Essays on Labour Supply and Policy Microsimulation in a Developing Country

by

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Abstract

This thesis contains three empirical essays. It is mainly motivated by the economic situations (low economic growth and high economic inequality) of many developing countries including Thailand. Nonetheless, the labour supply literature regarding developing countries necessary to address these issues is very limited.

The first empirical chapter investigates the determinants of labour supply at the extensive margin in the formal labour market of Thailand as a developing country. This chapter applies the structural binary probit to model behaviour of labour supply participation using the Household Socio-Economic Survey (HSES) of Thailand covering 2009, 2011, 2013, and 2015. The key focuses are the role of the informal sector, the effect of income restructure policies in 2012, and the impact of debt constraints on labour force participation. The results show that the informal sector has a negative effect on labour supply participation; the set of income restructure policies affects labour supply at the extensive margin negatively; and the amount of debts encourages people to participate in the labour market.

The subsequent chapter studies individual and household labour supply using a structural discrete hours approach. This essay adopts Thailand HSES covering 2009, 2011, 2013, and 2015 to estimate different model specifications based on the degrees of model flexibility and applies five criteria to select the preferred model at individual and household level. The results suggest that the most flexible model are preferred for individual and family labour supply.

The final essay focuses on applying the microsimulation technique to explore the effects of three different policy reforms including the perfect compliance of the national minimum wage, increases in non-transferable allowances, and a proposed personal income tax package. This chapter applies Thailand HSES in 2013 and 2015. The results of the first policy suggest that the minimum wage with perfect compliance helps promote household income at the bottom end of the distribution; the policy therefore ameliorates the poverty and income inequality problems. Increases in non-transferable

allowances as implemented in 2017 marginally impact labour supply response as well as gross and disposable incomes; however, the reform decreases the tax burden significantly. The results of the final simulation (the proposed tax package) reveal that it causes negative effects on labour supply and financial factors overall. Introducing this policy intensifies poverty and income inequality problems.

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Chapter 1 Introduction

1.1 Background

Labour supply behaviour is one of the most intensive economic research areas. The number of empirical studies on labour supply has been increasing exponentially, making labour supply behaviour arguably the largest area of labour economics research in terms of the number of empirical papers in the last 30 years. The increase is because many public policies such as minimum wage, income tax, and social welfare programs impact people's decision to work (Cahuc et al., 2014).

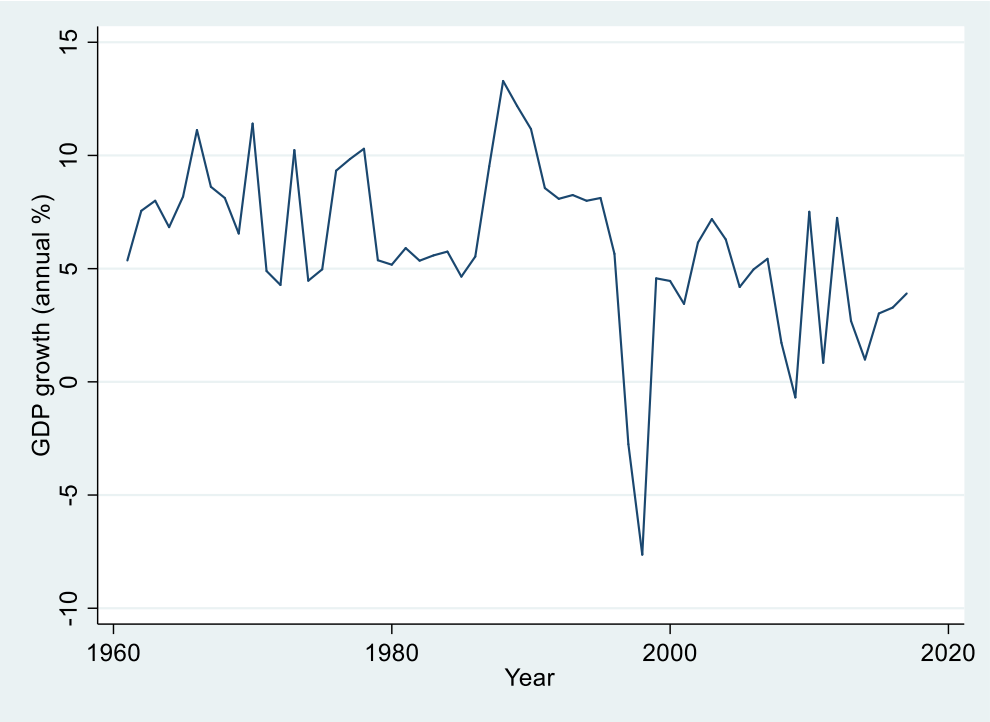
A comprehensive understanding of labour supply behaviour is therefore crucial since changes in government policies and economic contexts theoretically lead to structural changes (e.g., economic growth and income distribution) through labour supply behaviour. However, most empirical studies on labour supply focus on developed countries; knowledge related to labour supply behaviour in developing countries is limited.

This thesis examines labour supply in Thailand[1], a country in South East Asia with a population of about 66.2 million at the end of 2017 (Department of Provincial Administration, 2017), similar to the population of the United Kingdom which is 65.65 millions (Office of National Statistics, 2017). However, Thailand is more than twice as large as the United Kingdom in terms of geographical area (513,120 vs 243,305 square kilometres, respectively). As a developing country, Thailand is facing some major economic concerns which can be ameliorated with a better understanding of labour supply and policy consequences.

[1] This thesis focuses on the informal labour market. Hence, the words "labour force participation", "labour supply", and "labour market" usually refer to "activities in the formal labour market". The word "informal" is specifically used when the content refers to activities in the informal market.

The first economic concern is low economic growth which is an economic issue for many developing countries. FIGURE 1.1 shows the annual gross domestic product (GDP) growth rate of Thailand over the last 56 years.

FIGURE 1.1: Thailand's GDP annual growth rate (1961 – 2017)



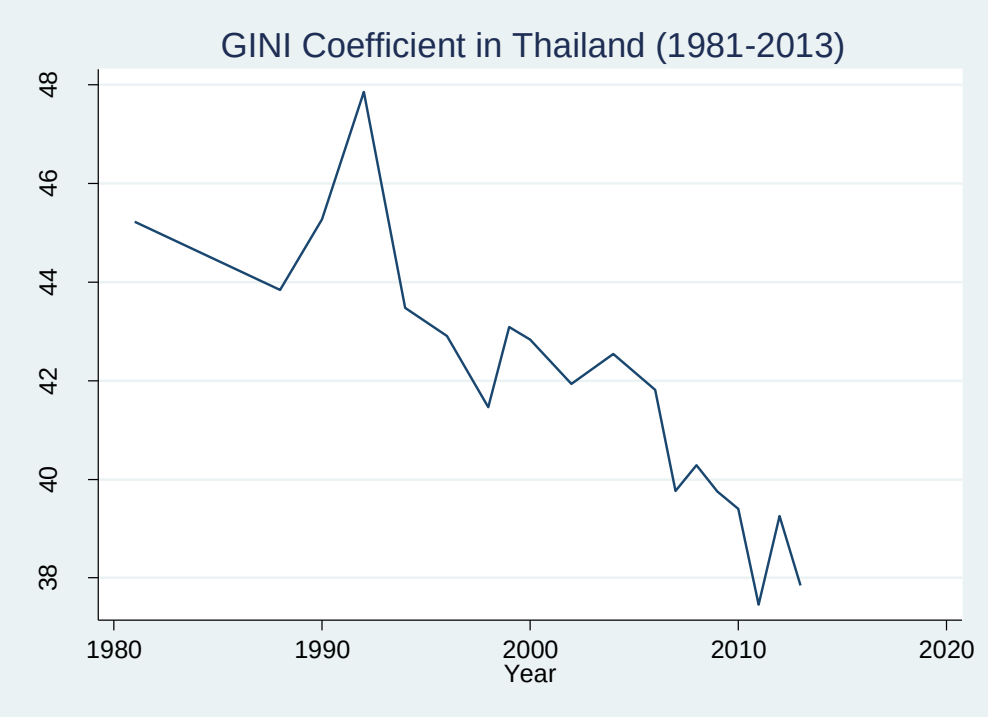
Source: Data from the World Bank

From FIGURE 1.1, it can be seen that Thailand had a high but relatively stable economic growth from 1961 to 1995. Due to the 1997 Asian financial crisis, the growth rate plunged into negative numbers in 1997 and 1998. After that the recovery in 1999, Thailand's economic growth has remained low. Between 2008 and 2017, there were only two years in which the rate of growth exceeded five percent: 2009, the year after the world economic crisis due to the collapse of the mortgage loans market in the United States; and 2012, the year after historic flooding in Thailand which caused economic damages and losses totalling approximately 1.425 trillion baht. In fact, Thailand's medium-term economic growth rate was about 7 percent during 1957 to 1991; however, since the 1997 Asian financial crisis, it has been approximately 4 percent (Jitsuchon, 2012).

Slow economic growth leads to the second concern, the middle-income trap, which was coined by Gill et al. (2007). Thailand has been mentioned as a synonym of a middle-income trap country

(Eichengreen et al., 2013). Agénor and Canuto (2015) also indicate Thailand as a typical example of many countries suffering from the middle-income trap. The middle-income trap term is usually defined by absolute and relative thresholds (Im and Rosenblatt, 2015). The absolute level of income is applied to approximate the number of years an economy takes to move from one income category to another (Felipe et al., 2012). Regarding the absolute level of income, World Bank data show that Thailand has been a lower-middle income country since 1987 (the beginning period of the available data); however, Thailand was still a middle income country in 2016 (the latest available year), however, it was in the higher-middle income sub-category. In other words, Thailand has been a middle-income country for at least 29 years. The relative threshold is defined as a number of years that a country takes to catch up to the income levels of the United States or other developed country (Lin and Rosenblatt, 2012). Im and Rosenblatt (2015) apply the relative income thresholds and concluded that Thailand would take about 50 years to reach half of the income level of the United States.

FIGURE 1.2: Thailand's Gini index from 1981 to 2013



Source: Data from the World Bank (2016)

Another economic concern is income inequality which is defined as the gap between groups of people (for example the rich and the poor) in a country. FIGURE 1.2 shows the Gini coefficient, a measure of economic inequality, for Thailand from 1981 to 2013 in percentage terms. After a gradual decrease in the 1980s, the coefficient increased and peaked at 47.9 during the final period of Asia's Economic Miracle in 1992. Since then, the coefficient has gradually declined and has fluctuated between 37.4 and 40.0 since 2009. Nevertheless, it remains just below 40.0, which is commonly taken as the threshold for high income inequality (Zhuang, 2014). To summarise, due to the economic boom from the 1990s and onwards, income inequality in Thailand has increased sharply. However, over the past 15 years, the situation has alleviated, although Thailand still remains one of the countries in Asia with the highest inequality index (Phongpaichit and Baker, 2015).

There are several important consequences resulting from income inequality. Firstly, Brueckner and Lederman (2015) assert that income inequality has a negative impact on GDP growth per capita, which implies that income inequality may have partly caused Thailand to fall into the middle-income trap. Secondly, income inequality is closely correlated with inequality in education and health leading to other social problems (Wilkinson and Pickett, 2010). Additionally, economic crises are possibly caused by a consequence of changes in income distribution (Kumhof et al., 2015). Finally, income inequality is also positively related to national and international conflicts (Cramer, 2003; Phongpaichit and Baker, 2015; Sen, 1973).

In summary, understanding labour supply behaviour is important for academics and policy makers. In fact, knowledge of labour supply behaviour helps governments of developing countries deal with serious economic issues. However, the number of empirical papers in this area is scarce. This thesis therefore aims to explore three different aspects of labour supply and policy simulation in Thailand as an example for other developing countries. The next section provides brief information about this thesis.

1.2 Objectives and overview of the thesis

1.2.1 Chapter 2 overview

Besides the economic concerns mentioned in the previous section, the first essay in Chapter 2 is also motivated by the economic contexts in Thailand. This includes a large proportion of the informal sector (i.e., agricultural sector in this study), the introduction of the income-restructuring policy package in 2012, and the increasing amount of household debt. Apart from exploring the overall behavioural of labour supply at the extensive margin, this chapter aims to investigate labour force participation of the formal labour market in a developing country by accounting for these economic circumstances.

The informal sector plays an important role in the Thai labour market. The Thai government reports that the informal sector accounts for 62.6 percent of the working labour force in 2012; in addition, the farming sector accounts for 62.5 percent of the working labour force in the informal sector[2]. Due to its unique characteristics, a large informal sector is expected to negatively affect labour force participation in the formal sector. In fact, a farming business is usually considered as a family business; hence, income from farming is usually shared among all household members, including those who are not participating in the farm and they consider shared income from farming as part of their non-wage income. A theoretical prediction and existing empirical studies indicate that an increase in non-wage income discourages labour force participation. This empirical essay incorporates a factor capturing whether any other household member besides the respondent doing farming business into the model of labour supply at the extensive margin.

In 2012, income restructuring policies in Thailand were completely launched. The government increased minimum wages by about 70 percent and salaries for undergraduate workers in the public sector by over 70 percent. The rice-pledging scheme raised rice prices by at least 50 percent. While increasing wages and salaries can encourage labour force participation in the formal labour market,

[2] The data from http://www.nso.go.th/.

rising agricultural prices can have the opposite effect. To capture the effects of the policies launched in 2012, this chapter includes a year variable which compares the years before (2009 and 2011) and after (2013 and 2015) the policies became effective[3].

Theoretical prediction and empirical evidence suggest that financial obligations encourage people to participate in the labour market. In Thailand, the household debts increased from 51.7 percent of GDP in 2007 to 81.2 percent in 2015. In 2019, the household debt to GDP ratio of Thailand is still high; it ranks in the top 10 list worldwide (as well as top 3 among Asian countries). This chapter investigates the extent to which different types of debt (housing, consumption, and education) affect labour force participation in a developing country.

The analysis uses data from the HSES in 2009, 2011, 2013, and 2015. The surveys include a large range of household sizes (from one member to twenty-three members). Households with a small number of members usually represent nuclear families whilst those with a large number indicate extended families which are common in many developing countries. This chapter applies the structural probit model to estimate labour force participation in the formal labour market for males and females separately. The selection bias due to absence of wages for non-workers is approached by a two-stage Heckman selection model.

The findings show that labour supply at the extensive margin in Thailand is overall consistent with theoretical predictions and existing literature. Regarding the informal sector, the results reveal that when a family has a farming business that is operated by another member besides the respondent, females are less likely to participate in the labour market. This is because farming income is considered as unearned household income from a respondent's perspective. The year effect, which captures the income structural policies, indicates that the policies negatively affected the labour force participation of both males and females. The results regarding debt constraints suggest that the amount of debts

[3] The results should be interpreted with caution as other events, e.g., economic growth and inflation, may be confounders.

generally has a positive effect on labour force participation of people. Different types of debt affect labour supply at the extensive margin of males and females differently.

1.2.2 Chapter 3 overview

Chapter 3 studies labour supply at the individual and family levels using structural discrete hours labour supply models. The motivation of this chapter is mainly because various governmental policies usually affect labour supply; however, the literature from developing countries is scarce. The main objective of this chapter is to estimate different discrete hours labour supply models with different degrees of model flexibility and to identify the preferred model for individual and household labour supply. Labour supply behaviour at the individual and household level can also be observed through the estimated results.

The initial dataset used in this chapter is the same as the one used in the previous chapter; however, the number of observations differ. In fact, this chapter focuses on households that comprise a single individual with no children or a married couple (either with or without children). This is because the model specification becomes extremely complex for other types of households, e.g. those containing two couples, three dependent adults, or one couple with two dependent adults. In the models estimation a two-stage Heckman selection approach is adopted to predict hourly wage rates for all adults. This chapter also includes a personal income tax calculation to obtain household disposable income for different hours points. There are four models for individual labour supply and each model is estimated for males and females separately. Six models for household labour supply are estimated for all married couples. Different estimation methods (conditional/multinomial logit[4] and mixed logit models) are applied depending on the flexibility of the model specifications.

[4] What I refer to as the conditional logit model is the model developed by McFadden (1973). Greene (2012) discusses that the McFadden conditional logit model is often referred as the multinomial logit model; however, the multinomial logit model can also refer to a discrete choice model applied when data are only individual specific.

The estimation results show that labour supply behaviour in Thailand is overall consistent with theory and existing literature. This chapter considers five aspects[5] to select the preferred models for male and female labour supply and the household labour supply. The results indicate that the most flexible model at both individual and household levels is the most preferable. At the end of the analysis, a number of checks for robustness are performed to examine the consistency of the preferred models across different settings. The results of these robustness checks are consistent with the preferred models at both levels. The estimation using the dataset covering 2013 and 2015 suggests that the models fit the data better than the previous period (2009 and 2011) as well as the whole sample (from 2009 to 2015). Hence, the models estimated from year 2013 and 2015 data are adopted as a simulation platform for the last empirical essay.

1.2.3 Chapter 4 overview

Chapter 4 extends the previous chapter. The first objective is to investigate, using microsimulation models (MSMs), the effects of factual and counterfactual policies on labour supply as well as economic factors including gross income, tax burden, and disposable income. The second objective is to determine the effect of each policy at a broader extent. This chapter, hence, presents a "winners-losers" analysis as well as the effects of simulated policies on poverty and income redistribution.

This chapter applies the HSES datasets from the 2013 and 2015 surveys because the results from Chapter 3 suggest that the preferred models fit the data from these surveys better than the others. In addition, this most recent dataset allows policy simulation with least divergence from changes in labour supply preferences. Besides a micro-dataset, MSMs are usually composed of two parts, namely, the arithmetical model and the behavioural model. The former applies personal tax rules and benefits

[5] They include the proportion of negative marginal utility of income, the proportion of the sample satisfying the quasi-concave condition, the proportion of the observations satisfying the monotonicity condition, the log-likelihood ratio test, and the consistency between individual and household labour supply levels.

to calculate disposable income under different policy scenarios. The latter allows households to maximise their levels of utility after disposable income adjustment due to a policy reform.

Before the policy simulation is undertaken, the chapter presents labour supply elasticities of the gross wage rate. The results are consistent with most of the existing studies; for example, in general female labour supply is more elastic than male labour supply. The chapter then simulates three different policies, namely, the perfect compliance of the minimum wage policy in 2015, changes in non-transferable allowances based on tax rule adjustment in 2017, and the restructuring of the personal income tax package proposed in September 2018. The results of the first policy suggest that law enforcement is a key factor of policy success; the national minimum wage with a perfect rate of compliance improves income of people at the bottom end of the household disposable income per adult capita (HDIPAC) distribution. The simulated policy can reduce the number of people living below the national poverty line and increase income equality. The results of the second simulated policy show that increasing non-transferable allowances affects labour supply and income only marginally; however, it causes significant reductions in the household tax burden. This policy does not significantly affect the poverty and income inequality situations. The results of the final policy simulation reveal that restructuring tax brackets and tax rates generally has a negative impact on household gross income, tax burden, and disposable income. The policy exacerbates the poverty problem and possibly expands the income gap between both ends of the income distribution.

1.3 The structure of the thesis

This thesis comprises five chapters. The first chapter presents the introduction. The second chapter, the first empirical work in this thesis, studies the determinants of labour supply at the extensive margin in Thailand. Chapter 3, the second empirical study, presents an analysis of different discrete hours labour supply models to determine the preferred models for individual and household labour supply. The next essay, presented in Chapter 4 (i.e., the final empirical study), focuses on applying the

microsimulation technique to investigate the effects of policies through the models obtained from Chapter 3. The conclusion of the thesis is given in chapter 5.

Chapter 2 starts with a discussion of the importance of a labour supply at the extensive margin in a developing country. This sections shows limitations of labour supply studies in developing economies which share some general contexts. It also provides interesting contexts in Thailand. The next section reviews existing literature which includes the random utility maximisation (RUM) model in labour force participation, theoretical predictions of different factors (e.g. wages, unearned income, and debt constraints) on labour supply at the extensive margin, and the selection bias possibly due to missing wages of non-workers. Then, the chapter provides a clear explanation on the data cleaning process as well as descriptive statistics pointing out the socio-economic contexts. The next section discusses empirical methodology which is how the structural binary probit model with incorporation of the two-stage Heckman selection model is specified. Model specification requires consideration of exclusion restriction in the selection model. The following section reports the results. First, it presents the results of the predicted wages which show the accuracy of prediction. Second, it provides marginal effects of labour force participation, discussing general and focused factors. The last section concludes the first essay with the summary of the chapter's findings as well as providing the extension from a labour force participation study in Chapter 2 to an hours labour supply study in Chapter 3.

Chapter 3 begins by presenting the background of the empirical essay. It refers back to the first chapter regarding the importance of labour supply in an economy. It also indicates the lack of literature focusing on labour supply in developing countries, especially studies applying discrete hours labour supply models. Then, a clear discussion about theoretical and empirical methodology in studying labour supply is provided. It starts with basic concepts of a discrete hours labour supply model, its advantages and disadvantages. Empirical models consider many aspects including predicted wages, utility functional forms, observed and unobserved preference heterogeneity, non-participation incorporation, and maximum simulated likelihood in estimation. At the end, this section explains

different models with different degrees of flexibility included in this chapter. The third section describes the process of disposable income calculation (i.e., the arithmetical model) as well as descriptive statistics for unmarried individuals and married couples. It presents results for both males and females separately for individuals. For married couples, it considers both gender and household size factors. In the next section, the results are reported at both individual and household labour supply levels. Then, the preferred model for each level is selected using different criteria. The last part presents a number of robustness checks. The final section provides a summary of findings and indicates that the estimated results are important for policy simulation.

The final empirical essay, presented in Chapter 4, begins with brief information about MSMs which have been applied in various branches of science and social science. In economics, many studies apply MSMs for simulating different policies and they are frequently applied through labour supply settings. However, most existing studies focus on developed countries. Three simulated policies, namely, perfect compliance of the national minimum wage, increases in non-transferable allowances, and the proposed tax package are explained. The next section gives a background on different reforms, such as income elasticities of labour supply, minimum wages, and tax-benefit policies, which have been simulated using the microsimulation approach in previous studies. The next section characterises the sample composition, pecuniary factors, and the situation of the minimum wage. The empirical methodology is provided in the fourth section. It covers technical information about MSMs including the arithmetical model and the behavioural model. Then, the section describes procedures of different simulations as well as policy evaluations in practice. The fifth section reports the results of the simulations beginning with the results of labour supply elasticities when gross wages increase by 10 percent, reporting labour supply response as well as transition metrics which explain behavioural changes. Regarding simulated policies, changes in hours worked and financial factors are presented in different ways. Lastly, effects on poverty and income redistribution are provided for each policy. The conclusion section completes the chapter by providing a summary of the findings.

This thesis concludes in the final chapter, Chapter 5, which includes two main sections. The first section reports the main findings as well as economic interpretations for each chapter. The second section provides discussion on policy implications, limitations, and the possibility for future research by chapter. In Chapter 2 some highlights are addressed. Interconnection between formal and informal sectors as well as debt constraints need to be taken into account when a policy related labour force participation is formulated. In Chapter 3 some policy implications can be directly drawn from the results of the estimations. Some policies are suggested to motivate people regarding labour supply behaviour. With respect to the fourth chapter, different policies are proposed to stimulate economic growth and promote income equality.

Chapter 2 Thailand Labour Supply at the Extensive Margin

2.1 Introduction

2.1.1 Background

As mentioned in the section 1.1, labour supply is one of the most intensely researched areas. With regard to labour supply at the extensive margin, many studies have been conducted using data from developed countries, and they have focused on either men or women. For example, Killingsworth and Heckman (1986) reported the empirical study done by Bowen and Finegan (1969) which investigate labour force participation for different age groups of females in U.S. Pencavel (1986) used the same dataset as Bowen and Finegan (1969) to study labour force participation across different age groups of males. Some other examples of research on labour supply at the extensive margin in developed countries are Kimmel and Kniesner (1998), Prieto-Rodríguez and Rodríguez-Gutiérrez (2003), Bottazzi (2004), Belkar et al. (2007), and (Benczur et al., 2014).

However, a limited number of empirical studies regarding labour force participation in developing countries are available. In addition, many studies apply data in the distant past. Cameron et al. (2001) focus on woman labour force participation in five Asia developing countries, including Thailand, in 1975-76. Sahn and Alderman (1988) apply a dataset from Sri Lanka in 1980/81 to study determinants of wages and labour participation for males and females. Existing studies concerning labour supply at the extensive margin in developing countries using recent datasets usually investigate only on female labour supply although their focuses are specific. Chen et al. (2014) investigate labour force participation of married females living in urban and rural areas in China using data from 2006. Majbouri (2019) uses data from 2000 to investigate the effects of twins and family size on female labour force participation in Iran. Karaoglan and Okten (2015) use data from 2005 to 2010 to investigate labour force participation with added and discouraged worker effects of married females

in Turkey. The study presented in this thesis uses a recent dataset (from 2009 to 2015) to investigate labour supply at the extensive margin of both males and females in Thailand.

This chapter aims to extend the labour supply literature regarding labour force participation in the formal labour market of a developing country since the economic structures between developed and developing countries are different. In general, developing countries have a larger informal sector than advanced economies. For example, Thailand informal sector shares about 62.60 percent of total working labour force in 2012. Regarding the literature associated with labour force participation in the informal sector, many previous studies, such as those by Telles (1992), Pradhan and van Soest (1995), and Dogrul (2012), investigate determinants of formal-informal labour market participation in Brazil, Bolivia, and Turkey, respectively. Other studies investigate formal labour market participation of households in the informal sector using datasets covering only farming households. However, most investigate labour supply behaviour in developed countries. Kimhi (2004) studies off-farm work participation of farming households in Israel. Corsi and Salvioni (2012) investigate labour allocation choices (between on-farm and off-farm working) of farming households in Italy. Existing literature suggests that on-farm and off-farm working in households are correlated. This leaves a gap in the literature for this thesis which investigates labour supply at the extensive margin in a developing country.

There are a couple of reasons why a large informal sector could affect labour force participation in the formal labour market. Firstly, with a large informal sector, people have a larger choice set for their occupations (e.g., employee, employer, and self-employed). Previous empirical studies such as those by Pradhan and van Soest (1995) and Dogrul (2012) allow people to select among non-participation, formal market participation, and informal market participation. . Unfortunately, this chapter does not cover this aspect due to limitations of the dataset; HSES does not collect data related to working days and hours worked for employees and own-account people. Secondly, farming income in many countries including Thailand is usually shared among members due to the nature of farming

businesses (i.e., they are usually family-owned). Income from farming is hence reported in HSES at the household level. It can be assumed that non-farming household members take a shared amount of farming income as their non-wage income (i.e. unearned income). The theoretical prediction shows that an increase in unearned income discourages labour force participation in the formal labour market (detailed discussion in Section 2.2.2).

Since this chapter covers households with and without farming businesses, it incorporates a factor capturing whether a household is in the agricultural sector (i.e., if another member besides the respondent has a farm business) into labour supply of the formal sector at the extensive margin. The agricultural sector is important because it shares the largest proportion of the informal sector (i.e., 62.50 percent of informal labour force in 2012).

Furthermore, income restructuring policies launched in 2012 makes Thailand an interesting case. They led to an enormous jump in the average minimum wage by over 70 percent and a huge salary increase in the public sector (up to 70.63 percent) are expected to have effects on labour force participation. In addition, the government also launched a policy to increase the prices of various rices, the main agricultural products requiring the largest proportion of labour inputs, by at least 50 percent above the market prices. This policy is also expected to have some impacts on labour force participation especially through the informal sector (i.e., when a household has any farm business but a respondent does not take part in any business).

Debt constraints are another key focus in this chapter because of the high household leverage in Thailand. According to CEIC[6], the household debt per GDP in percentage terms has increased from 51.70 percent in 2007 to 81.17 percent in 2015. In 2019, a government office, Office of the National Economic and Social Development Council, reports that, based on a household debt to GDP ratio, Thailand is one of the largest number in the world (Top 10) and in Asian (Top 3). However, the labour

[6] CEIC is a listed private company based in Hong Kong which provides data of more than 195 countries around the world.

force participation rates have slightly decreased during the same period mainly due to an increasing rate of unemployment. The proportions of labour market participation in the formal sector to that in the informal sector remain quite consistent over time. These numbers seems to be contrary with the theoretical explanations and most of empirical studies. In fact, theoretical predictions based on a life-cycle model indicate that household debts tighten up budget constraints. Providing labour supply in the labour market helps maintain the levels of consumption under debt constraints. In addition, working reduces the negative effects of income and expenditure disturbances. Previous empirical work usually finds a positive relationship between debt constraints and labour market participation (i.e., debt constraints encourage labour force participation). Nonetheless, most of the available literature focuses on the effect of housing debts on labour in advanced economies, for example, O'Brien and Hawley (1986) and Shack-Marquez and Wascher (1987) in the US; Fortin (1995) in Canada; Aldershof et al. (1999) in the Netherlands; Del Boca and Lusardi (2003) in Italy; Bottazzi (2004) in the UK; Belkar et al. (2007) and Atalay et al. (2016) in Australia. This chapter aims to explore to what extent household debt constraints affect decisions on labour force participation in Thailand as a developing country. This study thus covers the effects of financial obligations, including not only housing debt but also consumption and student loan debts.

The main objective of this chapter is to investigate labour supply behaviour at the extensive margin, i.e., the labour force participation, in the formal labour market context of Thailand as a developing country. Considering both genders with a comprehensive range of socio-economic characteristics and applying recent data (2009, 2011, 2013, and 2015) in this chapter enhances the body of literature and offers further understanding of labour force participation in developing countries, especially Thailand. In addition, inclusion of some interesting factors, i.e., farming households, a variable capturing before and after the income restructuring policies, and indebtedness, helps extend the scope of the labour supply literature. This essay focuses only labour force in the formal labour market; hence, it does not include own-account workers which are usually in the informal sector. The main reason is that these

workers do not have wage rates. It is also practically complicated to predict wage rates for own-account workers because the HSES does not contain information about working days or hours worked.

2.1.2 Organisation of Chapter 2

This chapter consists of six sections. Follow the introduction (Section 2.1), Section 2.2 reviews the literature including the random utility maximisation model of labour market participation, theoretical explanations on the determinants of labour force participation, discussion on specific economic contexts (i.e., the informal sector, government policies, and debt constraints), and the selection bias in labour supply. Section 2.3 presents details of empirical data which includes the sample construction processes for generating variable and estimating the empirical model. Section 2.4 discusses the econometric model, i.e., the structural probit model in detail. It also explain the two-stage Heckman selection model in this empirical setting. Section 2.5 reports the main estimation results which are predicted wage and marginal effects of the binary probit model for labour force participation. Section 2.6 presents the conclusion of this chapter as well as indicating the extension which is covered in the following chapter.

2.2 Literature review

2.2.1 Random utility maximisation (RUM) model of labour market participation

Early labour supply studies, between 1930s and early 1970s, defined as the first generation of labour supply studies (Killingsworth, 1983), they relied solely on the ordinary least squares technique in which the functional forms were not explicitly derived from a direct or indirect utility function. Moreover, the first generation research is criticised because of its econometric limitations.

The second generation of labour supply studies evolved to resolve the drawbacks of the previous generation, namely, interchangeable application of alternative labour supply measures, unobservable variables, sample selection bias, and non-linear budget constraints (Berndt, 1991). In fact, the second generation researchers put more attention on functional forms, e.g. the explicit application of utility

functions, and econometric techniques e.g. estimation allowing unobserved heterogeneity. In fact, RUM models have been adopted in empirical research since the second generation. Furthermore, this generation starts introducing policies, especially taxes, into the labour supply model leading to investigation on non-linear budget constraints.

This chapter based on The RUM model of discrete choice which offers the most common platform for discrete choice analysis (Greene, 2009). With regard to labour market participation, each individual makes a decision by choosing between two discrete alternatives i.e., participating and not participating in the formal labour market based on the utility maximisation process.

The utility comparison between alternatives is undertaken and the decision maker selects the alternative which yields greater expected utility. In practice, the observed choice between two choices reveals which one offers a greater level of utility; nonetheless, the utility is not directly observed. The observed index (y_i) equals to 1 if a respondent is employed; i.e. $U_{ia} > U_{ib}$ and 0 otherwise, where U_{ia} and U_{ib} designate the expected utility from being employed and inactive in the labour market respectively.

Based on Greene (2012), a random utility framework for the binary choice model in labour supply decision is shown as follows:

$$U_{ia} = W_i\beta_a + Z_i\lambda_a + \varepsilon_{ia}$$
$$U_{ib} = W_i\beta_b + Z_i\lambda_b + \varepsilon_{ib} \qquad (2 - 1)$$

where W_i is wage offered to individual i; Z_i designates socio-economic characteristics of individual i. Column vectors of parameters, namely, β_a, β_b, λ_a,and λ_b, are included. The random terms ε_{ia} and ε_{ib} designate unobservable stochastic components. The term “unobservable” indicates that the error terms are known by the decision maker only; they might denote an intangible and general preference for each alternative.

In labour market participation setting, a person compares utility between being active and inactive in the labour market. Since all other socio-economic factors are identical, that person decides whether the offered market wage (i.e., the return from working per time unit) is higher than the shadow wage (i.e. the opportunity cost of taking part in the labour market or the value of leisure per time unit). In other words, when the market wage exceeds the reservation wage, utility of participating in the market is greater than not participating ($y_i = 1$ or $y_i^* > 0$) and vice versa ($y_i = 0$ or $y_i^* \leq 0$), where y_i^* is a latent variable which represent difference between market wage and the reservation wage.

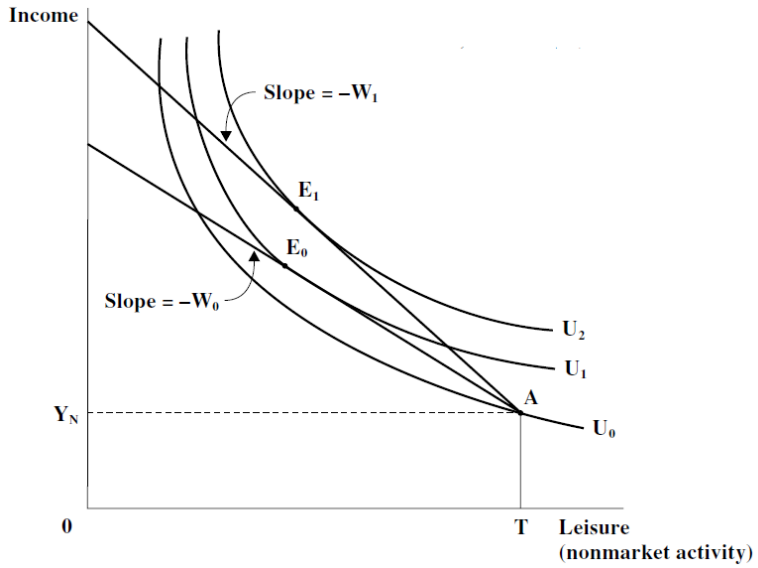
The main theoretical and empirical focuses of labour supply at the extensive margin are not only wages and unearned incomes but also other socio-economic characteristics in the vector Z_i. The next section explains different factors affecting decisions on labour market participation and discusses on related empirical studies.

2.2.2 Source of income, determinants, and labour force participation

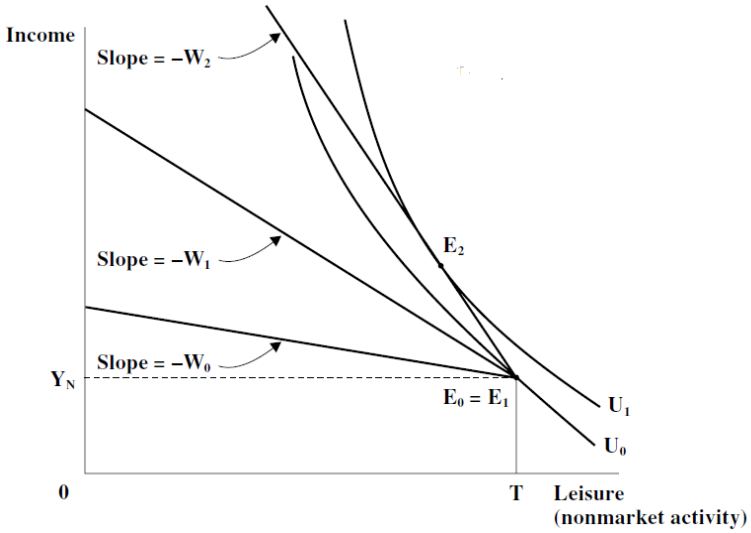
The first factor regarding labour supply at the extensive margin is a change in the market wage rate. FIGURE 2.1 shows how people in the labour force react to a change in the wage. Panel (a) assumes that a person participates in the labour market and earns the wage with slope $-W_0$; hence, he obtains the utility at U_1. The utility at $U_1$is clearly greater that the utility level if he decides to be a non-participant (U_0). If the wage increase from W_0 to W_1, the level of utility he receives increases to be U_2. The combination of working and leisure hours may change (comparing between E_0 and E_1) due to income and substitution effects; however, with a greater level of utility this person stays in the labour market definitely. If the wage decreases until there is a tangent point with the utility curve U_0, a person withdraws from the labour market because the offered wage rate is lower than their reservation wage.

FIGURE 2.1: The Effect of a Wage Change on Participation

(a) The effect on a participant



(b) The effect on a non-participant



Source: Benjamin et al. (2002)

For a non-participant as shown in Panel (b), assuming that a non-worker would earn the wage at W_0 if he worked. In this case he decides to be non-participant and obtains utility at U_0. When the wage increases from W_0 to W_1, a person does not make the decision to work in the market since the level of utility from working is still less than that from being a non-worker, i.e., an offered wage is less than the reservation wage. This person will participate in the labour market if and only if the wage rate is high enough to escalate the level of utility above U_0. For example, at W_2, a person can earn utility at U_1 if he decides to enter the market; in this case, he will decide to be a worker in order to yield a higher level of utility because an offered wage rate exceeds the reservation wage. On the other hand,

a decrease in the market wage rate makes a non-participant stays away from the labour market because the level of utility from working is lower than that from spending the total time endowment for leisure.

Most of the empirical studies generally fine that females have a substantially larger labour supply response due to changes in wage rate than males (Killingsworth, 1983). Kimmel and Kniesner (1998) investigate labour supply in the United States by gender and marital status. By using the structural fixed effects probit model, they found that the elasticity of being employed for women is much larger than that for men. Benczur et al. (2014) study aggregated labour supply at the extensive margin of Hungarians by using the structural probit model. They concluded that wage had a positive effect on labour force participation of both genders. They also indicate that wage elasticity is larger for females in relative to males.

With regard to non-labour income, the results of an increase in non-labour income are opposite to the effects of wage escalation. In fact, by assuming leisure as a normal good, a rise in unearned income never causes a non-participant to enter the market but it is possible that a participant exits the market. The intuition is that an increase in non-labour income provides a pure income effect or increase in the reservation wage. If leisure is considered as a normal good and a person is active in the market, a pure income effect causes a person to spend a larger amount of time on non-market activities; and with a sufficiently large amount of non-labour income (the reservation wage exceeds the market wage), a person will leave the market. For non-participants, the amount of time spent on non-labour activities does not decline because the person has already reached the maximum leisure point, i.e. non-participants remain inactive in the market because their reservation wages have initially been above the market wage. In case of a decrease in non-labour income, the theoretical explanation is opposite to an increase in non-labour income, yielding the reverse results.

In this chapter, a spouse's income is assumed as another source of non-labour income. In that case, a spouse's wage is assumed to have only the income effect on a person (Pencavel, 1986). In other words,

if income of a spouse is higher it results in a greater reservation wage, and a respondent is less likely to participate in the labour market. Some examples of previous works are provided as follows.

Killingsworth and Heckman (1986) report the results of Bowen and Finegan (1969) indicating that, based on cross-sectional data from the 1960 Census of Population, unearned income reduce the participation probability of females. Pencavel (1986) uses the linear probability model to reproduce the work of Bowen and Finegan (1969) for males; the result is consistent with the theory that unearned income reduces the participation probability. Benczur et al. (2014) find that non-labour income impacts the participation decision negatively; the results of both genders verified that females have much larger income elasticities than do males. Prieto-Rodríguez and Rodríguez-Gutiérrez (2003) indicate that non-labour income have negative effects on labour force participation for all countries.

In general, all of the determinants including wage, non-labour income, and other socio-economic variables, of an individual's decision for participating in the labour market can be generally categorised as any variable influencing the reservation or the market wage. For a factor that affects the offered wage rate only, the economic prediction is clarified in detail as above. Theoretical prediction of these factors is that if they are positively influence the market wage, they are positively associated with labour force participation and vice versa.

Ceteris paribus, a factor raising the individual's reservation wage causes a reduction in the probability of labour market participation theoretically and vice versa. Besides non-labour income, such variables that cause change in the individual's reservation wage could be either observable characteristics, e.g., the presence of very young children, and a number of elderly people in the households; or an unobservable characteristic such as the personal preference for domestic duties. For example, Karaoglan and Okten (2015) indicate that having children under 11 years old discourage labour force participation of married females in Turkey. It is worthwhile mentioning here that with regard to gender each characteristic could affect changes in the individual's reservation wage differently.

Some variables could affect both reservation and market wages of individuals leading to an uncertain effect on their decision for labour force participation. An increase in an individual's age is a distinct example. While it is possibly related to a higher market wage which makes a person more likely to participate in labour market activities, it also escalates the reservation wage, decreasing the probability of labour force participation because of a greater level of disutility relative to leisure. In turn, an individual will decide to retire from the labour force if the reservation wage surpasses the market wage.

In practice, non-budget constraint variables have had inconsistent effects since different labour supply studies, even focusing on the same gender, apply various sets of these control variables. Labour supply determinants such as socio-economic characteristics affect labour decision differently across settings. First, different genders have different household responsibilities; this makes males and females respond to factors, including budget constraints and non-budget constraints, differently. Second, the effects of determinants may differ across countries because of contexts, e.g., cultures and degrees of economic development. Eberharter (2001) studies labour market participation of people having incomes above and under the poverty line in German; the results by genders and economic statuses are different suggesting that these two factors influence market participation of both genders differently.

Studies across countries usually provide different results for some factors. Cameron et al. (2001) study female labour participation in five Asian countries, four of which are developing countries. They include many socio-economic factors; however, income factors are excluded from the model. They find some differences across countries e.g. location, education, and children characteristics. Prieto-Rodríguez and Rodríguez-Gutiérrez (2003) investigate labour participation of married women in 11 European countries. Some factors show different effects such as age, husband's education, husband's work status, and having young children. Al-Qudsi (1998) focuses on fertility in labour participation in developing Arab countries. The study includes many demographic factors but includes only one

variable indicating total household income; due to lack of data. The probit results across countries show that most of factors affect labour participation similarly because culture factors and degrees of economic development are very comparable.

This chapter hence tries to provide a comprehensive perspective towards labour supply at the extensive margin by including various factors such as income variables, socio-economic characteristics (individual, spouse, and household ones), as well as controlled variables (e.g., year and location) in order to see the results of specific factors. Chen et al. (2014) indicate that different characteristics affect labour force participation of married females living in urban and rural areas differently.

2.2.3 Informal sector and labour market participation

Regarding the informal sector, most of existing empirical attempts to understand or explain the characteristics of the informal sector. For instance, Maloney (2004) gathers data from developing countries in Latin America to indicates that the informal sector is an unregulated microentrepreneurial sector rather than a disadvantaged residual of segmented labour markets. Rothenberg et al. (2016) describes the characteristics of Indonesia's informal sector; they indicate the reasons why the informal sector is so persistent.

Existing literature associated with labour force participation in the informal sector generally covers determinants of formal and informal market participation. For example, Telles (1992) investigates the effects of different characteristics on labour market participation between formal and informal sectors in Brazil. Pradhan and van Soest (1995) use a 1989 dataset from urban areas in Bolivia to study formal and informal sector employment. Gündüz-Hoşgör and Smits (2008) use Turkish data from 1998 to study occupational choices including formal and informal labour market participation of married women. Dogrul (2012) investigates determinants of formal and informal labour market participation in urban areas of Turkey using data from 2006.

These studies provide interesting results indicating how different characteristics affect people's decisions on formal-informal labour market participation; however, they do not include any factors capturing the correlation between formal and informal sectors. This is because many existing studies assumes the informal sector as an inferior sector in a segmented market framework; however, recent empirical evidence has shown that labour markets in formal and informal sectors are linked (Albrecht et al., 2009).

Some other studies account for correlation between two sectors by focusing on formal labour market (off-farm) participation of households in the informal sector (i.e., their datasets contain farming households only). Kimhi (2004) studies off-farm labour participation of Israel farming families. Although the main focus is the effect of family composition on labour supply at the extensive margin, it suggests that on-farm and off-farm labour participation are linked. Corsi and Salvioni (2012) investigate the linkage between off-farm and on-farm labour participation of farm households in Italy. The results show that labour allocation choices of household members in a farm family are affected by on-farm and off-farm activities. The results also show a correlation of labour participation among member because most farms are operated as family businesses. However, these studies investigate labour supply behaviour in developed countries whilst studies associated with developing countries are far unattended.

This chapter aim to fill the literature gap by covering households in both formal and informal markets. It extends previous works by including a factor to captures linkage between on-farm and off-farm sector. In fact, an agricultural sector is one of the main informal industries, especially in Thailand. In addition, farmers in the informal sector usually work as a family (i.e., each member is responsible to some assigned tasks depending on skills and cultural factors). Therefore, some members in a farming family may be inactive in the formal labour market because there are assigned to do domestic duties in the household; moreover, they receive a portion of farming income which is considered as unearned income.

2.2.4 Effects of policies on labour market participation

Another main focus in the labour supply literature is public policy. Theoretically, as mentioned in Section 2.2.1 and 2.2.2, the labour supply is a function of non-labour income, the marginal wage rate (i.e., the amount of earned income from an extra hour worked), and certain characteristics. Many policies affect labour supply decisions through the wage or reservation wages of people. For instance, if a government increases non-working benefits for non-workers, this will increase reservation wages. In other words, unearned income is greater due to the policy and so leads to a reduction in the probability of labour market participation.

Most studies focus their attention on the effects of income tax-benefit policies on the labour supply. Income tax-benefit normally introduce a difference between average and marginal after-tax wage (Berndt, 1991). In fact, people's work effort and earnings can be significantly distorted and stimulated by those policies (Meghir and Phillips, 2010). Some examples of early studies on the impacts of tax-benefits on labour supply are Rosen (1976); Burtless and Hausman (1978); and Hausman (1980). Some other studies investigate impacts of welfare programs due to the fact that some transfers, e.g. in-work transfer and child benefits, could influence unearned income. Hoynes (1993) study whether welfare transfer programs have an impact on the labour supply of two-parent families in U.S. and indicated that the labour supply is highly responsive to changes in these programs. Bingley and Walker (1997) show that an increase in in-work transfer scheme affects the probability of working in a part-time job largely, and impacts the probability of working full-time moderately. Moreover, without the stigma associated with the in-work program, the probability of lone mother labour market participation increases due to the transfer scheme.

Among policies focused in previous literature, the number of studies on the effect of minimum wage policies on the labour force participation is limited. Schaafsma and Walsh (1983) explored the effect of the minimum wage policy on the labour supply in Canada. They applied pooled time-series provincial data and found a significant negative impact of the minimum wage on the labour supply for

males but an non-significant positive result for female labour supply. Müller and Steiner (2010) investigated the impacts of a legal minimum wage policy on labour market and income in Germany by using a microsimulation technique; they suggested that the policy was ineffective in increasing household income and reducing the inequality gap. In this study, a minimum wage and salary policies are taken in to account in order to investigate the effects of them on labour force participation in Thai contexts.

2.2.5 Debt constraints and labour market participation

One of the main focuses on this chapter is the effect of debt constraints (i.e., ceteris paribus, people with debts have less possibility to access to funds) on the labour market participation. This is because the literature finds decisions on labour force participation is generally more responsive to wage and income factors than do hours-of-work decisions for workers (Heckman, 1993). In recent years, the degree of indebtedness, which is identified by different factors across studies such as an amount of debt outstanding and a debt-service ratio, has become a factor of interest determining labour supply. The effect of debt constraints on labour force participation is usually based on a life-cycle model. The complete life-cycle model, which consists of endogenous consumption goods and leisure, predicts that debt constraints not only reduce current consumption but increase current labour supply as well (O'Brien and Hawley, 1986). The intuition of this is that an increase in labour supply eases such constraints; on top of that, in presence of debt constraints, working can ameliorate the income and expenditure shocks (Belkar et al., 2007).

Several existing empirical studies investigate the relationship between labour supply and debt using cross-sectional and panel data from a range of developed countries. Most of the studies conclude that debt and its servicing obligations positively impact labour supply with statistical significance.

O'Brien and Hawley (1986) as well as Shack-Marquez and Wascher (1987) investigate the borrowing constraints as a determinant of married women's labour force participation in the US. Both studies applied the binary probit model with very similar model specifications; however, with different

predicted credit constraint variables the estimation results are contrasting. Whilst O'Brien and Hawley (1986) finds a positive and significant impact on labour force participation of married women, Shack-Marquez and Wascher (1987) reports a negative and significant impact of debt constraints on labour market participation.

Bottazzi (2004) applies a binary fixed effect logit model to estimate a static labour force participation model with unobservable heterogeneity. The result indicates a positive effect of mortgage commitments, calculated by the division of monthly mortgage repayment by household income excluding female's labour income, on female labour market participation in the UK. Fortin (1995), which introduces a credit constraint based on earnings, and Aldershof et al. (1999), who incorporate a more general borrowing constraint, emphasise similar results about the significance of debts on the labour supply. Both studies showed the similar results that debt positively influences the labour supply decision of female while the presence of young children leads to the opposite result.

Del Boca and Lusardi (2003) adopt non-simultaneous and simultaneous specifications in estimating the relation between female labour force participation and financial obligations in Italy. They indicates that the mortgage debt has a positive and significant effect on the labour force participation decision.

Previous studies mentioned above focus on female labour supply except Belkar et al. (2007) which investigate the effects of different indebtedness variables on male and female labour supply at the extensive margin in Australia. They cover mortgage debts as well as other debts. Both cross-sectional and panel estimation results indicate similar results that indebtedness statistically increases or decreases an individual's probability of labour market participation.

Many empirical studies have been done for developed countries, to my knowledge, this chapter is the first study covering financial obligations in a developing country setting. This chapter investigates both male and female labour supply at the extensive margin. On top of that, whilst the existing empirical research usually focuses on overall household debts or housing debts, this essay also includes two

additional types of debt, namely, consumption and student loan debts. These factors had not been included into any previous work. These two additional factors are the main financial obligations expected to have effects on labour market participation, since they have been increasing overtime and have been a major concern to in many economies in recent years.

2.2.6 Selection bias in labour supply

Labour supply estimation requires an offered wage of each individual as an explanatory variable; however, a major issue is that actual (ex-post) wages for non-working individuals in the sample are unobserved, i.e., they are explicitly equivalent to zero (Hausman, 1978; Heckman, 1979; Heckman and Sedlacek, 1985; Lee, 1982). In particular, the observed wages are based on the labour force participation decision which is unlikely to be random. If those non-workers are employed, they will be paid and wages will be reported. In fact, the reason that a part of the wage distribution is unobserved is because the reservation wage is greater than the offered wage. Hence, any study on determinants of labour market participation requires predicted (ex-ante) wages for unemployed individuals. Ignoring the selection bias (i.e., applying the data without wages for non-workers) will lead to the biased results (Heckman, 1979). This is because a researcher either drops those observations or sets the wages for them equal to zero.

Heckman (1979) offers a procedure, known as the Heckman selection model, to solve the problem of selection bias; hence it enables labour supply estimation, using predicted wages from the model, to be estimated. The approach obtains an average wage measure estimated from the entire wage distribution in the economy by subjecting to a selective adjustment, i.e., people with the observed certain characteristics are expected to have a same reservation wage and predicted to have the exact level of a potential wage regardless of the employment situation; the model assumes that people who are not working is because their potential wages are lower than those of working people who have the similar characteristics (Myck and Reed, 2006).

