THREE IMPIRICAL ESSAYS ON RURAL DEVELOPMENTAND POVERTY ALLEVIATION IN LAO PDR

By

Bounmy Inthakesone

THESIS

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

DOCTOR OF PUBLIC POLICY

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Committee in charge:

Professor TaeJong, KIM, Supervisor	
Professor Jong-Il, YOU	
Professor Jinsoo, LEE	
Professor Kyewoo, Lee	
Professor Hyunjoo, YANG	

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ABSTRACT

THREE IMPIRICAL ESSAYS ON RURAL DEVELOPMENTAND POVERTY ALLEVIATION IN LAO PDR

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This dissertation consists of three empirical essays with main objective is to find out the way to eradicate poverty or to discover factors that influencing poverty alleviation in Laos, particularly in the rural areas. In the first essay, the author presents overviews of Rural Development and Financial Reform and Its Impact on Poverty Alleviation in Laos. The second essay examines the impact of road investment project on poverty alleviation in Laos; and the last essay analyzes the impact of irrigation investment project on poverty alleviation in Laos. The abstract of each essay is presented below:

Chapter 1: Rural Development and Financial Reform and Its Impact on Poverty Alleviation in Laos

The paper estimates the effects of financial policy reform through the effect of loans on household expenditure as proxy for poverty by taking the endogeneity of loans into account. While many previous studies have attempted to estimate such effects based on a restrictive distributional assumption, this study applies a unique identification strategy to resolve the problem of endogeneity by applying 2SLS. In this identification strategy, the

study uses LECS data collected before and after the policy change, and uses a unique instrument of the policy reform on state-owned commercial bank. The results show that financial policy reform leads to increase in amount of loans; and such amount of loans has positive effects on household expenditure. This evidence suggests that reforming the financial policy on state-owned commercial bank may have positive effects on household expenditure that may reduce poverty among the households.

Chapter 2: Impact of Road Investment Project on Poverty Alleviation in Laos

Rural roads have been widely known as champion for poverty alleviation instruments. Connecting to roads provides market access opportunities, develop market linkage, and improve farm production through technology improvement. This circulation ensures a stable income; later improve living standard and then poverty reduction. In Laos, road networks are extremely poor, many districts lack roads linked to the main national transportation. The paper will find out the mechanism of how the rural roads could contribute to the improvement of household livelihood, and standard of living. Difference in Differences (DD) method will be used in this analysis. The results confirm that the villages with road access may increase their total income around 14.9% compared to the ones without road access, and the result consistent with previous study as well. The recommendation for government to curve the poverty in Laos is to incorporate the connecting rural road plan into the national development strategy to allow the rural communities to have easy access to the main infrastructure and to be mainstreamed into the country economy to improve their daily activities and their livelihood

Chapter 3: Impact of Irrigation Investment Project on Poverty Alleviation in Laos

Water demand is continue to increase, particularly in agricultural and environmental sections. For this reason, it will create more competition for the limited and scarce water resources. Therefore, choosing an appropriate approach to manage water resources in

distributing and allocating to attain sustainable agriculture is critical role for every country worldwide. The most well known tool to preserve or to store water is irrigation. This chapter wants to find out the impact of irrigation on farmers' income, especially the income from rice which is the main crop of rural people in Laos. Different-in-Differences method was employed to find out regression results. The Different-in-Differences estimated by pooled OLS of the effect on log of total rice products with some control variables point out that the coefficient of interest (treatment) is 0.059 with a positive sign but statistically insignificant. The result implies that irrigation has no impact on rice products or the irrigation does not increase rice products as our expectation, even so it increases household's income. Finding indicates that type of irrigation, location of operation headquarter, management system or government are crucial factors for explaining the impact of irrigation on rice products in Laos.

Dedicated to my parents, Khamphong Inthakesone and Soumountha Inthakesone, wife, Pakaiphone Syphoxay, and daughter, Midaphone Inthakesone whom I love with all my heart

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Bounmy Inthakesone

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Chapter 1

Rural Development and Financial Reform and its Impact on Poverty Alleviation in Laos

1.1. Introduction

In most developing countries use rural financial access as a key instrument to sustain poverty eradication strategies and promote economic development, especially the agricultural credit has played a significant role in the process of agricultural development. Moreover, access of farm household to credits is an important accelerator in developing the agriculture sector. Since farm credit has rose as new technologies, knowledge and modern inputs. Consequently, improvement of access to credit is necessary for promoting of agricultural commercialization. Therefore, government in many developing courtiers have implemented direct credit policies by providing targeted and subsidized agricultural credit program along with strong support for input and output marketing projects (Meyer and Nagarajan 1999), and address the role of rural financial provision through credit scheme as a crucial instrument to encourage farmer to commercialize farm production. In line with this policy, the performance and effect of rural finance needs to be carefully studies in order to understand and seek for the most appropriate way to overcome the difficulties.

The effect of the loan, especially the loan from state-owned commercial banks, have been seriously discussed when such loan has been considered as a way of promoting credit access among rural poor households. Most developing countries have attempted to meet poverty reduction objective by implementing a direct credit policy to provide low interest loans to poor households. Such policies are expected to

improve credit access among poor households. However, these policies have been widely criticized since the 1970s for not encouraging formal financial institutions to provide financial services to rural poor households. Thus, many developing countries have considered reforming the financial policy on state-owned commercial bank by adopting market-oriented approach in rural financial markets and emphasizing the flexibility of interest rates.

The important question is whether this approach is the right way to correct for the failure of traditional agricultural credit policies if the rural poor in most developing countries remain too poor to accumulate savings. Even though market-oriented finance has been adopted in many Asian countries, policy-based loan programs continue to be implemented in, for example, the Philippines (Izumida 2001).

Therefore, the effects of such reform need to be seriously studied, to understand the problems and feasibility of switching from traditional finance to market-oriented finance. The adoption of this approach, leading to the elimination of subsidized loan programs, may produce negative effects on rural poor households if such loans have significantly positive effects on household incomes or expenditure.

Although the Government has strengthened the financial sector to contribute to agriculture and rural development, there is still a lack of capacity in financial institutions with regard to management, accounting, commercial finance, and risk management. In addition, the legal framework in areas such as transactions among banks, financial contract, and collateral is incomplete. Additionally, there is poor access to institutionalized finance in the rural areas and poor mechanisms for deposit mobilization. More than half the Lao rural population is highly impoverished; most people in the rural areas are engaged in agriculture. The government's approach to

reduce poverty focuses on rural development and on booting of agricultural productivity. Facilitating access to financial services is an important component of this approach. However, in Laos, the challenge is that the financial sector is small relative to the size of national economy. Therefore, Laos, similar to many developing countries, had adopted the market-oriented approach in order to improve the rural financial access among the poor due to the failure of the traditional credit policy which is the government support on financial provision including interest rate subsidy, refinance scheme, loan quota, and so on. Agricultural Promotion Bank (APB) is the only one bank providing the loan to rural areas in Laos; thus, the main financial reform focused on this study is the financial policy reform of in 2004. Such reform had reduced the dependence on government subsidies, especially through low interest rate Bank of Laos (BOL) loans, thus improving deposit mobilization.

This paper focuses on the effect of such main financial reform on the poverty reduction by using the household expenditure as poverty reduction indicators. The main obstacle to estimating the effects of such loan is the endogeneity of loans. Some previous studies (Feder et al. 1989, and 1990; Sial and Carter 1996; Duong and Izumida 2002) have attempted to estimate the impact of credit programs in China, Pakistan, and Vietnam, respectively, by applying an endogenous switching regression model. The model accounts for unobserved heterogeneity between borrowed and non-borrowed households. They found that credit has a significantly positive impact on household outcome and agricultural production.

The endogenous switching regression model, however, has two limitations. First, the model relies heavily on distributional assumptions for identification. The distribution of the error term in the structural model depends on the distribution of the error terms in the regimes, and these error terms are assumed to be normally distributed. Second,

the model does not account for farmer-specific unobserved heterogeneity, which is expected to be highly correlated with loan amounts.

This paper applies a distribution free identification strategy to resolve the endogeneity problem by using data from LECS 3 (2003) and LECS 4 (2008) collected by Lao National Statistics Bureau. Because the financial reform policy affects the individual household's loan, but is not correlated with unobserved variables that determine the household income and expenditure, this policy is used as an instrumental variable for the loan amount. Two objectives are attempted to analyze including background of financial policy reform and effect of policy reform on household expenditure.

1.2 The financial policy reform and a review of previous studies

During the 1960s, prior to the liberation of the country, Laos was divided into two zones and led by two Lao government parties: The Lao People's Party, later known as the Lao People's Revolutionary Party (LPRP) headed by Kaysone Phomvihane, and the government of Prince Souvanna Phouma known as the Royal Lao Government which was supported by the United states (ADB 2001). In the liberated zone administered by the LPRP, there was no financial system clearly developed. The government of LPRP had its own currency in circulation, and distributed funds to every province under its control. Meanwhile in the zone controlled by the Royal Lao Government or Vientiane Government, the National Bank of Laos performed as a central bank and had two main provincial branches in Champasak and Luangprabang provinces. There were six privately owned commercial banks in Vientiane. In order to implement the state budget, a branch of the National Treasury had to be established in all provinces under the control of the

Vientiane Government. During this period characterized by political struggles, civil war and bombings, the rural financial market made little contribution to economic development in general and to agricultural development in particular.

After the country was liberated on December 2, 1975, the LPRP set the goal of transforming the country into a communist state of the former Soviet, Marxist-Leninist model Under this goal, all-existing banks were nationalized; their activities were merged into the National Bank of Laos, while the name of the central bank was changed to the State Bank of Laos (SBL) in 1981. The financial market increasingly played an important role in developing the national economy including the agricultural sector. The SBL was responsible for carrying out functions of both a central bank and a commercial bank, known as the mono-banking system. The Government provided full authority to the SBL for legally extending credit within the country and also provided the exclusive right of note issue and the right to grant any kind of loans. During this period, the only provider of formal credit was SBL, which comprised about 16 branches at the provincial level (World Bank 1995). These branches gathered credit requests for head office approval and made cash transactions on behalf of the government. After the state planning authorities introduced an enterprise's plan, including financial needs both for working capital and investment, the approval credit was more or less automatically provided.

After the New Economic Mechanism (NEM) was introduced 1986 to transform the economic system from a centrally planned economy to a market-oriented economy, the financial sector started to grow rapidly employing a market-based approach. The role of financial sector was extended, so that it can perform as the Government's fiscal agencies (Souvannavong, 1994) Under this role, the State Bank tackled three major tasks, first, it acted as a government treasury transferring

funds from the central budget to the provincial and district budgets in line with credit and cash requirement plans approved by the National Assembly, second, it extended advances to state agencies; and, third, it provided loans to state enterprises. Yet these activities were still undertaken in a centrally planned economy. In this period, the government provided various incentives for collectivization, especially the fiscal incentives of a 15 percent reduction in tax (Bourdet, 2000). Access to credit for purchasing of modern farm inputs, and thereby improves farm productivity and incomes, was an important part of agricultural collectivization strategy from the beginning, according to the ADB (1989), in the mid-1980s, some 50 percent of the total credit to the agricultural sector was allocated to collectivization groups and 30 percent to state farms. Private farmers received only 20 percent of the total agricultural credit due to the government policy to strengthen collectivization activities. In practice, commercial and industrial sectors were the major beneficiaries of the domestic credit, while the percentage of credit flow to the agricultural sector as a whole was very small. This reflected the weakness of agricultural institutions.

Reform within the framework of the NEM has been applied to all sectors of the economy (MAF, 1999). Therefore, the Lao financial system started to undergo a reform in 1988. The reform focused on the development of a two-tier banking system. Under this system, the SBL was replaced by the Bank of the Lao PDR (BOL), established as the central bank; the seven States owned Commercial Banks were established as independent banks under the supervision of the BOL. Because there was separation of central bank from commercial banking functions, this provided the commercial banks with greater autonomy in making decisions based on performance factors.

The positive real interest rate policy was adopted in August 1989 for promoting deposit mobilization and controlling liquidity expansion, which resulted from a negative real interest rate policy. This negative rate gave State Owned Enterprises (SOEs) easy access to bank credit (Souvannavong, 1994). This policy led to changes in the setting of interest rates, leading to interest rates higher than the inflation rate, to lending rates higher than deposit rates, and to long-term rate higher than short-term rates. Thus, the long-term lending rate doubled to 8 percent between January 1988 and August 1989 (Than and Tan 1997). At the same time, the fiscal and monetary role for the BOL was formulated and implemented. A presidential and supervisory capacity was established at the BOL; a legal framework for operating the BOL was introduced (MAF and JICA, 2001).

1.2.1 The financial policy reform

Governments in many developing countries believe that access to credit could be used as a strategy for helping rural poor households escape the poverty cycle. Poor households especially farmers can utilize such loans for investing and purchasing modern farm inputs to increase farm productivity and income. In Laos, rural farmers receive agricultural credit mainly from the APB under government supervision and subsidy.

The government has implemented several financial policies to promote the economic growth and encourage the loan access since 2000 (Table 1). The main elements of the reforms including implementation market-oriented finance to state-owned commercial bank by eliminating the agricultural promotion duty of APB in 2004, reduction the interest rate from 35 percent in 2000 to 5 percent in 2011, decrease the reserve requirement rate for Kip deposits from 12 % in 2002 to 5 % in 2006 and for foreign currency deposits from 15% in 2002 to 10 percent in 2006,

establishing the Open-Market Operations (OMOs) in 2006, and encouraging the interbank market in 2006. Furthermore, the Repo and Outright bond trade were implemented in 2010 in order to inject liquidity to banking system.

In term of the farm households have been encouraged to cultivate agricultural production not only for achieving stability and self-sufficiency, but also for commercialization. Under such policies, the APB becomes a major supporter in promoting the cultivation because it is the only formal financial institution providing loans to poor households in rural area. The APB makes subsidized-interest-rate loans to farm households.

However, government subsidies have been gradually reduced, while the APB has implemented its financial structural reform to improve commercial financial services by reducing the role of traditional financial policy. This led the APB to end its duty on promoting the agricultural sector and plays only the role of financial institution in 2004. This reform may reduce the poverty in the rural areas. Therefore, careful estimation of the effect of loan amounts on the poverty reduction is necessary to examine the effect of this policy change. Whether the change in policy has had a negative impact on the poverty reduction depends on the magnitude of the effect of loan amount on the household income and expenditure.

The main obstacle to estimating the effects of the loans is endogeneity. The amount of the loan is likely to be correlated with unobserved variables that affect the poverty reduction. Previously, such identification problems have been dealt with by applying alternative identification strategies. Many previous studies have applied the endogenous switching regression model to account for the bias that is due to the self-selection of borrowers into credit programs.

