, rice farmers in the south have managed to keep their rice production unaffected by hiring more labour to substitute for family labour during periods of peak labour demand, and investing in more capital to facilitate less labour-intensive farming. This chapter finds that nonfarm incomes partially compensate for the labour reallocation effect by enabling more labour spending on hired labour and capital. This finding provides evidence that nonfarm incomes relax liquidity constraints on expanding crop production through purchased inputs, at least in the short run. - This chapter concludes that the participation of family members in nonfarm activities has only a small effect on rice production in Vietnam. While the decline in agricultural revenue in the north suggests some level of substitution between farming and nonfarm income generation strategies, the stability in rice production at the national level brings welcome news to policy makers and food production in Vietnam, despite rapid structural change over the past decades. However, agriculture in the north is losing its comparative advantage as farm households reduce their investment in agriculture.

Table 7.1 **Continued**

Research questions	Main findings
Chapter 6 *- Do land reforms directed towards land consolidation affect labour allocation and economic diversity in farm households? If so, how does it affect them?*	- Based on theoretical analysis, if a technical change is Hicks-neutral, it leads to more on-farm labour supply. Conversely, if technical change is labour saving and the elasticity of substitution is low enough, then it can reduce farm labour supply and release more labour to other sectors. The chapter has tested these theoretical predictions by developing an empirical analysis of the impact of land consolidation on nonfarm and farm outcomes. - The chapter finds that the reduction of land fragmentation reduces farm labour supply and labour intensity. In addition, it improves farm profits and agricultural productivity. If land fragmentation declines by 1 per cent, farm labour supply decreases by 0.36 per cent. Farm profits and productivity per hectare increase by 0.12 per cent and 0.055 per cent, respectively. Similarly, land consolidation releases more farm labour to nonfarm sectors and increase nonfarm profits. The chapter uses the methods of panel data and the correlated random effect model to control the unobserved heterogeneity and sample selection bias. - The empirical evidence also shows that factor biased technical change plays an important role in explaining the effect of agricultural productivity on economic diversification and income. If technical change is labour saving as in the case of land consolidation, it results in the release of more farm labour. Therefore, these results are consistent with theoretical predictions that the application of labour saving agricultural technical changes reduces labour demand and induces labour reallocation in farm households. The chapter also points to a linkage between the farm and nonfarm sector. The productivity improvement in the farm sector will promote the development of the nonfarm economy and economic diversification of households. From the survey data from 2004 to 2006, there is no evidence that the emerging land markets support land consolidation.

7.2 Policy implications

Since 1989, after more than half a century of importing rice, along with famines occurred in the 1970s and 1980s, Vietnam has implemented the 'rice first' policy to sustain rice self-sufficiency. Policy makers are reluctant to change the 'rice first' policy because rising rice output and exports are considered important indicators of the government's success. As a result, the opportunity cost of rice production has increased in recent years. While small rice farms are struggling to survive and have to diversify their livelihoods, the current rice policy has blocked the conversion of paddy land to other crops or nonfarm activities. More rice cannot solve the problem of food insecurity when income from rice production is declining.

The thesis has some key policy implications for reforming Vietnam's smallholder agriculture. First, as discussed in the theoretical framework, land reform is a crucial factor for maintaining the comparative advantage of agriculture in light of rising rural wages. Second, the current 'rice first' policy should be relaxed to improve rural household welfare. Third, crop diversification is a desirable strategy in the agricultural transformation of Vietnam. Fourth, rice production at the national level is still stable, to a significant extent, despite rising part-time farming of farm households. Fifth, due to increasing cost stress, supporting policies related to inputs is important to maintain incentives in agricultural production of diversified farms. Sixth, land reforms directed toward land consolidation result in less labour-intensive farming and promote the economic diversity of farm households. Finally, the creation of off-farm jobs and labour allocation to other sectors is a key policy framework for Vietnam's agricultural and rural development.

7.2.1 Crop diversification strategy

The policy implication of this research emphasises the need to design policies to promote crop diversification for small farms - this has been found to improve productivity through scale economies, output complementarity and technical efficiency improvement. The Vietnamese government seems to give priority to rice self-sufficiency policies rather than the incomes of farmers. Kompas et al. (2012) also conclude that the mandate to grow rice in all provinces, (at least, in terms of defined efficiency criteria), is not appropriate. The recent thrust of the Vietnamese government to promote diversification in the Strategy of Agriculture and Rural Development (2011-2020) is a positive step. Crop diversity should be expanded to improve the

incomes of farm households. Moreover, as part of an FAO nutrition-sensitive food systems approach, crop diversification improves the nutritional health status of low-income households through the increased production of nutrient-rich foods for direct consumption and generation of the income needed to procure the amount and variety of food that families need (FAO 2012).

In addition, the improvement of education, particularly for women, and the reduction of the dependency ratio both contribute to improving the technical efficiency and productivity of diversified farms. Thus, the development of a hired labour market and training programs for women are desirable in order to encourage more women to participate in the production process, and contribute to improving productivity and efficiency.