The Heckman selection model is usually applied in continuous hours and discrete hours labour supply studies. However, a limited number of empirical studies adopts this model in labour participation studies since many of them adopt reduced form probit models e.g. Al-Qudsi (1998) and Cameron et al. (2001). Some studies, for instance, Prieto-Rodríguez and Rodríguez-Gutiérrez (2003) predict wage through a wage equation without accounting for employment status; this could lead to over-predicted wage rates for unemployed people.

Sahn and Alderman (1988) estimate predicted wages using Heckman two-step approach in order to study the determinants of labour participation. Benczur et al. (2014) apply a similar method, the two-staged Heckman model, in their study of labour force participation. They use the model to predict total gains from work, which incorporate earned income, unearned income, and transfers, rather than earned wages. This chapter follows Sahn and Alderman (1988) and Benczur et al. (2014) by estimating the two-stage Heckman model to predict daily wage for all individuals in the sample; this can prevent the selection bias due to unobservability of wages for unemployed people.

2.3 Empirical data

This section provides a description of the HSES dataset used in this research. The HSES is cross-sectional dataset providing household income, expenses, and other economic information e.g. household debts. It also contains information of individual and household characteristics. The data for this research is acquired for four years (2009, 2011, 2013, and 2015) of the HSES carried out by the National Statistical Office (NSO); the data is not on a yearly basis because the HSES on revenue aspects used in the study is conducted every two years.

According to the NSO of Thailand, the labour force is a group of people in a particular area, who are over 15 years old and not categorised in these following work statuses, namely, housewife or househusband, student, too young or too old, physical and mental disabilities or chronic illness, not

working by preferences, working for others without paying (not a member of a household), voluntary work (without payment) for any organisation, and not working due to other reasons.

However, in this study the estimation sample size slightly differs from NSO's definition. In fact, labour force participation in this study covers two groups of people. First, people who are active in the labour market as employees include government employees, state enterprise employees, and private employees. Second, people who can participate in the labour without physical or mental restriction but they decide to be non-participants includes housewives and kinds, job-seekers, and voluntary non-participants. The reasons why the definition in this study is different from NSO's definition are described in Section 2.3.2.

2.3.1 Data cleaning process

From the four years of HSES datasets, the number of initial observations and households by year are shown in the table below.

TABLE 2.1: A number of initial observations and households between 2009 and 2015

Year	Observations	Households
2009	139,590	43,844
2011	128,071	42,083
2013	126,261	42,738
2015	125,346	43,400
Total	519,268	172,065

From TABLE 2.1, the number of observations and households are similar each year. The initial number of observations (everyone that is included in surveys) is 519,268 or 172,065 households. However, not every observation is included in the estimation. The comprehensive process of observation elimination is shown below.

The HSES contains several records. During the merging of records, the total number of observations increased due to the fact that each respondent could report up to three jobs and two businesses in the last 12 months. After merging the individual information with working or business records, the sample size expands to be 524,244 observations without any change at the household level.

When any respondent reports more than one job, one business, or both job and business, the HSES does not record which labour activities (job and business) are the current ones. In other words, it is not possible to identify if those respondents allocate time for multiple labour activities or they quit a previous labour activity to start a new one. To prevent errors caused by multiple labour market activities (jobs and businesses), households containing at least one person reporting multiple labour activities are eliminated from the study. There are 13,671 observations or 1,887 households are dropped due to the multiple-job issue; and another 6,764 observations or 2,558 households are excluded from the sample because of reporting multiple businesses. Lastly, 9,972 observations or 2,947 households are deleted because any of household members reports as both a worker and a businessman.

In the HSES, there are two variables indicating individuals' work status (ranging from 1 to 14: 1 to 7 are active statuses and 8 to 14 define inactivity in the labour market). The first variable identifies a primary work status (i.e., a work status on which an individual spent most of the time in the last 12 month); the second variable designates a secondary work status. Basically, if an individual reports a primary work status as inactive, a secondary work status will not be presented. Except observations with the exact same work status, all households containing any individual reporting non-identical work statuses on these two variables are dropped from the sample because it is impossible to identify the current work status; i.e., keeping these observations leads to the measurement error problem. Additionally, those households having any observation that reports as "not working for a wage" in a work status variable but appears in Record 13 (information about working people) are dropped from the dataset for estimation. As a result, 87,154 observations or 23,502 households are excluded from the sample.

Some observations (316 observations) are dropped because the information for the length of working or doing business (months) in the last 12 months is not enough (less than one month and no information provided). The length of being active in the labour market is required in calculating a wage

per day; therefore, keeping these observations could cause incorrect calculated daily wage (also known as the measurement error). In addition, people who receive non-financial income are excluded from the study (132 observations) since it is very difficult to approximate the value of goods and services they are given in the financial term.

The study also excludes 564 respondents working as servants or household workers because they are not actual members of the households. In fact, they have migrated from another family to work for and live in the considered household. Their income is hence an expense of the household. Some families with a polygamous characteristic of the household's head are excluded from this research because they are uncommon; 267 observations or 53 households are dropped at this stage leading to the total amount of remaining observations at 405,395 (i.e., 140,993 households). The remaining sample size includes all members in the household without any issue explained above. These observations are applied in generating important variables such as log of real average daily wage, real monthly spouse earnings, real household unearned income, and the number of children for specific age ranges.

2.3.2 The sample construction process for estimation

This sub-section provides explanation on how the sample size for the estimation process is obtained. TABLE 2.2 shown below shows the number of observations by work status.

To define the labour force, this research initially applies a condition used by NSO that the labour force includes people who are older than 15 years old. Those respondents under 15 years old are excluded from the estimation; however, there is no upper age boundary in this chapter[7]. The numbers of observations are shown in the third column of TABLE 2.2.

[7] The maximum age in the estimation sample is 96 years. The number of respondents aged over 60 years is 11,185 or 8.17 percent of the estimation sample.

TABLE 2.2: The number of observations by work status

Work status	All observations		Over 15 years old	
	Frequency	Percent	Frequency	Percent
Employers	8,294	2.05	8,294	2.52
Own-account workers	72,449	17.87	72,436	21.99
Contributing family workers	41,903	10.34	41,852	12.71
Government employees	24,933	6.15	24,932	7.57
State enterprise employees	2,081	0.51	2,081	0.63
Private company employees	76,836	18.95	76,750	23.3
Producer's cooperative	21	0.01	21	0.01
Housewives & kinds	28,542	7.04	28,531	8.66
Students	23,467	5.79	22,703	6.89
Too young/old persons	34,420	8.49	34,340	10.43
Ill/disabled persons	6,826	1.68	6,819	2.07
Looking for a job	1,909	0.47	1,908	0.58
Voluntarily unemployed	2,648	0.65	2,644	0.80
Others	6,085	1.50	6,084	1.85
N/A	74,981	18.50	-	-
Total	405,395	100	329,395	100

From TABLE 2.2, as the main focus of this chapter is the decision to participate in the formal labour market, i.e., the decision to work as an employee; the estimation sample does not include those people who report being employers (8,294 observations) and own-account workers (72,436 observations). Based on NSO's definitions, employers are those who have at least one employee in their business whilst own-account workers (i.e., self-employed people such as farmers and freelancers) are those who work on their own without any employees. Individuals who work for their family businesses without pay (i.e. contributing family workers) are a special case because they have restriction in providing labour supply in the market; consequently, 41,852 observations are removed from the estimation sample. People who work as members of producers' cooperatives (such as group farming) are also eliminated from the estimation sample since they are an exceptional case with a very small number of observations. The practical complexity is the other reason why these types of working status are excluded from the analysis. In fact, these people do not have enough information to calculate earned wage rates; in addition, it is very complicated to predict their wage rates.

Students (i.e. people who are full-time students) are restricted in making a decision for labour force participation due to law and culture. In consequence, observations reporting a work status as a student (22,703 observations) are not included in the estimation. Those who report that they are not active in the market because they are either too young or too old (34,340 observations) are also dropped from the estimation. The NSO's definitions for too young and too old people are not clearly specified. NSO combines too young and too old respondents into one category. In general, respondents are categorised into this group due to their physical conditions. Additionally, NSO includes those who are retired due to organisations' regulations into this category. In addition, people who are not working due to physical and psychological problems (i.e., ill or disabled people) are also not included in the labour force (6,819 observations).

All observations indicating a work status as "others" (6,084 observations) are also excluded from the estimation since people who retired from working report this work status. Furthermore, it is difficult to identify whether the observations in this category make a choice independently to be inactive in the labour market. Before estimating the Heckman selection model, 7 observations are dropped due to the fact that those households have any member reporting as being employed but no information about daily wage available.

The remaining observations (136,839), which are used in the estimation process, include several groups of people by work status. The first group is those individuals who work for government organisations (i.e., government employees such as public servants, judges, polices, and soldiers), public enterprises (i.e., state enterprise employees; state enterprises such as The Electricity Generating Authority of Thailand, Provincial Waterworks Authority, and Thailand Post Company), and private sectors (i.e., private company employees). The second group (housewives and kinds) includes people who decide to be housewives, househusbands, and kinds. The penultimate group consists of individuals searching for a job (they prefer to participate in the labour market they cannot do so due to some conditions). Lastly, the sample includes voluntary unemployed people i.e., individuals who

decide not to participate in the market; however, they may enter the labour market when conditions are satisfied.

2.3.3 Descriptive statistics

This research accounts for both genders, but investigates their labour market participation decision separately. Each factor is presumed to affect the participation decision differently because each gender has different prior responsibilities in the household.

TABLE 2.3: Work statuses by gender (based on the estimation sample size)

Work status	male	(%)	female	(%)	Total	(%)
government employees	12,027	20.23	12,904	16.67	24,931	18.22
state enterprise employees	1,434	2.41	645	0.83	2,079	1.52
private company employees	41,665	70.10	35,082	45.32	76,747	56.09
housewives & kinds	1,290	2.17	27,241	35.20	28,531	20.85
looking for a job	1,139	1.92	769	0.99	1,908	1.39
voluntarily unemployed	1,882	3.17	761	0.98	2,643	1.9.
Total	59,437	100.00	77,402	100.00	136,839	100.00

Based on the estimation sample size, it is apparent that the largest group for both genders is people who are working in the private sector, 70.10 and 45.32 percent among males and females respectively. The second largest group for male is people working in the government sector which shares 20.23 percent of males; the second large group for females is those doing housework without pay (35.20 percent of total females). This differentiates general responsibilities between genders; in fact only 2.17 percent of males stay home and do housework without pay. The percentage of males searching for a job is almost twice as large as that of females; and the percentage of males who are voluntarily unemployed are about three times larger than that of females.

TABLE 2.4 shown below shows brief descriptive statistics of the variables in the study. The first variable is the employment status of respondents; it indicates whether each individual is employed. In particular, its value equals to one when an individual is employed and zero otherwise. It also implies that 92.4 and 62.6 percent of males and females are employed, respectively.

TABLE 2.4: Descriptive statistics for variables by gender

Variables	Male			Female		
	Obs.	Mean	St. Dev.	Obs.	Mean	St. Dev.
Employed labour force	59,437	0.924	0.26	77,402	0.626	0.48
Real daily wage	54,926	563.96	703.78	48,444	533.42	594.71
real yearly unearned income ('000)	59,437	26.92	145.69	77,402	46.20	356.51
Spouse's income ('000)	59,437	4.52	10.12	77,402	6.01	13.69
Age	59,437	38.83	12.55	77,402	41.71	13.91
Age group—under 25	59,437	0.164	0.370	77,402	0.132	0.339
Age group—26-40	59,437	0.404	0.491	77,402	0.366	0.482
Age group—41-59	59,437	0.385	0.487	77,402	0.393	0.488
Age group—above 60	59,437	0.047	0.211	77,402	0.109	0.311
Education level 1—pre-primary	59,437	0.149	0.357	77,402	0.238	0.426
Education level 2—primary	59,437	0.192	0.393	77,402	0.150	0.357
Education level 3—middle	59,437	0.176	0.381	77,402	0.129	0.335
Education level 4—high	59,437	0.185	0.388	77,402	0.142	0.349
Education level 5—post secondary	59,437	0.073	0.260	77,402	0.052	0.222
Education level 6—undergraduate	59,437	0.160	0.367	77,402	0.211	0.408
Education level 7—postgraduate	59,437	0.032	0.175	77,402	0.030	0.170
Education level 8—others	59,437	0.034	0.181	77,402	0.050	0.217
Marital status—single	59,437	0.288	0.453	77,402	0.198	0.398
Marital status—married	59,437	0.647	0.478	77,402	0.660	0.474
Marital status—windowed	59,437	0.016	0.126	77,402	0.076	0.265
Marital status—divorced	59,437	0.021	0.142	77,402	0.031	0.174
Marital status—separated	59,437	0.028	0.165	77,402	0.035	0.184
Marital status—married (unconfirmed)	59,437	0.0001	0.011	77,402	0.0001	0.011
Disability	59,437	0.010	0.10	77,402	0.009	0.096
Spouse's age	59,437	23.39	21.53	77,402	25.95	25.00
Spouse's age group—no spouse	59,437	0.415	0.493	77,402	0.434	0.496
Spouse's age group—under 25	59,437	0.062	0.241	77,402	0.031	0.174
Spouse's age group—26-40	59,437	0.249	0.433	77,402	0.189	0.392
Spouse's age group—41-59	59,437	0.251	0.433	77,402	0.249	0.433
Spouse's age group—above 60	59,437	0.023	0.150	77,402	0.096	0.294
Spouse's disability	59,437	0.005	0.71	77,402	0.011	0.10
Lack of self-care ability of spouse	59,437	0.002	0.05	77,402	0.004	0.06
Non-working spouse	59,437	0.16	0.36	77,402	0.074	0.26
Children (< 3 years old)	59,437	0.075	0.28	77,402	0.087	0.30
Children age 3-5	59,437	0.078	0.28	77,402	0.081	0.29
Children age 6-9	59,437	0.105	0.34	77,402	0.106	0.34
Children age 10-14	59,437	0.142	0.40	77,402	0.141	0.40
Children age over 15	59,437	0.125	0.38	77,402	0.137	0.40

TABLE 2.4: Descriptive statistics for variables by gender (Continue)

Variables	Male			Female		
	Obs.	Mean	St. Dev.	Obs.	Mean	St. Dev.
Household size	59,437	3.52	1.77	77,402	3.55	1.75
Dummy variable of having a farm	59,437	0.085	0.279	77,402	0.117	0.32
Dependent members (< 3 years old)	59,437	0.012	0.12	77,402	0.020	0.15
Dependent members age from 3-5	59,437	0.016	0.13	77,402	0.021	0.15
Dependent members age from 6-9	59,437	0.022	0.16	77,402	0.028	0.18
Dependent members age from 10-14	59,437	0.027	0.18	77,402	0.037	0.21
Dependent members age from 15-60	59,437	0.081	0.35	77,402	0.112	0.42
Members age from 60 years old	59,437	0.364	0.65	77,402	0.495	0.74
Disabled members	59,437	0.059	0.31	77,402	0.066	0.33
Real housing debt (‘000)	59,437	86.164	388.713	77,402	83.568	380.962
Real educational debt (‘000)	59,437	4.271	49.773	77,402	4.434	50.137
Real consumption debt (‘000)	59,437	92.380	287.546	77,402	86.410	281.537
Non-municipal area	59,437	0.312	0.46	77,402	0.318	0.47
Year 2009	59,437	0.258	0.438	77,402	0.261	0.439
Year 2011	59,437	0.258	0.437	77,402	0.255	0.436
Year 2013	59,437	0.242	0.429	77,402	0.242	0.428
Year 2015	59,437	0.241	0.428	77,402	0.242	0.429

The daily real wage is only available for people who are working; this is the reason why the number of observations is fewer than other variables. The average values for males and females are 563.96 and 533.42 baht respectively. Previous research applied hourly wages such as those by Kimmel and Kniesner (1998), Nawata and Ii (2004), and Benczur et al. (2014); but in the context of Thailand, the daily wage is more suitable since the minimum wage is legally defined based on a daily basis. For example, in 2012 the Thai government announced the minimum wage at 300 baht national wide.

This research designates two variables as unearned incomes, which are defined as other incomes besides respondents’ wage income; examples of unearned incomes are interests, dividends, and rents. In TABLE 2.4, the average values of real household unearned income (contains non-negative numbers) for males and females are 26.92 and 46.20 thousand baht respectively. In regards of spouse’s income, which also allows for negative values due to loss from doing business, the average values in thousand baht are 4.52 for males and 6.01 for females.

A range of individual characteristics are included in this study. The average age for males and females are 38.83 and 41.71 years respectively. Age-group variable are defined to take values between 1 and

4 (1: age from 15 to 25; 2: age from 26 to 40; 3: age from 40 to 59; and 4: age over 59); this variable allows for lifecycle indicators for labour force participation (as discussed in Section 2.4.3). TABLE 2.4 exhibits the modified variables of age-group variable indicating the percentage of each group (from 1 to 4); the age groups for males are equivalent to 16.4, 40.4, 38.5, and 4.7 percent respectively whilst the age groups for females are 13.2, 36.6, 39.3, and 10.9 percent respectively.

This research divided levels of educational attainment into eight different categories (1: less than primary school; 2: primary school; 2: middle school; 4: high school; 5: high vocational; 6: undergraduate; 7: postgraduate; 8: other education types) which are more detailed than previous studies such as Benczur et al. (2014), Kabátek et al. (2014), and Prieto-Rodríguez and Rodríguez-Gutiérrez (2003). Overall, males receive more education than females do in Thailand. TABLE 2.4 shows that the percentages of pre-primary school and other education for females are higher than those for males. Males have a better chance than females of receiving education from primary to post-secondary (vocational) school. However, in regards to people holding a Bachelor's degree, the percentage of females is higher than that of males. The proportions of males and females who are holding postgraduate degree are similar (3.2 and 3.0 percent respectively).

With regards to marital status, this study covers six different groups of individuals including never married, married, widowed, divorced, separated, and married with unknown status. A larger number of marital statuses is expected to offer more in-depth analysis on the labour force participation than previous research e.g. Kabátek et al. (2014) which applies a dummy variable which indicates single or married status. From TABLE 2.4, most of respondents are categorised either single (28.8 percent for males and 19.8 percent for females) or married (64.7 percent for males and 66.03 percent for females). Nonetheless, this research also accounts for other marital statuses (3: widowed (1.6 and 7.6 percent for males and females respectively); 4: divorced (2.1 and 3.1 percent for males and females respectively); 5: separated (2.8 percent for males and 3.5 percent for females); and 6: married but unknown status (about 0.01 percent for both genders)). The last marital status category includes

married as reported by a person other than the respondent himself or herself (i.e. the proxy respondent). In this case, the proxy respondent is certain that the subject got married but uncertain about his or her current marital status.

A dummy variable indicating disability of respondents is equivalent to one when a respondent is disabled and zero otherwise. The average values are 0.01 and 0.009 for males and females respectively; they imply that disabled males are about 1 percent and disabled females are 0.9 percent.

Some variables in TABLE 2.4 are included in order to capture characteristics for those couples living together. The average wife's age is 23.39 while the mean of husband's age is 25.95. A variable for spouse's ages has 5 groups; the first category (a value equals zero) indicates whether a respondent having no spouse while the remaining groups (values from 1 to 4) reflect different age groups as different stages in the lifecycle. 41.5 percent of males and 43.4 percent of females do not live with a spouse. Spouse' age between 41 and 59 shares about 25 percent of males and female observations while 24.9 and 18.9 percent of spouses for males and females respectively are between 26 and 40 years old. The remaining groups are under 25 and over 60 years old spouses which share 6.2 and 2.3 percent for males and 3.1 and 9.6 percent for females, respectively.

Disabled wives and husbands share about 0.5 and 1.1 percent of the sample by gender, respectively; 0.2 percent of wives and 0.4 percent of husbands lack self-caring ability; and 16 percent of wives and 7.4 percent of husbands are unemployed.

The numbers of children, which include only the respondents' sons or daughters, at different age ranges (under 3 years old; 3 to 5; 6 to 9; 10 to 14; and over 15 years old) are included in this research; the average numbers of children for each group are 0.075, 0.078, 0.105, 0.142, and 0.125 for males and 0.087, 0.081, 0.106, 0.141, and 0.137 for females, respectively.

In this study, household demographic characteristics are also taken into account as suggested by Myck and Reed (2006) as well as other empirical studies. The average household sizes for male and female

observations are 3.52 and 3.55 persons per household, respectively. The dummy variable for having a farm business equals to one when a household has a farm business and zero otherwise. About 8.5 percent of males and 11.7 percent of females report that their families have at least one farm business.

The number of dependent members are those who need special care due to their age or they do not have income. These variables capturing the number of dependent members by age are different from variables indicating the number of dependent children by age discussed earlier. Whilst the former captures other dependent members, who are not the respondents' sons or daughters, in the household, the latter captures exclusively respondents' sons or daughters. Hence, there is no overlap between the number of dependent children and the number of dependent members. They are categorised into five groups by age ranges (under 3 years old; 3 to 5; 6 to 9; 10 to 14; and 15 to 59 years old); the average numbers are 0.012, 0.016, 0.022, 0.027, 0.081 persons for males and 0.020, 0.021, 0.028, 0.037, 0.112 persons for females, respectively. The average numbers of retired-aged members are 0.364 persons for male respondents and 0.495 persons for female respondents. The average numbers of disabled members in a household are 0.059 and 0.066 persons for males and females respectively.

Different financial obligations including housing debt, education debt, and household consumption debts are examined. Previous research such as those by Fortin (1995), Bottazzi (2004), and Butrica and Karamcheva (2014) focus on housing debts only; this research examiners not only housing debt but also education and household consumption debts in which their average real values are 86.16, 4.27, and 92.38 thousand baht for males and 83.57, 4.43, 86.41 thousand baht for females, respectively.

Last but not least, this study includes three control variables, namely, non-municipal area, provinces, and year. The first two variables are presented in TABLE 2.4; but the information of a variable for provinces is fully provided in Appendix 2.II. The dummy variable capturing whether a respondent lives in a city (a municipal area), which takes the value 0, or in a rural area, (a non-municipal area), which takes the value 1. NSO defines a municipal area (i.e., a city) based on the governance areas called

municipalities (including city municipalities, town municipalities, and sub-district municipalities). They are established and categorised by the municipal act (volume 12) 2000[8]. The average values of individuals living in rural areas are 31.2 and 31.8 percent for males and females respectively. There are about 25.8, 25.8, 24.2, and 24.1 percent of males and 26.1, 25.5, 24.2, and 24.2 percent of female respondents' information which were collected in 2009, 2011, 2013, and 2015 respectively. Since the income-restructuring policies were effective during year 2012, a year variable is included to capture the impact of these policies on the working probability of the Thai labour force.

2.4 Methodology

This research applies the structural probit model, similar to what used by Kimmel and Kniesner (1998) and Benczur et al. (2014). The model is based on the utility maximisation model and also provides some econometric advantages. Firstly, it allows for individual heterogeneity. Secondly, it is adjustable for the sample selection bias; i.e., incorporating the Heckman selection model into the model controls the problem. Thirdly, the structural probit allows the endogeneity of wage since the Heckman selection model can handle correlation between error terms of wage and selection equations. Lastly, using the predicted log of wage can prevent the measurement error of wage caused by incorrect or unreported information.

2.4.1 Structural equation for labour participation estimation

As mentioned in Section 2.2.1, an individual decides to participate in the labour market if and only if the level of utility obtained from participation is greater than that from being inactive. In other words, an individual chooses to be active in the market when the offered wage exceeds the shadow wage (i.e. the opportunity cost of taking part in the labour market). To estimate labour force participation behaviour, adopting either a binary logit or probit model is preferred over ordinary least squares (OLS)

[8] A city municipality has a minimum population of 50,000 and has revenue to achieve all related responsibilities. A town municipality has a minimum population of 10,000 and has revenue to achieve all related responsibilities. A sub-district municipality is founded by a notification of the Ministry of Interior.

estimation because the dependent variable definitely takes the value within the zero-to-one range. The structural probit model is adopted because it can deal with sample selection and wage measurement errors as well as allowing for nonlinearity, individual heterogeneity, and policy simulation in the estimation process.

The objective is to estimate a structural probit model when a person is employed given a wage and socio-economic characteristics. This model is based on the RUM, explained in Section 2.2.1, where an individual compares levels of utility between being active and inactive in the labour market and select an alternative offering a higher level of utility. In other words, when the offered wage exceeds the reservation wage, an individual participates in the labour market; when an offered wage is less than the reservation wage, that individual stays away from the market. The structural probit model is given by the following equation:

$$\Pr\left[y_i = 1 \middle| \widehat{logW}_i, Z_i\right] = \Phi(\widehat{logW}_i\beta + Z_i\lambda) \qquad (2 - 2)$$

where y_i is the outcome variable indicating whether an individual is employed or not; $\widehat{logW}_i$ designates predicted value of the individual wage in the logarithmic form obtained from the Heckman selection mode; Z_i is the vector of explanatory variables determining labour force participation in the structural probit model and Φ designates the cumulative density function of the standard normal distribution.

The wage variable in equation (2 - 2) is the predicted term because W_i is unobservable for non-working respondents. Some previous studies apply linear prediction models to obtain predicted wages[9]. However, the missing wages are not randomly defined; respondents' labour force participation and wages are possibly correlated (Benczur et al., 2014). Hence, the Heckman selection model is applied

[9] Predicted wages obtained from the Heckman model and a linear prediction model are quite consistent. The results are available upon request.

to predict wages in this context. In Heckman (1979), the wage equation takes the expression as follows:

$$logW_i^* = Q_i\Psi + \epsilon_{1i} \quad (2 - 3)$$

where $logW_i^*$ represents wage in the logarithmic form for all people (workers and non-workers) which depends on certain observed characteristics, Q_i, and some unobservable characteristics, ϵ_{1i}; Ψ is a column vector of coefficients. The actual wage, W_i, is observed only if a latent variable $s_i^* > 0$, which is given by the following:

$$s_i^* = R_i\alpha + \epsilon_{2i} \quad (2 - 4)$$

where R_i is a vector of dependent variables which combines those factors determining wage (i.e., Q_i) and those influencing labour force participation (i.e., Z_i); α is a column vector of parameters; ϵ_{2i} is an error term. Equation (2 - 4) is a selection equation of working in the labour market. It is important that the vector R_i must contain all variables in Q_i. In addition, ϵ_{1i} and ϵ_{2i} are assumed to be jointly normally distributed. In fact, the error terms yielded the wage equation (ϵ_{1i}) and those yielded from the indication equation (ϵ_{2i}) could be positively correlated. The theoretical explanation is that both the offered wage and the reservation wage influence the labour market participation; the decision on labour force participation depends upon the pecuniary return from working, ceteris paribus, persons with a lower financial working compensation will have less propensity to be active in the labour market. Thus, when unobservable factors influence the market participation and also help determine wages, given the identical observable characteristics, the predicted wages for non-participants are lower than those for employed individuals.

The first stage of the structural probit model starts with estimating the equation (2 - 4) by using a reduced form probit model which is expressed as follows:

$$\Pr[y_i = 1 | R_i] = \Phi(R_i \lambda_{rf}) \quad (2 - 5)$$

where λ_{rf} is a column vector of coefficients of the reduced form probit. This equation is called the selection equation which applies a RUM to estimate the probability of being employed.

At this stage, the inverse Mills ratio (γ_i) is obtained; it is designated as $\gamma_i = \frac{\Theta(R_i \hat{\lambda}_{rf})}{\Phi(R_i \hat{\lambda}_{rf})}$ where $\Theta(.)$ and $\Phi(.)$ represent the standard normal density function and standard normal cumulative distribution function, respectively.

The second step is applying the inverse Mills ratio as well as the correlation information between the error terms in estimation of the wage equation, $logW_i$; which accounts for market participation. This equation is subsequently applied to predict wages for the entire sample:

$$logW_i = X_i \beta_1 + \rho \gamma_i (R_i \hat{\lambda}_{rf}) + v_i \quad (2 - 6)$$

The coefficient of the inverse Mills ratio, ρ, captures two effects. First, it captures unobservable characteristics which identify that a higher wage causes a higher probability of being active in the market. Second, it captures the difference between variance of offered wages and the covariance between offered wages and reservation wages.

The final step is plugging the predicted wages obtained from equation (2 - 6) into the structural probit model, i.e., equation (2 - 2), in order to obtain labour supply behaviour at the extensive margin. This instrumental variable probit model provides a remedy to endogeneity of W_i (due to correlation between error terms in the wage and labour force participation equations) and a wage mismeasurement (e.g. unreported or incorrectly reported factors for calculating daily wage).

This research estimates the two-stage Heckman selection model for males and females separately as done by Kabátek et al. (2014). This chapter investigates labour supply at the extensive margin for

males and females by estimating them separately as done in Kimmel and Kniesner (1998) and Benczur et al. (2014). This offers a comprehensive examination of labour force participation in Thailand.

2.4.2 Exclusion restriction in the Heckman's procedure and variables descriptions

Referring to the Heckman selection model in Section 2.4.1., Wooldridge (2015) suggests that any variable in Q_i should be contained in the list of explanatory variables in the reduced form probit model, i.e., elements appearing as explanatory variables in the wage equation of the Heckman selection model should be included as explanatory variables in the selection equation. Excluding some variables in Q_i from the variables list in the selection equation could cause inconsistency when they are incorrectly specified.

Wooldridge (2015) also argues that exclusion restriction is required in the Heckman selection model in order to prevent multicollinearity due to high correlations between $Q_i$and the inverse Mills ratio. In particular, explanatory variables in the reduced form probit model should be at least one element larger than Q_i; in other words, at least a variable which influences labour force participation in the selection equation but does not have a partial effect on wage.

This chapter follows both suggestions since the list of variables in the reduced form probit model (i.e., R_i) include all variables in $Q_i$and other additional variables which are the determinants of labour force participation (i.e., Z_i). Since variables in Q_i are incorporated in the wage equation as well as the selection equation in Heckman (1979), other variables in R_i but not in Q_i are considered as exclusion restriction.

The complete list of variables in R_i, which include variables in Q_i and Z_i, are provided in TABLE 2.5 as shown below. In this chapter, variables in Q_i are the determinants of wages, which include age, age-squared, level of education, an interaction term between education and age, and interaction term between education and age-squared, disability condition, year, province, and municipal area.

TABLE 2.5: Variables in the estimation

Abbreviation	***Description***
Variables in Q_i: Variables included in both wage and labour force participation equations	
Age	Age of respondent (in years)
Age^2	The square of the respondent's age
edu	Level of education attainment
age * edu	Interaction term between age and level of education
age^2 * edu	Interaction term between age-square and level of education
disable	Dummy variable for disabled respondents
year	Categorical variable for years
province	Categorical variable indicating different provinces
area	Dummy variable for non-municipal areas
Variables in Z_i: those beside Q_i are exclusion restrictions in the Heckman selection model[10]	
ln_real_y_unearned_inc	Log of real yearly household income
spouse_real_inc	Real monthly income of spouse ('000 THB)
Ageband	Age group dummies for lifecycle periods
Edu	Level of education attainment
mstatus	Marital status
disable	Dummy variable for disabled respondents
spouse_ageband	Spouse's age group dummies for lifecycle periods
spouse_disable	Dummy variable indicating disabled spouse
spouse_selfcare	Dummy variable indicating spouse with lack of self-caring ability
spouse_notwork	Dummy variable showing unemployed spouse
child3	Number of children age under 3
child6	Number of children age from 3-5
child10	Number of children age from 6-9
child15	Number of children age from 10-14
childover15	Number of children age over 15
hhsize	Household size
dfarm	Dummy variable indicating if the household has any farm business
other3	Number of dependent members (< 3 years old)
other5	Number of dependent members age from 3-5
other10	Number of dependent members age from 6-9
other15	Number of dependent members age from 10-14
other15_60	Number of dependent members age from 15-60
hhover60	Number of household members older than 60 years
hhdisable	Number of disabled members in the household
ln_real_ad12	Log of real household housing debt
ln_real_ad13	Log of real household educational debt
ln_real_ad14	Log of real household consumption debt
year	Categorical variable for years
province	Categorical variable indicating different provinces
area	Dummy variable for non-municipal areas

[10] Some variables, namely, level of education attainment and disable appear in both Q_i and R_i because they determine both offered wages and reservation wages as described in Section 2.2.2.

From TABLE 2.5, variables for age and age-squared represent age and working experience; a variable for educational attainment and interaction terms are designated as human capital factors. Disability is expected to be negatively related to wages because it reduces labour productivity. Wages are usually adjusted at least once per year and minimum wages in Thailand are considered on a yearly basis; thus, a year variable is included in the wage equation. Locations possibly impact earned income; different provinces have different economic activities and before 2013, provinces determine variations in minimum wages in Thailand. A dummy variable for rural area is included as a wage determinant since wages in city areas tend to be higher than those in rural areas.

Variables in Z_i, which determine labour market participation, include unearned income (log of household income and spouse's income), individual characteristics (age group, level of education, marital status, and disability condition), spouse's characteristics (age group, disability condition, ability of self-caring, employment status), number of children for different age ranges, household characteristics (e.g., family size, number of dependent members by age range, number of retired-age members, and number of disabled members), financial obligations (housing, education, and household consumption debts), and other control variables (year, province, and non-municipal area).

Unearned income (i.e., non-wage income) theoretically affects labour force participation as discussed in Section 2.2.2. A variable for age group represents different periods in an individual's life-cycle. Educational attainment affects not only the wage but also the reservation wage of an individual; hence, Z_i includes a variable for levels of education attainment. Marital status leads to new responsibilities and shows a certain stage in a life-cycle. Disability is expected to have a negative relationship to the participation probability. Spouse's characteristics and number of children are included in Z_i because individuals are likely to take these factors into account when they make a decision on labour force participation. Household characteristics also play an important role in labour market participation because a high proportion of households in Thailand contain extended families. People who live in this type of family allocate specific responsibilities to each member; hence, while

some members focus on working for an income, the rest can focus on raising young members and performing domestic duties. In summary, household characteristics included in the model are likely to influence the decision on the probability of working in the market. Different debt constraints have theoretical and empirical evidence supporting their significance to labour force participation decisions. Variables for year, province, and rural area are included as control variables since these factors affect the wage as well as the reservation wage of an individual.

It is evident in TABLE 2.5 that age and age squared in Q_i are replaced by a variable for age group in Z_i. The main reason for this is that age has two major effects on labour force participation decision; the first one is that age represents a different lifecycle position (captured by a variable age group); the other reason is that age reflects working experience which is expected to determine wages positively (captured by variables age and age-squared) (Benczur et al., 2014). In fact, one additional year has a negligible direct effect on the labour market participation, but it strongly influences wages and thus affects the decision to be active in the market indirectly.

2.5 Results

2.5.1 Predicted wage

The detailed results of the Heckman selection models are shown in Appendix 2.III. Overall, variables in the wage equation show result as expected for both genders but at different magnitudes. Regarding both genders, age as a proxy of working experience has a positive and significant impact on wages while a variable age-square indicates the negative sign implying that at some point the older people tend to receive the lesser wage.

A variable for levels of educational attainment positively affects wages of respondents, i.e., human capital is one of the key factors in determining wage. The interaction terms (age and education as well as age-square and education) provides in-depth information that the higher level of educational attainment an individual acquires, the more value of an additional year of experience becomes.

Physical conditions have a negative and significant effect on wages for both genders. A year variable indicates that wage increase through time for both genders; other two controlled variables including province and rural area show significant results for both males and females.

From the two-stage Heckman selection model, the predicted values of the dependent variable (log of real wage) are obtained. The research applies a log-transformation technique[11] suggested by Wooldridge (2015) to calculate predicted real daily wages for employed and unemployed by gender as shown in TABLE 2.6

TABLE 2.6: Predicted real daily wage

Male	Observations	Mean	Standard error
Real daily wage	54926	563.9395	703.7848
Real daily wage (1% outlier)	54926	572.3712	714.5338
Predicted real wage (employed)	54926	559.2681	416.0912
Predicted real wage (unemployed)	4511	438.5645	331.7991
Female	Observations	Mean	Standard error
Real daily wage	48444	533.4201	594.7114
Real daily wage (1% outlier)	48444	541.6261	602.7164
Predicted real wage (employed)	48447	528.2283	427.5697
Predicted real wage (unemployed)	28955	320.3526	305.8158

For males, the average actual daily real wage is 563.94 baht; by accounting for the extreme outlier (1 percent), the average real daily wage from the HSES is 572.37 baht. The means of predicted wages from the Heckman selection model of employed and unemployed males are 559.27 and 438.56 baht respectively.

On the other hand, the average actual daily real wage for the whole sample and the 99 percent of the whole dataset (accounting for 1 percent outlier) for females are 533.42 and 541.63 baht respectively. The average predicted wages are 528.23 and 320.35 for employed and unemployed females respectively.

[11] I apply $\hat{y} = exp(\widehat{\sigma^2}/2) * exp(\widehat{logy})$ to obtain predicted real daily wages. y represents the objective variable which is real daily wages in this chapter. $\widehat{\sigma^2}$ refers the unbiased estimator of σ^2; and $\hat{\sigma}$ is the standard error of the wage equation.

From TABLE 2.6, three main points can be addressed here. First, for both genders, average actual daily wages calculated from 99 percent of the dataset provides a higher value than a number calculated from the whole distribution. It implies that there are many people received very low daily earned income. Second, the predicted values for both genders are consistent with the theoretical prediction in which offered wages of employed people are higher than those of unemployed. Finally, the wage gaps between genders for is consistent as actual and predicted data shows that on average males earned higher than females.

FIGURE 2.2: Kernel density plots for actual wages and predicted wages

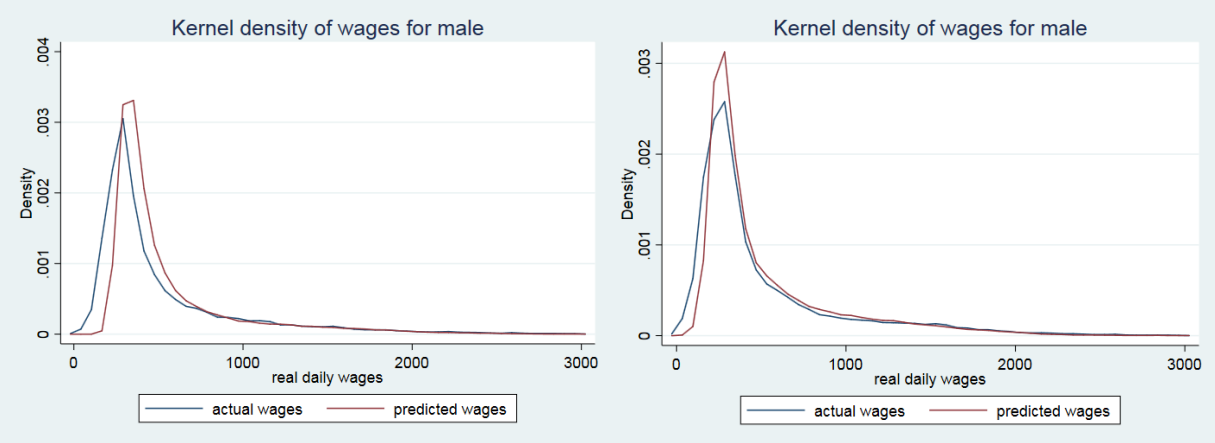


FIGURE 2.2 exhibits Kernel density plots[12] to compare distributional densities between actual wages and predicted wages. The left and right panels present the Kernel density plots for males and female respectively. Overall, distributions of actual and predicted wages for both genders have a very similar pattern. Regarding a gender factor, there are some variations at the left hand of the distributions for males. The density plots of females are very similar; however, the variation in density can be observed at the top of the distributions.

[12] The cut-off point is 3,000 baht per day in order to create the graph. There are 822 people who earn more than 3,000 baht per day. They are excluded because of the visibility of the graph.

2.5.2 Marginal effects from Labour force participation model

2.5.2.1 General factors

The detailed results of the binary probit model and the marginal effects for labour force participation are provided in Appendix 2.IV and 2.V respectively. This section presents the average marginal effects (AMEs) of important variables in the labour force participation model as well as predicted probability of labour market participation at different age groups.

TABLE 2.7: The marginal effects of incomes by gender

Income	Male		Female	
	Marginal effect	Std. Err.	Marginal effect	Std. Err.
Log of real daily wage	0.0485***	0.00642	0.106***	0.00779
Log of real yearly unearned income	-0.00658***	0.000269	-0.0117***	0.000375
Spouse real income	-0.000963***	0.000130	-0.00203***	0.000130

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

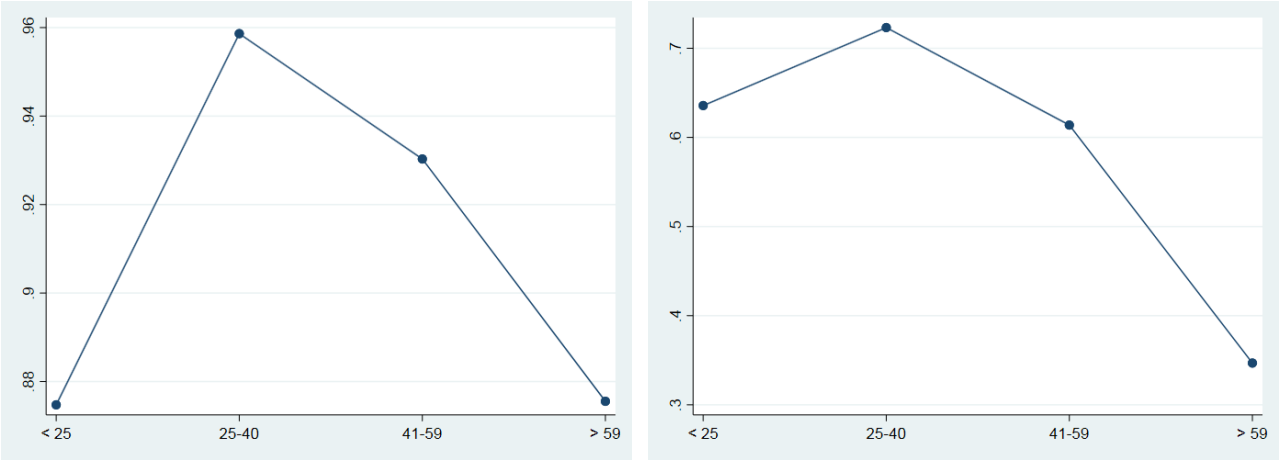
TABLE 2.7 exhibits marginal effects of the different income sources included in the study on the probability of labour market participation. Overall, the effect of every income factor on the probability of working is consistent with the theoretical prediction. In fact, the higher wage has the higher possibility to exceed the reservation wage leading to the higher probability of working. On the other hand, unearned incomes (yearly household income and spouse income) have a negative impact on the probability of being active in the labour market as theoretical expectation and previous empirical studies. This is because these incomes raised the reservation wage. All income factors affect the probability of working with statistical significance at the 1 percent level.

An increase in real daily wages by 1 percent will raise the probability of working for males and females by 4.85 and 10.6 percentage points respectively. An increase in real yearly household unearned income by 1 percent decreases working probability of males and females by 0.658 and 1.17 percentage point, respectively. When the spouse's income increases by a thousand baht, it reduces the probability of working by 0.096 and 0.203 percentage point for males and females respectively.

By comparison between genders, the results are also consistent with previous literature e.g. Benczur et al. (2014), Kimmel and Kniesner (1998), and Prieto-Rodríguez and Rodríguez-Gutiérrez (2003). In

fact, the income elasticity of labour supply at the extensive margin for females is generally greater than that for males. This is because of the larger proportion of working men, and the flattening slope of the probit curve at this upper range (Belkar et al., 2007).

FIGURE 2.3: The predictive probabilities at different age ranges by gender



Male Female

FIGURE 2.3 presents predicted probability curves of both genders at different age groups in people working life; the Y-axis presents predicted probability whilst the X-axis indicate age group. Both genders provide a similar shape of predicted probability curves at different lifecycle periods. In fact, from the starting period of working lifecycle (age 15-25), the working probability increases in the second period (26-40 years old). Then, the probability of labour force participation continuously declines in the next two periods (40-59 and over 59 years old). This pattern is as expected; age between 26 and 40 is considered as a prime age for working. The finding is also consistent with previous research that find the inverse U-shape relationship, i.e., the probability of working increases when an individual becomes older until at some age the probability starts to decline (Cameron et al., 2001; Prieto-Rodríguez and Rodríguez-Gutiérrez, 2003).

All predicted probabilities are statistically significant at the 1 percent level. The probability of being employed for males remains very high in all lifecycle periods; the probabilities for period 1 to 4 (not over 25, 26-40, 41-59, from 60 years old) are 89.78, 96.10, 91.33, and 85.57 percent respectively; with

regards to females, those for each period are 65.30, 72.79, 59.95, and 35.19 percent respectively. It is clearly seen that probabilities of males are higher than those of females in every age group.

TABLE 2.8: The average marginal effects for the levels of educational attainment

Education Base case: under primary school	Male		Female	
	Marginal effect	Standard error	Marginal effect	Standard error
2.primary school	-0.000863	0.00379	0.0257***	0.00608
3.middle school	-0.0176***	0.00446	0.00539	0.00728
4.high school	-0.0137***	0.00520	0.0356***	0.00836
5.higher vocational	-0.00842	0.00698	0.0859***	0.0113
6.bachelor's degree	-0.0294***	0.00941	0.167***	0.0130
7.postgraduate degree	0.0165	0.0110	0.266***	0.0161
8.other education	0.00890	0.00551	0.0352***	0.00795

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

From TABLE 2.8, by comparing males' education levels to the base case—not completed primary school, most levels of the educational attainment indicate negative marginal effects (except postgraduate degree and other education); middle school, high school, and bachelor degree also show negative marginal effects with statistical significance at the 1 percent level. Two levels of education have positive marginal effects but they are not statistically significant. Negative coefficients are different from some previous studies, e.g., Maloney (1991).

However, Prieto-Rodríguez and Rodríguez-Gutiérrez (2003) which find the negative sign in higher education levels provide the theoretical prediction regarding the negative sign on education that people with higher levels of educational attainment have higher reservation wages, and an increase in offered wages possibly fails to catch up an increase in reservation wages. Consequently, the probability of being participating in the market reduces. In addition, Thailand has limited government supports for unemployed people. This could be another reason why low-educated individuals more likely to participate in the market more than those with a higher education in which they tend to live in higher economic status families with some additional financial supports. Negative coefficients of education levels have small effects on the probability of participation (less than 2 percentage points); only an undergraduate level reduces the probability by 2.94 percentage points at the 1 percent

significance level; this accords with the oversupply of undergraduate labour force in Thailand. The NSO statistics in recent years also indicate that the largest proportion of unemployed people in Thailand is usually among those who hold a university degree; for example, in December 2009 and December 2015, this group account for 30.44 and 29.41 percent of the total number of unemployed people, respectively[13].

On the other hand, for females, the marginal effects of different education levels are all positive and statistically significant at the 1 percent level except middle school which is not significant. In addition, except the middle school level, the probability of being active in the labour market increases with the level of educational attainment as expected. The reason is that a level of education theoretically determines reservation and offered wages of people; and it has a larger positive effect on offer wages than reservation wages for females. Once the former exceeds the latter due to a higher level of education, ceteris paribus, they decide to participate in the labour market.

TABLE 2.9: The average marginal effects of the marital status by gender

Marital status	Male		Female	
Base case: never married	Marginal effect	Standard error	Marginal effect	Standard error
Married	0.0475***	(0.00498)	-0.0981***	(0.00609)
Widowed	0.00214	(0.00902)	-0.0418***	(0.00731)
Divorced	0.0358***	(0.00712)	0.0447***	(0.00880)
Separated	0.0367***	(0.00624)	0.0425***	(0.00813)
married (unconfirmed)	-0.0657	(0.112)	0.0201	(0.124)

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Considering marital status for males shown in TABLE 2.9, the working probability is higher (with statistical significance at the 1 percent level) relative to single men when they are married, divorced, and separated. This implies that when they have more responsibilities due to their marital statuses (married, divorced, and separated statuses), they tend to work in the formal labour market to support their spouse or ex-spouse as well as their children via child support and living allowance. However,

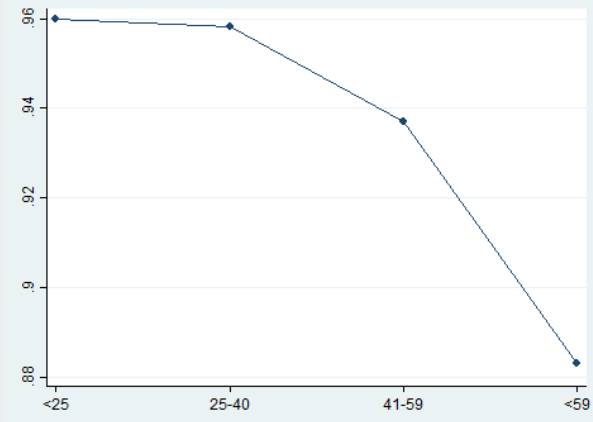
[13] Data from http://www.nso.go.th/sites/2014en/Survey/social/labour/LaborForce/

the probability of labour force participation is not significantly different to single men if they are widowed and married with unconfirmed status.

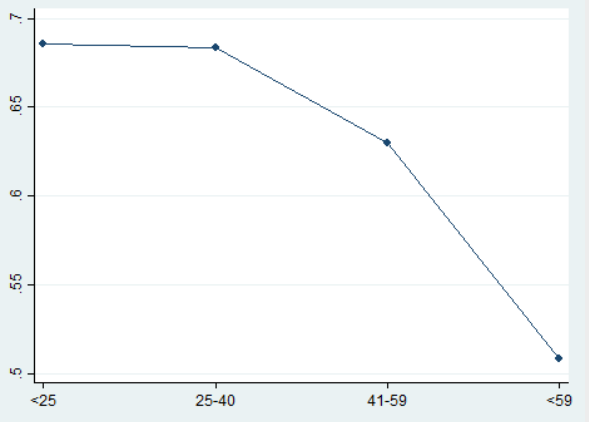
The marginal effects by marital status for female respondents imply that when females are either married or widowed, the probability of participating in the formal labour market is lower than single women with statistical significance at the 1 percent level. Nonetheless, when they have less support from their husbands due to divorce or separation, their probability of working increases in relative to single women with statistical significance at the 1 percent level.

Disability is one of the major individual characteristics in determining the probability of labour market participation. Considering disabled people, the probability of participation is lower than non-disabled. For disabled males, the probability of working does not change significantly. On the other hand, the probability of working for disabled females declines by 6.99 percentage point with statistical significance at the 1 percent level.

FIGURE 2.4: The predictive probabilities for people with a spouse by age group



Male



Female

The predicted probabilities of different age groups of spouse in FIGURE 2.4 suggest that the probability of labour force participation for both males and females declines when the age of spouse by age group is higher. All predicted probabilities are statistically significant at the 1 percent level. Considering different spouse age groups (not over 25, 26-40, 41-59, and from 60 years old) for males are 95.98,

93.62, and 88.74 percent, respectively; the predicted probabilities of these groups for females are 68.43, 68.32, 62.87, and 50.91 percent, respectively.

TABLE 2.10: The average marginal effects of spouse's characteristics by gender

Spouse's characteristics	Male		Female	
	Marginal effect	Standard error	Marginal effect	Standard error
disability	-0.0345*	0.0184	0.0622***	0.0157
self-caring	-0.0948***	0.0314	-0.0423	0.0277
inactive work status	-0.0121***	0.00417	-0.0535***	0.00804

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The results shown in TABLE 2.10 suggest that disabled spouses lead to a lower probability of labour force participation by 3.45 percentage points with statistical significance at the 10 percent level for males but females are more likely to participate in the labour market by 6.22 percent with statistical significance at the 1 percent level. The explanation for different signs between genders is possibly due to different responsibilities in the households. In particular, it is possible that in Thailand males are usually responsible for working while females are more likely to do domestic duties; when they have a disabled spouse, males are likely to take care their own spouses but females tend to take their husbands' responsibility of working for income.

When spouses are unable to take care themselves, males have a lower probability of participation by 9.48 percentage points with the statistical significance level of 1 percent; however, spouses are who unable to take came themselves does not affect females' labour force participation statistically.