Table 1.1 Financial policies reform, 2000-2013

Year	Financial policy reform
2000	- Introduced the high deposit interest rate 60 % per year during the beginning year and 48 % per year during the ending year; - Limited reserves requirement ratio at 12 %; - Applied short-run loan interest rate of commercial banks at 35 % per year; and - Operated the exchange rate management policy by maintaining the rate in the parallel market and the bank rate by less than 2 %.
2002	Beginning of the year: - Reduced short-run interest rate (BOL's rate) from 35 % to 20 % ; - Reduced the reserve requirement rate on kip account from 12 % to 6 % in Feb, 2002. Middle of the year: - Increased reserve requirement on kip accounts from 6 % to 8 % and foreign accounts from 12 % to 15 % at the end of July 2002.
2003	- Issued short run bond of 50 billion from 09/2003 to 12/2013; - Expanded the credit of state-owned commercial bank; - Applied reserve requirement ratios at 8 % for accounts in LAK and at 15 % for accounts in foreign currency; and - Maintained the intervention on the exchange rate as necessary by keep the rate in the parallel market and the bank rate by less than 2 %.
2004	- Rediscounted the treasury bills from commercial banks facing with liquidity problem. - Maintained reserve requirement rate on kip accounts at 8 % and foreign accounts

	at 15 %; - Maintained short-term interest rate (BOL's rate) at 20 % for one week loan and 30 % for more than one week loan; - Encouraged using kip in the market; and - Introduced market-oriented finance to state-owned commercial bank (APB).
2005	- Rediscounted the treasury bills from commercial banks facing with liquidity problem; - Maintained the reserve requirement ratios at 8 % for accounts in LAK and at 15 % for accounts in USD and THB; - Provided short term loans to commercial banks secured by treasury bills; and - Encouraged borrow and lend activities among the commercial banks to alleviate their liquidity problems.
2006	- Limited the growth of monetary base not exceeding 14 %; - Ensure the level of international reserve equivalent to more than 4 months of imports; - Continued to reform and strengthen the banking system toward financial soundness and modernization. - Reduced reserve requirement ratio from 8 % to 5 % for Kip and from 15 % to 10 % for foreign currency deposits; - Encouraged the active operation of interbank market to address shortage of liquidity; - Conducted Open-Market Operations (OMOs) to help support fiscal balance and overcome the shortage of liquidity of commercial banks; and - Encouraged commercial banks to adjust their interest rate consistently with the domestic economic conditions and the level of international interest rates.

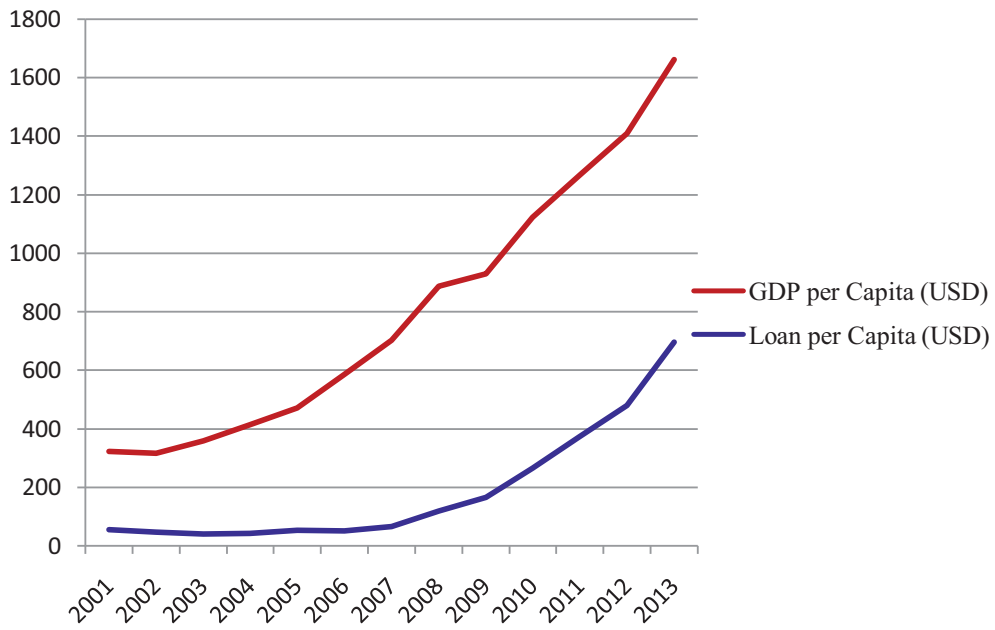
2007	- Adjusted interest rate on short-run loan for Kip from 20 % to 12 % per annum; - Operated the interbank market to address short-run liquidity and support fiscal balance.
2008	- Reduced the BOL interest rate from 10% to 7%; - Adjusted the reserve requirement structure by allowing eligible bonds covering 2% of the total reserve requirement rate; - Established the Open-Market Operations (OMOs) facilities by setting mechanism such as Repo, Outright rate determination and the issuance of BOL bonds.
2009	- Reduced BOL's short-term interest rate for Kip from 7 % to 4 %; - Promoted Open-Market Operations (OMOs) by issuing BOL bonds to mobilize fund to infrastructure development projects.
2010	- Increased BOL's short-term interest rate maturity less than 7 days from 4 % to 5 %; - Providing regular liquidity injection to banking system by implementing Repo and Outright bond trade.
2011	- Maintaining the BOL's short-term interest rate maturity less than 7 days at 5 %.
2012	- Promoted the open market operations (OMO) by issuing the BOL bills; - Promoted an active inter-bank market operation for the purpose of liquidity.
2013	- Maintained the lending interest rate at 5 %; - Keeping the reserve requirement ratio remain unchanged; - Continuing to promote the open market operations;

Source: Bank of Lao PDR.

1.2.2 The financial policy reform and poverty reduction

Accessing to financial services, especially formal loan, is one of the key element to achieve the poverty reduction goal. Thus, to improve the financial access, numerous financial policies have been reformed as mentioned above. Such reformation has leaded to increase the amount of loans per capita. This improvement of loan access would somewhat increase in GDP per capital as shown in Figure 1.1.

Figure 1.1 GDP and Loan per capita, 2001-2013



Source: World Bank and Bank of Lao PDR

Increasing in loan access is not only improving the household income, but also decreasing the poverty among the poor. Table 1.2 shows the national poverty rate and number of poor household are continuously decrease from 2011 to 2015 after implement several financial policies reform, the financial institutions has improved provision the loan to the market. Such positive effect of financial policy reform on poverty reduction needs to be seriously investigated in following section in order to provide the properly results.

Table 1.2 National poverty rate and number of poor household, 2011-2013

Year	2011	2012	2013	2014	2015
National Poverty Rate (%)	44.84	37.62	28.92	22.16	18.23
Number of Poor Households	20,689	17,538	13,683	10,656	8,894

Source: Bank of Lao PDR.

1.2.3 The review of previous studies

The rural financial market, in general, has been strongly debated in recent years, not only because of its failure to improve credit access in the rural areas of many developing countries but also over the way to resolve such failures, A simple question has been asked: is it time for developing countries to reconsider the role of traditional financial policies on rural development? Many economists have concurred that such policies need to be replaced by market-oriented financial policies. The changing perceptions of the rural financial market can be discussed in three periods: the 1950s- 1960s, the 1970s-1980s, and the 1990s to now.

First, during the period of the 1950s and 1960s, the government intervened in rural financial market through direct credit policies, called 'traditional' policies, to provide cheap loans to poor farmers. Many government-supported programs were implemented throughout Asia. Latin America, Europe and Africa, while commercial banks and private providers excluded poor farmers from their credit provision system. This had negative consequences. In Japan, as the nonagricultural sector grew faster than the agricultural sector, and capital flew disproportionately to the nonagricultural sector because financial institutions were able to reap greater profits than by providing loans to the agricultural sector. Moreover, the financial costs and risks were higher than lending to the nonagricultural sector including especially small farms. As a result, loan provision for agriculture gradually shifted from private capital to government capital through special credit institutions' loan programs (Kato 1966). It was also the case in many developing countries that commercial banks and private

financial sources avoided risky and costly loans to poor rural farmers. This led to an increase in the role of traditional credit policy to support cheap credit; hence governments have encouraged creating new special financial institutions, credit cooperatives, credit unions or saving groups and super credit programs to take responsibility for such a policy.

The failure of the traditional credit policy was increasingly realized from the mid 1960s and came to be seriously debated during the second period, the 1970s and the 1980s. Many economists, especially Dale W Adams, D.I. Nehman, Douglas H. Graham, Maqbool H. Sail, and Michael R. Carter (Adams and Nehman, 1979; Adams and Graham, 1981; Sail and Carter, 1996) argued that such traditional policies (old paradigm) are not rational economic policies because they may reduce rather than improve the credit access of rural poor households. They therefore argued for the reduction of government support to and intervention in the rural financial market. The most obvious problem of credit programs under such traditional policies is the loan repayment, high transaction costs as well as high risk. Many researchers found that the interest rate and loan supervision had a weak effect on decisions to adopt new technology or make on-farm investments (Adams and Graham, 1981). Edward S. Shaw and other economists pointed out that such intervention by the government causes the financial sector to become too small in the sense that the services provided are less than optimal (Long, 1998).

Traditional policies were found to be ineffective in allocating a large share of formal loans to agriculture in general and to the rural poor in particular in many countries. Anderson (1990) estimated the effects of the Brazilian Rural Credit regulations, which require banks to lend a specified volume to small farmers, on the credit access of small farmers. This study found that subsidiary results reflect

unfavorably in the broader set of Rural Credit regulations; the results of this study also suggested that it is difficult to use commercial banks as the of agents development policy.

Some economists argued that agriculture could be developed without credit (Howse, 1983). Howse pointed out that credit is necessary at a later stage farmer's development, but not at the early stage since poor farmers actually suffer from insufficient knowledge to ascend productive and income. Rather that subsidized credit, poor farmers need to be taught how to develop by using the available resources and by their own ability. In this period, encouraging savings among poor farmers was increasingly emphasized in order to promote self-financing. Then the adoption of market-oriented financial policies, called "new views" was strongly recommended in many developing countries, Gonzalez-vega and Vogel stressed that the key element of the now views is that the major determinant of borrower, saver and lender behavior is an expected real rate of interest (Adams and Graham, 1981). Sail and Carter (1996) explained that rather than reducing the interest rates on rural credit, policies and procedures reducing transaction costs would help improve the access to credit of rural poor households.

In the third phase, from the 1990s to present, the new view of the rural financial market, based on market-oriented finance, have been widely adopted. This new approach emphasizes the flexibility of interest rates and mobilization of savings, the adoption of such new views to rural financial policies in general, and to agricultural financial policy in particular, remains sluggish. Although much research provides evidence that traditional credit policies failed to improve the credit access of the poor, in many cases researchers also found that agricultural credit programs have significantly positive effects on households' outcomes or agricultural production. This

may be one reason that makes traditional policies continue to be implemented in many developing countries. Another explanation for the slow change in agricultural credit policies is that it may take time for policymakers to understand, accept, and adopt the ideas included in these new views (Adams and Grahim, 1981), the adoption of such new views needs to be associated with adjustment and reform in other economic policies.

The government policy of intervention may improve the credit access of farmers and help the evolution and integration of the capital market if implementation can lead to a reduction of cost and risk for financial providers (Bhatt, 1983). For instance, the government introduces the policies that support crop insurance schemes and a fixed-sum subsidy to a commercial bank for acquiring the financial technology or opening a branch in a non-banked area.

A reasonable question to ask is how feasible it is to adopt successfully such a new approach into the rural financial market in developing countries, particularly in Laos, where the traditional approach has been necessary for helping the rural poor. Are the new views or new paradigm the right alternative to resolve the failure of the old paradigm? Meanwhile, the new paradigm does not address the regulatory and supervisory framework for rural finance and microfinance, legal issues and institution-building; neither does it work as an appropriate method to subsidize institutional development without creating subsidy dependence.

We may need to look back and ask again: what is the motivation for the government to intervene in the rural financial market? The main motivation is to help small farmers without access to the credit. These farmers are generally poor and can hardly obtain credit; this is the case in many developing countries, and Laos is no exception. Therefore, under such a situation the direct credit programs cannot be

completely eliminated although market-oriented finance, the new paradigm, is being adopted.

Many countries in Asia have adopted market-oriented finance into the agricultural financial market, but the traditional policy-based loan programs have remained. The evidence from Japanese agricultural finance shows that under financial liberalization, the various controls on interest rates and banking operations have been eliminated in order to restructure the market and to promote competition. Nevertheless, not only the subsidized interest rate loan policy but also government programmed loans have retained an important role in agricultural credit provision This situation is the same as the case of the Philippines (Izumida, 2001). In Laos, similar to other developing countries, the direct credit policy, especially interest rate controls, remain an important instrument for improving rural households' credit access in Laos. Although the government subsidy has been gradually reduced, many necessary subsidized programs are still being implemented; in particular, the APB's and Policy Bank's (established on September, 2006) subsidized loan programs continue to support poor rural households. This is a necessary stage in the process of reform.

The effect of financial policy reform on household outcomes has been investigated by several previous studies which have found that it has positive effect on household outcome. Feder et al. (1990) and Duong and Izumida (2002) used the switching regression model with an endogenous criterion function to estimate the output supply by distinguishing between households that are and are not credit-constrained in the first stage of the estimation. They found a significantly positive correlation between liquidity and output supply. These studies, however, rely heavily on distributional assumptions for identification, and do not account for farmer-

specific unobserved heterogeneity, which is expected to be highly correlated with loan amounts.

Pitt and Khandker (1998) estimated the impact of credit provided by the Grameen Bank in Bangladesh on a variety of individual and household outcomes, including schooling, labor supply, household expenditure and assets. They used an identification strategy that applies the loan eligibility criteria as a quasi-experimental survey design. Whether a household is classified as eligible or no eligible is based on landholding. They found that credit is a significant determinant of many household outcomes.

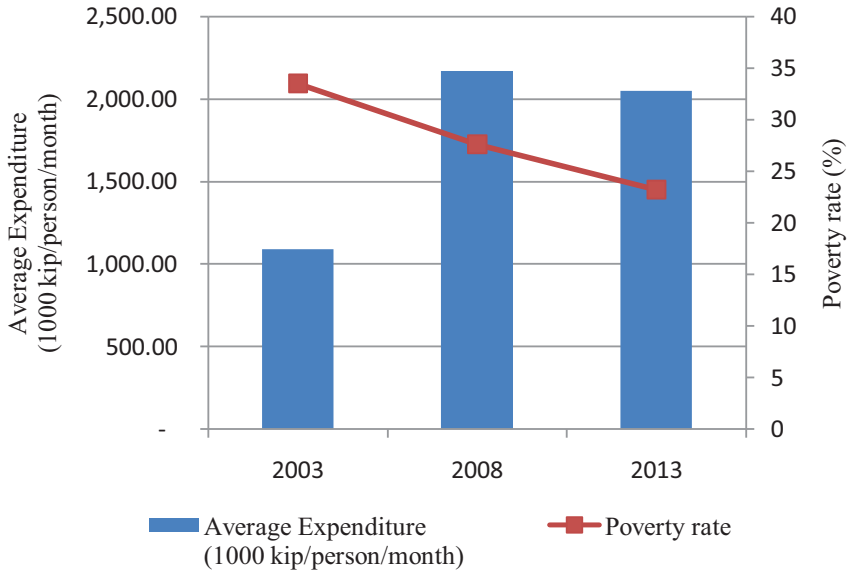
However, Coleman (1999), and Khandker and Faruqee (2003) have pointed out that it may be difficult to apply the identification strategy used by Pitt and Khandker in general because it relies on specific loan eligibility criteria. In many cases, most lending programs of formal financial institutions, including the APB, do not have such exogenous loan eligibility criteria.

