Household Livelihood Strategies, Environmental Dependency and Poverty: the Case of the Vietnam Rural Area

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Abstract

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This study explores households' dependency on environmental income for households that engage in different livelihood strategies. This study also investigates the impact of environmental income on rural household poverty and inequality, and identifies factors that determine the choice of rural households' livelihood strategies in rural communities in Vietnam.

A cluster analysis identifies five livelihood strategies: wage dependency; non-farm, non-wage dependency; mixed-income dependency; transfer dependency; and environment dependency. Households engaging in various livelihood strategies differ in their asset endowments. Households engaging in environmental dependency strategy are more likely to have abundant labour, land and physical capital. However, those following more remunerative livelihood strategies, such as mixed-income and non-farm, non-wage dependencies, are more likely to be endowed in financial and social assets.

Environmental income accounts for 40.65% of total household income, of which 36.89% comes from agricultural activities and 3.77% comes from common property resources extraction. In addition, the study finds that environmentally dependent households are the most reliant on environmental resources in both relative and absolute terms. Environmental income provides 82.48% of total income to households in this strategy group, which is worth about 11.8 million VND per capita per year. This amount is significantly higher than that of the other strategy groups.

The findings confirm the contribution of environmental income to income inequality and poverty reduction. In terms of income inequality, on average, the inclusion of environmental income reduces the Gini coefficient by more than 20%, from 0.598 to 0.475. With respect to rural poverty, environmental income reduces the poverty headcount index, poverty gap and poverty severity by 28.0%, 22.5% and 18.7%, respectively.

This study also provides evidence that households' asset endowments and contextual factors have an important influence on the choice of household livelihood strategy. Family size, agricultural land

owned, livestock herds, ownership of productive equipment and distance to all-weather roads all increase the likelihood that a household follows the environment dependency strategy. However, the educational level of the household head, social networks and credit loan accessibility has negative influences on the likelihood that a household is highly dependent on environmental resources. These characteristics constrain households from shifting to strategies that are more remunerative. Other variables also have mixed effects on the choice of household livelihood strategy.

In terms of policy implications, the results of this study suggest that policies should focus on enhancing the productivity of agricultural land plots owned by households rather than increasing households' access to common property resources. In addition, effective pro-poor policies should be targeted towards assisting the poor to shift to higher-return activities, such as wage employment and/or non-wage, non-farm businesses by investing in diploma education in rural areas, improving the road infrastructure and relaxing credit constraints in rural areas.

Keywords: Environmental income, household livelihood strategies, poverty and inequality

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Chapter 1

Introduction

1.1 Rationale of the Study

Environmental resources are important components of a nation's total wealth, especially for low-income countries. In the attempt to estimate the value of environmental resources of 120 countries around the world, the World Bank (2006) identified that, in poor countries, the share of environmental resources make up more than 20% of gross domestic product (GDP), of which the majority is derived from agricultural land, subsoil assets and timber and non-timber forest resources. A similar result is found in Vietnam in which natural capital accounts for 27% of total wealth (Tarp et al., 2007). At the household level in rural areas, environmental income accounts for 28% of total household income, 77% of which is derived from natural forests (Angelsen et al., 2014).

In the rural livelihood context, environmental income can be considered as "income earned from wild or uncultivated natural resources." (Vedeld, Angelsen, Sjaastad, & Kobugabe Berg, 2004, p.5). Meanwhile, United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), the World Bank (WB), World Resources Institute (WRI) (2005, pp. 34-35) defined environmental income in a broader manner, in which income from both uncultivated and cultivated natural resources are also considered as components of environmental income. Despite the difference in definition, there is a shared agreement that environmental income plays three primary roles in supporting rural likelihoods: (1) by supporting current consumption; (2) by providing safety-nets in response to shocks and gap-filling of seasonal shortfalls; and (3) by providing the means to accumulate assets and a have pathway out of poverty (Angelsen & Wunder, 2003). However, rural households are heterogeneous in demographic characteristics, asset holdings and are affected by different contextual factors. Therefore, the level of environmental resource use and the extent to which households depend on environmental income might not be the same across household's poverty status for households pursuing different livelihood strategies. In a meta-analysis of approximately 8,000 households from 24 countries, Angelsen et al. (2014) found that the poor rely more heavily on environmental resources. However, the rich tend to have a greater amount of resource extraction. In comparing household strategies, Babulo et al. (2008) found that asset-poor households rely more on forest-dominated activities. In contrast, the role of environmental resources is found to be consistent in all households despite their different livelihood strategies (Nielsen, Rayamajhi, Uberhuaga, Meilby, & Smith-Hall, 2013).

Over the last two decades, Vietnam has achieved a remarkable record in poverty reduction. However, according to the updated 2010 GSO-WB poverty line, 20.7% of Vietnam's population is still poor, with 27% in rural areas, 6% in urban areas, and with 8% of the population remaining extremely poor (World Bank, 2012). These poor people depend heavily on environmental assets as a key source of income from farming, forestry, fisheries, tourism, and other activities that depend directly upon the quality of the environment. The Vietnam Poverty Environment Program reports that where environmental assets are low in quantity or quality, poor people still identify them as highly valuable and irreplaceable because they have little access to other assets, especially financial assets (Bass et al., 2010). In other words, poor people are especially vulnerable to changes in environmental income due to external shocks, such as environmental hazards, environment degradation and/or changes in natural resource management that affect their access to environmental resources.

To the best of our knowledge, studies on environmental income in rural livelihoods are increasing ; however, they have yet to be widely included in rural income and livelihood studies and, if they are available, high quality of environmental income data is considered too difficult and costly to obtain (Angelsen, Larsen, Lund, Smith-Hall, & Wunder, 2011; UNDP et al., 2005). A similar conclusion can be found in the study of Mamo, Sjaastad, and Vedeld (2007), which indicates that poverty surveys in developing countries normally omit information about environmental resources. As the result, the rural poor have not effectively employed environmental resources as a potential wealth-creating asset (UNDP et al., 2005). In the context of Vietnam, the role of environmental resources has been investigated at the national level (Tarp et al., 2007). At the household level, the role of environmental resources and its impact on rural household livelihoods is rarely undertaken. Finally, there are very few studies about dependence on environmental income, as defined by the UNDP et al. (2005) in the literature. Therefore, the aim of this study is to conduct a comprehensive analysis about environmental income to fill the gap in the literature.

1.2 Aims and Objectives

The study aims to investigate the relationship among household livelihood strategies, environmental dependence and poverty in rural areas of Vietnam.

The specific research objectives are to:

i) Provide an overview of rural household dependence on environmental income across households engaging in different livelihood strategies in Vietnam;

ii) Analyze the impacts of environmental income on Vietnam's rural household poverty and inequality;

iii) Determine the factors that affect livelihood strategy choices with a focus on rural households' reliance on environmental resources in Vietnam.

1.3 Research questions

The specific research questions addressed in this study are:

i) What are the differences in household dependence on environmental income across households that engage in different livelihood strategies in rural Vietnam?

ii) What is the impact of environmental income on rural household poverty and inequality in Vietnam?

iii) What factors determine the choice of rural household livelihood strategies in Vietnam?

1.4 Significance of the Study

The significant influence of environmental income on the poverty of rural households in developing countries has been documented in many studies (Mamo et al., 2007; Narain, Gupta, & van 't Veld, 2008; Vedeld et al., 2004). This income also contributes to inequality reduction; that is, without the inclusion of environmental income in the calculation of the Gini coefficient, income inequality increases (Angelsen et al., 2014; Fisher, 2004; Kamanga, Vedeld, & Sjaastad, 2009; Mamo et al., 2007). However, the poverty and inequality of households who belong to different income quintiles and livelihood strategy groups may be affected by environmental income to various degrees. For example, the poorer households depend more heavily on environmental resources (Cavendish, 2000; Kamanga et al., 2009; Thondhlana & Muchapondwa, 2014). With respect to environmental dependency across household strategy categories, the agricultural environment-based strategy group exhibits the highest level for both poverty incidence and environmental dependency (Walelign, 2015). In the context of Vietnam, the dependence on environmental resources in rural communities is rarely researched. The study about the dependency of rural households on non-timber forest products in Nghe An by Quang and Anh (2006) is one of the very few studies conducted on this topic. In addition, no study has addressed the dependency of rural households in Vietnam on environmental resources across different household livelihood strategies. As a result, this current study about the nexus of household's livelihood strategy choice, environment dependence and poverty across different household livelihood strategies is the first to enhance our understanding of the extent to which environmental income influences the welfare of households using different livelihood strategies. Secondly, the findings of this study also help to answer the questions: What income strategy is predominant in Vietnam rural communities and what factors determine household livelihood strategy choice? This information is not only critical for policy makers to

evaluate which strategy policies they should aim for but it is also invaluable for understanding why some households could not get out of poverty even though their optimal strategies are chosen (Roy et al., 2007).

To the best of our knowledge, except for a study by Walelign (2015), which examines the impact of income from agriculture and wild resources together, other studies only consider environmental income as " income earned from wild or uncultivated natural resources," based on Vedeld's (2004, p5) definition. However, according to UNDP et al. (2005), income from wild resources is only one part of the environmental income equation. All income earned from ecosystem goods and services should be included, especially income from agricultural activities. For countries where income from wild resources only accounts for a minor proportion of the household's total income, like Vietnam, UNDP et. al (2005) state that "only when income from agriculture is combined with the income from wild products do we begin to get a clear idea of how important the ecosystem goods and services are as a source of rural livelihoods" (UNDP et al., 2005, p. 39). Therefore, by considering environmental income from UNDP's perspective, this current study is expected to fill the gap in the literature on environmental income dependency and its impact on rural household livelihoods.

1.5 Structure of the Study

The remainder of the thesis is structured, as follows: Chapter 2 reviews the literature on household welfare and environmental income, the linkage between poverty, the environment and household livelihood strategies, the role of environmental income and its impact on rural household welfare, and empirical models for the determinants of household livelihood strategy choice. Chapter 3 presents the data and research method. A discussion of the results is provided in Chapters 4 and 5. Chapter 4 focuses on the description of Vietnam's access to the rural household survey. In this chapter, individual characteristics, household characteristics and geographic factors are analysed and compared according to income quintile. Chapter 5 investigates household dependence on environmental income, the impacts of environmental income on poverty and inequality, and the factors affecting the household's livelihood strategy choice. The results in this chapter are analysed and compared based on the main household livelihood strategies in rural areas of Vietnam as identified by cluster analysis. Finally, Chapter 6 concludes the main findings of the study, suggests some relevant policy implications and provides some suggestions for further research.

Chapter 2

Literature Review

2.1 Basic definitions: consumption, income, environmental income

2.1.1 Consumption versus income

Income and consumption are the most common welfare indicators. Consumption is made up of cash consumption and household's self-consumption. Household self-consumption is the consumption of products that are produced and consumed by the households themselves. Between these two methods, consumption gains more preference over income in developing countries, while income is commonly used in developed countries for poverty measurement (Demombynes & Hoang Vu, 2015). Using consumption as a welfare indicator provides some advantages: (1) it measures the real living standard; (2) it is a better indicator for estimating long-term wellbeing, conditions that consumption is smooth overtime; (3) the probability of misreporting is less than for an income approach in developing countries; and (4) it is a more reliable method for households with significant amounts of own consumption. However, to collect consumption-related information, it requires more detail and time-consuming surveys (Demombynes & Hoang Vu, 2015). With regard to household classification, studies about environmental income dependence, in contrast, mostly used income as the indicator of welfare. This may be because the difference between income and consumption is minimal, given that the household's self-consumption, which can be found in both income and consumption, takes up a high proportion of the rural households' total income. Therefore, it is more convenient to use income as a measure of welfare (Cavendish & Campbell, 2008).

Vietnam currently uses both methods to measure poverty. The first method uses income as a welfare indicator and is mostly applied for targeting social programmes developed by the Ministry of Labour, Invalids and Social Affairs (MOLISA). The other method developed by the General Statistical Office (GSO) and the World Bank applies consumption in poverty measurement. This method particularly involves monitoring poverty overtime (Khai & Danh, 2012).

With the focus on environmental income dependence, income is more suitable as a welfare indicator compared to consumption. Therefore, this current study will use income indicator to analyze the impact of environmental income on poverty and inequality in rural Vietnam.

2.1.2 Environmental income

Natural resources are considered as natural capital when the access to these resources is guaranteed (Lee, Neves, Wiebe, & Zurek, 2011). Natural capital is defined as the natural resource base, and

includes land, water and trees that provide products for humans' survival. Natural capital is also thought of as environmental resources. This type of capital can be divided into two categories. The first category is renewable resources, such as fishery stocks, trees, water resources and soil in farmers' lands, which is important in the rural development context. The second category is non-renewable resources, which are less prevalent to rural livelihood. This mainly comprises of extractive resources such as metals, ores and oil (Ellis, 2000b).

At the national level, the System of Environmental-Economic Accounting (SEEA) classified the environmental assets in the SEEA Central framework. The scope of this framework focuses on components that could provide resources for use in economic activity. The framework divides environmental assets into seven components which are mineral and energy resources, land, soil resources, timber resources, aquatic resources, water resources and other biological resources (excluding timber resources and aquatic resources) (UNSTATS, 2014). Meanwhile, World Bank (2006) suggested that natural capital, produced capital and intangible capital are the three components of a nation's wealth. Of which, natural capital includes the total value of subsoil asset (i.e. mineral and energy), crop and pastured land, protected areas, forest products, water resources, fisheries, diamonds and ecosystem services, is an important component, especially for low-income countries. It accounts for 19% and 29% of gross domestic product (GDP) for lower-middle income countries and low-income countries in year 2000, respectively. The value of natural capital is mainly derived from agricultural land, subsoil assets and timber and non-timber forest resources. However, the value of nature capital calculated by World Bank (2006) has some limitations. First, it directly measured only value of subsoil assets, cropland, pastureland, forest areas, and protected areas. Second, the value of water resources, fisheries, diamonds are implicitly included in the total wealth aggregate as part of the intangible capital due to lack of data. Finally, the value of ecosystem services are implicitly captured in the values of cropland and pastureland due to data limitations.

At the household level under rural livelihood context, environmental income is "value, in cash or direct use, from ecosystem goods and services", including income from natural systems such as woodlands, grasslands, lakes and marine waters. Agriculture income is also included (UNDP et al., 2005). There are other definitions of environmental income which are not broadly defined as this definition. For example, Vedeld et al. (2004, p.5) defined environmental income as " income earned from wild or uncultivated natural resources. In this case, forest plantation, fish farms and agriculture fields cannot generate environmental income". This indicates that only non-cultivated resource income or wild income which is from less manipulated natural systems, such as forests and fisheries, are incorporated. Based on this definition, agriculture and wild income are often examined separately. Of which, wild income, particularly forest-related income, attracts special interest from policy makers and researchers, but is often neglected in most rural livelihoods studies (UNDP et al.,

2005). In addtion, UNDP et al. (2005) recommended that income from mineral and energy resources are also rationally considered as a component of environmental income. However, poor rural households normally do not gain direct sources of income from large-scale mineral and energy extraction. Therefore, this source of income is not included in the environmental income category in context of rural household livelihoods. **Figure 2.1** summarises the components of environmental resource accounting at the national and household levels.

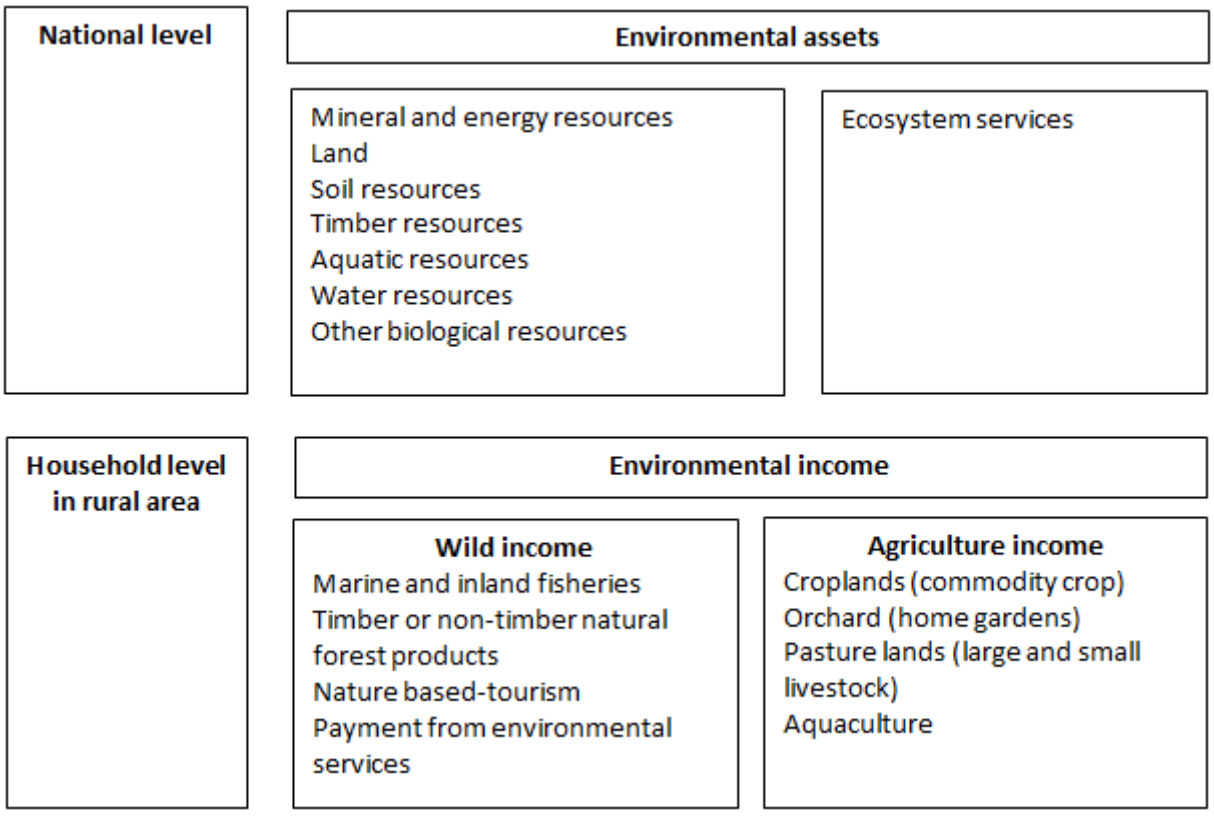

Figure 2-1 Environmental income components at national level and household level (UNDP et al., 2005; UNSTATS, 2014; World Bank, 2006)

In addition, the term 'environmental income' is used alternately to indicate forest-related income in many studies. Therefore, to simplify, the term 'environmental income' will be used throughout the literature review, the term 'forest income' is only mentioned when clarification is needed. The study uses environmental income, as defined by UNDP et al. (2005). That is, all sources of income based on nature given in the household budgets, are considered as components of environmental income. There are three main reasons for this consideration, as suggested by UNDP et al. (2005). First, both agricultural and wild income should be considered for producing a well-defined analysis of household dependence on the ecosystems. Secondly, it is sometimes difficult to compute the two income sources separately since an output from one source can be used as an input for the other source. For example, forest grasses can be used to feed livestock, while forest leaf litter is a natural fertiliser for cropping. Thirdly, income from wild products is only part of the environmental income equation and

income from agriculture is just as important. The importance of goods and services from ecosystems as a household livelihood source is achieved only when both agriculture and wild income are incorporated into the equation (UNDP et al., 2005).

2.2 Conceptual framework: the linkage between poverty, the environment and household livelihood strategies

The link between poverty and the environment has gained global interest from international development agencies and policy makers around the world. This relationship is often discussed with an emphasis on the 'vicious circle' between poverty and degradation, in which the former are usually claimed as both agents and victims of the latter (Angelsen et al., 1995; Reardon & Vosti, 1995). However, the conclusion that the poor are the agents or victims of environmental degradation should be made with caution because not all environmental degradation in developing countries is associated with poverty (Bucknall, Kraus, & Pillai, 2000; Reardon & Vosti, 1995). In addition, everyone is ultimately affected by environmental degradation, but poor people and poor nations suffer the effects more severely and sooner than the rich ones (Lele, 1991). The World Commission on Environment and Development (1987, Chap 1, para.3) reported that "poor people are forced to overuse environmental resources to survive from day to day, and their impoverishment of their environment further impoverishes them, making their survival ever more difficult and uncertain." Studies that focus on the poverty-environment linkage can be split into two camps. The first camp focuses on how environmental conditions influence the incidence of poverty, while the other camp investigates the dependence of the poor's income derived from natural resources (Angelsen et al., 1995).

With the regard to the poverty and environment linkage, Reardon and Vosti (1995) categorised types of poverty based on different kinds of household asset holdings. The authors claim that a household can be abundant in one asset, but can be poor in another. The linkages between the environment and poverty are determined by the types of poverty. In addition, the level of poverty, distribution of poverty across households within a community, the type of environmental problems, income and investment, as well as land use strategies of the rural households and the community, also affect the linkage. The level and type of poverty, then determine the choice of the household's income strategies and thus how the natural resource is used and enhanced.

This relationship is also considered as a fundamental premise of sustainable development (Lele, 1991). Accordingly, Scoones (1998) concludes that:

> *Given a particular **context** (of policy setting, politics, history, agro-ecology, and socio-economic conditions), what combination of **livelihood resources** (different types of 'capital') result in the ability to follow what combination*

*of livelihood strategies (agricultural intensification/extensification, livelihood diversification and migration) with what **outcomes**? Of particular interest in this framework are the institutional process (embedded in a matrix of formal and informal institutions and organizations) which mediate the ability to carry out such strategies and achieve (or not) such outcomes"*

(Scoones, 1998, p. 3)

Based on Scoones' (1998) framework, households' livelihood resources and contextual factors are determinants in the choice of their livelihood strategies, while institutional processes decide their capacity to carry out the chosen strategies and the ability to achieve the outcomes. Other well-known livelihood frameworks are those proposed by Department of International Development (DFID) (1999) and Ellis (2000b). In this study, the conceptual framework illustrated in **Figure 2.1** is adapted from the sustainable livelihood framework of Scoones (1998), Ellis (2000b) and DFID (1999) and the framework of poverty-environment links by Reardon and Vosti (1995).

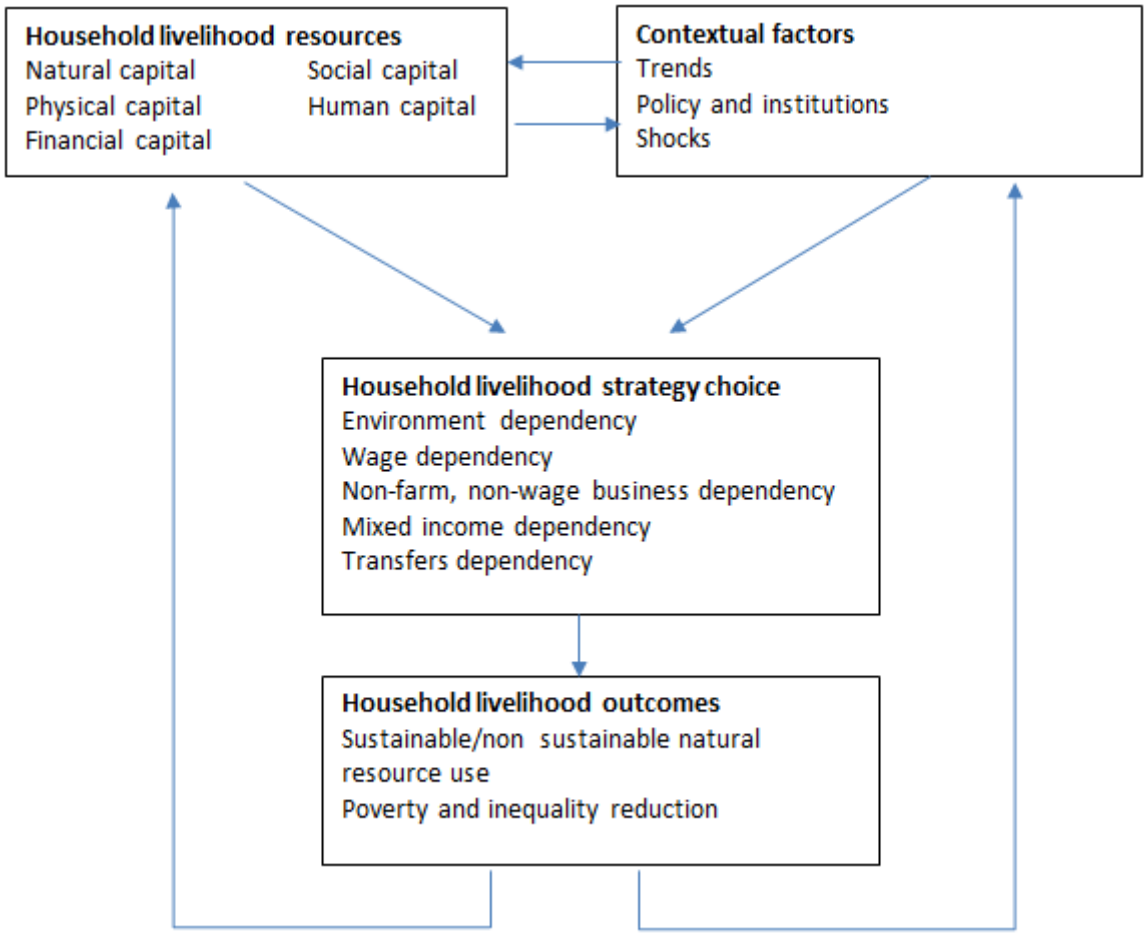

Figure 2-2 Determinants and the outcomes of household livelihood choices (Adapted from DFID (1999), Ellis (2000b), Reardon & Vosti (1995), and Scoones (1998))

This study focuses on three aspects: livelihood resources (household livelihood assets), livelihood strategies and livelihood outcomes. Household livelihood assets are categorised into five categories:

human, natural, physical, financial and social capital. The contextual factors contain shocks, market access and infrastructure. Secondly, the livelihood strategies will be based on the income share of particular income sources to total income. The specific strategies that a household chooses will affect the livelihood outcomes, which include poverty, inequality and the sustainable/non- sustainable use of the natural resources base. This study focuses on the first livelihood outcome, which is poverty and inequality reduction, because to investigate the sustainability, a long study period is prompted. Furthermore, 'livelihood strategies' used in this study also refers to 'income strategies'.

2.3 The role of environmental income in rural households' livelihoods

The definition of environmental income varies in the literature; however, shared knowledge about its role is that this income contributes significantly to the welfare of many rural households in developing countries (Mamo et al., 2007; Narain et al., 2008; Vedeld et al., 2004). Globally, there are more than 1.3 billion people involved in fisheries, forests and agriculture employment, accounting for nearly half of all jobs worldwide (FAO, 2004 cited in UNDP et al. (2005)). Environmental resources provide three principal functions in rural livelihoods; namely, income supplements, a safety net and a pathway out of poverty (Angelsen et al., 2014). Support of current consumption refers to the importance of environmental income in maintaining the current level of consumption. This role comprises three different sets of activities; namely, seasonal gap-filling, regular subsistence uses and low-return cash activities. The second function, safety net, is the role of environmental resources in helping households overcome unexpected income shortfalls or for cash needs. The third function of environmental income is poverty reduction or a pathway out of poverty, which includes three different sets of activities, such as diversification (cash income) strategies, specialised (cash income) strategies and payment of environmental services (Vedeld et al., 2004). Vedeld et al. (2004) also argue that the contributions to a pathway out of poverty are very limited compared to the first two functions. In addition, environmental income also helps reduce income inequality. By using the Gini coefficient, inequality increases when excluding environmental income from the calculation (Angelsen et al., 2014; Fisher, 2004; Kamanga et al., 2009; Mamo et al., 2007). Besides the positive contributions of environmental resources to the welfare of rural households, there is evidence to show that the high dependence on environmental resources may push the poorest people to potential perpetuated poverty (Pattanayak &Sills, 2001 cited in Thondhlana & Muchapondwa, 2014).