When spouses are inactive in the labour market, both genders are less likely to be active in the market by 1.21 and 5.35 percentage points for males and females with statistical significance at the 1 percent level, respectively. Some previous studies, e.g., Karaoglan and Okten (2015), find that the added work effect encourage married females to participate in the labour market. According to Prieto-Rodríguez and Rodríguez-Gutiérrez (2003) there is no consensus on this particular variable, i.e., different countries have different signs for this variable. The results are theoretically counterintuitive; however, there is no conclusive agreement among empirical studies. The explanation of the negative

relationship is that both spouses become unemployed at the same time due to they work in similar jobs and the labour demand declines (Prieto-Rodríguez and Rodríguez-Gutiérrez, 2003).

TABLE 2.11: The average marginal effects of a number of children (son or daughter) by age range

A number of children by age range	Male		Female	
	Marginal effect	Standard error	Marginal effect	Standard error
younger than 3	-0.00480	0.00519	-0.176***	0.00512
from 3 to 5	0.0123**	0.00544	-0.0486***	0.00524
from 6 to 9	0.0139***	0.00459	-0.00138	0.00457
from 10 to 14	0.0195***	0.00375	0.0280***	0.00390
Older than 15	0.0192***	0.00350	0.0100***	0.00384

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Regarding TABLE 2.11, for males, a change in a number of very young children (less than three years old) does not statistically impact the probability of labour force participation. Then, if a number of older children (3-5; 6-9; 10-14; and over 15 years old) increases by one the working probability is significantly higher by 1.23, 1.39, 1.95, and 1.92 percentage points, respectively. Males are more likely to be active in the market except for very young children because they need a certain amount of money to raise their children. However, when children are very young, males may share some domestic duties and childcare responsibilities with their spouses.

As females often have a major responsibility to raise their children, it is not surprising that a number of children for first two age ranges (younger than 3 and 3-5) cause reductions in the probability of the labour market participation by 17.6 and 4.86 percentage points with statistical significant at the 1 percent level. This is consistent with previous literature e.g. Cameron et al. (2001) that indicated having young children caused a decrease in the probability of participation. With an older group of children (6-9 years old) the average marginal effect has a negative value without statistical significance. The probability of working turns positive by 2.8 percentage points with a statistical significance level of 1 percent when the children age ranges are from 10 to 14; and the probability of labour force participation increases by 1 percentage point with statistical significance at the 1 percent level for children who are over 15 years old. This suggests that females with older children are more likely to be active in the labour market in order to help raise income.

TABLE 2.12: The average marginal effects for household's characteristic variables by gender

Household's demographical characteristics	Male		Female	
	Marginal effect	Standard error	Marginal effect	Standard error
Household size	-0.00896***	0.000658	-0.0204***	0.00106
Younger than 3 years old	0.0604***	0.0123	-0.0890***	0.0221
from 3 to 5 years	0.0544***	0.0117	-0.00670	0.0218
from 6 to 9 years old	0.0630***	0.0114	0.0110	0.0214
from 10 to 14 years old	0.0749***	0.0112	0.0649***	0.0211
from 15 to 60 years old	-0.0550***	0.00980	-0.0361*	0.0196
over 60	0.0104***	0.00191	0.0453***	0.00310
Other disabled members	0.00734*	0.00381	0.00872	0.00600
area	0.00971***	0.00229	0.0236***	0.00336

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Four different household's demographical variables are included in the TABLE 2.12. Initially, when a household has one additional member, the probability of labour market participation decreases with statistical significance at the 1 percent level by 0.896 and 2.04 percentage points for males and females, respectively.

Next, the composition of the household is also important for decision on labour force participation. Five different groups of a number of household members by age (excluding respondents' sons and daughters) are included in TABLE 2.12. Having one more of pre-working age (younger than 3, 3-5, 6-9, and 10-14) dependent household members or post-working age (over 60 years old) members results in a higher probability of labour market participation for males by 6.04, 5.44, 6.30, 7.49, and 1.04 percentage points respectively; all variables are statistically significant at the 1 percent level.

Regarding females, a number of other dependent young members, under 3 years old, negatively affect the probability of working for by 8.90 percentage points with statistical significance at the 1 percent level. The similar result is found for other members (excluding respondents' sons and daughters) who are from 15 to 60 years old; a number of this group decreases the probability of labour market participation by about 3.61 percentage point with statistical significance at the 10 percent level. Females are more likely to participate in the market by about 6.49 and 4.53 percentage point with a statistical significance level of 1 percent if a number of dependent members which are from 10 to 14

and over 60 years old increase by one, respectively. A numbers of dependent members in the remaining groups (from 3 to 5 and from 6 to 9) do not statistically affect females' labour force participation.

An increase in a number of disabled members has positive and significant relationship with the probability of participation by 0.734 percentage point with statistical significance at the 10 percent level for males. However, an increase in the number of disabled member does not have statistical significance on the probability of working for females.

A dummy variable capturing whether a household is in a non-municipal area is included in the estimation as a control variable (entering in both wage and labour supply response equations). In comparison with living in a municipal area, males and females living in a rural area are more likely to participate in the formal labour market by 0.971 and 2.36 percentage points respectively with statistical significance at the 1 percent level. While marginal effects of provinces are not discussed in this section, they are included in the estimation as a control variable.

2.5.2.2 Specific factors in developing countries and Thailand

As mentioned in section 2.1, there are three factors on which this analysis focuses due to the specific economic circumstances in developing countries and Thailand.

TABLE 2.13: The average marginal effects for households with any farming business by gender

Household's demographical characteristics	Male		Female	
	Marginal effect	Standard error	Marginal effect	Standard error
Dummy of having any farm	-0.00579	0.00368	-0.0680***	0.00523

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The estimation results indicate that when a household has any farm business (i.e., when any member besides the respondent has a farm business), the probability that a respondent is active in the formal labour market declines by 6.80 percentage points with statistical significant at the 1 percent level for females but having a farm business has no effect on the probability of participation for males. This is possibly because these households do farming businesses on a family basis. In other words, income

from farming is usually shared among all household members, and household members who are not working in the farm take shared farming income as their unearned income.

TABLE 2.14: The average marginal effects for the year variable

Year	Male		Female	
Base case: 2009	Marginal effect	Standard error	Marginal effect	Standard error
2011	-0.00312	0.00267	-0.0101**	0.00405
2013	-0.0111***	0.00308	-0.0237***	0.00445
2015	-0.0167***	0.00320	-0.0338***	0.00456

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

According to marginal effects shown in TABLE 2.14, for both genders, by assigning 2009 as the base year, the probability of being employed gradually decreased throughout the studied period. After two income restructuring policies had officially launched in 2012, the probabilities of labour force participation in 2013 and 2015 are lower than the base year with statistical significance at the 1 percent level for males and females, respectively. This possibly suggests that policies were not effective in raising the probability of labour market participation[14]. This policy package has three main policies, namely, raising minimum wages over 70 percent nationwide, increasing salary by about 70 percent for public officers who earned an undergraduate degree, and the rice-pledging scheme which increases rice prices by at least 50 percent over the market price.

Regarding the minimum wage policy, there are three possible explanations regarding the results. Firstly, immense increase in minimum wage negatively affects employment. Secondly, inefficiency of policy implication leads to low rate of minimum wage compliance (Leckcivilize, 2015). Thirdly, people with the minimum wage rate are usually participating in the labour market.

The government increased salary in the public sector. However, this policy seems ineffective in the formal labour market because people who want to work in the public sector prioritise other factors,

[14] The interpretation of the results should be done with caution as the variable for year captures not only the effects of policies in 2012 but also other events such as FDI, exchange rate fluctuation, and economic growth.

e.g., health and retirement welfare, over salary. In addition, a salary increase in the public sector does not spill over to the private sector due to oversupply of workforce with a Bachelor's degree.

Last but not least, an increase in the prices of rice possibly had a negative effect on labour force participation. A farming business is usually considered as a family business; therefore, members who are not working as farmers possibly take the farming income as their unearned income.

TABLE 2.15: The average marginal effects for household's debts by gender

Household's debts	Male		Female	
	Marginal effect	Std. err.	Marginal effect	Std. err.
Log of real housing debt	0.00117***	0.000307	0.000989**	0.000408
Log of real education debt	0.000727	0.000615	0.00520***	0.000910
Log of real consumption debt	0.00219***	0.000205	0.00485***	0.000291

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Marginal effects shown in TABLE 2.15 present that, overall, debt constraints have a positive and significant (except the education debt on males' working probability) impact on the probability of labour force participation for both genders. In addition, the results show differences between genders that males are more sensitive to housing debts whilst females are more sensitive to education and household consumption debts.

One percent increase in the real housing debt causes the probability of being active in the labour market to rise by 0.117 and 0.099 percentage point for males and females with statistical significance levels of 1 and 5 percent, respectively. In terms of education debts, the working probability for females increases by 0.52 percentage point with statistical significance at the 1 percent level if the educational debts rise by 1 percent. However, these debts do not have statistical impact on the probability of being active in the market for males. An explanation on this is that females take main responsibilities on raising their children; hence, they care more about education debts. One percent increase in real debts for household consumption cause an increase in probability of labour force participation for males and females with statistical significance at the 1 percent level by 0.219 and 0.485 percentage points, respectively.

The findings from debt constraint variables are consistent with most existing literature that has studied the relationship between labour force participation and debt constants. Even though most of the previous empirical studies focused on housing debts, this chapter provides additional evidence that household consumption debts have the similar effects, and education debts also have positive impact on the labour force participation at least for females.

2.6 Conclusion

This empirical essay aims to understand the behaviour of labour force participation in Thailand as a developing country. The socio-economic structures in developing countries are generally different from developed countries that have been covered by most of the previous empirical studies. One distinct difference between developing and developed economies is that the former usually has a larger informal sector in relative to the latter. Additionally, many developing countries like Thailand have economic problems including low economic growth, which relates to the middle income trap, and income inequality. The Thai government has tried to address these problems by income restructuring policies. From academic and policy stand points, understanding Thailand force participation is therefore beneficial for other developing countries and Thailand itself. The amount of household debts in Thailand has also been increased and this is expected to have an effect on labour force participation.

The study obtains four years of the HSES collected by Thailand NSO. A two-stage Heckman selection model is selected to deal with the sample selection bias; the log of predicted real wage is obtained at this stage; the predicted values are consistent with actual data and theoretical explanations. Then, the study applies the structural probit model to estimate the binary response model for formal labour market participation.

The results suggest that variables for earned and unearned incomes are consistent with the theoretical predictions and previous empirical studies, i.e., a variable for real wage has a positive and significant relationship with the probability of participation for both genders; non-labour incomes discourages both males and females from being active in the market. The Thai government should possibly consider allocating labour force from the informal sector to the formal labour market by increasing earned wage rates. In addition, labour force can be reallocated among industries through a policy of supporting earned income in the preferable industries. On the other hand, when the government considers introducing or increasing any welfare program, the policy needs to be studied in detail as it can affect labour supply at the extensive margin negatively.

Some other findings e.g. age of respondent are also consistent with theoretical predictions and previous empirical studies. However, some findings are less common in the literature. For example, the results of educational attainment for males are different from much of the previous literature. Possible explanations are that the offered wage increases at a smaller rate than the reservation wage or Thailand has a very limited amount of social welfare for unemployed people forcing people with lower education (i.e., having lesser support from others) to participate in the market. In addition, the rate of unemployment in Thailand has been increasing recently; the largest proportion of unemployed people is usually those who are holding a university degree.

Individual characteristics (e.g., marital status), spouse characteristics (e.g., spouse age, a number of children, and working status), and household characteristics (e.g., household size, a number of dependent members, and a number of retire-aged members), also affect the decision on labour force participation in Thailand for both genders. The results suggest that males and females have different responsibilities in the household leading to different behavioural responses regarding labour force participation.

A dummy variable indicating if any household member has a farm business, which captures an aspect of the informal sector in Thailand, indicates that when any member besides the respondent conducts a farm business, the females' probability of being active in the formal labour market is lower. Also, people who live in a rural area have a higher probability of participating in the market. These results indicate the importance of the informal sector, especially the agricultural sector, in Thailand. A government can apply the results in forming a policy. In fact, a policy which affects the informal sector directly may affect labour force participation in the formal labour market indirectly.

Evidence from the year variable suggests that policies lunched in 2012 were not effective in encouraging people to be active in the market. Regarding an increase in minimum wages, lack of policy effectiveness is possibly due to a negative effect on employment, ineffective policy implication and weak law enforcement, as well as a high labour force participation rate of minimum wage workers. An increase in the monthly salary in public sector does not affect labour force participation since people prefer to work for the government may consider other factors (e.g., health care and retirement welfares) rather than income. Additionally, the unemployment situation in Thailand reduces the effectiveness of the policy. With regard to the rice pledging policy, an increase in agricultural products' prices due to the government policy may negatively influence labour force participation of people if they consider farming income as household unearned income.

Last but not least, regarding housing debts, the results are consistent with theoretical predictions and previous empirical work in developed countries, and the educational and consumption debts also increase the probability of labour force participation in general. Whilst the housing debts have a larger effect on the probability of labour force participation for males, the other two types of debt have a larger impact on that for females. This has some policy implications. Whilst financial obligations could help encourage people to participate in the labour market, excessive household debts are possibly detrimental to productivity of workforce because of a skills to jobs mismatch (i.e., people with

excessive indebtedness tend to accept any available job regardless of their qualified skills and job specifications).

The next chapter extends this chapter which focuses mainly on decision of labour force participation by applying a multinomial discrete choice model to investigate labour supply at both extensive and intensive margins. Additionally, the model address non-linear budget constraints by incorporating tax-benefit rules.

2.7 Appendix 2.I: Recent income restructure in Thailand

TABLE A2.1: Increase in the minimum wage due to the recent policy

Province group No.	Number of provinces	Previous rate	1 April 2012			1 January 2013		
			Increase	% increase	New rate	Increase	% increase	New rate
1	1	221	79	35.7	300	-	-	300
2	6	215	85	39.5	300	-	-	300
3	1	196	77	39.5	273	27	9.7	300
4	2	193	76	39.5	269	31	11.4	300
5	1	190	75	39.5	265	35	13.2	300
6	1	189	75	39.5	264	36	13.8	300
7	1	186	73	39.5	259	41	1536	300
8	1	185	73	39.5	258	42	16.2	300
9	1	184	73	39.5	257	43	16.9	300
10	2	183	72	39.5	255	45	17.5	300
11	1	182	72	39.5	254	46	18.2	300
12	1	181	71	39.5	252	48	18.8	300
13	2	180	71	39.5	251	49	19.5	300
14	2	179	71	39.5	250	50	20.1	300
15	2	176	70	39.5	246	54	22.2	300
16	1	175	69	39.5	244	56	22.9	300
17	2	174	69	39.5	243	57	23.6	300
18	5	173	68	39.5	241	59	24.3	300
19	4	172	68	39.5	240	60	25.0	300
20	3	171	68	39.5	239	61	25.8	300
21	2	170	67	39.5	237	63	26.5	300
22	4	169	67	39.5	236	64	27.3	300
23	2	168	66	39.5	234	66	28.0	300
24	4	167	66	39.5	233	67	28.8	300
25	7	166	66	39.5	232	68	29.6	300
26	5	165	65	39.5	230	70	30.3	300
27	1	164	65	39.5	229	71	31.1	300
28	7	163	64	39.5	227	73	31.9	300
29	2	162	64	39.5	226	74	32.7	300
30	1	161	64	39.5	225	75	33.6	300
31	1	160	63	39.5	223	77	34.4	300
32	1	159	63	39.5	222	78	35.3	300
Average		175.73	69	39.5	245	60	25.5	300

Source: The Ministry of Labour

TABLE A2.2: Increase in the salary of public organisations due to the salary reformation policy

Education level	October 2011 (THB)	January 2012 (THB)	Change (%)	January 2013 (THB)	Change (%)
Vocational certificate	6,410-6,800	7,620-8,080	18.9	9,000-9,900	20.3
High vocational certificate	7,670-8,140	9,300-9,860	21.2	10,500-11,550	15.0
Bachelor's degree	9,140-9,670	11,680-12,390	28.0	15,000-16,500	30.8
Master's degree	12,600-13,360	15,300-16,220	21.4	17,500-19,250	16.5
Doctoral degree	17,010-18,040	19,000-20,140	11.7	21,000-23,100	12.6

Source: The Ministry of Finance

2.8 Appendix 2.II: Descriptive statistics for provinces and years

TABLE A2.3: Descriptive statistics of province dummies

No.	Male	Female	Total Obs.	No.	Male	Female	Total Obs.
10	6,537	8,173	14,710	51	432	679	1,111
11	1,527	1,800	3,327	52	745	960	1,705
12	1,528	2,018	3,546	53	581	972	1,553
13	1,602	2,026	3,628	54	539	811	1,350
14	984	1,329	2,313	55	384	637	1,021
15	547	808	1,355	56	289	584	873
16	792	1,146	1,938	57	398	757	1,155
17	734	1,048	1,782	58	555	690	1,245
18	589	890	1,479	60	807	1,161	1,968
19	1,123	1,197	2,320	61	418	656	1,074
20	1,449	1,600	3,049	62	580	854	1,434
21	1,313	1,208	2,521	63	678	949	1,627
22	631	849	1,480	64	462	696	1,158
23	741	956	1,697	65	637	1,060	1,697
24	907	1,117	2,024	66	560	808	1,368
25	666	889	1,555	67	602	819	1,421
26	643	890	1,533	70	846	986	1,832
27	574	687	1,261	71	708	926	1,634
30	912	1,078	1,298	72	573	813	1,386
31	574	724	1,298	73	1,149	1,294	2,443
32	506	662	1,168	74	1,385	1,497	2,882
33	372	489	861	75	1,023	1,452	2,475
34	641	813	1,454	76	767	1,042	1,809
35	428	517	945	77	1,103	1,328	2,431
36	412	594	1,006	80	607	772	1,379
37	250	343	593	81	547	771	1,318
38	151	337	488	82	585	796	1,381
39	280	386	666	83	811	952	1,763
40	717	908	1,625	84	834	1,096	1,930
41	627	767	1,394	85	732	971	1,703
42	419	561	980	86	655	907	1,562
43	590	818	1,408	90	882	1,073	1,955
44	443	564	1,007	91	604	816	1,420
45	430	528	958	92	642	825	1,467
46	380	586	966	93	365	518	833
47	534	694	1,228	94	914	1,203	2,117
48	495	574	1,069	95	600	823	1,423
49	466	519	985	96	1,106	1,314	2,420
50	818	1,041	1,859	total	59,437	77,402	136,839

2.9 Appendix 2.III: Heckman selection model outputs

Table A2.4: Heckman selection model outputs

Dependent variable	Male lnrealdailyw		Female lnrealdailyw	
Wage equation				
Age	0.0513***	(0.00297)	0.0590***	(0.00348)
age^2	-0.000521***	(0.0000301)	-0.000724***	(0.0000350)
under primary (base)	-	-	-	-
Primary	0.728***	(0.0848)	0.633***	(0.109)
Middle	0.772***	(0.0840)	0.692***	(0.104)
High	0.578***	(0.0912)	1.220***	(0.108)
post-secondary	0.684***	(0.125)	1.168***	(0.143)
undergraduate	0.241**	(0.106)	0.841***	(0.106)
postgraduate	0.241	(0.230)	0.698***	(0.229)
Other	0.537***	(0.115)	0.483***	(0.121)
under primary * age (base)	-	-	-	-
primary * age	-0.0352***	(0.00384)	-0.0322***	(0.00499)
middle * age	-0.0386***	(0.00381)	-0.0325***	(0.00478)
high * age	-0.0252***	(0.00420)	-0.0603***	(0.00508)
post-secondary * age	-0.0268***	(0.00623)	-0.0529***	(0.00713)
undergraduate * age	0.0122**	(0.00487)	-0.0214***	(0.00470)
postgraduate * age	0.0357***	(0.0104)	0.0103	(0.0107)
other * age	-0.0259***	(0.00539)	-0.0228***	(0.00536)
under primary * age^2 (base)	-	-	-	-
primary * age^2	0.000452***	(0.0000445)	0.000420***	(0.0000586)
middle * age^2	0.000609***	(0.0000438)	0.000493***	(0.0000567)
high * age^2	0.000539***	(0.0000487)	0.000977***	(0.0000612)
post-secondary * age^2	0.000660***	(0.0000764)	0.000990***	(0.0000879)
undergraduate * age^2	0.000223***	(0.0000552)	0.000757***	(0.0000523)
postgraduate * age^2	-0.000118	(0.000115)	0.000293**	(0.000123)
other * age^2	0.000218***	(0.0000605)	0.000209***	(0.0000576)
disability=0 (base)	-	-	-	-
disability=1	-0.148***	(0.0207)	-0.156***	(0.0243)
year=2009 (base)	-	-	-	-
year=2011	0.0340***	(0.00568)	0.0316***	(0.00595)
year=2013	0.183***	(0.00579)	0.208***	(0.00605)
year=2015	0.206***	(0.00582)	0.240***	(0.00609)
municipal area=1 (base)	-	-	-	-
rural area=2	-0.0355***	(0.00468)	-0.0267***	(0.00496)
Constant	4.635***	(0.0732)	4.419***	(0.0869)

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Controlled for provinces: Yes

Table A2.4: Heckman selection model outputs (continue)

	Male		Female	
Selection equation				
real monthly income of spouse	-0.00512***	(0.00113)	-0.00753***	(0.000479)
log of yearly unearned income	-0.0499***	(0.00229)	-0.0379***	(0.00135)
age ≤ 25 (base)	-	-	-	-
age 26-40	0.0942**	(0.0426)	0.168***	(0.0299)
age 41-59	-0.242***	(0.0721)	0.0735*	(0.0436)
age ≥ 60	0.0353	(0.0967)	-0.0968*	(0.0560)
Age	0.0611***	(0.0103)	-0.00265	(0.00781)
age^2	-0.000855***	(0.000101)	-0.000398***	(0.0000761)
under primary (base)	-	-	-	-
Primary	-1.722***	(0.269)	-2.703***	(0.223)
Middle	-1.768***	(0.270)	-2.534***	(0.218)
High	-2.085***	(0.302)	-1.608***	(0.235)
post-secondary	-1.966***	(0.456)	-0.977***	(0.324)
undergraduate	-3.407***	(0.361)	-3.025***	(0.255)
postgraduate	-2.916***	(1.064)	-4.372***	(0.811)
Other	0.998**	(0.420)	-0.641**	(0.258)
under primary * age (base)	-	-	-	-
primary * age	0.0892***	(0.0122)	0.123***	(0.00982)
middle * age	0.0850***	(0.0123)	0.117***	(0.00973)
high * age	0.106***	(0.0142)	0.0795***	(0.0107)
post-secondary * age	0.106***	(0.0237)	0.0570***	(0.0158)
undergraduate * age	0.164***	(0.0171)	0.163***	(0.0115)
postgraduate * age	0.144***	(0.0502)	0.237***	(0.0387)
other * age	-0.0429**	(0.0188)	0.0124	(0.0108)
under primary * age^2 (base)	-	-	-	-
primary * age^2	-0.00105***	(0.000141)	-0.00134***	(0.000111)
middle * age^2	-0.000953***	(0.000141)	-0.00128***	(0.000111)
high * age^2	-0.00122***	(0.000166)	-0.000881***	(0.000125)
post-secondary * age^2	-0.00124***	(0.000293)	-0.000560***	(0.000188)
undergraduate * age^2	-0.00171***	(0.000196)	-0.00150***	(0.000130)
postgraduate * age^2	-0.00124**	(0.000559)	-0.00217***	(0.000442)
other * age^2	0.000381*	(0.000199)	0.0000113	(0.000109)
never married (base)	-	-	-	-
Married	0.422***	(0.0391)	-0.372***	(0.0223)
Widowed	0.163***	(0.0618)	-0.0437	(0.0272)
Divorced	0.277***	(0.0627)	0.183***	(0.0357)
Separated	0.251***	(0.0544)	0.166***	(0.0327)
married (unconfirmed)	-0.381	(0.498)	0.122	(0.493)

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Controlled for provinces: Yes

Table A2.4: Heckman selection model outputs (continue)

	Male		Female	
disability=0 (base)	-	-	-	-
disability=1	-0.205**	(0.0870)	-0.309***	(0.0668)
year=2009 (base)	-	-	-	-
year=2011	-0.00239	(0.0242)	-0.0212	(0.0145)
year=2013	-0.0155	(0.0248)	-0.00588	(0.0149)
year=2015	-0.0361	(0.0247)	-0.0227	(0.0149)
municipal area=1 (base)	-	-	-	-
rural area=2	0.0685***	(0.0202)	0.0667***	(0.0120)
no spouse (base)	-	-	-	-
spouse age ≤ 25	0.330***	(0.0612)	0.237***	(0.0352)
spouse age 26-40	0.357***	(0.0503)	0.222***	(0.0222)
spouse age 41-59	0.251***	(0.0452)	0.0494**	(0.0217)
spouse age ≥ 60	0.00270	(0.0665)	-0.185***	(0.0318)
spouse_disable=0 (base)	-	-	-	-
spouse_disable=1	-0.263**	(0.119)	0.213***	(0.0600)
spouse_selfcare=0 (base)	-	-	-	-
spouse_selfcare=1	-0.564***	(0.150)	-0.142	(0.0952)
spouse_notwork=0 (base)	-	-	-	-
spouse_notwork=1	0.0602*	(0.0338)	-0.137***	(0.0272)
child3	-0.0651	(0.0439)	-0.647***	(0.0184)
child6	0.0715	(0.0459)	-0.211***	(0.0185)
child10	0.0675*	(0.0389)	-0.0557***	(0.0162)
child15	0.105***	(0.0319)	0.0319**	(0.0140)
childover15	0.168***	(0.0298)	-0.00314	(0.0137)
a number of members	-0.0754***	(0.00561)	-0.0640***	(0.00382)
farm business=0 (base)	-	-	-	-
farm business=1	-0.0268	(0.0299)	-0.230***	(0.0176)
other3	0.392***	(0.106)	-0.364***	(0.0785)
other6	0.340***	(0.100)	-0.0684	(0.0774)
other10	0.417***	(0.0978)	0.0111	(0.0761)
other15	0.524***	(0.0967)	0.198***	(0.0750)
other15_60	-0.367***	(0.0847)	-0.0981	(0.0695)
hhover60	0.0392**	(0.0163)	0.132***	(0.0111)
Hhdisable	0.0692**	(0.0325)	0.0358*	(0.0212)
household housing debt	0.0162***	(0.00263)	0.00301**	(0.00147)
household education debt	0.00805	(0.00519)	0.0189***	(0.00321)
household consumption debt	0.0221***	(0.00174)	0.0164***	(0.00104)
Constant	0.740***	(0.247)	1.693***	(0.192)
Constant athrho	-0.304***	(0.0236)	0.0419**	(0.0180)
Constant lnsigma	-0.738***	(0.00325)	-0.757***	(0.00323)

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Controlled for provinces: Yes

2.10 Appendix 2.IV: Probit model results

Table A2.5: Probit model results

Dependent variable	Male Employed		Female Employed	
log of daily wage	0.410***	(0.0542)	0.371***	(0.0275)
log of yearly unearned income	-0.0557***	(0.00226)	-0.0409***	(0.00134)
real monthly income of spouse	-0.00814***	(0.00110)	-0.00714***	(0.000457)
age ≤ 25 (base)	-	-	-	-
age 26-40	0.569***	(0.0276)	0.257***	(0.0194)
age 41-59	0.106**	(0.0440)	-0.170***	(0.0241)
age ≥ 60	-0.240***	(0.0597)	-0.938***	(0.0318)
under primary (base)	-	-	-	-
primary	-0.00803	(0.0354)	0.0816***	(0.0190)
middle	-0.150***	(0.0399)	0.0170	(0.0229)
high	-0.119**	(0.0464)	0.113***	(0.0261)
post-secondary	-0.0752	(0.0621)	0.280***	(0.0361)
undergraduate	-0.238***	(0.0745)	0.576***	(0.0440)
postgraduate	0.172	(0.123)	1.021***	(0.0712)
other	0.0880	(0.0564)	0.112***	(0.0255)
never married (base)	-	-	-	-
married	0.383***	(0.0381)	-0.345***	(0.0218)
widowed	0.0140	(0.0593)	-0.151***	(0.0261)
divorced	0.270***	(0.0611)	0.173***	(0.0350)
separated	0.278***	(0.0534)	0.164***	(0.0322)
married (unconfirmed)	-0.354	(0.517)	0.0764	(0.479)
disability=0 (base)	-	-	-	-
disability=1	-0.139	(0.0858)	-0.239***	(0.0663)
no spouse (base)	-	-	-	-
spouse age ≤ 25	0.512***	(0.0605)	0.243***	(0.0347)
spouse age 26-40	0.478***	(0.0493)	0.239***	(0.0220)
spouse age 41-59	0.219***	(0.0444)	0.0483**	(0.0214)
spouse age ≥ 60	-0.138**	(0.0645)	-0.346***	(0.0310)
spouse_disable=0 (base)	-	-	-	-
spouse_disable=1	-0.253**	(0.118)	0.226***	(0.0594)
spouse_selfcare=0 (base)	-	-	-	-
spouse_selfcare=1	-0.583***	(0.150)	-0.146	(0.0942)
spouse_notwork=0 (base)	-	-	-	-
spouse_notwork=1	-0.0982***	(0.0325)	-0.183***	(0.0269)

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Controlled for provinces: Yes

Table A2.5: Probit model results (continue)

	Male		Female	
child3	-0.0406	(0.0439)	-0.619***	(0.0183)
child6	0.104**	(0.0460)	-0.171***	(0.0184)
child10	0.117***	(0.0388)	-0.00484	(0.0160)
child15	0.165***	(0.0317)	0.0982***	(0.0137)
childover15	0.162***	(0.0296)	0.0352***	(0.0135)
family size	-0.0758***	(0.00557)	-0.0718***	(0.00375)
farm business=0 (base)	-	-	-	-
farm business=1	-0.0479	(0.0297)	-0.233***	(0.0175)
other3	0.511***	(0.104)	-0.312***	(0.0777)
other6	0.460***	(0.0990)	-0.0235	(0.0766)
other10	0.533***	(0.0964)	0.0387	(0.0752)
other15	0.633***	(0.0952)	0.228***	(0.0742)
other15_60	-0.465***	(0.0829)	-0.127*	(0.0686)
hhover60	0.0880***	(0.0161)	0.159***	(0.0109)
hhdisable	0.0621*	(0.0322)	0.0306	(0.0211)
household housing debt	0.00989***	(0.00260)	0.00347**	(0.00143)
household education debt	0.00614	(0.00520)	0.0182***	(0.00319)
household consumption debt	0.0186***	(0.00173)	0.0170***	(0.00103)
year=2009 (base)	-	-	-	-
year=2011	-0.0280	(0.0240)	-0.0357**	(0.0144)
year=2013	-0.0960***	(0.0265)	-0.0837***	(0.0157)
year=2015	-0.140***	(0.0268)	-0.119***	(0.0160)
municipal area=1 (base)	-	-	-	-
rural area=2	0.0837***	(0.0201)	0.0834***	(0.0120)
constant	-0.992***	(0.289)	-1.248***	(0.144)
observations	59437		77402	

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Controlled for provinces: Yes

2.11 Appendix 2.V: Marginal effects

Table A2.6: Marginal effects

Dependent variable	Male Employed		Female Employed	
log of daily wage	0.0485***	(0.00642)	0.106***	(0.00779)
log of yearly unearned income	-0.00658***	(0.000269)	-0.0117***	(0.000375)
real monthly income of spouse	-0.000963***	(0.000130)	-0.00203***	(0.000130)
age ≤ 25 (base)	-	-	-	-
age 26-40	0.0632***	(0.00389)	0.0749***	(0.00582)
age 41-59	0.0155**	(0.00645)	-0.0534***	(0.00750)
age ≥ 60	-0.0420***	(0.0109)	-0.301***	(0.00997)
under primary (base)	-	-	-	-
primary	-0.000863	(0.00379)	0.0257***	(0.00608)
middle	-0.0176***	(0.00446)	0.00539	(0.00728)
high	-0.0137***	(0.00520)	0.0356***	(0.00836)
post-secondary	-0.00842	(0.00698)	0.0859***	(0.0113)
undergraduate	-0.0294***	(0.00941)	0.167***	(0.0130)
postgraduate	0.0165	(0.0110)	0.266***	(0.0161)
other	0.00890	(0.00551)	0.0352***	(0.00795)
never married (base)	-	-	-	-
married	0.0475***	(0.00498)	-0.0981***	(0.00609)
widowed	0.00214	(0.00902)	-0.0418***	(0.00731)
divorced	0.0358***	(0.00712)	0.0447***	(0.00880)
separated	0.0367***	(0.00624)	0.0425***	(0.00813)
married (unconfirmed)	-0.0657	(0.112)	0.0201	(0.124)
disability=0 (base)	-	-	-	-
disability=1	-0.0177	(0.0118)	-0.0699***	(0.0198)
no spouse (base)	-	-	-	-
spouse age ≤ 25	0.0536***	(0.00541)	0.0698***	(0.00966)
spouse age 26-40	0.0511***	(0.00495)	0.0688***	(0.00624)
spouse age 41-59	0.0275***	(0.00550)	0.0143**	(0.00629)
spouse age ≥ 60	-0.0213**	(0.0104)	-0.105***	(0.00967)
spouse_disable=0 (base)	-	-	-	-
spouse_disable=1	-0.0345*	(0.0184)	0.0622***	(0.0157)
spouse_selfcare=0 (base)	-	-	-	-
spouse_selfcare=1	-0.0948***	(0.0314)	-0.0423	(0.0277)
spouse_notwork=0 (base)	-	-	-	-
spouse_notwork=1	-0.0121***	(0.00417)	-0.0535***	(0.00804)

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Controlled for provinces: Yes

Table A2.6: Marginal effects (continue)

	Male		Female	
child3	-0.00480	(0.00519)	-0.176***	(0.00512)
child6	0.0123**	(0.00544)	-0.0486***	(0.00524)
child10	0.0139***	(0.00459)	-0.00138	(0.00457)
child15	0.0195***	(0.00375)	0.0280***	(0.00390)
childover15	0.0192***	(0.00350)	0.0100***	(0.00384)
family size	-0.00896***	(0.000658)	-0.0204***	(0.00106)
farm business=0 (base)	-	-	-	-
farm business=1	-0.00579	(0.00368)	-0.0680***	(0.00523)
other3	0.0604***	(0.0123)	-0.0890***	(0.0221)
other6	0.0544***	(0.0117)	-0.00670	(0.0218)
other10	0.0630***	(0.0114)	0.0110	(0.0214)
other15	0.0749***	(0.0112)	0.0649***	(0.0211)
other15_60	-0.0550***	(0.00980)	-0.0361*	(0.0196)
hhover60	0.0104***	(0.00191)	0.0453***	(0.00310)
hhdisable	0.00734*	(0.00381)	0.00872	(0.00600)
household housing debt	0.00117***	(0.000307)	0.000989**	(0.000408)
household education debt	0.000727	(0.000615)	0.00520***	(0.000910)
household consumption debt	0.00219***	(0.000205)	0.00485***	(0.000291)
year=2009 (base)	-	-	-	-
year=2011	-0.00312	(0.00267)	-0.0101**	(0.00405)
year=2013	-0.0111***	(0.00308)	-0.0237***	(0.00445)
year=2015	-0.0167***	(0.00320)	-0.0338***	(0.00456)
municipal area=1 (base)	-	-	-	-
rural area=2	0.00971***	(0.00229)	0.0236***	(0.00336)
observations	59437		77402	
Pseudo R^2	0.184		0.237	

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Controlled for provinces: Yes

Chapter 3 Individual and family labour supply in Thailand: A structural discrete hours approach

3.1 Introduction

3.1.1 Background

As previously mentioned in Section 1.1, Thailand has been facing serious economic difficulties which are slow economic growth, the middle-income trap, and economic inequality. Thai governments have been attempted to deal with these economic issues with several policies such as increasing minimum wages, revising personal income tax brackets, and providing welfare supports. Public policies theoretically affect labour supply behaviour and subsequently lead to economic structural changes, e.g., boosting economic growth rate and reducing income inequality. Investigation of labour supply hence helps an understanding of how people make a decision on working and leisure. This is beneficial for policy formation and evaluation.

Previous studies on labour supply in developing countries usually adopt continuous hours models and focuses either individual or household labour supply. Schultz (1990) studies family labour supply in Thailand during the distant past, 1980-1981. Bardhan (1979) studies labour supply of the agricultural sector in India using data during October 1972 to September 1973. Sharif (1991) estimates 12 different equations to study labour of poor workers in India during 1970-1971. Dessing (2002) investigates labour supply of low-income households in the Philippines. Yamada (2008) study labour supply in Peru using a cross-sectional dataset in 2002 and a pooled dataset from 1985 to 2000. The model is considered an individual labour supply model rather than a family labour supply one although it accounts for a marital status factor.

Due to some advantages over the continuous labour supply models as discussed later in Section 3.2.2, the discrete hours labour supply models become widely applied in recent empirical studies. With

regard to existing work using discrete choice models to investigate hours labour supply, most of the studies focus on labour supply in developed countries. Additionally, they usually investigate either individual or family labour supply. There are several examples of studies in developed countries. van Soest (1995), which is considered as the seminal paper of structural discrete hours labour supply modelling, studies family labour supply in Netherlands. Keane and Moffitt (1998) study individual labour supply in the U.S. with the inclusion of welfare program participation. Duncan and Harris (2002) study sole parent labour supply in Australia. Kabátek et al. (2014) investigate household labour supply behaviour in France. There are a few studies, such as those by Labeaga et al. (2008) and de Boer (2016), cover both individual and household labour supply; however, they studied developed countries, namely, Spain and Netherland respectively.

Only one previous paper, Gong and van Soest (2002), investigates a developing country using the discrete hours labour supply model, studying the labour supply of married females in Mexico City. This chapter contributes to the existing body of literature by adopting the discrete hours labour supply model to investigate labour supply in Thailand (as a developing country) at both individual and family labour supply levels. It can be expected that people in countries with different degrees of economic development possibly have different labour supply behaviours. Studying labour supply comprehensively helps gain a better understanding of the labour market in Thailand and other developing countries with similar contexts.

Investigating labour supply in a household (family) context provides a number of important extensions since many tax and benefit policies are designed to have impacts on labour supply behaviour; these policies can be appropriately understood within a household labour supply framework (Blundell and Macurdy, 1999). Studying individual labour supply is also important as the number of households consisting a single individual with no children has increased as the demographic structure is transiting to an ageing society with a low birth rate. In fact, the percentage of one-person households in Thailand by the number of households has doubled during the last three decades (1987-2013); and this type of

family and multi-member households behave differently in certain aspects (The United Nations Population Fund Thailand and the Office of the National Economic and Social Development Board., 2015).

According to Aaberge and Colombino (2014), there are three main modelling strategies for studying labour supply. Firstly, the reduced form approach was widely applied up to the early 1970s. In general, this approach has problematic issues when corner solutions and non-linear budget constraints are present. Corner solutions, where hours worked is equivalent to zero, are typically ignored or handled as interior solutions; non-linearity of the budget constraints due to income taxes and benefits are ignored or taken into account by applying the average net wage rate.

Secondly, the structural approach is developed to account for drawbacks of the reduced form approach. This approach also offers a researcher the ability to identify preferences of individuals, to deal with unobserved wage rates, and to account for measurement errors, involuntary unemployment, and quantity constraints in the choice sets. However, the structural approach with a continuous dependent variable has some drawbacks. It is computationally cumbersome when individuals face non-convex budget sets or when there are more than two arguments in the utility function, e.g., the case of household labour supply; hence, researchers usually select relatively simple specifications in empirical work. Researchers applying this approach need to impose a priori the quasi-concave utility function in order to attain computationally and statistically consistent maximum likelihood estimation.

Lastly, the random utility maximisation approach is applied in response to the aforementioned problems. This approach is more convenient than its predecessors; it is affected neither by the complex budget set due to complicated tax-benefit rules nor by multiple goods included in the utility function. The deterministic part of the utility function is allowed to be very flexible without any computational issues. In addition, other dimensions of choices such as fertility, occupational choice, and leisure of other members can be implemented into the model.

This chapter applies the final approach, in particular, a discrete hours labour supply model, to investigate labour supply behaviour in Thailand. This model focuses on the supply side of the market only. Several specifications with different degrees of flexibility for individual and household labour supply are estimated by the conditional/multinomial logit models and the mixed logit models to identify the most appropriate model for individual and household labour supply that fits the Thai dataset. Later, additional tests are also performed to check the robustness of the model.

3.1.2 Organisation of the chapter

The next section, 3.2, is theoretical and empirical methodology. It starts with how the simple discrete choice model can be estimated in labour supply settings. Second, it discusses advantages and disadvantages of the model. Third, empirical techniques for obtaining predicted wages are described. The fourth sub-section provides information about utility function specifications for individual and household labour supply. The fifth part provides information about the incorporation of observed and unobserved heterogeneity into labour supply models. The next sub-section explains how incorporation of labour market participation into the model can be done to prevent that some hours points are not well-represented by the models. Then, it discusses maximum simulated likelihood estimation. Finally, information about empirical estimation models of individual and household labour supply is provided. The models are specified based on different degrees of model flexibility.

Section 3.3 describes the Thai dataset used in this chapter. The first part provides overall descriptive statistics of the Thai dataset obtained from the HSES. The next sub-sections describe disposable income calculation for each hours point in this empirical essay. The last two sub-sections present descriptive statistics for individual and family labour supply, respectively.

Section 3.4 shows estimation results of individual and family labour supply in Thailand. The first two sub-sections provide the results for individual labour supply whilst the next two sub-sections present the results for family labour supply. The results at each labour supply level include labour supply estimated coefficients as well as calculated marginal utilities and examinations of essential conditions.

Then, Section 3.4.5 provides the model selection criteria and shows the preferred labour supply model for each sup-group. The last part contains the results of robustness checks for the preferred models. The summary of labour supply in Thailand and suggestions for policy microsimulations, which are investigated in the last empirical chapter, are provided in the final part of the chapter, Section 3.5.

3.2 Theoretical and empirical methodology

3.2.1 Discrete choice model estimation for labour supply

The major distinguishing of the discrete hours choice models relative to the continuous hours labour supply models, which has continuous hours worked as the independent variable, is that the former has a discretised choice set. In other words, each responding decision unit (individual or family) is assumed to be able to choose among a list of alternatives, $j = 1,2, \dots J$, in the choice set of combinations between income and leisure hours (van Soest, 1995). In addition, the discrete hours models assume all agents (either individuals or households) have the same available set of hours alternatives (Aaberge and Colombino, 2014).

The basic discrete choice model which is usually applied in labour supply studies is known as the conditional/multinomial logit model. Based on a RUM, a unit of analysis (either individual or household level) maximises utility with respect to a budget constraint which is a function of leisure and income.

The general form of the utility functions for individual labour supply is as follows:

$$U_{nj} = V_{nj}\left(Y_{nj}, L_j;\ Z_n, \beta\right) + \varepsilon_{nj} \qquad (3 - 1)$$

where U_{nj} is the utility of an individual n received from an alternative j; Y_{nj} represents the net income of an individual n who selects an alternative j; L_j is leisure hours an individual chooses which is

assumed to be equivalent to $TE - H_j$ (TE is the total time endowment[15]; and H_j is hours worked from an alternative j); Z_n is a vector of individual characteristics; β is a column vector of coefficients; and ε_{nj} is an error term which reflects idiosyncrasies of an individual n on alternative j, this unsystematic component is usually assumed to be an independent and identically distributed (i.i.d) random variable.

The utility of a household is more complicated than that of an individual since more arguments are included in the utility function as shown below.

$$U_{gj} = V_{gj}\left(Y_{gj}, L_{mj}, L_{fj};\ Z_g, \beta\right) + \varepsilon_{gj} \qquad (3 - 2)$$

U_{gj} indicates the utility of a household g which chooses an alternative j. However, it is clearly seen that two leisure arguments appearing in the utility function; they are leisure of males, L_{mj}, and females L_{fj}. Z_g is designated as a vector of household characteristics whilst β is a vector of coefficients. ε_{gj} which captures unobservable preferences of a household g which affect the utility from $j - th$ choice is an i.i.d. stochastic component.

On the other hand, the budget constaints of individuals and households are expressed as follows:

$$Y_{nj} = w_n * H_j + y_n - T(w_n, H_j, y_n, Z_n) \qquad (3 - 3)$$

$$Y_{gj} = w_m * H_m + w_f * H_f + y_g - T(w_m, H_m, w_f, H_f, y_g, Z_g) \qquad (3 - 4)$$

where y designates unearned income; T represents the income tax which depends on arguments in parentheses. For an individual, the tax is calculated from individual wage, working hours, other unearned income, and individual characteristics. Considering a household agent, computation of the

[15] Many empirical studies assumed TE to be equal to 80 hours per week. However, this chapter assumes TE to be 100 hours per week. This is because a fair number of Thai people work longer than 80 hours per week. Each week has 168 hours; assuming TE = 100 allows 68 hours for necessary activities, e.g., sleeping and eating. In addition, this setting, i.e., 100 hours per week, is beneficial if one applies a direct translog utility function. Different forms of TE do not significantly affect the marginal utilities. Callen et al. (2009) indicate that another choice of TE would give an identical model.

income tax accounts for both partners' wages (male and female), working hours of both, household non-working income, and characteristics of the household.

Hence, the agent's problems for individuals and households take the following form.

$$Max\ U_{nj} \text{ subject to } Y_{nj} \leq w_n * H_j + y_n - T(w_n, H_j, y_n, Z_n) \quad (3 - 5)$$

$$Max\ U_{gj} \text{ subject to } Y_{gj} \leq w_m * H_m + w_f * H_f + y_g - T(w_m, H_m, w_f, H_f, y_g, Z_g) \quad (3 - 6)$$

The solution to these equations is complicated as $T(w_n, H_j, y_n, Z_n)$ and $T(w_m, H_m, w_f, H_f, y_g, Z_g)$ are non-linear. This makes Y_{nj} and Y_{gj} non-linear as well. The optimisation for a given marginal tax rate is always possible and a parametric Marshallian labour supply function is obtained; the discrete choice approach begins by utility specification (see Section 3.2.1 for more details) and coefficient estimation instead of estimating the Marshallian labour supply parameter as done in continuous models (Labeaga et al., 2008).

It is worth remarking that, in the household setting which is based on the static unitary household labour supply model, only one utility function is maximised by the couple (i.e. the model treats each household as one decision unit); this is a sensible assumption for households in which incomes of members are entirely pooled (Creedy and Kalb, 2005a). The static collective labour supply model may be more suitable if household members do not combine all incomes. This study selects the unitary model because the dataset combines all unearned incomes at the household level as well as it is simpler than the collective model which requires some extra assumptions or tasks, such as, resources allocation in households. Hence, the joint labour supply of both husband and wife is simultaneously estimated based on the assumption of one decision unit.

In practice, the utility of each alternative is unobservable. An analyst observes only the selected alternative which is assumed to yield the highest utility among all available alternatives. In other words, an agent a, which represents n and g for individual and household level respectively, chooses a leisure hours option j if the level of utility is greater than any other alternative i.

$$U_{aj} \geq U_{ai} \text{for all } i = 1, \dots, m \text{ and all } i \neq j \quad (3 - 7)$$

By substituting for U_{aj} using equation (3 - 1) for individual or (3 - 2) household labour labour supply to obtain this following equation.

$$V_{aj} - V_{ai} \geq \varepsilon_{ai} - \varepsilon_{aj} \text{ for all } i = 1, \dots, m \text{ and all } i \neq j \quad (3 - 8)$$

Then the equation (3 - 8) is rearranged to yield the expression as follows:

$$\varepsilon_{ai} \leq \varepsilon_{aj} + V_{aj} - V_{ai} \text{ for all } i = 1, \dots, m \text{ and all } i \neq j \quad (3 - 9)$$

Hence, for any given value of the random component of the alternative j, the probability that U_{aj}, exceeds all other unsystematic component values of other alternatives i, is equivalent to the joint probability that $\varepsilon_{aj} + V_{aj} - V_{a1} \geq \varepsilon_{a1}$ and $\varepsilon_{aj} + V_{aj} - V_{a2} \geq \varepsilon_{a2}$ and so on for all $i = 1, \dots, I$. If the numerous distributions are independent, the joint probability is basically the product of all separate probabilities, $P(\varepsilon_{ai} \leq \varepsilon_{aj} + V_{aj} - V_{ai})$. Hence, the probability that hours choice j offers maximum utility is expressed as follows:

$$\prod_{i \neq j} P(\varepsilon_{ai} \leq \varepsilon_{aj} + V_{aj} - V_{ai}) \quad (3 -10)$$

The equation (3 -10) is the conditional probability, for a given value of ε_{aj}. The total probability is easily obtained by aggregating terms as equation (3 -10) over all possible ε_{aj} values. To simplify the analysis, the distribution of ε_{aj} for each j is assumed to have an identical form (Creedy and Kalb, 2005b).

Some additional assumptions are made. First, the unsystematic component is a continuous random variable. Second, the unsystematic components are assumed to be i.i.d. with the extreme value type 1 error distribution (extreme value distribution) over all alternatives, the difference between utilities from alternatives follows a logistic distribution (Cameron and Trivedi, 2005).

In short, based on McFadden (1973) showed, the probability of an alternative j being selected by an agent a is as follows:

$$p_{aj} = P(U_{aj} \geq U_{ai}) = \frac{\exp(V_{aj})}{\sum_{i=1}^{M} \exp(V_{ai})}; i = 1, \dots, M \quad (3\text{-}11)$$

To calculate the probability for the alternatives, the parameters of the direct utility function need to be estimated, i.e., the agent's preferences for income and leisure are determined. The parameters in the utility function can be obtained by a conditional/multinomial logit using maximum likelihood.

The joint probability that agent 1 chooses l_{1j}, agent 2 chooses l_{2j}, agent 3 chooses l_{3j}, and so on is given by the product of each agent's probability for alternative *j* with an assumption that each decision agent (individuals for individual labour supply or households for family labour supply) makes the decision on labour supply independently. In other words, its decision is not affected by the alternative selected by any other decision unit. The expression is shown as follows:

$$P(l_{1j}, \dots l_{Aj}) = p_{1j}p_{2j} \dots p_{Aj} = \prod_{a=1}^{A} \frac{\exp(V_{aj})}{\sum_{i=1}^{M} \exp(V_{ai})} \quad (3\text{-}12)$$

This joint probability concerns the probability of the set of alternatives, l_{aj}, (leisure hours levels for individuals and combination of leisure hours levels between male and female for households) for $1, \dots, A$, being chosen by A agents (either N individuals or G households) given their preferences and socio-economic characteristics as well as assuming that all values of ε follow the extreme value type 1 distribution.

The parameters of the assumed form of the preference function are unknown for researchers; however, information about the working hours of each individual in a random sample obtained from the whole population is available. Regarding the individual level, the hours worked can be applied directly whilst, for the household case, both of the partners' hours worked are taken into consideration. Individual and household socio-economic characteristics are observable in practice. Disposable income of each agent (individual or household) at each discrete hours point are obtained

by using predicted wages, hours worked, socio-economic characteristics, and tax rules. The details as discussed in Section 3.3.2.

The probability in the previous equation, (3 -12), can be considered from another perspective. With an assumption about the general form of the utility functions and a given set of observed choices, the parameter values, which if they are true, they will produce the highest probability observing the actual hours, can be obtained. In other words, the equation (3 -12) is reinterpreted as a functional expression of unknown parameter values.

When the utility function of each agent depends upon a vector of parameter β, with element β_s, for $s = 1, \dots, S$. The probability statement based on equation (3 -12) can be specified as

$$L(\beta_1, \dots \beta_S) = \prod_{a=1}^{A} \frac{\exp(V_{aj})}{\sum_{i=1}^{M} \exp(V_{ai})} \tag{3 -13}$$

where $L(\beta_1, \dots \beta_S)$ is known as the likelihood function representing an unknown parameters function for a given sample in which hours worked are available. The likelihood function needs to be maximised over the coefficients $\beta_1, \dots, \beta_S$ of the utility function. In fact, the estimated coefficients, $\hat{\beta}_1, \dots, \hat{\beta}_S$, are yielded by finding values for $\beta_1, \dots, \beta_S$ which maximise the value of the function, i.e., the parameters with the highest likelihood value given the observed labour supply distribution are estimated. These estimated parameters are known as maximum likelihood estimates.