Khandker and Faruqee (2003) attempted to apply a more general identification strategy to estimate the impact of farm credit in Pakistan on household outcomes by applying two-stage least squares estimation. They account for the endogeneity of credit by using competitors' characteristics, including household and village characteristics, as instruments. They found that farm credit has a positive impact on household outcomes.

In this study, a unique identification strategy is applied to deal with endogeneity. We are concerned about the correlation between error terms (productivity shocks) and the amount of the loan. We overcome these two types of endogeneity problem by using data from LECS 3 (2003) and LECS 4 (2008) and a unique instrumental variable, the reform policy in 2004.

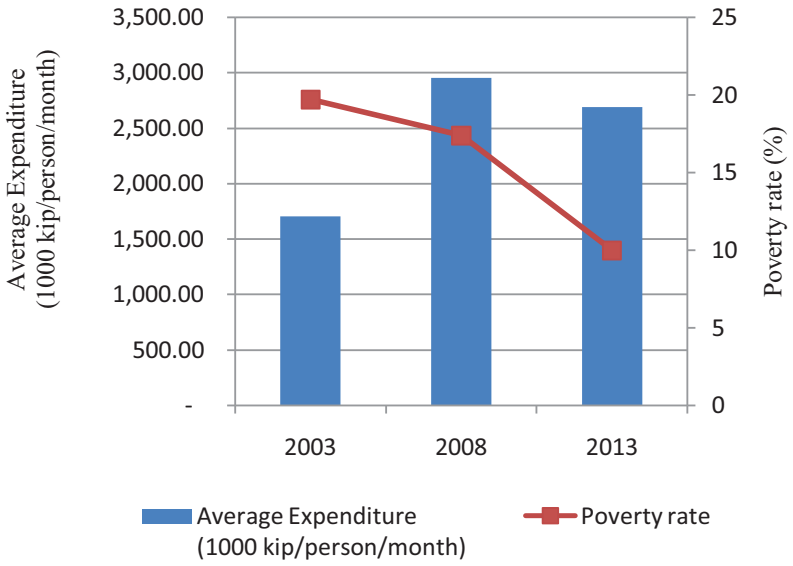
Generally, the income is used as an indicator for poverty. According to 7th Five-Year planning (2011-2015), the poverty line for whole country is 192,000 kip/person/month (about 24 USD/person/month), while it is about 180,000 kip/person/month (about 22.5 USD/person/month) for rural areas; and 240,000 kip/person/month (about 30 USD/person/month) for urban areas. However, due to insufficient income data for LECS 3 and 4, the expenditure data intended to be used as proxy for income and poverty indicators.

Figure 1.2 Average expenditure and poverty reduction in overall country (2011-2013)



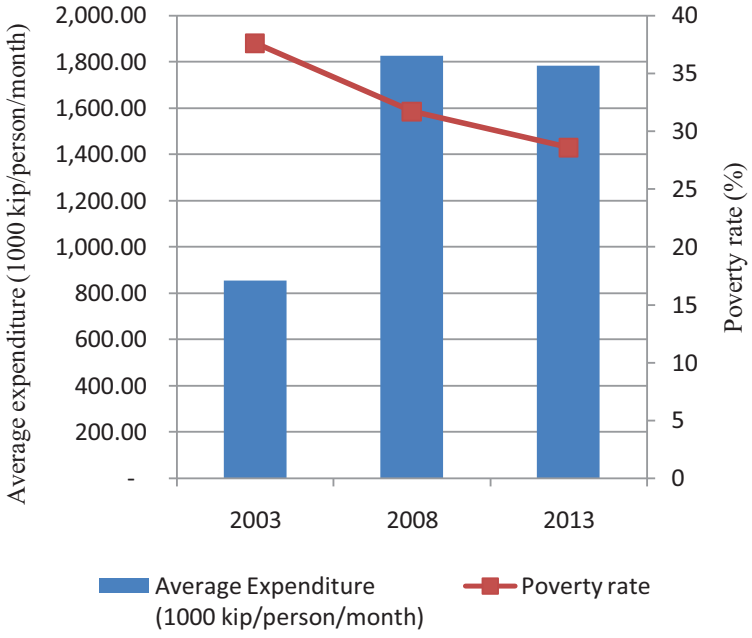
Sources: LECS 3, 4, 5. 2003-2013

Figure 1.3 Average expenditure and poverty reduction in urban area (2011-2013)



Sources: LECS 3, 4, 5. 2003-2013

Figure 1.4 Average expenditure and poverty reduction in rural area (2011-2013)



Sources: LECS 3, 4, 5. 2003-2013

1.3 Methodology

Estimating the effects of loan amounts is difficult because of the endogeneity problems. To overcome this problem, we use distribution free identification strategy that uses data from LECS 3 (2003) and LECS 4 (2008) collected Lao Statistics Bureau and uses the reform policy as an instrumental variable. Our simple model for the poverty reduction can be written as follows:

$$\ln(Ln_{it}) = \lambda_0 + \lambda_1 FR_i + \lambda_2 X_{it} + \upsilon_{it} \quad (1)$$

Ln_{it}^{*} Can be estimated, then it can be used following equation

$$Expenditure_{it} = \beta_0 + \beta_1 Ln^{*}{}_{it} + \beta_3 X_{it} + \varepsilon_{it} \quad (2)$$

where the dependent variable is the amount of expenditure (*Expenditure*) for household *i* at time period *t*. Ln_{it} are the amounts of loans made to household *i* at time period *t*. This paper focuses only on amount of loan that has been borrowed from formal and semi-formal financial institution such as banks, microfinance institutions, and saving groups or village funds. X_{it} is a vector of other explanatory variables of interest for household *i* at time period *t*, and includes education of household head, family number, the gender of the household head (1 if the household head is female, 0 otherwise), Status (1 if the household head is married, 0 otherwise), region, and ethnic. β_1 and β_2 are parameters of interest that measure the effect of the amounts of loans and other individual factors, respectively. ε_{it} is an error term, which is associated with productivity shocks and other disturbances.

We can estimate the empirical model in equation (1) by using alternative methods under various identification assumptions. For example, simple OLS estimation requires the restrictive exogeneity assumption of no correlation between

the error term (ε_{it}) and the explanatory variables, $E[\alpha_i + \varepsilon_{it} \mid Ln_{it}, X_{it}] = 0$. In our case, this assumption is violated because this compound unobserved variable is expected to be correlated with the loan variables. For example, an increase in the household's ability or a positive productivity shock (an increase in ε_{it}) would increase the amounts of loan borrowed. As a result, OLS suffers from omitted ability variable bias.

This problem is resolved by using a fixed-effects estimator. This method assumes that the error term (ε_{it}) is uncorrelated with the explanatory variables or $E[\varepsilon_{it} \mid Ln_{it}, X_{it}] = 0$. Again, the error term (ε_{it}) is expected to be correlated with the loans. For instance, a households who expects to have a positive productivity shock in the current year (and hence a larger value of ε_{it}) may increase current borrowing. Therefore, the assumption behind the fixed-effects method may fail and therefore generate inconsistent parameter estimates.

The study accounts for the remaining endogeneity, which is caused by the correlation between productivity shocks (ε_{it}) and loan amounts, by applying a two-stage least squares estimator (2SLS). The financial policy reform (FR_t) is exogenous to the individual households' loan amount because the reform policy affects the individual household's loan, but is not correlated with unobserved variables that determine the income. Hence, FR_t is used as an instrumental variable for the amounts of loan. The reform policy is a dummy variable that equals 0 if the public bank or APB implemented the traditional financial policy in 2003 and equals 1 if the market-oriented financial policy implemented in 2008. In this case, equation (1) and (2) can be estimated under the identification assumption as follows:

$$E[\varepsilon_{it} \mid FR_t] = 0 \text{ and } \operatorname{cov}(Ln_{it}, FR_t) \neq 0,$$

In the first stage, the amount of loan is regressed on the reform policy dummy variable and a vector of other explanatory variables of interest for household, as shown below:

$$Ln_{it} = \lambda_0 + \lambda_1 FR_t + \lambda_2 X_{it} + \upsilon_{it} \quad (3)$$

The first-stage function can be written as follow:

$$\ln(Ln_{it}) = \lambda_0 + \lambda_1 FR_t + \lambda_2 X_{it} + \upsilon_{it} \quad (4)$$

And, the second-stage function would be:

$$\ln(Expenditure_{it}) = \beta_0 + \beta_1 Ln_{it}^{*} + \beta_3 X_{it} + \varepsilon_{it} \quad (5)$$

The second-stage regression estimates the expenditure models by using predicted amount of loans from the first-stage regression in place of the observed values of loans.

1.4 Data

The research will mainly utilize data from Lao Statistics Bureau. It was the Lao Expenditure and Consumption Survey (LECS) which is the largest and most important survey that undertaken in Laos. It is not only large in sample size, it also covers a wide range of subject matter areas related to household living situation, consumption, incomes, own production in agriculture and household related business, construction, access to services, social indicators, food or rice intake, and so on. Until now there are five LECS were carried out, started from 1992/1993, but the last one is still now in the period of data entry. There are 5 wave of LECS was carried out, but in this study used only LECS 3 (2003) and LECS4 (2008) because LECS 1 and LECS 2 are not in line with the objectives of this study.

There are 3,879 households and 3,879 households in LECS 3 and LECS 4, respectively see in table 1.3

Table 1.3 the sample size

Item	Total	Borrower		Non-borrower	
	No. Household	No. Household	%	No. Household	%
LECS 3 (2003)	3,879	1,150	29.64	2,729	70.36
LECS 4 (2008)	3,879	1,160	29.90.	2,719	70.10
Total	7,758	2,310		5,448	

Source: Authors' computations from LECS 3 and 4.

1.5 Results Discussion

1.5.1 Descriptive analysis

Means and standard deviations of some key variables can be seen in some differences before and after the change in the financial policy, particularly for household expenditure and amount of loans from financial institution both from state-owned commercial and commercial banks.

The mean of household expenditure has double increased following the reform in financial policy, while the amount of loans has also twice augmented after reforming the financial policy in 2004 (Table 1.4 and 1.5). This suggests that the financial policy reform may affect the increasing in average loan amount which may lead to enhance the household expenditure.

However, as the household expenditure has been changed not only among the borrowed households, but also non-borrowed, the improvement of lending from

financial institution due to policy reform may not be significant factor affecting such a change. One main reason is that average of loan is slightly small amount with about 3.5 million kip (338 USD) in 2003 and about 6.3 million kip (740 USD) in 2008. Such small amount of loan may not be able to significantly contribute to household income generation activities, and hence it might have low effect on total expenditure of household.

Another point can be noticed that the number of household accessing to loan service has been slightly increase from 1,150 in 2003 to 1,160 households in 2008 after reforming the financial policy. This financial policy reform mainly affects the APB lending activity because APB has eliminated the duty of agricultural promotion agency, and focused only on providing the cash loan rather that kind loans (such as fertilizer loan). Other reason is that APB is the only financial institution providing loan to agriculture activities especially in rural area, while our sample households of about 78 percent are from the rural areas. Thus, after policy reform, it may cause reducing in lending amount from APB to rural households. Therefore, the indebted investigation on such effect needs to be considered by applying the highly recognized method of two-stage least square and financial policy reform is used as instrumental variable.

Table 1.4: Means and standard deviations of main variables

Variables	Before reform policy (2003)							
	Borrower (Observation: 1,150)				Non-borrower (Observation: 2,729)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Expenditure (kip)	798,450	592,475	109,600	8,333,065	861,022.600	697,245.600	118,100	10,900,000
Ln(expenditure)	13.428	0.546	11.605	15.936	13.489	0.557	11.680	16.204
Loan (kip)	3,561,438	2,500,000	50,000	70,000,000	0	0	0	0
Ln(Loan)	12.921	1.836	8.517	19.916	-	-	-	-
Family number (person)	6.268	2.430	2	18	6.217	2.306	1	18
Age of the household head	42.792	12.464	18	79	43.276	12.292	18	93
Education of head of hh (year)	14.737	3.032	6	16	14.298	3.413	6	16
Gender of the household head	0.037	0.189	0	1	0.051	0.220	0	1
Status of the household head	0.387	0.487	0	1	0.406	0.491	0	1
Region	0.206	0.405	0	1	0.188	0.391	0	1
Ethnic	0.419	0.494	0	1	0.430	0.495	0	1

Source: Authors' computations from LECS 3 and 4.

Table 1.5 Means and standard deviations of main variables

Variables	After reform policy (2008)							
	Borrower (Observation: 241)				Non-borrower (Observation: 3,634)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Expenditure (kip)	1,629,303	1,176,964	355,683	9,581,833	1,633,029	1,343,346	64,666	16,300,000
Ln(expenditure)	14.111	0.603	12.782	16.075	14.123	0.563	11.077	16.608
Loan (kip)	6,291,784	2,600,000	500,000	446,000,000	0	0	0	0
Ln(Loan)	14.850	1.232	10.820	18.064	-	-	-	-
Family number (person)	5.450	2.060	1	12	5.873	2.317	1	20
Age of the household head	49.790	12.531	17	80	44.573	12.227	16	99
Education of household head (year)	14.871	1.991	6	16	14.135	2.193	6	16
Gender of the household head	0.095	0.294	0	1	0.049	0.216	0	1
Status of the household head	0.450	0.498	0	1	0.447	0.497	0	1
Region	0.286	0.453	0	1	0.237	0.426	0	1
Ethnic	0.992	0.091	0	1	0.958	0.200	0	1

Source: Authors' computations from LECS 3 and 4.

1.5.2. Empirical results

The estimation results obtained from three specifications, OLS, fixed effects, and two-stage least squares (2SLS), are reported in table 1.7. This paper used real household expenditure as dependent variable and also use log (loan) = log (1+loan) for these three regressions. The OLS estimate shows that the loan amount significantly affects on household expenditure, when one percent increasing in loan amount leads to increase about 0.006 percent in household expenditure; the corresponding fixed-effects estimate is about 0.008 percent enlarging in household expenditure. A possible explanation for the effect of loans being small and statistically significant in both OLS and fixed-effects model is that the farmer-specific unobserved heterogeneity is not accounted for in the OLS model. Thus, the OLS estimates contain not only the effect of loans, but also confound the effects of household specific unobserved heterogeneity. This reflects the omitted variable bias in the OLS estimate. Although, the fixed effect model accounts for the household specific unobserved heterogeneity problem, the loans remain endogenous in the fixed-effects model.

The paper utilizes 2SLS estimation to resolve the remaining identification problem. In the first stage, we estimate functions for amount of loans by using the financial policy reform as instrumental variable. To maintain non-borrowers in the regression, this paper use log (loan) = log (1+loan) as dependent variable and the estimation results from the first stage are reported in table 1.6. The financial policy reform significantly affects the amount of loans with positive effect about 1.5 percent increase following the policy reform. The others control variables like education of head of household, age of household head and region are also show statistic significant with positive sign. While the others rest are statistics insignificant. However, the Adjusted R-squared from this regression is very low. This may be because of endogeneity problem

Table 1.6: First stage estimates of the effects of reform policy on loan access

Dependent variable: Log loan

Explanatory variables	Coefficient	Standard error	P-value
FR	1.492***	0.185	0.000
Education of household head	0.051***	0.018	0.005
Family number	-0.023	0.022	0.292
Gender of household head	0.014	0.239	0.951
Age of household head	0.011***	0.004	0.007
Status of household head	-0.093	0.105	0.374
Region	0.259**	0.126	0.040
Ethnic	-0.034	0.138	0.805
Intercept	1.69***	0.364	0.000
Number of Observations			7,758
F- test			42.57
R-squared			0.042
Adjusted R-squared			0.041

Note: *, **, and *** denote significance at the 90%, 95%, and 99% levels, respectively.