The dependence on environmental resource is more significant among the rural poor since a substantial fraction of their total income is derived from the ecosystem goods and services (UNDP et al., 2005). With this recognition, numerous empirical studies have attempted to quantify this dependence. One of the most remarkable studies is the comparative analysis of forest income in 24 countries by Angelsen et al. (2014). The study revealed that the average total income share derived

from forest contributes 28% of total household income, 77% of which comes from natural forest. Similar findings varying from 20%-22% of total household income, are also found in studies by Thondhlana and Muchapondwa (2014) and Vedeld, Angelsen, Bojo, Sjaastad, and Berg (2007). Some studies found the dependence is heavier, since the environmental income accounts for about 40% of the households' total income (Cavendish, 2000; Mamo et al., 2007).

Furthermore, the literature suggests that the higher relative income share from environmental resources was found in the poorer income households while the better-off households have higher absolute income. This indicates that poorer households depend heavily on these resources but the richer households use greater quantities of environmental resources in total (Cavendish, 2000; Kamanga et al., 2009; Thondhlana & Muchapondwa, 2014). Asset poverty and lack of access to key markets are believed to be reasons behind such high dependence on environmental resources among rural poor households. This is because these factors limit households' ability to adapt technologies to enhance their farming systems and livelihoods (Barbier, 2010). With regard to environmental dependency across household strategy groups, Walelign (2015) reported that the agricultural environment-based strategies not only exhibit the highest poverty incidence but also the highest level of environmental dependency. Meanwhile, Nielsen et al. (2013) found that environmental reliance is the same regardless of what livelihood strategies a household pursues.

To the best of our knowledge, in the context of Vietnam, the role of environmental resources in household livelihood is rarely studied. A study conducted by Quang and Anh (2006) investigating the dependence of households on non-timber forest products in Nghe An province may be one of a very few studies on this topic. The study found that poor households are more dependent on non-timber forest product collection than other groups, which is in line with the findings in the literature.

To formulate effective poverty-related policies, information about what income strategies a household pursues and why they choose to pursue the strategy is very important. This information is not only crucial for policy makers to evaluate which strategy policies it should aim for but also invaluable for understanding why some households could not get out of the poverty even though they chose their optimal strategies (Roy et al., 2007). For that reason, studies about the nexus of household's livelihood strategy choice, environment dependence and poverty across different household livelihood strategies will provide a better understanding for implementing relevant policies related to natural resources conservation and poverty reduction.

2.4 Identify and measure environmental income and environmental dependence

Measuring environmental income and environmental dependence is not straightforward. This is because the environmental incomes are generated from different resources and some of them are collected only occasionally. In addition, there are some environmental products or services not traded in the markets, such as products for self-consumption. These features make it difficult to fully recall and value incomes from environmental resources. Angelsen et al. (2011) conducted a meta-analysis of 54 case studies and found substantial variability in the theories, methods and reporting of results. There are inconsistencies in key definitions, for example, how environmental income is defined. This study classifies environmental income by ecosystem, as suggested in UNDP et al. (2005). That is, environmental income in this study is considered as income from all activities that use an environmentally-related resource as one of the inputs.

Various measures of environmental dependence have been developed. Jodha (1986) investigated the contribution of common property resources (CPR) in terms of employment and income generation by CPR. In terms of employment generation, Jodha (1986) used four sets of data: (1) time spent by different household members in collecting CPR products in different seasons; (2) number of CPR employment days of individual workers in a given year; (3) share of CPR-based activities in the household workers' total labour time allocation; and (4) CPR activities during days of involuntary unemployment. The latter measure, in terms of income generation, examines the share of income from CPR to total income from all income sources. Some studies also presented other measures but, so far, the simple measure of economic dependence is the share of income derived from environmental sources relative to the household's total income (Angelsen et al., 2014; Cavendish, 2000; Fisher, 2004; Vedeld et al., 2007). The higher this ratio is represents the higher the household's dependence on environmental income.

2.5 The impacts of environmental income on rural household welfare

The impacts of environmental income on rural household welfare are usually analysed in terms of poverty reduction and income inequality.

2.5.1 Environmental income and poverty

From an income point of view, "people are poor when they are in a state where, their income (or consumption) is less than that required to meet certain defined needs" (Sola & Zimbabwe, 2001, p.2). There is a variety of poverty measures; however, poverty headcount, poverty gap and the squared poverty gap are the most common methods. These measures are derived from the Foster,

Greer-Thorbecke (FGT) (P∝) class of poverty measures from Foster, Greer, and Thorbecke (1984). The $P_\propto$ poverty indices are described in the equation, as follows:

$$P_\alpha(y;z) = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-y_i}{z}\right)^\alpha \quad (1)$$

where z is the poverty line (z>0), y_i is the per capita income of the ith poor household (the total income is applied if y < z), q= (y; z) is the number of households with income below the poverty line (the poor), n is the total number of households. α can take the value of 0, 1 and 2. When $\alpha = 0$, P_0 is the headcount index, $\alpha = 1$, P_1 is the poverty gap index, and $\alpha = 2$, P_2 is the squared poverty gap or poverty severity index (Foster et al., 1984). The squared poverty gap is less commonly used compared to the headcount and poverty gap indices (Demombynes & Hoang Vu, 2015).

The headcount index (P_0) (incidence of poverty) measures the proportion of a population that is poor, that is, with income or consumption below the poverty line. This index is straightforward to understand and measure, but does not change if households below the poverty become poorer or richer, as long as they remain below the line (Haughton & Khandker, 2009; López-Feldman, 2006). The headcount index can be obtained, as follows:

$$P_0(y;z) = \frac{1}{n}\sum_{i=1}^{q} 1 = \frac{n_q}{n} \quad (2)$$

where n_q is the number of households having an income below the poverty line.

The poverty gap index (P_1) (poverty depth) measures the extent to which individuals fall below the poverty line (the poverty gap) as a proportion of the poverty line. It is also considered as a measure of expenses needed to push the poor up to the poverty line. The measure, nevertheless, does not reflect the differences in inequality among the poor (Haughton & Khandker, 2009). The lower the welfare levels of the poor, the greater the index is (Demombynes & Hoang Vu, 2015; Lopez-Feldman, Mora, & Taylor, 2007). The poverty gap index is below:

$$P_1(y;z) = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-y_i}{z}\right) \quad (3)$$

The squared poverty gap index (P_2) (poverty severity) averages the squares of the poverty gaps relative to the poverty line. This measure is not used widely because it is difficult to interpret (Haughton & Khandker, 2009).

$$P_2(y;z) = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-y_i}{z}\right)^2 \quad (4)$$

A common method to measure the impact of environmental income on household livelihoods is by simply deducting the environmental income from the household's total income, and then comparing

the indices with and without environmental income (Angelsen et al., 2014; Kamanga et al., 2009; Mamo et al., 2007; Thondhlana & Muchapondwa, 2014). This approach is simple but it only shows the total elimination of environmental income on poverty and inequality. Actual policies may have different effects on different types of income as well as on different groups of household livelihood strategies. Therefore, it is necessary to decompose the overall poverty or inequality among different household groups and income sources.

Some decomposition methods of the poverty indices have been developed. For example, Foster et al. (1984) introduced a decomposition of the poverty indices by population sub-groups. Meanwhile, Reardon and Taylor (1996) presented an approach to decompose the FGT poverty coefficients by income source, with a focus on the changes in income before and after a severe shock.

2.5.2 Environmental income and inequality

Inequality is a broader concept than poverty. It does not only focus on the poor, but also on the entire population. The simplest measure of inequality sorts the population from poorest to richest, and shows the percentage of expenditure (or income) attributable to each fifth (quintile) or tenth (decile) of the population. In general, the poorest quintile accounts for 6-10% of all expenditure, the richest quintile for 35-50%. Several measures of inequality have been developed, such as the Gini coefficient derived from the Lorenz curve, Theil's T and Theil's L, Atkinson's class and A Pen's Parade graph (Haughton & Khandker, 2009).

The **Lorenz Curve** is a cumulative frequency curve that compares the distribution of a variable, such as income, with the uniform distribution that represents equality (Haughton & Khandker, 2009). The Lorenz curve is useful for visually representing the information, particularly income inequality.

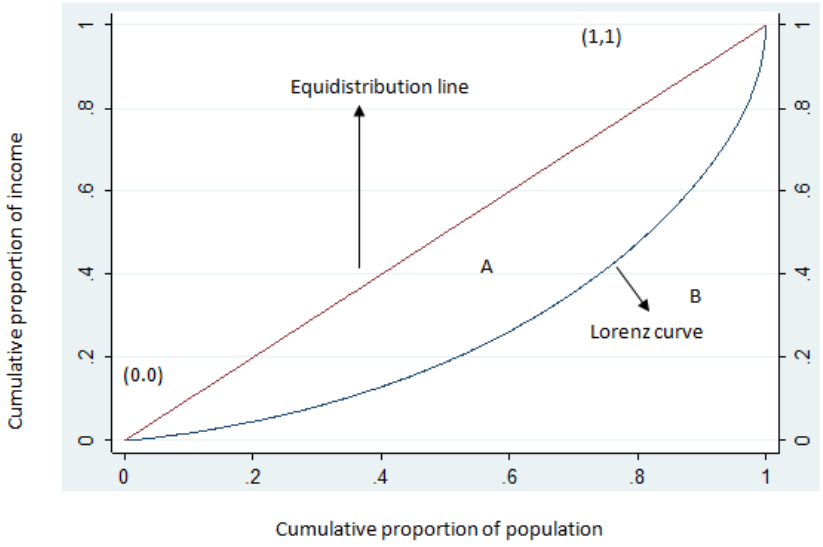

Figure 2-3 Lorenz curve and the equidistribution line (Bellù & Liberati, 2005)

According to Bellù and Liberati (2005), the Lorenz Curve is obtained as follows:

The x-axis records the accumulative percentage of the population ranked by income level. Thus, it varies in the range of (0, 1).

The y-axis records the cumulative proportion of income for a given proportion of population; that is, the income share calculated by taking the cumulated income of a given share of the population, divided by total income Y, as follows:

$$L\left(\frac{k}{P}\right) = \frac{\sum_{i=1}^{k} y_i}{Y} \qquad (5)$$

where:

k = 1….n is total number of individuals in a given proportion of population at an income level;

i= 1….k is the position of each individual in the income distribution in a given proportion of population;

P is the total number of individuals in the income distribution;

y_t is the income of the i^{th} individual in the income distribution;

$\sum_{i=1}^{k} y_i$ is the cumulated income up to k^{th} individual; and

$\sum_{i=1}^{k} y_i$ ranges between 0, for k=0, and Y, for k=n; therefore, $L\left(\frac{k}{P}\right) = \frac{\sum_{i=1}^{k} y_i}{Y}$ range between 0 and 1.

The **Gini coefficient** is the most popular measure of inequality, which is derived from the Lorenz Curve. The extreme values of the Gini Coefficient are 0 and 1. These are often presented in statistical publications as percentages. Hence, the corresponding extreme values are 0% and 100%. The former implies perfect equality (in other words, everyone in society has exactly the same amount of wealth), whereas the latter implies total inequality in that one person has all the wealth and everyone else has nothing (World Bank, n.d.).

The Gini coefficient is graphically-represented by the area between the Lorenz Curve and the line of equality (World Bank, n.d.). The Gini coefficient is measured by area A divided by the sum of areas A and B (A/A+B), where A and B are the areas shown in **Figure 2.2**. If A=0, the Gini coefficient becomes 0, which indicates perfect equality. Whereas, if B=0, the Gini coefficient becomes 1, which indicates complete inequality. The Gini coefficient meets several criteria that make it a good measure of income inequality, such as mean dependence, population size independence, symmetry and Pigou-Dalton Transfer sensitivity. However, it is sometimes argued that the Gini index is not easily

decomposable across groups to show the sources of inequality. That is, the sum of the Gini coefficients of its sub-groups is not equal to the total Gini coefficient of the society (Haughton & Khandker, 2009). However, similar to poverty indices, decomposition of Gini coefficients has been proposed. If the Gini coefficients are decomposable, it allows us to examine the contribution of a particular component to the total Gini coefficient (Babulo et al., 2009).

A Gini coefficient can be decomposed by population sub-group (Pyatt, 1976; Shorrocks, 1984) and by income source (Lerman & Yitzhaki, 1985; Pyatt, Chen, & Fei, 1980). In terms of decomposition methods by income source, the method proposed by Lerman and Yitzhaki (1985) is widely used because it provides the marginal effect of a particular income source to the overall income inequality. However, this decomposition method does not provide a simple solution to decompose by population class as the covariance cannot obtained by applying a simple OLS regression (Yao, 1999).

Therefore, Yao (1999) proposed a decomposition method that enables decomposition by population class and income source at the same time without using matrix algebra, integration, regression and covariance. In addition, it enables the decomposition for all kinds of data (individual, evenly and unevenly grouped).

Theil's T and Theil's L indices are the best known of the entropy measures. Although they are less commonly used than the Gini coefficient, they allow inequality to be decomposed into parts that are within areas, such as urban and rural, and parts that are due to differences among areas, such as the rural-urban income gap, and the sources of the changes in inequality over time. Generally, in a country, at least three quarters of the inequality is because of within-group differences and the remaining quarter is due to between-group inequality (Haughton & Khandker, 2009; World Bank, n.d.).

Atkinson's class of inequality is more general and is used occasionally. The decile dispersion ratio is a popular but a very crude measure of inequality. It is measured by dividing the expenditure (or income) of the richest decile by that of the poorest decile (Haughton & Khandker, 2009).

Pen's parade graph can be helpful when describing how income and income distribution change over time. This graph is most useful when a comparison of inequality between two different areas or periods is required.

This study uses the two most common measures, the Gini and Lorenz curves to investigate the inequality impact of environmental income on Vietnam's rural households. The procedure is discussed in detail in the **Methods chapter**.

2.6 Determinants of households' livelihood strategy choices

Based on the household livelihood frameworks proposed by DFID (1999), Ellis (2000b), Reardon and Vosti (1995) and Scoones (1998), a household's reliance on a specific economic activity, in general, and on environmental resources, in particular, may differ depending on the household livelihood assets as well as contextual factors (Babulo et al., 2008; DFID, 1999; Ellis, 1998, 2000b; Fisher, 2004; Narain et al., 2008; Nielsen et al., 2013; Reardon & Vosti, 1995; Scoones, 1998). Based on a particular context and household livelihood resources, they will allocate their resources to higher return activities, which are either on-farm or non-farm activities (Ellis, 2000a). Household livelihood resources consist of human capital, natural capital, physical capital, financial capital and social capital. Contextual factors beyond the households' direct control, relate to access to markets and infrastructure, prices, technologies and institutions, etc. (Angelsen & Kaimowitz, 1999; Babulo et al., 2008; Fisher, 2004).

2.6.1 Household asset-related factors

Physical-related capital factors

***Machinery or Equipment*:** farm equipment creates opportunities for the households to engage in activities that require more capital, such as coffee production. They also increase productivity of labour and land. While machinery is helpful to increase agricultural operations, equipment increases the ability for the adoption of technology. In addition, equipment for food processing and storing also contributes to transport cost reductions and improves product selling. Thus, households with machinery or equipment may have extra labour for more remunerative off-farm activities. However, in the case of households that only engage in basic grain and livestock production, it is likely that those two physical assets are much less remunerative (Jansen, Pender, Damon, Wielemaker, & Schipper, 2006). Angelsen et al. (2014) found that asset-poor households are relatively more reliant on forest and environmental resources. Similar findings are found in the study by Godoy et al. (1997). The authors noted that wealth presented by the total number of plastic buckets a household owns, may encourage the household to undertake less forest clearing. The reason is that wealth may assist borrowing and smooth consumption.

The household number of livestock (livestock units): Oksanen and Mersmann (2003) claimed that forests and trees are considered as inputs for livestock production. For poor farmers who work in a border environment, the role of these environmental resources is even more important because most of them cannot afford to pay for inputs or feed their cattle from other sources. Therefore, the more livestock a household owns, the more likely for them to engage in agricultural-environmentally-based strategies (Walelign, 2015). In contrast, Nielsen et al. (2013) identified that the number of

livestock holding demonstrates “liquidity capacity of undertaking more risky and more remunerative income activities”.

Human-related capital factors

The most common factors related to household head characteristics are the age, gender and educational level of the household head. In terms of age of the household head, the relation with resources use is an inverted U. That is, the use of environmental resources may be positively affected by the age of the household head until, at a certain stage, the resource use declines even as the age continues to increase. The decrease in resource use may occur after the household heads reach their ultimate strength of physical fitness so it is less likely for them to engage in labour-related activities. Another reason could be the reduction in the number of household dependents when their children grow up and move away for new opportunities or to their own households (Godoy et al., 1997). However, there is also evidence of a linear relationship between age and environmental resource use. For example, in a study on environmental income dependence among communities bordering the Kgalagadi Transfrontier Park in South Africa, Thondhlana, Vedeld, and Shackleton (2012) found a negative relationship between the age of household head and environmental resource use. In particular, households with older heads tend to have low wild resource demand due to the small size of their households, and they mostly depend on government allowances. In addition, collecting environmental resources is considered a labour-intensive activity because of the long distance from their home to the resource sites. This finding is in line with evidence found in Adhikari, Di Falco, and Lovett (2004) and Cavendish (2000).

Gender also determines the household livelihood choice. In rural Ethiopia, a male-headed household may be less likely to pursue informal jobs; for example, collecting forest-related products, or local food products (Babulo et al., 2008). Another study by Adhikari et al. (2004) presented an opposite result in which the households headed by males collect forest environmental products to a much greater extent than households headed by females. This is because female-headed households own less productive assets and their knowledge of forest management decisions are not appreciated as much as those from men.

Education is also a key factor contributing to the greater ability of better-off families to diversify compared to poorer families. Several studies reported that more educated household heads have access to more profitable activities, such as off-farm employment, self employment, or migration for better jobs. A higher level of education makes labour-intensive activities unprofitable due to higher opportunity costs for labour (Godoy et al., 1997; Mamo et al., 2007; Narain et al., 2008). However, educated individuals also have higher capacity to use environmental resources as an income source (Mamo et al., 2007; Narain et al., 2008).

Many studies included household size in their models to analyse the determinants of household livelihood strategy choice. A common finding is that households with a greater number of members are more likely to be attracted by high labour-intensive activities (Angelsen et al., 2014; Babulo et al., 2008). However, household composition and the number of adults, in particular, are found to be more important determinants (Mamo et al., 2007). The greater availability of adult labour possibly allows households to tap into more common property resources. Higher numbers of adult labour in a household may, conversely, encourage households into higher-return activities, such as agriculture or off-farm employment (Adhikari et al., 2004 cited in Mamo et al., 2007).

Financial-related capital factors

Small-scale farmers are restrained from improving output by the availability of funds. The lack of funding makes it difficult for the households not only to purchase cash inputs for agriculture operations, but also to purchase equipment and machinery. In this case, given the absence of lending facilities, such as banks, households tend to diversify their livelihood strategies to off-farm activities in order to create funding for their agricultural inputs, as well as other farm equipment or machinery (Ellis, 2000a). Godoy et al. (1997) reported that households without loans or with fewer loans extract more primary rainforest products than households with loans. Alternatively, households who are able to borrow or engage in off-farm employment, therefore, have less spare time to spend on forest extraction activities. In addition, households have more opportunities to pursue activities that require large initial cash investments, such as trade or livestock rearing if they have lower credit constraints (Babulo et al., 2008). Beside credit access, savings are reported to be lowest in households engaging in environmental-agriculture-based strategies compared to households engaging in wage-based strategies or business-based strategies (Walelign, 2015). Loans and savings are financial sources households use to engage in non-farm businesses, such as trade (Ellis, 2000a).

Natural-capital related factors

Babulo et al. (2008) showed that two of the primary factors related to natural capital that determined the choice of household livelihood activities in rural Ethiopia, were plot size and access to grazing land. With all else being equal, it is more likely that a household will choose crop production and livestock production strategies if they own larger plots and are able to access grazing land. A similar conclusion can be found in a study by Jansen et al. (2006). However, Walelign (2015) found the opposite result since households engaging in environmental-agriculture-based activities own the least land. The lack of land holdings can be substituted by renting land from other households who pursue off-farm activities.

Social-related capital factors

Social-related capital factors, such as households' kin network, group membership, and social and political voices and influence, may affect the choice of the households' livelihood strategies. Xu et al. (2015) claimed that a broader social network enables a household to obtain useful employment information, as well as engage in non-farm activities. Jansen et al. (2006) found that training programmes support greater technology or the adaptation of new practices. Therefore, the households who participate in training programmes can obtain higher income from crop production or livestock rearing. Regarding the existence of financial organisations, non-farm activities are often encouraged by these organisations; therefore, labour intensive activities, such as farming activities, will be less attractive to these households. Meanwhile, non-government organizations, in contrast, are more likely to support the engagement in crop production. Thus, the type of organization that a household participates in may affect the household's choice of strategy. With a particular focus on the use of forest resources, Angelsen et al. (2014) found that, members of forest user groups, may result in higher forest extraction because participants are granted forest resource access. In addition, active forest users have more motivation to join these groups. On the other hand, forest user groups may establish some rules to prevent participants from overexploiting forest resources.

2.6.2 Contextual factors

Apart from household characteristics and related factors, contextual factors, which are beyond the households' control, also have an important influence on their livelihood strategy choice. First, Ellis (1998) claimed that infrastructure, specifically rural road access, plays an important role in household livelihood strategies. Better rural road systems decrease spatial transaction costs, such as inputs, outputs, and labour and consumer markets. They also create different income-earning opportunities since the movement between places becomes more convenient. In addition, the availability of electricity also makes choices about higher rural productivity possible. Numerous kinds of manufacturing industries require electricity access. The absence of electricity also constrains the development of small-scale services in rural areas. For example, Jansen et al. (2006) found that off-farm livelihood strategies are encouraged with an improved road infrastructure. Meanwhile, Angelsen and Kaimowitz (1999) reported that activities related to environmental resource collection, such as forest extraction, are positively influenced by greater forest and market access. However, when given secure rights for property, markets, on the other hand, will possibly stimulate resource protection (World Bank, 1992).

In terms of distance to agricultural markets, Narain et al. (2008) described that environmental resource dependence is adversely affected by the distance to markets for agriculture. The authors explained that a shorter distance to agricultural markets makes it easier to buy either resources or

substitutes for resources. However, their evidence is somewhat mixed, depending on the type of resources. Winters et al. (2009) also documented mixed effects from the proximity of markets on the choice of income-generating activities in their study. On the one hand, access to market facilities self-employment and non- agricultural activities also creates opportunities for trading inputs and outputs. On the other hand, the proximity to markets promotes better access to input supplies and to high-value crops; therefore, households may achieve higher returns from their agricultural activities.

Shocks experienced by households are also associated with the livelihood strategy choice. For example, Walelign (2015) observed that households suffering an agricultural shock probably prefer wage-based and business-based livelihood strategies other than an agricultural environment-based strategy. This indicates that shocks force households to reallocate their resources from agriculture to more defensive activities or to diversify their livelihood activities to reduce the magnitude of income loss as well as supporting a consumption shortage (Marschke & Berkes, 2006; van den Berg, 2010 cited in Walelign, 2015). In addition, Angelsen et al. (2014) investigated the influence of income, labour and asset shocks on forest and environmental incomes. The study revealed that while income shocks exhibit a positive effect on both environmental resource use and dependence, asset and labour shocks do not display any significant influence.

Chapter 3

Data and Methods

3.1 Classification of income and income accounting

3.1.1 Classification of income

Each household in this study can earn income from seven main types of sources, as displayed in **Figure 3.1**. They are incomes from environmental resources, non-farm and/or non-wage businesses, private and public transfers, wage employment, rental income, sales of assets and other activities. Environmental income is further divided into two main components: common property resources income and agriculture environmental income. Therefore, the overall household income can obtained from eight income sources.

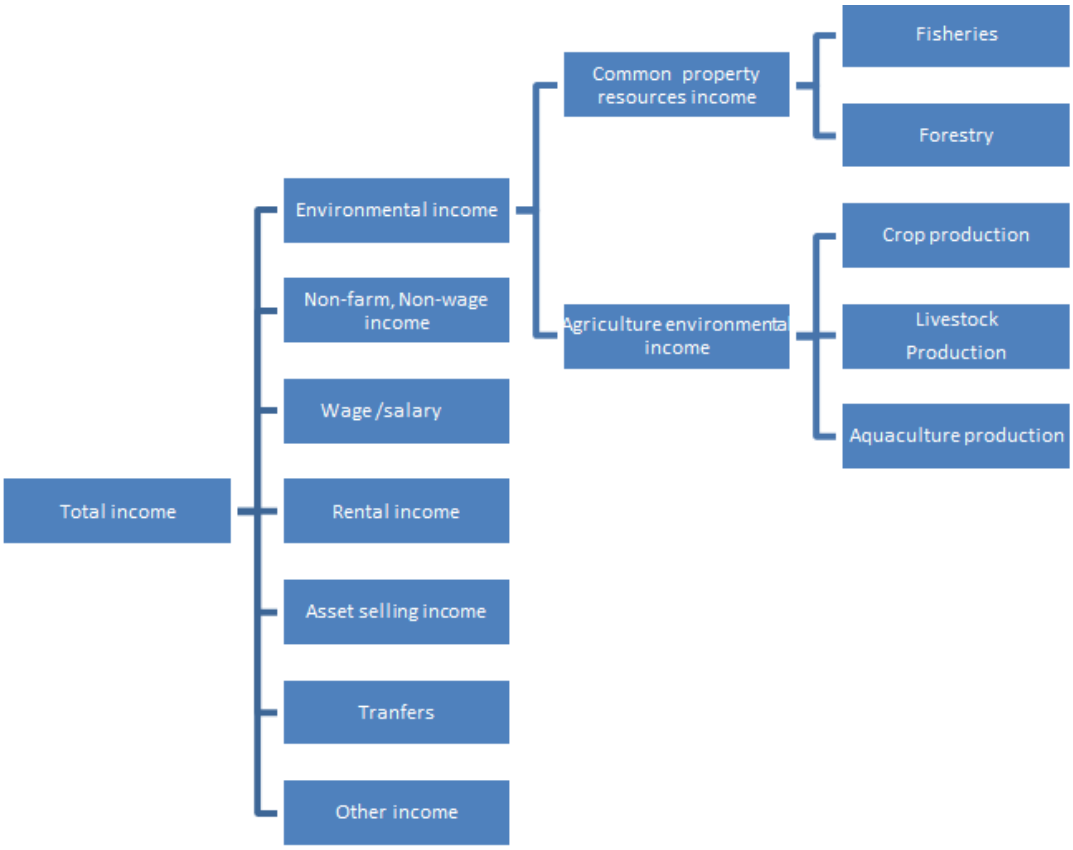

Figure 3-1 Rural household income accounting (classified by the author)

Environmental income: The components of the environmental income calculation in this study will follow the definition of environmental income suggested in UNDP et al. (2005). Accordingly, environmental income comprises common property resources income and agricultural income. Common property resources income consists of incomes from fisheries and forestry products. For example, forestry products from common property resources include timber and non-timber forest

products, such as fuelwood, medicines, animals, etc. Aquaculture products from common property resources are derived from fish, shrimps, oysters, crabs, etc. In terms of agricultural income, it consists of income from crop production, livestock production and aquaculture production.