By taking logarithms, the log-likelihood function for this model is given as follows:

$$LL = \sum_{a=1}^{A} \left[U_{aj} - \log \left(\sum_{i=1}^{M} \exp(U_{ai}) \right) \right] \tag{3 -14}$$

This monotonic transformation provide less computational burdens in estimation whilst it does not affect the maximum likelihood estimates. However, in general, this standard discrete hours labour supply model using the conditional/multinomial logit model does not fit data of labour supply so well (Aaberge and Colombino, 2014). van Soest (1995) suggests that the model over-predicts the numbers

of part-time jobs, and it does not allow for random preference heterogeneity. This chapter modifies the conditional/multinomial logit model to fit the dataset better; the modifications are presented in Section 3.2.5, 3.2.6, and 3.2.7.

In empirical studies, applying a discrete choice approach of labour supply requires considering a number of available alternatives (working hours) for each individual. Under the individual setting, numbers of working hours are multiples of a given fixed interval length, IL, and each hours worked alternative, j; in other words, $h_j = jIL$ for some $j \in \{0, \ldots\ldots, k_{ind} -$. Consequently, the choice set for individual labour supply is equivalent to $k = k_{ind}$. For the household labour supply, hours worked of both partners are taken into consideration. The husband's alternatives of working hours are $h_{mj} = jmIL$ for some $j \in \{0, \ldots\ldots, km_{ind} - 1\}$ whilst the wife's alternatives of working hours are $h_{fj} = jfIL$ for some $j \in \{0, \ldots\ldots, kf_{ind} - 1\}$. The available choice set of each household is hence $km(kf)$ or k_{ind}^2 if both have the exact number of alternatives.

In survey data, people usually report weekly hours worked as an integer; hence, $IL = 1$ seems to be a natural choice. In practice, however, IL is expanded so as to limit the computational burden of the estimation process. Some studies assume that the choice set comprises only few alternatives, e.g., non-participation, part-time, and full-time; the common approach is adopting an equally spaced hours points (Aaberge et al., 2009). This chapter selects to apply the common method. Previous empirical studies selected different fixed interval length making different numbers of alternatives; few examples are provided as follows. van Soest (1995) decides $IL = 10$ or $IL = 12$ to reduce the computation burden during the estimation procedure. This allows each family to have 25 or 36 choice possibilities. Creedy et al. (2002) and Duncan and Harris (2002) use $IL = 5$ and provide 11 alternatives of hours worked on individual labour supply and 121 choice opportunities for household labour supply.

Hence, each individual is assumed to maximise utility function over a set of discrete hours points $L_j \in \{L^1, L^2, \dots, L^J\}$. The observability rule for a discrete hours choice labour supply in this chapter is:

$$L_j = L^1 \text{ if } L \leq L_1^B$$
$$= L^2 \text{ if } L_1^B < L \leq L_2^B$$
$$\dots\dots\dots\dots\dots\dots\dots\dots$$
$$= L^{J-1} \text{ if } L_{J-2}^B < L \leq L_{J-1}^B$$
$$= L^J \text{ if } L > L_{J-1}^B$$

This chapter uses $IL = 8$ for each individual; this is in-line with usual working hours per day in Thailand. This chapter also considers the actual hours worked distribution as exhibited in FIGURE A3.1 in Appendix 3.I. In fact, in all panels the largest proportion of working people spend roughly 48 hours per week. The other spike in every panel is about 40, 32, and 56 hours. All these number are related to $IL = 8$ since they are divisible by eight. The total number of alternatives available for each individual are equivalent to 11 hours points which are identical to what used in Creedy et al. (2002) and Duncan and Harris (2002). Thus, in the individual labour supply setting, people are assumed to have 11 leisure hours choice opportunities; in the household labour supply, each family is allowed to select one out of 121 combinations of husband and wife leisure hours.

3.2.2 Advantages and drawbacks of discrete hours labour supply models

The discrete hours choice labour supply models based on RUM have been a dominating paradigm in labour supply studies (Aaberge and Colombino, 2014). There are several advantages why it became more popular than the continuous hours models in labour supply literature regarding labour supply with policy simulation (Creedy and Kalb, 2005b).

Firstly, the discrete hours approach can be considered as more realistic, compared with the continuous hours counterpart, because, in practice, a limited number of hours worked (part-time and full-time jobs) are available. This is supported by the observed peaks in hours distributions in many

countries. This coincides with the assumption of the discrete models in which agents are able to select a relatively small number of hours choices rather than being allowed to alter hours work continuously. From this perspective, the continuous approach is just an approximation to a discrete optimisation problem (Gong and van Soest, 2002).

Secondly, the discrete hours models require considerably less complex information of the budget set faced by each agent. The models simplify the information by estimating utility at a small number of hours levels (Creedy and Kalb, 2005b). By using utility maximisation with a discretised budget set, the discrete hours approach prevents the complexities arising from a non-linear budget constraint characterised by non-linear tax and benefit systems (Creedy and Duncan, 2002). Under a non-linear budget constraint, the continuous hours models face some difficulties. For example, with non-convexity of the budget constraint, theory allows multiple combinations of the arguments (consumption and leisure hours) to achieve the same level of utility; this makes identification of preference parameters difficult (Myck and Reed, 2006). In practice, it is cumbersome to evaluate the complete range of each person's unique budget set since most tax and transfer structures are complex. This issue becomes further complicated when investigating family labour supply with joint utility maximisation due to the three-dimensional budget constraint of households. In a nutshell, the discrete hours models are less complicated than the continuous hours models in incorporating taxation, social security, and social welfare details in estimation as well as simulation.

Thirdly, the discrete hours approach with a structural modelling technique early developed by van Soest (1995) and Keane and Moffitt (1998) allows researchers to incorporate random heterogeneity (details in Section 3.2.5) into the models. The discrete hours model can deal with the population heterogeneity which is an essential feature of cross-sectional datasets (Creedy and Kalb, 2005b).

The disadvantages of a limited number of choice opportunities are rounding errors, i.e., the difference between numbers results from calculated approximation and exact mathematical computation due to rounding, and the incomplete utilisation of available information (van Soest, 1995). For instance,

the actual hours worked of an individual is 43 hours per week, the number is reduced to 40 in the disposable income calculation process because the closest available hours choice is 40 hours per week. This causes some rounding error in the income calculation process.

3.2.3 Predicted wages for non-working individuals

In empirical labour supply studies, it is important to obtain hourly wage information to calculate the disposable income at different counterfactual hours worked alternatives for every individual. Whilst the wage rates for actual workers can be calculated from information in a survey, e.g., gross earned income and hours of works, the wage rates are unobservable for non-workers. Missing wages for these individuals has become a common issue as found in research on labour supply; however, this issue can lead to the selection bias if observations with unobserved values are dropped or these values are defined to be equivalent to zero.

This chapter follows Sahn and Alderman (1988) and Benczur et al. (2014) by applying the two-stage Heckman selection model pioneered by Heckman (1979) to deal with the predicted wage issue (See detail in Section 2.2.6). The predicted hourly are estimated by gender as done in Kabátek et al. (2014). The empirical strategy for wage prediction in Chapter 2 and 3 are pretty similar; however, this chapter applies hourly wages as the dependent variable instead of daily wages as in the previous chapter. This chapter selects to impute predicted hourly wages for all individuals in the sample (in which the predicted values are provided for those with missing wages and those with reported wages). This make the wage imputation consistent with the previous chapter and helps prevent biased estimates caused by two distinct wage distributions, namely, the observed one for actual workers and the imputed one for non-workers (Löffler et al., 2014a; MaCurdy et al., 1990). The details of the econometric model in wage prediction are discussed in Section 2.4.2 and 2.4.3.

3.2.4 Quadratic direct utility function

In labour supply estimation using discrete choice models, one of the important aspects is the utility functional form. This chapter applies the quadratic direct utility function for investigating individual and household labour supply behaviour.

The quadratic direct utility function has a long history in theoretical and empirical aspects of economics. According to Creedy et al. (2002), the quadratic direct utility function was firstly applied in Launhardt's work in 1885 which uses the exchange model of Jevons and Walras to examine supply and demand curves for two parties in which the utility increases at diminishing rates. Allen and Bowley (1935) is another example of the early application of the quadratic direct utility function. They adopted the utility function to present that for any form by which the marginal rate of substitution is a linear function of two tradable goods; the expenditure spent on each good is a linear function of total expenditure; the coefficients are dependants upon the prices of goods.

However, later on, the quadratic form of the direct utility function had been generally neglected in theoretical or empirical studies, until more recently, it has been widely adopted in empirical research on labour supply, e.g., Duncan and Weeks (1997), Keane and Moffitt (1998), Blundell et al. (2000), Creedy et al. (2002), Duncan and Harris (2002), Labeaga et al. (2008), Kabátek et al. (2014).

There are two other utility functions which are applied in previous empirical studies. The first one is the translog form of the quadratic direct utility function, the utility function is expressed as a quadratic function in the logarithms. The examples of studies using this utility function are van Soest (1995), van Soest and Das (2001), Haan (2006), and (Flood et al., 2007). The other utility function is the Box-Cox utility function. This function are used by e.g. Aaberge et al. (1995), Aaberge et al. (1999), Dagsvik and StrØm (2006), Aaberge et al. (2009), Dagsvik et al. (2011) , and Blundell and Shephard (2012).

This chapter uses the quadratic utility function because it is more widely used in existing literature as well as having advantageous features over other functional forms as discussed later. In this chapter, the quadratic direct utility functions for both levels are expressed as follows:

$$U_{aj} = v'Av + b'v + \varepsilon_{aj} \quad (3\text{-}15)$$

where v is a matrix containing income and leisure; it will be two arguments (Y_{nj} and , L_j) for the individual level and three arguments (Y_{gj}, L_{mj}, and L_{fj}) for the household level; a symmetric matrix A which is a 2*2 matrix for the individual labour supply and a 3*3 matrix for the household labour supply and a column matrix b' containing the preference parameters. The unobservable random component, ε_{aj}, captures unobservable preferences.

The simple quadratic form of the direct utility function for the individual labour supply is expressed as follows:

$$U_{nj} = \alpha_{YY}Y_{nj}^2 + \alpha_{LL}L_j^2 + \alpha_{YL}Y_{nj}L_j + \beta_Y Y_{nj} + \beta_L L_j + \varepsilon_{nj} \quad (3\text{-}16)$$

As presented, two main arguments in the utility function are Y for individual net income and L for leisure hours. While the coefficients α and β reflect preferences of individuals in the sample. This specification allows non-linear marginal utility through the quadratic terms, namely, α_{YY} and α_{LL}. For instance, if α_{YY} has a negative value, the marginal utility of income will decline with increasing amount of income. The cross-product term between net income and leisure hours, α_{YL}, allows for investigating whether these two arguments are complementary or substitutable. For example, the additional net income may be less appreciated if the availability of leisure time decreases, i.e., people do not have time to spend money they earned.

The quadratic direct utility function is augmented to permit for households comprising of couples. The utility function for the household level is more complicated than for an individual as shown below:

$$U_{gj} = \alpha_{YY}Y_{gj}^2 + \alpha_{LL_m}L_{mj}^2 + \alpha_{LL_f}L_{fj}^2 + \alpha_{YL_m}Y_{gj}L_{mj} + \alpha_{YL_f}Y_{gj}L_{fj} + \alpha_{L_mL_f}L_{mj}L_{fj} + \beta_Y Y_{gj} + \beta_{L_m}L_{mj} + \beta_{L_f}L_{fj} + \varepsilon_{gj} \quad (3\text{-}17)$$

Regarding household labour supply, three main arguments are included in the utility function. Y_{gj} designates each household net income at each alternative whilst, in a given family, L_{mj}, and L_{fj} indicates leisure hours of a male and leisure time of a female respectively. Similar to the individual level, the non-linear marginal utility function is still captured through the quadratic terms; the interaction terms between net income and leisure hours for both partners, i.e., α_{YL_m} and α_{YL_f} still allow for complementarity or substitutability. The extra cross-product, $\alpha_{L_mL_f}$, informs if the male's leisure time complements or substitutes to the female's leisure time.

These quadratic direct utility functions are tractable, and also permit an extensive rage of potential behaviour response (Creedy et al., 2002). The main reason why this chapter uses a quadratic direct utility function instead of a basic linear direct utility function is that the former provides more flexibility and allows non-constant marginal utility of income, i.e., usually utility functions allow for diminishing marginal utility; furthermore, the cross-product terms in the quadratic direct utility function indicate whether the arguments are complements (if the coefficient is positive) or substitute (if the coefficient is negative) (Creedy and Kalb, 2005b). This chapter selects to use leisure hours rather than working hours as specified in e.g. Keane and Moffitt (1998) and Labeaga et al. (2008) because the leisure hours argument reflects the utility of an agent more directly. Creedy and Kalb (2005a) state that the argument for hours of work is applied as the complement of leisure hours in the utility function.

The translog utility function has similar advantages as the quadratic utility function (Kalb et al., 2018). In fact, it also allows non-linear marginal utility as well as capturing complementarity or substitutability

between income and leisure. However, Creedy et al. (2002) indicated that awkwardness from the logarithmic transformations can appear where fixed costs of labour market participation are included; this is because consumption can be negative (fixed costs exceeds total income). The Box-Cox utility function is beneficial when the negative marginal utility is an issue; however, it provides less flexibility and yield substantially larger labour supply elasticity than do the quadratic and translog utility functions (Mauro et al., 2017)

The quadratic, as well as the translog utility functions, are not automatically quasi-concave across all possible values of estimated coefficients. This is not problematic as long as the utility function based on the optimal parameter values is quasi-concave in the observed labour supply points (Creedy and Kalb, 2005b). van Soest (1995) showed two necessary conditions to check quasi-concavity after obtaining the estimation result. First, marginal utility of income must be positive, so the utility function is quasi-concave (at income and leisure for the individual level and at income, male's leisure, and female's leisure for the household level). Second, the matrix of second order derivatives of income with respect to leisure (of a respondent for the individual level and of both partners for the household level) along the indifference surface at income and leisure must be a positive definite matrix. The matrix for individual and household level can be expressed as follows:

$$H_n = -U_{Yn}^{-1}[y_{Ln} \quad 1]\, HU[y_{Ln} \quad 1]' \tag{3-18}$$

$$H_g = -U_{Yg}^{-1}\begin{bmatrix} y_{Lm} & 1 & 0 \\ y_{Lf} & 0 & 1 \end{bmatrix} HU \begin{bmatrix} y_{Lm} & 1 & 0 \\ y_{Lf} & 0 & 1 \end{bmatrix}' \tag{3-19}$$

where H is the matrix of second order derivatives of income with respect to leisure along the indifference surface at income and leisure arguments; U_Y represents the first order derivatives of utility, U, with respect to income, Y, while HU is as the Hessian matrix of second order derivatives of utility with respect to income; they are a 2*2 and 3*3 matrices for individual and household levels respectively; U_Y designates the partial derivatives of utility with respect to leisure hours; y is equal to $-U_L/U_Y$, i.e., the marginal rates of substitution of leisure with income; and the subscripts n, m, and l indicates individual, male, and female in a given unit of the decision maker.

In practice, H_n is a 1x1 matrix; the condition that H_n satisfied as a positive definite matrix if and only if the element is positive. H_g is a systematic 2x2 matrix hence determining whether H_g is positive definite is more complicated. In fact, there are a number of tests, e.g. an eigenvalue test and a pivot test, to examine whether a symmetric matrix is positive definite. This chapter applies the determinants test. Given a systematic 2x2 matrix, $\begin{bmatrix} a & b \\ b & c \end{bmatrix}$, this matrix is defined to be positive definite if and only if $a > 0$, and $ac - b^2 > 0$.

Another important condition to be checked in a discrete hours labour supply is the monotonicity of the utility function, because interior points of the budget set of the discrete model are a priori excluded since the budget set becomes discrete; the model would lose the economic meaning if the monotonicity condition in which the utility increases with income does not hold (van Soest, 1995). The utility increase in income at (income and leisure) if and only if this following expression is true.

$$2(\alpha_{YY}Y + \alpha_{YL}L) + \beta_Y > 0 \quad (3\text{ -}20)$$

$$2\left(\alpha_{YY}Y + \alpha_{YL_m}YL_m + \alpha_{YL_f}YL_f\right) + \beta_Y > 0 \quad (3\text{ -}21)$$

These equations (3 -20) and (3 -21) check whether the estimation results satisfy the monotonicity condition for the individual level and the household level, respectively.

3.2.5 Observed and unobserved preference heterogeneity

Incorporating observed and unobserved heterogeneity allows the model to be more flexible, for instance, preferences of individuals with a certain characteristic, such as having a university degree, may differ from preferences of those without the characteristic. The random heterogeneity captures unobservable characteristics that affect the choice preference. This approach is also known as parameterisation (Kabátek et al., 2014).

The observed preference heterogeneity approach can be applied to investigate the impact of socio-economic characteristics on preferences as well as may help to explain behavioural differences

between agents with similar wages but different characteristics (Creedy and Kalb, 2005a). van Soest (1995) shows that observed heterogeneity across agents (families specifically) can be linearly introduced through any parameter in the direct utility function.

In practice, different empirical studies incorporate preference variation across agents differently. van Soest (1995) introduces observed family heterogeneity through leisure of males and females as well as an interaction between both arguments. Keane and Moffitt (1998) apply parameterisation on the marginal disutility of work and the marginal disutility (i.e., costs) of welfare program participation. Coefficients for the taste of work show a number of children decrease labour supply significantly; some certain characteristics including older persons, having university education, having good health, and white race, positively impact female labour supply. Labeaga et al. (2008) incorporate observed heterogeneity on parameters of household income as well as hours worked of the household's head and the spouse. Regarding individual labour supply, the results show the age factor is the only observed characteristic which significantly affects marginal utility of income while none of them affects marginal utility of leisure. In terms of family labour supply, many of characteristics influence marginal utility of leisure hours for both heads and spouses with statistical significance but one characteristic (i.e., age of the spouse) has a significant positive effect on marginal utility of income. Callan et al. (2009) allow for observed preference shifters through husband's leisure and wife's leisure. The results shows age, unhealthiness, and number of children influence marginal utility of leisure for both genders whilst presence of a child under 5 years old affect marginal utility of leisure for females only. Kabátek et al. (2014) assume parameters of leisure hours and working hours of both partners to be functions of a vector of observed household socio-economic characteristics but they do not introduce any demographic characteristics into the household income parameter. Some interesting results are observed. Age negatively affects marginal utility of leisure and housework of both genders with statistical significance. A very young child has significantly negative effect on market work for both genders. Duncan and Harris (2002) as well as Creedy et al. (2002) apply similar methodology by

allowing observed heterogeneity across agents on linear and squared terms of income and leisure parameters as well as on the fixed cost constant; however, the instruments for the linear term, the squared term, and the fixed cost constant are different. Duncan and Harris (2002) show that several factors influence marginal utility of income and leisure for sole parents. For example, having a very young child and a number of children increase marginal disutility of work but reduces marginal utility of income for sole parents. Creedy et al. (2002) show that only few characteristics affect the utility for sole parents but many observed taste shifters significantly influence the utility at the household level.

Random heterogeneity can be incorporated into the model by including error terms to the expressions of arguments in the utility function. Previous empirical studies do not have any conclusive justification how to incorporate unobserved heterogeneity. Regarding studies which accounting for random heterogeneity terms, some of them only include a random term to a leisure hours argument such as van Soest (1995) and van Soest and Das (2001). Some studies incorporate random heterogeneity to only an income argument, e.g., Haan (2006) and Bargain et al. (2014). Some studies allow more than one random heterogeneity into their model; for sample, Duncan and Harris (2002) account for random heterogeneity at income and leisure hours arguments. Another example is Flood et al. (2007) which incorporate unobserved heterogeneity to income, leisure hours, fixed costs, and welfare participation[16]. It is infrequent to incorporate a random term to any squared term; Flood et al. (2004) allow for random heterogeneity to squared leisure hours besides leisure hours and welfare participation terms. Justifications for these specifications regarding unobserved heterogeneity are unclear. However, incorporating unobserved heterogeneity terms allows for larger degrees of flexibility with an assumption that decision agents (either individuals or households) have unobserved preferences, which are possibly different with statistical significance.

[16] Welfare participation is a term accounting for those situations when a decision agent participate a welfare program e.g. working support.

Typically, the random preference heterogeneity is assumed to be normally distributed with zero mean; some additional different assumptions on the correlation with other random heterogeneity terms, explanatory variables, and error terms can be found across a number of empirical studies. The results in previous works are also varied.

The first group of studies consists of those which do not incorporate correlation between random heterogeneity. van Soest (1995) incorporates random preference heterogeneity through leisure hours of males and females; these random error terms are assumed to be mutually independent (no correlation with other random terms and covariates), and normally distributed with zero mean. The results between models with and without random preference heterogeneity indicate that they are not significantly different; this could be because of inaccuracy in estimating standard deviations of the random heterogeneity terms and doubtfulness in the importance of including these terms. de Boer (2016) allows for random heterogeneity into leisure hours; however, it is assumed independent from other random terms and covariates. The results show that the random preference heterogeneity for singles is very close to zero without statistical significance. At household level, the random preference heterogeneity is statistically different across males but females.

The second group of studies includes those allowing random preference heterogeneity to be correlated. Keane and Moffitt (1998) allow random heterogeneity on both parameters (the marginal disutility of work and program participation); all error terms are assumed to follow the multivariate normal distribution with an unrestricted covariate matrix. The results suggest that random preference heterogeneity is significantly different across individuals. Duncan and Harris (2002) assume the stochastic heterogeneity to be jointly normally distributed with constant variances when they introduce random heterogeneity into models; they find some improvement in precision of preference parameters in the models with random heterogeneity; however, the values of parameters between models with and without random heterogeneity are slightly different. Kabátek et al. (2014) introduce unobserved heterogeneity terms which are normally distributed with zero mean with an arbitrary

covariance matrix. The results suggest that unobservable heterogeneity for leisure hours is greater than that for housework hours. In addition, their preferences positive correlated indicating assortative mating.

This chapter modifies Creedy et al. (2002) and Duncan and Harris (2002) strategy for incorporation of observed and unobserved heterogeneity. In fact, observed preference variation across agents is introduced into parameters of income and leisure hours at level and squared terms whilst unobserved random preference heterogeneity is incorporated at level terms of income and leisure hours. The assumption behind incorporation of unobserved heterogeneity is that people in general have their personal preferences on choosing the level of income and leisure hours; other terms such as squared terms and their observed characteristics aim to allow for larger degrees of model flexibility. However, for simplicity in the estimation process, this chapter assumes the random heterogeneity follows the normal distribution with zero mean and they are independent from any other terms in the model as done in many previous studies such as de Boer (2016).

Based on the quadratic direct utility function, the linear specifications of parameters for single individual labour supply are expressed as follows:

$$\beta_Y = \beta_{y0} + \beta_y' Z_y + \omega_y \quad (3\text{-}22)$$

$$\beta_L = \beta_{l0} + \beta_l' Z_l + \omega_l \quad (3\text{-}23)$$

where parameters with the subscript 0, namely, β_{y0} and β_{l0}, are the constant terms, parameters with a transpose sign represent a vector of coefficients, Z designates a vector of socio-economic characteristics, and the subscripts y and l indicate terms in the utility function including income and leisure respectively. The stochastic heterogeneity terms, ω, are as in Callan and van Soest (1996), assumed to follow the normal distribution with zero mean with a given standard deviation and they are not correlated with any other parameter. The set of socio-characteristics for taste variation for

income, Z_y, and leisure, Z_l, includes two dummy variables indicating if an individual is older than 40 years old[17] and if an individual has any Bachelor's degree or higher.

The functions of parameters for household labour supply are shown below:

$$\alpha_{YY} = \alpha_{yy0} + \alpha'_{yy} Q_{yy} \quad (3\text{-}24)$$

$$\alpha_{LL_m} = \alpha_{ll0_m} + \alpha'_{ll_m} Q_{ll_m} \quad (3\text{-}25)$$

$$\alpha_{LL_f} = \alpha_{ll0_f} + \alpha'_{ll_f} Q_{ll_f} \quad (3\text{-}26)$$

$$\beta_Y = \beta_{y0} + \beta'_y Q_y + \omega_y \quad (3\text{-}27)$$

$$\beta_{L_m} = \beta_{l0_m} + \beta'_{l_m} Q_{l_m} + \omega_{lm} \quad (3\text{-}28)$$

$$\beta_{L_f} = \beta_{l0_f} + \beta'_{l_f} Q_{l_f} + \omega_{lf} \quad (3\text{-}29)$$

The notations for household labour supply parameters are very similar to those for individual labour supply ones. The parameters with the subscript 0, namely, α_{yy0}, α_{ll0}, β_{y0}, and β_{l0}, indicate the constant terms in the linear expressions of labour supply parameters whilst those with a transpose sign and the subscripts yy, ll, y, and l are a vector of coefficients of socio-economic characteristics incorporated into the main coefficients in the utility function including income squared, leisure squared, income, and leisure respectively. The stochastic heterogeneity terms, ω, are identical to individual labour supply in which it is normally distributed with zero mean.

Socio-economic characteristics in observed preference variation across families for income squared, Q_{yy}, leisure squared for males, Q_{ll_m}, and leisure squared for females, Q_{ll_f}, are dummy variables for youngest child at different age ranges (younger than three years old, between three to six years old,

[17] A dummy variable rather than age or age categories is applied to capture an age characteristic for individual and household labour supply for two reasons. First, the model specifications follow Creedy et al (2002) and Duncan and Harris (2002) in which these papers apply an identical variable to capture an age characteristic for observed preference heterogeneity. Specified models are already complicated; applying variables for age categories additionally inflicts computational difficulties. Secondly, the results in the previous chapter suggests that labour supply behaviour changes drastically after the age of 40. Models incorporating a dummy variable if respondents are older than 40 also perform better than those incorporating variables for age categories (the results are available upon request).

and between six to ten years old). Observed household heterogeneity incorporates the same set of socio-economic characteristics for income, Q_y, leisure hours for males, Q_{lm}, and leisure hours for females, Q_y; six variables (five dummies and one variable) are included in the set of characteristics in which three of them are identical to those interacting with squared terms, the rest are a number of children, a dummy if an individual is older than 40 years old, and a dummy if an individual is holding Bachelor's degree or higher.

Child-related characteristics are not incorporated into any individual labour supply model because the sample used in estimation includes only unmarried lone individuals (without children). Hence, the individual labour supply models allow individual characteristics as observed heterogeneity at the level terms only (i.e., the models do not include any child-related characteristics at the level terms and there is no incorporation of observed heterogeneity at squared terms).

3.2.6 Modelling non-participation

Creedy and Kalb (2005b) state that the basic discrete hours labour supply model (as shown in Section 3.2.1), which does not allow for demand-sided restrictions, can lead to unrepresentative labour supply at some discrete hours points. In fact, labour supply models that do not consider non-participation (i.e., characteristics of hours points, hours restrictions, or fixed costs) typically yield under-predicted values for the number of non-workers and over-predicted values for the number of part-time jobbers which work few hours per week (Gong and van Soest, 2002; van Soest et al., 2002).

There are some examples of previous studies that apply different approaches to overcome this issue. van Soest (1995) introduces an *ad hoc* alternative specific constant, a penalty parameter which reduces utility and probability, on certain hours points (part-time jobs) in the direct utility function. The results indicate that this helps reduce hours prediction errors for those hours points. Woittiez (1991) applies the hours restrictions in specifying the model by determining a subset of the whole hours points to have positive probability; he defines a subset based on actual hours since all other possible job offers must yield a lower utility. Gong and van Soest (2002) include a parameter indicating

fixed revenues for non-working people in which positive fixed revenues raise the probability of choosing an alternative of zero worked hours by increasing the utility of labour market nonparticipation; this is beneficial when the translog utility function is applied. The results show that fixed revenue term is consistently positive across models. Some characteristics including age and presence of other female and young child have negative effects on fixed revenue for non-working, i.e., increase the probability of labour force participation. Other characteristics, e.g., the number of household's head children (under 12 years old), the number of elderly or disabled, and the number of adults (over 12 years old), positively affect fixed revenues.

Some recent works generally apply an estimated parameter, reflecting working fixed costs subtracted from net income, into the quadratic utility function. Creedy et al. (2002), and Duncan and Harris (2002), which estimate different models by degrees of flexibility, indicate that when researchers added a dummy for working to capture fixed costs to the model, it seems to absorb the influence of significant variables in the previous model. However, the results of fixed costs are inconclusive. Duncan and Harris (2002) and Callan et al. (2009) both interpret the fixed costs in financial term; the former find a significant result whilst the latter find a constant fixed costs is not statistically significant. Kabátek et al. (2014) show that the fixed cost terms of both genders have negative values with statistical significance. de Boer (2016) suggests an implication through fixed costs that working is disutility for individual and family labour supply. Labeaga et al. (2008) find mixed results; in fact, the fixed cost term has a positive significant value at the individual level but it does not have any statistical effect at the household level.

According to Creedy and Kalb (2005b), the *ad hoc* approach and fixed costs approaches are similar. Both parameters (an alternative specific constant and a fixed costs estimate) contain both pecuniary (e.g., childcare and traveling costs) and non-pecuniary costs (e.g., working stress) of working (Creedy and Kalb, 2005b; van Soest, 1995). It is cognizant of that since a parameter for fixed costs is presented in financial terms whilst an alternative specific constant is expressed in a utility unit; a concept of fixed

costs is intuitively more appealing than an *ad hoc* alternative specific constant. Another drawback of applying *an ad* hoc approach is that the parameterisation depends on the selected discretisation of the choice set. Models with different values of fixed interval length and numbers of alternatives in the choice set have different parameters; hence, results of various models with non-identical fixed interval lengths and numbers of alternatives in the choice set can no longer be compared (van Soest, 1995). Because of these reasons, most of the recent empirical studies apply a fixed costs method in the discrete hours labour supply model which is initially introduced by Callan and van Soest (1996). This chapter follows many existing studies by applying the concept of fixed costs in order to enhance goodness of fit to the observed labour supply.

To incorporate the fixed costs into the discrete hours choice labour supply model, this chapter follows Bargain et al. (2014) and Mauro et al. (2017), which are similar to previous literature, e.g., Duncan and Harris (2002) and Callan et al. (2009), by including a dummy variable representing whether an individual is working. In fact, only one dummy variable is added into the individual labour supply. With regard to the household labour supply model, three dummies for working males, working females, and both married partners working are added into the household direct utility function.

The fixed cost term when both married partners are workers is a new approach in the labour supply literature. Existing empirical studies include only two fixed cost terms for males and females. This chapter presumes that the household utility is significantly affected if both partners are working. For instance, they could save some travelling costs by going to work together by car; however, they possibly need to spend extra childcare costs.

Thus, the direct utility functions for individuals and households can be rewritten as follows:

$$U_{nj} = \alpha_{YY}Y^2 + \alpha_{LL}L^2 + \alpha_{YL}YL + \beta_Y Y + \beta_L L + Par_{nj} + \varepsilon_{nj} \quad (3\text{-}30)$$

$$\begin{aligned} U_{gj} = {} & \alpha_{YY}Y^2 + \alpha_{LL_m}L_m^2 + \alpha_{LL_f}L_f^2 + \alpha_{YL_m}YL_m + \alpha_{YL_f}YL_f + \alpha_{L_mL_f}L_mL_f \\ & + \beta_Y Y + \beta_{L_m}L_m + \beta_{L_f}L_f + Par_{mj} + Par_{fj} + Par_{bj} + \varepsilon_{gj} \end{aligned} \quad (3\text{-}31)$$

where Par is designated as fixed costs for alternatives in which an individual decides to participate in the labour market; regarding households, the parameter Par with subscripts m, f, and b indicate whether males, females, and both partners are labour market participants.

Theoretically, these fixed cost terms indicate expenses and disutility. Hence, they are definitely equal to zero for non-participants; nevertheless, they cost people differently based on socio-economic characteristics, such as the number of children at certain stages and living in the capital city, if people participate in the market. Duncan and Harris (2002) show that the incorporation of observed preferences variation across individuals for fixed costs is done to make the model more flexible; the log-likelihood ratio test suggest the improvement in terms of goodness of fit. Different empirical studies show that socio-economic characteristics influence the utility differently. Duncan and Harris (2002) indicate that an increase in the number of pre-school and school aged children decreases the fixed costs while living in New South Wales increases the fixed costs significantly. Callan et al. (2009) show that, for husbands, age reduces the fixed costs whilst unhealthiness increases the fixed costs. Regarding wives, age reduces the fixed costs but remaining factors including unhealthiness, the number of children with eligibility for child benefit and presence of children under 5 years old increases the fixed costs. de Boer (2016) suggests that the fixed costs of singles and single parents increase if they have a low educational attainment or a non-Western background. A dummy for the Western region (representing relatively high economic activity) has a positive and significant coefficient for single parents. The working fixed costs of household labour supply are greater for both partners when they have a low educational attainment or non-Western background. The fixed costs

of females living in the Western region are lower than those of people living outside. Labeaga et al. (2008) indicate that none of socio-economic characteristics statistically influence the fixed costs.

In this chapter, the fixed cost variables are hence allowed for observed preference variation across individuals through socio-economic characteristics. Thus, the fixed costs of labour market participation can be expressed as following functions.

$$\begin{aligned} Par_{qj} &= 0 \\ Par_{qj} &= \varphi_0 + \varphi_1 BKK + \varphi_2 PreS + \varphi_3 AS \end{aligned} \tag{3 -32}$$

where Par_{qj} is designated as the fixed costs (i.e., disutility of working); the subscript q can be replaced by n for individual labour supply and m, f, and b for family labour supply; BKK is a dummy variable representing an agent lives in the capital of Thailand; $PreS$ and AS designates the number of pre-school children (younger than 6 years old) and the number of children older than pre-school age (older than 6 years old).

However, for the individual labour supply setting, this chapter focuses only on single males and females without children. In other words, since they do not have any child, some socio-economic characteristics, i.e., $PreS$ and AS, are not applicable for the individual labour supply context.

To reduce the computational burden, this chapter does not allow unobserved heterogeneity through fixed cost terms. Most studies do not incorporate any random heterogeneity, through the fixed costs, into models (Löffler et al., 2014b). Creedy et al. (2002) is an example allowing random heterogeneity into labour supply models.

3.2.7 Maximum simulated likelihood

The estimation procedure described in Section 3.2.1 (i.e., the maximum likelihood estimation for the conditional/multinomial logit model) would be straightforward if all actual wages and random taste heterogeneity terms were completely observed (Callan et al., 2009). The issue of unobserved wages

can be approached by a Heckman selection type of model to predict wages for the whole sample and treat them as exogenous (Kabátek et al., 2014). For other error terms that are unobservable, introducing random heterogeneity into the model complicates the maximum likelihood estimation procedure; the standard maximum likelihood estimation for conditional/multinomial logit can no longer be applied (Gong and van Soest, 2002). With these terms in the structural discrete hours choice labour supply model, the likelihood contribution is not simply given as the conditional/multinomial logit expression, (3 -11). It is instead given by the mean value of the appropriate expression based on (3 -11) with the mean which are taken over the unobserved random terms. As the specified models in this chapter have up to six unobserved errors, this indicates that up to a six-dimensional integral is required. Approximation on such a complex integral by applying conventional numerical (quadrature) routines is cumbersome and intractable; hence, a more convenient approach is maximum simulated likelihood.

In this chapter, the estimation procedure applies a mixed logit model which is very flexible model providing estimation on any random utility model (McFadden and Train, 2000). As described in Train (2009), the probabilities are approximated by simulation for any given value of parameters of the distribution, θ, (e.g. the mean and covariance of coefficient). The first stage is to draw a value of each unobserved errors from the distribution (such as multivariate normal), and then label it as r^{th} draw, $r = 1$ is the first draw. The next step is the calculation of the conditional/multinomial logit formula with the r^{th} draw. The last step is to repeat the first and second steps for a number of independent times (the total number of draws is defined as R), and average the results from R draws in order to obtain $\check{p}_{aj}$ (known as the simulated probabilities) which is an unbiased estimator of p_{aj} by construction. According to the law of large numbers, as R becomes large, the approximation is accurate (the variance of $\check{p}_{aj}$ decrease). There are three major characteristics of $\check{p}_{aj}$. First, it is strictly positive hence $\ln(\check{p}_{aj})$ can be defined; the log transformation is useful for log-likelihood approximation. Second, $\check{p}_{aj}$ is smooth (twice differentiable) in parameters θ and variables in the utility

function; this offers efficiency in the numerical search for the maximum likelihood function as well as the calculation of elasticities. Last but not least, the summation of $\check{p}_{aj}$ over alternatives is equal to one; this is beneficial for forecasting.

After obtaining the simulated probabilities, they are included into the log-likelihood function to yield a simulated log-likelihood function expressed as follows:

$$SLL = \sum_{a=1}^{A} \sum_{j=1}^{M} d_{nj} \ln(\check{p}_{aj}) \tag{3 -33}$$

where d_{nj} is an indicator variable which gives a value equal to 1 if an agent a choose alternative j and zero otherwise.

Because the simulated maximum likelihood requires high computational capacity and a long period of time, this chapter hence applies 100 draws from Halton sequence in the estimation process as done by Kabátek et al. (2014) and Bargain et al. (2014). Five models and seven models are estimated for individual and family labour supply respectively. Later on, estimation with 500 Halton draws is performed for the preferred model at individual and household level to investigate the sensitivity for different numbers of draws.

3.2.8 Empirical estimation scenarios

This section provides a description of the different estimation models for individual and household labour supply. Labour supply models are differently specified based on the degree of flexibility in order to find the preferred model for the Thai dataset.

With regard to individual labour supply models, four different models are estimated for each sub group (males and females). TABLE 3.1 presents different individual labour models with different degrees of complexity.

TABLE 3.1: Estimation models for individual labour supply

	I1	I2	I3	I4
Income-squared	/	/	/	/
*socio-economic characteristics				
Random hetero				
Leisure-squared	/	/	/	/
*socio-economic characteristics				
Random hetero				
Income*leisure	/	/	/	/
Income	/	/	/	/
*socio-economic characteristics			/	/
Random hetero		/	/	/
leisure	/	/	/	/
*socio-economic characteristics			/	/
Random hetero		/	/	/
Fixed cost each person	/	/	/	/
*socio-economic characteristics				/

The fixed costs term is incorporated into every model since it has been shown that labour supply models that do not account for participation do not yield accurate labour supply estimation (Gong and van Soest, 2002; van Soest et al., 2002). The first model called I1 is the simplest model among all estimation models. It consists of each argument in the utility function, namely, squared income, squared leisure, interaction between income and leisure, income, and leisure; it also includes a fixed costs term. The second model (Model I2) introduces two additional terms capturing random preference heterogeneity for income and leisure into the first model. The next model, which is Model I3, incorporates observed preference heterogeneity for income and leisure into Model I2. The last model is the most flexible model of individual labour supply in this study. This model extends the Model I3 by including observed taste shifters of the fixed costs.

In terms of household labour supply, six different labour supply models with different degree of complexity are estimated. TABLE 3.2 provides the summary of six different models.

TABLE 3.2: Estimation models for family labour supply

	H1	H2	H3	H4	H5	H6
Income-squared	/	/	/	/	/	/
*socio-economic characteristics				/	/	/
Random hetero						
Leisure-squared	/	/	/	/	/	/
*socio-economic characteristics				/	/	/
Random hetero						
Income*leisure	/	/	/	/	/	/
Leisure*leisure	/	/	/	/	/	/
Income	/	/	/	/	/	/
*socio-economic characteristics			/	/	/	/
Random hetero		/	/	/	/	/
leisure	/	/	/	/	/	/
*socio-economic characteristics			/	/	/	/
Random hetero		/	/	/	/	/
Fixed cost each person	/	/	/	/	/	/
*socio-economic characteristics				/	/	/
Random hetero					/	/
Interactions between fixed cost					/	/
*socio-economic characteristics						/

All models are incorporated with the fixed cost terms, similar to individual labour supply. There are fixed costs for each partner in all models. This is to prevent over-predicted and under-predicted results at some hours points. The first model, Model H1, is the simplest model which includes only a basic utility function with fixed costs terms for males and females. The utility function contains 1) squared terms of household income, male leisure, and female leisure, 2) interaction between income and leisure for males, 3) interaction between household income and leisure for females, 4) interaction between leisure of males and females, 5) Household income, 6) male leisure hours, and 7) female leisure hours. The second model called Model H2 adds to Model H1 by allowing additional terms which capture random heterogeneity on income and leisure hours for both partners. The next model, Model H3, includes some additional terms, i.e., observed taste preferences for household income, male leisure, and female leisure, into Model H2. The fourth model, Model H4, is more complex than Model H3 because the former allows for observed heterogeneity terms for squared-terms as well as fixed costs terms. The fifth model, which is named as Model H5, includes one additional term into Model H4 to capture the fixed costs if both partners are working on the household utility function. The last

and most complex model, Model H6, extends Model H5 by allowing observed taste shifters into a fixed costs term if both partners are workers to capture how socio-economic characteristics influence labour force participation.

3.3 Empirical data and predicted wages

3.3.1 Descriptive statistics of Thailand HSES

This chapter uses the dataset obtained from the HSES covering year 2009, 2011, 2013, and 2015. This is the same dataset used in the previous chapter. However, the research questions and analysis in this chapter differ from the previous one. Hence, the sample used in both chapters are different.

At the outset, this chapter follows the first step of the data-cleaning process in the preceding chapter (Section 2.3.1). However, this chapter accounts for people who report unrealistic hours worked (e.g., too long hours worked) as well. The remaining number of observations is 405,124 people, i.e., 140,908 households.

TABLE 3.3: The total number of observations by gender

Gender	Observations	percent
Male	189,678	46.82
Female	215,446	53.18
Total	405,124	100

With respect to genders, TABLE 3.3: The total number of observations by gender shows that 189,678 males (46.82%) and 215,446 females (53.18%) are included in this dataset.

TABLE 3.4: The total number of observations by year

Year	Observations	percent	Households	percent
2009	105,694	26.09	34,806	24.70
2011	102,766	25.37	35,150	24.95
2013	99,043	24.45	35,313	25.06
2015	97,621	24.10	35,639	25.29
Total	405,124	100	140,908	100

In TABLE 3.4, it is apparent that this dataset has very balanced proportion across years in the studied period. The percentage of total observations for year 2009, 2011, 2013, and 2015 are 26.09, 25.37,

24.45, and 24.10 respectively. In terms of the number of households, the percentages are 24.70, 24.95, 25.06, and 25.29 for the year 2009, 2011, 2013, and 2015 respectively. The opposite trends between the total number of observations (gradually declined) and households (steadily increased) imply that the size of Thai family in general shrinks continuously throughout the studied period.

This chapter focuses on investigating individual and family labour supply behaviours using the discrete hours choice model. To prevent complexities on econometric model specification and statistical computation, this chapter initially opts to keep households with one adult for the individual labour supply and households with a married couple without any other adults for the family labour supply. These households may include dependent sons and daughters.

In turn, those households which consist of more than one adult but they are not a married couple are dropped from the analysis. Households with a married couple are categorised as a family labour supply sample whilst households with a married couple and any other adults are excluded from the analysis as well. The initial number of one-member households is 27,755, and the original number of households with one married couple is 104,315. The details of sample construction for individual and household labour supply are provided in Section 3.3.3 and 3.3.4 respectively.

Before describing the samples for individual and family labour supply study, brief information on the hypothetical net income calculation is provided in the following sub-sections.

3.3.2 Calculation of the net income at each discrete point

Net incomes are not directly observed but are calculated from knowledge of the predicted hourly wage of each individual, discrete hours points, and the tax and transfer system. According to the Thai revenue code, there are eight main income types called assessable incomes[18] in the Thailand personal income tax system. However, Thailand HSES covers only four types of income which include 40(1),

[18] Eight assessable income types are taken into account for personal tax income tax calculation; there are some types of income are tax-exempt.

40(3), 40(4), and 40(5) in the revenue code. Details about assessable incomes are in Appendix 3.II. Obtaining net income at each discrete point for each decision maker requires five main steps.

Firstly, after the predicted hourly wages are obtained and applied for all individuals in the sample, weekly earned incomes for different discrete hours points for each individual are generated by multiplication of the predicted hourly wage by the weekly hours worked at each discrete hours point (11 points in total). Since income tax is levied on an annual basis, yearly earned income for different hours alternatives are calculated by multiplying weekly earned income with 52.142857 weeks, 365 days in a year divided by 7 days per week. Information about unearned incomes is available in the yearly basis. The summation of earned and unearned income gives the gross income.

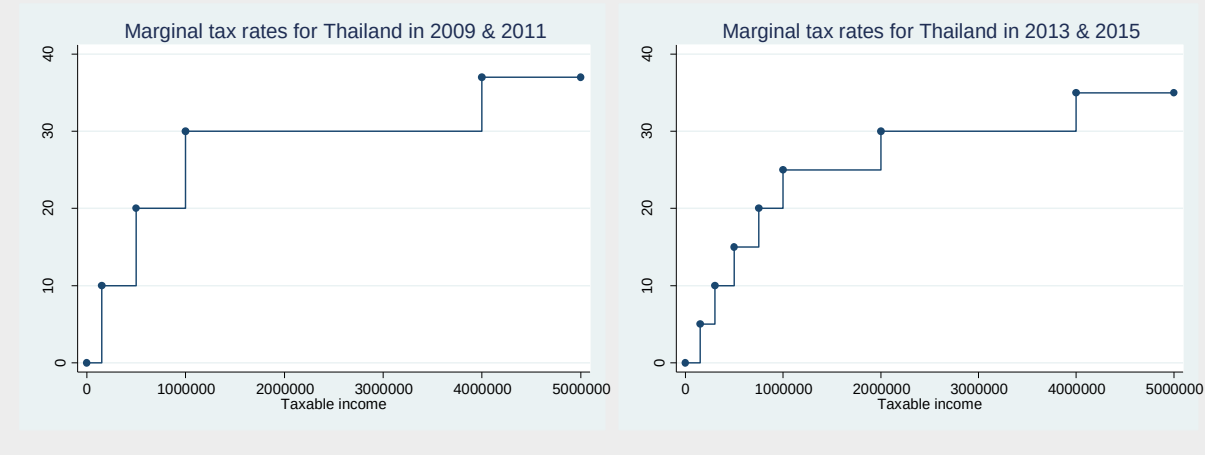
Secondly, incomes after allowable expenses are calculated by subtracting allowable expenses from the assessable income. The allowable expense for earned income, 40(1), or income from intellectual properties, 40(3), is 40 percent of total earned income but it must not exceed 60,000 baht. Income from financial investment, 40(4) does not allow for any tax calculation expense. Income from rent of property, 40(5), allows for different rates of expenses depending on property type; this study applies the average rate since HESE does not identify property types. This calculation is straightforward at the individual level, but it becomes more complicated at the household level due to changed tax rules of joint filing. Tax rules on joint tax filing changed in 2012 (details in Appendix 3.II), after which couples have options for tax filing (separate, partly-joint, and joint). Couples are assumed to have perfect information of these taxation rules; they will select the option that makes them pay the least amount of personal income tax.

Thirdly, summation between yearly earned, 40(1), and unearned, 40(3), 40(4), and 40(5), incomes after expenses deduction yields the total assessable incomes after expenses (i.e., taxable income). It is apparent that this income amount varies across hypothetical hours choices due to variation in yearly-earned income. Unearned incomes, on the other hand, remain unchanged across hours points and they enter at the household level.

Next, allowances and exemptions are deducted from the total taxable income yielded in the second step. Regarding personal allowances, there is only one possibility at the individual level whilst six different scenarios of total taxable incomes after expenses and allowances due to different approaches at the household level[19]. In this empirical work, disability allowance and retire-aged allowance are not applicable for the calculation as the sample does not include any disabled or retirement-aged adult. For households with children, a taxpayer is allowed to deduct the child allowance from the remaining taxable income; when a child is disabled, an extra amount of allowance is added. At the end of this step, the net taxable incomes at available hours points are subsequently obtained.

Lastly, tax computation for each hours points is carried out. As shown in FIGURE 3.1, because of tax brackets and tax rates amendment in 2012, there are two tax calculation systems (four brackets in 2009 and 2011, and seven brackets for 2013 and 2015) in this chapter.

FIGURE 3.1: Marginal tax rates for Thailand from 2009 to 2015



In practice, the tax calculation strictly follows the actual tax brackets. There are four tax brackets including 10, 20, 30 and 37 percent for year 2009 and 2011 whilst there are seven tax brackets, namely, 5, 10, 15, 20, 25, 30, and 35 percent for year 2013 and 2015. The detailed information of the tax base and tax rate at each tax bracket for two different scenarios are provide in Appendix 3.II, Section 3.7.4.

[19] This chapter accounts separate tax filing, partly-joint tax filing, and joint tax filing for husbands and wives.

Different levels of net income are reported at different hours points; thus, taxed amounts are usually different across hours except when the taxable income after allowances and deductions does not exceed the exempted amount. Regarding individual labour supply, the total amount of income tax burdens is subtracted from total gross incomes per annum for each hours point to give the disposable income. Each individual hence has 11 points of incomes for 11 hours points. For household labour supply, there are net incomes for males and females (each has 11 hours points). The summation of these two amounts yields the household disposable income at each combination; there are 121 possibilities of the household net income in total.

3.3.3 Single individual households

With regard to data cleaning for the analysis, the most straightforward and simplest household type is one-member households, in which they are unmarried individuals without children. From total 27,755 one-member households, 8,950 households are eligible for the estimation process. The details of the cleaning process are shown as the following

TABLE 3.5: The sample construction process for single individuals

Process	Drop	Remain
Initial observations	-	27,755
Non-labour force	15,213	12,542
Marital status	2,808	9,734
No predicted wage	205	9,529
Disabled	129	9,400
Retire-aged	450	8,950

From TABLE 3.5, the initial number of one-member households is 27,755. Firstly, those people who are not defined as potential labour force due to age (younger than 15 years old) and work status (e.g. doing business, having own-account, and studying) are excluded (15,213 individuals) from this chapter. Secondly, for all married people living alone, it is assumed that their spouses migrate to work. Unfortunately, data on migrating people are not available for the analysis; hence, all such people who indicated their status as married are dropped. Next, people without predicted wages are excluded from the study; 205 single individuals are deleted at this step. Lastly, disabled people (129 individuals)

and people who are older than or equal 65 years old (450 individuals) are excluded. The total number of one-member households for analysis is 8,950 which comprise 4,456 males and 4,494 females.

FIGURE 3.2: Discrete hours worked distributions for unmarried individuals

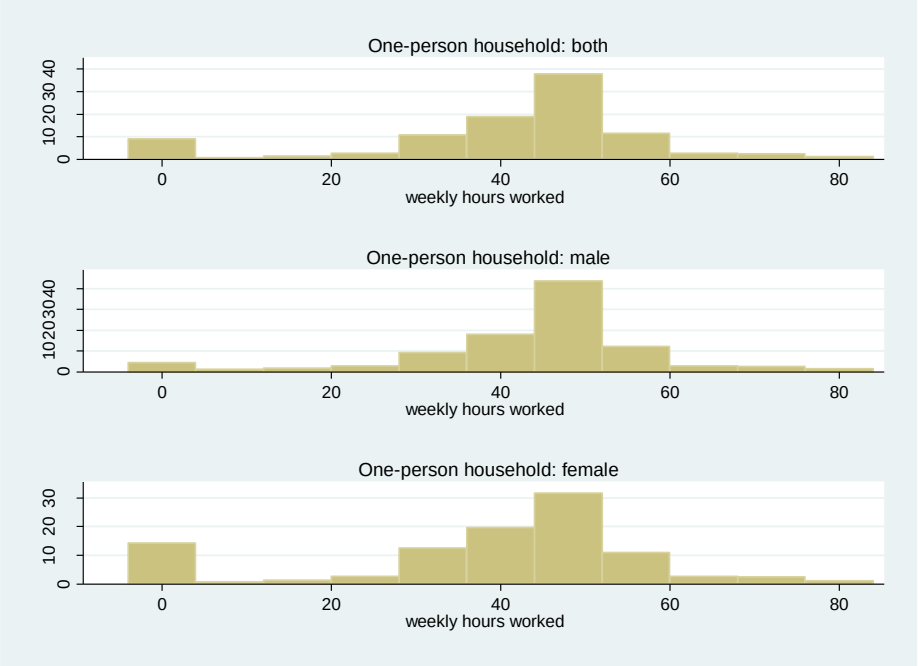


FIGURE 3.2 shows hours worked of single-individual households by gender; each bar represents an hours choice as applied in the analysis as discussed in 3.2.1. The top panel shows the selected hours worked of both genders; the mode is 48 hours per week which account for 37.72 percent of the whole sample. The second most significant proportion of people, 18.84 percent, worked 40 hours per week. The next largest group, 11.58 percent, is people who worked 56 hours per week. 9.26 percent of the whole sample selected not to work at all.