7.2.2 The development of the nonfarm economy

It is widely recognised that low farm incomes in smallholder agriculture push working members of land-poor farm households into nonfarm activities. Rural households are diversifying their livelihoods and thereby improving household welfare. However, polices that keep agricultural production stable place food self-sufficiency into conflict with the goals of improvement of household welfare and rural structural transformation. Rozelle et al. (1999) argue in the context of China that the policy tension facing policy makers is whether the increase in household welfare is sufficient to offset the reduction in grain output. Politically, policy makers who are concerned about food security that when more farm labour moves into nonfarm employment, food security is compromised. Consequently, food security policy always means the 'rice first' policy in Vietnam, despite the declining trend of income from rice production.

The findings in this thesis show that rice production at the national level is still stable, in spite of Vietnam's rapid rural structural transformation. Therefore, such a policy should aim to develop the nonfarm sector so as to provide ample employment opportunities for the rural labour force. Vietnam should change its approach toward food security, particularly the rice self-sufficiency policy. Food self-sufficiency does not imply food security (Warr 2014). Rice farmers with small and fragmented landholdings are struggling to survive and have to diversify their livelihoods. The increase in nonfarm incomes contributes to improving the purchasing power of farm households. In addition, credit reforms could support farm households by relaxing liquidity

constraints and thus promoting investment in farm production in response to increasing labour movement out of farming. In addition, the development of labour markets in rural areas is also important in alleviating the negative effect of the reduction in family labour. If these reforms are successful, nonfarm income may be invested in expanding nonfarm activities and facilitating sustainable rural transformation.

7.2.3 Land reforms directed toward land consolidation

Otsuka (2013 and 2015) finds that in the economic development of Asia, the consolidation of land parcels is needed to promote large mechanisation and maintain the comparative advantage in agriculture. The reduction of land fragmentation will create more incentives to apply mechanisation in farming production and improve productivity.

Evidence in this thesis indicates that land consolidation is an appropriate public policy. The issues of land use have become an important threshold that Vietnam has get to reform despite the increasing public investment in agriculture. Thus, if land policies encourage more consolidated land holdings, they will release more farm labour and result in the economic diversification of farm households. The findings shows that land reforms, such as land consolidation programs, free up labour to work in other sectors, and to invest in the creation of human capital. Furthermore, land reforms toward the reduction of land fragmentation and proper land rights should be strengthened to improve technical efficiency in multi-crop production. As Warr (2009) concludes, these released resources are used more productively in other sectors and improve the productivity of the country. In addition, the expansion of land intuitions to develop land markets, such as land ownership rights and the promotion of land rental markets, are key factors for the next reforms if Vietnam is to accelerate the land consolidation process, mainly implemented through plot exchange and depends greatly on the quality of land governance.

7.2.4 Input supporting policy

The findings of Chapter 4 show that on diversified farms, input use is sensitive to the cost of inputs. Family labour use falls if the costs of fertiliser, pesticides and seed increase, implying that these inputs are complements. The discussion in Chapter 3 also points to the cost stress that squeezes farmers' profits. Policies that lead to more incentives to invest in crop farming activities should focus on the reduction of input costs. The government should spend more resources on reducing prices of

fertilizers, pesticides and hiring capital for farmers. The evidence on the elasticity of substitution between farm labour and fertilisers and pesticides indicates that the decline in the cost of these can have a positive effect on the probability that a household demands family labour, which in turn can reduce the increasing trend of the abandonment of agricultural production in rural Vietnam.

The adjustment of the cost structure also impacts on the rural labour market when more farmers work for farm wages (Akram-Lodhi, 2005). The result shows that there is substitution between family labour and hired labour. With the increasing participation of smallholders in off-farm activities, the reliance on hired labour is more important for producers. The farm household can allocate more hours to off-farm work by hiring replacement workers on the farm. Therefore, it would be expected that a large increase in government input subsidies would have a significant impact on the flow of labour into farming activities. Warr and Yusuf (2014) find that in Indonesia input subsidies such as fertiliser have large and positive impacts on unskilled wages.

7.3 Directions for further research

Although the three topics in this research address some questions about policy reforms for smallholder agriculture in Vietnam, many questions remain unanswered and therefore more studies are needed at the household level. First, do rising rural wages result in more mechanization in agricultural production? In the future, it would be useful if farm surveys captured the trend of mechanisation in crop production. Second, future research should investigate the risk effects in understanding the economies of diversification of farm households. Third, future research should examine the impact that policy reforms such as agricultural diversification and land institutions have on poverty reduction and household welfare. Fourth, future research needs to understand better the behaviour of remaining members in a family related to farm production such as incentives to work less or more. Fifth, the expansion of remittances from non-household members may conceivably crowd out existing nonfarm incomes from current household members and reduce incentives to work. The crowding out effects should be further investigated in future research.

Sixth, return migration section should be surveyed in household living standard datasets in Vietnam, particularly the migration history needed to capture information on those non-household members who send remittances to local communities. In this case, it is

possible to use migration and remittances simultaneously in the framework of NELM model. Finally, the analysis examined a sample of continuously existing farms, operated either full-time or part-time. Farm exits were not considered. Future research should capture the dynamics of employment to understand more fully household behaviour during the agricultural transformation.

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