Wage employment refers to a wide range of work for wages in public administration, corporations, manufacturing factories, or professionals working in the science, education and training sector. In addition, these income components also include wages involved in the supply of paid labour on farms.

Non-farm, non-wage business-related incomes include income from non-agriculture, non-forestry, non-aquaculture businesses, non-wage employment and production trades. It also includes incomes from the processing of agricultural, forestry and aquaculture products, as well as agriculture and aquaculture services.

Transfers is defined as the sum of all private transfers (money or goods from persons who are, or are not, household members, such as children, relatives living elsewhere, friends or neighbours) and public transfers (funds from various government programmes) over the past 12 months. Transfers can be in cash or in kind.

Rental income and sales of assets include incomes from rental activities (land/real estate and other assets) and from selling household assets.

Other income - besides the six major income components identified above, interest from savings and loans, pensions, lottery winnings, and earnings from share investments, are regarded as other income.

3.1.2 Calculation of income

The calculation of income in this study is based on five assumptions and the available data:

i) Only actual harvested products from environmental resources are included in the income calculation. The price of the products is the actual price the households provide. In the case that the price of the products is missing; for example, the household forgets the price of the products they sell, then the regional average selling price for the products will be used.

ii) Based on the data available in the VARHS dataset, only the extractive or consumptive direct value of products from environmental resources are analysed. This means that the value of natural-based tourism and payments from environmental services are not included in environmental income.

iii) Gross value of products from common property resources will be applied because the cost information is not provided in the Vietnam Access to Resources Household Survey (VARHS). However, Babulo et al. (2008) explained that to collect products from common property resources, households normally require low or medium skill levels with minimal capital investments, and the opportunity cost of labour is insignificant. Thus, the gross value of environmental income is a good substitution for natural rent.

iv) Energy, mineral and water resources are not explicitly expressed in the environmental income components because such information is not provided in the VARHS dataset. Energy and mineral resources are assumed to have minimal impacts on rural households. Rural households do not gain a direct source of income from large-scale mineral and energy extraction (UNDP et al., 2005) and these resources are not widely available, especially in Vietnam, and are only indirectly relevant to rural livelihoods (Ellis, 2000b). However, the value of water resources may be included implicitly, for example, rural households use water for their crop production (see Worldbank, 2006).

v) Net income includes the value of own-labour costs by households. According to Babulo et al. (2008), the computation of opportunity cost of labour time is difficult in the case of an absent or imperfect labour market. This is confirmed by Van de Walle's (1998) study on infrastructure and poverty in Vietnam. The author did not exclude household's own labour costs in the net crop income because there is uncertainty about how to calculate the opportunity cost for the household's own labour.

Following these assumptions, the components of total income in this current study are calculated, as follows:

Cropping production income is obtained by deducting crop production costs from the gross value of crop production, including income from orchard gardens. The gross income value of crop production is the sum of the sales value, the value of crop by-products and the value of crop production consumed at home. In addition, forestry products from plots operated by the households, but not from communal forests, are also included in cropping production. Crop production costs are costs for seeds, fertilisers, pesticides, land rentals, hired labour, storage and marketing.

Livestock income - similar to cropping income, is derived from the value of sales and home consumption of animal products (including meat and other animal products, such as milk and eggs) minus the value of animal purchases and other production costs.

Aquaculture income is calculated in a similar way to cropping income, that is, the gross value of sales and home consumption minus the production costs (seeds, breed, energy, etc.).

Non-farm and/or non-wage business income captures the amount of money the households earned from cash revenues, the value of exchanged goods and services, the value of goods and services consumed by the households and the value of by-products consumed or sold by the households. This gross income excludes the costs related to non-farm and/or non-wage business activities to obtain the net income.

Wage employment is estimated by the sum of annual earnings in wages and value of in-kind payments from the most time-consuming job over the past 12 months.

Transfers is defined as the sum of all private transfers (money or goods from persons who are or are not household members, such as children, relatives living elsewhere, friends or neighbours) and public transfers (funds from various public institutions such as insurance money or social assistance) over the past 12 months.

Rental income and sales of assets include incomes from rental activities (land/real estate and other assets) and from selling household assets over the past 12 months.

Other income includes pensions, lottery winnings, earning from share investments and interest from savings and loans.

3.2 Measures of environmental income and dependence

This study follows the measures proposed by Vedeld et al. (2004). The author suggested several basic measures of forest environmental income and reliance, of which, absolute environmental income (AEI) and relative environmental income (REI) are the most important measures.

Absolute environmental income is used to indicate the household income derived from the environment. This income involves both home consumption, and in cash form, from common property resources extraction and agricultural activities, as discussed above.

AEI = absolute cash income + absolute subsistence income

To measure the environmental dependence, this study uses the relative environmental income, which is the ratio of absolute environmental income over the households' absolute income from all income sources (AI).

REI = AEI/ AI

To make the income comparable across households, income per capita is the most commonly used indicator. However, some studies used adult equivalent units to capture the differences in age and economies of scale (size) in household welfare (Angelsen et al., 2014; Cavendish, 1999). In this study, income per capita is used as an income measure, which is obtained by dividing the household income by the household size. This measure not only allows comparisons across households but also comparison between individual income and the poverty line, which is calculated as income per capita.

3.2.1 Determining livelihood strategies

There are several methods used to assign households into groups. Most studies about household dependency on environmental income compare income quintiles of the sampled households (Angelsen et al., 2014; Cavendish, 2000; Hogarth, Belcher, Campbell, & Stacey, 2013; Rayamajhi, Smith-Hall, & Helles, 2012). Cavendish (2000) used five household quintiles (lowest 20%, 20%-40%, 60%-80%, top 20%). Some studies use the threshold of relative environmental income to assign households into groups based on their dependence on specific income sources (Babulo et al., 2008; Porro, Lopez-Feldman, & Vela-Alvarado, 2015). Regarding household livelihood strategy analysis, principal component analysis (PCA) and cluster analysis are the most common methods used for clustering household sample according to certain indicators.

Principal component analysis (PCA)

Principal component analysis (PCA) is appropriate to reduce the dimensionality of a dataset that has a high correlation among the variables. The original variables will be transformed into a new set via principal components that are considered to be uncorrelated and ordered. The principal components will contain most of the variation in the original variables (Jolliffe, 2002). The principal components may then be used in subsequent analysis, such as multiple regressions or multivariate techniques. In this study, instead of inserting the original variable into cluster analysis, the use of principal components helps to avoid the multicollinearity problem that may occur in the cluster analysis. As a result, it is expected to improve the quality of the cluster analysis (Hair, 1998 cited in Walelign, 2015).

With the focus on explaining livelihood activity choice, and with a particular interest on the household's reliance on environmental income, the relative incomes from each source are included in the PCA. According to Walelign (2015), the importance of a particular income source relative to others is shown by relative income, not absolute income. Eight variables are used in the PCA, including relative wage, agricultural income, common property resources income, non-farm and/or non-wage income, rental income, asset selling income, transfer income and other incomes.

Cluster analysis

Discriminant analysis and cluster analysis are commonly used to assign samples to several homogeneous groups or populations. Discriminant analysis assigns observations into one of several known groups. Meanwhile, cluster analysis is one of the most common methods used in combination with principal component analysis for data classification. Unlike discriminant analysis, cluster analysis does not require a clear group structure in the data (Jolliffe, 2002). Some studies on livelihood activity choice assign household samples into known groups. For example, Babulo et al. (2008) grouped the household samples into four clusters according to the share of the household's income from forest resources to total income, as follows: forest income less than or equal to 20%, 20-40%, 40-60% and above 60%. These groups are labelled as less dependent on forest income, a moderate dependence on forest income, a high dependence on forest income and a very high dependence on forest income, respectively. This initial income threshold method is applied in Porro et al.'s (2005) study to categorize households in term of livelihood strategies. However, these studies did not explain how the income thresholds are defined. In the context of Vietnam, there is no previous study about rural household livelihood strategies that focuses on environmental income; therefore, there will be uncertainty about how household groups should be categorised. Thus, this current study uses cluster analysis to define the household typologies.

Widely used clustering techniques are k-means clustering, agglomerative hierarchical clustering and two-step clustering (Bacher, Wenzig, & Vogler, 2004). In this study, a two -step cluster analysis is considered more appropriate because it offers distinctive features not provided by the k-means clustering and agglomerative hierarchical clustering. The features include: (1) the best number of clusters is automatically chosen, combined with methods for selecting among the cluster models; and (2) cluster models are immediately created according to given categorical and continuous variables; and (3) it allows large data file analysis, such as the dataset from VARHS used in this study. The two-step cluster analysis is based on the assumption that the variables are independent; based on the principal component analysis, the continuous variables are normally distributed and the categorical variables are multinomial (Khai & Danh, 2012). In the first step, the principal components detected from the PCAs are inserted into the clusters analysis. In this step, the data is pre-clustered by a sequential clustering approach. In the second step, the agglomerative hierarchical clustering method is applied to group the sub-clusters derived from the first step into the desired number of clusters (SPSS Inc., 2001). Finally, ANOVA analysis is used to clarify whether the households in the sample will be categorized into mutually exclusive clusters (Hair, Black, Babin & Anderson, 2010 cited in Soltani, Angelsen, Eid, Naieni, & Shamekhi, 2012).

The clusters derived from two-step cluster analysis represent different household livelihood strategy groups. Once the household livelihood strategy groups are determined, the impact of environmental

income on poverty and inequality across different livelihood strategies, as well as the determinants of household livelihood choice, will be investigated.

3.2.2 Measures of the impact of environmental income on household livelihood

The impacts of environmental income on household livelihoods are analysed in two cases: (1) comparison of indices with and without environmental income; and (2) comparison of indices across different household livelihood strategies.

Environmental income and poverty

This study uses headcount, poverty gap and poverty severity indices to measure poverty. Cavendish (1999) and Thondhlana and Muchapondwa (2014) used these indices to investigate the poverty incidence and depth of poverty. For example, Cavendish (1999) analysed the impact of environmental income on rural poverty and inequality using a data set of 213 households from rural Zimbabwe. The results showed that environmental income contributed to a significant 50% decrease in measured poverty and a 30% decrease in measured inequality. Similarly, Thondhlana and Muchapondwa (2014) studied the dependence on environmental resources and their influence on households' welfare in South Africa. The findings showed that the poverty incidence and poverty gap decreased by 13% and 7%, respectively, with the inclusion of environmental income.

Vietnam National Poverty line

Vietnam currently has two poverty measurement approaches developed by the Ministry of Labour, Invalids, and Social Affairs (MOLISA), the General Statistical Office of Vietnam (GSO) and the World Bank. The first method identifies poverty lines based on income, which is suitable for guiding poverty reduction targets; whereas, the second method is based on consumption and is more useful for monitoring poverty over time (Demombynes & Hoang Vu, 2015).

In this study, the poverty line proposed by MOLISA is used for two reasons: (1) the study uses income as the welfare indicator; and (2) MOLISA identifies two separate poverty lines for urban and rural areas. In particular, the official MOLISA poverty lines for the period 2011-2015 are VND 400,000 per person per month ($1.33 per day) and VND 500,000 per person per month ($1.66 per day)[1] for rural areas and urban areas, respectively. With the focus on rural areas, this current study only uses the rural poverty line, which is VND 400,000 per person per month ($1.33 per day).

Compare indices with and without including environmental income

First, this current study subtracts environmental income from total household income. Secondly, indices for total income with and without environmental income are computed. Thirdly, when

[1] Conversion of MOLISA poverty lines into 2005 PPP$ per day by using the annual average CPI for 2010

comparing the indices with and without environmental income, the estimation of the impact of the environment on poverty is achieved.

Comparison of indices across household livelihood strategies

This study will apply the decomposition of poverty indices by population sub-group as proposed by Foster et al. (1984). Babulo et al. (2009) has adapted the equation from Foster et al. (1984), as in equation (6). The authors assumed that the population is divided into k distinct groups of households (i = 1, 2,…, k).

$$P_\alpha = \sum_{j=1}^{q^{(1)}} \frac{1}{n} \left[\frac{Z - Y_j^{(1)}}{Z}\right]^\alpha + \sum_{j=1}^{q^{(2)}} \frac{1}{n} \left[\frac{Z - Y_j^{(2)}}{Z}\right]^\alpha + \cdots + \sum_{j=1}^{q^{(k)}} \frac{1}{n} \left[\frac{Z - Y_j^{(k)}}{Z}\right]^\alpha \quad (6)$$

where $q^{(k)}$ is the number of people below the poverty line in a sub-group k, n_k is the population size of sub-group k, $Y_j^{(k)}$ is the income of the jth household in the sub-group k with the income below the poverty line. This method provides the effect of changes in sub-group poverty on total poverty.

The quantity $\sum_{j=1}^{q^{(k)}} \frac{1}{n} \left[\frac{Z - Y_j^{(k)}}{Z}\right]^\alpha$ indicates the total contribution of a sub-group k to the overall poverty index. Meanwhile, $100 \sum_{j=1}^{q^{(k)}} \frac{1}{n} \left[\frac{Z - Y_j^{(k)}}{Z}\right]^\alpha / P_\alpha$ is the percentage contribution of sub-group j.

Environmental income and inequality

This study uses the two most common measures of inequality, the Lorenz Curve and Gini coefficient, to analyse the impact of environmental income in terms of the inequality effect. Similar to poverty analysis, the inequality status is analysed in two cases: (1) with and without environmental income; and (2) across different household livelihood strategy groups.

Lorenz curve

A step-by-step procedure to build the Lorenz curve is adapted from Bellù and Liberati (2005):

Step 1: Sort the income distribution.

Step 2: Identify the percentage of income owned by each household and the percentage of the population corresponding to each household.

Step 3: Identify the accumulative percentage of income and population.

Step 4: Identify the equidistribution line. The equidistribution line is constructed by following Steps 1 to 3 with the assumption that everyone has the same level of income.

Step 5: Plot the accumulative percentage of income against the accumulative percentage of the population.

Gini coefficient

Similar to poverty analysis, this current study estimates the Gini coefficient in two cases: (1) Gini coefficients with and without environmental income; and (2) Gini coefficients across household livelihood strategies by the decomposition of Gini index by population sub-group, as proposed by Yao (1999). However, the analysis of inequality is slightly extended by using the decomposition method of Lerman and Yitzhaki (1985) to estimate the marginal effect of environmental income on total household inequality.

Compare Gini coefficients with and without environmental income

First, environmental income is deducted from total household income. Secondly, Gini coefficients for total income with and without environmental income are computed. Thirdly, a comparison of the Gini coefficients with and without environmental income provides an estimation of the impact of environmental on inequality.

Compare Gini coefficients by household livelihood strategies

Yao (1999) divided the total population into a finite numbers of sub-groups in his study. The decomposition of Gini coefficient by household livelihood strategies is, as follows:

$$G = G_A + G_B + G_O \quad (7)$$

where G is the Gini coefficient for the whole population and G_A is the intra-class element of G. If no income inequality exists within each of the classes, then $G_A = 0$. G_B is the inter-class element of G. If the mean incomes of every class are the same, then $G_B = 0$. G_O is the overlapped element of G. If the richest person in any low income class I is not better off than the poorest person in any high income class J, then $G_O = 0$.

$$G = 1 - \sum_{i=1}^{n} p_i \left(2 \sum_{k=1}^{i} Q_i - w_i\right) \quad (8)$$

$$Q_i = \sum_{k=1}^{i} w_i \quad (9)$$

where n is the number of income group (a group can contain just one household), Q_i, wi, m_i, p_i denotes, respectively, the cumulative income share, the income share, per capita mean income, and relative population frequency of the ith group (i= 1, 2, 3…., n).

$$G_B = 1 - \sum_{I=1}^{S} p_I \left(2Q_I - w_I\right) \quad (10)$$

$$Q_I = \sum_{K=1}^{I} w_I \quad (11)$$

where Q_I denotes for the cumulative income share up to I, S is the number of population classes, p_I and w_I are population and income shares of the Ith class (I = 1, 2, …., S) in the population.

$$G_A = \sum_{I=1}^{S} w_I \, p_I G_I \quad (12)$$

where G_I is the Gini coefficient for the Ith sub-population. There are S Gini coefficients for S classes.

$$G_O = G - G_A - G_B \quad (13)$$

where $G_A, G_B, G_O > 0$

Marginal effect of environmental income on inequality

Lerman and Yitzhaki (1984) assumed that the population (n) consists of N households (n=1, 2, …., N) and that the total income of each household is the sum of incomes from k different sources. The Gini coefficient for total income inequality (G) with k exclusive income components can be decomposed as follows:

$$G = \sum_{k=1}^{k} R_k G_k S_k \quad (14)$$

Where R_k is the Gini correlation between income component k and total income, G_k is Gini of income component k, and S_k is income component k's share of total income

Decomposition of the Gini coefficient by income source presents the effect of changes in environmental income on overall income inequality in comparison with other income sources.

This study assumes that a change in each household's income from source k equal eY_k, where e is close to 1. The marginal effect of a particular income source k, as follows:

$$\frac{\partial G}{\partial e_k} = S_k(R_k G_k - G) \quad (15)$$

The relative marginal effect of a particular income source is shown in equation (16)

$$\frac{\partial G / \partial e_k}{G} = \frac{S_k G_k R_k}{G} - S_k \quad (16)$$

Equation (16) shows the change in overall Gini coefficient when income from source k increases by 1%.

3.2.3 Model-identifying factors that affect the choice of household livelihood strategies

In order to identify the determinants of the household's livelihood choice and to investigate the constraints on the households who depend on environmental resource away from more remunerative livelihood strategies, the multinomial logit model (MLM) is applied. This model is appropriate to determine the influence of a set of explanatory variables on a response variable with more than two unordered outcomes (Gujarati, 2004 cited in Walelign, 2015). In general, a multinomial logit model can be used to model the probability of choosing a livelihood strategy conditional on the independent variables, as follows:

$$\text{Prob}\,(Y_i = j|\, x_i) = \frac{e^{\beta_j' x_{ji}}}{1+\sum_{k=1}^{j} e^{\beta_k' x_{ji}}} \qquad (17)$$

$$for\ j = 0, 1, 2, \ldots., j;\ i = 1, 2, 3, \ldots., n\ and\ \beta_0 = 0$$

where β_{j}' are vectors of coefficients, X_i is the associated vector of explanatory variables.

The multinomial model also shows the effects of the independent variables on the log-odd ratios.

$$\ln\left[\frac{P_{ij}}{P_{ik}}\right] = x_i'\beta_j \text{ if k = 0} \qquad (18)$$

where β_j indicates the change in log-ratio between the probability of the choice of livelihood strategy j and the probability of the choice of livelihood strategy, k, which is the base group, given each unit change of x_i (Greene, 2003 cited in Nielsen et al., 2013). The odds ratio , $\frac{P_{ij}}{P_{ik}}$ does not depend on the other choices. This property is convenient in terms of estimation. Therefore, model (18) is used in this study with the environment dependency strategy proposed as the base group.

Based on the livelihood strategy framework proposed in the literature, it is assumed that the households' livelihood strategies are explained by the households' asset and conditioning/contextual factors (Scoones, 1998). However, according to Babulo et al. (2008) and Walelign (2015), there is an endogenous interdependence among the asset-related variables and livelihood outcomes. That is, the outcomes generated by a particular chosen livelihood strategies can, in turn, endogenously affect the households' assets. For example, households can use cash income from cropping production to invest in financial assets. For that reason, the sustainable livelihood framework is dynamic. This current study targets the determinants of households' livelihood strategies with a focus on environmental income; therefore, only the static role of households' asset holdings is analysed. The solutions to eliminate the problems of endogeneity, as suggested by Babulo et al. (2008) and Xu et al.

(2015), are to select truly exogenous predetermined independent variables and to conduct a multicolinearity test.

3.3 Study site

Vietnam consists of eight regions (Red River Delta, North East, North West, North Central Coast, South Central Coast, Central Highlands, South East and Mekong River Delta) with an area of 330,957 square km and a population of 86.93 million (year 2010), 69.5% of whom live in rural areas (GSO, 2010). Over the past two decades, Vietnam has achieved significant improvements in economic growth and poverty reduction. Based on the old Government poverty line (period 2006-2010), the country's poverty rate in 2010 decreased to 10.7%. In 2010, the Government issued a new poverty profile that distinguishes between the total poor (individuals living below the GSO-WB poverty line) and the extreme poor (individuals living below two-thirds of the GSO-WB poverty line). Accordingly, in 2010, 20.7% of the population were poor, including 27% living in rural areas (GSO, 2010; World Bank, 2012). However, the poor in Vietnam, particularly in rural areas, are still characterised by "low educational achievement and limited job skills, heavy dependence on subsistence agriculture, physical and social isolation, specific disadvantages linked to ethnic identity, and exposure to natural disasters and risks" (World Bank, 2012, p.7).

There is an increase of opportunities for rural household to engage in off-farm activities. These opportunities have significantly contributed in helping some rural households to get out of poverty. However, with incomes still falling very close to the poverty line, many households are susceptible to falling back into poverty if idiosyncratic and wide economic shocks occur (World Bank, 2012). Meanwhile, the remaining poor still inhabit rural areas with a high dependence on agricultural and related jobs with low incomes (GSO, 2010; World Bank, 2012).

Vietnam has numerous critical ecosystems, such as marine and coastal habitats, inland lakes and rivers, tropical forests, etc. that provide a wide range of habitats for many species. However, similar to other developing countries, growing populations and economic growth have put natural resources in Vietnam under great stress and pressure. For example, Vietnam was ranked 6th, 15th and 18th for reptiles, mammals and birds, respectively, among the countries that have large numbers of threatened species in the 2000 IUCN Red List of Threatened Species. In addition, the speed of forest clearing and degradation has also gained considerable attention. Under this context, the Vietnam government has introduced many legal documents about the conservation of ecosystems, such as the National Conservation Strategy (1985), Environment and Sustainable Development (NPESD) (1991), the National Environment Action Plan (NEAP) (1995), the Biodiversity Action Plan (BAP) (1995) and the latest National Strategy on Environment Protection to 2020 with visions up to 2030

(2012). The documents show Vietnam's commitment to biodiversity and natural resource conservation (ICEM, n.d).

3.4 Data

This study uses the Vietnam Access to Resource Household Survey (VARHS) in 2012, which is conducted with the co-operation of the University of Copenhagen, the Central Institute for Economic Management (CIEM), the Institute of Labour Science and Social Affairs (ILSSA) and the Centre for Agricultural Policy Consulting of the Institute of Policy and Strategy for Agriculture and Rural Development (CAP-IPSARD). This survey has been conducted every two years since 2002. In 2012, the survey was conducted national-wide with a sample size of 3,700 households in rural areas of 12 provinces in Vietnam. The information was collected in the months of June and July for 2012. Face-to-face interviews were conducted with household heads and important commune officials in communes included in the sample enumeration areas. The VARHS surveys are designed to supplement and extend the Vietnam Household Living Standards Survey (VHLSS) managed by the General Statistics Office (GSO). Many households surveyed in the VARHS are derived from the sample from VHLSS. Similar to VHLSS, important information on household income and expenditure from different sources is given particular attention. However, more detailed information on income from common property resources is provided in VARHS. In addition, this dataset also focuses on the access to, and interaction of, rural Vietnamese households with markets for land, labour and credit. In comparison to the previous surveys of 2006, 2008 and 2010, details of agricultural data at the plot level of farmers are also collected in 2012. In addition, new questions about migration, climate change and social welfare are included (CIEM, ILSSA, IPSARD, & more, 2012).

The data consists of information which is divided into twelve categories: (1) Household structure and demographic; (2) Land use; (3) Agricultural production; (4) Livestock, aquaculture, agricultural services and access to markets; (5) Occupation, time use and other sources of income; (6) Access to extension services; (7) Expenditure, savings and assets; (8) Credit; (9) Shocks and risk coping; (10) Social capital; (11) Migration; and (12) Trust, politics, information, social activities and rural society.

This study focuses on the dependence on environmental resources in rural areas of Vietnam. To achieve this aim, the relative environmental income is applied, as described in **Section 3.2**. Therefore, households having negative total net incomes in 2012 are eliminated. As a result, total observations extracted from the VARHS 2012 data set are 3,608 households. The information on environmental income is derived from Sections 3 and 4 of the VARHS dataset. Information on income sources from different household strategies and consumption expenditure are extensively used in this current study. Further, household social-economics characteristics such as age, gender, education, and community-related characteristics are also used in the current study.

Chapter 4

Description of the Vietnam Access to Rural Household 2012 Survey

This chapter provides a description of the Vietnam Access to the Rural Household survey. **Section 4.1** discusses the characteristics of the household heads. **Section 4.2** provides some key characteristics of rural households. This is followed by the characteristics of households' agricultural activities and extract ion of common property resources in **Section 4.3**. Finally, geographical factors are analysed in **Section 4.4**. Rural households are divided into five income quintile sub-groups (poorest, second poorest, middle, second richest and richest) based on annual net income per capita. Descriptive tables contain frequency, mean and statistical tests, including ANOVA tests and Chi-square tests. An ANOVA test is used to test whether the means of individual and household characteristics among the five income quintiles are statistically equal. Meanwhile, a Chi-square test is applied to test the association between a categorical variable and the distribution of income quintiles. Finally, Turkey's HSD method is used to test the statistically significant differences of the means between at least one pair of income quintile groups for individual and household characteristics.

4.1 Individual characteristics

The individual characteristics are illustrated by *age, gender, ethnicity and education* of household heads, as summarised in **Table 4.1**. All the variables are significantly different at the 1% level. This indicates the distribution of income quintiles is strongly associated with *age, gender and education* of household heads.

The age of the household heads ranged from 18 to 98 years-old with an average of approximately 50 years-old. The age of household head is categorised into five groups with most of the respondents in the 31-65 years age group. The percentage of richer households increases as the age of household head increases. In fact, the two poorest groups have a higher proportion of respondents in the 18-40 years groups, while the majority of richer household heads are in the 41 years-old and above group. This means households with older heads are more likely to be in the higher income quintiles.

The majority of the household heads are male (81.62%). This is not surprising since males are usually the main income earners in Vietnam, especially in rural areas. Therefore, they have a strong voice in making decisions. There is an interesting fact about the association between gender and poverty. That is, when women take control over resources, households are more likely to be less poor. **Table 4.1** displays that 13.55% of the poorest households are female-headed compared to 21.36% of the richest households. In addition, female-headed households constituted minor percentages of the surveyed household heads (18.38%); however, only 36.49% are in the two most poorest income

quintile, compared to 41.19% of male-headed households **(see Appendix 1)**. This finding is consistent with the result found in the World Bank (2011) report, which highlighted that females are unlikely to live in poorer households when gender is analysed on its own. Gaps in the economic situation between women and men in Vietnam still remain when there is an interaction of gender with other individual and group characteristics.

The largest ethnic group in Vietnam is the Kinh group; therefore, unsurprisingly, the proportion of Kinh households is almost twice as that of non-Kinh households (64.77% and 35.23%, respectively). In comparison, among the income quintiles, 91.26% of the richest households are Kinh and 74.41% of the poorest households are non-Kinh. A higher percentage of Kinh households are in the richer income quintiles, compared to non-Kinh households, which suggests that Kinh households are significantly more likely to have a better economic situation so the poverty gap for ethnic minorities still remains in rural areas of Vietnam.