The middle panel presents hours worked of unmarried male individuals; 43.76 percent of males selected to work 48 hours per week. The second largest group, 17.95 percent, worked 40 hours weekly. The next largest group which shares 12.21 percent selected to work 56 hours per week. Non-working males share 4.23 percent of the male sample.

The last panel is the histogram of weekly hours worked for females. Similar to males, the largest proportion is 48 hours per week which accounts for 31.73 percent. The second largest group of

females, i.e., 19.72 percent, chose an alternative of 40 hours worked. The third largest proportion which is 14.20 percent who select to be non-participants in the labour market.

TABLE 3.6: Descriptive statistics of unmarried individuals by gender

	Males		Females	
Observations	4,456		4,494	
Variables	Mean	S.D.	Mean	S.D.
Predicted wage[H]	63.69	38.31	65.27	50.83
Earned income[Y]	142.03	87.75	131.74	111.32
Unearned income[Y]	1.89	17.84	3.84	28.52
Total income[Y]	143.92	90.60	135.59	115.30
Disposable income[Y]	143.48	87.83	135.43	112.51
Age	36.88	10.97	41.06	12.51
Age$\geq$ 40	0.3638	0.4811	0.5151	0.4998
University degree	0.2078	0.0458	0.3674	0.4821
Bangkok	0.1075	0.3098	0.0801	0.2715

[H] Predicted hourly wage in baht; [Y] yearly basis income in thousand baht.

TABLE 3.6 shows the descriptive statistics for key variables. The average predicted hourly wage for males and females are 63.69 and 65.27 baht respectively. Even though females have a higher predicted wage than males on average, males generally earn more than females; this is due to males usually spend longer hours working. The average earned incomes for males and females are 142.03 and 131.74 thousand baht respectively. The unearned income of female (3.84 thousand baht) is greater than it of males (1.89 thousand baht). As the result, unmarried males have a larger amount of the total annual income (as well as the yearly disposable income) than unmarried do females overall. Another notable point is that the discrepancy between the total income and the disposable income is very minute. This indicates that in general unmarried Thai people pay a very small amount of income tax. This is not surprising since the total personal tax has been about 2 percent of Thailand GDP since 2000.

Regarding important socio-economic characteristics, the first one is an individual's age; the average age of single males is 36.88 years old whilst that of single females is 41.06 years of age. However, an age variable is not included in the model; this chapter applies the next characteristics indicating if individuals are older than 40 years of age; the numbers show 36.38 percent of single males and 51.51 percent of single females. In addition, 20.78 and 36.74 percent of males and females hold university

degree respectively. These factors (age and education attainment) possibly imply why the average hourly wage of females is greater than that of males, because age and education are key factors determining wages. In addition, males with higher wages are more likely to get married while single females usually must rely economically on themselves. The final row indicates that 10.72 and 7.98 percent of males and females live in Bangkok, the capital city of Thailand.

3.3.4 Married couple households

This chapter also investigates family labour supply. TABLE 3.7 below presents the sample construction process for the analysis at the household level.

TABLE 3.7: The sample construction process for households

Process	Two-member		Three-member		Four-member		Five-member	
	Drop	Remain	Drop	Remain	Drop	Remain	Drop	Remain
Initial obs.	-	39,391	-	30,931	-	22,531	-	11,498
Couple	14,335	25,056	19,705	11,226	14,787	7,744	9,997	1,501
Labour force	17,332	7,734	6,558	4,668	4,614	3,130	938	563
Gender issue	70	7,664	13	4,655	4	3,126	3	560
Marital status	34	7,630	10	4,645	6	3,120	0	560
No wage	176	7,454	110	4,535	108	3,012	21	539
Disabled	75	7,379	33	4,502	27	2,985	3	536
Retire-aged	185	7,194	28	4,474	4	2,981	0	536

In TABLE 3.7, 39,391 of households in the HSES consist of two adults. This chapter focuses on the 25,056 households who are married couples, hence, 14,335 households are dropped because they are other types of households e.g. two-individual and sole-parent households. Next, the couples in the analysis must be labour supply decision makers. In other words, the family will be excluded from the study if any person is not a decision maker in the labour market, for instance, either of them is working as a business owner or own-account. This is because the HSES contains hours worked for workers only. This step reduces the sample to 7,734 households.

Same gender marriage has not been legal in Thailand; hence, these people could not claim any tax benefit as married couples. In turn, 70 households are dropped. Cohabiting couples (34 households) are also dropped because these people are legally the same as two independent individuals. Next, people without predicted wages are taken into consideration; 176 households are excluded at this

stage. There are 75 and 185 households dropped from the study because either of partners is disabled or older than 65 respectively. The final remaining observations for two-member households with a married couple are 7,194.

For three-member households, this chapter aims to obtain households consisting of a married couple with a dependent child. In TABLE 3.7, from 30,931 initial households having three members, 11,226 of them are those contain a couple and one dependent child. However, some additional issues need to be considered. First, both spouses are expected to be labour supply decision makers. Households with anyone who is not a decision maker in the labour market are dropped; 4,668 households remain at this stage. Second, when both partners have the same gender, the household is excluded from the study; there are 13 households dropped due to this cause. The main reason dropping these households is that these couples are equivalent to two separate individuals in the income taxation regard. Third, since only married couples are eligible to acquire certain tax-benefits, ten cohabiting households are excluded. If any of partners does not have a predicted wage, the entire household will be dropped from the analysis. Hence, in this step, 110 households are deleted. Next, when any of couples is disabled, a household is excluded; hence, 33 households are taken out from the sample. The final step is accounting for retired people; both partners are expected to be of the working age, leading to 28 households being dropped. This leave 4,474 observations for three-member households.

There are 22,531 households having four members; nonetheless, 7,744 of them comprises of a couple and two dependent children. The same process of the sample construction is still applied to this type of households. It starts with the issue of labour market decision makers; 3,130 households meet this requirement, both partners are decision makers in the market. The second step is accounting for partners of the same gender; four households are dropped because of this issue. Thirdly, six additional households are excluded since they are cohabiting households. Next, 108 households are excluded since any member of married couples does not have any predicted wage. Fifthly, 27 families are dropped due to having any disabled person in the couple; and four additional household are excluded

because an adult is older than 65 years of age. The remaining sample of four-member households is 2,981.

In TABLE 3.7, the final group is five-member households. From 11,489 five-member households, 1,501 of them comprise of one couple and three dependent children. Similar to previous sub-samples, there are few more steps to get the final observations for estimation. Firstly, when an adult in the household is not a labour supply decision maker, that household is not included in the study; 968 households fail to fulfil this requirement. Secondly, 3 additional households are cut because the both partners share the same gender. Thirdly, issues on cohabiting households are considered; however, zero observation are excluded on these aspects. The next step is to deal with people without predicted wages; 21 households are excluded. Then, three families are dropped because any person of married couples is disabled. There are zero household having a retirement-aged issue; the final number of observations with five-member households is 536 households.

In summary, the total number of sample for family labour supply using the discrete hours choice model is 15,231 households. There are the two major reasons why this chapter stops acquiring more observations when family size gets bigger than five members. First, the number of observations acquired from the larger family sizes is small. In fact, only 536 households are obtained from five-member households. The number of obtained observations becomes smaller for bigger families whilst it requires more complicated computer processes to extract legitimate observations from those larger families. Secondly, the reason is the Thailand tax rules which allow a certain number of children to be eligible for child allowance. When a number exceed three children, the rules become very complex. This could cause a lot of time to handle a small number of households. Besides that, this possibly causes an error in after-tax income calculation leading an error in the estimated result. For simplicity and efficiency, the sample for family labour supply includes households which are not larger than five persons.

FIGURE 3.3: Discrete hours worked distributions for couples

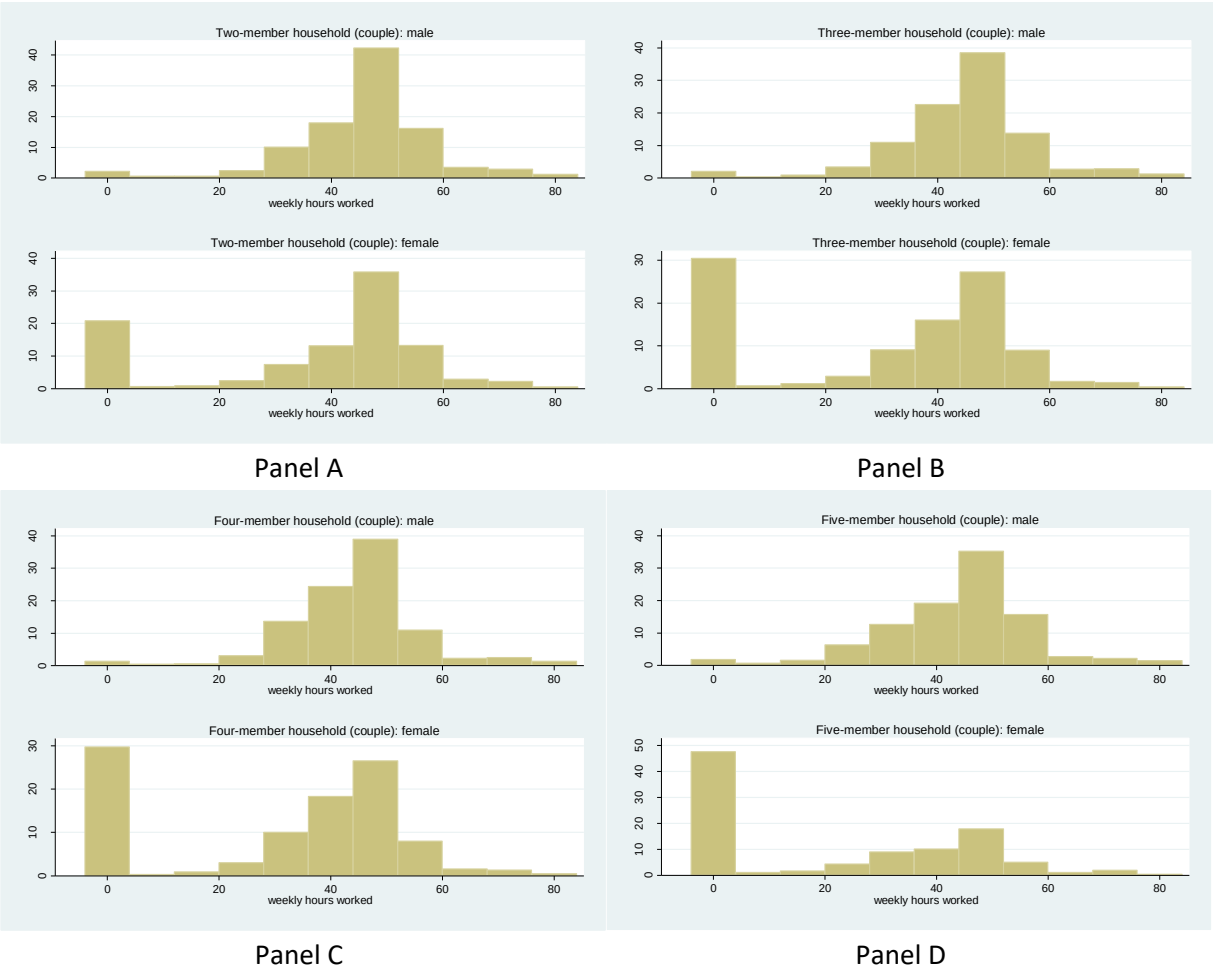


FIGURE 3.3 exhibits histograms of selected worked hours of four different household types by size for family labour supply analysis. Alphabetically, Panel A, B, C, D present histograms for two-member, three-member, four-member, and five-member respectively; the upper graph for each panel is the distribution for males whilst the lower one is the distribution for females. Overall, the shapes of distributions look similar across different household sizes. The most prominent spike of all males in any household type is working for 48 hours weekly.

In Panel A, 42.26 and 35.81 percent of males and females respectively select to work about 48 hours per week. The next two favourite choices for males in two-member households are 40 hours and 56 hours per week at 17.95 and 16.14 percent respectively. Only 2.21 percent of males choose not to participate in the labour market at all. On the other hand, 20.86 percent of females offer zero hours

worked; this is the second most significant proportion. Then, 13.25 and 13.21 percent of females select to work 56 and 40 hours per week respectively.

In Panel B, The largest selected alternative for males is to work about 48 hours per week (38.56 percent) whilst the largest group of females select to be non-working (30.46 percent). With respect to males, the distribution is similar to that shown in Panel A, two-member households; the most popular choices are 40 hours (22.66 percent) and 56 hours (13.86 percent). Male non-participants are only 2.08 percent of males decide to be non-participant in the labour market. Considering hours worked of married females in three-member households, the 30.46 percent prefer to supply zero hour in the labour market; 27.29 percent decide to work 48 hours per week. The next largest proportions are those selecting to work 40 hours (16.00 percent) and 56 (8.99 percent).

Next, Panel C shows the hours distributions for four-member households. Similar to Panel B, while most of the males decide to work at 48 hours per week (38.95 percent), most of the females choose to provide zero hours labour supply (29.72 percent). Regarding males, the next two popular choices for male labour supply decision makers are 40 hours (24.42 percent) and 32 hours (13.72 percent) per week respectively. A very small number of males (1.41 percent) are inactive in the labour market. The second largest group of females (26.50 percent) decides to work for 48 hours per week. Then, 18.32 and 10.00 percent of females choose to work for 40 hours and 32 hours per week respectively.

The last panel, Panel D, shows the distributions for five-member households. As in the previous panels, the largest proportion for male observations is to work 48 hours per week (35.26 percent). The biggest group of females (47.57 percent) chooses to be inactive in the labour market, i.e., zero hours per week. In terms of males, the next two largest groups are similar to what presented in Panel A and B; they select to work 40 and 56 hours worked per week at 19.22 and 15.67 percent respectively. Only 1.87 percent of male observations are labour market non-participants. For females, the second largest proportion (17.91 percent) selects to work 48 hours per week; 10.07% and 8.96% decide to provide weekly labour supply at 40 and 32 hours respectively.

In conclusion, the distributions are similar across different household sizes, especially for male observations. Most of the males tend select to work 48 hours per week in all panels. Concerning females, when households comprise of a couple only, females tend to work more. However, when households have any child, a large proportion of the females decide to work zero hours. Having a child or children is presumed to have an impact on the labour supply decision. It is apparent for females that they are more likely to opt to be inactive in the labour market when they have a child or children.

TABLE 3.8: Descriptive statistics of couples by family size

	Two-member		Three-member		Four-member		Five-member	
Observation	7,230		4,474		2,981		536	
Variables	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Predicted wage[H] (M)	72.02	53.07	72.89	50.13	78.01	51.54	69.46	45.70
Predicted wage[H] (F)	55.26	44.65	55.35	42.33	58.34	41.03	49.15	35.40
Earned income[Y] (M)	163.20	109.49	162.70	106.43	174.94	115.28	155.92	108.41
Earned income[Y] (F)	105.78	99.91	93.44	101.73	100.12	102.44	64.85	90.49
Unearned income[Y]	4.11	25.82	3.96	31.09	5.84	34.13	3.50	21.10
Total income[Y]	273.10	191.16	260.11	185.84	280.90	197.07	224.27	173.86
Disposable income[Y]	272.31	189.20	258.91	181.13	280.06	193.01	223.95	170.25
Age (M)	40.69	11.25	40.72	8.98	40.84	7.16	40.67	6.36
Age (F)	38.52	11.26	37.55	8.92	37.70	6.74	36.96	6.15
Age$\geq$ 40 (M)	0.5079	0.5000	0.5463	0.4979	0.5713	0.4950	0.5933	0.4917
Age$\geq$ 40 (F)	0.4479	0.4973	0.4350	04958	0.4029	0.4906	0.3489	0.4771
University degree (M)	0.1854	0.3887	0.2034	0.4026	0.2529	0.4348	0.1884	0.3914
University degree (F)	0.2007	0.4006	0.2204	0.4146	0.2627	0.4402	0.1623	0.3691
Bangkok	0.1186	0.3233	0.0975	0.2966	0.0939	0.2918	0.0877	0.2831
Youngest child$<$ 3	-	-	0.1757	0.3806	0.1989	0.3993	0.3638	0.4815
Youngest child 3-6	-	-	0.1623	0.3687	0.1926	0.3944	0.2164	0.4122
Youngest child 6-10	-	-	0.1806	0.3844	0.2664	0.4421	0.2239	0.4172
Number of								
- children	-	-	1.00	0.00	2.00	0.00	3.00	0.00
- pre-school child	-	-	0.3380	0.4731	0.4626	0.6253	0.7351	0.7109
- school-aged child	-	-	0.6620	0.4731	1.2868	0.6434	1.6679	0.7063
- disabled children	-	-	0.0110	0.1041	0.0117	0.1167	0.0168	0.1286

[H] Predicted hourly wage in baht; [Y] yearly basis income in thousand baht.

TABLE 3.8 shows important descriptive statistics, including pecuniary factors such as predicted wages and disposable income, personal characteristics of couples, e.g., age and education, and household composition characteristics, e.g., the age of the youngest child and number of pre-school children.

From TABLE 3.8, the average predicted wage of males is greater than that of females. Five-member households have the lowest predicted wages of males at 69.46 baht per hour whilst four-member households have the highest predicted wages of males at 78.01 baht per hour. The average predicted wage of females from four-member families is also the greatest (58.34 baht per hour) among households with different numbers of members. The lowest average predicted wage of females is for five-member households at 49.15 baht per hour. Comparison between unmarried and married individuals show that wages of unmarried males are less than wages of married males in general; the opposite relationship is found in the female case.

Regarding yearly earned income, it is apparent that males earn more income than females do on average because male wages are higher than female wages. Also, hours distributions show that males tend to work longer and participate more in the market than females. Female behavioural change in labour market participation affect earned income, for example, the mean of female earned income of households without children is greater than that of households with one child although the average wage rates are very similar. This is mainly because a proportion of non-working females are different between these types of households.

Unearned income, which is presented in a household basis, shares a small percentage of total income (i.e., the summation between earned and unearned incomes). The average values of two-member and three-member households are very similar (4.11 and 3.96 thousand baht per annum respectively). Average unearned income increases to 5.84 thousand baht per annum for four-member households; however, that of five-member households is lower than other types of families at 3.50 thousand baht per year.

Total income is the summation of earned and unearned incomes. Disposable income (the total income after tax) is the crucial variable in labour supply analysis. Disposable income is consistent with earned income since the latter shares a large proportion of after tax income.

There are two concluding remarks for financial information. First, the difference between the total income and the disposable income for each household type is very small. This depicts the similar picture as observed from unmarried individuals that on average Thai married couples pay small amounts of tax. In other words, tax rules barely leads to disposable income variations. This is consistent with the information that since year 2000 the total amount of personal income tax on GDP is approximately 2 percent in Thailand. Second, the information about income by family size implies that families with three children are less wealthy than other family types.

With regard to socio-economic characteristics, there are several important variables relevant to this chapter. The average age of males and females are similar across different types of households (ranging from 40.67 to 40.84 years old for males and from 36.96 to 38.52 years old for females). Married males are usually older than married females; this is opposite to the pattern of unmarried individual shown in TABLE 3.6. This make the proportions of individuals who are at least 40 years old are different between the samples for individual and household labour supply models.

In TABLE 3.8, a dummy variable indicating if a person is 40 years old and over across household types at the family level suggests an interesting pattern. In fact, percentages of males aged over 40 are positively correlated to a number of children whilst the correlation between the percentages of females older than 40 years and a number of children is negative. This suggests that age gap between both genders may affect the number of children. It also indicates the two mating patterns in Thailand. First, couples with a narrow age gap are generally those who have similar mediocre economic statuses. They both usually work and focus on economic achievement. This Second, couples with a larger age gap are usually those consist of a man with good economic status and a younger woman. In this type of couples, a man works for the whole family whilst a woman is usually responsible for domestic duties and childcare. This characteristic is different between individual and household levels. Whilst the proportion of unmarried males who are older than 40 is smaller than that of females, the opposite result is observed for married couples.

TABLE 3.8 shows that the percentages of males who are holding any university degree are 18.54, 20.34, 25.29, and 18.84; on the other hand, the percentages of females graduated from a university are 20.07, 22.04, 26.27, and 16.23 for households with two, three, four, and five members, respectively. Comparison between TABLE 3.6 and 3.8 reveals the fact that whilst the proportions of males with a university degree are similar across all household types, the proportion of unmarried females holding a university degree is clearly greater than that of married females.

It is also noticeable in TABLE 3.8 that four-member households have the largest proportion of couples with a university degree; this could help explain why average predicted wages of them for both partners are higher than others. Regarding five-member households, the percentage of males holding a university is quite low whilst the percentage of females with a higher education is smallest among all types of households; this also implies why their average predicted wage rates are the lowest among their counterparts. Another point is that the percentage of females holding a university degree is usually greater than that of males except for those in five-member households. This reflects the fact in Thailand that women with adequate educational opportunities tend to continue study in the university. On the other hand, many men decide to enter the labour market or study in vocational institutes.

The percentage of families without children which live in Bangkok is 11.86 percent which is higher than other types of families living in Bangkok at 9.75, 9.39, and 8.77 for three-member, four-member, and five-member households, respectively. The proportions of households living in Bangkok at individual and household level are comparable.

For characteristics of children, variables are not applicable for two-member households since they consist of a couple only. The dummy variables of the youngest child by age ranges (under three, older than 3 but younger than 6, and older than 6 but younger than 10) can be interpreted in terms of percentage. Households with one child have similar numbers for these variables, namely, 17.57, 16.23, and 18.06 percent for the youngest child aged under three, older than 3 but younger than 6, and older

than 6 but younger than 10 respectively. The percentage of the youngest child is aged between 6 and 10 is highest at 26.64 for families with two children; the percentages of the youngest child in remaining groups (under three years old and between 3 and 6 years old) are 19.89 and 19.26 respectively. For the last type of families (a couple with three children), the highest percentage is the youngest child aged under three years old at 36.38; the percentages of remaining groups are 21.64 for age between 3 and 6 and 22.39 for age from 6 to 10.

The number of children is straightforward since families are differentiated by numbers of children. For three-member households, the proportion of pre-school children (age under six) is 0.380; the number of children older than six years old is 0.6620. Regarding households with two children, the numbers of pre-school children and non-pre-school children are 0.4626 and 1.27 respectively. On average, five-member households have 0.7351 pre-school child and 1.67 non-pre-school children. The average numbers of disabled children for families with one child, two children, and three children are quite small at 0.0110, 0.0117, and 0.0168 respectively. However, having any disabled child affects the disposable income through child allowance.

3.4 Results

3.4.1 Estimation results for individual labour supply

TABLE A3.2 and A3.3 in Appendix 3.II show the estimation results of four models with different degrees of flexibility for male and female labour supply, respectively. Interpretation of labour supply models is not straightforward due to parameterisation and random heterogeneity. The exceptions are interaction terms between leisure hours and socio-economic characteristics, as these parameters indicate how these characteristics affect the marginal utility of leisure (van Soest et al., 2002). In practice, interpreting some parameters, e.g., an interaction term between income and leisure, can also provide some better understanding of relationship between two arguments.

Regarding the parameter of squared income all models for both genders show a negative sign suggesting that marginal utility of income increases at a diminishing rate. The negative estimate of squared income is consistent with theoretical prediction and findings in previous works, e.g., Labeaga et al. (2008) and de Boer (2016). However, the level of statistical significance differs across models and genders. In terms of male labour supply, the coefficient does not statistically influence the utility in Model I1 and I2 although it is statistically significant at the 10 percent significance level in Model I3 and I4. In the female models, the coefficient statistically affects the utility in Model I1 and I2 at the 1 percent significance level. It becomes non-significant in Model I3 and I4 because the effect is possibly captured by observed preferences. A negative parameter of squared leisure hours reported for both genders indicates a diminishing rate of marginal utility of leisure hours. This parameter is statistically significant at the 1 percent level in all models. However, previous studies find different values of this coefficient; for instance, regarding individual labour supply, Labeaga et al. (2008) find a positive value of squared hours of leisure in Spain whilst de Boer (2016) show a negative value of this variable in Netherland. This implies a difference in leisure hour preferences across countries.

For the cross-product term between income and leisure hours, the results across the models for both genders suggest that the arguments are complements, i.e., people prefer having more consumption and leisure hours. It also shows a strong statistical significance at the 1 percent level in every model. This finding is similar to previous studies such as Duncan and Harris (2002) as well as Labeaga et al. (2008).

Socio-economic characteristics are incorporated into income and leisure in Model I3 and I4. The effects are consistent across models, although each factor influences marginal utility of income and leisure for males and females differently. These coefficients determine how the marginal utility changes with these characteristics. For the income variable, the utility of males is not statistically affected by the age characteristic (whether they are older than 40 years old). Their marginal utility of income increases with the statistical significance level of 10 percent when male individuals have a

university degree. On the other hand, females get greater marginal utility when their ages are over 40 with statistical significance at the 5 percent level whilst having a university degree does not statistically influence the marginal utility of income. A possible reason why attaining a higher degree does not affect the marginal utility of income for females could be due to gender inequality. In fact, unmarried females with a university degree prioritise labour market participation (i.e. having a similar working opportunity as males) over the level of income. Similar results are found in Duncan and Harris (2002) in which the estimated coefficient for females holding a university degree becomes statistically non-significant when models additionally include a fixed costs term.

The results also suggest that, with regard to leisure, males and females gain more utility (with the statistical significance level of 1 percent) when they are more than 40 years old. Attaining any university degree of education affects the marginal utility of leisure hours differently across genders. In fact, whilst it positively influences the marginal utility of males with statistical significance at the 1 percent level, it does not affect the utility level of females. The results of marginal utility of income for males are comparable with Duncan and Harris (2002) whilst that for females are opposite. The difference between genders is possibly because of cultural factors; for example, females who are older than 40 years old are more prudent about financial security than males with the similar age.

For unobserved random preferences of income and leisure, the standard deviation of income is statistically significant at the 10 percent level in male labour supply models and at the 1 percent level in female labour supply. This is similar to the finding in Duncan and Harris (2002). The standard deviation of leisure is not statistically significant for both genders; the results are similar to findings in Duncan and Harris (2002) as well as Labeaga et al. (2008). The results imply the unobserved preferences across the sample are statistically different for income but not for leisure

Labour market participation, represented by the fixed costs terms, affects utility negatively with statistical significance at the 1 percent level in all five models of both genders. This implies working is a disutility for males and females as expected. Previous empirical studies find both positive fixed costs

(e.g., Labeaga et al. (2008)) and negative fixed costs (e.g., de Boer (2016)). Living in the capital of Thailand does not statistically lead to disutility from working. The results is similar to what reported in Duncan and Harris (2002) which also include a dummy indicating if a person lives in the capital of Australia.

3.4.2 Marginal utilities in individual labour supply

As mentioned above, most of the coefficients in the utility function cannot be directly interpreted (van Soest et al., 2002). The marginal utility of income and leisure hours are calculated using the model specifications for ease of economic interpretation. The marginal utility is calculated by following steps. First, calculating the utility level using Equation (3 -30) for individual labour supply and (3 -31) for household labour supply. Second, taking the first derivative respect to each argument. Individual labour supply models have two arguments, namely, income and leisure hours; hence, the marginal utility of income and leisure hours are obtained. Household labour supply models have three arguments including income, leisure hours for males, and leisure hours for females; thus, three marginal utility numbers (the marginal utility of income as well as the marginal utility of leisure hours for males and females) are obtained.

TABLE 3.9 shown below presents the marginal utilities of both arguments as well as the proportion that are negative for each of the four models. Overall, all models provide positive computed values of the average marginal utility of income and leisure hours for both males and females as expected. The negative proportion for the marginal utility of leisure suggests that some would prefer to work without returns if fixed costs were zero (Kabátek et al., 2014). This implies these people have a higher preference for work than those have positive marginal utility of leisure (de Boer, 2016).

TABLE 3.9: Calculated results for individual labour supply

Individual	100 draws			
	Male labour supply		Female labour supply	
	mean	neg. %	mean	neg. %
MUyI1	0.0094	4.11	0.0198	1.11
MUyI2	0.0122	4.82	0.0451	3.05
MUyI3	0.0169	1.19	0.0320	4.63
MUyI4	0.0167	1.19	0.0311	4.76
MUlI1	0.0156	28.95	0.0120	31.00
MUlI2	0.0251	26.35	0.0906	20.45
MUlI3	0.0414	20.44	0.0524	26.39
MUlI4	0.0408	20.53	0.0499	26.72
	Unsatisfied (%)		Unsatisfied (%)	
Quasi-concave I1	9.58		1.11	
Quasi-concave I2	9.07		7.45	
Quasi-concave I3	1.19		8.61	
Quasi-concave I4	1.19		9.08	
Monotonicity I1	0.00		0.00	
Monotonicity I2	0.00		0.00	
Monotonicity I3	0.00		0.00	
Monotonicity I4	0.00		0.00	
Observations	4,456		4,494	

Notes: MUy and MUl designate the marginal utility of income and marginal utility of leisure, respectively. I1 to I4 indicate the estimated models (Model 1, 2, 3, and 4) for individual labour supply. Each MUy and MUl reports the mean value and the proportion of the negative values (neg. %). Quasi-concave and monotonicity, followed by a model indicator, represent the percentage of unsatisfied conditions for the level of utility.

With regard to male labour supply, the average marginal utility of income from Model I1 to I4 are positive as expected. This suggests that males usually prefer having a larger amount of income. The negative proportions of marginal utility of income for Model I1 and I2 are similar at 4.29 and 4.98 percent. The negative marginal utility of income yielded from Model I3 and I4 are equivalent at 1.19 percent of the total observations. The mean marginal utility of leisure hours from Model I1 to I4 are also positive for all models; this also indicates that males usually prefer having a longer leisure hours. The proportions of negative marginal utility of leisure are 28.95, 26.35, 20.44, and 20.53 percent for Model I1 to I4 respectively. This implies that a certain group of people have a higher working preference than others. It also implies that people with negative marginal utility of leisure possibly spend a large proportion of non-working hours to do domestic duties which are not considered as real leisure. 9.58 and 9.07 percent of the sample do not satisfy the quasi-concave condition in Model I1

and I2 respectively. The proportion drops to 1.19 percent for Model I3 and I4 respectively. Nonetheless, all models satisfies the monotonicity condition at the perfect rate.

Labour supply for unmarried females provides similar results to those of males. As theoretical expectation, the average marginal utility of income from Model I1 to I4 yield positive values. The proportions of negative marginal utility of income are 1.11, 3.05, 4.63, and 4.76 percent for Model I1 to I4, respectively. The results of average marginal utility of leisure hours for Model I1 to I4 are also positive. The percentages of negative marginal of leisure hours are over 30 for Model 1. The negative proportions of the remaining models (I2, I3, and I4) are 20.45, 26.39, and 26.72 percent respectively. 1.11, 7.45, 8.61, and 9.08 percent of the total observations in Model I1, I2, I3, and I4 fail to satisfy the quasi-concave condition respectively. However, all models completely satisfy the monotonicity condition.

By comparing the marginal utility of income between genders for each model, it is observable that the number for females is greater than that for males. This implies that labour supply for females is more elastic than that for males on average than. The marginal utility of leisure hours for females is generally higher than that of males. This suggests that females are more sensitive to leisure hours than do males.

3.4.3 Estimation results for household labour supply

TABLE A3.4 in Appendix 3.III presents the estimation results of household labour supply models by different degrees of flexibility. Similar to individual labour supply, six models are estimated from simple to complex. As mentioned previously, most of the parameters cannot be directly interpreted. The calculated marginal utilities are discussed in the next section. Regarding squared-terms, the squared income parameter in all models is negative with statistical significance as theoretically predicted as well as previous research such as van Soest (1995) and Labeaga et al. (2008). An interaction between squared income and age of the youngest child (under three years old) is negative and statistically significant; this suggests that diminishing rate of marginal utility of income increases

significantly when a household has a very young child; the result is consistent with Duncan and Harris (2002) and Creedy et al. (2002)

Results related to squared leisure for both partners suggest that the marginal utility of leisure increases with a diminishing rate because the parameter of squared leisure hours for males and females in all models is negative with statistical significance at the 1 percent level. The results are consistent with Callan and van Soest (1996), Callan et al. (2009), and Kabátek et al. (2014). Some studies such as van Soest (1995) find that the squared leisure hours of males is negative whilst the opposite result appears for female. Some other works, e.g., de Boer (2016), indicates that the coefficients of squared leisure hours for both gender are positive. The difference across studies provides an implication that preferences on leisure hours are difference across countries as well as periods (van Soest (1995) and de Boer (2016) study labour supply in Netherland at different periods of time). The interaction terms reflecting observed heterogeneity in Model H4 to H6 are all positive for both partners. This implies that the age of the youngest child reduces the degree of diminishing marginal utility of leisure. However, some of the interaction terms are not significant.

The cross-product terms between income and leisure hours for males and females are all positive and statistically significant at the 1 percent level across models. This indicates that income complements leisure hours for both partners. The results are similar to what found in Callan and van Soest (1996), Callan et al. (2009), Kabátek et al. (2014), and de Boer (2016). The interaction terms between male leisure hours and female leisure hours in all models are also positive with the statistical significance level of 1 percent. The results suggest that leisure hours of both partners are complements. The results are consistent with previous research such as van Soest (1995), Callan et al. (2009), and de Boer (2016). Callan and van Soest (1996) find a negative value for the cross-product term with statistical significance. The different results in previous research suggest different preferences across countries.

Coefficients for socio-economic characteristics incorporated with income and leisure in Model H3 to H6 can be interpreted as observed taste shifters. The coefficients of interactions with income are

consistent across models; however, those with leisure hours for both partners provide few sign differences across models for characteristics of the youngest child at different age ranges. This is possibly explained by the inclusion of observed and unobserved heterogeneity in fixed costs for both partners in more flexible models (H4 to H6).

The interaction terms between income and the age of the youngest child implies that if a household has younger child, the household utility of income increases. An increase in the number of children also influences the utility in the same regard. In other words, holding other factors constant, a household with a larger numbers of children has the greater marginal utility of income. However, this coefficient is significant at 10 percent level in model H4, H5, and H6. The results for the number of children on leisure hours for both partners are similar to the findings in Kabátek et al. (2014). The results for the presence of a very young child are similar to what found in Mauro et al. (2017); but differ from the results in Kabátek et al. (2014).

The estimates reveal that age interacted with income have different results across genders. In fact, if a male is over 40 years old, the household marginal utility of income will be lower than those who are younger than 40. On the other hand, if females are older than 40, the marginal family utility of income will be greater than those whose age are less than 40. Creedy et al. (2002) show that age characteristics of both gender do not statistically affect the marginal utility of income.

Regarding educational characteristics, the results suggest positive effects on the utility of income when any of partners graduated from a university. The coefficients obtained from all models (H3 to H6) are statistically significant at the 1 percent level for male education but not statistically significant for female education. Creedy et al. (2002) indicate that the education level of the household's head negatively affects the marginal utility of income but the educational attainment of the female spouse has an opposite. The difference results imply different preferences towards income in different countries with different degrees of economic development.

Positive coefficients on the interactions between leisure hours of both genders and a number of children suggest that both males and females value an extra leisure hour more when they have a larger number of children. Creedy et al. (2002) show a very similar results for females but they indicate that the number of children does not statistically influence marginal utility of leisure for males. People value an additional leisure hour more when they are older than 40 years old with statistical significance at the 1 percent level. The results are consistent with the findings in Creedy et al. (2002). The utility of an individual's leisure also depends upon the age of their spouse, i.e., if the age of the spouse is greater than 40, the marginal utility of leisure will increase especially for males. The estimate are significant at the 1 percent level in all models while the estimate for females is not significant in any model (H3 to H6). The results of these socio-economic characteristics are comparable with those obtained in Creedy et al. (2002). If males hold a university degree, the utility of leisure for both partners increases. However, the levels of female educational attainment significantly (varied across models) increases the utility of leisure for males but does not significantly affects their own utility of leisure for females themselves. The findings are opposite to results in Creedy et al. (2002); this is possibly due to difference in cultures and preferences across countries.

Considering unobserved preferences for household income and leisure hours for males and females, the standard deviation of random heterogeneity for income is statistically significant at the 1 percent level in Model H2 and 5 percent level for other models (H3 to H6). The standard deviation of random heterogeneity for leisure hours of both males and females are significant at the 1 percent level in all models. This suggests that the random preferences of income differs significantly across households; the random preferences of leisure hours are different across individuals. The results are consistent with Kabátek et al. (2014). Callan et al. (2009) and de Boer (2016) find the standard deviation of random heterogeneity is significant only for male leisure hours. The results in van Soest (1995) indicate that random heterogeneity is not significantly different across males and females.

The results of the fixed costs of working suggest that working is a disutility for both males and females as expected. These parameters for male working, female working, and both partner working are statistically significant at the 1 percent level. The results are consistent with Kabátek et al. (2014) and de Boer (2016). Some other studies find different results implying different preference in the market participation across countries. Socio-economic characteristics incorporated into the fixed costs terms provide consistent results in terms of sign but are less consistent in terms of statistical significance across models.

Living in Bangkok increases the costs of working when either of partners are working but reduces some fixed costs when both are employed. The transportation costs are possibly the major part of difference between living in the capital city and other provinces. The government can reduce the transportation cost in the long run by investing on the public transportation.

The number of pre-school and non-pre-school children negatively affects the fixed costs (increase the utility) when either of partners is working. However, children have the opposite effects when both partners are working. This is possibly because they bear more childcare costs when both partner are working.

3.4.4 Marginal utilities in household labour supply

TABLE 3.10 shown below shows calculated numbers of marginal utilities and other related numbers including the negative percentage of each marginal utility, a number of tested conditions (i.e., quasi-concave and monotonicity).

The second column of TABLE 3.10 presents calculated marginal utility of household income, male leisure hours, and female leisure hours. It also includes their negative proportions obtained from the six models for household labour supply.

TABLE 3.10: Calculated results for household labour supply

Household	100 draws					
	Whole sample		Couples without child		Couples with children	
	mean	neg. %	mean	neg. %	mean	neg. %
MUyH1	0.0093	1.90	0.0092	4.99	0.0091	0.84
MUyH2	0.0124	3.20	-	-	0.0101	0.98
MUyH3	0.0144	2.86	0.0154	1.74	0.0120	2.60
MUyH4	0.0154	3.56	0.0155	1.70	0.0136	3.84
MUyH5	0.0161	2.87	0.0159	1.18	0.0143	3.24
MUyH6	0.0161	2.89	0.0161	1.24	0.0143	3.22
MUmH1	0.0277	29.75	0.0276	36.73	0.0268	29.65
MUmH2	0.0399	34.84	-	-	0.0306	34.71
MUmH3	0.0499	34.49	0.0550	32.24	0.0396	34.88
MUmH4	0.0528	34.37	0.0553	32.30	0.0440	34.61
MUmH5	0.0548	34.40	0.0558	32.19	0.0463	34.60
MUmH6	0.0547	34.33	0.0567	32.22	0.0462	34.64
MUfH1	-0.0720	47.18	-0.0562	39.82	-0.0873	53.61
MUfH2	-0.0635	45.08	-	-	-0.0843	51.88
MUfH3	-0.0568	45.37	-0.0398	41.09	-0.0766	51.27
MUfH4	-0.0533	45.34	-0.0396	41.03	-0.0706	50.33
MUfH5	-0.0523	44.98	-0.0394	40.34	-0.0690	50.01
MUfH6	-0.0524	44.97	-0.0390	40.31	-0.0692	50.03
Household	100 draws					
	Whole sample		Couples without child		Couples with children	
Conditions	Unsatisfied %		Unsatisfied %		Unsatisfied %	
Quasi-concave H1	32.74		34.32		2.75	
Quasi-concave H2	32.91		-		4.56	
Quasi-concave H3	11.76		13.26		10.96	
Quasi-concave H4	12.19		13.16		15.04	
Quasi-concave H5	10.95		6.94		14.44	
Quasi-concave H6	12.17		7.10		15.94	
Monotonicity H1	0.00		0.00		0.00	
Monotonicity H2	0.06		-		0.00	
Monotonicity H3	0.05		0.03		0.09	
Monotonicity H4	0.06		0.03		0.09	
Monotonicity H5	0.04		0.01		0.09	
Monotonicity H6	0.05		0.01		0.09	
Observations	15,185		7,194		7,991	

Note: MUy designates the marginal utility of income whilst MUm and MUf defines the marginal utility of leisure hours for males and females, respectively. H1 to H6 indicate the estimated models (Model 1, 2, 3, 4, 5 and 6) for household labour supply. Each MUy, Mum and MUf represents the mean value and the proportion of negative values (neg. %). Quasi-concave and monotonicity, followed by a model indicator, represent the percentage of unsatisfied conditions for the level of utility.

The marginal utility of income obtained from all models has a positive average value as theory would predict. The results from Model H2 and H4 show that 3.20 and 3.56 percent of the sample have negative marginal utility, respectively. The other of models yields smaller proportions of observations

(less than 3 percent) with a negative marginal utility of income. Model H1 provides the best performance in terms of the negative marginal utility of income (1.90 percent of the sample).

All models yield the positive for the marginal utility of male leisure hours as expected. The proportions with negative marginal utility (about 34 percent) are very similar across models except for Model H1 which yields 29.75 percent of the sample.

The results for the marginal utility of leisure hours for females are different from the theoretical prediction; all models give negative average values. In addition, most of the models yield negative marginal utility of leisure hours for females for about 45 percent of the sample. Model H1 gives a larger proportion of the negative marginal utility than others at 47.18 percent.

It is possible that the negative values observed for the average marginal utility of females' leisure hours could result from household work responsibilities especially when couples have a very young child. In fact, leisure hours comprises pure leisure hours and domestic duties hours; and these are undistinguishable in Thai dataset. The results are hence re-examined by estimating sub-groups, namely, couples with children and couples without children. By comparing the results in third and last columns in TABLE 3.10, the marginal utility of leisure hours for females in households without a child is less negative than that in households with a child. The negative numbers imply that Thai females spend a large proportion of non-working hours doing housework and perceive housework hours as non-leisure. Females in households without children are expected to have fewer housework responsibilities than those in households with children. Labeaga et al. (2008) give two reasons for the negative marginal utility of leisure for females. First, due to the increasing labour market participation rate in recent years, females need to remain in employment longer to be eligible for retirement benefits. Second, women temporarily leave the labour market or work only part-time because of childbearing responsibilities; they will return to the market when their children grow up.

The proportions of families with negative marginal utility of leisure for both partners is larger than in Kabátek et al. (2014) who find 26.62 percent of males and 34.89 percent of females have negative marginal utility of leisure respectively. However, Kabátek et al. (2014) investigate the household utility function with five main arguments, namely, income, male leisure hours, male housework hours, female leisure hours, and female housework hours; it is not possible to do this in the Thailand case due to the availability of the data. Hence, the results of these two empirical studies cannot be directly compared.

The utility functions produced by six different models are tested for quasi-concavity and monotonicity. The results for the quasi-concave condition can be divided into two groups. First, Model H1 and H2 have non quasi-concave utility for about 33 percent of the total observations. Second, the rest of the models yield a similar proportion non quasi-concave utility at about 11 to 12 percent of the whole sample. Nonetheless, the results of the monotonicity condition are almost identical; most of the models produce the result that more than 99.90 percent of observations have monotonic utility functions.

3.4.5 Model selection

This chapter sets five criteria to select the preferred labour supply models for unmarried males, unmarried females, and married couples, namely, 1) the negative proportion of marginal utility of income, 2) the proportion of observations in which the utility function is not quasi-concave, 3) the proportion of observations which has non-monotonic utility function, 4) the log-likelihood ratio test, and 5) the consistency between individual and household models.

Starting with the household labour supply models, the estimated results are very similar for first and the third criteria. The second criterion identifies that Model 1 and 2 are not very suitable for the Thai data. The log-likelihood ratio test reveals that Model H6 has the best goodness of fit relative to other models with statistical significance at the 1 percent level. In conclusion, Model H6 is selected to be the preferred model for policy microsimulation.

For male labour supply, the first and second criteria suggest Model I3 and I4 are superior since they outperform Model I1 and I2 and the numbers of Model I3 and I4 are equivalent for both the proportion of the negative marginal utility and the proportion of quasi-concave utility. The third criterion does not indicate any difference among models. The final criterion (log-likelihood ratio test) indicates that Model I4 is not significantly better than Model I3 in terms of goodness of fit. Female labour supply provides a different picture to the male counterpart. The first and second criteria suggest Model I1 as the preferred model for unmarried female labour supply whilst the monotonicity condition does not provide additional information for the model selection. Additionally, the log-likelihood ratio test indicates that Model I4 does not fit the data better than Model I3. In statistical regards, Model I3 seems preferable than other models for individual labour supply. An additional variable in Model I4 allowing observed heterogeneity for a fixed costs term is not significant in terms of an individual variable as well as model performance; nonetheless, this variable makes the model consistent with the preferred household labour supply model (H6) which allows for observed preference heterogeneity.

In conclusion, Model I4 is selected for the individual labour supply whilst Model H6 is the representation of family labour supply models for Thailand. Both models are the most flexible among all estimated models.

3.4.6 Robustness checks

This section shows the result comparisons for checking robustness of the preferred models. Four different robustness checks are performed. The first is the estimation of the preferred models with 500 Halton draws to see the consistency of the models with different numbers of draws. The second check decreases the number of alternatives to seven choices for each individual (7 choices for individual labour supply and 49 choices for household labour supply). The third and the last robustness checks are done by estimating preferred models with two divided datasets, before and after the structural tax change in 2012.

Robustness check tables reported in Appendix 3.IV (TABLE A3.5, A3.6, and A3.7 for male, female, and household labour supply, respectively) consist of six columns. The first one indicates variables in the labour supply models. The second column provides the base estimation results; the third one contains the results of the estimation with 500 Halton draws; the fourth column provides the results of estimation with seven choices; the fifth and the last columns are the estimated results using the samples before and after changes in tax rules in 2012 respectively.

TABLE A3.5 and A3.6 show robustness checks for males and females labour supply, respectively. By comparing the different numbers of Halton draws in maximum simulated likelihood estimation, the results are very consistent for both genders. The estimates are almost identical; the statistical significance of each variable is unchanged. Changing the number of leisure hours alternatives also yields consistent results with the base model. No change of sign is observed and only one estimate changes in its level of statistical significance in each gender labour supply. The result is consistent with previous works such as those by van Soest (1995) and Gong and van Soest (2002) which suggest that changing the number of hours points from 6 to 5 does not significantly affect the estimates.

By splitting the whole sample into two periods (i.e., 2009-2011 and 2013-2015), the results clearly show that the second sub-sample outperforms the whole sample as well as the first sub-sample based on the model selection criteria. From TABLE A3.5 and A3.6, the negative proposition of the marginal utility of income from the model using the latest dataset (2013-2015) is smaller than that from the whole sample and the first sub-sample (2009-2011) for males (0.35 percent) and females (2.41 percent). The quasi-concave condition also improves for both males and females when the model uses the second sab-sample (2013-2015) in relative to the results from other samples (the whole sample and the first sub-sample).

From TABLE A3.5, the numbers for the average marginal utility of income and leisure vary across samples which possibly suggests that labour supply behaviour of unmarried males change overtime. This help support that the results from latest sub-sample is appropriate for microsimulation since they

reflect the latest behaviour. The squared terms (income and leisure hours) as well as the interaction term between income and leisure hours provide the similar results across samples. The square terms indicate the diminishing marginal utility of income and leisure whilst the interaction term suggests that two arguments are complimentary. Socio-economic characteristics suggest how labour supply behaviour changes overtime because of changes in sign and magnitude.

From TABLE A3.6, the results across different sample are quite consistent. The average marginal utility of income and leisure hours differ marginally. The squared terms and the interaction term between income and leisure are also consistent across samples. The squared terms indicate the diminishing marginal utility of income and leisure; the interaction terms implies complementarity between income and leisure for the utility of females. The similar results across samples are observed for socio-economic characteristics. In fact, there are only changes on magnitude at slight extents.

By considering the selection criteria as well as behaviour difference overtime, the results from the sub-sample (2013-2015) for unmarried males and females are more appropriate to be applied in microsimulation than the results from other samples.

TABLE A3.7 presents robustness checks for family labour supply. A change in the number of Halton draws in estimation provides the consistent results with the base model. There are some changes in the level of statistical significance and there is only one change of sign. In addition, a decrease in the number of hours points obtains results consistent with the base model as well; few changes in the level of statistical significance and only one change of sign is observed.

When the results from different samples by year are compared, the second sub-sample (year 2013-2015) provides improved results regarding the selection criteria. In fact, the negative proportion of the marginal utility of income from the latest sub-sample (0.86 percent) is less than the numbers from the whole sample (2.89 percent) and the first sub-sample (16.05 percent). In addition, the quasi-concave and monotonicity conditions from the second sub-sample are also improved; the percentage

of quasi-concave utility increases to 98.82 percent whilst the proportion of non-monotonic utility drops to 0.01 percent.

Regarding the estimation results, the squared terms (household income, male leisure, and female leisure) are consistent across samples; they suggest the diminishing rates of marginal utility. The interaction terms between arguments are also consistent across samples since they all provide positive numbers which imply complementarity between arguments for the utility of households. The overall results for socio-economic characteristics are consistent with some differences; there are some changes in the magnitude and the statistical significance level as well as few changes in sign observed. These differences across samples possibly indicate that labour supply behaviour changes overtime.

Since the results from the latest sample outperforms those from other samples based on the selection criteria and the expectation that labour supply behaviour can change overtime, the results obtained from year 2013-2015 are most appropriate to be used in policy microsimulation.

3.5 Conclusion

This chapter studies individual and family labour supply behaviour in Thailand using the discrete choice approach. Several models with different degrees of flexibility are estimated for individual labour supply (four models) and household labour supply (six models). Overall, consistent results are obtained across these models; they are in general consistent with economic theory and previous empirical studies as well.

According to results as well as statistical and economic rationales, the preferred model for individual labour supply in Thailand is the most flexible model estimated. The result is similar for household labour supply, when the most flexible model is selected to be the preferred model for the Thailand dataset.

The results of family labour supply indicate that the most flexible model outperforms other models. The model yields the positive mean of marginal utility of income as well as the small percentage of negative marginal utility of income, i.e., it is very consistent with the theory in this regard. It also yields the positive mean of marginal utility of male leisure hours as expected. However, a negative mean of marginal utility of female leisure is observed. This is possibly because females in a family setting have many housework responsibilities and they do not treat these tasks as leisure. The tests for quasi-concavity and monotonicity indicate that the most flexible model gives the results most consistent with the utility function assumptions. The log-likelihood ratio test confirms that the most flexible model is the most preferable regarding goodness of fit.

Regarding the robustness checks, changing the number of draws and with modifying the number of hours points yield results consistent with the base model. By dividing the whole sample into two parts, the results are still consistent although some differences can be observed. The estimation using the sample after the structural tax change provides better results overall. This implies that the preferred model fits the sample in year 2013 and 2015 the most.

One strong advantage of the discrete hours labour supply model is compatibility with factual and counterfactual policy simulation. The next chapter applies the microsimulation technique to simulate different policies reforms and investigate effects on labour supply response, incomes, and tax amounts. These factors are used on further analysis on economic performance and income inequality.