The regression in the second stage is estimated by using the predicted values of loans from the first stage. Relative to the OLS and fixed-effects estimates, the 2SLS estimate implies a greater significant effect of loans on household real expenditure after reforming financial policy in 2004 with a coefficient of 0.401. This effect is quite large compare with both OLS and fixed-effects estimation, while the standard errors are similar in all three models. Thus, the 2SLS estimate can be compared with the OLS estimate and the fixed-effects estimate.

The additional one percent loan amount would increase household real expenditure by about 0.4 percent. This means that financial policy reform may have positive effects on

enhancing the household real expenditure because such policy reform significantly increases the amount of loan lent to the households by formal institutions.

Other explanatory variables (education of household head, family member, status of household head, age of household head and region), except ethnic, gender of household head variables, are statistically significant after accounting for productive shocks or endogenous of loans. All those significant factors including household and village characteristics have positive effect on real expenditure. The household having more members would likely to have high amount of expenditure; similarly to the case of the head of household who has been married may have greater amount of expenditure than who not married. The reason for these outcomes is all related to an increase of number of family member which leads to increase demand for not only food, but also non-food consumption for their leaving.

In case of the village characteristics, the household leaving in the urban area trends to have higher amount of expenditure than who leave in rural area. Urban household may have more ability to access to market and job opportunity leading to have high income and hence having high ability on spending, and this make urban households have lower poverty rate than among the rural households (Figure 1.3)

In the same way, the household being Lao Lum ethnic have no different in real expenditure level compare to others minority. The reason is that all ethics are equally in doing agriculture, business, and factories. This opportunity becomes key factor supporting those people to generate more income which make them having more ability on spending for their leaving than other ethic.

Table 1.7: Estimates of the effects of reform policy on poverty reduction

Dependent variable: Log expenditure

Explanatory variables	OLS		Fixed-effects estimator		2SLS estimator	
Ln(Loan)	0.006***	(0.001)	0.008***	(0.001)	0.401***	(0.014)
Education of hh head	0.044***	(0.001)	-0.053***	(0.001)	0.017***	(0.002)
Family number	0.029***	(0.002)	0.038***	(0.003)	0.022***	(0.002)
Gender of household head	0.026	(0.029)	-0.031	(0.038)	0.025	(0.028)
Age of the household head	0.0009*	(0.0005)	0.00003	(0.0006)	0.005***	(0.0005)
Status of household head	0.009	(0.013)	0.013	(0.017)	0.037***	(0.012)
Region	0.352***	(0.015)	0.125***	(0.025)	0.444***	(0.015)
Ethnic	0.207***	(0.015)	0.246***	(0.020)	0.024	(0.016)
Intercept	13.847***	(0.037)	13.955***	(0.048)	13.875***	(0.035)
Number of Observations	7,758		7,758		7,758	
F- test	309.97		316.35		428.66	
R-squared	0.242		0.395		0.3068	
Adjusted R-squared	0.241		-		0.3061	

Note: *, **, and *** denote significance at the 90%, 95%, and 99% levels, respectively. Standard errors are in parentheses.

1.5.3 Conclusion and implementation

The study estimates the effect of loan amount on household real expenditure by using the policy reform as a unique instrumental variable in order to deal with endogeneity problem due to correlation between the loan amount and productivity shocks. The estimation results show that the financial policy reform has leaded to increase in average amount of

loan; and this amount of loans has a significantly positive effect on household real expenditure.

A comparison of the OLS and fixed-effects estimates reveals the importance of controlling for household-specific unobserved heterogeneity that affects loan amounts. The OLS and fixed-effects estimates differ substantially. The OLS estimate of the effect of loans on household real expenditure is small with low significant level, while the loans effect is somewhat greater in the fixed-effects model with high significant. This means that the OLS estimates might be affected by omitted variables bias. This evidence reflects the fact that small numbers of productive households receive loans from formal financial institutions, while large numbers of unproductive households may be excluded from formal financial services. Therefore, unlike poor households, productive households can afford to obtain fund from the financial market even without loans from the formal financial institutions.

Due to the minor effect of loan in the fixed-effects model, this model may face the endogeneity that arises because of a correlation between loan amounts and productive shocks which cannot be dealt with by using fixed-effects estimation. Thus, we applied two-stage least squares (2SLS) estimation by utilizing policy reform as a unique instrumental variable. We found that loans have a statistically significant positive effect on household expenditure. The magnitude of the effect is reasonable and implies that borrowing one additional percent raises household expenditure by about 0.4 percent.

This evidence implies that the cessation of loans may be one of the main reasons for the observed increase in household expenditure. Loans would strongly encourage households to improve their income generating activities which can enhance their income level leading to recuperate their ability of spending for food and non-food. This would help them to get rid of poverty condition. Therefore, encouraging financial service access, particularly loan access,

of households is important, especially for those households who undertake insufficient capital investment and leaving in the rural areas.

One efficient approach for encouraging financial service access among households is adaptation of the market-oriented financial policy rather than focusing on direct credit policy which provides various subsidized loan program. However, subsidized-credit policy remains necessary for helping the rural poor households in order to reach poverty reduction goal in 2020; Lao rural financial authorities, therefore, face a great challenge to adopt market-oriented financial policy in order to improve both loan access and average loan amount per household.

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Chapter 2

Impact of Public Road Investment Project on Poverty Alleviation in Rural

2.1 Introduction

Recently, rural roads have been widely known as champion for poverty alleviation instruments by the World Bank and donor institutions. Rural roads provide substantial benefits to households in low-income countries, especially the poorest. It is also the key to raising living standard in poor rural areas (van de Walle, 2002).The close link between village connecting roads and poverty reduction has been addressed for long term through the increase of income opportunities to rural people. In general, the rural connection roads provide market access opportunities to rural people especially the farmers. They can develop market linkage with other stakeholders in the economy. The development market linkage, in other word, network development helps them diversify their income source as they have linked with more variety and functional livelihood value chain system. Through this, they can earn more income with stable sources. When their income improves, their farming production also improved through the increase of opportunity to improve technology and other those relevant to their farming. This circulation ensures a stable income; improve living standard and that reduction of poverty (Oraboune, 2008).

In Laos, many districts lack the roads linked to the main national transportation. Moreover, a good number of villages have yet to be connected to the main district of provincial roads. Thus, the economic growth is obstructed and poverty persists. Rural road improvement and development are poverty alleviation in itself, and it is also a source for the creation of an enabling environment for a market economy (Oraboune, 2008). However, the connecting roads to villages as to provide the rural people with opportunities to have easy

access to the markets and gradually to improve their living standard would be pointless unless they understand the objectives of such infrastructure benefits and profit their advantages. That said, due to the budget constraint to construct all connecting roads for every single village around the country will never be realized. Furthermore, the rural villagers, the main stakeholders, with their understanding of the vital need of the rural roads that can improve their livelihood and reduce poverty, should participate in the initiation of the provision of rural access roads and ensure the sustainability of the road maintenance.

The government of Laos recognizes that the absence of transportation infrastructure is a substantial cause of poverty, especially for rural and remote areas. Therefore, there is heavy public investment in basic infrastructures, particularly road network nationwide with high expectation of the Lao government to bring the country of out poverty by 2015 and break away from the least-developed country status in 2020.This chapter tries to answer the main questions of what is the impact of road investment on rural household income, and what happens to other factors that influence rural household income such as rice product, cultivated areas, and other economic activities. More precisely, the paper will find out the mechanism of how the rural roads could contribute to the improvement of household livelihood, and to the increase of household income.

2.2 Overview of Road Sector in Laos

Laos implemented opened-door policy in 1986, since then road is one of the most developed sectors and play a key role for economic development of the country. Laos is the land-locked country where is no way out to the open-sea. Consequently cargo is a bit complicated comparing with other surrounding countries like Cambodia, China, Myanmar, Thailand and Vietnam. To breakthrough this barrier, the Lao government adopted and introduced a new policy with the aim of converting the country from being landlocked to a land link country. Therefore, surface transportation is considered to be the most economic

efficient option comparing to other mode of transportation of the country, especially in this era of international economic integration and regional cooperation. Overall, the total length of road is 39,586 Km with only about 14 percent paved and total area of the country is 236,800 square Kilometers. This make up the road density is about 0.17 (WDI, 2013). However, this ratio is relatively low comparing to other neighboring countries like Cambodia is 0.22(2009), China is 0.42 (2010), Thailand is 0.35 (2010), Vietnam is 0.48 (2007), excluding Myanmar is 0.05 (2010).

2.2.1 Transportation development

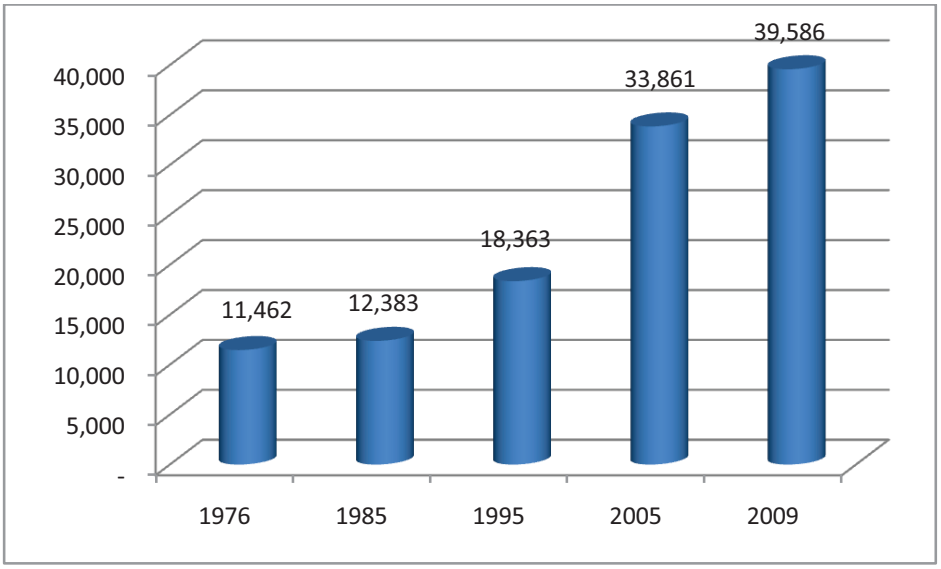
The Ministry of Public Works and Transport (MPWT) is the national government agency primarily responsible for expansion and maintenance of the transport infrastructure in the country. The Lao PDR's development plans have consistently supported the expansion of the road network but have also recognized the limitations imposed by funding constraints. In recent years, regional connectivity has been emphasized. MPWT's multi-criteria mechanism for prioritizing projects gives more weight to funding regional projects connecting the international borders than the projects providing access to remote areas within the country. With regards to air transport, in the civil aviation subsector, the Lao PDR operates the Wattay Airport at Vientiane and two regional airports at Louangphrabang and Pakxe. In addition, there are 10 minor airports in the provincial capitals and 39 other airstrips. Inland waterways, the Lao PDR's topography has traditionally facilitated inland waterway transport. However, this form of transport is insufficiently used and lacks integration with the other forms of transport, especially roads. The country has over 2,000 km of rivers, comprising the Mekong and its tributaries. Twenty-one river port facilities, constructed by the government, have typically been employed for domestic trade only. However, recent years have witnessed a growth in cross-border trade with the People's Republic of China (PRC), Myanmar, and Thailand. Railways, other than a 3.5-km rail link across the Mekong River between

Thanaleng in the Lao PDR and Nongkhai in Thailand, the railway subsector in the Lao PDR has not been developed, restricting the transport of bulk and heavy freight at lower costs. This has contributed to slow growth of large industries in rural areas. Most remote parts of the Lao PDR remain inaccessible and depend on earth roads, which are often impassable during the rainy season.

2.2.2 Road sector development in Laos (1976 – 2009)

After liberalization in 1975, the government of Laos has paid close attention to the development of the country in overall dimension especially infrastructure that is a key for economic development of the country, more specifically after 1986 when the government launched the New Economic Mechanism (NEW), infrastructure both hardware and software have gradually developed with quantity and quality supporting to the development of socio-economic of the country as a whole. The main mode of transportation in Laos is travelling by road. Hence, the development of road network always has been a critical issue for the country especially the expansion of roads in rural and remote areas. In the beginning of 1980s, the road network was in a very poor condition and further deteriorated due to the lack of funding and appropriate maintenance (Alberto Nagales, 2004). After the implementation of the NEW, road network has gradually been developed and expanded all over the country. The Ministry of Communication, Transport, Post and Construction (MCTPC) is responsible for the planning, budgeting, and development of this type of infrastructure network including roads, inland waterways, ports, railways and aviation and airports. Under the government development policy, the MCTPC has carried out the development of road expansion across the country. In 2009, the total length of the road in Laos is 39,568 km, an increase from only 33,861 km and 18,363 km in 2005 and 1995, respectively. (see Figure 2.1). According to the statistic 2009, the entire road network in Laos was about 39,586 km, but only about 13.7% of total roads are paved, and the rest is either in gravel or earthen surfaces.

Figure 2.1 Total length Road in Laos (1976-2009)



Source: MPWT, 2009

Road expenditures are financed from general budgetary allocations, foreign loans, and grants. Road sector revenues are derived from sales and import duties on vehicles, spare parts, tires, and automotive fuel products, as well as annual vehicles license fees, vehicle registration, inspection fees, and driver's license fees. In current Lao Kip terms, annual road sector expenditures for construction, operation, and maintenance have been increasing in recent years. This overall increase was mostly due to increase in expenditures funded from external sources (Alberto Nogales, 2004).In 2001, the government decided to establish the Road Maintenance Fund (RMF) and Road Fund Advisory Board in order to be responsible for road maintenance fund mobilization. The RMF provides an enhanced and sustained source for financing the maintenance of the national road network. Since 2002, the RMF has been operated and experienced positively well especially after the government approved and established the fuel levy and others surcharges in January 2001. The RMF has played the main tool for fund mobilization including inflows of funds from donors or board. In the main time, the RMF also benefit from the proceeds of levy on gasoline and diesel fuel, a heavy vehicle surcharge, fines and penalties, and any road tolls and in near future will also benefit

from international transit charges, etc. As defined by its regulation, about 90% of the RMF proceeds will finance the maintenance cost of the national roads, and the rest will go to provincial and other lower level of roads.

The development of infrastructure development during this period has shown significant improve and contribute to transportation sector of the country. The development of road, bridge, waterway airway, etc., has supported the development of other sectors including agriculture, commerce as it eases market access.

To sum up, road sector in Laos has dramatically improved in the last three decades, but many areas are still needed to be further developed in order to contribute to social and economic development of Laos.

2.2.3. Road Characteristic in Laos

Roads in Laos have been classified into six categories, national road, provincial road, district road, urban road, rural road and special road

National Roads: The road network classified as strategic roads which are very important for the development of national economy and wider region, including connections between the national capital, province and special zone capitals; roads to international borders; and roads of socio-economic or defense security importance. Currently, the MPWT is directly responsible for the development of national roads in the whole country. The Development of Roads of the Ministry has developed strategic plan for national roads of the country in concurrence with the national land-link strategy.