In terms of education, the VARHS survey collected information on the highest general education and highest professional educational status. The majority of surveyed respondents attain at least one form of education, where 44.35% of the entire sample manages to finish lower secondary school and only 14.68% of the household heads cannot read and write. There is a distinct difference in literacy levels across the income quintiles. Richer household heads are clearly more educated, with only 2.19% of them reporting that they are illiterate compared to 42.13% of heads in the poorest households. With respect to the professional educational status, a relatively high percentage of household heads have no professional education (80.22%). A handful of them manage to complete vocational school (both short and long term), professional high school or college/university (13.46%, 3.54% and 2.79%, respectively). Comparing the professional educational status across income groups, the trend is similar to the general educational status. Poorer households are less likely to have a professional education compared with the richer households (5.55% for the poorest and 32.51% for the richest).

In summary, rural household heads have some distinct individual characteristics. The majority are male, belong to the Kinh ethnic group and are of working age. Their educational level is low with a high proportion of household heads leaving school after completing secondary education and with no professional education. The variation in individual characteristics is displayed across income quintiles. Finally, gender and education gaps still remain in rural areas.

Table 4-1 Profile of the VARHS surveyed respondents (individual characteristics)

Household head characteristics	Income quintiles						
	Poorest	2nd Poorest	Middle	2nd Richest	Richest	Total	Statistical test
Age of household head							
18-30	8.58	8.74	7.49	5.12	4.58	6.9	
31-40	30.29	23.72	21.36	17.17	19.14	22.34	
41-50	28.22	25.52	28.16	29.64	27.74	27.85	
51-65	18.95	25.66	26.35	34.07	34.95	27.99	
66-98	13.97	16.37	16.64	13.99	13.59	14.91	
Total	100	100	100	100	100	100	$\chi^2(16)=100.76$***
Mean of household head age	47.14	49.36[a]	50.09[a]	51.05[a]	50.79[a]	49.69	F=8.75***
Gender of household head							
Female	13.55	18.45	20.11	18.42	21.36	18.38	
Male	86.45	81.55	79.89	81.58	78.64	81.62	
Total	100	100	100	100	100	100	$\chi^2(4)= 6.93$***
Ethnicity							
Non-Kinh	74.41	47.3	30.65	14.96	8.74	35.23	
Kinh	25.59	52.7	69.35	85.04	91.26	64.77	
Total	100	100	100	100	100	100	χ^2 (4) =890.87***
Highest general education of household head							
Cannot read and write	42.13	18.43	8.11	4.25	2.19	14.68	
Completed lower Primary	25.77	28.35	25.07	18.59	15.74	22.58	
Completed Lower Secondary	28.40	43.94	49.26	51.68	47.67	44.35	
Completed Upper Secondary	3.70	9.29	17.55	25.48	34.40	18.38	
Total	100	100	100	100	100	100	$\chi^2(12)=785.33$***
Highest professional education household head							
No Diploma	94.45	86.15	79.22	73.74	67.59	80.22	
Short Term Vocational school	4.58	11.05	14.37	15.78	13.06	11.76	
Long Term Vocational school	0.14	0.98	1.67	2.79	2.92	1.70	
Professional high school	0.83	1.4	3.77	4.05	7.64	3.54	
College/University	0.00	0.42	0.98	3.63	8.89	2.79	
Total	100	100	100	100	100	100	$\chi^2(12)=310.49$***

Source: Author's calculation based on the VARHS 2012 dataset, N=3,608 households

*, **, and *** indicate the significance levels at 10%, 5%, and 1%, respectively.

For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level. Superscripts letters denote the significant differences between groups. Means sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.

4.2 Household characteristics

Table 4.2 describes some important household characteristics; namely, *household size, income earners, number of children, agriculture land and household income.* All the variables are statistically significant at the 1% level. This means the household characteristics displayed statistical differences among the income quintile groups. In addition, the statistically-significant differences in the means between at least one pair of income groups are found for all variables. Similar to the individual analysis, Turkey's HSD method is used for pairwise comparisons for each variable between every combination of income quintile.

The average household size is approximately five members. There is a higher prevalence of households with one to four members (54.74%) than households with five to seven members (39.63%). Households with more than eight members only account for 5.63% of the sample. The birth control policy in Vietnam encourages households to have one to two children. In addition, the growth of the economy has a positive impact on the acceptance of smaller household sizes. Therefore, most households would have four members or fewer. The household size in rural areas is slightly more than four members. The reasons probably are: (1) it is more likely for households in rural areas have more than one generation living in a family; (2) most of the households in rural areas engage in agricultural activities that require a large manual labour force; and (3) the birth control policy is less effective in rural areas since fewer household heads have jobs in government sectors or private companies. Comparing across income groups, the majority of the poorest households have five to seven members (54.77%), while other income groups are more likely to have one to four members. The variation in the average household size among income quintile group is significant at the 1% level. Overall, richer households are more likely to have fewer household members compared to their poorer counterparts.

The result shows a high percentage of households with one to four income earners (83.33%). However, only 14.18% of the households have more than four income earners. The average number of income earners is about three and the variation among income quintile groups is significant at the 1% level. The proportion of poorest households with more than four income earners is much higher than that of the richest households (25.84% versus 6.51%). This implies that a high number of income earners does not guarantee a higher overall household income.

More than half of the households have one to two children (51.86%). The average number of children is about two children and is significantly different across household income groups at the 1% level. In addition, the majority of poorest households have one to four children (78.09%); in contrast, the majority of their four upper income counterparts have no more than two children (77.38%, 90.12%, 91.9%, and 94.62%, respectively). In addition, the proportion of households with more than

four children is much higher in the poorest households than in the other income groups. Therefore, households with more children are more likely to be under financial pressure.

Land is important for agricultural production. If households are not landless[2], their current agriculture land holding status falls in at least one of the following categories: (1) Household has rights to, and operates, any agriculture plot; (2) Household is renting or borrowing any agricultural plot; and (3) Household has rights to but is renting out agricultural plots. A substantial percentage of households operate agricultural activities on plots that they have rights to (98.84%). Although the difference in this agricultural landholding status is significant at the 5% level, the variance is not distinct. **Table 4.2** also shows only 15.08% of households rent land for agricultural activities and 13.05% of the surveyed households own plots but are renting them out instead of operating them themselves. In addition, richer households are more likely to have plots they are renting out in comparison with the poorer households. This indicates that the richer households are more likely to have sufficient land areas for their production demands.

Large income gaps across household income groups are displayed in **Table 4.2**. The difference in net household income is statistically significant at the 1% level. The mean net income, in 2012, of the surveyed households in the whole sample is 78.08 million VND. The average incomes of the two richest income groups are much higher than the two lowest income groups. For example, the richest households earn 189.46 million VND while the poorest households earn only 24.04 million VND, on average. In terms of the income bracket, the majority of the surveyed households earn from 10 to 50 million VND (46.51%) and from 50 to 100 million VND (29.55%). Only 2.11% of the households earn less than 10 million VND. A high proportion of the richest households earn more than 100 million VND per year (76.7%). However, the prevalence of total net income for the poorest is from 10 to 50 million VND (91.01%) lower.

Household income is generated from different sources. In this study, these income-generating sources are classified into eight categories: wage/salary, agricultural activities, common property resources, rental income, sales of assets, transfers, and other income sources (interest from savings, earnings from share investments, etc.). **Table 4.2** exhibits net income distribution by household income group. In 2012, agricultural activities and wages are the two most important income sources in rural areas. Specifically, 36.89% and 29.95% of total household income comes from these two sources in the whole sample, respectively. However, the importance of the two income sources changes according to household income. For the two lowest income groups, agriculture remains the most predominant income source; however, wages overtake agriculture as a main income source in

[2] Households are considered as landless if they neither own nor operate any agricultural land

the three upper income quintiles. The relatively high percentage of total net income from wages implies the increasing reliance on wage employment outside the household in rural areas. There is a wider variation in income distribution for poorer households. This reflects that the poorer heavily depend on certain income sources compared to the rich. For example, the poorer households tend to rely more heavily on environmental resources than their richer counterparts. Specifically, 63.13% of the poorest households' income comes from agricultural activities and common property resources, which is approximately twice that of the richest households (27.47%). Another noticeable finding is the importance of non-farm economic activities in proportion to household income. For the richest income group, non-farm economic activities account for 19.43% of total income, only lower than the proportions of wages and agricultural activities. Meanwhile, this income source only accounts for 3.1% for the poorest households. This implies that wealthier households become less dependent on farming and are more likely to be able to undertake high-return activities, while poorer households are more likely to engage in low-return activities, especially agriculture.

Table 4-2 Profile of the VARHS surveyed respondents (household characteristics)

Household characteristics	Income quintiles						
	Poorest	2nd Poorest	Middle	2nd Richest	Richest	Total	Statistical test
Household size							
1-4	30.01	47.99	62.27	61.22	72.26	54.74	
5-7	54.77	46.60	34.40	35.87	26.49	39.63	
8-10	13.14	4.85	2.77	2.91	1.25	4.99	
11 and over	2.07	0.55	0.55	0.00	0.00	0.64	$\chi^2(12)=392.49$***
Total	100	100	100	100	100	100	
Mean household size	5.62	4.64	4.22[a]	4.18[a]	3.77	4.48	F=117.05***
Number of income earners							
None	1.54	2.23	2.92	2.37	3.39	2.49	
1-2	32.72	39.8	49.72	44.55	56.01	44.55	
3-4	39.89	42.04	36.77	41.06	34.09	38.78	
5 and above	25.84	15.92	10.58	12.01	6.51	14.18	
Total	100	100	100	100	100	100	$\chi^2(12)=172.80$***
Mean of number of income earners	3.53	3.06[a]	2.77[b]	2.87[ab]	2.54	2.96	F=49.64***
Number of children[3]							
None	11.80	22.35	29.81	38.13	47.52	29.90	
1-2	42.98	55.03	60.31	53.77	47.10	51.86	
3-4	35.11	20.67	9.19	7.96	5.09	15.61	
5 and above	10.11	1.96	0.70	0.14	0.28	2.63	
Total	100.00	100.00	100.00	100.00	100.00	100.00	$\chi^2(12)=682.67$***
Mean of number of children	2.47	1.65	1.24	1.03	0.85	1.45	F=200.51***

[3] Children are any household member under the age of 18

Household characteristics	Income quintiles						
	Poorest	2nd Poorest	Middle	2nd Richest	Richest	Total	Statistical test
Agricultural land holding status							
Land owned and operated by the household							
Yes	99.86	99.03	98.61	98.61	98.06	98.84	
No	0.14	0.97	1.39	1.39	1.94	1.16	
Total	100	100	100	100	100	100	$\chi^2(4)=11.25^{**}$
Land not owned but operated by the household							
Yes	9.68	15.95	17.75	16.07	15.95	15.08	
No	90.32	84.05	82.25	83.93	84.05	84.92	
Total	100	100	100	100	100	100	$\chi^2(4)=21.88^{***}$
Land owned but not used by the household							
Yes	3.87	8.18	12.9	15.65	24.69	13.05	
No	96.13	91.82	87.1	84.35	75.31	86.95	
Total	100	100	100	100	100	100	$\chi^2(4)=159.05^{***}$
Household net income in 2012 (in million VND) (Note that this is not income per capita)							
Less than 10	7.05	3.47	0.00	0.00	0.00	2.11	
10 to less than 50	91.01	79.33	44.94	13.71	3.47	46.51	
50 to less than 100	1.94	17.06	51.32	57.62	19.83	29.55	
100 to less than 200	0.00	0.14	3.74	28.25	51.04	16.63	
200 and above	0.00	0.00	0.00	0.42	25.66	5.21	
Total	100	100	100	100	100	100	$\chi^2(16)=3{,}226.66^{***}$
Mean of household net income	24.04[a]	37.20[a]	54.33	85.51	189.46	*78.08*	$F=277.99^{***}$
Net income distribution (% of total net income)							
Wages/Salary	18.53	27.88	36.76	38.96	27.64	29.95	
Agricultural activities	54.04	43.14	32.77	27.86	26.57	36.89	
Common property resources	9.09	5.04	2.64	1.16	0.90	3.77	
Non- farm/non-wage economic activities	3.10	6.07	10.31	14.45	19.43	10.67	
Rental income	0.45	0.49	0.85	0.50	1.50	0.76	
Sales of assets	0.25	0.45	0.81	0.78	4.41	1.34	
Transfers	13.70	16.11	14.87	14.49	16.53	15.14	
Other	0.86	0.82	0.99	1.80	3.01	1.50	
Total	100	100	100	100	100	100	

Source: Author's calculation based on the VARHS 2012 dataset, N=3,608 households

*, **, and *** indicate the significance levels at 10%, 5%, and 1%, respectively.

For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level. Superscripts letters denote the significant difference between groups. Means sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.

4.3 Agriculture activities and common property resource income characteristics

This section presents a descriptive analysis of households' engagement in agricultural activities, including crop production, and livestock and aquaculture activities operated by households on their own land, as well as the households' engagement in common property resource extraction; namely, forestry and aquatic products. The characteristics of these activities are the activity involved, types of output products, commercialisation of the outputs and the use of inputs.

4.3.1 Agriculture activity characteristics

Table 4.3 and **Table 4.4** present the main characteristics of agricultural activities by income quintile. The findings show some distinct patterns where applicable, Chi-square tests and ANOVA tests are applied.

Crop production

The proportion of the households working in crop production illustrates the magnitude of the household engagement in this activity. Crop production remains the most important occupation since 85.31% of the surveyed households are engaged in this activity. The poorer households are more frequently involved in crop production. That is, 94.33% of the poorest households undertook crop production in 2012 compared to 70.18% of the richest households. The difference in likelihood to engage in crop production across household income quintile is significant at the 1% level. This indicates that the distribution of income quintiles is strongly associated with the households' engagement in crop production.

With respect to the crop production structure of farming households, rice is still the predominant crop (82.39% of crops involved the households cultivating rice). Common crops are maize (38.79%), vegetables (24.78%), fruits (24.04%) and coffee (15.67%). The structure of crop production varies by economic status. Most of the annual crops are more likely to be cultivated by poorer households, while forest products (e.g. timber, bamboo, bamboo shoots, rattan sicklack and cardamom) and the majority of perennial crops are more likely to be grown by richer households. For example, a high frequency of households in the poorest income group plant rice (95.31%) and maize (69.55%), complemented by vegetables (32.65%), cassava (31.92%), and fruits (16.54%). Meanwhile, the richest group are less likely to cultivate rice (61.54%) and maize (15.19%), focusing relatively more on fruits (31.76%) and coffee (28.40%). There are some possible explanations for this pattern. First, most of the perennial crops are tree crops, which require long-term commitment. Secondly, households raising perennial crops are more likely to have access to credit to meet the higher investment requirements. These investments include proper irrigation, more input expenditure, larger land areas cultivated, etc.

Commercialisation is measured by the share of trade products[4]. The increasing commercialization reflects increasing market orientation where households are more dependent on markets for buying inputs, trading their outputs and hiring labour, if needed. This process promotes specialised production which enhances yields (CIEM et al., 2012). For the whole sample, about 34.50% of the products produced are sold and bartered. The rest of the products are used for household self-consumption. The correlations of commercialization and household income are evident from **Table 4.3**, where the differences in average share of sold and bartered products by income quintiles are statistically significant at the 1% level. In particular, higher market involvement falls in the richer household income groups.

The two highest income groups also have the highest level of commercialisation (42.65 % for the richest households and 40.75% for the second richest), followed by the middle and second poorest income groups (34.61% and 32.55%, respectively). The poorest households are least involved in commercialisation (24.81%). This could be explained by financial limitations of the poor households. This constraint restricts many poor households from being able to produce sufficient products to sell constantly. Small-scale production implies fewer goods available to sell and more for their own consumption requirements. In addition, poor households are more likely to reside in remote areas, creating significant challenges in market access. This, in turn, affects transaction making decisions.

In addition to selling outputs, the commercialisation process is related to purchasing inputs and hiring outside labour. Purchased inputs enable households to increase their scale of production since self-provided inputs are not sufficient. **Table 4.3** captures information of some of the main inputs used in crop production, such as seeds and samplings, chemical fertilisers, organic fertilisers (self-produced and bought), pesticides and herbicides, and outside hired labour. In general, the most common inputs used are pesticides and herbicides (88.70%), chemical fertilisers (87.62%), seeds (86.53%), outside hired labour (64.02%), following by self-produced organic fertilisers (39.73%), saplings and purchased organic fertilisers (19.23%). A substantial proportion of farming households use pesticides and herbicides and chemical fertilisers, while a minor percentage of households use either of two types of organic fertilisers. This indicates that crop production is highly dependent on unfriendly environmental inputs. The high reliance on chemical fertilisers, pesticides and herbicides may lead to adverse impacts on the ecosystem, food safety and farmers' health. In addition, a high proportion of households hiring outside labour reflects the labour shortages for farming activities. This may partly be explained by the trend where more and more young people migrate to cities to study or work in the wage employment sector. The differences in the share of households using certain inputs are found across household income groups. More poor households use seeds, saplings,

[4] Trade products are products produced to sell or barter

self-produced organic fertilisers than richer households. In contrast, the percentage of richer households using outside hired labour are higher in comparison with the lower income households. Once again, financial constraints and small-scale production may partly explain this pattern. The pattern of chemical fertilisers, pesticides and herbicides, organic fertilisers (bought) are not as clear as other types of inputs since the highest percentages of households using these inputs fell in the middle and the second richest income quintiles. However, a higher frequency of the richer households, in general, use these kinds of inputs. The influence of income on the use of these inputs in the interaction of other households' characteristics would be of interest.

Table 4-3 Crop production characteristics[5] (percent of farming households)

Household characteristics	Income quintiles						
	Poorest	2nd Poorest	Middle	2nd Richest	Richest	Total	Statistical test
Crop production involvement (%) n=3608							
Yes	94.33	91.26	87.79	82.96	70.18	85.31	
No	5.67	8.74	12.21	17.04	29.82	14.69	
Total	100	100	100	100	100	100	$\chi^2(4)=205.74$***
Types of crops produced (only apply for households involved in crop production) n=3083							
Rice	95.31	88.18	82.97	78.30	61.54	82.39	
Maize	69.55	46.52	32.18	22.20	15.19	38.79	
Potatoes	1.76	0.61	0.47	1.17	1.38	1.07	
Sweet potatoes	1.02	1.52	1.10	1.34	0.99	1.20	
Cassava	31.92	26.52	20.03	8.68	6.31	19.59	
Peanuts	9.66	8.03	7.73	5.84	4.54	7.33	
Soy beans	15.08	8.33	5.05	3.34	3.35	7.36	
Vegetables	32.65	24.85	23.82	19.70	21.30	24.78	
Other annual crops	3.51	5.91	5.21	4.84	4.54	4.80	
Fruits	16.54	21.82	26.18	26.21	31.76	24.04	
Coffee	4.54	13.03	15.46	20.70	28.40	15.67	
Tea	2.05	1.52	3.63	1.84	1.38	2.11	
Cocoa	0.29	0.00	0.00	0.17	0.20	0.13	
Cashew nuts	1.61	5.61	4.73	6.84	5.52	4.77	
Sugar cane	0.15	1.97	0.47	1.00	1.58	1.01	
Pepper	0.15	1.06	2.21	3.51	8.28	2.76	
Rubber	0.00	0.45	0.63	1.50	2.56	0.94	
Medicinal trees	4.98	2.12	1.26	1.50	0.59	2.21	
Other perennial crops	5.86	2.58	2.68	1.84	1.97	3.08	
Forest products[6]	2.05	1.97	2.21	3.51	3.35	2.56	

[5] For types of crop products, commercialization, and crop inputs statistics, only households involving in crop production are included

[6] Only products from plots operated by the household, not from communal forest are included

Household characteristics	Income quintiles						
	Poorest	2nd Poorest	Middle	2nd Richest	Richest	Total	Statistical test
Commercialization of crop products (n= 3083)							
Share of trade products (sold and bartered)	24.81	32.55[a]	34.61[a]	40.75[b]	42.65[b]	34.50	F= 21.16***
Crop inputs used[7] (% HH say yes) N = 3141							
Seeds	97.95	91.28	87.13	83.58	68.61	86.53	
Saplings	47.22	41.05	33.33	22.93	27.26	34.93	
Chemical fertilisers	78.07	87.52	92.09	91.38	90.23	87.62	
Organic fertilisers (self-produced)	49.85	45.86	38.76	34.80	25.94	39.73	
Organic fertilisers (bought)	7.46	17.29	21.86	26.67	25.00	19.23	
Pesticides and herbicides	87.87	90.38	91.47	88.94	84.02	88.70	
Outside hired labour	57.16	60.90	63.26	69.43	71.43	64.02	

Source: Author's calculation based on the VARHS 2012 dataset, N=3,608 households
*, **, and *** indicate the significance levels at 10%, 5%, and 1%, respectively.
For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level. Superscripts letters denote the significant difference between groups. Means sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.

Livestock and aquaculture production

The characteristics of livestock and aquaculture production are summarised in **Table 4.4**. The information includes livestock and aquaculture involvement, livestock and aquaculture products and commercialization status.

In terms of livestock and aquaculture engagement, 67.52% of the surveyed households undertake livestock and aquaculture production. The difference in the likelihood to being involved in livestock and aquaculture operation across household income groups is statistically significant at the 1% level. In particular, the poorer households are more likely to participate in livestock and aquaculture compared to the richer households. This reflects the same trend as seen in crop production, confirming that households move out of farming once their wealth increases.

Table 4.4 provides the prevalence of households engaging in livestock and aquaculture activities by the kind of product. The engagement in livestock or/and aquaculture activities and the engagement in aquaculture, by itself, are statistically associated with income since the Chi-square is significant at

[7] Table 4.3 only summarises some of the main crop inputs. Other crop inputs are small, non-durable tools, energy and fuel, minor repairs or/and maintenance, rental of asset and production equipment, irrigation fees, cultivation loan interest, etc.

the 1% level, while the engagement in livestock production is significant at the 5% level. In general, 67.52% of surveyed households have livestock and/or aquaculture operations, of which, 92.07% of households have livestock production and 12.10% have aquaculture production. Therefore, livestock raising is more predominant than aquaculture in rural areas. In terms of aquaculture production, only 24.9% of the surveyed households report that they engage in this activity. The reason is that aquaculture activities require substantial initial investment to convert plots from crop production to ponds. It is considered as a high return activity but relatively labour-intensive and a moderately risky activity with a high level of uncertainty for returns (CIEM, 2015).

Rural households normally raise different types of livestock, such as cows, buffaloes, horses, sheep, chicken, ducks, etc. As shown in **Table 4.4**, the most common livestock products are poultry (chicken, duck, quail) (99.34% of the surveyed households have poultry), followed by pigs (96.03%), buffaloes (86.50%), cows and bulls (73.15%). A high percentage of households engaging in poultry production are doing so because it is easy to raise chickens, ducks or quail by using crops such as rice or vegetables or, even, households' leftover food. In addition, poultry can be consumed by households or sold (CIEM et al., 2012). Similar to poultry, pigs are easier to raise using households' leftovers or agricultural residues and pork is the most common meat consumed by households in Vietnam. In addition, poultry and pigs have shorter life expectancies than other types of livestock; therefore, this allows the households to get returns quickly. Buffaloes and cows are relatively popular. They are usually raised for meat consumption and used as draught animals. In terms of wealth status, livestock products are found to vary across household income groups. In general, except for poultry, households with higher incomes exhibit the lowest rate for raising most types of livestock.

Aquaculture products, such as fish, shrimps, crabs and oysters are relatively uncommon. Only 11.65% of the households who undertake either livestock or aquaculture activities extract products from aquatic resources. Fish is the most common aquaculture product, while other types of aquaculture products only account for a small percentage. It is noted that only aquaculture products from households' own plots or ponds are presented in **Table 4.4**. Those aquatic products from common property resources are summarised in the following section. The pattern of engagement in different types of aquaculture products by income quintile is random, with no evident trends emerging.

Similar to crop production, the share of trade products (i.e. sold and bartered livestock and aquaculture products) is used as a proxy for commercialization. Overall, about 58.75% of the products produced are used for commercial purposes. The difference in average share of trade products by income group is significant at the 5% level, but the pattern is clear. Richer households have higher levels of commercialization compared to their poorer counterparts. More specifically, a difference is only found between the poorest income quintile and the four upper income groups, but

there is no statistical difference in the average share of trade products among these four groups. This indicates that commercialization is associated with household wealth. The finding is similar to previous findings by CIEM et al. (2012) and CIEM (2015).

Table 4-4 Livestock and aquaculture activities characteristics (per cent of farming households)

Household characteristics	Income quintiles						
	Poorest	2nd Poorest	Middle	2nd Richest	Richest	Total	Statistical test
Livestock or/and aquaculture involvement (%) (n=3,608)							
Yes	87.14	77.67	64.91	58.31	49.51	67.52	
No	12.86	22.33	35.09	41.69	50.49	32.48	
Total	100	100	100	100	100	100	$\chi^2(4)=297.47$***
Type of livestock and aquaculture activities (n = 2,257)							
Livestock (n = 2,257)							
Yes	94.24	93.81	90.65	89.34	90.56	92.07	
No	5.76	6.19	9.35	10.66	9.44	7.93	
Total	100	100	100	100	100	100	$\chi^2(4)=12.17$**
Aquaculture (n = 2,257)							
Yes	7.46	9.48	15.83	13.71	17.70	12.10	
No	92.54	90.52	84.17	86.29	82.30	87.90	
Total	100	100	100	100	100	100	χ^2 (4) =31.70***
Types of livestock products (n = 2,257)							
Cows/Bulls	74.39	78.98	73.28	71.68	56.14	73.15	
Buffaloes	94.55	90.79	81.46	69.81	55.77	86.50	
Horses, ponies	32.50	33.33	8.89	7.14	3.45	21.09	
Pigs	98.62	97.17	95.79	92.63	90.18	96.03	
Sheep, goats	16.18	21.15	16.33	7.50	12.90	15.42	
Chickens, ducks, quail	98.56	99.58	99.49	99.73	99.68	99.34	
Other	52.54	49.38	36.07	27.78	39.53	43.70	
Types of aquaculture products (n = 2,257)							
Fish	7.29	9.48	15.83	12.69	16.22	11.65	
Shrimps	1.36	1.35	1.92	3.3	2.36	1.95	
Crabs	0.51	0.19	1.92	1.78	1.47	1.06	
Oysters	0.34	0.00	0.24	0.76	0.29	0.31	
Other	0.51	0.39	0.96	0.51	0.00	0.49	
Commercialisation of livestock and aquaculture products							
Share of trade products (sold and bartered)	56.44^{a}	57.41^{ab}	59.70^{ab}	60.17^{ab}	63.06^{ab}	58.75^{b}	F= 2.47 **

Source: Author's calculation based on the VARHS 2012 dataset, N=3,608 households
*, **, and *** indicate the significance levels at 10%, 5%, and 1%, respectively.
For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level. Superscripts letters denote the significant difference between groups. Means sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.
For livestock and aquaculture products and commercialisation, only households engaging in these operations are included (n= 2,257)

4.3.2 Common property resources (CPR) engagement

Income from common property resources only accounts for a relatively small proportion of total income, which is about 4% for the whole sample and about 9% for the poorest income quintiles (**Table 4.2).** However, in examining income from these sources in combination with income from agricultural activities, it is important to understand the economic contribution of environmental resources to rural households' welfare. In addition, the evidence of CPR extraction is necessary for natural resources management, especially in Vietnam, where unsustainable use of natural resources is a persistent threat (CIEM et al., 2012). **Table 4.5** provides information on the characteristics of common property resources activities, including common property resources engagement, types of common property resources activities and types of CPR products.