3.6 Appendix 3.I: The distributions of hours worked

FIGURE A3.1: The distributions of hours worked for individuals and couples by gender

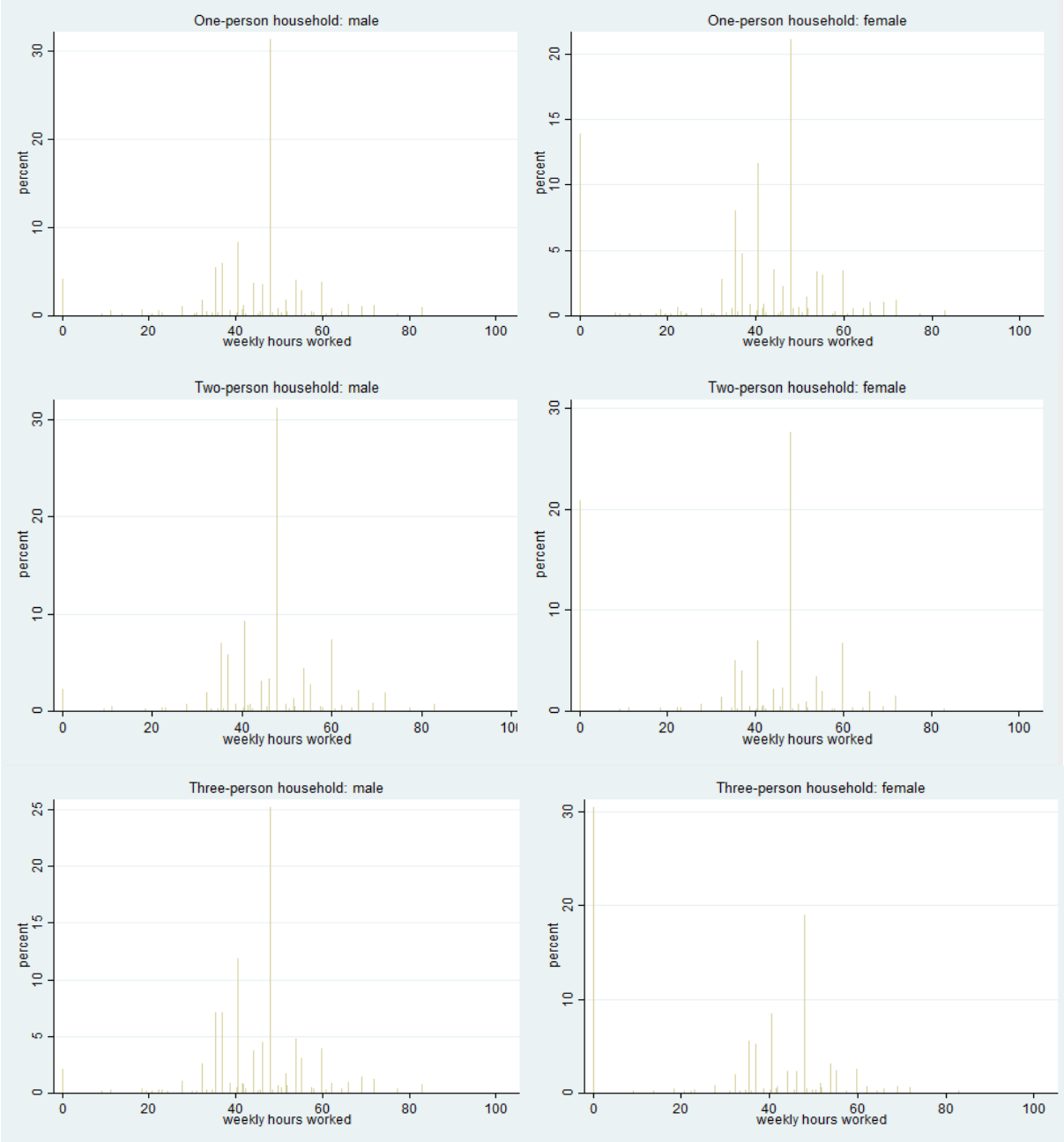
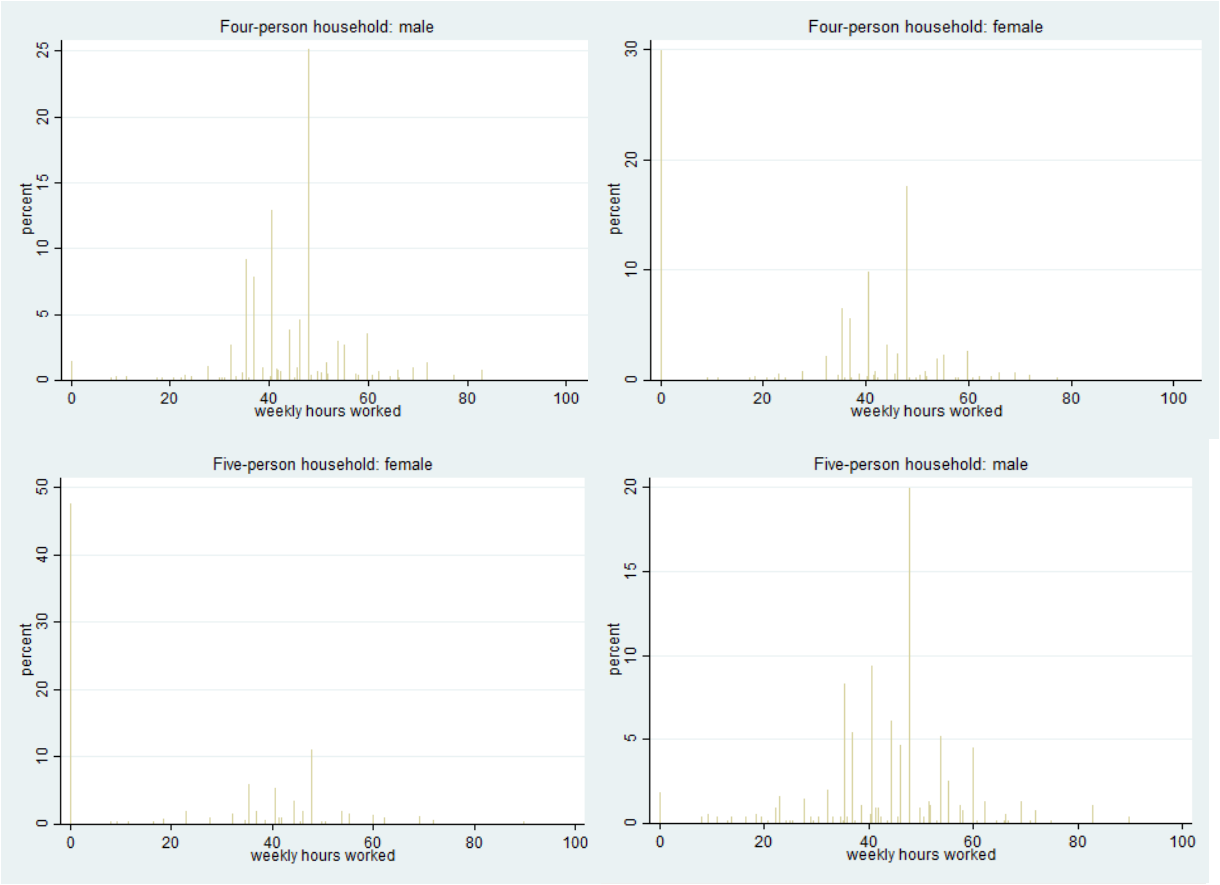


FIGURE A3.1: The distributions of hours worked for individuals and couples by gender (continue)



3.7 Appendix 3.II: Thailand personal income tax

This section strictly follows the official English version of Thailand revenue code; most information is directly adopted from the code.

3.7.1 Types of assessable income and their expenses

The Thailand revenue code categorises personal income into eight different groups of assessable income. The term "assessable income" both cash and in kind. Thus, any benefit received from an employer or other persons, such as a rent-free house, is included as assessable income.

The Thailand revenue code also specifies the expenses allowed to be deducted from each type of assessable income.

These categories of assessable income and their expense deductions, which have not changed throughout the period covered in this chapter, are clearly described as follows:

1. Income from personal service rendered to employers, Section 40(1), includes salary, wage, per diem, bounty, gratuity, pension, rent allowance, employer-provided rent-free lodging, debt liability paid by an employer, and any money, property, or benefit a person received in connection to employment.

2. Income by virtue of jobs, positions, or services rendered, Section 40(2), includes commission, meeting allowance, fee, discount, subsidy, gratuity, bonus, rent allowance, employer-provided rent-free lodging, debt liability paid by an employer, and any money, property or benefit your received in connection to your contract.

Income in Section 40(1) and 40(2) includes an amount of one-time compensation received due to termination of an employment contract.

When a person earns incomes from Section 40(1) and 40(2), they are combined for the taxable income calculation. A person may choose to deduct allowable expenses at 40% of income but not exceeding 60,000 baht. If a married couple declares income jointly, both of them will apply the same rule, i.e., the maximum allowable expense is 120,000 baht (60,000 baht per person). This indicates that the total allowable expenses of income in 40(1) and 40(2) for both separate and joint tax filings are identical.

Additionally, some income is exempted from Section 40(1) and 40(2), namely, the contribution to a provident fund (only the part that exceeds 10,000 baht but not over 490,000 baht), the contribution to the Government Pension Fund (up to 500,000 baht), the total contribution to a provident fund for teachers in private schools (up to 500,000 baht), and severance pay up to 300,000 baht (only if a person has included this amount into Section 40(1)).

3. Income under Section 40(3) includes goodwill, copyright, franchise, other rights, annuity, and income in the nature of yearly payments derived from a will, juristic act, or court verdict. The deduction of expenses in Section 40(3) equals to 40 percent of the total amount of income but not above 60,000 baht. If a married couple declares income jointly, both of them will apply the same rule, i.e., the maximum allowable expense is 120,000 baht.

4. Income from investment, Section 40(4), includes

    a. interest from deposits, loans, bonds, debenture, bills (with or without security), part of interest on a loan after withholding taxes prescribed under the law governing petroleum income tax, or the discount from a bill or debt instrument issued by a company or juristic partnership or by another juristic person and sold for the first time at a price below its face value. This type of income includes income in the same kind as interest, benefit, or other consideration derived from a loan or from a debt claim with or without security as well. A person can select to pay 15 percent tax rate for the total income of this type of income.

b. Income received as share of profits or other benefits from mutual fund. This type of share of profits or other benefits may be paid out by a mutual fund or a financial institution that provides loans in support of agricultural, commerce, or specific industry. A person can select to pay 10 percent tax rate for the total income of this type of income.

c. Income from dividends or shares of benefits a person received from a company or juristic partnership incorporated under foreign law.

d. Income from dividends or shares of benefits a person received from a company or juristic partnership incorporated under Thai law. A person can select to pay 10 percent tax rate for the total income of this type of income.

e. Dividend tax credit included in Section 40(4) when a person received income stated as income from dividends or shares of benefits from company or juristic partnership incorporated under Thai law.

f. Other incomes in Section 40(4) including bonus received as a shareholder or partner of a company or juristic partnership, a decrease of capital holding in a company or juristic partnership for amount not exceeding profits and reserves, an increase of capital holdings in a company or juristic partnership for amount determined from profits and reserves, a benefits for the amount which exceeds capital receive from amalgamation acquisition or dissolution of a company or juristic partnership, gains received from transfer of partnership holdings or shares, debentures, bonds, or bills or debt instruments issued by a company or juristic partnership or by any other juristic person, share of profit or dividends, after withholding tax, paid out under the law governing petroleum income tax.

5. Income under Section 40(5) is rent of property and benefits received from a breach of hire-purchase or instalment sale contract. A person can choose to deduct allowance expense from rental income either by actual expenses or by percentage depending on types of assets (house, building, construction built to land, and floating house: 30 percent, land used for agriculture: 20 percent, land used for other purposes besides agriculture: 15 percent, vehicle: 30 percent, and other property: 30 percent). For benefits received from a breach of hire-purchase or instalment sale contract, a person can deduct expense allowance by 20 percent.

6. Income under Section 40(6) is income from liberal professions, i.e., legal services, arts of healing, engineering, architecture, accounting services, and fine arts. A person can select to deduct expense allowance either by actual expense or by percentage (60 percent for art of healing e.g. physicians, or 30 percent for other liberal professions).

7. Income under Section 40(7) is from independent contracts. A person is considered to receive this income when that person supplies own equipment and other materials which are essential for the work, a person controls hours of work, or the work can be either temporary or permanent. A person can select to deduct expense by a 70 percent fixed-rate expense or an actual expense.

8. Income under Section 40(8) includes as follows:

    a. Income from business, commerce, agriculture, industry, transports, sale(s) of immovable property acquired in a commercial or profitable manner. A person may either apply a fixed-rate expense or provide an actual expense to deduct the expense. In case both of a couple received income in Section 40(8) and fill the income tax form jointly. They may specify the proportion of income (the default proportion rate is 50 percent).

b. Dividends or share of profits from mutual funds setting up under Securities and Exchange Act B.E. 2535.

c. Income from sale(s) of inherited immovable property of sale(s) of immovable property acquired not for commercial or profitable manner purposes. A person may choose to not include this income with other assessable income in tax calculation. If a person received income from sale(s) of inherited property or property gratuitously transferred to a person and opted to include such income in the tax calculation for tax return, he will apply a deductible fixed-rate expense at 50 percent on this income. If a person received income from sales(s) of immovable property not for commercial or profits and decided include this in the income tax computation for tax return, he will able to deduct expense either at a fixed-rate depending on a number of holding years or an actual expense.

d. Income from sale(s) of units in Retirement Mutual Fund (RMF).

3.7.2 Allowances and exemptions for the calculation of personal income tax

In Thailand, different allowances also called exemptions are allowed in personal income tax calculation. This section describes relevant allowances and exemptions applied in this chapter.

3.7.2.1 Personal allowance

The revenue code allows personal allowance for any taxpayer at 30,000 baht. Another incremental 30,000 baht may be included as spouse allowance when either the spouse does not earn income or a couple decides to jointly declare income tax.

3.7.2.2 Child allowance

A taxpayer may be able to claim child allowance i.e. child tax credit if these following conditions are met.

a. A legitimate child of a taxpayer or the spouse is eligible for child allowance.

b. An adopted child of a taxpayer is allowed for child allowance.

c. A child in a. and b. has not earned assessable income over 15,000 baht in a given tax year; moreover, a child has any of these characteristics including not sui juris (under 20 years old and not married), under 25 years old and studying at the university level, adjusted incompetent, or quasi-incompetent. Note that the HSES does not have information about adjusted incompetent, or quasi-incompetent characteristics for child allowance calculation.

Child allowance is 15,000 baht for a child who is not studying or studying abroad; additional 2,000 baht is added up when a child is studying in a domestic educational institution. A taxpayer may include any child was born before 1980; regarding children born after 1980, a taxpayer may include up to three children including child was born before 1980.

3.7.3 Separate filing due to the constitution court

Thailand had been using joint taxation for married couples earning certain types of incomes. In particular, before 2012 tax year, any married female who earned income under Section 40(2), (3), (4), (5), (6), (7), and (8) had to include these incomes to the husband income in the tax calculation process.

In 2012 the constitutional court judge the case that the Section 57 ter and 57 quinque contradicts to the constitution of Thailand 2550 B.E. (i.e. 2007). Hence, these sections were terminated; this verdict also led to additional personal tax regulations vis-à-vis married couple taxation.

The 2012 rules allow any married couple to declare personal income tax either separately, jointly, or partially jointly. TABLE Appendix A3.1 exhibits all five filing possibilities for a married couple based on the 2012 rules.

TABLE A3.1: Filing possibilities for married couples

Taxation	Husband	Wife
Separate		
1. Each do filing individually	- Section 40(1) to (8) - Personal allowance - Child allowance	- Section 40(1) to (8) - Personal allowance - Child allowance
Completely joint (all types of income)		
2. As husband's income	- Section 40(1) of both - Section 40(2) to (8) of both - Personal allowance for both - 2 times of child allowance	No filing
3. As wife's income	No filing	- Section 40(1) of both - Section 40(2) to (8) of both - Personal allowance for both - 2 times of child allowance
Partially joint (only Section 40(2) to (8)		
4. As husband's income	- Section 40(1) - Section 40(2) to (8) of both - Personal allowance - Child allowance	- Section 40(1) - Personal allowance - Child allowance
5. As wife's income	- Section 40(1) - Personal allowance - Child allowance	- Section 40(1) - Section 40(2) to (8) of both - Personal allowance - Child allowance

The first option is married couples declare income tax separately. If they are unable to share assessable income in Section 40(2) to (8), they can divide the income into halves. Each individual accounts for personal and child allowance.

If either of spouses does not have income in a tax year, they will apply married filing completely jointly. However, a person without income in a tax year is not eligible to claim for child allowance. This suggests a reason when both partners with children participate in the labour market or earn any other type of income because they have a larger amount of the child tax benefit.

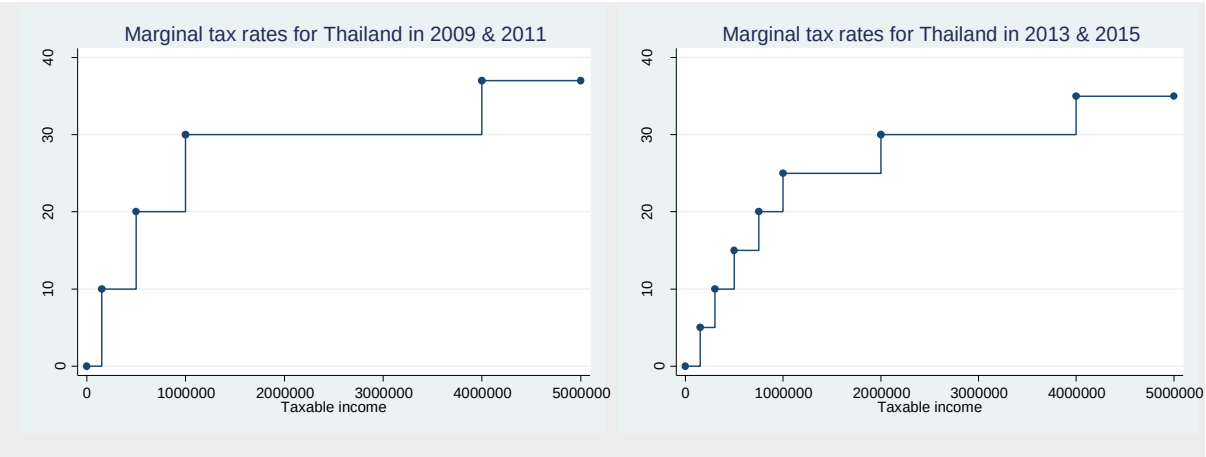
Completely joint tax declaration is that a couple decides to combine assessable income, allowances, and exemptions of both as one person's income. They may choose to define all income as belonging either to husband or wife. The person, who is responsible for declaring all income, accounts for personal and child allowances of both spouses.

A couple may do partially joint tax declaration, i.e., they decide to combine assessable income in Section 40(2) to 40(8) to male's or female's income while assessable income in Section 40(1) is declared individually. Personal and child allowances are attached to income in Section 40(1); in other words, each spouse accounts for personal and child allowance individually.

3.7.4 Structural change in Thailand personal income tax in 2013

Thailand has a progressive income tax structure. During the period in this study, from 2009 to 2015, there are two main tax scenarios as shown in FIGURE A3.2.

FIGURE A3.2: Marginal tax rates for Thailand from 2009 to 2015



Since 1992 Thailand had used a personal income tax structure with four tax brackets including 10, 20, 30 and 37 percent. Thai government modified the personal income tax structure in 2013 to seven tax brackets in total; this structure was continued using in 2015.

In fact, as shown in the left-hand panel of FIGURE A3.2 (tax brackets for 2009 and 2011), the first 100,000 baht and next 50,000 baht of taxable income, which they should have been taxed by 5 and 10 percent respectively, are exempted from being taxed. For the amount of taxable income from 150,000.01 to 500,000 baht, a person has to pay tax at 10 percent, next 500,000 baht (taxable income exceeding 500,000 but less than 1,000,000 baht) is taxed by 20 percent. The amount of taxable income over 1,000,000 baht but fewer than 4,000,000 baht is taxed at 30 percent. When a person has taxable income over 4 million baht, the government taxes this amount at 37 percent.

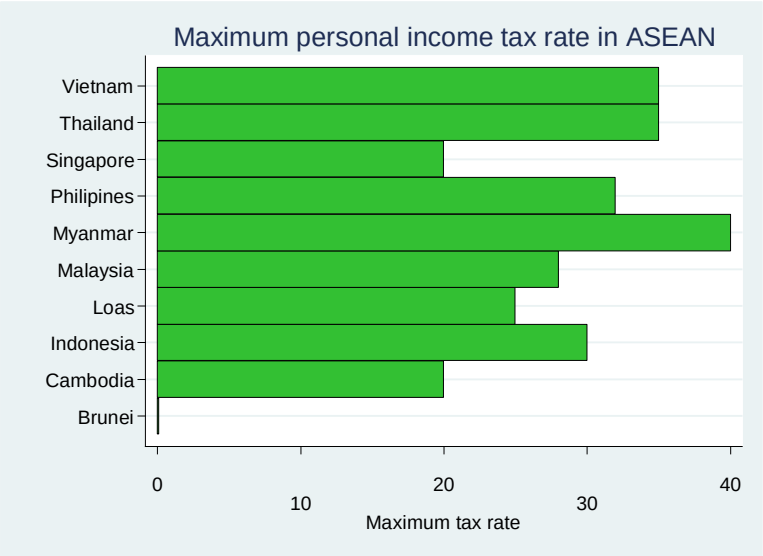
In regarding the right-hand panel of FIGURE A3.2 (tax brackets for 2013 and 2015), the first 300,000 baht of taxable income is set to be taxed by 5 percent; however, the half of it (first 150,000 baht) is exempted. Taxable income which exceeds 300,000 baht but fewer than 500,000 baht is taxed at 10 percent. For the next 250,000 baht of taxable income, a person pays tax at 15 percent. When a person has taxable income over 750,000 baht but less than 1,000,000 baht, this amount is taxed by 20 percent. The next 1 million baht of taxable income (1,000,000.01 to 2,000,000 baht) is taxed at 25 percent and the next 2 million baht (2,000,000.01 to 4,000,000) is taxed at 30 percent. In case, a person has taxable income over 4 million baht, this amount is taxed at 35 percent.

The main reason of adjusting the tax brackets is that the government sought to stimulate economic growth via the revised tax brackets; with the modified structure, people will pay a smaller amount of tax compared to the previous structure. This implies a higher amount of dispensable income as well as a larger amount of consumption in the economy. Nonetheless, an argument about equality is raised; cutting the highest income tax rate from 37 to 35 provides benefits for rich people; this could expand income gap between poor and wealthy people.

The other important reason is to compete with other countries in South East Asia countries with the ASEAN Economic Community (AEC) which started in 2015. This would be a giant improvement in ASEAN economic integration. Having a higher personal tax rate than other countries could make Thailand less competitive in terms of foreign direct investment. Another potential main effect of AEC is increased labour mobility in the forthcoming future. With a higher personal income tax rate, it might be more difficult to attract outstanding human resources to work in Thailand.

As shown in FIGURE A3.3 below, Thailand has a higher maximum tax rate relative to most of the ASEAN countries. In fact, only Myanmar has a higher maximum personal income tax rate than Thailand; and the maximum personal income tax rate of Thailand is identical to Vietnam. The maximum tax rates of other remaining ASEAN countries are lower than Thailand's.

FIGURE A3.3: Maximum personal income tax rate in ASEAN (2013)



An argument regarding the income inequality problem was raised. The policy supporters indicated that people with lower-middle income could benefit from this structure most. For example, people who earned between 150,000 to 300,000 baht would pay 50 percent less tax since the tax rate was reduced from 10 to 5 percent. However, the policy opponents criticised that the structure was not designed for dealing with the income inequality problem because rich people would benefit from reducing the celling of the personal income tax most.

3.8 Appendix 3.III: Estimation results

TABLE A3.2: Estimation results for unmarried male labour supply

	I1	I2	I3	I4
Y^2	-0.00000513	-0.00000621	-0.0000149*	-0.0000149*
	(0.00000301)	(0.00000345)	(0.00000601)	(0.00000599)
L^2	-0.00264***	-0.00255***	-0.00280***	-0.00281***
	(0.000131)	(0.000162)	(0.000184)	(0.000181)
$Y * L$	0.000394***	0.000454***	0.000360***	0.000357***
	(0.0000423)	(0.0000688)	(0.0000776)	(0.0000777)
Y	-0.0113***	-0.0114***	-0.000141	-0.000218
	(0.00306)	(0.00328)	(0.00415)	(0.00415)
Y * age over 40			-0.00109	-0.00106
			(0.00229)	(0.00229)
Y * Uni. degree			0.00753*	0.00757*
			(0.00347)	(0.00346)
L	0.255***	0.247***	0.285***	0.285***
	(0.0172)	(0.0201)	(0.0227)	(0.0224)
L * age over 40			0.0239***	0.0239***
			(0.00659)	(0.00655)
L * Uni. degree			0.0552***	0.0551***
			(0.0143)	(0.0142)
P	-6.281***	-6.271***	-6.257***	-6.265***
	(0.197)	(0.197)	(0.197)	(0.198)
P *BKK				0.105
				(0.319)
SD: Y		-0.00444*	-0.00448*	-0.00442*
		(0.00219)	(0.00209)	(0.00212)
SD :L		0.00394	0.00476	0.00433
		(0.0139)	(0.0146)	(0.0143)
Observations	49016	49016	49016	49016
Log lik.	-8251.1	-8250.3	-8184.2	-8184.1
lrtest_chi2		1.50	132.24	0.11
lrtest_df		2	4	1
lrtest_p		0.4727	0.0000	0.7401

Notes: Standard errors in parentheses; *, **, *** indicate statistical significance at 10%, 5%, and 1% levels respectively.

TABLE A3.3: Estimation results for unmarried female labour supply

	I1	I2	I3	I4
Y^2	-0.0000161***	-0.0000264***	-0.00000640	-0.00000637
	(0.00000235)	(0.00000440)	(0.00000545)	(0.00000540)
L^2	-0.00245***	-0.00193***	-0.00231***	-0.00233***
	(0.000111)	(0.000133)	(0.000145)	(0.000145)
$Y * L$	0.000467***	0.000952***	0.000808***	0.000796***
	(0.0000332)	(0.0000841)	(0.0000831)	(0.0000823)
Y	-0.00456	-0.00608	-0.0171***	-0.0174***
	(0.00237)	(0.00361)	(0.00413)	(0.00411)
Y * age over 40			0.00703**	0.00707**
			(0.00239)	(0.00237)
Y * Uni. degree			-0.00641	-0.00604
			(0.00376)	(0.00374)
L	0.249***	0.199***	0.196***	0.197***
	(0.0139)	(0.0170)	(0.0186)	(0.0185)
L * age over 40			0.0623***	0.0622***
			(0.00590)	(0.00584)
L * Uni. degree			-0.00330	-0.00304
			(0.0126)	(0.0126)
P	-7.338***	-7.411***	-7.403***	-7.424***
	(0.198)	(0.203)	(0.200)	(0.201)
P *BKK				0.315
				(0.261)
SD: Y		0.0171***	0.0120***	0.0118***
		(0.00204)	(0.00165)	(0.00163)
SD :L		0.000318	0.00103	0.000980
		(0.00599)	(0.00661)	(0.00630)
Observations	49,434	49,434	49,434	49,434
Log lik.	-8266.5	-8219.2	-8006.7	-8005.9
lrtest_chi2		94.52	425.08	1.5
lrtest_df		2	4	1
lrtest_p		0.0000	0.0000	0.2211

Notes: Standard errors in parentheses; *, **, *** indicate statistical significance at 10%, 5%, and 1% levels respectively.

TABLE A3.4: Estimation results for household labour supply

	H1	H2	H3	H4	H5	H6
Y^2	-0.00000123**	-0.00000135*	-0.00000304**	-0.00000295*	-0.00000304**	-0.00000287*
	(0.000000420)	(0.000000643)	(0.00000112)	(0.00000115)	(0.00000117)	(0.00000116)
Y^2*young child 3				-0.0000142***	-0.0000152***	-0.0000146***
				(0.00000282)	(0.00000286)	(0.00000285)
Y^2*young child 6				7.64e-08	-0.000000199	0.000000255
				(0.00000237)	(0.00000240)	(0.00000239)
Y^2*young child 10				-0.00000299	-0.00000329	-0.00000319
				(0.00000202)	(0.00000205)	(0.00000205)
L_m^2	-0.00374***	-0.00493***	-0.00589***	-0.00630***	-0.00651***	-0.00646***
	(0.0000509)	(0.000175)	(0.000206)	(0.000224)	(0.000235)	(0.000235)
L_m^2*young child < 3				0.00118***	0.00124***	0.00125***
				(0.000154)	(0.000156)	(0.000155)
L_m^2*young child 3-6				0.000606***	0.000587***	0.000549***
				(0.000160)	(0.000162)	(0.000161)
L_m^2*young child 6-10				0.000159	0.000187	0.000179
				(0.000135)	(0.000137)	(0.000137)
L_f^2	-0.00392***	-0.00432***	-0.00451***	-0.00467***	-0.00469***	-0.00468***
	(0.0000568)	(0.000103)	(0.0000976)	(0.000107)	(0.000107)	(0.000106)
L_f^2*young child < 3				0.000777***	0.000785***	0.000785***
				(0.000133)	(0.000133)	(0.000133)
L_f^2*young child 3-6				0.000164	0.000166	0.000167
				(0.000119)	(0.000119)	(0.000118)
L_f^2*young child 6-10				0.0000601	0.0000636	0.0000626
				(0.0000851)	(0.0000851)	(0.0000850)
YL_m	0.000243***	0.000330***	0.000202***	0.000198***	0.000207***	0.000211***
	(0.00000633)	(0.0000155)	(0.0000168)	(0.0000175)	(0.0000177)	(0.0000177)
YL_f	0.000117***	0.000167***	0.000201***	0.000198***	0.000198***	0.000201***
	(0.00000496)	(0.0000118)	(0.0000133)	(0.0000137)	(0.0000139)	(0.0000139)
L_mL_f	0.00183***	0.00220***	0.00206***	0.00209***	0.00230***	0.00230***
	(0.0000414)	(0.0000818)	(0.0000755)	(0.0000784)	(0.0000834)	(0.0000834)

TABLE A3.4: Estimation results for household labour supply (Continue)

	H1	H2	H3	H4	H5	H6
Y	-0.0112***	-0.0161***	-0.0124***	-0.0129***	-0.0129***	-0.0132***
	(0.000830)	(0.00145)	(0.00201)	(0.00208)	(0.00211)	(0.00210)
Y*young child < 3			0.00998***	0.0262***	0.0277***	0.0272***
			(0.00156)	(0.00353)	(0.00359)	(0.00358)
Y*young child 3-6			0.00696***	0.00775*	0.00813*	0.00764*
			(0.00148)	(0.00323)	(0.00327)	(0.00325)
Y*young child 6-10			0.00312**	0.00727**	0.00771**	0.00755**
			(0.00112)	(0.00280)	(0.00285)	(0.00284)
Y*number of children			0.000753	0.000892*	0.000857*	0.000866*
			(0.000394)	(0.000409)	(0.000409)	(0.000409)
Y * age40(m)			-0.00242*	-0.00235	-0.00214	-0.00218
			(0.00121)	(0.00126)	(0.00126)	(0.00125)
Y * University degree(m)			0.00577***	0.00631***	0.00656***	0.00640***
			(0.00106)	(0.00110)	(0.00110)	(0.00110)
Y * age40(f)			0.00231*	0.00235*	0.00231*	0.00230*
			(0.00107)	(0.00111)	(0.00112)	(0.00111)
Y * University degree(f)			0.00211	0.00254	0.00205	0.00186
			(0.00130)	(0.00134)	(0.00135)	(0.00135)
L_m	0.251***	0.344***	0.446***	0.484***	0.492***	0.486***
	(0.00648)	(0.0164)	(0.0210)	(0.0227)	(0.0234)	(0.0235)
L_m*young child < 3			0.0229***	-0.0792***	-0.0852***	-0.0871***
			(0.00637)	(0.0173)	(0.0176)	(0.0175)
L_m*young child 3-6			0.0309***	-0.0315	-0.0298	-0.0267
			(0.00631)	(0.0183)	(0.0186)	(0.0185)
L_m*young child 6-10			0.0219***	0.0123	0.0102	0.0106
			(0.00550)	(0.0162)	(0.0165)	(0.0164)
L_m*number of children			0.00474*	0.00729**	0.00716**	0.00712**
			(0.00213)	(0.00227)	(0.00231)	(0.00230)
L_m * age40(m)			0.0184***	0.0197***	0.0208***	0.0204***
			(0.00495)	(0.00513)	(0.00521)	(0.00519)

TABLE A3.4: Estimation results for household labour supply (Continue)

	H1	H2	H3	H4	H5	H6
L_m * Uni. degree(m)			0.0925***	0.0982***	0.100***	0.0990***
			(0.00779)	(0.00810)	(0.00822)	(0.00820)
L_m * age40(f)			0.0334***	0.0352***	0.0354***	0.0350***
			(0.00490)	(0.00510)	(0.00519)	(0.00516)
L_m * Uni. degree(f)			0.0157*	0.0188**	0.0146*	0.0131
			(0.00690)	(0.00712)	(0.00729)	(0.00725)
L_f	0.319***	0.346***	0.341***	0.354***	0.346***	0.344***
	(0.00702)	(0.0103)	(0.0110)	(0.0118)	(0.0118)	(0.0118)
L_f*young child <3			0.0933***	-0.00216	-0.000752	-0.00164
			(0.00569)	(0.0172)	(0.0172)	(0.0172)
L_f*young child 3-6			0.0519***	0.0282	0.0286	0.0277
			(0.00478)	(0.0158)	(0.0158)	(0.0157)
L_f*young child 6-10			0.0215***	0.0214	0.0215	0.0214
			(0.00381)	(0.0126)	(0.0126)	(0.0125)
L_f*number of children			0.00252	0.00960***	0.00943***	0.00941***
			(0.00142)	(0.00180)	(0.00181)	(0.00180)
L_f * age40(f)			0.0257***	0.0272***	0.0272***	0.0270***
			(0.00339)	(0.00355)	(0.00355)	(0.00354)
L_f * Uni. degree(f)			0.000193	0.00226	0.00204	0.00142
			(0.00589)	(0.00608)	(0.00607)	(0.00607)
L_f* age40(m)			0.00539	0.00622	0.00643	0.00623
			(0.00332)	(0.00345)	(0.00346)	(0.00344)
L_f * Uni. degree (m)			0.0112*	0.0137**	0.0138**	0.0130**
			(0.00486)	(0.00504)	(0.00507)	(0.00504)
P_m	-6.385***	-6.684***	-6.941***	-7.577***	-6.733***	-6.921***
	(0.121)	(0.139)	(0.144)	(0.182)	(0.207)	(0.221)
P_m*BKK				-0.680*	-0.617*	-1.628***
				(0.307)	(0.310)	(0.446)
P_m* $PreS$				1.511***	1.208***	2.308***
				(0.286)	(0.284)	(0.404)

TABLE A3.4: Estimation results for household labour supply (Continue)

	H1	H2	H3	H4	H5	H6
$P_m * AS$				0.506***	0.552***	0.643**
				(0.142)	(0.144)	(0.220)
P_f	-8.759***	-8.840***	-8.955***	-9.262***	-7.776***	-8.057***
	(0.117)	(0.121)	(0.124)	(0.142)	(0.208)	(0.242)
$P_f * BKK$				-0.164	-0.174	-1.629**
				(0.104)	(0.103)	(0.517)
$P_f * PreS$				0.167	0.181	1.872***
				(0.176)	(0.176)	(0.413)
$P_f * AS$				0.500***	0.506***	0.657**
				(0.0717)	(0.0717)	(0.238)
P_{hh}					-1.562***	-1.272***
					(0.162)	(0.207)
$P_{hh} * BKK$						1.483**
						(0.516)
$P_{hh} * PreS$						-1.715***
						(0.378)
$P_{hh} * AS$						-0.156
						(0.231)
SD:Y		0.00320***	0.00274**	0.00280**	0.00256**	0.00260**
		(0.000752)	(0.000906)	(0.000970)	(0.000952)	(0.000960)
SD:L_m		0.0630***	0.0757***	0.0806***	0.0856***	0.0845***
		(0.00557)	(0.00548)	(0.00569)	(0.00589)	(0.00593)
SD:L_f		0.0369***	0.0439***	0.0468***	0.0467***	0.0463***
		(0.00482)	(0.00364)	(0.00377)	(0.00373)	(0.00374)
Observations	1,837,385	1,837,385	1,837,385	1,837,385	1,837,385	1,837,385
Log lik.	-53926.3	-53903.4	-52828.4	-52724.4	-52675.6	-52659.5
lrtest_chi2		45.94	2150.00	207.88	97.62	32.20
lrtest_df		3	24	15	1	3
lrtest_p		0.0000	0.0000	0.0000	0.0000	0.0000

Notes: Standard errors in parentheses; *, **, *** indicate statistical significance at 10%, 5%, and 1% levels respectively.

3.9 Appendix 3.IV: Results for robustness checks

TABLE A3.5: Robustness checks for estimation results for unmarried male labour supply

	100 draws	500 draws	7 choices	2009-2011	2013-2015
Y^2	-0.0000149*	-0.0000151*	-0.0000149*	-0.0000199*	-0.0000326**
	(0.00000599)	(0.00000609)	(0.00000614)	(0.00000979)	(0.0000107)
L^2	-0.00281***	-0.00277***	-0.00298***	-0.00280***	-0.00301***
	(0.000181)	(0.000173)	(0.000192)	(0.000361)	(0.000273)
$Y * L$	0.000357***	0.000374***	0.000382***	0.000191*	0.000465***
	(0.0000777)	(0.0000803)	(0.0000786)	(0.0000890)	(0.000134)
Y	-0.000218	-0.000155	-0.000949	0.000812	0.0136
	(0.00415)	(0.00420)	(0.00428)	(0.00653)	(0.00725)
Y * age over 40	-0.00106	-0.00113	-0.00168	-0.000452	0.333***
	(0.00229)	(0.00231)	(0.00232)	(0.00345)	(0.0351)
Y * Uni. degree	0.00757*	0.00757*	0.00740*	0.00922	0.000937
	(0.00346)	(0.00351)	(0.00351)	(0.00526)	(0.00392)
L	0.285***	0.282***	0.305***	0.282***	0.0155*
	(0.0224)	(0.0217)	(0.0239)	(0.0414)	(0.00614)
L * age over 40	0.0239***	0.0239***	0.0236***	0.0167	0.0421***
	(0.00655)	(0.00655)	(0.00667)	(0.00973)	(0.0114)
L * Uni. degree	0.0551***	0.0554***	0.0563***	0.0459*	0.112***
	(0.0142)	(0.0143)	(0.0144)	(0.0202)	(0.0269)
Par	-6.265***	-6.261***	-6.236***	-5.646***	-6.777***
	(0.198)	(0.198)	(0.209)	(0.282)	(0.280)
Par *BKK	0.105	0.0994	0.112	0.0710	-0.0113
	(0.319)	(0.320)	(0.319)	(0.431)	(0.542)
SD: Y	-0.00442*	-0.00503*	-0.00380	-0.000835	-0.00996***
	(0.00212)	(0.00201)	(0.00231)	(0.00369)	(0.00258)
SD :L	0.00433	-0.00146	0.00471	0.0132	-0.00148
	(0.0143)	(0.0159)	(0.0158)	(0.0244)	(0.0116)
Observations	49,016	49,016	31,192	20,504	28,512
Log lik.	-8184.1	-8183.8	-6289.2	-3560.1	-4593.8
	100 draws	500 draws	7 choices	2009-2011	2013-2015
MUyI4	0.0167088	0.0176083	0.0174516	0.0081087	0.0333347
neg. %	1.19	1.37	0.81	4.94	0.35
MUlIH4	0.0407644	0.043631	0.0411778	0.0107289	0.1002574
neg. %	20.53	19.61	23.45	34.71	12.85
Quasi-concave I4	1.19	1.37	0.81	4.94	0.35
Monotonicity I4	0.00	0.00	0.00	0.00	0.00
Observations	4,456	4,456	4,456	1,864	2,592

Note:
Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Y and L are designated as income and leisure hours, respectively.
MUy and MUl represent marginal utility of income and leisure hours, respectively.
neg.% indicate a proportion of negative values of a variable in an upper row.

TABLE A3.6: Robustness checks for estimation results for unmarried female labour supply

	100 draws	500 draws	7 choices	2009-2011	2013-2015
Y^2	-0.00000637	-0.00000581	-0.0000113*	-0.00000286	-0.0000162*
	(0.00000540)	(0.00000568)	(0.00000566)	(0.0000107)	(0.00000773)
L^2	-0.00233***	-0.00226***	-0.00245***	-0.00184***	-0.00282***
	(0.000145)	(0.000150)	(0.000152)	(0.000219)	(0.000217)
$Y * L$	0.000796***	0.000835***	0.000806***	0.00101***	0.000678***
	(0.0000823)	(0.0000861)	(0.0000822)	(0.000163)	(0.000109)
Y	-0.0174***	-0.0185***	-0.0175***	-0.0195*	-0.00951
	(0.00411)	(0.00425)	(0.00422)	(0.00765)	(0.00592)
Y * age over 40	0.00707**	0.00707**	0.00732**	0.0107*	0.00816*
	(0.00237)	(0.00244)	(0.00241)	(0.00457)	(0.00331)
Y * Uni. degree	-0.00604	-0.00566	-0.00246	-0.0203**	0.000394
	(0.00374)	(0.00386)	(0.00379)	(0.00724)	(0.00525)
L	0.197***	0.189***	0.210***	0.147***	0.258***
	(0.0185)	(0.0193)	(0.0194)	(0.0285)	(0.0282)
L * age over 40	0.0622***	0.0625***	0.0631***	0.0631***	0.0712***
	(0.00584)	(0.00596)	(0.00592)	(0.00994)	(0.00883)
L * Uni. degree	-0.00304	-0.00134	0.0112	-0.0441*	0.0255
	(0.0126)	(0.0129)	(0.0127)	(0.0213)	(0.0200)
Par	-7.424***	-7.406***	-7.226***	-6.745***	-8.127***
	(0.201)	(0.201)	(0.210)	(0.278)	(0.295)
Par *BKK	0.315	0.365	0.296	0.263	0.261
	(0.261)	(0.267)	(0.261)	(0.406)	(0.369)
SD: Y	0.0118***	0.0122***	-0.0117***	0.0163***	0.0111***
	(0.00163)	(0.00163)	(0.00160)	(0.00347)	(0.00207)
SD :L	0.000980	-0.000575	0.0000887	0.00456	-0.0000884
	(0.00630)	(0.00644)	(0.00652)	(0.0102)	(0.00699)
Observations	49,434	49,434	31,458	22,539	26,895
Log lik.	-8005.9	-8002.4	-6310.3	-3754.6	-4224.9
	100 draws	500 draws	7 choices	2009-2011	2013-2015
MUyI4	0.0310987	0.0326321	0.0320849	0.0388954	0.0318124
neg. %	4.76	4.49	4.07	7.27	2.41
MUlIH4	0.0498654	0.055418	0.05217	0.0632855	0.0536646
neg. %	26.72	25.90	24.72	25.72	26.05
Quasi-concave I4	9.08	9.28	7.88	8.49	3.44
Monotonicity I4	0.00	0.00	0.00	0.00	0.00
Observations	4,494	4,494	4,494	2,049	2,445

Note:
Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Y and L are designated as income and leisure hours, respectively.
MUy and MUl represent marginal utility of income and leisure hours, respectively.
neg.% indicate a proportion of negative values of a variable in an upper row.

TABLE A3.7: Robustness checks for estimation results for family labour supply

	100 draws	500 draws	7 choices	2009-2011	2013-2015
Y^2	-0.00000287*	-0.00000220	-0.00000267*	-0.00000366	-0.00000316*
	(0.00000116)	(0.00000120)	(0.00000132)	(0.00000226)	(0.00000148)
Y^2*young child 3	-0.0000146***	-0.0000169***	-0.0000185***	-0.00000884*	-0.0000207***
	(0.00000285)	(0.00000314)	(0.00000333)	(0.00000417)	(0.00000403)
Y^2*young child 6	0.000000255	0.000000125	-0.000000784	-0.00000640	0.00000160
	(0.00000239)	(0.00000261)	(0.00000283)	(0.00000471)	(0.00000273)
Y^2*young child 10	-0.00000319	-0.00000336	-0.00000325	-0.00000281	-0.00000542*
	(0.00000205)	(0.00000219)	(0.00000237)	(0.00000337)	(0.00000263)
L_m^2	-0.00646***	-0.00740***	-0.00795***	-0.00619***	-0.00642***
	(0.000235)	(0.000322)	(0.000329)	(0.000359)	(0.000308)
L_m^2*young child <3	0.00125***	0.00138***	0.00165***	0.000920***	0.00159***
	(0.000155)	(0.000173)	(0.000185)	(0.000210)	(0.000223)
L_m^2*young child 3-6	0.000549***	0.000568**	0.000828***	0.000560**	0.000499*
	(0.000161)	(0.000180)	(0.000189)	(0.000212)	(0.000245)
L_m^2*young child 6-10	0.000179	0.000186	0.000229	0.000132	0.0000879
	(0.000137)	(0.000155)	(0.000163)	(0.000187)	(0.000193)
L_f^2	-0.00468***	-0.00489***	-0.00507***	-0.00447***	-0.00480***
	(0.000106)	(0.000117)	(0.000124)	(0.000152)	(0.000154)
L_f^2*young child <3	0.000785***	0.000859***	0.000865***	0.000687***	0.000802***
	(0.000133)	(0.000139)	(0.000149)	(0.000176)	(0.000197)
L_f^2*young child 3-6	0.000167	0.000201	0.000238	0.000297	-0.000103
	(0.000118)	(0.000124)	(0.000130)	(0.000153)	(0.000184)
L_f^2*young child 6-10	0.0000626	0.0000721	0.0000227	0.000134	-0.0000543
	(0.0000850)	(0.0000881)	(0.0000931)	(0.000113)	(0.000127)
YL_m	0.000211***	0.000222***	0.000265***	0.000214***	0.000184***
	(0.0000177)	(0.0000186)	(0.0000207)	(0.0000290)	(0.0000234)
YL_f	0.000201***	0.000215***	0.000253***	0.000219***	0.000164***
	(0.0000139)	(0.0000144)	(0.0000160)	(0.0000230)	(0.0000184)
L_mL_f	0.00230***	0.00248***	0.00278***	0.00218***	0.00234***
	(0.0000834)	(0.0000953)	(0.000101)	(0.000119)	(0.000119)
Y	-0.0132***	-0.0152***	-0.0173***	-0.0219***	-0.00730**
	(0.00210)	(0.00232)	(0.00253)	(0.00358)	(0.00281)
Y*young child <3	0.0272***	0.0316***	0.0343***	0.0213***	0.0353***
	(0.00358)	(0.00401)	(0.00420)	(0.00500)	(0.00522)
Y*young child 3-6	0.00764*	0.00894*	0.0105**	0.0140*	0.00748
	(0.00325)	(0.00357)	(0.00385)	(0.00551)	(0.00410)
Y*young child 6-10	0.00755**	0.00836**	0.00898**	0.00460	0.0129**
	(0.00284)	(0.00308)	(0.00329)	(0.00419)	(0.00397)
Y*N of children	0.000866*	0.00102*	0.00115*	0.00150*	0.0000671
	(0.000409)	(0.000442)	(0.000484)	(0.000612)	(0.000511)
Y*age40(m)	-0.00218	-0.00210	-0.00307*	0.0000183	-0.00203
	(0.00125)	(0.00136)	(0.00149)	(0.00192)	(0.00161)
Y*Uni. degree(m)	0.00640***	0.00719***	0.00781***	0.00757***	0.00616***
	(0.00110)	(0.00119)	(0.00129)	(0.00178)	(0.00140)
Y*age40(f)	0.00230*	0.00250*	0.00325*	0.00547**	-0.00000434
	(0.00111)	(0.00122)	(0.00133)	(0.00171)	(0.00143)

TABLE A3.7: Robustness checks for estimation results for family labour supply (Continue)

	100 draws	500 draws	7 choices	2009-2011	2013-2015
Y *Uni. degree(f)	0.00186	0.000861	0.00173	0.00171	0.00256
	(0.00135)	(0.00144)	(0.00158)	(0.00221)	(0.00175)
L_m	0.486***	0.566***	0.605***	0.451***	0.489***
	(0.0235)	(0.0308)	(0.0323)	(0.0362)	(0.0313)
L_m*young child < 3	-0.0871***	-0.0915***	-0.112***	-0.0645**	-0.104***
	(0.0175)	(0.0193)	(0.0210)	(0.0238)	(0.0249)
L_m*young child 3-6	-0.0267	-0.0233	-0.0475*	-0.0287	-0.00840
	(0.0185)	(0.0206)	(0.0219)	(0.0241)	(0.0284)
L_m*young child 6-10	0.0106	0.0145	0.0148	-0.00134	0.0438
	(0.0164)	(0.0184)	(0.0196)	(0.0219)	(0.0240)
L_m*N of children	0.00712**	0.00799**	0.00915**	0.0111***	0.00171
	(0.00230)	(0.00260)	(0.00281)	(0.00318)	(0.00318)
L_m*age40(m)	0.0204***	0.0252***	0.0264***	0.0196**	0.0248***
	(0.00519)	(0.00595)	(0.00638)	(0.00723)	(0.00727)
L_m*Uni. degree(m)	0.0990***	0.112***	0.127***	0.0886***	0.102***
	(0.00820)	(0.00937)	(0.00996)	(0.0118)	(0.0116)
L_m*age40(f)	0.0350***	0.0404***	0.0471***	0.0448***	0.0228**
	(0.00516)	(0.00593)	(0.00635)	(0.00740)	(0.00701)
L_m*Uni. degree(f)	0.0131	0.0150	0.0159	0.0121	0.0155
	(0.00725)	(0.00826)	(0.00881)	(0.0103)	(0.0103)
L_f	0.344***	0.354***	0.355***	0.316***	0.363***
	(0.0118)	(0.0126)	(0.0136)	(0.0166)	(0.0172)
L_f*young child < 3	-0.00164	0.00400	0.0160	-0.00528	0.0141
	(0.0172)	(0.0179)	(0.0192)	(0.0228)	(0.0257)
L_f*young child 3-6	0.0277	0.0305	0.0320	0.00570	0.0766**
	(0.0157)	(0.0164)	(0.0173)	(0.0202)	(0.0250)
L_f*young child 6-10	0.0214	0.0233	0.0340*	0.00269	0.0504**
	(0.0125)	(0.0130)	(0.0138)	(0.0165)	(0.0189)
L_f*N of children	0.00941***	0.0100***	0.0106***	0.0123***	0.00445
	(0.00180)	(0.00196)	(0.00209)	(0.00244)	(0.00258)
L_f*age40(f)	0.0270***	0.0297***	0.0347***	0.0322***	0.0201***
	(0.00354)	(0.00389)	(0.00425)	(0.00506)	(0.00493)
L_f*Uni. degree(f)	0.00142	-0.00416	0.00483	-0.0158	0.0173
	(0.00607)	(0.00638)	(0.00704)	(0.00876)	(0.00893)
L_f*age40(m)	0.00623	0.00802*	0.00656	0.00719	0.00916
	(0.00344)	(0.00381)	(0.00414)	(0.00478)	(0.00483)
L_f*Uni. degree(m)	0.0130**	0.0170**	0.0167**	0.0132	0.0138
	(0.00504)	(0.00555)	(0.00599)	(0.00720)	(0.00709)
Par_m	-6.921***	-7.180***	-7.016***	-6.241***	-7.535***
	(0.221)	(0.244)	(0.255)	(0.319)	(0.306)
Par_m*BKK	-1.628***	-2.076***	-2.307***	-1.959**	-1.105
	(0.446)	(0.493)	(0.516)	(0.646)	(0.612)
Par_m*$PreS$	2.308***	2.397***	2.791***	1.946***	2.524***
	(0.404)	(0.423)	(0.435)	(0.564)	(0.572)
Par_m*AS	0.643**	0.664**	0.707**	0.877*	0.321
	(0.220)	(0.236)	(0.239)	(0.343)	(0.288)

TABLE A3.7: Robustness checks for estimation results for family labour supply (Continue)

	100 draws	500 draws	7 choices	2009-2011	2013-2015
Par_f	-8.057***	-8.078***	-7.557***	-7.778***	-8.250***
	(0.242)	(0.253)	(0.256)	(0.351)	(0.334)
Par_f*BKK	-1.629**	-2.027***	-2.047***	-1.886*	-1.325
	(0.517)	(0.555)	(0.564)	(0.735)	(0.727)
Par_f* $PreS$	1.872***	1.869***	1.969***	1.895***	1.509*
	(0.413)	(0.434)	(0.444)	(0.575)	(0.588)
Par_f* AS	0.657**	0.625*	0.665**	1.017**	0.250
	(0.238)	(0.251)	(0.252)	(0.365)	(0.315)
Par_{hh}	-1.272***	-1.367***	-1.555***	-1.154***	-1.480***
	(0.207)	(0.219)	(0.220)	(0.306)	(0.277)
Par_{hh}*BKK	1.483**	1.789**	1.771**	1.828*	1.172
	(0.516)	(0.552)	(0.561)	(0.732)	(0.725)
Par_{hh}* $PreS$	-1.715***	-1.668***	-1.734***	-1.866***	-1.309*
	(0.378)	(0.398)	(0.405)	(0.532)	(0.536)
Par_{hh}* AS	-0.156	-0.109	-0.147	-0.495	0.174
	(0.231)	(0.245)	(0.245)	(0.358)	(0.304)
SD:Y	0.00260**	0.0000582	0.00221*	0.00142	-0.00181
	(0.000960)	(0.00375)	(0.000930)	(0.00376)	(0.00134)
SD:L_m	0.0845***	0.108***	0.120***	0.0866***	0.0720***
	(0.00593)	(0.00785)	(0.00782)	(0.00918)	(0.00786)
SD:L_f	0.0463***	-0.0555***	0.0627***	0.0477***	0.0390***
	(0.00374)	(0.00399)	(0.00407)	(0.00567)	(0.00553)
Observations	1,837,385	1,837,385	744,065	934,967	902,418
Log lik.	-52659.5	-52644.4	-41591.9	-27169.8	-25411.0
	100 draws	500 draws	7 choices	2009-2011	2013-2015
MUyH6	0.0160538	0.0167235	0.0201286	0.0119805	0.0167839
neg. %	2.89	2.60	2.37	16.05	0.86
MUmH6	0.0547289	0.0573014	0.0697437	0.0388096	0.0592436
neg. %	34.33	35.97	35.10	38.84	31.68
MUfH6	-0.0523611	-0.0515169	-0.0444479	-0.0625566	-0.0498856
neg. %	44.97	45.35	45.16	49.29	42.60
Quasi-concave H6	12.17	15.52	15.14	30.97	1.18
Monotonicity H6	0.05	0.01	0.00	0.54	0.01
Observations	15,185	15,185	15,185	7,727	7,458

Note:

Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Y and L are designated as income and leisure hours, respectively.