Provincial Roads: The connected roads between provincial capitals and district centers, river port, tourist and important historic sites of the province. The provincial Department of Public Works and Transport (DPWT) in each province is responsible for the development of strategic plan for construction and implementation of those relevant to provincial road issues, in respect to the strategy issues by the MPWT. Currently, there are 17 provinces in Laos and

each province is responsible for the development of provincial roads to connect at least provincial capital to all district capitals in the province. However, due to the capacity of local officers, the Department of Roads of the MPWT still plays crucial role in assistance all provinces in the country in terms of development of road sector in each province.

District Roads: The inter-district roads in order to connect the district centers to villages, river ports, tourist and historic sites and special economic zones of the district. Currently, there are 141 districts in Laos. According to public administration system of the country, district is the administration level under provincial level. District has classified as the lowest level of public administration organ. Under district, there are villages as autonomous level of people. Office of Public Work and Transportation (OPWT) of the district is responsible for the development of district roads. Due to the real situation of the country, especially in mountainous and remote areas district roads are often in not very well condition.

Urban Roads: The roads within urban areas. Due to level of infrastructure development in Laos is still low, there are not so many areas considered as urban. Currently, only few areas have been classified as unban including Vientiane Capital, Savannakhet, Champasack and Louangprabang province. Since the structure of urban administrative body has not clear been developed and unified. Often, provincial Department of Public Works and Transport is still responsible for the issues regarding roads and transportation of relevant areas.

Rural Roads: the roads that connect a village to others villages, to the main road accessing to markets, or to connect related production or service to particular centers. Due to the real situation of rural roads dominant of the country and most of poor people live in rural areas. Rural roads have been considered very important and play significant role in poverty reduction through linking rural farming to market, improve their productivity and increase income level. A constraint for rural road construction is budget these public goods in Laos are mainly provided by the government, where the budget would mainly allocate to more

economic strategic roads at national level. Majority of rural roads in Laos are earth surface and often non-all weather roads. Especially in rural remote areas, only dry season that the roads are able to commune and not for wet season. This situation by more or less reduces rural farming productivity to access to stable income and that poverty.

Special Roads: The roads that use for special purposes of production or service to particular activities, for national security, and in forest preservation zones. Generally, special roads can be classified into two categories. One is special in terms of economic aspect; and the other is in terms of security reasons:

Economic special roads are economic strategic roads that support the development of potential industries of the country. For example, roads number 9 can also be classified as special road. This road is the regional road (East-West Economic Corridor) of the Great Mekong Sub-region (GMS), where the country can economically gain from.

Security roads are the roads in the areas where related to national security, non-traditional security issues such as forest preservation zones, and so on.

2.2.4. Government policy regarding road sector in Laos

Due to the recognition of the significant of road sector as an importance means to shore up market system of the country, the government of Laos always emphasizes the development of the road infrastructure as a key for country development. With recognition of the obstacle of the country location "land-locked" situation, this put tremendous constraint for economic development of the country especially high cost of transportation that reduces competitiveness of export sector of the country. Together of the trend of regional development and an effort to overcome this difficulty, the government of Laos has introduced a "land-link" strategy as a tool to catch up regional opportunity pushing industrialization and modernization of the country. Land-link strategy is a strategy to develop the country as bridging land to neighboring countries. This will not only improve opportunity of market

access of the country, but the country would also gain from the development of the related industries in concurrence with road sector development. In order to achieve the said strategy, the Ministry of Public Works and transport (MPWT) introduced development plan to 2010, and the road/ transportation was noted that "*develop and expand national roads which are sub-regional and link between the north to the south, and from the east to the west, complete construction of paved roads in Vientiane Capital, which link with municipal areas to district in the provinces and focal development areas must be ensured to use in both seasons*" (Orabune, 2008)

- **Rural Road Development Policy**

During the past decade a number of attempts have been made to write a Rural Transport Infrastructure Strategy or Policy for the MPWT without reaching the final acceptance and approval from the Ministry. The most recent Strategy-and Policy papers are listed below.

2006: Rural Roads Policy – prepared by a consultant working together with a MPWT working group;

2007: National Strategy on Accelerated Provision of Rural Transport Infrastructure – prepared under the Basic Access Component of LSRSP;

2007 - 2009: Rural Transport Infrastructure Policy – prepared under the Basic Access Component

Currently MPWT drafting Rural Transport Strategy paper by using information from above earlier prepared strategy/policy papers together with recent data and information. This "Rural Transport Infrastructure Strategy" intends to assist the Lao Government to use all its available resources to execute approved plans as effectively as possible, in order to improve

the Rural Transport Infrastructure, and thus further the development and poverty alleviation in the rural areas.

2.2.5 Concepts and Definitions of Poverty

The concept and definition of poverty is a highly contested issue, depending on the subject, geographic location or purpose that is being examined (Lok-Dessalien, 1998). In a human development perspective, poverty is defined as development that leads to a long healthy, creative life and enjoyment of a decent standard of living, freedom, dignity, self-respect and the respect of others" "the absence and denial of choices and opportunities most basic to human (UNDP, 1997). In the 1995 World Summit for Social Development in Copenhagen, the United Nation defined "overall poverty" as a combination of: "the lack of income and productive resources sufficient to ensure sustainable livelihoods; hunger and malnutrition; ill health; limited or lack of access to education and other basic services; increased morbidity and mortality from illness; homelessness and inadequate housing; unsafe environments; and social discrimination and exclusion. It is also characterized by a lack of participation in decision-making in civil, social and cultural life. It occurs in all countries in various forms: as mass poverty in many developing countries; pockets of poverty amid wealth in developed countries; loss of livelihood as a result of economic recession; sudden poverty as a result of disaster or conflict; the poverty of low-wage workers; and the utter destitution of people who fall outside family support systems, social institutions and safety nets" (UN, 2000).

Accordingly, poverty has been defined by the Asian Development Bank (ADB) in its poverty reduction strategy (PRS), in a broad context as: "The deprivation of essential assets and opportunities to which every human being is entitled" (ADB, 2004b). The definition of poverty includes income and non-income dimensions, measuring poverty in terms of income, nutrition, education, health, and empowerment. Everyone should have

access to basic education and primary health services. Poor households have the right to sustain themselves and be reasonably rewarded, as well as having some protection from external shocks. Beyond income and basic services, individuals and societies are making the decisions that shape their lives. The definition of poverty has attracted considerable political and social scientific controversy. The social definition of poverty is crucial because it determines to what extent governments accept that the problem itself exists; it also influences what policies are to be adopted to tackle poverty and, as a consequence, how the poor themselves will be treated. Poverty can be conceived and distinguished in three perspectives: (i) 'income', (ii) 'basic needs', and (iii) 'human capability' (UNDP, 1997). Poverty is, sometimes, associated with inequality, and often correlated with vulnerability and social exclusion (Lok-Dessalien, 1998).

Poverty in Laos, poverty has been defined by the Government as "the lack of ability to fulfill basic human needs of daily life such as not having enough food (less than 2,100 calories per person per day), a lack of adequate clothing, not having medical treatment in case of illness, education and transportation services'' permanent housing and lacking access to health – inability to afford fees (Government of Laos, 2003).

Based on Lao National Statistic Bureau (LSB, 2012), the poverty lines are adjusted over time by changes in prices of the consumption basket as well as spatial price differences. The urban poverty line was about 220,000 Kip (USD 27.5) per person per month, and for rural was about 180,000 Kip (USD22.5) and the national poverty line was about 192,000 Kip (USD 24) per person per month.

2.2.6 The reviews of related studies

Transportation plays a multifaceted role in the pursuit of development objectives. Restriction of accessibility limits efficient factor mobility, and defers the transfer of human and material resources to places where they can be employed most productively. Conversely,

transportation development helps to attain an efficient distribution of population, industry and income. There many researchers have been working on the relationship road access and economic development.

Study by Worku (2011) analyzed the impact of roads sector development on economic growth in Ethiopia. The study used time series data on the country's road network and GDP growth over the period 1971-2009. The author used total road network per worker and he also tests the significance of paved and gravel roads independently. Results show that paved roads have positive and significant impact on economic growth while gravel roads do not. Although he finds a positive impact of road on overall GDP, it does not show the variation in road access in different parts of the country and how this might affect economic performance at lower levels of administrative units.

A study by Renkow et al. (2004) showed that physical remoteness brings economic isolation and this increases fixed transaction cost incurred by farm households in Kenya. They use maximum likelihood model to estimate how transaction costs and market participation is responsive to rural infrastructure. They underline public infrastructure facilitate market integration and minimize the transaction cost. A major limitation of Renkow et al. (2004) is that they do not have a direct measurement of the road accessibility of rural villages. They rather classify villages into those that are served by trucks and those served by non-motorized vehicles. Their finding that remoteness increases fixed transaction costs is only significant for villages served by trucks.

Dercon et al. (2009) use panel data from fifteen rural villages in Ethiopia and examine the impact of agricultural extension program and roads access on poverty and consumption growth. The study finds based on GMM estimation that access to all-weather roads reduces poverty by 6.9% and it increases average consumption growth by 16.3% after controlling for regional fixed-effects and seasonal shocks. While this is interesting, the

authors use a very crude measure of road access, basically a dummy variable indicating whether the household has access to all-weather road to the nearest town. This road accessibility measure does not capture the actual change in roads through upgrading, maintenance and construction of new roads.

Study by Jalan and Ravallion (2002) has found robust results on geographic poverty trap of rural households using longitudinal data from 1985-90 on 5600 farm households in rural China. They hypothesize that consumption growth is a function of a household's own capital and geographic capital. The study takes road density per ten thousand populations as one of the geographic variables which affect the productivity of private capital. Using GMM estimation, the authors find that roads have positive and significant impacts on consumption growth in China. In addition the study emphasizes consumption growth needs road density level to exceed 6.5Km per 10,000 population.

Khandker and Koolwal(2011) examine the impact of rural roads in the long run by using household level panel data from Bangladesh between 1997and 2005. They estimate the benefit of road projects on consumption expenditure before and after the project in control and treatment villages. Results from GMM estimation show positive and significant outcomes of roads on per capita expenditure in the short-run especially for extremely poor households. However, in the long-run large benefit will be accrued to higher-income groups due to the increasing rate of return to rural investments and expansion of non-farm employments. They also identified the initial difference in the households' characteristics and quality of roads determines the long-run impact of the roads.

Other studies by Mu and Dominique (2007); Khandker et al (2006); Stifel et al (2012) and Wondemu and John(2010) are also found significant impact of roads on poverty reduction and economic growth using impact evaluation techniques and panel data estimation by taking specific road projects.

A study by Fan and Chan-Kang (2005) exhibited rapid development of expressways and especially low standard feeder roads contribute to poverty reduction and economic growth in China. The study shows how investment on roads increase agricultural productivity and improve non-farm employment and this can also lower food prices which are very important for poor households in particular. Similar studies on China by Fan et al. (2002) indicated that government spending on productivity improving investments such as research and development (R&D); education, irrigation and basic infrastructures such as roads, electricity and telecommunications have high contributions to increase agricultural productivity and poverty reduction. Among these, investment on roads has biggest return in non-farm economy by increasing employment opportunity and rural wages. They assert that impact of road on poverty reduction is channeled mainly through non-farm employment.

Another perspective is that road can benefit rural households by enhancing the value of their asset. A study by Jacoby (2000) examined the distributional effects of rural roads in Nepal and estimates the outcomes of low transportation cost. He argued that road access decreases transport cost which in turn increases non-farm wages and land values. The study also tries to examine the distribution of road benefit across different income groups in Nepal and found much of rural benefit accrues to the poor households but the extent is not large enough to reduce the income inequality.

Estimation the effect of road on poverty in Laos was studied by Oraboune and Warr (2005) from LECS 2 and LECS 3 were collected in 1997/98 and 2002/03 respectively. The relationship between road infrastructure development and rural poverty in Laos by Warr (2005), has shown a strong correlation between access to services and rural infrastructure, and between accessibility and poverty alleviation. The study also showed clear relationships between road access improvements in rural areas and improved educational participation of primary school children, together with reduced rates of illness. A large part of the 13%

decline in the incidence of poverty in Laos recorded between 1997/98 and 002/03, has been attributed to improved rural road access alone (Warr, 2005).

2.1. Methodology and Data Collection

2.1.1. Data Collection

The data used in this chapter is taken from the Lao Expenditure and Consumption Survey (LECS). Actually, 5 waves of LECS were carried out, but this study is going to use only LECS 3(2003) and LECS4 (2008) this because LECS1 and LECS2 are not in line with the objectives of this study. There are a total of 540 villages and 518 villages in LECS3 and LECS4, respectively. The matching of the two waves results in 506 villages and out of 506 only 119 villages are without road access as can be seen in LECS3; then the number in LECS3 was matched against that of LECS4. As a result, 51 villages with road access are in LECS4 are considered as treatment group and the other 68 villages with no road access are used as comparison group. Finally there are 2,142 household as sample see in table 2.1.

In the survey, village with road access means that the village has roads linked to the main transportation in district level, provincial level and national level which can travel by any kind of vehicles in all seasons (Rainy and dry seasons).

Table 2.1 Sample size

Item	Treatment groups		Control groups	
	No. Villages	No. Household	No. Villages	No. Household
LECS 3	51	408	68	544
LECS 4	51	510	68	680
Total	102	918	136	1,224

Source: Author Computation

2.3 Research Methodology

The current study tries to use a suitable comparator, which is defined as comparison of various outcomes before and after road project, in comparison with or without projects. Difference-in Differences (DD) method will be used in this analysis. The main assumption of this method, if the two groups receive no intervention, the change in values of the outcomes between treatment and control groups should be comparable. The following is the Difference-in Differences in Econometric Model:

$$\mathbf{Y_{it} = \beta_0 + \beta_1\, after_t + \beta_2\, treat_i + \delta_1\, treat_i{*}after_t + \beta_3 X_{it} + u_{it}}$$

$\boldsymbol{Y_{it}}$ indicates the outcome of interest such as rice farm income, non-farm income and total income, total rice product, yield, cultivated areas of household *i* in year *t*.

After = 1 after treatment (2008), and 0 before treatment (2003)

Treat = 1 if in treatment group, and 0 if in control group

$\boldsymbol{X_{it}}$ is a vector which captures household and village characteristics such as age of head of household, family size, and so on.

$\boldsymbol{u_{it}}$ is an error representing unobserved factors that affects Y_{it}

The coefficient of interest is on the interaction term, $\boldsymbol{\delta_1}$. This gives us the difference-in-differences estimator of the treatment effect.

- **Hypotheses**

This paper will test the hypothesis by each outcome variable which is considered as the main variable influencing rural household income such as income from farm, non-farm income and other factors that could be a source of income such as rice product, yield or cultivated areas and so forth.

The hypotheses to be tested are investment in road infrastructure with significant impact on rice farm income, non-farm income and total income. Other hypotheses to be tested in this chapter are the investment in the road infrastructure with significant impact on

rice production and yield and cultivated areas. To test the null hypotheses, the investment in road infrastructure, have no significant impact on rice production and yield, and cultivated areas.

2.4 Results and Discussion

Difference-in-Differences methodology is used to obtain all results in this section by running equation (1) to confirm that Difference-in-Differences method meets its main assumption mentioned in the methodology part. This section begins with the baseline of road project survey in 2003.