The results reveal that 47.17% of the surveyed households have CPR activities. There is a statistical difference in the prevalence of CPR engagement by income groups at the 1% level. The majority of the two poorest income groups are involved in this activity (83.54% and 64.22% of the surveyed households). However, the frequency of households extracting some products from CPR significantly declines as household income increases. In fact, only 27.42% of households in the second richest group and 16.23% of households in the richest group engage in CPR extraction. This implies that the poorer households are more likely to rely on CPR activities than the richer households.

Common property resources extraction activities comprise aquaculture[8] and forestry[9]. The majority of the households involved in CPR activities engage in forestry extraction activities (94.42%); by contrast, only 23.09% of them report catching aquatic products from CPR. The difference in participating rate in forestry activities by economic status is strongly significant at the 1% level. However, the Chi-square test shows the insignificant difference in the intensity of aquaculture activities among different income levels. Forestry activities are less concentrated in wealthier households. For example, 97.02% of the poorest households exploit forestry products compared to 88.03% of the richest households.

There is a variety of products from CPR. Some common aquatic products extracted by rural households are fish, shrimps, oysters, crabs and other aquatic products. Forestry products consist of cinnamon, anise, pine, oil trees, varnish trees, bamboo, fan palm trees, water coconuts, hunted animals, fuelwood, timber, rattan, mushrooms, nuts, herbs, roots and other forestry products. **Table**

[8] This section only focuses on aquaculture and forestry products from CPR. For aquaculture production from households' own ponds or plots, please refer to livestock and aquaculture production

[9] VARHS 2012 collected the information on both forestry activities with and without processing of extracted products. However, processing of forestry products from CPR is not common; thus, only forestry extraction without a processing process is presented. For more information of processing of forestry products, see CIEM et al. (2012)

5.5 presents some popular forest products reported by the households surveyed. In terms of aquaculture, fish is by far the most common product; 94.13% of households engaged in CPR activities report this product. Shrimps, oysters, crabs and other aquatic products are less common. With respect to forestry products, fuelwood is the predominant type of CPR extraction, where all the household engage in forestry extraction to collect this product, complemented by roots (93.28%), bamboo (83.93%) and timber (73.13%). There is no distinct pattern in extracting products for both CPR aquaculture and forestry.

Table 4-5 Common property resource activities characteristic (percent)

Household characteristics	Income quintiles						
	Poorest	2nd Poorest	Middle	2nd Richest	Richest	Total	Statistical test
Common property resources engagement (%) n = 3608							
Yes	83.54	64.22	44.38	27.42	16.23	47.17	
No	16.46	35.78	55.62	72.58	83.77	52.83	
Total	100	100	100	100	100	100	$\chi^2(4)=860.09^{***}$
Type of common property resources activities							
Engaging in catching aquatic products from common property resource (%)							
Yes	24.17	22.68	21.56	23.74	22.22	23.09	
No	75.83	77.32	78.44	76.26	77.78	76.91	
Total	100	100	100	100	100	100	$\chi^2(4)=0.96^{ns}$
Engaging in extracting forestry products from common property resource (%)							
Yes	97.02	94.17	94.06	91.41	88.03	94.42	
No	2.98	5.83	5.94	8.59	11.97	5.58	
Total	100	100	100	100	100	100	χ^2 (4)= 20.32***
Types of aquatic products from common property resources (n =392)							
Fish	95.21	91.43	95.65	91.49	100.00	94.13	
Shrimps	15.07	14.29	8.70	19.15	16.00	14.29	
Oysters	0.00	0.95	0.00	4.26	0.00	0.77	
Crabs	6.16	14.29	7.25	19.15	8.00	10.20	
Other aquatic products	3.42	6.67	1.45	10.64	0.00	4.59	
Types of forestry products from common property resources (n = 1593)							
Cinnamon	58.33	0.00	25.00	0.00	0.00	30.77	
Pine	14.29	0.00	0.00	0.00	0.00	4.76	
Bamboo	90.57	77.14	83.33	80.00	0.00	83.93	
Hunted animals	64.29	42.86	50.00	50.00	0.00	51.35	
Fuelwood	100.00	100.00	100.00	100.00	100.00	100.00	
Timber	78.26	60.00	76.92	85.71	75.00	73.13	
Rattan	44.44	38.46	50.00	50.00	0.00	41.94	
Mushrooms	62.50	47.06	50.00	75.00	0.00	54.55	
Herbs	25.00	10.00	0.00	0.00	50.00	16.67	
Roots	95.41	90.24	92.68	95.65	92.31	93.28	

Source: Author's calculation based on the VARHS 2012 dataset, N=3,608 households
For types of aquatic and forestry products, only households engaging in common property resources extraction are included
*, **, and *** indicate the significance levels at 10%, 5% and 1%, respectively.

4.4 Geographical factors

Vietnam' access to resource household survey collected information from provinces; namely, Ha Tay, Lao Cai, Phu Tho, Lai Chau, Dien Bien, Nghe An, Quang Nam, Khanh Hoa, Dak Lak, Dak Nong, Lam Dong, Long An. These provinces are grouped into five regions: Northern Midland and Mountain Areas, Red River Delta, North Central and Central Coast, Central Highland and Mekong River Delta. The provinces nested in a region share similar geographical and economic characteristics, which possibly affect the households' livelihoods. For example, the Northern Midland and Mountain areas include the provinces of Lao Cai, Phu Tho, Lai Chau and Dien Bien, which are located in remote areas with low population densities, and share borders with China and Laos. The Central Coast region consists of Nghe An, Quang Nam, and Khanh Hoa. These provinces are covered by large areas of forest, dependent on agriculture, mainly rice and cash crops, as well as having high rates of industrial and tourism activities. The third region is Central Highlands, including the provinces of Dak Lak, Dak Nong, and Lam Dong. Characterised by a range of adjacent plateaux and high mountain chains, this region is suitable for upland rice activities and a variety of cash crops. Finally, the Red River Delta and Mekong River Delta are considered as the two largest rice bowls of Vietnam. In addition, these two regions consist of Ha Tay[10] (Red River Delta) and Long An (Mekong River Delta) that are close to the metropolitan areas of Hanoi and Ho Chi Minh. These characteristics allow these provinces to focus on high-yield rice production and to develop urban-related activities (CIEM, 2015).

Table 4.6 shows the distribution of the surveyed households within the 12 provinces and five regions by income quintiles. In addition, information on how the households from different income groups are aggregated into urban and rural communes is provided. All the geographically-related characteristics exhibit statistical differences among income quintiles at the 1% level. This indicates that the distribution of income is strongly associated with the location of the households.

The majority of the surveyed households are located in Northern Midland and Mountain Areas (36.25%), followed by the Central Highlands (20.34%), North Central and Central Coast (18.04%) and Red River Delta (16.16%). The percentages of surveyed households in the Mekong River Delta are relatively low compared to the other four regions (9.20%). The distribution of the surveyed households in different regions is different across income quintiles. The majority of surveyed households in the poorest and second poorest income groups are located in Northern Midland and Mountain area (72.06% of the households in the poorest group and 42.86% of the households in the second poorest group). For the middle-income group, the households mostly live in the Northern Midland and Mountain areas (28.29%), North Central and Central Coast (24.41%) and the Central

[10] In 2008, Ha Tay was merged into Hanoi. However, the VARH survey still reports Ha Tay as a separate province

Highlands (21.22%). Meanwhile, a high percentage of the second richest and richest households are located in the Central Highlands (27.18%), Red River Delta (23.72%) and Mekong River Delta (15.40%).The surveyed households are spread out across the sample provinces. **Table 4.6** shows that poorer households are more likely to reside in remote and isolated areas, such as Lao Cai, Lai Chau and Dien Bien. However, richer households are more likely in areas close to metropolitan areas, such as Ha Tay and Long An or in areas suitable for cash crop production, such as Dak lak and Dak Nong.

Table 4-6 Geographic characteristics by income quintiles (per cent)

Province	Income quintiles						Statistical test
	Poorest	2nd Poorest	Middle	2nd Richest	Richest	Total	
Region							
Northern Midland and Mountain areas	72.06	42.86	28.29	17.87	20.11	36.25	
Red River Delta	4.84	10.68	16.50	25.07	23.72	16.16	
North Central and Central Coast	11.48	21.08	24.41	19.67	13.59	18.04	
Central Highlands	9.68	19.69	21.22	23.96	27.18	20.34	
Mekong River Delta	1.94	5.69	9.57	13.43	15.40	9.20	
Total	100	100	100	100	100	100	χ^2 (16)= 731.42***
Province							
Ha Tay	4.84	10.68	16.50	25.07	23.72	16.16	
Lao Cai	23.93	9.43	4.72	2.08	1.39	8.31	
Phu Tho	6.64	9.29	11.10	11.08	12.76	10.17	
Lai Chau	21.02	12.62	5.83	2.22	2.77	8.90	
Dien Bien	20.47	11.51	6.66	2.49	3.19	8.87	
Nghe An	3.18	7.49	8.04	5.40	5.83	5.99	
Quang Nam	7.88	10.26	12.07	10.11	4.44	8.95	
Khanh Hoa	0.41	3.33	4.30	4.16	3.33	3.10	
Dak Lak	6.64	10.54	10.12	10.94	10.12	9.67	
Dak Nong	2.63	7.63	8.32	10.66	13.18	8.48	
Lam Dong	0.41	1.53	2.77	2.35	3.88	2.19	
Long An	1.94	5.69	9.57	13.43	15.40	9.20	
Total	100	100	100	100	100	100	χ^2 (44)= 0.001***
Urbanised location[11]							
Rural	99.59	98.06	94.04	95.43	91.12	95.65	
Urban	0.41	1.94	5.96	4.57	8.88	4.35	χ^2 (4)= 77.04 ***

Source: Author's calculation based on the VARHS 2012 dataset, N=3,608 households
*, **, and *** indicate the significance levels at 10%, 5%, and 1%, respectively.

[11] Urbanised locations indicates central areas of commune where markets, schools, hospitals, community offices are concentrated.

Chapter 5

Typology Analysis and Empirical Results

This chapter provides an overview of rural households' dependence on environmental income, the impacts of environmental income on poverty and inequality, and the factors affecting livelihood strategy choices. This chapter is structured as follows. **Section 5.1** briefly provides a typology analysis of rural households in Vietnam. **Section 5.2** examines the economic importance of environmental resources and their impact on household poverty and inequality are presented in **Section 5.3**. **Section 5.4** discusses the empirical results of the multinomial logit model for household livelihood strategies. The maximum likelihood method is applied to estimate the model. The results identify the determinants of household livelihood strategy choice, with a focus on rural households' reliance on environmental resources in rural areas of Vietnam.

5.1 Typology analysis

This section identifies the main household livelihood strategies in rural areas of Vietnam by cluster analysis. This is followed by a description of household income distribution, the characteristics of household assets, and the economic value and contribution of environmental resources to total household income. These analyses are differentiated based on the five livelihood strategy groups. Descriptive tables report the means and ANOVA tests for each specific indicator of interest. Similar to the descriptive analysis sections in **Chapter 4**, Turkey's HSD method is used to test the statistically significant differences of the means between at least one pair of household typology groups.

5.1.1 Main household livelihood strategies

The household data are organised into household livelihood strategy groups by cluster analysis[12]. Cluster analysis classified the data into typologies according to the share of eight income components over the total household income. These household typologies are the basis for the analyses in the following sections.

[12] Principal component analysis has been conducted. However, very few correlation coefficients of 0.3 and above are found in the correlation matrix table. This result indicates that the principal component is not suitable for this study (Pallant, 2007).

Table 5-1 Final cluster analysis of household livelihood strategies (in percentages)

Income source	Household livelihood cluster					
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Total sample
Wages/Salary share	69.89	7.21	13.41	10.16	8.28	29.95
Agricultural income share	18.07	10.63	20.90	19.22	74.53	36.89
CPR income share	1.87	0.51	1.79	1.69	7.94	3.77
Non-farm and non-wage Income share	3.51	75.61	8.36	3.04	2.33	10.67
Rental income share	0.19	0.16	9.52	0.68	0.06	0.76
Asset selling income share	0.05	0.09	21.37	0.13	0.16	1.34
Transfer income share	5.59	4.71	11.33	64.48	6.02	15.14
Other income share	0.83	1.09	13.33	0.61	0.68	1.50

Source: Author's calculation based on the VARHS 2012 dataset

Table 5.1 shows the contribution of each income source for the household livelihood strategy typologies created by cluster analysis. Cluster analysis identified five clusters that are equivalent to five household livelihood strategy groups. These household clusters are labelled based on the predominant relative incomes from each household's livelihood activities. In particular, for the first cluster, income from wage employment accounts for 69.89% of the total household income. Therefore, this cluster is named the wage dependency livelihood strategy. Similarly, Cluster 2 comprised households who earned their income mainly from non-farm and non-wage businesses. Households in this cluster have income from non-farm and non-wage businesses that constitute about 75.61% of their total income. As a result, this cluster of households has a non-farm/non-wage dependency livelihood strategy. Cluster 3 consists of households who earned a large proportion of their income from rentals (land, real estate and other assets), sales of assets and other income sources (interest from savings, earnings from share investments, etc.) jointly make up of 44.18% of the total income. Thus, this cluster is named the mixed income dependency strategy. Following this procedure, households classified in Cluster 4 have a transfer dependency livelihood because they earned most of their total income from transfers, including both public transfers and private transfers (64.48%). Finally, households in the last cluster have a substantial share of their income from agricultural activities and common property resources (82.47% of their total income). Accordingly, this cluster appears as an environment dependency livelihood strategy. The five labels identified for clusters are used to discuss the descriptive statistics and empirical results in the following sections.

The majority of the households surveyed belong to the wage dependency and environment dependency groups, complemented by transfer dependency, non-farm, non-wage dependency and mixed income dependency **(see Appendix 2).** A more detailed breakdown of household livelihood

strategy by income quintile is provided in **Table 5.2.** The table reports some interesting insights into livelihood strategies. In general, environment- and wage-based strategies are predominant in rural areas since more than 60% of the surveyed households follow these two strategies. However, the predominant strategy type varied in each income quintile group. For the two lowest income quintiles, the environment dependency strategy is predominant. That is, 63.35% of the poorest households depend highly on environmental resources, while the figure is 40.64% for households in the second poorest quintile. In contrast, the wage-based strategy plays an important role in the upper three income groups where the percentages of households with a wage-based strategy are 45.35%, 44.32% and 28.43% for middle, second richest and richest income quintiles, respectively.

Furthermore, the variance in the distribution of household strategies decreases according to increases in household incomes **(see Table 5.2**). For example, the poorest households are highly specialised in environment-based strategies and very few of them follow the mixed-income and non-farm and non-wage strategy. With regard to the highest income quintile, the percentages of households following each livelihood strategy do not differ much; that is, 28.83% of them follow the wage strategy, 21.64% the environment strategy, 19.42% engage in non-farm and non-wage businesses, 16.64% follow the transfer strategy and 13.87% of them are in the mixed income strategy group. This means the richer households have more opportunities to diversify into different types of income-generating activities, especially into non-farm and non-wage businesses, and the mixed income strategy. Newman and Kinghan (2015) explained the reason why the non-farm, non-wage strategy is not popular for the rural poor in Vietnam. They claimed that the initial investment to start the business is the constraint for the poor in diversifying into these activities. In addition, households with a mixed income strategy have high proportions of their income from rents, asset selling, interest from savings, or earnings from share investments, etc. To obtain these income sources, households are more likely to have physical and financial asset endowments that are not common for the poor. It is noted that the share of households with a mixed-income strategy in the poorest quintiles is higher compared to the second poorest quintile. This may be because in the survey year, the poorest needed to sell more assets to substitute for their lack of income or to cope with shocks.

Table 5-2 Distribution of households and ranked strategy typology by income group (%)

Poorest		**2nd poorest**		**Middle**	
Environment dependency	63.35	Environment dependency	40.64	Wage dependency	45.35
Wage dependency	20.19	Wage dependency	33.70	Environment dependency	24.27
Transfer dependency	10.93	Transfer dependency	17.34	Transfer dependency	16.37
Mixed income dependency	3.32	Non-farm, non-wage dependency	5.41	Non-farm, non-wage dependency	9.99
Non-farm, non-wage dependency	2.21	Mixed income dependency	2.91	Mixed income dependency	4.02
Total	100	Total	100	Total	100
2nd richest		**Richest**		**Total**	
Wage dependency	44.32	Wage dependency	28.43	Wage dependency	34.40
Environment dependency	20.36	Environment dependency	21.64	Environment dependency	34.06
Transfer dependency	16.48	Non-farm, non-wage dependency	19.42	Transfer dependency	15.55
Non-farm, non-wage dependency	13.99	Transfer dependency	16.64	Non-farm, non-wage dependency	10.20
Mixed income dependency	4.85	Mixed income dependency	13.87	Mixed income dependency	5.79
Total	100	Total	100	Total	100

Source: Author's calculation based on the VARHS 2012 dataset

5.1.2 Household income and livelihood strategy typologies

Table 5.3 summarises the information from 2012 about the average total net income and each income component across the different household livelihood strategies. In general, the average net income per capita of surveyed households is approximately 19.28 million VND per year, which is slightly higher than the findings in CIEM et al. (2012)[13]. This is because of two possible reasons: firstly, the study does not include households with negative net incomes and, secondly, the net income reported in CIEM et al. (2012) is real income adjusted for possible comparisons across time and province. The net income per capita also varied across household strategy groups. The richest household livelihood group is mixed income dependency (43.48 million VND per year), followed by transfer, non-farm and non-wage, and wage dependency (31.64, 19.29 and 16.71 million VND per year, respectively). The households following an environment dependency strategy have the lowest net income per capita, only 14.03 million VND per year, and about one third of the net income that the mixed-income dependency group earned in 2012. This finding confirms the pattern in **Table 5.2** where households in the higher income quintiles become less dependent on income from wage employment and environmental resources. In addition, the income from mixed income sources increases substantially in the richest quintiles.

There is a noticeable variance observed in each household's income sources across the household livelihood strategies. This finding confirms that households' incomes exhibit a pattern following the livelihood strategy groups. For example, households in the environment dependency group have significant income from agricultural activities and common property resources. Unsurprisingly, the Turkey's HSD test shows statistically significant differences in the means for agricultural and common property incomes in possible pairs of the environmental dependency group versus the other four groups. Furthermore, the insignificant differences in the means for agricultural income and common property income are prevalent for possible pairs of wage dependency, non-farm and non-dependency, mixed income dependency, and transfer dependency category. Similarly, households following wage dependency strategy earn much of their income from wage employment while households following non-farm and non-wage dependency have higher income from non-farm and non-wage activities. Besides, households following a mixed income dependency livelihood earn the majority of their income from rentals, sales of assets and other income sources. Finally, households that adopt a transfer dependency strategy derive most of their income from private and public transfers in terms of money or goods.

[13] CIEM et al. (2012) reported the household net income in 2012 is 84.7 million VND. The average household size in this study is 4.48 members (**Table 4.2**). Therefore, the household net income is about 86.37 million VND

Table 5-3 Average total household net income from each livelihood activity (by household livelihood strategy)

Mean net income per capita in 2012 for each livelihood activities (000 VND)	Household livelihood strategies						Statistical test
	Wage dependency	Non-farm, non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total sample	
Wages/Salary	11,987.35	1,980.70[ab]	4,915.53	2,095.10[b]	1,046.07[a]	5,291.99	F= 554.30***
Agricultural income	2,610.20[a]	2,535.46[a]	5,828.32	2,862.69[a]	11,153.89	5,738.51	F= 126.40***
CPR income	194.10[a]	55.40[a]	212.65[a]	161.20[a]	643.20	328.89	F= 36.21***
Non-farm and non-wage Income	714.73[ab]	25,359.20	3,408.04[b]	904.88[ab]	395.95[a]	3,305.35	F= 276.20***
Rental income	44.86[a]	32.81[a]	5,274.12	122.06[a]	7.39[a]	345.78	F= 26.58***
Asset selling income	5.16[a]	58.42[a]	13,522.11	13.87[a]	25.60[a]	801.90	F= 117.07***
Transfer income	976.46[a]	1,264.31[a]	3,525.96	12,952.60	580.16[a]	2,880.66	F= 378.67***
Other income	184.60[a]	354.67[a]	6,788.98	176.25[a]	182.46 [a]	582.49	F= 27.69***
Total net income	16,717.45[ab]	31,640.97	43,475.71	19,288.65[b]	14,034.73[a]	19,275.57	F= 85.96***

Source: Author's calculation based on the VARHS 2012 dataset

*, **, and *** indicate the significance levels at 10%, 5%, and 1%, respectively.

For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level.

Superscripts letters denote the significant difference between groups. Means sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.

5.1.3 Household assets

Households engaging in various livelihood strategies may differ in owning assets. This section examines this variance by considering five types of household assets; namely, human assets, physical assets, natural assets, financial assets and social assets. In addition, this section explores the differences in contextual factors (shocks, infrastructure system, etc.) that are expected to determine households' involvement in the different livelihood strategies. The ANOVA and Turkey's HSD tests are applied to provide detailed insights into the differences in households' asset endowments through their household livelihood strategies.

Human capital

Table 5.4 presents seven selected human capital indicators; namely, *household size, highest general education of household head, highest professional education of household head, household head age, number of working age members, gender of household head and ethnicity of household head*. The ANOVA tests show significant differences in all human capital indicators at the 1% level. This highlights the considerable importance of human capital in the choice of household livelihood strategy.

On average, each surveyed household comprises 4.48 members with 2.92 members of working age[14]. Households that follow the environment dependency strategy have the highest household size as well as working age members, while the transfer dependency group exhibits the lowest values for both indicators. The highest number of household members and labour force are, as expected, in the environmental dependency strategy. Agricultural activities and common property extraction are considered as labour extensive activities. In addition, these kinds of environment-related activities in Vietnam still rely heavily rely on human labour instead of machinery. Therefore, the households who engage in these activities normally have more family members to meet their labour demands.

The education of the household head in rural communities is still limited. With the respect to general education, a household head typically completes lower secondary school in all five categories. The majority of the surveyed households do not continue professional education after completing a general education. If a household head decides to receive a professional education, he or she mostly obtains short-term vocational training. College or university education is minimal. The household head in the environment dependency group has the lowest level of education. The percentage of the household heads who cannot read and write in this category is still high and attending professional education is not popular. The non-farm and non-wage dependency groups have the highest level of

[14] In Vietnam, the working age is defined as 15-65 years (CIEM, 2015)

Table 5-4 Mean value of human capital indicators by livelihood strategies[15]

Human capital	Household livelihood strategy group						
	Wage dependency	Non-farm, non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total	Statistical test
Household size (members)	4.45[b]	4.41[ab]	4.09[a]	3.29	5.15	4.48	F= 113.15***
Number of household members of working age (member)	3.12[a]	2.97[ab]	2.69[b]	1.93	3.19[a]	2.92	F= 89.96***
Highest general education of household head[16]	2.87[a]	3.09	2.80[a]	2.78[a]	2.24	2.66	F= 102.90***
Highest professional education of household head [17]	1.59	1.44[a]	1.38[a]	1.38[a]	1.11	1.37	F= 46.81***
Household head age (years)	48.34[b]	46.50[ab]	54.51	61.23	45.92[a]	49.69	F= 145.99***
Gender of household head (1= male, 0= female)	0.80[bc]	0.84[cd]	0.75[ab]	0.67[a]	0.90[d]	0.82	F= 36.94***
Ethnic group (1= Kinh, 0= Non-Kinh)	0.77[a]	0.94	0.79[a]	0.82[a]	0.34	0.65	F= 268.66***

Source: Author's calculation based on the VARHS 2012 dataset

*, **, and *** indicate significance levels at 10%, 5%, and 1%, respectively.

For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level. Superscripts letters denote the significant difference between groups. Means values sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.

[15] Means of the categorised variables are interpreted slightly differently from the continuous variables. For example, the dummy variable of gender exhibits a value of 0.82, meaning that 82% of the observations are male. For the categorised variables with more than two values, a frequency table is provided in the Appendix to provide more detail.

[16] Highest general education of the household head is categorised as follows: 1- Cannot read and write, 2, Completed lower primary, 3 – Completed lower Secondary, 4- Completed Upper Secondary

[17] Highest professional education of the household head is classified as follows: 1- No diploma, 2- Short term Vocational Training, 3- Long Term Vocational Training, 4- Professional High School, 5- College/University

general education, since the percentage of household heads completing lower and upper secondary is highest in these groups. However, household heads with wage dependency livelihoods are the most likely to obtain a professional education and they also have the highest percentage of household heads with a college or university degree **(see Appendix 3)**. This indicates that well-educated household heads may have more networks or connections; therefore, this enables them to support other family members in getting better-paid jobs. In addition, a high educational level contributes to the households' heads ability to run their family business more effectively.

The average age of household heads is 49.68 years, which is still in the working age range. The head of households in the environment dependency group have the lowest average age (45.92 years), while the highest average age of household heads is in the transfer dependency group (61.15 years). The average age of the household heads in the environment dependency groups are not statistically different from the heads of households engaging in non-farm and non-wage dependencies, but are statistically different from the other three groups. This pattern reflects that households with poor labour endowments, such as a low household size, numbers of working age members, and high age of household heads, are more likely to depend on income from other family members or support from public funds.

Male heads are still predominant in Vietnam rural communities in all strategy categories as about 82% of household heads are male. In comparing across household livelihood groups, female-heads are more likely to be in the transfer and mixed income dependency groups compared to the other three livelihood categories. This exhibits the fact that women are more disadvantaged than men in all economic activities.

The ethnicity of the household heads is also an important characteristic. Among 54 official ethnic groups, the Kinh group comprised about 65% of the surveyed household heads. In Vietnam, the ethnicity of the head defines the ethnicity of the household. This means a Kinh-headed household belongs to the Kinh ethnicity. As presented in **Table 5.4**, non-Kinh households are more likely to depend on environmental resource-related activities and have limited access to higher return livelihood strategies, especially for non-farm or non-wage businesses. In fact, only 34% of the surveyed households with an environment-based strategy belong to the Kinh ethnic group while this ethnic group accounts for 94% of households with non-farm and non-wage based strategies; they are also predominant in the transfer, mixed income and wage dependency groups (82%, 79% and 77% of the surveyed households, respectively). Kinh households have more opportunities to shift to higher remunerative activities compared to their non-Kinh counterparts. This is explained by the following reasons: (1) ethnic minorities have lower endowments for their main assets, such as land holdings, education, access to credit, etc.; (2) they tend to be geographically concentrated in mountainous and

remote areas of the country where longer distances to residential and industrial centres may lead to limited access to public services, infrastructure and increasing transportation costs; and (3) the language barrier makes it difficult for ethnic minorities to access the labour markets (CIEM, 2015; CIEM et al., 2012). In short, ethnicity significantly influences households' ability to engage in different income-generating activities.