MUy and MUl represent marginal utility of income and leisure hours, respectively.

neg.% indicate a proportion of negative values of a variable in an upper row.

Chapter 4 Policy microsimulation

4.1 Introduction

4.1.1 Background

Microsimulation modelling is a simulation-based tool applied on a micro unit of analysis (e.g., cars, individuals, families, firms, and farms) from surveys or administrative datasets to evaluate a given change[20] (O'Donoghue, 2014). A change can be a policy reform or a socio-economic change that affects the population of micro units (Mitton et al., 2000).

Microsimulation modes (MSMs) are widely applied in many branches of sciences, e.g., engineering and social sciences. For example, they are applied in transportation studies in simulating traffic control systems and pedestrian walkways; urban planning studies apply spatial microsimulation techniques to investigate population dynamics and urban expansion. Regarding MSMs in economics, several areas of studies (e.g., public finance, agricultural policy, health economic policy, and labour market) use microsimulation in policy simulation. For instance, Lux and Marchesi (1998) apply a microsimulation of interacting agents to study volatility clustering in financial markets; Spatial MSMs are also applied to investigate environment and economic efficiency in farming. Rutter et al. (2011) provide a review which covering an overview of dynamic MSMs as well as different studies applying the models to answer health policy questions.

In fact, MSMs have been used in economic studies to simulate the effect of a policy on economic agents such as individuals, households, and firms at the micro-level (i.e., the result can be observed for each agent); policy evaluation is based on economic contexts of individual agents, their budget constraints, and optionally their behavioural reaction to a policy (Bourguignon and Spadaro, 2006). MSMs have turned into one of the general analytical approaches in empirical studies for welfare and

[20] A given policy change or reform is generally referred to a factual or a counterfactual policy.

distributional analysis (Löffler et al., 2014a). MSMs are widely applied to simulate the distributional consequences of an issued policy (e.g., a tax or benefit rule) among heterogeneous population groups can also be used to evaluate the possible costs and benefits of a policy to the economy (Creedy and Duncan, 2002). This aspect of MSMs is closely associated with labour supply studies.

Many empirical studies in labour supply apply MSMs to investigate the effects of policies through the labour supply model; following empirical studies are provided as examples (details are provided in Section 4.2). van Soest (1995) studies family labour supply in the Netherlands using a MSM; the paper simulates different tax-benefit policies (e.g., separate taxes and benefits) . Duncan and Harris (2002) study labour supply responses of sole parents in Australia; they simulate the effects of actual and hypothetical welfare policy reforms (e.g., abolishment of single parent rebate and an increase in basic income tax rate). Callan et al. (2009) study female labour supply in Ireland and the effects of implementing raised independence in tax treatment of both partners. Müller and Steiner (2013) apply a German data set to study family labour supply and the effects of increases in the minimum wage. Kabátek et al. (2014) investigate household labour supply using a French dataset; they apply a MSM to evaluate the effects of separate taxation for married couples and joint taxation for cohabitating couples.

It can be apparently seen that most of the existing literature focuses on developed countries. Gong and van Soest (2002) is an example in the literature focusing on a developing country investigating married female labour supply in Mexico City. However, the study aims to learn labour supply responses of different sub-groups and model specifications in a developing country setting; it applies a MSMs for wage elasticity of labour supply only. The literature which applies a MSM model through labour supply behaviour to investigate effects of different policies is lacking; this is one of the key motivations of this chapter.

The main objective of this chapter is to investigate the effects of actual and counterfactual policies on labour supply response as well as financial factors, namely, gross income, tax burden, and disposable income at individual and household level. On top of that, this chapter aims to explore the effect of policies on poverty and income equality. This chapter contributes to the small literature investigating such issues in a developing country, which is important as a similar policy can lead to different results in developing and developed countries due to different economic contexts.

This chapter focuses on the MSM based on the static unitary labour supply setting for individual and family levels. The model for individual labour supply is more straightforward because only one labour supply response is observed under a simulated situation. The model for household labour supply is more complicated as behavioural changes of both partners can be observed due to a simulated scenario. This chapter is closely linked to the previous chapter; the labor supply behaviour obtained from the preferred discrete hours labour supply models in the previous chapter are adopted in MSMs in this chapter. The behavioural MSMs based on data in year 2013 and 2015 are applied in the simulation for a couple of reasons. First, actual and counterfactual policy reforms simulated in this chapter are more relevant to years 2013 and 2015. Second, according to results in the previous chapter, the models fit the 2013 and 2015 dataset better than the 2009 and 2011 dataset and than the whole sample, four years altogether.

The next section provides detailed discussion on different policies included in this chapter. The three main policy reforms include the national minimum wage, increases in non-transferable allowances, and a proposed tax structure reform.

4.1.2 Thailand policy issues

This section provides a brief explanation about the policy simulations in this chapter. The details of the empirical simulation procedure are provided in Section 4.4.4.

4.1.2.1 Minimum wage

As mentioned in Section 2.1, the Thai government changed from provincial minimum wages to a national minimum wage in 2012. The minimum wage was set to be 300 baht per day, i.e., it increased by about 70 percent on average at the beginning of 2013 (the details of the wage increase are provided in TABLE A2.1). The political explanation is that the policy can help increase household income for families at the lower end of the income distribution; therefore, it benefits are at least twofold. Firstly, it helps raise a living standard of people. The government also claimed that it could promote economic growth since people earning the minimum wage spend a larger proportion of income relative to other groups. Secondly, increased incomes of people at the lower end of the distribution makes the income gap narrower; this ameliorates the income inequality situation in Thailand.

However, a major concern is a low rate of policy compliance and inefficient law enforcement. Leckcivilize (2015) indicates that the minimum wage policy is effective in large businesses but the effectiveness drops for small and medium sized businesses in the covered industries; the policy is overall ineffective in reducing income wage inequality because of the low compliance rate and inefficient law enforcement in Thailand. This is similar to the reason why del Carpio et al. (2014) who study the effects of the minimum wages on welfare in Thailand conclude that the minimum wage increased inequality within the lower half of the income distribution since people in very poor households tend to work in industries or organisations that are not compliant with the policy. If the government increased the rate of policy compliance, the policy will be more effective to achieve its key purposes.

The minimum wage with perfect compliance is expected to yield different results because the different inherent structures of the income distributions between developing and developed countries. In fact, developed countries such as Germany in Müller and Steiner (2013) and the UK in Atkinson et al. (2017) indicate that people earning the minimum wage in these countries are scattered across the income distribution. However, minimum wage workers in Thailand are heavily distributed at the bottom half of the income distribution.

This chapter simulates a perfectly compliant rate of the national minimum wage policy (300 baht per day) and investigates the effect on labour supply behaviour, incomes, and personal income tax.

4.1.2.2 Increases in non-transferable allowances

In the 2017 tax year, the Thai government increased some allowable expenses and allowances. The government adjusted these tax benefits to reflect increased costs of living in recent years. Ceteris paribus, the reform is expected to help raise disposable income. Among these changes were increases in two non-transferable allowances including earned income allowable expenses and child allowance. The allowable expense was increased from 40% of income (not over 60,000 baht) to 50% of income (not over 100,000 baht); child allowance was also raised from a maximum of 17,000 baht to 30,000 baht per year. These non-transferable allowances are interesting because they are expected to change the labour supply behaviour of people directly, especially those who are not paying personal income tax, such as non-workers and part-time workers, encouraging them to participate in the labour market and increase hours worked respectively. This is because each person needs to work and earn a certain amount of income to utilise these non-transferable allowable tax-benefits efficiently. Although, the government also increased other transferable allowances such as personal spouse allowances[21], they

[21] They were doubled from 30,000 baht per person (60,000 baht in total) to 60,000 baht per person (120,000 baht in total).

are not included in this chapter due to its transferable property, which does not directly affect the labour supply response of each individual in specific.

This chapter simulates an increase on these non-transferable allowances based on the rules in 2017 to see the effect on labour supply and related pecuniary variables.

4.1.2.3 Recently proposed tax code restructure

In September 2018, a government committee[22] proposed a rudimentary package of tax reforms. Personal income tax is a part of the package; other taxes such as corporate tax, VAT, and specific business taxes are also included. While most parts of the proposal are still unclear, some interesting issues have enough information to be worthwhile investigating. Regarding personal income tax, the focus in this chapter, Thai government plans to restructure these following aspects which are related to this study[23].

First, based on the current rule, people need to report their incomes if they earn more than a threshold amount depending on whether they are single or a married couple. However, the proposal states that all people older than 18 years old must declare income for personal income tax; those are who younger than 18 years old and earn over the threshold amount as indicated in the current tax code also need to declare their incomes to the Revenue Department, Ministry of Finance. The objective of this amendment is to expand the tax base (i.e., the number of people declaring income for taxation). In this chapter, this proposed rule is incorporated into the simulation. However, since a new income thresholds is unknown, it is set as the most recent tax rules at the day the simulation is executed (tax year 2017). This specific change is expected to affect some individuals who are younger than 18 years old but earn less than the income declaration threshold. However, the effects on labour supply

[22] This sub-committee is under the Thai law reforming committee appointed by the Prime Minister's Office.
[23] Some aspects of personal income are not applicable in this study such as incomes earned by groups of persons or ordinary partnerships.

response and financial variables (income and tax amounts) are likely to be limited because people under 18 years old are less likely to have any personal income tax burden.

Second, the proposed tax codes plan to eliminate joint tax and partially join tax filings to simplify the tax calculation as well as to eliminate tax planning for married couples. In recent years, Thai people can choose among separate, partially joint, and joint income declarations for personal income tax; each option may yield a different tax burden. Allowing options in tax calculation leads to tax planning. This study follows the proposed rules by removing all possibilities for married couples to do joint tax and partially joint income declarations. This reform possibly has a slight effect on disposable income. In the tax calculation process, people are assumed to have perfect information about tax rules and therefore they select the best option (separate, joint, or partially joint taxation) to minimise their tax burden. Elimination of joint taxation (including partially joint taxation) causes people to pay tax as given. This proposed rule is expected to increase tax burden for some households, which do tax planning by choosing joint or partially joint tax declaration to minimise the tax amount in the pre-reform scenario.

Third, the government committee aims to revise the tax base and tax rates by amending the tax threshold, tax brackets, as well as tax rate at each bracket. In fact, the tax threshold, which is currently set at first 150,000 baht of taxable income, will be removed. Hence, if a person has net taxable income greater than zero, all of the amount will be taxed. Unfortunately, the details about tax brackets and tax rates are still unknown. According to available information, the committee plans to expand the income range in each bracket and reduce the celling tax rate to be more comparable to the corporate income tax rate, which is currently 20 percent. This study is compliant with the proposed reform by eliminating the tax thresholds in the tax calculation. In addition, this chapter reduces the number of tax brackets and expands the income range at each bracket by applying the rules in 2009 and 2011.

FIGURE 4.1: Marginal tax rates and tax brackets for the recently proposed tax restructure

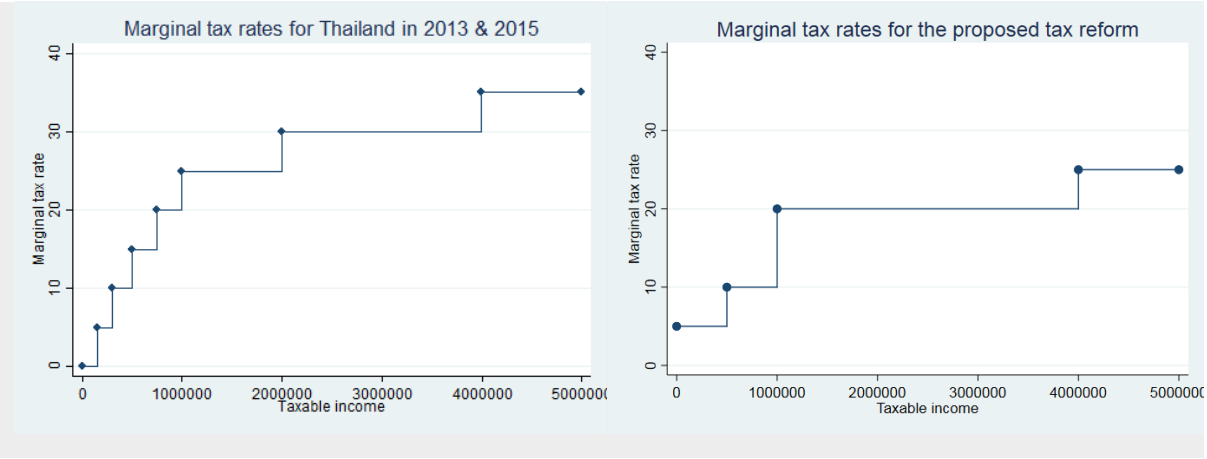


FIGURE 4.1 exhibits marginal tax rates in the pre-reform case (2013-2015) and the proposed personal income tax package. This chapter amends the 2013 and 2015 tax rules (shown on the left graph of FIGURE 4.1) based on the proposed changes. The right graph of FIGURE 4.1 shows the reformed tax brackets and rates. There are some other proposed rules such as reducing income types from eight types to three types, revising allowable expenses to suit new income types, and increasing allowances for children and the disabled. However, detailed information about these amendments is unavailable. On top of that, the HSES does not provide enough information to calculate disposable incomes using assumptions based on the proposed rules.

The effect of this hypothetical reform including removing the tax threshold, reducing a number of tax brackets, and revising tax rates is unclear because this change can affect different people differently.

4.1.3 Organisation of the chapter

This chapter applies the microsimulation technique on labour supply models to investigate the impact of simulated policy reforms on labour supply responses, gross incomes, tax burdens, and disposable incomes. The implications on household income and income equality are also investigated.

The next section, Section 4.2, reviews the literature, which is sectioned by different simulations. In Section 4.3, the data and descriptive statistics are presented. Section 4.4 provides a description of the methodology applied in this study, which includes microsimulation in the labour supply setting, an

explanation of the microsimulation model taxonomy in labour supply studies, a discussion of the labour supply elasticity calculation, and a description of the simulated policies and the policy evaluation. Next, Section 4.5 provides simulated results for the labour supply elasticity and each separate policy. The final section, Section 4.6, concludes the chapter with a summary of findings and economic explanations.

4.2 Literature reviews

This section reviews previous empirical work using microsimulation techniques in policy evaluation. Different studies simulate different policies depending on their objectives under varied contexts. Some studies focus on the impact of actual recent policies; some studies assess the results of counterfactual policy reforms; and other studies simulate both types of policies to evaluate their effects. The policy measures are also varied across studies.

4.2.1 Labour supply elasticities

Empirical studies which focus on the effects of policy reforms applying microsimulation approaches with labour supply settings usually include an analysis of labour supply elasticities. It is to investigate the labour supply response when an income factor increases by a given percent. The net wage rates or household disposable incomes are endogenously changed through the tax-benefit system. Most of the studies focus on labour supply at either the individual level or household level; however, individual labour supply research usually studies married individuals. Thus, this section includes empirical work that covers labour supply models at the family level so that this allows comparison of own wage and cross wage elasticities of labour supply as well as labour supply elasticity between genders and marriage status.

van Soest (1995) is the seminal paper on discrete hours labour supply models and microsimulation; the paper uses Dutch household data collected in 1987 to study household labour supply. The author increases before tax wage rates of males and females by 10 percent. When wages of males increase

by 10 percent, both partners increase their hours worked. Increases in male and female labour supply are also observed when females' wages increase by 10 percent. However, the own wage elasticity of labour supply is greater than the cross wage elasticity of labour supply for both cases. Overall, the results indicate that labour supply is more elastic for females than males.

van Soest and Das (2001) study family labour supply in Netherlands using Dutch cross-sectional data in 1995. The framework is similar to van Soest (1995); they extend some aspects. For instance, they incorporate fixed costs into the model rather than apply an *ad hoc* alternative specific constant on certain hours points (part-time jobs) in the direct utility function as in van Soest (1995). They increase the before tax wage rates by 1 percent to analyse the own and cross wage elasticities of labour supply. The own wage elasticity of labour supply for both genders are positive. The cross wage elasticities of labour supply are found to be negative for both genders which is different from the results in van Soest (1995). Nevertheless, the relative size of the elasticity in both cases (own wage and cross wage elasticities) are consistent with previous work; female elasticities are greater than male elasticities. They also provide the overall result when wages of both genders increase by 1 percent. They find a very small positive increase on male labour supply but a larger positive increase on female labour supply.

Some studies include standard errors to allow statistical significance testing. Callan and van Soest (1996) extend van Soest (1995) by accounting for involuntary unemployment and fixed costs in studying the household labour supply in Ireland. They apply a one-percent increase in before tax wage rates to investigate both own wage and cross wage elasticities of labour supply for men and women. The results indicate that the own wage elasticity of labour supply for males is less elastic than for females. The cross wage elasticities of both genders show very small negative numbers; the female cross wage elasticity is not statistically significant.

Kabátek et al. (2014) study household labour supply in France. They increase net wages by 1 percent to investigate elasticities of labour supply for husbands and wives. The results are similar to other studies. For both genders, own wage elasticities of labour supply are positive, and cross wage elasticities of labour supply are negative. The relative size of (own wage and cross wage) labour supply elasticities for females are greater than those for males. The study also investigates the unearned income elasticity of labour supply by increasing non-labour income by 1 percent. The simulated results indicate that both husbands and wives decrease their hours worked; however, females reduce their labour supply more than do males as expected.

de Boer (2016) studies labour supply in Netherland at individual and household level. The author simulates elasticities of labour supply by increasing gross wages by 10 percent. Regarding individual labour supply, the elasticity of single parents is larger than that of singles without children. In terms of household labour supply, the results are consistent with other studies in that female labour supply is more elastic than the male labour supply. The own wage elasticities are positive whilst the cross wage elasticities are negative. The study also shows that couples with children have more elastic labour supply relative to couples without children.

Mauro et al. (2017) study not only family labour supply, but also individual labour supply in the Netherlands. By applying a large and rich panel data, the microsimulation results suggest that in general own wage elasticities of labour supply for both genders are positive; labour supply of females is more elastic than that of males. The cross wage elasticities of labour supply, which are only available at the family level, are negative for both genders. The cross wage elasticities of labour supply in households without children are identical whilst in households with children, the cross wage elasticity of labour supply for females is more elastic. The subgroup results indicate that singles without children have less elastic labour supply in comparison with singles with children. A similar pattern is observed for the household labour supply level as well.

It is apparent that most existing studies investigate labour supply in developed countries; hence, there is very limited knowledge about labour supply elasticity in developing countries. Gong and van Soest (2002) investigate married female labour supply in Mexico City. They simulate a one-percent rise of all respondent wage rates; the results suggest that the average hours worked increases. When other unearned income (i.e., incomes of husband and unmarried children) increases by 1 percent, married females reduce working hours. The findings are similar to previous research in developed countries; however, the study does not provide any analysis about male labour supply elasticities and cross wage elasticities of both genders. This study aims to fill this gap in the literature by simulating labour supply elasticities covering own wage and cross wage elasticities of labour supply for both genders in a developing country (Thailand).

4.2.2 Minimum wage policy

The extensive literature associated with the effects of minimum wages focuses mainly on employment (Brown, 1999; Neumark and Wascher, 2008). Many studies focus on the effects of an increase in the minimum wage on poverty (e.g., Mincy (1990), Addison and Blackburn (1999), and Müller and Steiner (2009). However, less research attention has been devoted to the economic question whether and to what extent the minimum wages affect household income distribution (Müller and Steiner, 2013).In addition, empirical studies investigating the effects of minimum wages on labour supply is limited (Rozenbes et al., 2013).

This section primarily reviews existing empirical research which studies the effect of a minimum wage on labour supply, poverty, and income distribution. Although the focus of this chapter is to apply microsimulation in the analysis, this section includes a study using other techniques to obtain the results as well.

Bredemeier and Juessen (2012) study the labour supply response of married and single females in Germany. They estimate a structural labour supply model with home production. The results show large positive effects of the minimum wage on minimum wage recipients. The results are different (positive, neutral, and negative) with smaller effects for non-minimum wage workers. The experiments reveal a stronger effect on married women than single ones. However, the effect on the total labour supply is relatively small.

Buddelmeyer and Kalb (2008) investigate the impact of an increase in the minimum wage. Their microsimulation uses data from Australia to increase the federal minimum wage from 13.74 to 14.31 AUDs. The results indicate that all population subgroups (minimum wage workers and all employed workers) increase their labour supply after the reform. Regarding minimum wage workers, sole parents have the greatest labour supply response followed by partnered women, single women, single men, and partnered men respectively.

Müller and Steiner (2009) apply STSM which is a MSM based on Socio-Economic Panel (SOEP) to investigate the effects of an increase on the minimum wage on poverty in German. In simulation they introduce a national minimum wage at 7.50 Euros. This cause overall increases in the minimum wage from about 4 percent in West Germany to 15 percent in East Germany. The policy raises the average gross hourly wage by 30 percent at the bottom decile of the wage distribution and about 65 percent at the first five percentile. However, they find that the minimum wage is not an effective policy for poverty remedy because of the means-tested income support. Sabia and Burkhauser (2010) study the effects of increases in the minimum wage in the U.S. They estimate a fixed effect model using a dataset from March 2004 to March 2008. The simulation results suggest that increasing the minimum wage from 7.25 USD to 9.50 USD is ineffective in reducing poverty.

However, some empirical studies find increasing the minimum wage is an effective in poverty reduction. Mincy (1990) uses the March 1987 Current Population Survey in the U.S. to estimate the results and simulate the effects of increases in the minimum wage. The results suggest that the minimum wage increases narrow poverty gap, reduce the number of poor households, and increase household income. Addison and Blackburn (1999) apply a more flexible reduced form model to estimate the U.S. state-level dataset during the year 1983 to 1996. The results suggest that increases in the minimum wages benefit poverty reduction for teenagers and older junior high school dropouts.

Müller and Steiner (2013) develop Müller and Steiner (2009) in studying the effects of an increase of the legal minimum wage using the microsimulation technique. The authors use German data to investigate distributional effects of a minimum wage through labour supply, employment, and price effects models. The study shows that an increase in the minimum wage has a small effect on disposable incomes. This is because low-wage earners are distributed across the whole income distribution and the effects of the minimum wage increase is cancelled out by reductions in means-tested welfare transfers and high marginal tax rates. Increases in the minimum wage induce negative effects on employment and consumer prices (i.e., inflation); positive direct effects on disposable incomes caused by the minimum wage are wiped out.

Atkinson et al. (2017) apply a MSM which is based on the labour supply based tax-benefit model EUROMOD to evaluate the effects of several policies in reducing poverty and inequality in the UK. One of the key policies the paper focuses on is increasing the national minimum wage. The microsimulation results of a considerable increase in the minimum wage show that the increase affects a large proportion of earners, but has a very modest effect in ameliorating inequality or poverty. This is because low-wage workers are scattered across the entire distribution rather than concentrated towards the lower end. Inclusion of the minimum wage with other tax-benefit policy packages makes little difference in terms of incentives to work relative to the effect of those policies without the effect

of the minimum wage. Increasing the minimum wage helps to reduce the number of people reliant on means-tested support with each policy.

According to previous work, there is no conclusive result regarding the effect of raising the national minimum wage on labour supply, poverty, and income distribution. In addition, previous studies simulate the policy in the developed country contexts. There is a gap in the literature for national minimum wage policy simulations in developing country settings.

4.2.3 Tax and transfer structure simulations

van Soest (1995) simulates the effects of different tax-transfer scenarios. First, the study assumes separate taxation without transfers. This makes one-earner families face an increase in personal income tax and a disincentive for female market participation is removed from the tax-benefit system. The simulation results reveal that this policy causes an increase in female labour supply; whilst the male labour supply changes in the opposite direction. Second, taxes and benefits are completely individualised. The simulated results when a government applies a completely separate tax on couples suggest that the proportion of lone-working families increases due to benefits received if the partner does not work, and both genders reduce their overall hours worked.

Callan and van Soest (1996) compare simulation results between family-based taxation and two more independent taxation systems. First, the simulation applies the quasi-independent taxation whereby the transferability of allowances between spouses is limited. The results indicate that the effects on male labour supply are small at both intensive and extensive margins. The average hours worked drops whilst the participation and employment rates slightly increase. On the other hand, the effects for females are larger for worked hours, participation, and involuntary unemployment. The second tax system is fully independent individual taxation, which allows married spouses to transfer allowances freely. This system reduces effective tax rates by about 10 percent. The effects on males are moderate.

Average hours decline slightly; and an increase in nonparticipation leads to a fall in the employment rate. The effects on women, on the other hand, are relatively substantial.

Kabátek et al. (2014) study the effects of changing from joint taxation to separate taxation for married couples and vice versa for cohabiting partners in France. Their structural discrete hours labour supply model considers market work, domestic duties, and leisure. The simulated effects of income tax reforms suggest that replacing joint taxation with separate taxation for married couples increases marginally the participation rate and the average market hours for females and reduces the participation rate and the hours worked of males slightly. On the other hand, changing the tax system from separate taxation to joint taxation for cohabiting couples leads to a slight increase in the participation rate and the market labour supply for males and a small negative impact on the participation rate and the market hours for women.

Along with an increase in the minimum wage, Atkinson et al. (2017) simulate a tax system with more progressive tax rates (ranging between 25 to 65 percent) using UK labour supply models. Following Atkinson (2015) they also investigate the impact of setting the Child Benefit at 18 percent of the median equivalised household net income for all children apart from the first child. In fact, the weekly payments of Child Benefits for the first child increase from 20.5 to 89.15 pounds per week whilst the benefits for any following child rise from 13.55 to 52.50 pounds per week; the baseline system uses information from 2014. They also aim to offer two alternative routes to revise social transfers. One option is strengthening Social Insurance by raising payment rates, reducing the personal tax allowances, and converting child benefits to be taxable. The other option is introducing Participation Income[24] (75 pounds per week) with some changes including the elimination of the personal income tax allowance and age allowance, and interactions between Participation Income and the tax-benefit

[24] Participation Income is a partial financial support which is complement existing social transfers. Adults receive Participation Income when they meet a condition such as caring for someone (a child or an adult), doing volunteer work, doing formal work, seeking for a job training, and etc.

system. The simulation results suggest that the each proposed tax-transfer package can help reduce income inequality and poverty substantially.

Creedy and Mok (2017) study labour supply and effects of the New Zealand 2010 tax-transfer change. They also provide implications for government revenue and the income distribution. In 2010, the New Zealand government introduced a tax package including an increase in the Goods and Services Tax rate from 12.5 to 15 percent, decreases in personal income tax rates, and increases in the major benefits. Data in year 2009/2010 are used in the estimation and simulation. Reforms in personal income tax help increase labour supply at the intensive and extensive margins. Considering separate components in the package suggests that the change in tax rates has the largest impact on labour supply. This is because it affects a larger percentage of the population relative to other changes.

Simulations on income taxes and benefits are different across studies because their samples have contextual differences (countries and periods). Previous empirical papers usually simulate effects on policies in developed countries; this leave some academic opportunities for investigating effects of tax-benefit reforms in developing country contexts.

4.3 Empirical data

4.3.1 Descriptive statistics of Thailand HSES

The data used in the microsimulation is from the HESE in 2013 and 2015. The data is quite recent which is an advantage why simulating recent factual policies as well as counterfactual policies. Labour supply responses of people in recent years to a simulated policy are likely to differ from their own behaviour in the past and hence using older data may give misleading results.

The data covers 12,495 households; the number of observations is identical to what is used in the estimation in the previous chapter. Households are divided into six different types categorised by the type of labour supply (individual or family) and the number of dependent children for married couples. Descriptive statistics are shown in TABLE 4.1.

TABLE 4.1: The number of observations by household type

Household type	Number of observations	Percentage
Unmarried males without children	2,592	20.74
Unmarried females without children	2,445	19.57
Married couple without children	3,824	30.60
Married couple with a child	2,115	16.93
Married couple with two children	1,292	10.34
Married couple with three children	227	1.82
Total	12,495	100.00

The first household type is unmarried males. These individuals are applied in the estimation to obtain coefficients for the policy simulations; the detailed estimation results which are obtained in the previous chapter are presented in TABLE A3.5, Appendix 3.IV. Unmarried males account for 20.74 percent of the total households. The second group of observations is unmarried females. Similar to the unmarried male case, a separate model is estimated specifically for these female individuals who comprise 19.57 percent of the whole sample; the details of estimation results are shown in TABLE A3.6, Appendix 3.IV.

The parameters of household labour supply are obtained from estimating models for married couples (details of the estimates are shown in the previous empirical chapter, TABLE A3.7 in Appendix 3.IV), which are divided into three types. Married couples without children, the third household type, consist of two adults in each household; they account for 30.60 percent of the whole sample. The next household type is married couples with a dependent child; each household includes two married adults and their child. This household type covers 16.93 percent of the total observations. This study includes households of married couples with two dependent children which share 10.34 percent of the whole sample. The last household group is five-member households; each of them consists of a married couple and three children. They comprise 1.82 percent of all household types.

TABLE 4.2: Descriptive statistics of predicted and calibrated values in the status quo

Variable	Unmarried individuals		Married couples	
	Males [2,592]	Females [2,445]	Males [7,458]	Females [7,458]
Predicted hourly gross wage	67.82	70.66	78.57	60.71
Hours worked	43.30	37.97	45.21	33.81
Gross income ('000)	152.44	146.68	292.31	
Tax burden ('000)	0.837	1.40	2.59	
Disposable income ('000)	151.60	145.27	289.73	

TABLE 4.2 presents important values under the status quo also known as the pre-reform scenario or the base case; besides predicted wages which is obtained from the Heckman selection model[25], these numbers are obtained from the calibration under status quo (i.e., the microsimulation is performed without changing any variable value (details about calibration in Section 4.4.2).

The predicted wages are applied in calculating incomes and tax burdens. The average predicted wages of unmarried males and females are 67.82 and 70.66 baht per hour, respectively. The reason why the wage of unmarried females exceeds the wage of male counterparts is that unmarried females are more educated and older than unmarried males in general. Among married couples, it can be observed that the husband's hourly wage, 78.75, is greater than wives' hourly wage, 60.71. A comparison between unmarried and married males suggests that males who earn higher wages are more likely to be married. The opposite picture is shown for females. Unmarried females who have better economic status than married ones are less likely to rely on males (i.e., the former are less likely to be married). Predicted wages are also consistent with the fact that in Thai culture husbands take the major responsibility in earning income for their families.

[25] The predicted wages are obtained by using a two-stage Heckman model before labour supply estimation (the details are in Section 3.2.3).

From TABLE 4.2, regardless of marriage status, males usually work longer hours than females do. In fact, unmarried and married males work 43.30 and 45.21 hours per week on average, respectively. On the other hand, unmarried and married females spend 37.97 and 33.81 hours in the labour market, respectively. If people get married, males tend to increase hours worked whilst females are likely to decrease hours worked. This is because of an economic factor (i.e., earned wage) and a cultural factor (i.e., responsibilities in households).

Gross income includes earned income, which is a function of wages and hours worked, and unearned income, which is assumed to be exogenous. Average gross annual incomes for unmarried males, unmarried females, and married couples are 152.44, 146.68, and 292.31 thousand baht respectively. Unmarried males usually pay less tax than unmarried females due to the proportions of earned and unearned income. In fact, there are eight types of incomes in personal income tax, and different types may have different rules about allowable expenses leading to different amounts of net taxable income and tax burden. The average tax burden of married couples is 2.59 thousand baht. Although tax burden amounts are small, they are consistent with the fact that the percentage of personal income tax per GDP in Thailand is just about two percent.

Disposable income is obtained by subtracting the personal income tax burden from gross income. The average disposable incomes of unmarried males, unmarried females, and married couples are 151.60, 145.27, and 289.73 thousand baht, respectively.

4.3.2 Minimum wage in Thailand

The national minimum wage during the study period is 300 baht per day (i.e., the minimum daily wage, 300 baht, divided by 8 working hours per day[26] is equivalent to 37.5 baht per hour). Based on predicted wages, the numbers of people, by marriage status and gender, who have gross wages below the minimum wage are provided in TABLE 4.3.

TABLE 4.3: Predicted wages for people earn under the minimum wage

	Frequency	Percentage	Mean	Min.	Max.
Unmarried males	164	6.30	35.14	27.82	37.48
Unmarried females	807	33.00	31.83	22.67	37.48
Married males	455	6.10	35.08	27.14	37.49
Married females	2,830	37.90	33.06	22.90	37.49
Total	4,256	34.10	33.12	22.67	37.49

The total number of people earning less than the national minimum wage account for 34.1 percent of total individuals. The average wage of these people is about 33.12 baht per day or 88.32 percent of the legal minimum wage. The least gross earned wage is 22.67 baht per day or 60.45 percent of the minimum wage whilst the highest gross earned wage of these people is just below the minimum wage.

The number of male and female individuals whose gross wages are below the national minimum wage share about 6.3 and 33 percent of total observations in their categories respectively. In addition, the number of married males and females who earn less than the minimum comprise approximately 6.1 and 37.9 percent of married males and females respectively. This identifies a major concern regarding the rate of minimum wage policy compliance in Thailand.

Among people who fail to earn up to the minimum wage, unmarried females have the lowest mean wages (31.83); while unmarried males have the highest mean of wages (35.14). The mean predicted wages for married males and females earning less than the minimum wage are 35.08 and 33.06, respectively.

[26] Eight hours are the maximum normal (excluding over-time) working hours per day in Thailand.

4.4 Methodology

4.4.1 Microsimulation in labour supply

Microsimulation is a form of partial equilibrium analysis which simulates the effects of a given policy, such as tax or benefit reforms, on only one side of the market, i.e., individuals, households, or firms (Löffler et al., 2014a). The usefulness of MSMs in the analysis of policy reforms is threefold. Firstly, MSMs apply microdata which allow them to account for heterogeneity of individual agents; therefore, MSMs offer a precise identification of winners and losers due to a policy change, which also allows a researcher to evaluate welfare effects and political economy factors that possibly obstruct the policy implementation (Löffler et al., 2014a). Secondly, MSMs provide the possibility of accurately calculating the aggregate financial costs or benefits of a policy change (Bourguignon and Spadaro, 2006). In fact, the results from MSMs at a micro-unit level can be aggregated for a macro-level analysis, e.g., to find the impact on the government budget, household income, and income inequality. Thirdly, previous empirical studies as shown in Section 4.2 are good examples for the versatility of the microsimulation technique which allows a researcher to simulate any factual and counterfactual policy. The key objective of an actual policy simulation is to evaluate whether the policy is effective or not. On the other hand, a hypothetical policy simulation aims to find the best solution in a particular context.

The next section provides information on a general taxonomy of microsimulation models in the labour supply context.

4.4.2 A taxonomy of labour supply related microsimulation models

Bourguignon and Spadaro (2006) state that MSMs models consist of three main elements. Firstly, a micro-dataset which contains socio-economic information of individuals or households. This component of MSMs is straightforward; thus, it is not discussed here. Secondly, an arithmetical model is basically the rules of the simulated policies (i.e., the model for the budget constraint faced by each agent). An arithmetic MSM (i.e. a non-behavioural MSM) allows a researcher to simulate a policy

reform which affects the disposable income and tax burden of decision agents in the micro-level dataset while assuming that individual behaviour remains unchanged. Lastly, a behavioural model that is built from a theoretical model to incorporate the behavioural responses of micro units. In fact, it takes the behavioural response of decision agents due to a change in their budget constraint, i.e., disposable income, into account.

Beginning with arithmetical MSMs, policy simulations possibly affect household gross income or tax burden, depending on policies. Consequently, they possibly change household disposable income. The theoretical explanation of arithmetical MSMs in labor supply models begins with recalling the utility functions and budget constraints as described in the previous chapter. For simplicity, the explanation focuses on individual labour supply.

$$U_{nj} = V_{nj}\left(Y_{nj}, L_j;\ Z_i, \beta\right) + \varepsilon_{nj} \tag{4 - 1}$$

$$Y_{nj} = w_n * H_j + y_n - T(w_n, H_j, y_n, Z_n) \tag{4 - 2}$$

Any policy reform, e.g. wage (w_n) and tax structure (T), which is a function of earned income ($w_n * H_j$), unearned income (y_n), and socio-characteristics (Z_n) (e.g. the number of children) affects the direct utility, V_{nj}, through a change in the budget constraint, Y_{nj}, i.e., disposable income. The welfare effect of a reform affecting individual disposable income marginally at unchanged leisure hours, L_j, i.e., at constant hours worked, H_j, is designated as follows:

$$\Delta V_{nj} = MU_y \Delta Y_{nj} \tag{4 - 3}$$

where Δ represents the proportional change, and MU_y is marginal utility of income.

Arithmetical models have the benefits of indicating how disposable income changes at any hour point for each agent due to a given policy reform.

As with arithmetical MSMs, behavioural MSMs are based on micro-data (individuals or households), but they contain an additional important part to the analysis. Behavioural MSMs extend arithmetical MSMs by including a detailed representation of the behavioural response into the MSMs. Since the arithmetical part of behavioural MSMs is explained in the previous section, this section focus only upon the behavioural part.

In a labour supply setting, the structural discrete choice models for labour supply do not provide any explicit labour supply function, which is directly determined by wage and other socio-economic characteristics; however, they obtain estimated parameters of the utility function, which determines labour supply (Creedy and Kalb, 2005b). From the results obtained by the structural discrete hours choice models in the previous chapter, behavioural MSMs allow simulation of people's reaction to a policy change by comparing the levels of utility across alternatives faced by each decision agent (either individual or household).

The key process of the behavioural MSMs is calibration. In this chapter, the calibration is done through the probability prediction process as described in Train (2009). According to equation (4 - 1), utility consists of a systematic component, $V_{nj}\left(Y_{nj}, L_j;\ Z_i, \beta\right)$, and a random component, ε_{nj}. The estimation of the discrete hours labour supply model obtain the coefficients (β) which are distributed with density $f(\beta|\Theta)$, where Θ refers to the parameters of the distribution, e.g., mean, variance, and covariance of β.

The predicted probabilities are obtained through simulation given the density of coefficients, $f(\beta|\Theta)$ by the following steps. The process starts with drawing a value of each coefficient from its distribution and label it β^r; with r denoting the draw. Secondly, the conditional probability is calculated for each draw by the logit formula as follows:

$$L_{nj}(\beta^r) = \frac{e^{V_{nj}}}{\sum_{i=1}^{M} e^{V_{ni}}} \quad (4 - 4)$$

where M is the total number of alternatives available for each decision agent; the subscript i designates the alternatives and the predicted alternative is identified by the subscript j.

Third, the first and second steps are repeated many times. Next, after obtaining the conditional probability for many draws, the predicted probability is calculated by averaging the probability over the number of draws. The formula is expressed as follows:

$$p_{nj}^{*} = \frac{1}{R}\sum_{r=1}^{R} L_n(\beta^r) \quad (4 - 5)$$

where R is the total number of draws (1,000 in this study). There are some desirable properties of the simulated probability in simulation. p_{nj}^{*} is unbiased estimator of $p_{nj} = \int L_{nj}(\beta) f(\beta|\Theta) d\beta$, its variance decreases as the total number of draw increases and summation of p_{nj}^{*} over alternatives is equal to 1.

When p_{nj}^{*} is obtained, the key outputs of behavioural MSMs which are expected hours worked and other pecuniary factors can be calculated by using the following expression:

$$E(G) = \sum_{j=1}^{M} p_{nj}^{*} G_{nj} \quad (4 - 6)$$

where G represents interested factors such as hours worked, gross income, tax burden, and disposable income. In practice, this chapter applies calibration on pre-reform (i.e. status quo) and post-reformed scenarios (i.e. simulated policies). The calibration on the pre-reform case applies the actual data to obtain the predicted probability as well as interested factors including expected hours worked and expected financial factors.

In this study, the calibration based on the status quo (also called the bese case or the pre-reform case) is firstly done. In other words, by using the actual data, the predicted probabilities and expected numbers including hours worked, leisure hours, gross incomes, tax burdens, and net incomes are obtain through the calibration process as explained from equation (4 - 4) to (4 - 6). The results obtained from the calibration based on the status quo are presented in TABLE 4.2 in Section 4.3.1.

Next, the calibration based on each simulated policy is performed. The calibration on a post-reform case applies simulated data calculated through the arithmetical model. A simulated policy could be any factor (e.g., wage, tax rule, social benefit, or socio-economic characteristic) which eventually changes disposable income at available alternatives whilst estimated parameters remain unchanged. Behavioural MSMs calculate the optimal hours worked through the utility maximisation process, i.e., they allow decision agents to reconsider the optimal alternative which yields the highest utility under a simulated policy scenario. The mathematical expression for utility maximisation after a reform is shown as follows:

$$Max\ U_{nj}^{1} \text{ subject to } Y_{nj}^{1} \leq w_n^1 * H_j + y_n - T(w_n^1, H_j, y_n, Z_n) \qquad (4 - 7)$$

by assuming that a policy changes the wage to w_n^1. This leads to a change in disposable income to Y_{nj}^1 and utility to U_{nj}^1. With the calibration process as described above in equation (4 - 4) to (4 - 6), the interested outputs are computed as done in the pre-reform case.

The post-reform analysis allows a researcher to examine the impacts of diverse reforms such as the minimum wage policy, and income tax reforms. The impacts of a policy is obtained by investigating differences between simulated results based on the status quo and the simulated scenario. The details of each policy simulation are provided in the following sections.

This chapter also applies the parametric bootstrapping technique to obtain standard errors of the estimated impacts of the simulated policies[27]. Behavioural MSMs allow for a more sophisticated analysis of policy reforms than arithmetical MSMs because ignoring behavioural response possibly leads to misleading results in many situations. Therefore, this chapter applies behavioural MSMs in evaluating the effects of several policy changes.

4.4.3 Labour supply elasticities

In this chapter, the (uncompensated) wage elasticity of labour supply is measured by expected hours worked. It can be approximated by comparing the expected labour supply for each individual after a given percent increase in gross hourly wage with the expected labour supply under the initial case, and expressing the wage elasticity of labour supply as the percentage change in labour supply divided by the percent increase in wage (Kalb, 2010). Different studies apply different percentage (usually 1 or 10 percent) changes and different types of income (gross or net wage rates); the details are presented in section 4.2.1.

Three main types of elasticities are evaluated in this chapter. The first type of labour supply elasticity is the own wage elasticity of labour supply designated as the change in labour supply behaviour of a person, n, due to a change in that own person's wage. Secondly, the cross wage elasticity of labour supply is defined as the labour supply elasticity of a person, n, when a wage of the spouse, m, changes. Finally, this chapter evaluates the total labour supply elasticity which is how household labour supply changes when gross wages of both partners change. The first type of elasticity is calculated for labour supply at individual and household level; the other two types are done for household labour supply only.

[27] This study performs 1,000 repetitions for each simulation to generate standard errors in statistical significance testing. The number of repetitions is larger than that in many of the existing literature such as Kabátek et al. (2014) and de Boer (2016) which apply 500 and 200 repetitions in bootstrapping, respectively.

The calculation process is carried out in the following order. Firstly, the process starts by increasing the gross hourly wage (depending on the type of elasticity) keeping other factor constant. This chapter applies 10 percent increase in the gross wage rate to calculate wage elasticity of labour supply as found in previous woks such as de Boer (2016). Secondly, the predicted probabilities are obtained by the calibration process. Next, the new expected labour supply is computed by applying multiplication between a predicted probability and the number of hours worked at that discrete point. Finally, the elasticity is the comparison of expected labour supply between the base case and the case with 10 percent wage increase. The percentage difference in labour supply is interpreted as the wage elasticity of labour supply. The mathematic expression for calculating the average wage elasticity on average of labour supply is:

$$\varepsilon_{wage} = \frac{1}{N}\sum_{n}\frac{h_{1n} - h_{0n}}{h_{0n}};\ h_{0n} > 0 \qquad (4 - 8)$$

where ε_{wage} designates wage elasticity of labour supply which is the mean percentage change in hours worked because of increase in wage; N represents the number of observations; h is defined as the expected hours worked; the subscripts 0 and 1 indicate the base case and the reformed case, respectively, while the subscript n identifies the decision agent.

The elasticity described above is designated as an unconditional wage elasticity since the calculation takes into consideration labour supply reactions at both the intensive and extensive margins[28] (Löffler et al., 2014a). In other words, it allows individuals to change hours worked as well as labour market participation.

4.4.4 Simulated policies

This section provides a detailed discussion of the simulated policies including the perfect rate of the national minimum wage compliance, changes in non-transferable allowances in the personal income

[28] Conditional elasticities assess labour supply reactions conditional on being participants in the labour market prior to the change in gross hourly wage.

tax, and the recent proposed tax rules (removing the taxable person threshold, eliminating joint taxation, as well as revising the tax brackets and tax rates).

For simplicity, this chapter adopts the case of one-member households (single people without children) to explain the arithmetical model in obtaining gross income, tax burden, and disposable income for each policy.

4.4.4.1 Minimum wages

This policy simulation in this study assumes that the minimum wage at 2015 is perfectly complied with. In other words, the hourly wage is nationally designated to be 37.5 baht per hours (i.e., it is equal to the daily minimum wage at 300 baht divided by 8 hours worked) for anyone who earned less than the minimum wage prior to implementation.

The arithmetical calculation starts with the earned income. The earned income at each hours alternative is the product of the wage rate and hours worked. The policy simulation affects wage rates of people who earn less than 37.5 baht per hours. The earned income varies across hours choices whilst the unearned income remains unchanged. The summation of earned and unearned incomes yields the gross income which is different across alternatives due to earned income. The tax amount paid and the disposable income at each hours point are calculated through the tax-benefit system based on tax rules in 2013 and 2015. Then, calculated disposable income due to the change in the rate of policy compliance at each hours point replaces actual disposable income. Finally, the behavioural MSM is executed to investigate labour supply response and changes in financial parameters.

4.4.4.2 Change in non-transferable allowances

This policy simulation adopts an adjustment in personal income tax rules (i.e., two non-transferable allowances). Firstly, the government increases allowable expenses of earned income from 40% of income (not over 60,000 baht) to 50% of income (not over 100,000 baht). Secondly, the government also increments the child allowance from from maximum 17,000 baht to 30,000 baht yearly.

For this policy, the gross income remains unchanged because there is nothing modified at the stage of gross income calculation. Whilst other personal income tax rules for 2013 and 2015 remain unchanged, changes in these non-transferable allowances in the tax rules affect tax burden as well as disposable income at each hours point. In fact, increases in these non-transferable allowances cause a decrease in taxable income at each hours alternative for tax payers; this leads to less tax burden as well as increased disposable income if an individual retains hours worked. Then, the calculated disposable income variable replaces the pre-reform disposable income variable in the behavioural MSM to simulate the predicted probability and parameters of interest.

4.4.4.3 Income tax restructure

According to the proposed tax package as described in 4.1.2.3, this policy simulation starts with calculating earned income at each hours point. Similar to the previous simulation gross income at each hours alternative faced by a decision agent does not alter. The policy reform affects directly to personal income tax rules.

In the arithmetical model, the first change is that the taxable person threshold is amended t. All people older than 18 years of age are included in the tax calculation. Other people younger than 18 years old are included in the tax calculation if and only if their income exceeds the income threshold depending on household type (60,000 baht for single individuals and 120,000 for married couples). The second adjustment is the elimination of joint taxation and partially joint taxation. The pre-reform scenario allows all married couples to choose among separate, joint, and partially joint taxation based on disposable income maximisation. In the proposed tax package setting, this rule is completely removed. The last amendment in this simulation is discontinuing the tax threshold, decreasing the number of tax brackets, and revising the tax rate at each tax bracket. The summary of the adjustment is as shown in FIGURE 4.1.

The remaining tax rules in this simulation follows the rules in 2013 and 2015. The proposed tax package in the simulation affects the tax burden and disposable income of each decision agent; however, the result depends on many factors, e.g., household types and the level of income. The disposable income at each hours point calculated under this setting replaces the disposable income in the status quo case. Finally, the behavioural MSM can be processed to obtain predicted probability, expected hours worked, and expected pecuniary variables.

4.4.5 Policy evaluation

In comparison between status quo and post-reform cases, this study compares changes in labour supply responses, household incomes, and amounts of tax paid. The statistical significances of changes are tested by a standard errors obtained as mentioned in Section 4.4.2.2.

4.4.5.1 Labour supply responses

The effects of a policy reform on labour supply is also known as efficiency effects, i.e., the efficiency costs, measured in terms of hours worked, of the reforms (Labeaga et al., 2008). Evaluating the effects on labour supply is similar to the calculation process for the wage elasticity of labour supply; the only difference is that a policy reform can take several forms rather than a given percent change in wage. In particular, the simulated labour supply based on a policy reform (i.e., the conditional post-reform hours distribution) is computed and then compared with labour supply under the pre-reform situation.

For any given policy change, this chapter shows the average labour supply response. This provides the overall picture of the labour market under a policy reform, which also indicates the dominance of either the income effect or the substitution effect on labour supply.

4.4.5.2 Winner-loser analysis and aggregate national income per capita

Winner-loser evaluation of policy consequences is to compare disposable income between status quo and post-reform cases for each agent. By following Labeaga et al. (2008) the number of winners,

unaffected individuals, and losers in terms of disposable income are provided. In addition, those agents for whom the disposable income changes by at least 5 percent are also reported as done in Atkinson et al. (2017).

The key purpose of winner-loser analysis is to see how changes vary across different household types and certain characteristics e.g. the income distribution. This is beneficial in teasing out overall impact of a reform policy, as well as in detecting any inadvertent consequences. On top of that, the aggregation of disposable income changes can be interpreted as an impact on national income per capita due to a policy reform.

4.4.5.3 Effects on poverty

Regarding measures of a policy reform on poverty, two indicators are adopted in this chapter. Firstly, the primary indicator for poverty is the percentage of the population falling below a national poverty line. According to the Office of the National Economic and Social Development Board of Thailand, the Thailand national poverty line in 2016 is equal to 88.90 Thai baht per capita per day (approximately 2.72 USD) which is greater than the global poverty set by the World Bank at 1.90 USD per day (PPP using 2011 prices) in 2015[29]. This chapter applies HDIPAC[30] in comparison with the national poverty threshold. If HDIPAC of a household is lower than the poverty line, members in this household are considered to be poor people. A number of poor households are compared between pre-reform and post-reform cases.