The table 2.2 shows the mean of outcome variables in the baseline survey for a group of villages with road project (treatment group) and a group of villages without road project (control group). All outcome variables in treatment group and control group are slightly different. However, they are not statistically significant, indicating that overall there is no statistically significant difference in the mean of outcome variables between treatment and control groups in the baseline survey or without intervention of road project, and the mean of outcome variables in both group are comparable which supports the main assumption of the Different-in-Differences method.

Table 2.2 Comparison Mean of outcome variables in the baseline survey (2003)

Outcome variables	Treatment group	Control group
Expenditure (KIP)	803,860	810,580
Total product (ton)	3523.57	3605.13
Productivity (ton/ha)	3202.29	3122.87
Cultivated areas (ha)	1.52	1.42
HH using tractor	0.07	0.10
HH using fertilizer	0.12	0.11

Source: Reproduced by the Author

2.4.1 Results of Different-in-Differences in Household level

The table 2.3 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of rice farm income without control variables. The result indicates that the coefficient of interest is 0.348 with a positive sign and statistically significant. This empirical result illustrates that villages with road access may increase rice farm income around 34.8% compared to the one without such infrastructure. The result is also in line with the hypothesis of the investment in road infrastructure with significant impact on rice farm income.

Table 2.3 Difference-in-Difference estimation of the effect on log of rice farm income

	Treatment Group	**Control Group**	**Difference**
Before	14.239	14.279	-0.04
	(0.064)	(0.046)	(0.079)
After	15.514	15.206	0.308***
	(0.081)	(0.072)	(0.108)
Difference	1.275	0.927	0.348***
			(0.134)
observations	2,142	2,142	2,142

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1%

The table 2.4 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of non-farm income without control variables. The result indicates that the coefficient of interest is 0.657 with a positive sign and statistically significant. This empirical result illustrates that villages with road access may increase non-farm income by around 65.7% in comparison with the ones without the connecting road. The result is also in

consistence with the hypothesis of investment in road infrastructure with significant impact on non-farm income.

Table 2.4 Difference-in-Difference estimation of the effect on log of non-farm income

	Treatment Group	Control Group	Difference
Before	11.857	12.001	-0.144
	(0.135)	(0.097)	(0.166)
After	13.003	12.489	0.513**
	(0.166)	(0.148)	(0.223)
Difference	0.489	0.657	0.657**
			(0.278)
observations	2,142	2,142	2,142

Note: before=2003, after=2008; the numbers within the parentheses are standard errors ** represent significant level at 5%

The table 2.5 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total income without control variables. The result indicates that the coefficient of interest is 0.258 with a positive sign and statistically significant. It means that village with road access may increase total income by around 25.8% compared to the one lacking the connecting road. The result is also in consistence with the hypothesis of investment in road infrastructure with significant impact on total income.

Table 2.5 Difference-in-Difference estimation of the effect on log of total income

	Treatment Group	Control Group	Difference
Before	14.485	14.416	0.069
	(0.086)	(0.061)	(0.105)
After	15.446	15.118	0.328**
	(0.105)	(0.092)	(0.140)
Difference	0.960	0.702	0.258**
			(0.125)
observations	2,142	2,142	2,142

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.** represent significant level at 5%

The table 2.6 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total rice production without control variables. The result indicates that the coefficient of interest is 0.291 with a positive sign and statistically significant. It means that village with road access may increase total rice product by around 29% compared to village without road access. The result is also in consistence with the hypothesis of investment in road infrastructure with significant impact on total rice production.

Table 2.6 Difference-in-Difference estimation of the effect on log of total rice production

	Treatment Group	Control Group	Difference
Before	7.431	7.461	-0.030
	(0.062)	(0.044)	(0.076)
After	7.931	7.670	0.261**
	(0.076)	(0.067)	(0.101)
Difference	0.500	0.209	0.291**
			(0.127)
observations	2,142	2,142	2,142

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. ** represent significant level at 5%

The table 2.7 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of yield without control variables. The result indicates that the coefficient of interest is 0.038 with a positive sign but statistically insignificant. This implies that investment in road infrastructure has no significant impact on yield. The result is in consistence with the hypothesis.

Table 2.7 Difference-in-Difference estimation of the effect on log of yield

	Treatment Group	Control Group	Difference
Before	7.308	7.366	-0.057
	(0.045)	(0.032)	(0.055)
After	7.642	7.661	-0.019
	(0.055)	(0.049)	(0.074)
Difference	0.334	0.295	0.039
			(0.092)
observations	2,142	2,142	2,142

Note: before=2003, after=2008; the numbers within the parentheses are standard errors

The table 2.8 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log cultivated areas without control variables. The result indicates that the coefficient of interest is 0.252 with a positive sign and statistically significant. It means that village with road access may increase cultivated areas around 25.2% compared to village without road access. The result is also in consistence with the hypothesis of investment in road infrastructure with significant impact on cultivated areas.

Table 2.8 Difference-in-Difference estimation of the effect on log of cultivated areas

	Treatment Group	Control Group	Difference
Before	0.123	0.096	0.027
	(0.55)	(0.040)	(0.068)
After	0.289	0.009	0.280***
	(0.068)	(0.060)	(0.090)
Difference	0.166	0.087	0.253**
			(0.113)
observations	2,142	2,142	2,142

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. ** represent significant level at 5%

The table 2.9 shows the results of Different-in-Differences estimated by pooled OLS of the effect on the number of households using tractors without control variables. The result shows that the coefficient of interest is 0.032 with a positive sign but statistically insignificant. The result suggests that the number of households using tractors does not increase in spite of their village having the road access, and the result is in line with the hypothesis.

Table 2.9 Difference-in-Difference estimation of the effect on the number of households using tractors

	Treatment Group	Control Group	Difference
Before	0.075	0.096	-0.021
	(0.028)	(0.020)	(0.035)
After	0.202	0.191	0.011
	(0.035)	(0.031)	(0.046)
Difference	0.128	0.096	0.032
			(0.058)
observations	2,142	2,142	2,142

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.

The table 2.10 shows the results of Different-in-Differences estimated by pooled OLS of the effect on the number of households using fertilizer without control variables. The result indicates that the coefficient of interest is 0.222 with a positive sign and strongly statistically significant. It means that the number of households using fertilizer in village with road access may increase around 22.2% compared to the one without road access.

Table 2.10 Difference-in-Difference estimation of the effect on households using fertilizer

	Treatment Group	Control Group	Difference
Before	0.119	0.107	0.012
	(0.032)	(0.023)	(0.39)
After	0.461	0.226	0.235***
	(0.039)	(0.034)	(0.052)
Difference	0.341	0.119	0.222***
			(0.065)
observations	2,142	2,142	2,142

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1%

The table 2.11 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total income with some control variables. The result indicates that the coefficient of interest is 0.149 with a positive sign and statistically significant. The result is also in consistence with previous result. However, the size of effect is smaller. This result confirms that the villages with road access may increase their total income around 14.9% compared to the ones without road access. The result also supports the hypothesis.

Other control variables like age of the head of household, household size, the number of households using tractors and fertilizer also show positive effect with statistical significance. These result also in line with the previous results especially the number of households using tractors and fertilizer. Conversely, in spite of their positive sign the control variables such as the gender and the education of the head of household, the villages with electricity access and the villages with financial institution are statistically insignificant.

Table 2.11: Difference-in-Difference estimated by pooled OLS of the effect on log of total income with some control variables

Independent Variable	Single Pooled OLS	Multiple Pooled OLS	Panel Fixed Effect
after	0.641	0.641	0.117
treatment	0.025	0.025	0.101
treatafter	***0.898***	***0.149****	***0.067***
hhage		***0.013*****	***0.004***
hhsex		0.069	0.235
hheduc		0.081	0.054
hhsize		***0.030****	***0.014***
tractor		***0.457*****	***0.117***
fertilizer		***0.654*****	***0.11***
electric		0.049	0.097
financial		0.292	0.187
constant		***13.388*****	***0.302***
No. of observations			2,142
R-squared			0.335
Adj R-squared			0.324
Prob > F			0.000

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1% and ** represent significant level at 5%

The table 2.12 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total rice product with some control variables. The result indicates

that the coefficient of interest is 0.302 with a positive sign and statistically significant. The result is also consistent with previous result and almost the same size of effect. This result confirms that the villages with road access may increase their total rice product around 30% compared to the ones lacking road access.

The control variables, for example age of head of household, household size, the number of household using tractors and fertilizer, and the village with financial institution also show positive effect with statistical significance. Conversely, control variables such as the gender and the education of the head of household, the villages with electricity access present positive sign but having no statistical significance.

Table 2.12: Difference-in-Difference estimated by pooled OLS of the effect on log of total rice production with some control variables

Independent Variable	Coefficient	SE
after	0.157	0.081
treatment	-0.089	0.070
treatafter	***0.302 ******	***0.115***
hhage	***0.012*****	***0.002***
hhsex	0.07	0.162
hheduc	0.035	0.038
hhsize	***0.072*****	***0.010***
tractor	***0.343*****	***0.081***
fertilizer	***0.381*****	***0.076***
electric	0.047	0.067
financial	***0.445*****	***0.129***
constant	6.27	0.209
No. of observations		2,142
R-squared		0.268
Adjusted R-squared		0.255
Prob > F		0.000

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1%

2.4.2 Results of Different-in-Differences in village level

The table 2.13 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of rice farm income without control variables in the village level. The result indicates that the coefficient of interest is 0.366 with a positive sign but statistically insignificant.

Table 2.13 Difference-in-Difference estimation of the effect on log of rice farm income

	Treatment Group	Control Group	Difference
Before	14.251	14.462	-0.211
	(0.264)	(0.246)	(0.158)
After	15.256	15.101	0.154
	(0.281)	(0.172)	(0.108)
Difference	1.005	0.639	0.365
			(0.299)
observations	238	238	238

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1%

The table 2.14 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total income without control variables. The result indicates that the coefficient of interest is 0.343 with a positive sign but statistically insignificant.

Table 2.14 Difference-in-Difference estimation of the effect on log of total income

	Treatment Group	Control Group	Difference
Before	14.410	14.329	0.0080
	(0.386)	(0.161)	(0.307)
After	15.368	14.944	0.424
	(0.405)	(0.492)	(0.427)
Difference	0.958	0.615	0.343

			(0.582)
observations	238	2238	238

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.** represent significant level at 5%

The table 2.15 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total rice production without control variables. The result indicates that the coefficient of interest is 0.298 with a positive sign but statistically insignificant.

Table 2.15 Difference-in-Difference estimation of the effect on log of total rice production

	Treatment Group	**Control Group**	**Difference**
Before	7.413	7.591	-0.178
	(8.162)	(7.844)	(0.136)
After	7.790	7.671	0.119
	(9.076)	(8.067)	(0.190)
Difference	0.378	0.080	0.298
			(0.259)
observations	238	238	238

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. ** represent significant level at 5%

The table 2.16 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log cultivated areas without control variables. The result indicates that the coefficient of interest is 0.05 with a positive sign but statistically insignificant.

Table 2.16 Difference-in-Difference estimation of the effect on log of cultivated areas

	Treatment Group	Control Group	Difference
Before	0.130	0.125	0.005
	(0.155)	(0.140)	(0.110)
After	0.130	0.075	0.055
	(0.168)	(0.160)	(0.154)
Difference	0.000	-0.050	0.050
			(0.209)
observations	238	238	238

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. ** represent significant level at 5%

The table 2.17 shows the results of Different-in-Differences estimated by pooled OLS of the effect on the number of households using tractors without control variables. The result shows that the coefficient of interest is -0.057 with a negative sign and statistically insignificant. The result is not in line with the results from household level

Table 2.17 Difference-in-Difference estimation of the effect on the number of households using tractors

	Treatment Group	Control Group	Difference
Before	0.080	0.113	-0.033
	(0.128)	(0.220)	(0.074)
After	0.144	0.234	-0.090
	(0.235)	(0.331)	(0.103)
Difference	0.064	0.121	-0.057
			(0.140)
observations	238	238	238

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.

The table 2.18 shows the results of Different-in-Differences estimated by pooled OLS of the effect on the number of households using fertilizer without control variables. The result indicates that the coefficient of interest is 0.256 with a positive sign and weakly statistically significant. It means that the number of households using fertilizer in village with road access may increase around 25.6% compared to the one without road access.

Table 2.18 Difference-in-Difference estimation of the effect on households using fertilizer

	Treatment Group	Control Group	Difference
Before	0.037	0.080	-0.044
	(0.039)	(0.093)	(0.079)
After	0.374	0.162	0.212*
	(0.339)	(0.134)	(0.110)
Difference	0.337	0.082	0.256*
			(0.150)
observations	238	238	238

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1%

The table 2.19 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total income with some control variables. The result indicates that the coefficient of interest is 0.548 with a positive sign but statistically insignificant. Other control variables like age of the head of household, household size, and fertilizer also show positive effect with statistical insignificance, excluding the number of households using tractors that has positive impact on total income.

Table 2.19: Difference-in-Difference estimated by pooled OLS of the effect on log of total income with some control variables

Independent Variable	Single Pooled OLS	Multiple Pooled OLS	Panel Fixed Effect
after	0.614*	0.498	0.233
treatment	0.080	0.038	0.138
treatafter	***0.343***	***0.548***	0.840
hhage		0.006	0.008
hhsex		0.881	0.193
hheduc		0.265	0.100
hhsize		-0.083	0.087
tractor		***0.987****	***1.046****
fertilizer		0.599	0.618
electric		0.171	0.179
financial		0.677	0.668
constant	***14.329*****	***14.033*****	***14.108*****
No. of observations			238
R-squared			0.073
Adj R-squared			0.048
Prob > F			0.000

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1% and ** represent significant level at 5%

2.5 Conclusion

2.5.1 Conclusion

Previous chapter shows an important linkage between road connection and income of rural people. With the above analysis, we can observe that the investment in road has significantly contributed to the increase of household rice production, cultivated areas and total income, thus improving household living standard, and reducing poverty. However, in order to reap the full benefit of road access, the rural population will have to be aware of what they can gain from such infrastructure, seizing the opportunity to increase their agriculture production in hope to increase their income, thus alleviating the poverty. At the same time, other issues such as the provision of agriculture extension works including agriculture market information will have to be addressed and incorporated into the national strategy.

In summary, the results estimated from difference-in-differences of all outcome variables with or without some control variable show statistic insignificant. This may be caused by the household representative from each village is quite small. Therefore, in the village level we cannot see clearly what the impact of road access.

2.5.2 Policy Implication

It is important to realize that infrastructure development, particularly rural road or village connecting road can play a significant role in the country poverty alleviation. The pro-poor development strategy is regarded as a nation priority as the country sets its strategy to reduce the poverty by 2015 and graduate the country from the list of the least developed countries by 2020. Thus, the rural road development should be an integral part of the national road sector development strategy and to be addressed accordingly and appropriately vis-a-vis the actual situation. The recommendation in connection with the issue of the development of rural road to curve the poverty in Laos is, in spite of the constrain of budget allocated for

other national social and economic development, to incorporate the connecting rural road plan into the national development strategy to allow the rural communities with no connecting roads to have easy access to the main infrastructure and to be mainstreamed into the country economy to improve their daily activities and their livelihood.