Natural capital

Natural capital consists of the land, water and biological resources that households use to support their lives (Ellis, 2000b). As shown in **Table 5.3**, regardless what livelihood strategy a household follows, agriculture still contributes to rural households' income to some degree. Land is anticipated to be associated with agricultural production, including crops, livestock and aquaculture production, as it is the main input for agricultural activities. Therefore, this section examines households' natural capital in terms of land ownership across all livelihood strategies. First, it provides information about the status of the landless, farm size and area of agricultural land owned by households. Then, it investigates the pattern in areas of different agricultural land types, including land for crop production, forestland, pastureland, and the area of water surface for aquaculture. Finally, access to irrigation, which is the proximity of quality of land is discussed. Except for the insignificant differences in the areas of forestland, pastureland and the area of aquaculture water surface, the ANOVA tests show significant differences in other indicators at the 1% level. This indicates, in general, that there is an association between the choice of livelihood strategy and the quantity and quality of land. However, this association is not clear in terms of the types of land.

Landless households are those who neither own nor operate any kinds of agricultural land. **Table 5.5** displays the pattern of landlessness in five livelihood categories. On average, only 9% of the surveyed households are considered as landless households. Landlessness is highest in the non-farm and non-wage dependency and mixed income dependencies (18% and 14% of the surveyed households, respectively), and lowest in environment dependency category (only 1%). This pattern is expected since the environment dependency group is highly dependent on crop production, livestock, aquaculture production, and environmental resources extraction. As a result, land is definitely an indispensable asset to generate their household incomes. In developing countries, landlessness is usually expected to be linked to poverty and vulnerability (CIEM, 2015). However, in comparison with other livelihood strategy groups, the environment-based livelihood strategy has the lowest average income per capita, as displayed in **Table 5.3**. Therefore, it seems that landlessness is not generally related to poverty in Vietnam. This finding reinforces the conclusion by Ravlion and Van De Walle (2009) cited in CIEM (2015) that landlessness in Vietnam rural areas is generally not caused by the households' experience of both negative and economic shocks. It is a result of land trading undertaken to move out of farming activities and take up opportunities in non-farm sectors.

Table 5-5 Mean value of natural capital indicators by livelihood strategies

Natural capital	Household livelihood strategy group						
	Wage dependency	Non-farm, non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total	Statistical test
Landlessness (%)	0.11[a]	0.18[b]	0.14[ab]	0.12[a]	0.01	0.09	F= 39.47***
Farm size (ha)	0.59[a]	0.61[ab]	1.05[b]	0.79[ab]	1.56	1.02	F= 39.50***
Area of agriculture land owned (ha)	0.55[a]	0.46[a]	1.12[bc]	0.74[ab]	1.49[c]	0.95	F= 43.00***
Cropland area (ha)	0.52[a]	0.45[a]	1.16[bc]	0.68[ab]	1.41[c]	0.91	F= 37.26***
Forestland area (ha)	1.24	3.38	1.46	2.33	1.10	1.47	F= 1.64[ns]
Pastureland area (ha)	0.10	0.03	0.70	0.21	0.36	0.28	F= 1.02[ns]
Aquaculture water surface area (ha)	0.12	0.32	0.19	0.10	0.19	0.17	F= 1.80[ns]
Percentage of agricultural irrigated plots (%)	71.97[a]	77.69[a]	68.59[a]	72.61[a]	54.67	66.03	F= 49.97***

Source: Author's calculation based on the VARHS 2012 dataset

Only households operating agriculture land are included in farm size calculation.

Only households who are not landless are included in agriculture land owned calculation

*, **, and *** indicate the significance levels at 10%, 5%, and 1%, respectively.

For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level. Superscripts letters denote the significant difference between groups. Means values sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.

On average, each household operates an area of agricultural land of 1.02 ha and owns an area of 0.94 ha of agricultural land. In terms of land ownership for each land type, the average land area for forest is highest compared to other land types, at about 1.47 ha. This is followed by the areas of cropland and pastureland (0.91 ha and 0.28 ha, respectively). The water surface area for aquaculture production is not common since households only have 0.17 ha for this activity. **Table 5.5** shows that farm size, the area of agricultural land owned and the area of cropland are highest for the environment dependency strategy and lowest for non-farm and non-wage dependency, and wage dependency groups. These findings reveal that agricultural land is limited in Vietnam rural areas, which is in line with the findings by Khai and Danh (2012). The limitations of agricultural land may negatively affect agricultural productivity and income. Therefore, effective irrigation systems are necessary to increase land productivity and agricultural incomes (Khai & Danh, 2012).

Compared with land quantity, land quality is usually at least as important. To assess the quality of land, access to an irrigation system is used as a proxy. In Vietnam, irrigation systems are invested in by the government and farming households. The category of irrigation systems varies, and includes reservoirs, wells, canal, dykes and other water conservation infrastructure (CIEM, 2015). In general, investment in irrigation systems is common in rural areas when 66.03 % of agricultural plots are irrigated. The investment in irrigation systems provides a good water supply for agricultural activities, so that farming households may increase the production by land use intensification and rotation. Surprisingly, the lowest percentage of irrigated plots are in the environment dependency group. This may be partly explained by the financial limitations that restrict households in this group from investing in irrigation.

Physical capital

This section examines the physical assets of rural households in terms of two main indicators, livestock herds and productive equipment ownership. As documented in **Table 4.4**, the common types of livestock raised in rural areas in Vietnam are cows, buffaloes, horses and ponies, pigs, sheep and goats, chickens, ducks, quail and other animals. The productive equipment for farming activities includes: boats, feed grinding machines, rice milling machines, grain harvesting machines, pesticide sprayers, tractors, ploughs, carts, etc.

To estimate the size of households' livestock herds, the Tropical Livestock Units (TLU) conversion factors are applied. This indicator allows a comparison of livestock herd size by the applicable household livelihood strategy. **Table 5.6** shows each household owns an average livestock herd size of 1.65 TLU. The difference in the mean sizes of livestock herds is statistically significant at the 1% level, indicating that the sizes of livestock herds are strongly associated with the households' livelihood engagement. In comparing the different household strategy groups, households with an

environment dependency strategy report the highest size of livestock herd, of 2.22 TLU. For the other four livelihood strategies, the average size of livestock herd is statistically the same.

Agricultural equipment is necessary to produce farming outputs. However, rural households have a low prevalence of productive equipment ownership. In fact, only 39% of the surveyed households own at least one type of productive equipment. The highest prevalence of productive equipment ownership is only 59% for households following the environmental livelihood strategy. For the other four livelihood groups, there is less than one third who own productive equipment. It is evident that rural households in Vietnam are poorly equipped for agricultural activities, and agriculture lacks mechanisation and still relies highly on human labour. The finding reinforces the points made in the human capital section **(Table 5.4)** where households engaging in environment dependency strategy have the highest number of family members and labour. Khai and Danh (2012) reported this discouraging situation in their study about the interrelationship between livelihood assets and poverty in rural areas in Vietnam. In addition, the growth of agriculture mechanization is reported to be at an early stage in Vietnam (Duc Long (2013) cited in (CIEM, 2015)). This important feature may constrain households' capacity to improve the quantity and quality of their agricultural outputs, as well as to reduce post-harvest losses.

Financial capital

Financial capital is measured in terms of the value of credit loans at borrowing and the value of savings in 2012. The differences in the average values of loans and savings across household livelihood categories are statistically significant at the 1% level, implying that the amount of loans and savings links to the selection of household livelihood strategy.

Loans and savings are normally considered as households' risk-coping measures for different income shocks (CIEM et al., 2012). Once shocks occur, households first try to cope with the situation by themselves. They may do nothing, reduce consumption or rely on their savings. If the savings are not sufficient for coping with the shocks, they ask for assistance from relatives or friends, banks or other moneylenders for loans (CIEM et al., 2012; Xu et al., 2015). Besides functioning as a risk coping measure, loan credit also plays an important role in agricultural development and the diversification of farming. Specifically, loans are vital for households for increasing agricultural production as well as for starting a non-farm business since those activities require initial investment (CIEM, 2015). Therefore, households with limited access to credit can be restricted to small-scale production and are highly dependent on environment-related activities.

Generally speaking, rural households may borrow from formal or informal sectors, such as banks, local authorities, private banks, farmers' union, private moneylenders, friends and relatives, etc. The value of the loan is calculated by a sum of the three most important loans that a household received

at the time of borrowing. The average value of loans each of the surveyed households receives is 20.64 million VND. In particular, households in the non-farm and non-wage dependency group receive the highest value of loans at 81.83 million VND. The other four livelihood strategies have much lower loans, ranging from 11.63 million VND to 36.65 million VND. In addition, there are no statistically significant differences in the amounts of credit loans among these four livelihood categories. This pattern supports the finding in the literature that credit is significantly important for households in shifting to more remunerative income activities, especially to non-farm and non-wage businesses. In addition, this implies that households following the non-farm and non-wage livelihood strategy have easier access to credit compared to other livelihood strategy categories.

Rural households could have savings either in formal or informal forms. In term of formal forms, households hold their savings in state-owned commercial banks, private banks or other credit organizations to earn interest. They can use these formal savings to access extra loans. However, in rural areas of Vietnam, formal savings forms are not as common as informal forms. They prefer to hold their savings in the form of cash or gold held at home or through private moneylenders (CIEM et al., 2012). **Table 5.6** shows the surveyed households had savings of 29.85 million VND, on average, at the time of the survey (2012). Households using a mixed income dependency strategy have the highest amount of savings (144.52 million VND), followed by households with non-farm and non-wage dependency (54.09 million VND). The other three livelihood strategy groups have similar amounts of savings since there are no statistically significant differences in their average savings. With higher savings, households in the mixed income, and non-farm and non-wage strategy groups are more likely to access further loans. They are then able to use these financial sources to support their households' production and consumption activities. This seems to reinforce the finding about credit loans where the non-farm and non-wage dependency groups have the highest value of loans. Furthermore, savings play a key role in helping households recover after experiencing shocks. Therefore, households in wage dependency, transfer dependency and environment dependency categories are more likely to be vulnerable to shocks.

Social capital

Social capital is examined in terms of group membership. Group membership consists of three main categories; namely, Communist Party membership, mass organizations and other voluntary associations. In Vietnam, the Communist Party is considered as the principal source of political capital. Along with the Communist Party, mass organizations, including Women's Union, Farmers' Union, Youth Union, are the key types of formal associations in Vietnam. While participation in the Communist Party is restricted, membership of mass organisations is unrestricted. However, mass organizations still have strong connections with the State. They are sometimes involved in the decision making processes at the local government level. The third category of group membership is

voluntary groups. These consists of farmer interest groups, water user associations, business associations, credit groups, religious groups, sports and cultural groups, the Red Cross, groups for the elderly and other voluntary groups. Membership in social groups provides different benefits to rural households. For example, it may enhance information sharing and access to public benefits (Newman, Tarp, & Broeck, 2012). In addition, households with networks may have more opportunities to get good jobs and have easier access to less expensive sources of credit and labour. As a result, they are more likely to invest and make a profit from their non-farm enterprises (Markussen, 2015).

Table 5.6 shows the majority of surveyed households are members of at least one form of social group (85%). Of those, 10.38% of households are members of the Communist Party, 88.09% participated in a mass organization and 27.18% are involved in voluntary groups **(see Appendix 5)**. Therefore, membership of a mass organization is predominant in Vietnam rural areas, which is in line with the finding by Markussen (2015). The variance in the share of households with group membership across household livelihood groups is statistically significant at the 1% level. This reflects the strong association between group membership and the choice of household livelihood strategy. While the pattern of group membership, in general, is not clear, more evident trends emerge for each social membership category. First, membership of the Communist Party is least common for households with non-farm and non-wage, and environment-based strategies (6.73% and 7.70%, respectively). With respect to mass organizations, households that are highly dependent on transfers exhibit the lowest participation rate (70.3%). The wage dependency, non-farm and non-wage dependency and environment-based strategies have a significantly high share of households' involvement in this social group (more than 90%). Finally, the transfer dependency group is most likely to participate in voluntary groups (53.74%), while the environment group has the lowest share of households' membership (17.60%). To summarise, mass organisations gain a great interest from all livelihood strategies. Membership in the Communist Party is not popular (overall only 10.38%), especially for households with non-farm and non-wage, and environment based strategies. Similarly, voluntary groups do not attract rural households, except those with transfer livelihood strategies.

Table 5-6 Mean value of physical, financial, and social capital indicators by livelihood strategies

Household capital	Household livelihood strategy group						
	Wage dependency	Non-farm, non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total	Statistical test
Physical capital							
Livestock herds[18] (TLU unit)	1.20[a]	1.34[a]	1.30[a]	1.13[a]	2.22	1.65	F= 22.28***
Ownership of productive equipment (1= Yes, 0= No)	0.32[b]	0.22[a]	0.30[ab]	0.27[ab]	0.59	0.39	F= 6.94***
Financial capital							
Credit loan value (million VND)	11.78[a]	81.83	36.65[a]	11.63[a]	12.65[a]	20.64	F= 28.47***
Total savings (million VND)	17.88[a]	54.09	144.52	17.03[a]	21.02[a]	29.85	F= 75.35***
Social capital							
Social group membership (1= Yes, 0 = No)	0.87[b]	0.85[ab]	0.86[ab]	0.88[b]	0.81[a]	0.85	F= 5.95***

Source: Author's calculation based on the VARHS 2012 dataset

Only households owning livestock were included.

*, **, and *** indicate the significance levels at 10%, 5%, and 1%, respectively.

For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level. Superscripts letters denote the significant difference between groups. Means values sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.

[18] The size of livestock herd is calculated based on Tropical livestock conversion unit: cattle = 0.70 (including all cattle and buffaloes), Sheep and goats = 0.10, Houses = 0.80, Pigs = 0.20, Chickens = 0.01 (Jahnke, Tacher, Keil, & Rojat, 1987)

Contextual factors

Apart from the household's characteristics factors, contextual factors are beyond the households' control, and they also have important influence on their livelihood strategy choice. **Table 5.7** displays three key contextual factors: *unexpected loss from shocks, distance to the nearest all weather road, and road density (percentage[19] of central commune roads that are asphalt or concrete, percentage of village roads that are concrete, percentage of hamlet roads that are clean and not muddy in the rainy season, percentage of field roads that are concrete and available to vehicle travel)*. The information on shock experience and distance to the nearest all weather road is collected from direct interviews with the households, while information on the other indicators of road access are derived from interviews with commune officials. All contextual variables are significantly associated with the engagement of the household livelihood strategy at the 1% level.

The VARHS survey has collected information on households' unexpected losses from shocks since July 2010. Shocks are categorised into three groups; namely, natural shocks, biological shocks and economic shocks. Natural shocks include shocks from floods, droughts, typhoons and other natural disasters, while biological shocks are shocks from pest infestations, crop diseases and the Avian flu. Economic shocks are more diverse, comprising shocks caused by changes in input and output prices, unemployment, unsuccessful investments, divorce, illness or death of a household member, etc. As summarised in **Table 5.7**, nearly half of the surveyed households report a loss experience from at least one type of shock. To households exposed to a shock, the most frequent shocks are biological shocks, followed by economic and natural shocks. Since July 2010, 45.9% of shocked households suffered biological shocks, while 32.96% of them face losses from some form of economic shock. The prevalence of shocked households facing losses from natural shocks is small (21.07%).

In addition, the incidence of unexpected losses from shocks varies across household livelihood strategy groups. In fact, households whose significant income is from environmental resources are more likely to suffer an expected loss from shocks (62% of shocked households), compared to the other four livelihood strategy groups. Furthermore, 68.87% of them do not completely recover from shocks, the highest across the livelihood strategies. In particular, nearly one fourth of households with an environmental-based strategy still suffer badly after a shock experience (**see Appendix 6**). Meanwhile, households with a non-farm and non-wage dependency are least likely to face losses from shocks and have the most capacity to completely recover from shocks. This pattern is expected because households with environment-based strategy are the most frequent group facing losses

[19] Percentage of central commune roads that are asphalt or concrete reflects what percentage of roads in the commune are in a good condition for travel (i.e. roads are asphalt or concrete). The higher percentage indicates the better road systems in the areas.

Table 5-7 Mean value of contextual factors indicators by livelihood strategy

Contextual factors	Household livelihood strategy group						
	Wage dependency	Non-farm, non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total	Statistical test
Unexpected loss from shock (1= Yes, 0 = No)	0.41[a]	0.35[a]	0.43[ab]	0.49[b]	0.62	0.49	F=39.30***
Distance to the nearest all weather road (Km)	1.93[a]	1.16[a]	1.68[a]	1.40[a]	5.06	2.82	F=71.11***
Percentage of central commune roads that are asphalt or concrete	65.42[a]	71.69[b]	66.90[ab]	67.45[ab]	36.17	56.55	F=141.79***
Percentage of village roads that are concrete	51.13[a]	58.96[b]	51.71[ab]	51.48[a]	19.55	41.31	F=187.08***
Percentage of hamlet roads that are clean and not muddy in the rainy season	53.35[a]	57.30[a]	54.49[a]	54.32[a]	25.73	44.61	F=120.74***
Percentage of field roads that are concrete and available to vehicle travel	25.52[a]	21.08[a]	26.48[a]	23.78[a]	13.65	20.83	F=27.83***

Source: Author's calculation based on the VARHS 2012 dataset

*, **, and *** indicates the significance levels at 10%, 5%, and 1%, respectively.

For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level. Superscripts letters denote the significant difference between groups. Means values sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.

from shocks, and they also have the lowest net income per capita in 2012, meaning they are the poorest. Therefore, they are more vulnerable in terms of shock experience and the extent of recovery from shocks. This finding also supports the important role of credit and savings as a coping strategy. In fact, the non-farm and non-wage dependency group has the highest amount of credit and savings while the environment dependency strategy is the group with the lowest credit and savings **(see Table 5.6).** This indicates that policies that increase access to credit and household savings may mitigate the negative impacts of shocks on the households.

The distance to the nearest all-weather road is a proxy for remoteness, reflecting how good the connection is between a household and its immediate surroundings. A shorter distance to an all-weather road contributes to reducing transportation times as well as easing the transportation of people, agricultural products and other goods, especially during the flood season (Kaila, 2015). In the study areas, the average distance to the nearest all-weather road is 2.82 kilometres. The distance to the nearest all weather road is much greater for households in the environment dependency category, at about 5.06 kilometres. Therefore, this strategy group is, on average, more remotely located than its livelihood strategy counterparts. Generally, the other four livelihood strategies live fewer than two kilometres away from their nearest all-weather road, and the differences in their distance to the road are not statistically significant.

According to Ellis (2000b), roads assist livelihood diversification from different perspectives. Firstly, roads may reduce the spatial cost of input and output transactions. Secondly, they assist the transportation of people between places so people have more chances to access different income earning activities. Thirdly, some markets would not exist without the assistance of roads. Finally, roads are essential for information transmission between rural centres and remote areas. In this study, the characteristics of rural roads are examined using indicators for the share of good road density[20] at different administrative subdivision levels, including communes, villages, hamlets and field roads. These subdivision levels also indicate the remoteness from rural centres. The good road networks are less dense in the surrounding settlements further away from rural centres. In particular, the percentage of central communal roads that are asphalt or concrete is 56.55% while the percentage of field roads that are concrete and available for vehicle travel is only 20.83%. The share of good road networks at all administrative subdivision levels is the lowest for the environment-based strategy, implying that households who are highly dependent on environmental resources live in more remote locations with poorer road infrastructure. The lack of good road networks limits these households' potential for economic diversification because they have to face higher transaction costs, lack key markets and have limited ability for information transmission.

[20] Roads are concrete or asphalt and available to vehicle travel

Therefore, improving road infrastructure may encourage households to move out of farming to other income activities, such as wage employment or non-farm and non-wage businesses.

5.2 The importance of environmental resources

In this section, a detailed analysis of the households' dependence on environmental resources, in terms of absolute and relative values is discussed. Further, environmental income is also divided into two components: incomes from agricultural activities and extraction of common property resources.

Table 5.8 shows that in any livelihood strategy group, the extraction of environmental resources contributes no less than 11% and 2.6 million VND per capita in relative and absolute terms, respectively, to the households' total annual income. Overall, environmental income contributes about 6.1 million VND per capita per year, including 5.7 million VND from agricultural activities and 328 thousand VND from the extraction of common property resources. With respect to the relative value, environmental income accounts for 40.65% of total household income, of which 36.89% comes from agricultural activities and 3.77% from CPR extraction. In addition, the higher percentage of total household income from common property aquaculture compared to forestry (5.12% versus 3.10%), probably reflects a lower pressure on forests than on aquaculture resources in Vietnam.

The important role of agriculture in Vietnam is anticipated since it is still considered by far as the most important livelihood (CIEM, 2015). In many countries, the extraction of common property resources is particularly important to poor households during agricultural off-periods, seasonal food shortages and times of shock and other natural disasters (UNDP et al., 2005; Wunder, Börner, Shively, & Wyman, 2014). However, the findings from **Table 5.8** show that the common property resources are less important than those reported in many case studies. For example, Angelsen et al. (2014) reported that income from common property resources contributed 28% to total household income. For poor households in India, common property resources provided 12% of the total household income (Beck & Nesmith, 2001). In Southern Malawi, the contribution of products from wild forests is up to 30% of total income (Fisher, 2004). The minor contribution of common property resources in Vietnam confirms the fact that "income from wild products is only a part of the environmental income equation. Agricultural income is just as crucial. Only when income from agriculture is combined with the income from wild products do we begin to get a clear idea of how important ecosystem goods and services are as a source of rural livelihoods"(UNDP et al., 2005, p. 39).

As shown in **Table 5.8**, households in all livelihood strategies earned some of their income from environmental resources, but at different magnitudes. It is evident the environment-dependent households are the most reliant on environmental resources in both relative and absolute terms.

Table 5-8 Contribution of environmental resources to rural households' income by household strategy group

Income category	Household strategy group						Statistical test
	Wage dependency	Non-farm, non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total	
Absolute income per capita(000 VND) (n= 3608)							
Agriculture	2,610.20[a]	2,535.46[a]	5,828.32	2,862.69[a]	11,153.89	5,738.51	F= 126.40***
Common property resources	194.10[a]	55.40[a]	212.65[a]	161.20[a]	643.20	328.89	F= 36.21***
- Forestry products	167.58[a]	55.17[a]	181.74[a]	148.54[a]	479.36	260.18	F= 27.93***
- Aquaculture products	70.51[a]	180.54[ab]	81.01[ab]	73.07[ab]	220.52[b]	133.84	F= 3.84***
Total environmental income	2,804.30[a]	2,590.86[a]	6,040.97	3,023.89[a]	11,797.10	6,067.40	F= 142.35***
Relative income (%)							
Agriculture	18.07[a]	10.63	20.90[a]	19.22[a]	74.53	36.89	F= 2094.28***
Common property resources	1.87[b]	0.51[a]	1.79[ab]	1.69[ab]	7.94	3.77	F= 149.73***
- Forestry products	1.64[b]	0.51[a]	1.48[ab]	1.52[ab]	6.34	3.10	F= 136.84***
- Aquaculture products	1.07	3.61	1.07	19.16	3.94	5.12	F= 1.17[ns]
Total environmental income	19.94[a]	11.14	22.69[a]	20.91[a]	82.48	40.65	F=2930.85***

Source: Author's calculation based on the VARHS 2012 dataset

*, **, and *** indicate the significance levels at 10%, 5%, and 1%, respectively.

For the post hoc test, Turkey's HSD method was used and the mean difference is significant at the 5% level. Superscripts letters denote the significant difference between groups. Means values sharing the same letter(s) in the group label are not significantly different from one another at the 5% level.

Environmental income provides 82.48% of total income to households in this strategy group, and is worth about 11.8 million VND per capita per year. This amount is significantly higher than that of the other four strategy groups. The mixed income dependency cluster is the group that earns the second highest environmental income (6 million VND per capita), followed by transfer dependency (3 million VND per capita), wage dependency (2.8 million VND per capita), and non-farm and non-wage dependency groups (2.6 million VND per capita). There are no statistically significant differences in absolute environmental income for the wage, non-farm and non-wage and transfer dependency groups, while the differences in average shares of environmental income are insignificant among the wage, mixed-income and transfer dependency groups. Therefore, an interesting finding emerges that wage and transfer dependency strategies earn the lowest environmental income but are the second highest groups relying on environmental income in terms of statistical tests. The non-farm and non-wage dependency strategy groups are the least reliant typologies for environmental income. The contributions of each component of environmental resources, and environmental resources as a whole to the total households' income are significantly different across livelihood strategy groups at the 1% level, except in the case of aquaculture products from CPR resources, which is insignificant. This implies that there is a strong association between the importance of environmental resources and the choice of livelihood strategies.

5.3 The impacts of environmental income on rural household welfare

This section examines the impact of environmental income on poverty and inequality. The impacts are calculated with and without environment income. In addition, the poverty and inequality level is investigated across households identified in the livelihood strategy clusters. This allows us to detect if there is any difference in the effect of environmental income on poverty and inequality across the livelihood strategies.

5.3.1 Environmental income and inequality

Gini coefficient analysis

Gini coefficients and Lorenz curves are used to investigate the impact of environmental income on income inequality. Gini coefficients are calculated with and without environmental income for the five identified livelihood strategies. In addition, the contributions of each income component to total income inequality are presented in **Table 5.9** and then Lorenz curves are applied to provide a visual comparison of income inequality in rural areas of Vietnam.

Table 5.9 shows the contribution of environmental income to income inequality reduction. For the whole sample, the inclusion of environmental income reduces the Gini coefficient from 0.598 to 0.475, a relative drop of 20.57% (0.123/0.598). The results are consistent with the findings in

previous studies, such as Fisher (2004) and Kamanga et al. (2009). Comparing across household livelihood strategies, the Gini coefficient is highest for mixed-income dependency (0.563), followed by environment dependency (0.502), non-farm, non-wage dependency (0.459), transfer dependency (0.434) and the lowest is the wage dependency strategy group (0.339). However, the impact of environmental income in reducing income inequality is highest in the environmental dependency group. That is, for the environment-based cluster, the Gini coefficient increases to 0.097 when the environmental income is removed. This effect is lowest in non-farm, non-wage dependency groups and quite similar for the other three groups.

Table 5-9 Gini coefficient with and without environmental income

Livelihood strategy	With environmental income	Without environmental income	Mean difference
Wage dependency	0.339	0.383	-0.044
Non-farm, non-wage dependency	0.459	0.483	-0.024
Mixed income dependency	0.563	0.617	-0.054
Transfer dependency	0.434	0.484	-0.050
Environment dependency	0.502	0.599	-0.097
Total	0.475	0.598	-0.123

Source: Author's calculation based on the VARHS 2012 dataset

Turning to the Gini decomposition by income source, as presented in **Table 5.10**, the analysis shows how each income component, especially environmental income, affects the aggregate income inequality. The Gini coefficients are higher for each income component compared to the aggregate Gini index. This means that income diversification may reduce income equality across the sample. Some interesting findings emerged from **Table 5.10**. Although the environmental income accounts for the largest proportion of total income, its unequal distribution is the lowest with the lowest Gini coefficient of 0.635. In addition, the impacts of each income component on income inequality are not identical and not all income sources reduce income inequality (**see column 6 Table 5.10**). That is, only income from wages/salary, environmental resources and other income sources contribute to reducing income inequality. The marginal effects presented in column (6) reflect the impact of a 1% change in an income component of the income inequality. For example, the marginal effect of environmental income is 0.09%, and this is the highest of the income components. This indicates that a 1% increase in environmental income, given others income sources are held constant, decreases the aggregate income inequality by 0.09%. Therefore, environmental income has an equalizing effect on total income inequality in the studied areas and policy implications for income equity should pay significant attention to developing environment-based activities.

Table 5-10 Gini decomposition by income source

Source income (1)	S_k (2)	G_k (3)	R_k (4)	Share (5)	% Change (6)
Wage/salary	0.275	0.695	0.562	0.225	-0.049
Environmental income	0.315	0.635	0.535	0.225	-0.090
Non-farm/non-wage income	0.172	0.913	0.750	0.247	0.075
Rental income	0.018	0.990	0.808	0.030	0.012
Asset selling income	0.042	0.990	0.887	0.077	0.035
Transfer	0.149	0.816	0.575	0.148	-0.002
Other income	0.030	0.956	0.799	0.049	0.018
Total net income		0.475			

Source: Author's calculation based on the VARHS 2012 dataset

Lorenz curve analysis

Figures 5-1 and **5-2** visually illustrate the impact of environmental income on income inequality. The crosswise line is the equidistributional line, representing perfect inequality (Bellù & Liberati, 2005; Fisher, 2004). The Lorenz curves in **Figure 5-1** are developed using the household incomes from the included and excluded environmental incomes. **Figure 5-1** shows that the Lorenz curve with the inclusion of environmental income is closer to the equidistributional line than that without the inclusion of environmental income. This means the environmental income reduces the income inequality.

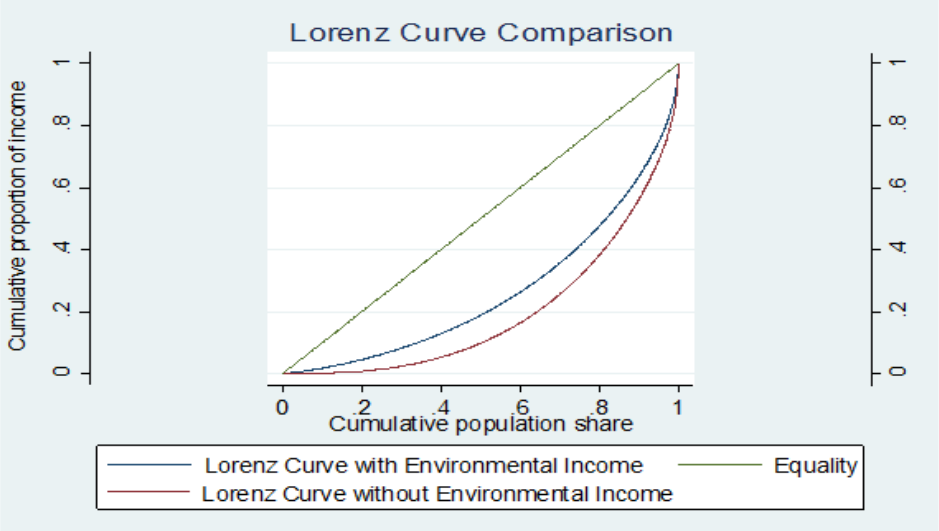

Figure 5-1 Lorenz curve comparison with and without environmental income

Source: Author's calculation based on the VARHS 2012 dataset

The Lorenz curves for different livelihood strategies in **Figure 5-2** confirm the findings from the Gini coefficient analysis. That is, the mixed income strategy group has the furthest Lorenz curve from the equalisation line and the wage dependency group has the closest. Therefore, income inequality is highest in the mixed income dependency strategy and lowest in the wage dependency group.

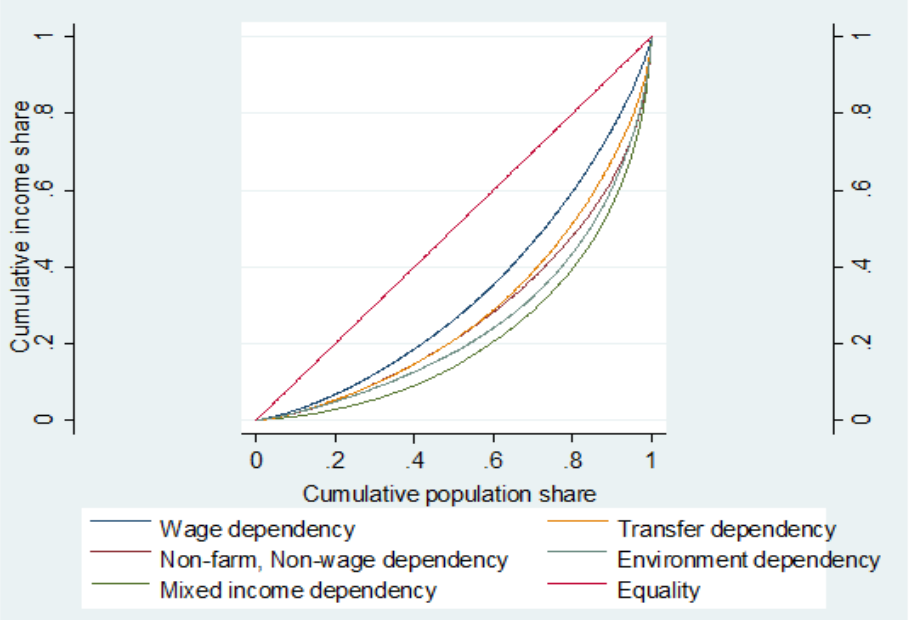

Figure 5-2 Lorenz curve comparison across livelihood strategies

Source: Author's calculation based on the VARHS 2012 dataset

5.3.2 Environmental income and poverty

Comparison of poverty with and without including environmental income

The Foster, Greer and Thorbecke (1984) (FGT) class of poverty measures, including poverty headcount, poverty gap and the squared poverty gap, are used to examine the effect of environmental income on rural households' poverty. A comparison of poverty indices, with and without environmental income, provides insights into how poverty income changes in the absence of environmental resources, such as in the case of resource depletion.

Table 5.11 shows the results of FGT poverty indices. The official MOLISA poverty line applied for rural areas during the period 2011-2015 is VND 400,000[21] per person per month (approximately $1.33 per day). In the headcount measure, about 39.6% of individuals are classified as poor. In other words, about 39.6% of the individuals in rural areas live below the poverty line. However, when environmental income is taken into account the headcount index drops to 11.6%. This means that environmental income reduces poverty by 70.7% (28/39.6). Similar changes in direction are observed for the poverty gap and poverty severity. Specifically, poverty gap and poverty severity indices drop by 22.5% and 18.7% percentage point, respectively. In terms of the depth of poverty (poverty gap), on average, the poor have an income deficit of 2.9% and 25.5% of the poverty line, with and without environmental income, respectively.

[21] Conversion of MOLISA poverty lines into 2005 PPP$ per day by using the annual average CPI for 2010

Table 5-11 FGT Poverty Indices with and without environmental income

Poverty index	With environmental income		Without environmental income		Mean difference
	Mean	Std. Dev	Mean	Std. Dev	
Headcount	0.116	0.320	0.396	0.489	-0.280
Poverty gap	0.029	0.103	0.255	0.365	-0.225
Poverty severity	0.012	0.056	0.198	0.327	-0.187

Source: Author's calculation based on the VARHS 2012 dataset

Poverty indices decomposition by household livelihood strategy group

The poverty indices are decomposed by livelihood strategy groups, as presented in **Table 5.12.** The results are evident. All three poverty indices are highest in the environment dependency cluster and lowest in non-farm, non-wage dependency group. That is, 23.1% individuals who depend on environmental resources are poor with an income deficit of 5.9% of the poverty line of VND 400,000 per person per month. However, only 1.9% of individuals in the non-farm, non-wage dependency cluster are poor, and their income deficit is minimal, at 0.1% of the poverty line.

This result reveals that individuals who depend highly on environmental income bear a heavier poverty burden than those in the other four livelihood strategies. Non-farm and non-wage businesses seem to play important roles in reducing income poverty in rural areas.

Table 5-12 Poverty Indices decomposition by household livelihood strategy group

Household livelihood strategy group	Annual income per capita	Head count	Poverty gap	Poverty severity
Wage dependency	16,717.45	0.065	0.013	0.004
Non-farm, non-wage dependency	31,640.97	0.019	0.004	0.001
Mixed income dependency	43,475.71	0.057	0.013	0.004
Transfer dependency	19,288.65	0.062	0.023	0.012
Environment dependency	14,034.73	0.231	0.059	0.023

Source: Author's calculation based on the VARHS 2012 dataset

5.4 Determinants of households' livelihood strategies

5.4.1 Definitions of the explanatory variables used in the Multinomial Logit model

The choice of a household's livelihood strategy is a function of the households' capital (human capital, natural capital, physical capital, financial capital and social capital) and contextual factors. Human capital includes the household size (HHSIZE), education of the head (EDU_HEAD), age of household head (AGE_HEAD), number of working-age members (WORKING_AGE_MEMBER), gender of household head (GENDER_HEAD) and household ethnic group (ETHNIC). Area of agricultural land owned (AGRI_LAND_OWNED) and percentage of agricultural irrigated land (IRRIGATION) represent the households' natural capital. Physical capital comprises two variables; namely, size of livestock herds (LIVESTOCK) and ownership of productive equipment (PRODUC_EQUIP). SAVING and LOAN are

dummy variables, included to capture the effect of financial capital on a households' livelihood strategy. For social capital, a dummy variable representing membership of social groups (NETWORK) is applied. Finally, experience of unexpected loss from shocks (SHOCK) and the distance to the nearest all-weather road (DIS_ROAD) are used to examine the impact of the contextual factors. A detailed explanation and summary statistics for all explanatory variables used in the model is presented in **Tables 5.13**.and **5.14.**

Previous studies have shown the effect of human capital on households' livelihood strategy choice, including *household size*, *household head education*, *age of the household head*, and *number of household members of working age*, *gender* and *ethnicity*. In this study, household size is a continuous variable, calculated by the number of members in a family. A household with a greater number of members is expected to be more likely to engage in labour-intensive activities. Education of the household head is a dummy variable, and takes a value of 1 if the household head has completed high school and above and 0 otherwise. Household heads with higher educational levels have higher access to more remunerative activities, such as wages and non-farm, non-wage businesses. The number of household members of working age is another continuous variable, which represents the households' labour endowment. The age of the household head is also included, with the expectation that households with older heads are less likely to engage in environment dependency activities. Male heads are still predominant in Vietnam rural communities. In addition, females are normally considered to be more disadvantaged than men in most economic activities. Therefore, the gender of the household head is included in the model to test whether a male-headed family is more likely to be involved in more remunerative strategies. Minority ethnic groups in Vietnam are characterised by low asset endowments, language barriers and living in remote areas. These characteristics normally trap them in agriculture and resources activities. Therefore, the ethnicity of the household is taken into account in the model as a dummy variable, which takes a value of 1 if the household belongs to the Kinh ethnic group and 0 otherwise.

The size of agricultural land owned by a household and the percentage of irrigated agricultural land are proxies for the quantity and quality of land, an important component of the households' natural assets. The endowment in natural assets is expected to induce a household to engage in environment-related activities, in comparison to other livelihood strategies. Similarly, the possession of larger physical assets for production activities is hypothesised to positively influence households' engagement in environment-related activities.

Savings and loans are two important indicators of financial assets, which also influence households' choice of livelihood strategy. Walelign (2015) and Babulo et al. (2008) found that households who are not credit constrained and have savings may have easier access to finance-intensive activities or

activities that require an initial investment. Therefore, loans and savings are included as dummy variables in the model. A loan takes the value of 1 if the household has had any loan since 1st July 2010, and 0 otherwise. Similarly, saving equals 1 if the household has savings at the time of the interview, and 0 otherwise. Loans and savings are expected to reflect the positive impact of the choice on more remunerative income activities.

The network variable is defined as the households' membership in social groups. Membership in formal and informal organizations or groups may enhance households' access to public benefits, and information sharing. In addition, households with strong connections may have more opportunities to get better jobs as well as easier access to less expensive sources of credit and labour (Markussen, 2015; Newman et al., 2012). Therefore, households' social networks are hypothesised to reduce environmental dependency as more households shift to higher return income activities.

Shock variable is a contextual factor that affects the choice of livelihood strategy. It is defined as the households' experience of any unexpected loss from shocks since July 1, 2010. The variable takes a value of 1 if the household did not experience any unexpected loss from shocks (natural, biological and economic shocks), and 0 otherwise. The experience of shocks induces the households to reallocate their resources from agriculture to more defensive livelihood activities (van den Berg, 2010).

Road as an component of infrastructure is one of the crucial factors that shape the choice of livelihood strategy (Ellis, 2000a). In this study, the distance to the nearest all-weather road is taken into account to reflect the remoteness. A longer distance to a road makes the transportation of people and agricultural products and other goods less convenient, as well as increasing transaction costs. In addition, roads are essential for information transmission between rural centres and remote areas.

According to Ellis (2000b), roads assist livelihood diversification from different perspectives. Firstly, roads may reduce the spatial cost of input and output transactions. Secondly, they assist the transportation of people between places so that people have more opportunities to access different income earning activities. Thirdly, some markets would not exist without the assistance of roads. Finally, roads are essential for information transmission between rural centres and remote areas. As a result, easier accessibility to roads encourages households to engage in more profitable activities (Babulo et al., 2008).

Table 5-13 Definitions of dependent and explanatory variables of the multinomial model

Variable	Type	Explanation
Dependent variable		
Household livelihood strategy cluster	Categorical	The dependent variable takes a value from one to five created by the results of the cluster analysis. That is, 1, 2, 3, 4 and 5 represent wage, non-farm and non-wage, mixed-income, transfer and environment dependency strategies, respectively.
Independent variables		
Human asset		
HHSIZE	Continuous	The number of household members in a family (persons)
EDU_HEAD	Dummy	Household head education (EDU_HEAD = 1 if the household head finishes high school or above, and 0 otherwise)
AGE_HEAD	Continuous	Age of the household head (years)
WORKING_AGE_MEMBER	Continuous	The number of households members between 15 and 65 years of age (person)
GENDER_HEAD	Dummy	Gender of the household head (GENDER_HEAD = 1 if the head is male, and 0 if the head is female)
ETHNICITY	Dummy	The ethnicity of the household (ETHNICITY = 1 if the household belongs to Kinh ethnic group, and 0 otherwise)
Natural asset		
AGRI_LAND_OWNED	Continuous	The total amount of agricultural land owned by the household (ha)
IRRIGATION	Continuous	The percentage of irrigated agricultural land (%)
Physical capital		
LIVESTOCK	Continuous	The size of livestock herd (TLU unit)
PRODUC_EQUIP	Dummy	Ownership of productive equipment (PRODUC_EQUIP = 1 if the household have any equipment for production purposes, and 0 otherwise)
Financial capital		
SAVING	Dummy	Households' saving (SAVING = 1 if household have any saving, and 0 otherwise)
LOAN	Dummy	Households' access to credit (LOAN = 1 if the household has any loan since 1st July 2010, and 0 otherwise)
Social capital		
NETWORK	Dummy	Household membership in social groups (NETWORK = 1 if the household has any member participating in any formal or informal organizations or groups, and 0 otherwise)
Contextual factors		
SHOCK	Dummy	Unexpected loss from shocks (SHOCK = 1 if the household has any unexpected loss from any type of shocks, and 0 otherwise)
DIS_ROAD	Continuous	Distance to the nearest all-weather road (km)

Table 5-14 Summary statistics for the explanatory variables by livelihood strategy

Variable	Total sample		Wage dependency		Non-farm, non-wage dependency		Mixed income dependency		Transfer dependency		Environment dependency	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
HHSIZE	4.48	1.86	4.45	1.54	4.41	1.60	4.09	1.91	3.29	1.89	5.15	1.90
EDU_HEAD	0.18	0.39	0.23	0.42	0.29	0.45	0.20	0.40	0.21	0.41	0.09	0.29
AGE_HEAD	49.69	14.30	48.34	13.27	46.50	11.79	54.51	15.02	61.23	15.34	45.92	12.33
WORKING_AGE_MEMBER	2.92	1.45	3.12	1.29	2.97	1.29	2.69	1.57	1.93	1.55	3.19	1.39
GENDER_HEAD	0.82	0.39	0.80	0.40	0.84	0.37	0.75	0.44	0.67	0.47	0.90	0.30
ETHNICITY	0.65	0.48	0.77	0.42	0.94	0.23	0.79	0.41	0.82	0.38	0.34	0.47
AGRI_LAND_OWNED	0.95	1.98	0.55	0.88	0.46	1.13	1.12	1.85	0.74	3.91	1.49	1.52
IRRIGATION	66.03	37.09	71.97	35.71	77.69	35.37	68.59	40.09	72.61	36.47	54.67	35.68
LIVESTOCK	1.08	2.28	0.70	1.30	0.54	1.35	0.68	1.36	0.68	1.08	1.87	3.35
PRODUC_EQUIP	0.39	0.49	0.32	0.47	0.22	0.41	0.30	0.46	0.27	0.45	0.59	0.49
SAVING	0.82	0.38	0.83	0.38	0.84	0.37	0.87	0.34	0.76	0.43	0.84	0.37
LOAN	0.40	0.49	0.39	0.49	0.46	0.50	0.34	0.48	0.34	0.47	0.42	0.49
NETWORK	0.85	0.36	0.88	0.33	0.85	0.36	0.86	0.35	0.88	0.32	0.81	0.39
SHOCK	0.49	0.50	0.41	0.49	0.35	0.48	0.43	0.50	0.49	0.50	0.62	0.48
DIS_ROAD	2.82	6.01	1.93	4.05	1.16	2.61	1.68	3.44	1.40	2.78	5.06	8.62

Source: Author's calculation based on the VARHS 2012 dataset

5.4.2 Determinants of households' livelihood strategy choices

The findings of the determinants of households' livelihood strategy choice are displayed in **Table 5.15.** The table includes the estimated coefficients, odd ratios and marginal effects for continuous variables.[22] The Variance Inflation Factor (VIF) is applied to diagnose the potential for a multicollinearity problem. No evidence of multicollinearity is presented in the model (mean VIF = 1.28). The Likelihood Ratio (LR) Chi-Square test shows that the model is significant at the 1% level (LR chi2 (60) = 1680.04, Prob > chi2 = 0.0000), which indicates that at least one of the explanatory variables has a significant influence on the dependent variable. In addition, Wald tests for combining alternative assumptions and Small-Hsiao tests of the independence of irrelevant alternative (IIA) assumption are conducted. The results show that these two assumptions are not violated. Details on VIF, Wald tests and Small-Hsiao tests are presented in **Appendices 7, 8** and **9**, respectively. With the focus on identifying the determinants for the households' livelihood choices, and investigating the constraints on households who depend on environmental resources instead of more remunerative livelihood strategies, Cluster 5 (i.e. the environment dependency strategy group) is the base outcome in the model. Therefore, the coefficients, odd ratios and marginal effects reveal the influence of the independent variables on the likelihood of livelihood strategy choice relative to environment dependency strategy.

Table 5.15 presents the significant influence of household size, education of the household head, age of the household head, number of household members of working age, ethnicity, agricultural land owned, size of livestock herds, ownership of productive equipment, savings, loans, membership in social groups, shocks and distance to the nearest all-weather road, on the likelihood of household strategy choice. Meanwhile, the gender of the head and irrigation variables exhibit no significant influence on the dependent variables.

Effect of human capital on household livelihood strategy choice

The household size (HHSIZE) is a significant and negative influence on the likelihood of choosing wage dependency, mixed-income dependency and transfer dependency strategies. This implies that the households with more family members are more likely to adopt the environment dependency strategy. The odd ratios of 0.89, 0.88 and 0.81 are for wage, mixed-income and transfer dependency groups, respectively. These ratios indicate that given an additional member in the household size, the relative probabilities (can be called relative risk or the relative odds) of being in the three strategies are from 1.12 to 1.23 (1/0.89 and 1/0.81) times lower when other variables in the model are held constant. In addition, the marginal effects of household size on the livelihood choice are minimal. For

[22] Marginal effects may not be meaningful for discrete variables ((Greene, 2003, p. 668)

example, the marginal effect[23] of the transfer dependency strategy is -0.016, which indicates that an additional member in a household reduces the likelihood of being in the transfer livelihood strategy by 1.6%, given the other variables in the model are held constant.[24] The finding is expected since the environment dependency strategy is more labour-intensive than the other four strategies; therefore, a larger number of household members enable the households to meet the demand for a labour force.

The education of household head positively influences the likelihood of households' decision for all livelihood strategies. This means that a household head finishing high school or higher is more likely to participate in wage, non-farm and non-wage, mixed-income and transfer strategy groups than a household head with an educational level below high school. More educated household heads have better skills and knowledge; therefore, they have the capacity to find good jobs, as well as engaging in more remunerative activities, such as non-farm and non-wage businesses, and mixed income. In addition, heads that are more educated also have broader social connections; therefore, they have easier access to private and public transfers. The odds ratios reveals that the odds for household heads who complete high school and above are in wage, non-farm and non-wage, mixed-income and transfer dependency are , 1.619, 1.704, 1.622 and 2.104 times, respectively, higher than those who cannot read or write, or only finish primary or secondary school.

Table 5.15 indicates that the age of household head significantly and negatively influences the households' engagement in the non-farm and non-wage dependency groups, while this variable exhibits a positive effect on livelihood strategies choices for the mixed-income and transfer dependencies. This implies that older heads are more likely to be in mixed-income and transfer dependency groups, but less likely to decide to pursue a non-farm and non-wage dependency strategy relative to their younger counterparts. However, the marginal effects of this variable on the choice of livelihood strategies are minimal. That is, a one-year increase in the age of the household head only decreases the likelihood of a household choosing non-farm and non-wage dependency by 1.1% and increase the likelihood of a household being in a mixed-income and transfer livelihood strategy by 0.1 % and 0.5%, respectively. The reasons for are, as follows: (1) Older households have accumulated enough capital; thus, they are more conservative about investing in non-farm and non-wage businesses that are lucrative, but more risky than other strategies. The higher amount of accumulated assets also allows households to earn incomes from selling of assets, asset rentals, as well as interest from savings in banks. Those incomes are components of mixed income sources; (2) Household heads may reach their ultimate strength of physical fitness when they get older, and

[23] The marginal effect is calculated at the mean value
[24] This assumption is also applied for the interpretation of other independent variables.

Table 5-15 Multinomial model for the determinants of households' livelihood strategy choice

Variables	Cluster1 Wage dependency			Cluster 2 Non-farm, non-wage dependency			Cluster 3 Mixed-income dependency			Cluster 4 Transfer dependency		
	Coeff.	Odd ratios	ME	Coeff.	Odd ratios	ME	Coeff.	Odd ratios	ME	Coeff.	Odd ratios	ME
HHSIZE	-0.113	0.893***	-0.015	0.047	1.048	0.008	-0.121	0.886*	-0.003	-0.202	0.817***	-0.016
		(0.0360)			(0.0662)			(0.0641)			(0.0442)	
EDU_HEAD	0.482	1.619***		0.533	1.704***		0.484	1.622**		0.744	2.104***	
		(0.246)			(0.330)			(0.389)			(0.388)	
AGE_HEAD	0.002	1.002	-0.002	-0.011	0.989*	-0.001	0.031	1.032***	0.001	0.053	1.054***	0.005
		(0.00432)			(0.00640)			(0.00687)			(0.00527)	
WORKING_AGE_MEMBER	0.390	1.477***	0.092	0.230	1.258***	0.006	0.096	1.100	-0.003	-0.188	0.829***	-0.041
		(0.0770)			(0.0989)			(0.0982)			(0.0583)	
SEX_HEAD	-0.175	0.840		0.230	1.258		-0.241	0.786		-0.124	0.883	
		(0.130)			(0.292)			(0.186)			(0.159)	
ETHNICITY	1.112	3.041***		2.752	15.68***	0.128	1.255	3.508***		1.062	2.892***	
		(0.388)			(4.263)			(0.827)			(0.494)	
AGRI_LAND_OWNED	-0.676	0.509***	-0.140	-0.584	0.557***	-0.019	-0.020	0.980	0.018	-0.063	0.939	0.030
		(0.0317)			(0.0558)			(0.0468)			(0.0441)	
IRRIGATION	0.001	1.001	0.000	0.000	1.000	0.000	0.000	1.000	0.000	0.003	1.003	0.000
		(0.00157)			(0.00230)			(0.00264)			(0.00207)	
LIVESTOCK	-0.261	0.770***	-0.043	-0.286	0.751***	-0.009	-0.205	0.814***	-0.004	-0.129	0.879***	0.002
		(0.0278)			(0.0460)			(0.0551)			(0.0354)	
PRODUC_EQUIP	-0.588	0.555***		-1.146	0.318***		-0.801	0.449***		-0.677	0.508***	
		(0.0597)			(0.0546)			(0.0858)			(0.0721)	
SAVING	0.114	1.121		0.228	1.256		0.462	1.588		-0.345	0.708**	
		(0.158)			(0.266)			(0.447)			(0.122)	
LOAN	-0.112	0.894		0.308	1.361**		-0.278	0.758		0.321	1.378**	
		(0.0946)			(0.211)			(0.143)			(0.191)	

Variables	Cluster1 Wage dependency			Cluster 2 Non-farm, non-wage dependency			Cluster 3 Mixed-income dependency			Cluster 4 Transfer dependency		
	Coeff.	**Odd ratios**	**ME**	**Coeff.**	**Odd ratios**	**ME**	**Coeff.**	**Odd ratios**	**ME**	**Coeff.**	**Odd ratios**	**ME**
NETWORK	0.502	1.652***		0.326	1.385		0.369	1.446		0.485	1.624**	
		(0.248)			(0.316)			(0.397)			(0.341)	
SHOCK	-0.120	0.887		-0.056	0.945		0.241	1.273		0.453	1.573***	
		(0.0968)			(0.152)			(0.236)			(0.219)	
DIS_ROAD	-0.027	0.973***	0.000	-0.071	0.931**	-0.003	-0.049	0.952**	-0.001	-0.076	0.927***	-0.006
		(0.00979)			(0.0258)			(0.0221)			(0.0189)	
Constant	-0.599	0.550*		-3.102	0.0450***		-3.660	0.0257***		-2.826	0.0593***	
		(0.185)			(0.0249)			(0.0157)			(0.0263)	
Observations		3,041										
Log likelihood		-3,414.71										
LR chi2(64)		1,680.04										
Prob > chi2		0.0000										

*** p<0.01, ** p<0.05, * p<0.1

Source: Author's calculation based on the VARHS 2012 dataset

reduce labour when their children grow up and move away for new opportunities or set up their own households. Therefore, they are less likely to participate in activities that require intensive labour, such as agriculture and common property resources extraction. This findings are in line with those of Godoy et al. (1997) and Babulo et al. (2008).

The number of household members of working age shows mixed effects on the choice of household livelihood strategy. That is, it has a positive influence on the probability of choosing wage and non-farm, non-wage dependency strategies, but a negative effect on the likelihood of selecting a transfer dependency strategy. This means that households with more labour are more likely to be in the first two clusters (i.e. wage dependency, and non-farm, non-wage dependency) and less likely to engage in transfer strategy relative to the environment dependency strategy. If the household has one more workers, the likelihood for them to engage in wage dependency and non-farm, non-wage dependency increases by 9.2% and 0.6%, respectively, while the likelihood of the household falling into the transfer strategy group declines by 4.1%. Thus, a higher number of workers induces households into labour-intensive activities (Adhikari et al., 2004). However, the fragmentation of land and the absence of significant crops in Vietnam generally make agriculture small-scale and low-–return. Therefore, the marginal increase in environmental income is relatively small when the number of workers engaging in these activities increases, especially during off-farm seasons. Therefore, the surplus workers may seek higher return opportunities in wage employment and non-farm, non-wage businesses and leave farming activities to older people and children.