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Chapter 3

Impact of Irrigation Investment on Poverty alleviation in Rural Laos

3.1 Introduction

Water demand is continue to increase, particularly in agricultural and environmental sections. For this reason, it will create more competition for the limited and scarce water resources. Therefore, choosing an appropriate approach to manage water resources in distributing and allocating to attain sustainable agriculture is critical role for every country worldwide. The most well known tool to preserve or to store water is irrigation. In addition, it is one of the prime factors for agricultural development. Consequently, development of irrigation is vital for a country where the majority population dependents on agricultural production.

Agriculture plays a dominant role in the Lao economy since it contributed about 60 percent of gross domestic products, and employed 85 percent of the workforce, especially rural people (Yves Bourdet, 2000). Access to reliable irrigation can enable farmers to adopt new technologies and intensify cultivation which lead to increase productivity, overall higher production. This, in turn, opens up new employment opportunities both on-farm and off-farm. As a result this will incase household's incomes and then get better quality of life in rural areas. Overall, irrigation can have a significant income generating function in agriculture specifically. The government of Laos recognizes that without an essential of irrigation infrastructure it is impossible to bring the country of out poverty in 2015 and break away from the least-developed country status in 2020. For that reason, there is heavy public investment in basic infrastructures, particularly irrigation nationwide.

The objective of this research is to answer the question that is "what is the impact of infrastructural investments in irrigation on rural household income and poverty alleviation in rural Laos", more precisely what are mechanisms to influence rural household income? Finding of this study can contribute to evaluations of the impact of infrastructure investments, particularly irrigation on poverty alleviation by bringing new empirical evidence and its result can be one source of information for policy maker in making an appropriate policy for poverty eradication in the future.

3.2 Overview of Irrigation Schemes in Laos and Literature Reviews

3.2.1 Overview of Irrigation Schemes in Laos

Irrigation can be defined as the technologies used to convey water from a river or water source to fields in order to increase crop productivity. Irrigation consists of both the hardware (the weir, the canals, water sources and land) and the software (the behavior of farmers in relation to the planning, operation and management of the scheme). Understanding the latter case is the most complex and time consuming part. It is, however, of the utmost importance in any irrigation initiative. According to the irrigation law provides that the scales of Irrigation in Laos are classified into four levels as below:

1. Community Irrigation: This scale is normally less the 10 ha and owned or managed by water users group, for example families or village organizations and sharing responsibility.

2. Small scale Irrigation: This scale is under District Agriculture and Forestry Office (DAFO), but it is often managed and used by families, groups of people, or water users associations. Typically its size is bigger that 10 ha but less than 100 ha.

3. Medium scale Irrigation: This scale is under Provincial Agriculture and Forestry Office (PAFO), but it is managed and used by a cooperative, water users groups or water users association, and its size is bigger that 100 ha but less than 500 ha.

4. Large scale Irrigation: Large scale irrigation is bigger than 1,000 ha. It is under the Ministry of Agriculture and Forestry (MAF), used and managed by a cooperative, water users group or water users association

Table 3.1: Irrigation classification in Laos

Community Irrigation	Small Scale	Medium Scale	Large Scale
<10 ha	10 - 100 ha	100 – 500 ha	>1,000 ha

Source: The Department of Irrigation (DOI), MAF, 2012

The number of irrigation schemes has continued to increase from 24,695 in 2004 to 33,836 by the end of 2012. Irrigated crop areas during the dry season increased from 148,456 hectare in 2004 to 215,000 hectare in 2012, while the irrigated area during the rainy season decreased from 315,000 hectare in 2004 to 260,820 hectare

Table 3.2: Numbers and Areas of Irrigation Schemes by types in Dry and Rainy Season

Project Type	Dry season		Rainy season	
	No. of project	Areas (ha)	No. of project	Areas (ha)
Weir	1,367	32,741	1,981	69,922
Reservoirs	300	17,372	381	32,574
Pump schemes	2,800	78,152	9,574	85,147
Dikes& gates	187	4,776	321	11,527
Gabions	125	1,064	290	4,694
Temporary weir	5,940	14,351	10,570	56,956
Total	10,719	148,456	23,117	260,820

Source: The Department of Irrigation (DOI), MAF, 2012

3.2.2 Review of relevant theories

To ensure the increase of agro productivity namely in the sector of agriculture, animal rearing, fish raising, tree growing and others, inclusive of food provision and commercialized production, it calls for a strong infrastructure, mainly the electricity network and irrigation system to insure the success of production process. Thus, the construction of irrigation is considered a national urgent task because the water represents the vitality of the living and production. Whenever the water is utilized to increase agriculture production is called irrigation, and in turn, many of them constitute an irrigation system (Pholavane, 2012). In terms of economic (Monetary Dimension), the poverty is seen as an individual income insufficient to live up to the standard of living or an income that is below the minimum requirement acceptable within the society he or she lives in. When the definition of poverty is based on the disposal income as mentioned, the tool used to assess poverty is the household income or expense. Furthermore, the solution to such issue is to focus on the household income by improving and increasing the efficiency of the utilization of the production components, production process and service by the poor. The improvement of the market condition to provide facilities to the have-not inclusive of support in various forms, e.g., allowance and others. We can assess the poverty with two different approaches. One is the "absolute poverty", which is the assessment of the basic need of a household to survive to be translated into money known as "Poverty line" to be compared with the household income. Another approach is the "Relative line". This method draws comparison between a household standard of living and average standard, i.e., the inequality in terms of income "income inequality" (Somsay, 2002).

Agriculture is a source of food and virtually a prime resource for one's living in every country in the world, particularly for the developing countries, the population growth rate of which stands at 3 % annually. At this rate, the population figure can double in 25-year

time. When the population growth rate increases, so does the demand for food supply. Additionally, agriculture can be considered as a capital saving, which means that an agriculturally self-sufficient country imports less, thus, the national saving is expected to be high, resulting in having a large pool of capital to promote industrial and service sector and others. At the same time, the agriculture sector is a source supplying labor to others. A number of economists such as A. Lewis and Ranis Fei came up with the idea of the role of agriculture labor in the industrial development. They stated that there existed a large pool of labor or manpower in the agriculture sector and could be moved around to other sectors without much effect to itself. In turn, the industry sector would benefit of cheap labor, thus reducing the production cost and generating higher profit. On top of this, agriculture is seen as the source of hard currency because the export products of the developing countries are mostly agriculture ones. It also creates market for industrial products because these developing countries are in need to import the industrial equipment and machineries, tools, modernized farm equipment and others to increase the production efficiency (Bounteng and Bounlert, 2004).

The objective of socio-economic development is the promotion and the eradication of poverty and provision of the four basic necessities of live: food, clothing, shelter, and medicine. To successfully obtain such necessities, the households have to be allowed to live their life to the fullest and to be involved in the community, thus having chance to participate in socio-economic, cultural, and political activities and become households of economic mainstream. What follows is the effect on their life and their country. Lao socio-economic development focuses on agriculture and animal rearing, the products of which are to be related to the industrial growth and service; tourism and the country's corridor position are to be used to spearhead investment in building the infrastructure and various activities to jump start and speed up the economic development sustainably. There is a need to focus on food

production, strengthening the production foundation, encouraging a more systematic way of animal rearing, providing seedling and baby animals, information, disseminating information, training, and advising scientific technique to increase the efficacy and sustainability to boost the food production to meet the demand by advocating the growing of high protein plants, vegetables, fruit trees, industrial plants, advancing the animal rearing commercialization. Moreover, a special financial preference is to be given to this sector inclusive of long-term and low-rate loan for investment to provide a secure foundation for food production, and the emphasis on the commercialization, which is to be in line with the eradication of shifting cultivation and provision of permanent employment to the farm population. Thus, the State and the Party has urged for commercialization to gradually increase individual household income to help with the poverty alleviation. The focus is on agricultural products to substitute imported goods, and to be made available for consumption and sold locally on the market. There is also emphasis on producing goods to be consumed domestically, particularly the commercialization of industrial unit and crafts to reduce the import goods and to generate more employments for the minority population, thus resulting in their gradual improvement of living standard.

3.2.3 Reviews of relevant studied

According to Maadhusydan et al (2003), the study of the irrigation construction set out to examine the impact on reduction of rural poverty in India. The studied applied Panel data from the year 1970 to 1993 in 14 different states of India. The study result revealed that the construction of irrigation system has no effect on the alleviation of poverty. Majorities of farmers used fertilizer into the production in areas with the absence of irrigation water, besides; more rain water has been commonly used in lieu of that from irrigation.

The study of irrigation construction by Intiza et al. (2003) was carried out to examine the irrigation effect on the reduction of poverty in South Asia and South East Asia. The study

included Vietnam (1996), Thailand (1998), Philippines (1997), India (1996), Sri Lanka (2000), and Pakistan (2000). The study in the form of descriptive analysis suggested that household using irrigation water could increase production, additionally, its production volume increased much more than that of a household using no irrigation water. Thus, such increase is considered as one of the factors contributing to alleviating poverty.

Michael et.al. (2003) was undertaken to examine the irrigation effect on alleviation of poverty in India. The study, descriptive and qualitative analysis in form, attempted to find out the irrigation effect on the environment due to building dam, resulting in contributing to the economic growth, which was less than that of the irrigation in 1970's. The study indicated that the irrigation system represented a vital component in the agriculture production in a major effort to alleviate poverty.

The study into irrigation impact on income, poverty, and distribution of income in rural regions of China was carried out by using the information gathered in rural areas in 2000 according to Huang et al. (2005). The result was in the form of descriptive analysis to explain the relationship between irrigation and income, and between irrigation and poverty. "Decomposed" was used as the source of income and the people with access to irrigation and those deprived of itin the study of irrigation effect on income distribution and inequality. The study demonstrated that the irrigation had a direct importance on income and poverty and contributed to redressing inequality as well.

The objective of the study (Bose, 2007) is to assess the outcome of government spending with effect on economic growth of some 30 developing countries between the period of 1970-1980 with the usage of "Endogeneity test" and three stage least squares (3SLS). The study result indicated that there was some significant difference in government spending between developed and developing countries. However, the outcome revealed that the government spending on transportation, communication, and defense were of less

important in comparison with that on education as regards the long-term economic growth in the developing countries.

3.3 Methodology and Data Collection

3.3.1 Data Collection

The research will mainly utilize data from National Statistic Center (NSC) of Laos. It was the Lao Expenditure and Consumption Survey (LECS) which is the largest and most important survey that undertaken in Laos. It is not only large in sample size, it also covers a wide range of subject matter areas related to household living situation, consumption, incomes, own production in agriculture and household related business, construction, access to services, social indicators, food or rice intake, and so on. Until now there are five LECS were carried out, started from 1992/1993, but the last one is still now in the period of data entry. This study used only LECS 3 (2003) and LECS4 (2008) because the data in LECS 1 and LECS 2 are not in line with this study. There are 540 villages and 518 villages in LECS3and LECS4, respectively.

In the village level, there are 506 villages were matched in both waves and 441 villages without irrigation scheme in LECS3 were matched with LECS4. As a result, 91 villages which have irrigation scheme are considered as treatment group and the rest 350 villages are used as comparison group.

Table 3.3: Sample size

Item	Treatment Groups		Control Groups	
	No. Villages	No. Household	No. Villages	No. Household
LECS 3	91	500	350	1,494
LECS 4	91	235	350	766
Total	182	735	700	2,260

Source: Authors' computations

3.3.2 Research Methodology

The current study tries to use a suitable comparator, which defined as comparison of various outcomes before and after road project, comparison with or without projects. Difference-in Differences (DD) method will be used in this analysis and the main assumption for this method is: without intervention, the change in values of the outcomes between treatment and control groups should be comparable. Here below is Difference-in Differences in Econometric Model:

$$\mathbf{Y_{it} = \beta_0 + \beta_1\, after_t + \beta_2 treat_i + \delta_1 treat_i * after_t + \beta_3 X_{it} + u_{it}}$$

Y_{it}indicate the outcome of interest such as rice farm income, non-farm income and total income, total rice product, yield, cultivated areas of household *i* in year *t*.

After = 1 after treatment (2008), and 0 before treatment (2003)

Treat = 1 if in treatment group, and 0 if in control group

$X_{it}$is a vector which captures household and village characteristics such as age of head of household, family size, and so on

$u_{it}$is an error representing unobserved factors that affect Y_{it}

The coefficient of interest is on the interaction term, δ_1. This gives us the difference-in-differences estimator of the treatment effect.

- **Hypotheses**

This paper will test the hypothesis by each outcome variables which is considered as the main variable influencing rural household income such as income from farm, non-farm income and other factors that could be a source of income like rice product, yield or cultivated areas and so forth.

The hypotheses to be tested are investment in irrigation infrastructure has significant impact on rice farm income, non-farm income and total income. Other hypotheses which will be tested in this chapter, is that investment in irrigation infrastructure has significant impact on

rice production, yield and cultivated areas. To test these hypothesis the null hypotheses that are investment in irrigation infrastructure has no significant impact on rice production, yield and cultivated areas.

3.4 Results and discussion

3.4.1 Results from Difference-in-Differences estimation in household level

Difference-in-Differences methodology is used to obtain all results in this section by running equation (1). To confirm that Difference-in-Differences method meet its main assumption mentioned in the methodology part. This section begins with the baseline of road project survey in 2003.

The table 3.4 shows mean of outcome variables in the baseline survey for a group of villages that do have irrigation project (treatment group) and a group of villages that do not have irrigation project (control group). All outcome variables in treatment group and control group are slightly different. However, they are not statistically significant, with the exception of number of household using tractor and number of household using fertilizer; this indicates that in general there is no statistically significant difference in the mean of outcome variables between treatment and control group in the baseline survey or without intervention of road project the mean of outcome variables in both group are comparable which supports the main assumption of the Different-in-Differences method.

Table 3.4: Comparison Mean of outcome variables in the baseline survey (2003)

Outcome variables	Treatment group	Control group
Expenditure (KIP)	1,563,000	1,633,050
Total product (ton)	3415.79	3708.23
Productivity (ton/ha)	3152.20	3521.37
Cultivated areas (ha)	1.64	1.32
HH using tractor	0.31	0.22***
HH using fertilizer	0.36	0.29***

Source: Reproduced by the Author; . *** represent significant level at 1%

The table 3.5 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of rice farm income without control variables. The result in table 3.5 indicates that the coefficient of interest is 0.019 with a positive sign but statistically insignificant. This empirical result illustrates that village with irrigation project may not have any impact on rice farm income. In other word, there is no different in rice farm income between villages with and without irrigation project. The result is inconsistent with the hypothesis.

Table 3.5 Difference-in-Difference estimation of the effect on log of rice farm income

	Treatment Group	**Control Group**	**Difference**
Before	14.646	14.544	0.101
After	15.455	15.335	0.120
Difference	-0.810	-0.791	0.019 (0.076)
observations	3,013	3,013	3,013

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.

The table 3.6 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of non-farm income without control variables. The result indicates that the coefficient of interest is 0.056 with a positive sign but statistically insignificant. This empirical result illustrates that village with irrigation project may not have any impact on log non-farm income. In other word, there is no different in non-farm income between villages with and without irrigation project. The result is inconsistent with the hypothesis.

Table 3.6 Difference-in-Difference estimation of the effect on log of non-farm income

	Treatment Group	Control Group	Difference
Before	12.647	12.585	0.062
After	13.189	13.071	0.118
Difference	-0.541	-0.485	0.056 (0.134)
observations	3,013	3,013	3,013

Note: before=2003, after=2008; the numbers within the parentheses are standard errors

The table 3.7 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total income without control variables. The result indicates that the coefficient of interest is 0.034 with a positive sign but statistically insignificant. This empirical result illustrates that village with irrigation project may not have any impact on log total income. In other word, there is no different in total income between villages with and without irrigation project. The result is inconsistent with the hypothesis.