Ethnicity is a significant and positive influence on the choice of livelihood strategy at the 1% level. This result suggests that households from the Kinh ethnic group are less likely to engage in a environment dependency strategy compared to other minority groups. The possible reasons for this influence are that other minority groups are more disadvantaged than the Kinh group in many key aspects. For example, they mostly live in remote areas, have language barriers, as well as low educational levels, low accumulated assets and poor social networks, etc. These characteristics make it more difficult for them to shift from farming and extraction of common property resources to more lucrative activities but requiring more asset endowments, such as wage employment or non-farm businesses. The odds ratios are high, especially for the non-farm and non-wage dependency group. In particular, the result reveals that the relative probability of choosing non-farm and non-wage dependency for the Kinh ethnic group is 15.68 times higher than for the minority ethnic groups. Similarly, the odds that Kinh households engage in wage, mixed-income and transfer dependencies are 3.04, 3.51, and 2.92 times, respectively, higher than minority ethnic groups.

Effect of natural capital on household livelihood strategy choice

The area of agricultural land owned by a household and the percentage of irrigated agricultural land are included in the model to examine the influence of natural capital on the choice of household livelihood strategy. The former indicator has a significant influence at the 1% level, while the latter has an insignificant effect on the households' strategy decisions**. Table 5.15** presents the negative influence of the area of agriculture land owned on the likelihood of choosing wage employment and non-farm and non-wage businesses. In other words, households with larger areas of agriculture land tend to follow environment-based strategies rather than those involved in the wage, and non-farm, non-wage strategies. This result is in line with the findings by Babulo et al. (2008), Jansen et al. (2006) and Xu et al. (2015) and it is expected, since agricultural land is the key input for agricultural activities, especially crop production. Therefore, the larger agricultural land a household owned allows the households to increase their farm production, which then increases their agricultural income, improves their livelihoods and makes them less motivated to shift out of farming activities. In addition, more agricultural land indicates that more labour is required, and that family members are less likely to migrate to the city for wage employment or non-farm and non-wage businesses. Thus, the dependence on agricultural activities is greater. Finally, rural households in Vietnam are still characterised by low educational levels and low financial capital endowments which, in turn, create entry barriers for rural households in adopting wage employment and non-farm, non-wage enterprises. **Table 5.15** also shows the marginal effects of this indicator on the household strategy choice. That is, when holding other variables constant, an additional hectare of agricultural land owned by a household reduces the likelihood of being in the wage dependency strategy by 14% and decreases the likelihood that a household adopts a non-farm, non-wage dependency strategy by 1.9%.

Effect of physical capital on household livelihood strategy choice

Both indicators of physical capital; namely, the size of the livestock herds and productive equipment ownership is significant, and negatively influences the likelihood of choosing the other four livelihood strategies relative to the environment dependency strategy. Similar to land, livestock, productive tools and machines are important inputs and equipment for farming activities. A larger livestock herd allows the households to obtain more income from livestock production; thus, in general, they are more likely to secure their livelihood from this activity or in farming. As a result, rural households may not need to be highly involved in other livelihood strategies if they lack motivation for accumulating asset holdings. The finding is similar to the study of Gecho, Ayele, Lemma and Alemu (2014). The result reveals that an additional tropical livelihood unit (TLU) increases in the size of livestock herd and decreases the likelihood that a household falls in the wage, non-farm and non-

wage, mixed-income and transfer dependency strategy groups by 4.3%, 0.9%, 0.4% and 0.2%, respectively.

Households owning productive equipment are more likely to participate in environment-related activities. The odds ratios displayed in **Table 4.12** imply that the odds that households who own production equipment and are in the wage, non-farm and non-wage, mixed income, and transfer dependency strategies are 1.80 (1/0.555), 3.14 (1/0.318), 2.23 (1/0.449) and 1.97 (1/0.508) times lower than those without productive equipment. The ownership of productive equipment may help households to increase their scale of agricultural production[25] which, in turn, enhances the household's income from agriculture. Similar to land and livestock ownership, the increase in agricultural income may encourage the households to concentrate their resources into agricultural activities.

Effect of financial capital on household livelihood strategy choice

The influence of financial capital on the household livelihood strategy choice is confirmed by the significant influence of loans and savings on the household's decision about a non-farm, non-wage and transfer dependency strategies. Savings have a negative influence on the likelihood of households' decision to transfer, indicating that households with savings are less likely to engage in a transfer dependency strategy. The odds ratio of 0.708 indicates that the relative probability a household having savings following the transfer dependency strategy is 1.41 (1/0.708) times lower than those who have no savings. The reason is that households engaging in environment dependency need financial capital to buy the required inputs for agricultural activities and the extraction of common property resources. Therefore, they have more motivation to save and accumulate their assets. This result is not in line with Walelign's (2015) study who reported that households with more savings were less likely to engage in an agricultural environment-based strategy.

Meanwhile, having a loan has a positive effect on the households' decision to adopt non-farm and non-wage, and transfer livelihood strategies. This means that households with loans are more likely to participate in the two livelihood dependency strategies. This, again, confirms that better access to credit allows rural households to undertake more remunerative activities but also requires more financial capital, such as from non-farm and non-wage businesses. This finding is in line with previous studies, which showed that households with easier access to credit are more likely to participate in more lucrative livelihood strategies that need greater non-labour and non-land inputs (Soltani et al., 2012; Walelign, 2015).

[25] The scarcity of inputs in agriculture, such as land, may be substituted by rentals.

Effect of social capital on household livelihood strategy choice

The membership in social groups has a positive and significant effect on the choice of households to participate in the wage and transfer dependency strategies, relative to the environment dependency strategy. The odd ratios in **Table 5.15** shows the odds that the households with memberships in social groups being involved in wage and transfer dependency strategies are 1.652 and 1.624 times higher compared to those without membership in social groups, respectively. This is probably because households with memberships in social groups may have broader and more established connections which, in turn, help them have more opportunities and support in finding good jobs, as well as assistance from relatives, friends or formal organizations when they are in the need of money or goods.

Effect of contextual factors on household livelihood strategy choice

The experience of unexpected loss from shocks and the distance to the nearest all-weather road are included in the model to examine the effect of contextual factors on household livelihood strategy choices. Both indicators have a significant influence on the likelihood of household livelihood strategy choice at the 1% level. The shock variable shows a positive effect only on the choice of household livelihood strategy towards the transfer dependency strategy. That is, households who experience unexpected losses from shocks are more likely to be in the transfer dependency strategy compared to those who have never faced any unexpected loss from shocks since 1st July 2010. The possible reason is that shocks cause shortages in income and consumption. Therefore, households who face losses from shocks will become more conservative in their investments and may re-allocate their resources to more defensive livelihood strategies. This finding is similar to van den Berg's (2010) results. The author claims that households in rural Nicaragua who experience hurricanes or other natural hazards are then more likely to choose strategies that are more defensive. This is because the experience of natural disasters may lead to the destruction or the hardship of selling productive assets. Therefore, the switch to more defensive strategies allows these households to survive.

Distance to the nearest all-weather road is a proxy for remoteness. According to Stifel (2008), the remoteness affects the transactions costs and the degree of households' access to markets which, in turn, influence the households' decision about their choice of livelihood strategy. The result shows that a longer distance to the nearest all-weather road will decrease the probability that a household will engage in all four livelihood strategies relative to the environment dependency strategy. However, the marginal effect of this variable on the choice of household livelihood strategy is quite small. For example, the addition of a one kilometre increase in the distance to nearest all-weather road will reduce the likelihood of households being in a non-farm and non-wage-based strategy by 0.3%. The short distance to roads increases the household access to labour and other markets, reduces transaction costs, and makes the transportation of goods and people more convenient.

Therefore, households can have more opportunities to participate in lucrative activities. The finding is consistent with previous studies by Xu et al. (2015) and Babulo et al. (2008). For example, in the study about household livelihood strategies and dependence on agriculture in China, Xu et al. (2015) found that households living in more remote areas are more likely to depend on agricultural activities. Babulo et al. (2008) also reported similar findings where a longer distance to all-weather roads induced households to be in the forest-dominant strategy group compared to their less forest-dependent counterparts.

Chapter 6

Conclusions

This chapter summarises the study of household livelihood strategies, environment dependency and poverty in Vietnam rural areas. **Section 6.1** presents the main findings of the study. **Section 6.2** discusses the potential implications emerging from the study, and then **Section 6.3** considers the limitations and provides suggestions for further studies.

6.1 Main findings

Understanding environmental income and its role in rural households' livelihoods is an on-going debate. However, environmental income information in quality terms is still considered difficult and costly to obtain (Angelsen et al., 2011; UNDP et al., 2005). In addition, when it comes to environmental income, most of the studies only considered it as " income earned from wild or uncultivated natural resources" (Vedeld et al., 2004, p.5). However, according to UNDP et al. (2005, p. 39), "only when income from agriculture is combined with the income from wild products do we begin to get a clear idea of how important ecosystem goods and services are as a source of rural livelihoods." In the context of Vietnam, the role of environmental resources has been investigated at the national level (Tarp et al., 2007). At the household level, the role of environmental resources and its impact on rural household livelihood is limited.

To formulate effective poverty-related policies, information about what income strategy a household pursues and why he/she chooses to pursue that strategy is very important. This information is not only crucial for policy makers to evaluate which strategies and policies they should aim for but it is also invaluable for understanding why some households could not get out of poverty even though they chose optimal strategies (Roy et al., 2007). Therefore, this study aims to understand the household dependence on environmental income across households who engage in different livelihood strategies. This study also investigates the impact of environmental income on rural household poverty and inequality, as well as identifying the factors that determine the choice of rural household livelihood strategies in Vietnam's rural communities. Some main findings are emerging.

Individual characteristics: Rural household heads have some distinct individual characteristics. The majority of them are male, belong to the Kinh ethnic group and are of working age. Their educational level is low with a high proportion of household heads who leave school after completing their secondary education and have no professional education. The variation in individual characteristics is seen across the income quintiles. Finally, the gender and educational gaps still remain in the rural areas.

Household characteristics: Poorer households in rural areas of Vietnam are more likely to have higher numbers of household members and children. Therefore, they are more likely to be under financial pressure. The number of income earners and agricultural land holdings are not associated with income since the two indicators are found to be higher in the worse-off households. In addition, a large income gap has been identified from the study's results. In fact, the average net income in 2012 of the richest households is about eight times higher than that of the poorest households. Income from wage employment and environmental resources are still predominant in rural communities regardless of which income quintile a household belongs to. On average, environmental income and wage income accounts for 40.66% and 29.95% of total household net income, respectively. This confirms that households in rural areas of Vietnam have high levels of dependency on environmental resources for income.

Agricultural activities and extraction of common property resources: Crop production remains the most important agricultural activity, complemented by livestock and aquaculture production in rural communities. However, most of the crop products are used for household consumption, while the level of commercialisation is higher for livestock and aquaculture products. Unsurprisingly, better-off households have higher levels of commercialization of their agricultural products. Although about half of the surveyed households engage in the extraction of common property resources, income from this source only accounts for a relatively small proportion of total income, which is about 4% for the whole sample and about 9% for the poorest income quintiles. The extraction of common property resources is seen in all five income quintiles, but the poorer households are more likely to be reliant on CPR activities than their richer counterparts. In addition, extraction activities from forests are more popular than aquatic activities.

Geographical factors: Poorer households are more likely to live in remote and isolated areas, such as Lao Cai, Lai Chau and Dien Bien. However, the richer households are more likely to be in areas close to metropolitan areas, such as Ha Tay and Long An, or in areas that are suitable for cash crop production, such as Dak Lak and Dak Nong.

Typology analysis: The sampled households are grouped into different livelihood strategies using cluster analysis. Five livelihood strategies are identified; namely, wage dependency, non-farm, non-wage dependency, mixed-income dependency, transfer dependency and environment dependency. Based on net income per capita generated in 2012, mixed income dependency and non-farm, non-wage dependency strategies are the most lucrative livelihood strategies, while the environment dependency strategy is the least. Therefore, the role of environmental income is more as a support for household consumption or a safety net, rather than as a pathway out of poverty.

Households engaging in various livelihood strategies differ in their asset endowments. Households engaging in the environment dependency strategy are more likely to be abundant in labour, land and physical capital. However, more remunerative livelihood strategies, such as the mixed-income and non-farm, non-wage dependency groups, are more likely to be endowed with financial and social assets.

Contextual factors, including unexpected losses from shocks and road infrastructure also have an important influence on the households' livelihood strategy choices. The prevalence of shocked households faced with losses from natural shocks is small. Across the household livelihood strategies, households who are highly dependent on environmental resources have the highest incidence of unexpected losses from shocks. They are also located in more remote areas with poorer road infrastructure compared to their four livelihood strategy counterparts**.**

I**mportance of environmental resources:** Overall, environmental income contributes about 6.1 million VND per capita per year, including 5.7 million VND from agricultural activities and 328 thousand VND from the extraction of common property resources. With respect to the relative value, environmental income accounts for 40.65% of total household income, of which 36.89% comes from agricultural activities and 3.77% comes from CPR extraction. The study results show that the role of common property resources is less important than that reported in other countries. In addition, the study found differences in environmental dependency across the livelihood strategies. It is evident that the environment dependency households are the most reliant on environmental resources in both relative and absolute terms. Environmental income provides 82.48% of total income to households in this strategy group that is worth about 11.8 million VND per capita per year. This amount is significantly higher than for the other four strategy groups.

Impacts of environmental income on rural household welfare: The findings confirm the contribution of environmental income to income inequality and poverty reduction. In terms of income inequality, the inclusion of environmental income reduces the Gini coefficient from 0.598 to 0.475, on average, a relative drop of 20.57% (0.123/0.598). Although the Gini coefficient is found to be the second highest in the environment dependency strategy, the impact of environmental income in reducing income inequality is highest for this strategy group. Furthermore, the impacts of each income component on income inequality are not identical, and not all income sources reduce income inequality. That is, only income from wages/salary, environmental resources and other income sources contribute to reducing income inequality. With respect to rural poverty, environmental income reduces the poverty headcount index, poverty gap and poverty severity by 28, 22.5 and 18.7 percentage points, respectively. Finally, individuals who depend highly on environmental income bear the poverty burden more than those in the other four livelihood strategy groups.

Determinants of household livelihood strategy choice: This study provides evidence that households' asset endowments and contextual factors have an important influence on the choice of household livelihood strategy. Specifically, out of 15 variables included in the multinomial model, 13 variables significantly determine what dominant livelihood strategy a household decides to follow up to less than the 10% level. These variables are household family size, educational level of the household head, age of the household head, the number of members of working age, ethnicity, the total amount of agricultural land owned, the size of livestock herds, the ownership of productive equipment, saving, credit loans, social membership, unexpected losses from shocks, and distance to the nearest all-weather road. Of which, family size, agricultural land owned, livestock herds and ownership of productive equipment and distance to all-weather roads positively affect the choice of households for the environment dependency strategy. Whereas, educational level of household head, social networks and credit accessibility have a negative influence on the likelihood of households being highly dependent on environmental resources. These characteristics constrain households from shifting to strategies that are more remunerative. Other variables have mixed effects on the choice of household livelihood strategies.

6.2 Implications

As demonstrated in this study, environmental income is critically important to the livelihoods of rural households in Vietnam, especially for the poor who are highly dependent on environmental resources. Without this source of income, rural poverty and inequality in Vietnam would be more severe and widespread. Therefore, a secure income from environmental resources is obviously an influential tool to protect household livelihoods, as well as improve economic equity. This provides a rationale for comprehensive environmental resources management, especially in the situation where environmental resource degradation is witnessed in many places in Vietnam.

The results indicate that poor households are highly dependent on environmental income; however, a major proportion of environmental income comes from agricultural activities (36.89%). In fact, the income from common property resources only accounted for 3.77% of total household net income. For that reason, efforts to conserve Vietnam's common property resources, such as by restricted access, might not necessarily lead to reductions in household welfare. In other words, policies should focus on enhancing the productivity of agricultural land plots owned by households, which are the main inputs of agricultural activities, instead of enhancing the households' access to common property resources.

Even though the study found that environmental income might reduce poverty and inequality in rural communities in Vietnam, an environment dependency strategy still commands a low-return and is the least remunerative livelihood strategy. Therefore, policies that maintain rural households in

this strategy group may actually perpetuate poverty. More importantly, effective pro-poor policies should assist the poor with shifting to higher-return activities, such as wage employment and/or non-wage, non-farm businesses. To achieve this goal, the government may consider effective public investment to ease the constraints revealed in the multinomial model that prevents households from more remunerative strategies, as detailed in the paragraphs below:

Larger family sizes may help households with labour demands in agricultural activities. However, as household size increases, the agricultural land may not fulfil the demand from large household sizes since the agricultural land in Vietnam is limited (Khai & Danh, 2012). This situation causes difficulties for the households in maintaining food security as well as good health and education for their families. The scarcity of agricultural land may force rural people to move out of farming and migrate to large cities for job opportunities. However, due to their low educational levels, they usually end up the in low-paid employment sectors. Therefore, programmes to encourage public awareness of family planning, as well as the effects of population growth are necessary, especially in rural communities.

The positive influence of education on the probability of households' engaging in high-return activities is revealed in this study. The majority of household heads in rural areas of Vietnam only complete primary and secondary school (66.93%) and very few of them obtain a professional education. Meanwhile, activities that are more remunerative normally require higher education. For that reason, there is a priority to promote professional education in rural areas (i.e. short and long-term vocational schools, professional high schools, and colleges/universities) to enhance the quality of education at all levels.

The study shows that a shorter distance to an all-weather road also increases the probability that households participate in strategies that are more lucrative. In addition, households in the environment dependency strategy live in more remote locations with poorer road infrastructure. Therefore, improving road infrastructure in rural areas, in both quantity and quality, should be promoted to reduce the spatial costs of input and output transactions, increase information transmission and assist in the development of rural markets. Improvement in road infrastructure will also assist the transportation of rural people between places so they can have more chances to access different income earning activities.

Non-farm, non-wage dependency and mixed-income dependency are the two most lucrative livelihood strategies but they are also the most financially-intensive activities among the five strategies identified in this study. Easier credit accessibility can promote the likelihood of households being involved in these strategies. In relaxing credit constraints in rural areas, the government should consider a proper credit allocation regime to reduce the transaction costs as well as support target

households with adequate credit loans (Chau, 2014). In addition, a market for agricultural land may be created so that environmentally-dependent households who are endowed in agricultural land can use it as collateral to obtain loans (Hoff & Stiglitz, 1990; Meyer & Nagarajan, 2000; Seibel, 1997 cited in Chau, 2014).

6.3 Limitations and Further Research

The analysis in the current study is based on cross-sectional data from 2012. Therefore, the results do not reflect the long-term effect of environmental income on household livelihood welfare. Future research should use a nationally-representative panel dataset for analysis. The use of the panel dataset allows better access to the degree that environmental income can help the rural poor improve their livelihoods over time and provide more detailed information about the relationship between the growth of environmental income across different income quintiles and livelihood strategy groups.

This study investigates only the extractive or consumptive direct value of products from environmental resources. In addition, energy and mineral and water resources are not explicitly expressed in the environmental income components because such information is not provided in the VARHS dataset. Therefore, the economic value of environmental resources is underestimated. In-depth studies about the total economic value of environmental resources to rural households are needed to provide more detail and accurate information for policy making on environment management.

According to the frameworks proposed by the DFID (1999), Ellis (2000b), Reardon and Vosti (1995) and Scoones (1998), the combination of households' livelihood assets determines what combination of livelihood strategies a household follows, given particular trends (population, migration, technological changes, national and world economic changes, price changes, etc.), policy and institution considerations (government and private sectors, laws, macro-polices, culture and institutions, etc.) and shocks (drought, floods, pests, diseases, etc.). However, due to the lack of data availability and the use of cross-sectional data, variables related to trends and policy and institution considerations are not included in the multinomial model. For that reason, further studies should consider the use of panel data or combine with other datasets, such as Vietnam Household Living Standards Survey (VHLSS), to provide more comprehensive information on the determinants of household livelihood strategy choices.

There is no guarantee that the poor can derive environmental income to increase their wealth even if the environmental resources are endowed to them. The capacity of rural poor households to use environmental resources as their source of prosperity requires supportive governance conditions as

mentioned in the report of UNDP et al. (2005). This report also presents three governance factors that most affect the poor and their capacity to earn income from environmental resources; namely, resource tenure and property rights, decentralisation of resource management, and rights to participation, information and justice. Further research is needed to examine these key factors to form an effective governance policy where access to environmental income is secured for the poor. These policies may then, in turn, contribute to the greater environmental income for the rural poor households.

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Appendices

Appendix 1 Gender of the household head by income quintile

Gender	Poorest	2nd Poorest	Middle	2nd Richest	Richest	Total
Female	98	133	145	133	154	663
	13.55	18.45	20.11	18.42	21.36	18.38
Male	625	588	576	589	567	2,945
	86.45	81.55	79.89	81.58	78.64	81.62
Total	723	721	721	722	721	3,608
	100.00	100.00	100.00	100.00	100.00	100.00

Source: Author's calculation

Appendix 2 Household distribution by livelihood strategy typology

Cluster	Household livelihood strategy group	Number of HH	Percentage
1	Wage dependency	1,241	34.4
2	Non-farm, Non-wage dependency	368	10.2
3	Mixed income dependency	209	5.79
4	Transfer dependency	561	15.55
5	Environment dependency	1,229	34.06
	Total	3,608	100

Source: Author's calculation

Appendix 3 Highest general education of the household head

General education	Wage dependency	Non-farm, Non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total sample
Cannot read and write	6.31	2.56	9.69	10.32	29.95	14.68
Completed lower primary	22.82	15.1	20.92	22.62	24.96	22.58
Completed lower Secondary	48.06	53.28	48.98	46.23	36.1	44.35
Completed Upper Secondary	22.82	29.06	20.41	20.83	9.0	18.38
Total	100	100	100	100	100	100

Source: Author' calculation

Appendix 4 Highest professional education of the household head

Highest professional education	Wage dependency	Non-farm, Non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total sample
No diploma	67.94	74.38	79.33	83.87	92.75	80.22
Short term Vocational Training	19.97	15.43	11.54	5.73	5.21	11.76
Long Term Vocational Training	2.03	3.86	2.88	1.79	0.49	1.70
Professional High School	4.87	4.13	3.85	5.56	1.06	3.54
College/ University	5.19	2.20	2.40	3.05	0.49	2.79
Total	100	100	100	100	100	100

Source: Author's calculation

Appendix 5 Percentage of household participating in social groups

Household capital	Household livelihood strategy group						
	Wage dependency	Non-farm, non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total	Statistical test
The Communist Party							
No	86.74	93.27	86.59	89.29	92.30	89.62	
Yes	13.26	6.73	13.41	10.71	7.70	10.38	
Total	100	100	100	100	100	100	χ^2 (4) =23.68***
Mass Organisation							
No	9.48	5.77	16.20	29.70	6.90	11.91	
Yes	90.52	94.23	83.80	70.30	93.10	88.09	
Total	100	100	100	100	100	100	χ^2 (4) =193.58***
Voluntary groups							
No	76.24	76.60	65.36	46.26	82.40	72.82	
Yes	23.76	23.40	34.64	53.74	17.60	27.18	
	100	100	100	100	100	100	χ^2 (4) =236.47***

Note: Only households had members engaging at least one form of social groups are included
Source: Author's calculation

Appendix 6 Household shock experience and the extent of recovery from shocks

Shock experience	Household livelihood strategy group						
	Wage dependency	Non-farm, non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total	Statistical test
Type of shocks							
Natural shocks	23.77	11.64	23.92	21.24	20.5	21.07	
Biological shocks	42.76	39.68	37.68	36.99	52.25	45.99	
Economic shocks	33.46	48.69	38.39	41.77	27.25	32.96	
Total	100	100	100	100	100	100	$\chi^2(64)$=330.28***
The extent of recovery from shocks							
Completely	40.6	46.81	34.31	36.19	31.13	35.56	
Partly recovered	42.41	30.85	47.45	46.21	45.6	43.96	
Still suffering badly	16.99	22.34	18.25	17.6	23.27	20.49	
Total	100	100	100	100	100	100	$\chi^2(8)$=41.47***

Source: Authors' calculation

Appendix 7

Variable	VIF	1/VIF
HHSIZE	2.15	0.466108
WORKING_AGE_MEMBER	1.96	0.511188
ETHNICITY	1.63	0.612306
IRRIGATION	1.31	0.761583
DIS_ROAD	1.16	0.860544
SHOCK	1.16	0.861839
AGE_HEAD	1.14	0.874013
SEX_HEAD	1.14	0.878737
PRODUC_EQUIP	1.14	0.879696
EDU_HEAD	1.08	0.923188
AGRI_LAND_OWNED	1.07	0.931858
LOAN	1.07	0.933879
LIVESTOCK	1.07	0.934041
NETWORK	1.04	0.966059
SAVING	1.02	0.976153
Mean VIF	**1.28**	

Appendix 8

```
. mlogtest, combine

Wald tests for combining alternatives (N=3041)

  Ho: All coefficients except intercepts associated with a given pair
      of alternatives are 0 (i.e., alternatives can be combined)

                    |       chi2    df    P>chi2
--------------------+------------------------------
Wage dep & Non~m    |     79.538    15     0.000
Wage dep & Mix~n    |    123.689    15     0.000
Wage dep & Tra~r    |    350.154    15     0.000
Wage dep & Env~m    |    545.930    15     0.000
Non-farm & Mix~n    |    116.118    15     0.000
Non-farm & Tra~r    |    246.532    15     0.000
Non-farm & Env~m    |    320.033    15     0.000
Mixed-in & Tra~r    |     58.373    15     0.000
Mixed-in & Env~m    |    167.778    15     0.000
Transfer & Env~m    |    432.024    15     0.000
```

Appendix 9

```
. mlogtest, smhsiao

Small-Hsiao tests of IIA assumption (N=3041)

  Ho: Odds(Outcome-J vs Outcome-K) are independent of other alternatives
```

	lnL(full)	lnL(omit)	chi2	df	P>chi2
Wage dependency	-823.804	-3414.710	-5181.811	64	1.000
Non-farm busin~y	-1286.532	-1664.349	-755.633	64	1.000
Mixed-income-s~y	-1416.933	-1664.349	-494.833	64	1.000
Transfer depen~y	-1183.228	-1664.349	-962.242	64	1.000
Environment in~y	-977.096	-1664.349	-1374.506	64	1.000

```
  Note: A significant test is evidence against Ho.
```

```
. fitstat
```

	mlogit
Log-likelihood	
Model	-3414.710
Intercept-only	-4254.728
Chi-square	
Deviance (df=2977)	6829.420
LR (df=60)	1680.037
p-value	0.000
R2	
McFadden	0.197
McFadden (adjusted)	0.182
Cox-Snell/ML	0.424
Cragg-Uhler/Nagelkerke	0.452
Count	0.579
Count (adjusted)	0.337
IC	
AIC	6957.420
AIC divided by N	2.288
BIC (df=64)	7342.696

Appendix 10

Red book for land	Wage dependency	Non-farm, non-wage dependency	Mixed income dependency	Transfer dependency	Environment dependency	Total sample
Yes	74.07	79.09	72.87	76.83	48.04	64.02
No	25.93	20.91	27.13	23.17	51.96	35.98
Total	100	100	100	100	100	100

Source: Author's calculation