Table 3.7: Difference-in-Difference estimation of the effect on log of total income

	Treatment Group	Control Group	Difference
Before	14.916	14.826	0.090
After	15.668	15.545	0.123
Difference	-0.752	-0.719	0.034 (0.071)
observations	3,013	3,013	3,013

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.

The table 3.8 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total rice product without control variables. The result indicates that the coefficient of interest is 0.003 with a positive sign but statistically insignificant. This empirical result illustrates that village with irrigation project may not have any impact on log total rice product. In other word, there is no different in total rice product between villages with and without irrigation project. The result is inconsistent with the hypothesis.

Table 3.8: Difference-in-Difference estimation of the effect on log of total rice production

	Treatment Group	**Control Group**	**Difference**
Before	7.763	7.630	0.134
After	7.900	7.764	0.136
Difference	-0.137	-0.134	0.003 (0.070)
observations	3,013	3,013	3,013

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.

The table 3.9 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of yield without control variables. The result shows that the coefficient of interest is -0.076 with a negative sign and statistically insignificant. This empirical result illustrates that village with irrigation project may not have any impact on log yield. In other word, there is no different in total rice product between villages with and without irrigation project or villages with irrigation project may have less productivity as it has a negative. The result is inconsistent with the hypothesis.

Table 3.9: Difference-in-Difference estimation of the effect on log of yield

	Treatment Group	Control Group	Difference
Before	7.747	7.510	0.236
After	7.765	7.604	0.16
Difference	-0.018	-0.094	-0.076 (0.047)
observations	3,013	3,013	3,013

Note: before=2003, after=2008; the numbers within the parentheses are standard errors

The table 3.10 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of cultivated areas without control variables. The result indicates that the coefficient of interest is 0.079 with a positive sign but statistically insignificant. This empirical result illustrates that village with irrigation project may not have any impact on log cultivated areas. In other word, there is no different in total rice product between villages with and without irrigation project. The result is inconsistent with the hypothesis.

Table 3.10: Difference-in-Difference estimation of the effect on log of cultivated areas

	Treatment Group	Control Group	Difference
Before	0.017	0.012	-0.103
After	0.135	0.159	-0.024
Difference	-0.118	0.040	0.079 (0.067)
observations	3,013	3,013	3,013

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. ** represent significant level at 5%

The table 3.11 shows the results of Different-in-Differences estimated by pooled OLS of the effect on number's household using tractor without control variables. The result in table 11 indicates that the coefficient of interest is -0.086 with a negative sign but statistically significant. This empirical result illustrates that village with irrigation project may decrease the on number's household using tractor. The result is inconsistent with the hypothesis.

Table 3.11: Difference-in-Difference estimation of the effect on number's household using tractor

	Treatment Group	Control Group	Difference
Before	0.0312	0.220	0.092
After	0.387	0.381	0.006
Difference	-0.075	-0.161	-0.086** (0.039)
observations	3,013	3,013	3,013

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. ** represent significant level at 5%

The table 3.12 shows the results of Different-in-Differences estimated by pooled OLS of the effect on the number of household using fertilizer without control variables. The result indicates that the coefficient of interest is -0.041 with a negative sign and statistically insignificant. This empirical result illustrates that village with irrigation project may not have any impact on number of household using fertilizer. In other word, there is no different in using fertilizer between villages with and without irrigation project. The result is inconsistent with the hypothesis.

Table 3.12: Difference-in-Difference estimation of the effect on household's using fertilizer

	Treatment Group	Control Group	Difference
Before	0.360	0.294	0.066
After	0.427	0.402	0.025
Difference	-0.067	-0.108	-0.041 (0.042)
observations	3,013	3,013	3,013

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.

The table 3.13 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total income with some control variables. The result indicates that the coefficient of interest is 0.129 with a positive sign and statistically significant. The result is not consistent with previous result. This result confirms that the village with irrigation project may increase their total income around 12.9% compare to village without irrigation project. The result is also support the hypothesis.

Other control variables like age of head of household, education of head of household, household size, the number of household using tractor and fertilizer, the village with electricity access and also the village with financial institution are also show positive effect with statistically significant. Conversely, control variables such as the gender of head of household present positive sign but they are not statistically significant.

Table 3.13: Difference-in-Difference estimated by pooled OLS of the effect on log of total income with some control variables

Independent Variable	Coefficient	SE
after	0.657***	0.039
treatment	-0.035	0.038
treatafter	***0.129****	***0.064***
hhage	***0.005*****	***0.001***
hhsex	-0.054	0.235
hheduc	**0.032****	**0.016**
hhsize	***0.030****	***0.006***
tractor	***0.510*****	***0.030***
fertilizer	***0.383*****	***0.030***
electric	***0.072*****	***0.029***
financial	0.284***	0.053
constant	***14.061*****	***0.093***
No. of observations		3,013
R-squared		0.331
Adj R-squared		0.329
Prob> F		0.000

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1% and ** represent significant level at 5%

The table 3.14 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total rice product with some control variables. The result indicates that the coefficient of interest is 0.059 with a positive sign but statistically insignificant. The result is also consistent with previous result and almost the same size of effect.

The control variables, for example age of head of household, household size, the number of household using tractor and fertilizer, and the village with financial institution are also show positive effect with statistically significant. Conversely, control variables such as the gender of head of household, the education of head of household, the village with financial institution present positive sign but they are not statistically significant.

Table 3.14: Difference-in-Difference estimated by pooled OLS of the effect on log of total rice production with some control variables

Independent Variable	Coefficient	SE
after	0.063	0.039
treatment	0.056	0.038
treatafter	*0.059*	*0.064*
hhage	***0.006******	***0.001***
hhsex	0.015	0.235
hheduc	0.009	0.015
hhsize	***0.056******	***0.006***
tractor	***0.504******	***0.029***
fertilizer	***0.357******	***0.030***
electric	*-0.025*	*0.029*
financial	0.065	0.053
constant	***6.792***	***0.093***
No. of observations	3,013	
R-squared	0.202	
Adjusted R-squared	0.199	
Prob> F	0.000	

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1%

The estimation results obtained from above calculation, particularly the estimation from Pooled OLS with control variables show positive sign and statistically significant. However, the results from estimation show unclear results or not follow the same direction. For example, the Different-in-Differences estimated by pooled OLS of the effect on log of total income with some control variables indicates that the coefficient of interest (treatment) is 0.129 with a positive sign and statistically significant. The result confirms irrigation has an impact on household income in general or in other word the village with irrigation project may increase their total income around 12.9% compare to village without irrigation project. On the other hand, the Different-in-Differences estimated by pooled OLS of the effect on log of total rice products with some control variables point out that the coefficient of interest (treatment) is 0.059 with a positive sign but statistically insignificant. The result implies that irrigation has no impact on rice products or the irrigation does not increase rice products as our expectation, even so it increases household's income. This is somewhat strange because households' income or farmers' income of rural people, especially a country like Laos, are predominantly from rice products and about 90 percent of Lao agriculture was dominant by rice (Yves Bourdet, 2000). There are two possible explanations for this phenomenon, one is because of the inaccurate data and the other one is about management system or government policy.

For imprecise data, the current paper utilized data from LECS3 and LECS4. The data set provides information only village with or without irrigation system, but it did not give precise information, for instant type of irrigation, location of operation headquarter, and the most important thing is that the data did not us any information of how many household in the village can access irrigation system. Moreover, in LECS 3 and LECS 4, there are only 15 household was selected as sample size in each village. These factors are crucial for explaining the impact of irrigation on rice products, for example in Laos there are 5 types of

irrigation scheme; namely Weir, Reservoir, Traditional, Pump using fuel and Pump using electricity (Department of Irrigation, 2012). Each of them has its own impact on productions. For the location of operation headquarter, Phinseng (2007) stated that the down-stream zone has negative impact on rice production. Households with farmland located in the down-stream of irrigation scheme are likely to reduce the cultivated area, particularly in the dry season because of insufficient irrigated water. In the opposite way, rice cultivating is relatively high in middle-stream or up-stream zones. This can be one explanation in this study.

For management system or government policy, this related to management system and site selection problem. Based on the Irrigation Diagnostic Study of Department of Irrigation, Ministry of Agriculture and Forestry (2008) point out that irrigation schemes are not well maintained and water user organization is very weak. Moreover, operations costs such as electricity are not paid in full by the majority of users resulting in large debts nationally to Electricity Department. Scheme infrastructure depreciates rapidly with the lack of maintenance and repair resulting in investment intensive rehabilitation cycles of usually less than 10 years and un-sustainability. In irrigation management transfer theory, the site selection must be community demand driven. In the case of Laos, however, it based upon a top down process push by donors or top down driven supply (2008) that creates some problems. Furthermore, many site selections are very near city and have no specific boundary. As a result, when population growth, agricultural areas were used in different purposes.

Above explanations could be the answers of the question that why irrigation has not impact on rice production or not increase rice products but increase household income in general. However, to confirm the results above is reasonable. The author used village level data to analysis the effect of irrigation

3.4.2 Results from Difference-in-Differences estimation in village level

. The table 3.15 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of rice farm income without control variables in the village level. The result indicates that the coefficient of interest is -0.018 with a negative sign but statistically insignificant.

Table 3.15 Difference-in-Difference estimation of the effect on log of rice farm income

	Treatment Group	Control Group	Difference
Before	14.669	14.515	0.154
	(8.264)	(9.246)	(0.168)
After	15.996	15.860	0.135
	(8.281)	(8.172)	(0.108)
Difference	0.327	0.345	-0.018
			(0.191)
observations	882	882	8821

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1%

The table 2.16 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total income without control variables. The result indicates that the coefficient of interest is 0.017 with a positive sign but statistically insignificant.

Table 2.16 Difference-in-Difference estimation of the effect on log of total income

	Treatment Group	Control Group	Difference
Before	14.960	14.852	0.108
	(8.386)	(9.161)	(0.155)
After	15.228	15.102	0.125
	(9.405)	(9.492)	(0.087)
Difference	0.268	0.250	0.017
			(0.176)
Observations	882	882	882

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.** represent significant level at 5%

The table 2.17 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total rice production without control variables. The result indicates that the coefficient of interest is 0.094 with a positive sign and statistically significant.

Table 2.17 Difference-in-Difference estimation of the effect on log of total rice production

	Treatment Group	Control Group	Difference
Before	7.701	7.631	0.070
	(8.162)	(7.844)	(0.138)
After	7.803	7.639	0.164**
	(3.076)	(3.067)	(0.074)
Difference	0.102	0.008	0.094**
			(0.049)
observations	882	882	882

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. ** represent significant level at 5%

The table 2.18 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log cultivated areas without control variables. The result indicates that the coefficient of interest is 0.231with a positive sign but statistically insignificant.

Table 2.18 Difference-in-Difference estimation of the effect on log of cultivated areas

	Treatment Group	Control Group	Difference
Before	-0.144	0.137	-0.281**
	(0.055)	(0.014)	(0.127)
After	0.054	0.104	-0.050
	(0.168)	(0.160)	(0.068)
Difference	0.198	-0.033	0.231
			(0.144)

observations	882	882	882

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. ** represent significant level at 5%

The table 2.19 shows the results of Different-in-Differences estimated by pooled OLS of the effect on the number of households using tractors without control variables. The result shows that the coefficient of interest is 0.049 with a negative sign and statistically insignificant. The result is not in line with the results from household level

Table 2.19 Difference-in-Difference estimation of the effect on the number of households using tractors

	Treatment Group	Control Group	Difference
Before	0.215	0.200	0.015
	(0.128)	(0.220)	(0.072)
After	0.328	0.264	0.064
	(0.235)	(0.331)	(0.039)
Difference	0.064	0.121	0.049
			(0.082)
observations	882	882	882

Note: before=2003, after=2008; the numbers within the parentheses are standard errors.

The table 2.20 shows the results of Different-in-Differences estimated by pooled OLS of the effect on the number of households using fertilizer without control variables. The result indicates that the coefficient of interest is -0.089 with a positive sign and weakly statistically significant.

Table 2.20 Difference-in-Difference estimation of the effect on households using fertilizer

	Treatment Group	Control Group	Difference
Before	0.331	0.161	0.169
	(0.239)	(0.093)	(0.093)
After	0.379	0.299	0.080
	(0.339)	(0.134)	(0.050)
Difference	0.048	0.138	-0.089
			(0.106)
observations	238	238	238

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1%

The table 2.21 shows the results of Different-in-Differences estimated by pooled OLS of the effect on log of total income with some control variables. The result indicates that the coefficient of interest is -0.019 with a negative sign and statistically insignificant. Almost all control variables like age of the head of household, household size, and fertilizer also show positive effect with statistical insignificance, the number of households using tractors that has positive impact on total income with highly statistic significant.

Table 2.21 Difference-in-Difference estimated by pooled OLS of the effect on log of total income with some control variables

Independent Variable	Single Pooled OLS	Multiple Pooled OLS	Panel Fixed Effect
after	0.248	0.075	0.0723

treatment	0.103	0.025	0.033
treatafter	***0.024***	***-0.019***	-0.025
hhage		0.002	0.002
hhsex		0.128	0.133
hheduc		***0.097****	***0.099****
hhsize		***0.037****	***0.036*****
tractor		***0.767*****	***0.746*****
fertilizer		***0.462*****	***0.466*****
electric		***0.160*****	***0.162*****
financial		***0.248****	***0.247****
constant	***14.853*****	***14.180*****	***14.108*****
No. of observations			882
R-squared			0.324
Adj R-squared			0.320
Prob > F			0.000

Note: before=2003, after=2008; the numbers within the parentheses are standard errors. *** represent significant level at 1% and ** represent significant level at 5%

3.5 Conclusion

This chapter wants to find out the impact of irrigation on farmers' income, especially the income from rice which is the main crop of rural people in Laos. The estimation results obtained from above calculation, particularly the estimation from Pooled OLS with control variables show positive sign and statistically significant. However, the results from estimation show unclear results or not follow the same direction. For example, the Different-in-Differences estimated by pooled OLS of the effect on log of total income with some control variables indicates that the coefficient of interest (treatment) is 0.129 with a positive

sign and statistically significant. The result confirms irrigation has an impact on household income in general or in other word the village with irrigation project may increase their total income around 12.9% compare to village without irrigation project. On the other hand, the Different-in-Differences estimated by pooled OLS of the effect on log of total rice products with some control variables point out that the coefficient of interest (treatment) is 0.059 with a positive sign but statistically insignificant. The result implies that irrigation has no impact on rice products or the irrigation does not increase rice products as our expectation, even so it increases household's income. This is somewhat strange because households' income or farmers' income of rural people, especially a country like Laos, are predominantly from rice products. Finding indicates that type of irrigation, location of operation headquarter, management system or government are crucial factors for explaining the impact of irrigation on rice products in Laos.

The analysis in the village level shows that irrigation has no impact on total income. However, almost all control variables present statistic significant, this implicitly tell that other factors have more influence farmer income rather than irrigation. Nevertheless, consider a future in-depth case study in irrigation projects successful versa wasteful is need to better understand how things may go wrong and what may be done to avoid wastes in public investment for irrigation in the future.

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