Secondly, this chapter applies the poverty gap measure to reflect the distance between HDIPAC and the threshold under each policy scenario. This captures the impact of a reform on those people living

[29] Data from http://www.worldbank.org/en/topic/poverty/brief/global-poverty-line-faq
[30] HDIPAC is equivalent to household disposable income divided by a number of adults (anyone who are older than 15 years old) in a household.

under the poverty line by showing changes in the gap between HDIPAC and the threshold for pre-reform and post reform situations.

4.4.5.4 Effects on income redistribution

This study also investigates effects of simulated policies on income redistribution. In fact, HDIPACs in both status quo and post-reform cases are compared along the distribution of HDIPAC to observe if a given policy affects HDIPAC at any part of the distribution and to what extent.

This study applies the quantile-quantile plot to compare income distributions before and after the policy simulation in order to evaluate the effect of a policy simulation on income redistribution. The result can be also implied for the income equality analysis.

4.5 Results

4.5.1 Wage elasticities

Wage elasticities are computed based on a 10 percent change in gross wages of people depending on different scenarios including own-wage, cross-wage, and both-wage elasticities.

4.5.1.1 Labour supply responses

The following table shows the overall labour supply elasticities when wages are raised by 10 percent. Regarding individual labour supply, only one simulation is performed for single individuals whilst three scenarios, namely, increases in wages of males, females, and both genders, are simulated for the household labour supply setting. In TABLE 4.4, the first number reported in each block is the change in hours worked; it can be converted to minutes by multiplying the result by 60. The second number is the standard error, which is shown in parentheses. The next number is the elasticity of labour supply, i.e., the percentage change in hours worked if the wage increases by 1 percent. The last number in the square brackets is the number of observations in each type of households.

From TABLE 4.4, Panel (1) shows the unconditional wage elasticities when males' wages are raised by 10 percent. This change does not influence single females without children (reported as N.A.) because this type of household does not comprise any male. This change positively affects hours worked of unmarried males by 0.33 hour or about 20 minutes per week, with statistical significance at the 1 percent level. The own wage elasticity of labour supply is 0.076 percent. In terms of married couples, a 10 percent increase in male wages statistically influences labour supply behaviour change for males by about 0.25 hour or 15 minutes per week, whilst it reduces hours worked of females by 0.89 hour or 53 minutes per week with statistical significance at the 5 percent level. Thus, the own-wage and cross-wage elasticities of labour supply for married males and females are 0.056 and -0.263 percent respectively.

TABLE 4.4: Overall labour supply response when increase in wages by 10 percent

Policy changes	Unmarried individuals		Married couples	
	males	females	males	females
(1) 10% change in male wage	0.3307225*** (0.1068394) 0.076% [2592]	N.A.	0.2527185*** (0.039318) 0.056% [7458]	-.8894429*** (.0564362) -0.263% [7458]
(2) 10% change in female wage	N.A.	0.4947338*** (0.1183232) 1.224% [2445]	-.2052379*** (.0242569) -0.045% [7458]	.8758556*** (.08362) 0.259% [7458]
(3) 10% change in wages of males and females	N.A.	N.A.	.0570549 (.0443109) 0.013% [7458]	.0077422 (.087828) 0.002% [7458]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively.

Panel (2) indicates labour supply responses in the case that there is a 10 percent increase in females' wages. Hence, there is no result for single males without children (reported as N.A.) since the households do not have any female. Individual females increase hours worked by 0.49 hours or about half an hour with statistical significance at the 1 percent level. In other words, the elasticity of labour supply for single females without children is 1.224 percent. At the household level, an increase in females' wage negatively affects male hours worked by about 0.20 hour or 12 minutes and positively

influences female hours worked by 0.88 hours or 53 minutes per week. The labour supply responses of both genders due to an increase in females' wages are statistically significant at the 1 percent level. The own-wage and cross-wage elasticities of labour supply for females and males are 0.259 and -0.045 percent, respectively.

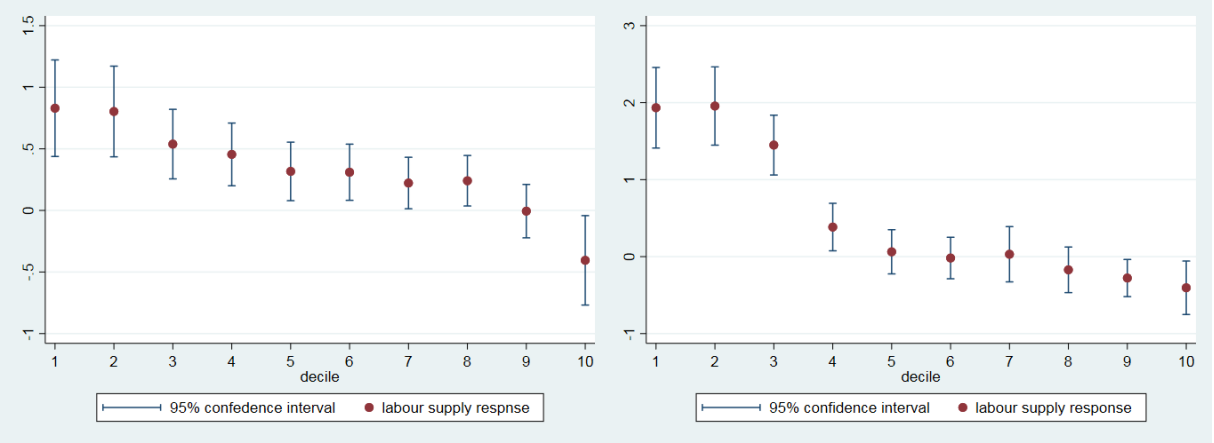
Panel (3) presents to what extent married couples react to a 10 percent increase in both partners' wages. This simulation is applicable for household labour supply only because it is not possible to increase both partner wages in one-member households. The small increases without statistical significance that are observed for the overall labour supply responses of both partners indicates that their labour supply are statistically unchanged when their wages are increased by the same proportion. The wage elasticities of labour supply for married males and females are very small at 0.013 and 0.002 percent, respectively. This is possibly because the effects of own-wage elasticity and cross-wage elasticity cancel each other out for both partners. According to labour supply responses in Panel (1) and (2), these two cases yields opposite effects but similar magnitudes for both genders.

Overall, the simulated results are consistent with most of the previous studies. The own wage elasticities of labour supply are positive whilst the cross wage elasticities of labour supply are negative. Similar results are found in previous studies such as Callan and van Soest (1996), van Soest and Das (2001), Kabátek et al. (2014), de Boer (2016), and Mauro et al. (2017). In addition, female labour supply is more elastic than for males at both individual and household levels; these findings are similar to what are found in many previous studies, e.g., van Soest (1995), Callan and van Soest (1996), van Soest and Das (2001), Kabátek et al. (2014), de Boer (2016), and Mauro et al. (2017). The results when wages of both partners increase are also similar to van Soest and Das (2001)[31], in that the labour supply responses of both genders are positive and very small.

[31] Other previous studies rarely discuss on the labour supply elasticity when wages of both partners are raised.

Next, the labour supply elasticities are reported by decile of disposable income per adult capita[32] to investigate labour supply responses across the income distribution. FIGURE 4.2 shows the labour supply response by income decile; Panel (A) and (B) present the results of unmarried males and females, respectively.

FIGURE 4.2: Labour supply responses by income decile of unmarried individuals



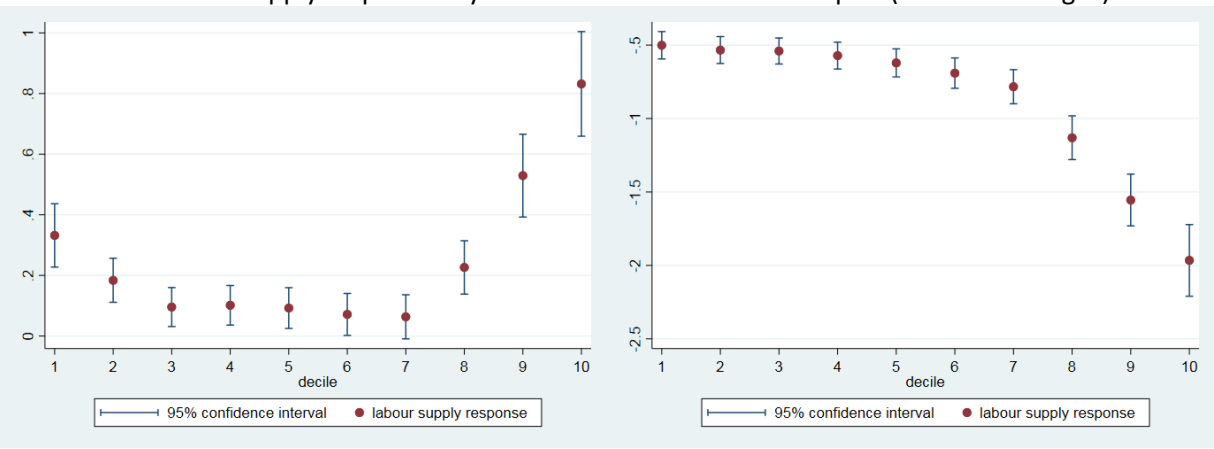
Males Females

FIGURE 4.2 exhibits the overall pattern of labour supply response with 95 percent confidence intervals of single males (the left panel) and females (the right panel) by income decile when the gross wage rates increased by 10 percent. The details of the results are provided in TABLE A4.1, Appendix 4.I. The behavioural patterns between two genders are generally similar. However, the female labour supply response is overall more elastic and changes more abruptly than the male labour supply response. The results indicate that when wages are increased by 10 percent, the substitution effect prevails at the lower end of the income distribution (i.e., both genders increase hours work with statistical significance). However, the increases in hours worked are declining due to the increasing income effect as disposable incomes move towards the upper end of the income distribution. Males start reducing labour supply at the 9th decile while females start doing so at the 6th decile. The results show

[32] Disposable income per adult capita is calculated by household disposable income divided by the number of adults (age over 15) in a household.

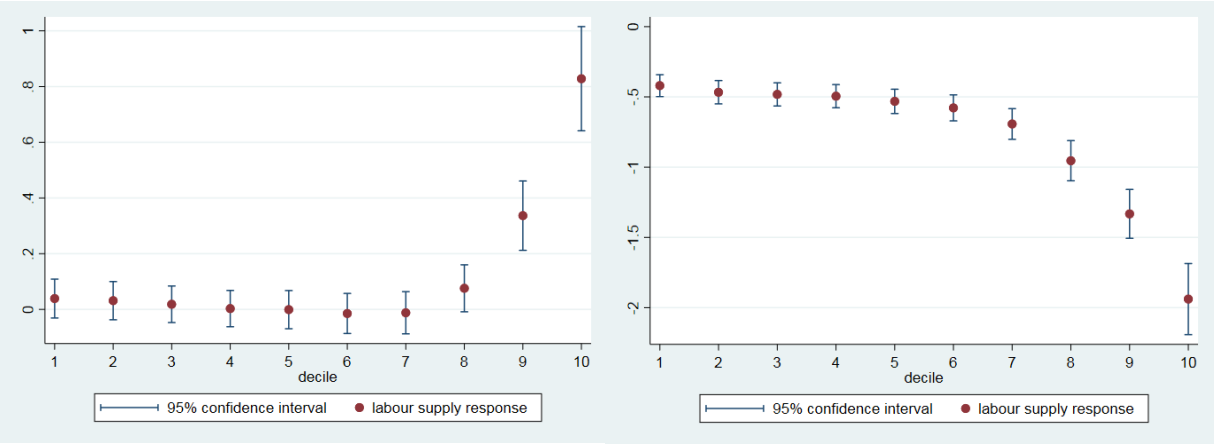
decreases in labour supply with statistical significance at 5 percent level for the last decile of male labour supply and at last two deciles for females.

FIGURE 4.3: Labour supply responses by income decile of married couples (husbands' wages)



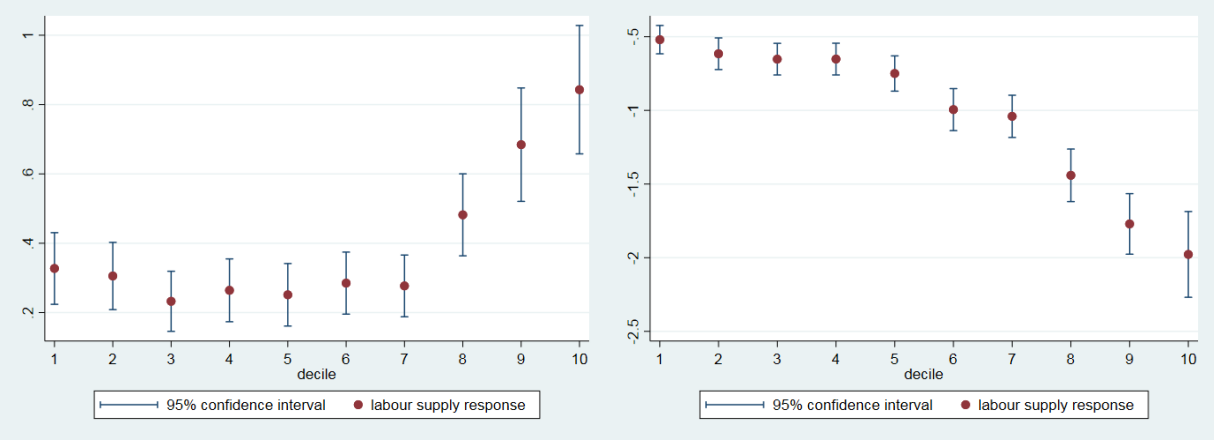
Overall males

Overall females



Males without children

Females without children



Male with children

Female with children

FIGURE 4.3 presents labour supply response with 95 percent confidence interval for married males on the left-hand-side panels and married females on the right-hand-side panels when the male wage rates increase by 10 percent. The top panels show the results of all household types. The middle panels exhibit the labour supply response of males and females in two-member households (i.e., married couples without children). The bottom panels present the results of four-member households (i.e. married couples with two children) as representatives of households with children. The detailed results by HDIPAC decile and household type (the number of the household members) are provided in TABLE A4.2 for married males and TABLE A4.3 for married females.

In comparison between genders, it is apparent that the labour supply responses of males and females are generally opposite. Regarding married males, the overall pattern in the top-left panel shows that they tend to work more if their HDIPACs are either at the bottom or at the top end of the income distribution. This is because married males at the bottom end of the HDIPAC distribution want to raise their living standard; the males at the other end of the distribution usually work fewer hours than other males categorised in lower deciles and therefore they are able to increase hours worked[33]. Those in households without children shown in the middle-left panel barely change their works hours until the HDIPACs reach the 8th decile. On the other hand, in the bottom-left panel, married males are found to increase their hours worked if they have children. This implies that the household size affects the married male labour supply response as well. In general, males with the larger number of dependent children supply are more responsive to changes in their wages.

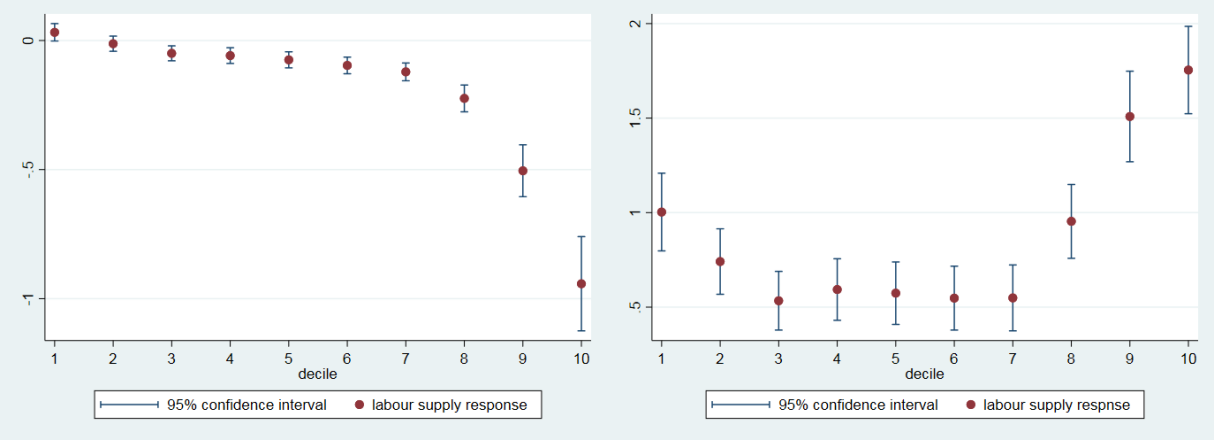
[33] In deciles where males tend to increase hours work, the proportions of males working about 48 hours are lower than 76 percent while these proportions are greater than 85 percent in other deciles.

With regards to married females, they reduce hours worked when the wages of their husbands increase by 10 percent. The overall results from all three panels on the right-hand-side of FIGURE 4.3 show that the reduced hours worked are positively related to household disposable income (HDIPAC). Overall female hours worked decreases by approximately a half-hour at the first decile of the HDIPAC distribution and the magnitude of the reduction in hours worked becomes almost 2 hours at the highest income decile. The middle-right and bottom right panels also suggest that the degrees of reduced labour supply increases in the number of children. This is possibly due to domestic duties and childcare responsibilities.

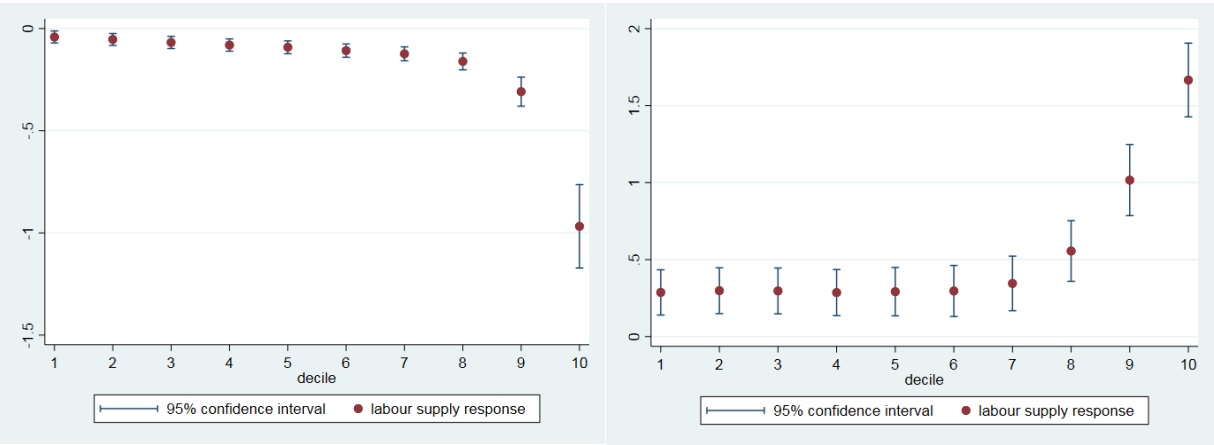
FIGURE 4.4 shown below presents the labour supply response with 95 percent confidence interval for married males on the left-hand-side panels and married females on the right-hand-side panels when the female wage rates increase by 10 percent. Similar to FIGURE 4.3, the top, middle, and the bottom panels present different household types, namely, all households, household without children, household with two children. All results are provided in TABLE A4.4 for males and TABLE A4.5 for females.

The labour supply responses of both genders generally have the opposite sign. The overall results for males in the top-left panel show that only those living in households in the 1st decile of the HDIPAC distribution increase their hours worked. This is mainly due to households with children as shown in the bottom-left panel. When the females' wages are increased in percentage, married males in higher HDIPAC households are more likely to reduce their hours worked. This is because females in the high HDIPAC households usually make earned income more than females in the low HDIPAC households.

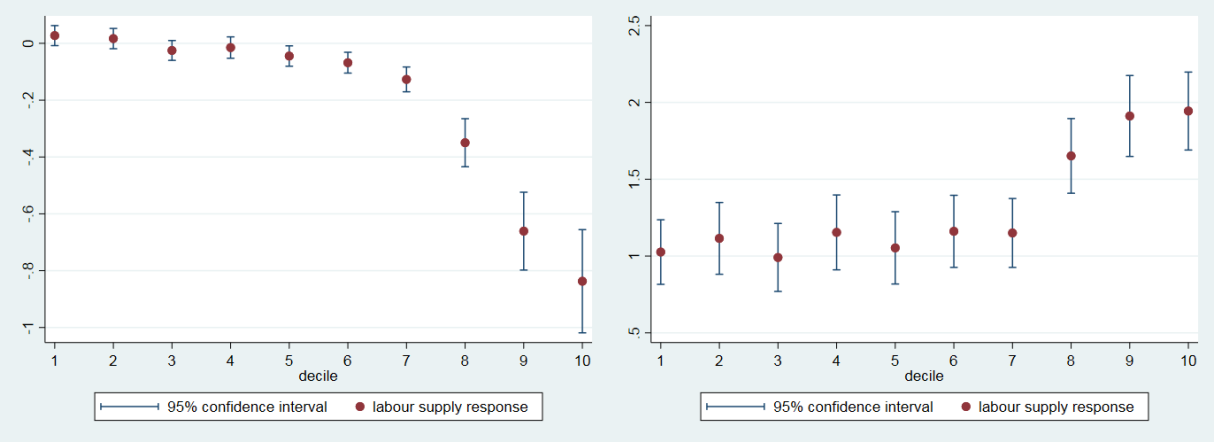
FIGURE 4.4: Labour supply responses by income decile of married couples (wives' wages)



Overall males | Overall females



Males without children | Females without children

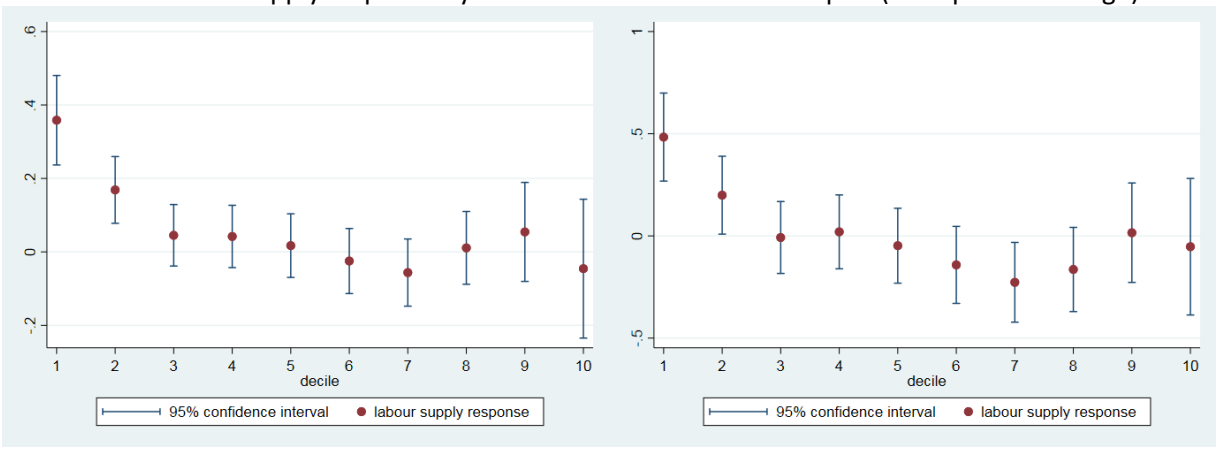


Males with children | Females with children

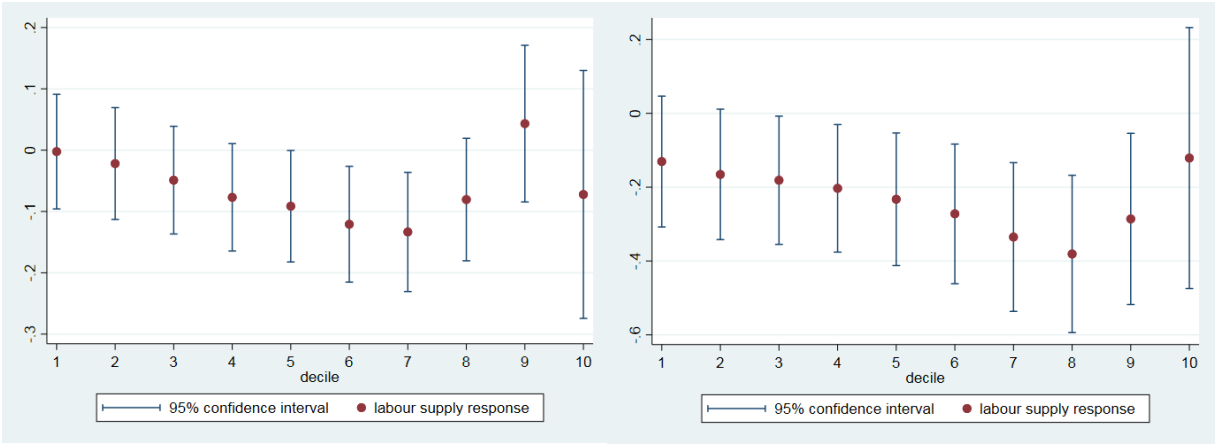
On the other hand, married females increase their hours worked regardless HDIPAC and household type. However, the patterns in the right-hand-side panels suggest that the degrees of increases in females' labour supply are depending on HDIPAC and household type which is similar to the results for married males. In fact, the females in the upper end of the HDIPAC distributions (from the 8th

decile) are more responsive to an increase in their wage than females in the remaining households. On top of that, the number of dependent children is positively related to the degree of increase in labour supply.

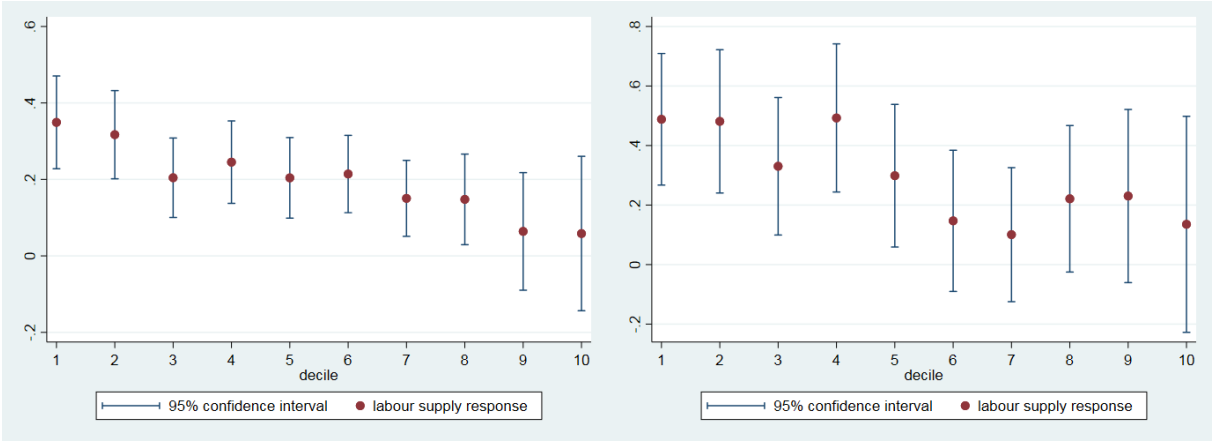
FIGURE 4.5: Labour supply response by income decile of married couples (both partners' wage)



Overall males | Overall females



Males without children | Females without children



Males with children | Females with children

FIGURE 4.5 presents the labour supply response with 95 percent confidence interval for married males on the left-hand-side panels and married females on the right-hand-side panels when the wage rates of both partners increase by 10 percent. Similar to FIGURE 4.3 and 4.4, the upper, middle, and lower panels exhibit different household types, namely, all households, households without children, and households with two children. Details of the simulated results for males and females are shown in Appendix 4.I, TABLE A4.6 and A4.7, respectively. The statistical significance of the results is not as apparent as in previous cases (FIGURE 4.3 and 4.4). The explanation is similar to the overall results; for both genders, the effects of an increase in husbands' wages are cancelled out by the effects of an increase in wives' wages.

Comparing males and females by household type finds similar patterns for the top and middle panels. The pattern is less similar for households with children, probably because husbands and wives are responsible for different tasks in the household. In addition, the number of children positively affects the labour supply response. Both males and females usually increase their hours worked when they have children, i.e., the substitution effect exceeds the income effect. The opposite result is observed for households without children, where the labour supply response by HDIPAC decile of both partners is usually negative.

4.5.1.2 Transition matrices for wage elasticities

This section presents labour supply transition matrices for males and females at individual and household levels for different cases of gross wage increases by 10 percent (one scenario for individual labour supply and three scenarios for household labour supply). In fact, tables 4.5 to 4.8 present hours worked that people select in the status quo and the simulation (i.e. a 10 percent increase in wages) by sub-sample.

In each table, hours worked resulting from calibrations based on the status quo are reported in rows whilst hours worked resulting from simulations based on a 10 percent increase in wages depending on each scenario are reported in columns. The elements along the diagonal line present the number of people consistently selecting the same number of hours across the pre-reform and post-reform cases. For example, when a person selects 40 hours worked under the status quo and the reform case (10 percent increase in his wage), this observation is presented on the diagonal panels (40 hours worked for both cases).

A person's observation will move to the right of the diagonal line if that person increases their hours worked, and vice versa (i.e., an observation will move to the left of the diagonal line if that person reduces hours worked). Changes in hours worked depend on the magnitude of the income effect and the substitution effect. In other words, people can either increase, decrease, or keep constant the number of hours they work. In theory, assuming leisure hours and consumption goods to be normal goods, the income effect makes people reduce the number of hours they work (i.e., increase leisure hours) whilst the substitution effect makes people increase the number of hours they work (i.e., decrease leisure hours). If the income effect exceeds the substitution effect, people will offer less labour supply, and vice versa. If both effects cancel each other, people’s labour supply will remain unchanged.

TABLE 4.5: Transition matrices of single individuals in the case of 10% own wage increase

Unmarried males								
elasticity / base case	0	8	16	24	32	40	48	Total
0	1	0	0	0	0	0	0	1
8	0	0	1	0	0	0	0	1
16	0	0	1	2	0	0	0	3
24	0	0	0	4	0	0	0	4
32	0	0	0	0	21	17	0	38
40	0	0	0	0	6	1,262	0	1,268
48	0	0	0	0	0	0	1,277	1,277
Total	1	0	2	6	27	1,279	1,277	2,592
Unmarried females								
elasticity / base case	0	8	16	24	32	40	48	Total
0	5	1	0	0	0	0	0	6
8	0	10	0	0	0	0	0	10
16	0	0	11	8	0	0	0	19
24	0	0	0	234	186	0	0	420
32	0	0	0	0	303	56	0	359
40	0	0	0	0	17	956	0	973
48	0	0	0	0	0	0	658	658
Total	5	11	11	242	506	1,012	658	2,445

TABLE 4.5 shown below presents transition matrices of married individuals by gender. Whilst the transition matrix for males is shown at the top part of TABLE 4.5, the matrix for females is located at the bottom part.

Comparing between two genders, a larger proportion of females switch hours choices, reflecting a greater wage elasticity of labour supply in relative to males. However, most of the unmarried individuals (both males and females) do not change their hours worked after a 10 percent increase in gross wage. Similar to males, some females have a tendency to increase hours worked if they work less than 40 hours per week in the base case. On the other hand, some of them (both genders) decrease hours worked if they work about 40 hours per week.

TABLE 4.6: Transition matrices of married couples in the case of 10% increase in males' wage

Married males								
elasticity / base case	0	8	16	24	32	40	48	Total
0	0	0	0	0	0	0	0	0
8	0	1	0	0	0	0	0	1
16	0	0	1	0	0	0	0	1
24	0	0	0	1	2	0	0	3
32	0	0	0	0	72	61	0	133
40	0	0	0	0	0	1,913	159	2,072
48	0	0	0	0	0	0	5,248	5,248
Total	0	1	1	1	74	1,974	5,407	7,458
Married females								
elasticity / base case	0	8	16	24	32	40	48	Total
0	14	0	0	0	0	0	0	14
8	10	115	0	0	0	0	0	125
16	0	48	525	0	0	0	0	573
24	0	0	121	702	0	0	0	823
32	0	0	0	195	2,362	0	0	2,557
40	0	0	0	0	303	2,361	0	2,664
48	0	0	0	0	0	398	304	702
Total	24	163	646	897	2,665	2,759	304	7,458

TABLE 4.6 presents the transition matrices of married couples when husbands' wages increase by 10 percent. With regards to husbands, the base case results reveal that most married men work full time (32 hours per week and more). The simulated results suggest that when males' wages increase by 10 percent, they either decide to increase or remain their hours worked.

In terms of married females, the hours distribution of the status quo is relatively more balanced for females than males. The simulated results are consistent with the theoretical expectation. In fact, none of the married females increase hours worked under the case when their husbands' wages increase by 10 percent; they choose to either reduce or remain their hours worked.

TABLE 4.7: Transition matrices of married couples in the case of 10% increase in females' wage

Married males								
elasticity / base case	0	8	16	24	32	40	48	Total
0	0	0	0	0	0	0	0	0
8	1	0	0	0	0	0	0	1
16	0	0	1	0	0	0	0	1
24	0	0	0	3	0	0	0	3
32	0	0	0	2	131	0	0	133
40	0	0	0	0	140	1,929	3	2,072
48	0	0	0	0	0	114	5,134	5,248
Total	1	0	1	5	271	2,043	5,137	7,458
Married females								
elasticity / base case	0	8	16	24	32	40	48	Total
0	10	4	0	0	0	0	0	14
8	0	84	41	0	0	0	0	125
16	0	0	409	164	0	0	0	573
24	0	0	0	652	171	0	0	823
32	0	0	0	0	2,305	252	0	2,557
40	0	0	0	0	0	2,409	255	2,664
48	0	0	0	0	0	0	702	702
Total	10	88	450	816	2,476	2,661	957	7,458

TABLE 4.7 exhibits the transition matrices of married couples when wages of wives are incremented by 10 percent. Whilst the largest group is those whose labour supply remain unchanged, among husbands who change hours worked, they mostly decide to reduce their labour supply in the market. The results are consistent with the theoretical prediction stating that labour supply response of cross-wage is overall negative.

Most married females make the same choices between the status quo and the reform case. For those who switch labour supply choices, 100 percent of them choose to increase labour supply. This is consistent with theoretical prediction in which the own-wage elasticity is generally positive.

TABLE 4.8: Transition matrices of couples in the case of 10% increase in both partners' wages

Married males								
elasticity / base case	0	8	16	24	32	40	48	Total
0	0	0	0	0	0	0	0	0
8	0	1	0	0	0	0	0	1
16	0	0	1	0	0	0	0	1
24	0	0	0	3	0	0	0	3
32	0	0	0	0	129	4	0	133
40	0	0	0	0	18	1,943	101	2,072
48	0	0	0	0	0	44	5,204	5,248
Total	0	1	1	3	147	2,001	5,305	7,458
Married females								
elasticity / base case	0	8	16	24	32	40	48	Total
0	12	2	0	0	0	0	0	14
8	3	109	13	0	0	0	0	125
16	0	13	492	68	0	0	0	573
24	0	0	22	758	43	0	0	823
32	0	0	0	57	2,458	42	0	2,557
40	0	0	0	0	34	2,621	9	2,664
48	0	0	0	0	0	180	522	702
Total	15	124	527	883	2,535	2,843	531	7,458

TABLE 4.8 presents transition matrices of married couples if their (both husbands and wives) gross wages increase by 10 percent. Both partners mostly keep their hours worked unchanged between the base case and the simulated case. Regarding those who change hours points, the transition patterns of both genders do not provide a clear picture. However, married males are likely to increase hours worked when they work full-time (from 32 hours per week) in the base case. On the other hand, married females tend to reduce rather than increase their hours worked under the reformed scenario if they work 32 hours or over per week in the status quo.

4.5.2 Perfect compliance of the national minimum wage policy

This section provides simulated results of behavioural changes when the government is able to implement the national minimum wage policy at the perfect rate (i.e., everyone working in the labour market is paid at least 37.5 baht per hour).

4.5.2.1 Labour supply responses: perfect compliance of the national minimum wage policy

In TABLE 4.9, there are four groups of people categorised by four different panels, i.e., row (1) to (4). The first group is those unaffected by the policy, i.e., they earn an hourly wage at least 37.5 baht in the pre-reform case.

TABLE 4.9: Labour supply responses for affected people from the minimum wage policy reform

Policy changes	Unmarried individuals		Married couples	
	males	females	males	females
(1) households in which the policy does not affect anyone	- - [2428|93.67]	- - [1638|66.99]	- - [4621|61.96]	- - [4621|61.96]
(2) households in which only males earn less than the minimum wage	.3238665*** (.121502) [164|6.33]	N.A.	.0778215*** (.0171269) [16|0.21]	-.1185123*** (.010054) [16|0.21]
(3) households in which only females earn less than the minimum wage	N.A.	2.753187*** (.3947254) [807|33.01]	-.030791* (.0163325) [2391|32.06]	.6954015*** (.0921687) [2391|32.06]
(4) households in which both males and females earn less than the minimum wage	N.A.	N.A.	.1418486** (.0639513) [439|5.87]	1.514349*** (.2242492) [439|5.87]
Total observations	[2592|100]	[2445|100]	[7458|100]	[7458|100]

S.E. in parentheses; the number of observations and percentages in square brackets, respectively;
*, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively.

The second group as reported in Panel (2) is households in which only males are affected by the perfect compliance of the minimum wage policy. It is noticeable that the result for single females without children is not applicable. About 6.33 percent of unmarried males earn wages lower than the national minimum wage at 300 baht per day in the pre-reform case. The simulated results suggest that if the policy is perfectly compliant, these males increase their labour supply by about 0.32 hour or 19.2 minutes per week with statistical significance at 1 the percent level. Regarding family labour supply, 0.21 percent of married couples for which the reform affects only husbands since their hourly wages are below 37.5 baht. In this case, the labour supply responses of both partners are similar to the case when males' wages increase. Males in these households extend weekly hours worked by about 0.08 hours or just below 5 minutes with statistical significance at the 1 percent level; females in these

households reduce their weekly hours worked by about 0.12 hour or 7 minutes with statistical significance at the 1 percent level.

The next group, which is shown in the row (3), covers households in which the simulated policy on the minimum wage affects only females. Hence, single males without children are not applicable (N.A.) for this case. Inefficient enforcement of the national minimum wage policy causes approximately 33 percent unmarried females without children earn less than 37.5 baht per hour under the pre-reform case. These females increase hours worked by about 2.75 hours, or 2 hours and 45 minutes, per week with statistical significance at the 1 percent level. With regards to married couples, about 32 percent of them are households that the policy affects only females because they receive daily wages under 300 baht. In this scenario, the behavioural responses of couples are similar to the case when females' wages increase. In fact, husbands decrease weekly hours worked by only 0.03 hour with statistical significance at 10 percent, whilst wives increase weekly hours worked by 0.70 hour with statistical significance at the 1 percent level.

Last but not least, the group of households in which both partners are affected by the simulated policy are considered; they are presented in Panel (4). Both single males and females without children are not applicable for this case because they are one-member households. 5.87 percent of households with married couples for which wages of both partners fall below the national minimum wage. This case is comparable to the scenario when wages of both husbands and wives increase. As expected both partners provide more labour supply; weekly hours worked of males increase by 0.14 hour or 8 minutes and 24 seconds with statistical significance at the 5 percent level, whilst females extend weekly hours worked by 1.51 hours, or 1 hours 30 minutes, with statistical significance at the 1 percent level. Since the female labour supply at the lower end of the income distribution is more elastic than the male labour supply (as discussed in Section 4.5.1), it is expected that the magnitude of change in female labour supply is larger.

4.5.2.2 Winners-losers analysis: perfect compliance of the national minimum wage policy

This section describes changes in gross income, tax paid, and disposable income between pre-reform and post-reform cases. Positive changes in incomes suggest that those observations are winners whilst negative changes in incomes indicate those observations as losers. In addition, positive or negative changes in tax paid can be interpreted as a gain or a loss in government income, respectively. This section also provides the number of households for which their disposable income increases or decreases by at least 5 percent to identify winners or losers.

Regarding labour supply, it is apparent that there are no losers due to the government perfectly enforcing the national minimum wage. In others words, some households have more incomes (positive effect) whilst the incomes of the remaining households does not change at all (neutral effect).

According to TABLE 4.10, the proportion of winner is about 30.5 percent of the total observations in this study (12,495 households). About 17.81 percent of the whole sample are able to increase their disposable income by at least 5 percent under the post-reform setting compared to the pre-reform one.

These households (one-member households and married couples) can be categorised into four groups based on the members affected by the policy. Both gross and disposable incomes of these groups increase significantly whilst the amounts of taxes paid for these groups are either equal to zero or very close to zero as their taxable incomes are usually below the tax threshold. It follows that changes in gross income and disposable income are almost identical. This section describes only disposable income; however, other numbers including gross income and tax paid are provided in TABLE 4.10.

TABLE 4.10: Change in incomes and taxes due to the minimum wage policy compliance

Policy changes	(a) Unmarried males	(b) Unmarried Females	(c) Households
(1) does not affect anyone	- - [2428|93.67]	- - [1638|66.99]	- - [4621|61.96]
(2) affects only males			
Gross income	6.200545*** (.1679739) [164|6.33]	N.A.	2.323938*** (.035511) [16|0.21]
Tax paid	- - [164|6.33]	N.A.	-6.15e-06*** (1.33e-06) [16|0.21]
Disposable income	6.200545*** (.1679739) [164|6.33]	N.A.	2.323944*** (.0355105) [16|0.21]
(3) affect only females			
Gross income	N.A.	13.9786*** (.6586006) [807|33.01]	7.718541*** (.1813544) [2391|32.06]
Tax paid	N.A.	0.00000127 (0.000000912) [807|33.01]	.0004161*** (.000123) [2391|32.06]
Disposable income	N.A.	13.9786*** (.6586007) [807|33.01]	7.718125*** (.1812783) [2391|32.06]
(4) affects both males and females			
Gross income	N.A.	N.A.	22.83342*** (.4402173) [439|5.87]
Tax paid	N.A.	N.A.	- - [439|5.87]
Disposable income	N.A.	N.A.	22.83342*** (.4402173) [439|5.87]
Total observations	[2592|100]	[2445|100]	[7458|100]

S.E. in parentheses; the number of observation and percentage in square brackets, respectively;
*, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively.

6.33 percent of all unmarried male households increase their disposable income by about 6.20 thousand baht with statistical significance at the 1 percent level. Among unmarried males, about 3.82 percent of them are able to increase their disposable income by at least 5 percent because of this reform. With regard to unmarried females, 33.01 percent earn higher disposable incomes by approximately 13.98 thousand baht with the statistical significance level of 1 percent. 28.96 percent

of the total unmarried females can earn disposable incomes more than 5 percent higher after the national minimum wage policy is perfectly implemented.

This policy affects 38.16 percent of all married couples. Only 0.21 percent are considered as winners due to only husbands earning below 37.5 baht per hours in the status quo situation. These households increase their disposable income by about 2.32 thousand baht with statistical significance at the 1 percent level. However, none of them is able to increase their disposable income by at least 5 percent.

32.06 percent of all married couples for which the wages of married females are less than the minimum wage indicate a positive effect on their income because of the reform. Their disposable incomes rise significantly at the 1 percent level by about 7.72 thousand baht due to the policy reform. About 13.21 percent of total married couples gain their disposable income by at least 5 percent if the national minimum wage is perfectly complied with.

The remaining households (5.89 percent of the married couples) are those households for which wages of both partners are lower than the minimum wage; their disposable incomes increase due to the reform by about 22.83 thousand baht with statistical significance at the 1 percent level. About 5.81 percent of all married couples are affected by the policy and their disposable incomes rise by at least 5 percent.

4.5.2.3 Effects on poverty: perfect compliance of the national minimum wage policy

Among all 12,495 households[34], regardless of household types (individuals or couples), the simulated results show that only 0.088 percent of the whole sample in the pre-reform case have HDIPAC below the national poverty line, which is equivalent to 88.90 Thai baht per capita per day.

Under the perfect rate of the minimum wage policy compliance, none of households has HDIPAC below the national poverty line. This implies that if the government is able to execute the national

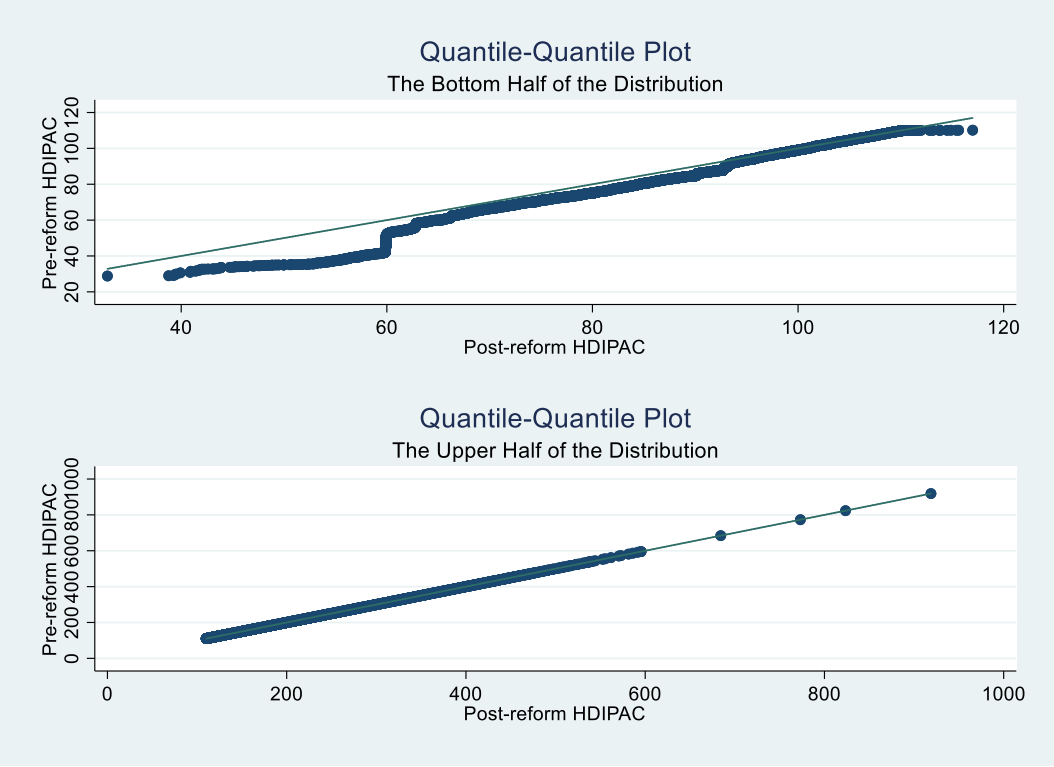
[34] They comprise 2,592 of single males, 2,445 of single females, and 7,458 of married couples.

minimum wage policy perfectly, the number of poor people in the labour market will be likely to decline to zero.

The discrepancies between HDIPAC and the poverty line are ranging from 311 baht to 3,630 baht per year. As the reform eliminates all households in poverty in the sample, households with HDIPAC falling below the national poverty line manage to rise their HDIPAC over the poverty line by 378 baht to 30.36 thousand baht per year. Married couples are the household type that has the least change between the pre-reform and the post-reform cases; this is foreseeable because domestic duties make the labour supply less elastic. They are less likely to increase hours worked to raise HDIPAC than others.

4.5.2.4 Effects on income distribution: perfect compliance of the national minimum wage policy

FIGURE 4.6: Comparison of HDIPAC distributions due to the minimum wage reform



Quantile-quantile plots presented as FIGURE 4.6 provides a comparison the income distributions between pre-reform and post-reform. The vertical axis of the figure presents HDIPAC of the pre-reform case; the horizontal axis in each provides HDIPAC after policy simulation. The diagonal line indicates one-to-one relationship between pre-reform and post-reform scenarios, i.e., the blue dots

lie on the diagonal line (or 45-degree line) if incomes in both cases are identical. When the blue dots locate on the right-hand-side of the diagonal line, HDIPACs in the post-reform scenario exceed HDIPACs in the pre-reform cases. This can be observed at the beginning of the diagonal line. On the other hand, if the blue dots appear on the left-hand-side of the 45-degree line, HDIPACs after the policy launch decline below HDIPACs in the base case.

FIGURE 4.6 contains two quantile-quantile plots; the upper and lower panels present the lower half and the upper half of the HDIPAC distribution, respectively. The upper panel shows that the minimum wage policy with complete compliance affects mainly the lower half of the HDIPAC distribution. To be specific, perfect compliance of the minimum wage policy improves HDIPAC at the lower half of the distribution; and the group at the bottom end gains from the policy reform more than other groups. The lower panel indicates the policy reform does not affect HDIPAC at the upper half of the distribution significantly. The result presented in FIGURE 4.6 implies that the reform helps to reduce income inequality since the HDIPAC gap between the upper and the bottom ends become narrower. The result is different from the previous work, i.e., Müller and Steiner (2013) and Atkinson et al. (2017), which indicated that the minimum wage policy is not effective because minimum wage workers are distribute across the whole income distribution. This implies that the distribution of income may differ across countries, especially between developed and developing countries.

4.5.3 Reforms on non-transferable allowances

This section presents the effects of reforms in important non-transferable allowances in personal income tax rules. They include earned income allowable expenses and the child allowance; whilst the former is related to the whole labour force, the latter is associated with only those household with children.

4.5.3.1 Labour supply responses: changes in non-transferable allowances

TABLE 4.11: Labour supply responses due to changes in non-transferable allowances

Policy changes	Males	Females
(1) Singles without children	.0337255***	.018909
	(.0066294)	(.4800627)
	[2592]	[2445]
(2) Households without children	.0145103	-.0313676
	(.2524606)	(.4250545)
	[3824]	[3824]
(3) Households with one child	.0450247	-.0021952
	(.2411392)	(.3893336)
	[2115]	[2115]
(4) Households with two children	.0760588	.0278461
	(.3577033)	(.5851339)
	[1292]	[1292]
(5) Households with three children	.0713438	.0524638
	(.6132488)	(1.011806)
	[227]	[227]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively.

From TABLE 4.11, besides single male individuals, changes in non-transferable allowances do not statistically influence labour supply behaviour at both individual and family levels. The non-significant results are observed because changes in non-transferable allowances are marginal in general aspects.

First, the allowable expenses affected only people earning a certain range of earned income. In fact, some people who do not pay personal income tax in the pre-reform case are highly probable to be unaffected by the policy. People who pay tax and deduct allowable expenses in the base case gain some benefits from the reform. The degree of benefits depends on the amount of earned income (i.e., the ceiling earned income, which has the maximum allowable amount, increased from 150,000 baht per year in the pre-reform case to 200,000 baht per year in the reformed case). Thus, people who earn over 200,000 baht per year do not receive any benefit from the reform.

Second, households gaining benefits from the child allowance are those with children. As expected, the simulated results suggest that couples with children increase their hours worked more than people without children do. However, the benefit from the child allowance is quite limited (13,000 baht per

child each year); the maximum amount of the benefit is 39,000 baht per year for households with three dependent children.

While the impact of the policy is limited in general, the results imply some behavioural patterns. Unmarried individuals generally increase their hours worked. It is noticeable that unmarried males extend hours worked more than unmarried females. The reason for this may be that changes in tax rules influence those working in the base case more than those who are inactive. The pre-reform simulation shows that the proportion of working males is greater than that of working females.

Although the results for married couples are not significant, some behavioural response can be observed. The number of dependent children seems to positively affect hours worked of married couples. Regarding couples without children, husbands increase a small amount of hours worked whilst wives decrease their hours worked by a fraction of an hour. For households with children, married males gradually increase their labour supply except those in the households with three children. Married females in households with children also provides longer hours worked gradually as the number of children increases.

4.5.3.2 Winners-losers analysis: increases in non-transferable allowances

TABLE 4.12 shows the results of changes in gross income, personal income tax paid, and disposable income by household type. These numbers can be also applied for winners and losers analysis.

From TABLE 4.12, the results in the gross income column indicates that only unmarried males provide statistically significant change in gross income at about two hundred baht with statistical significance at the 1 percent level. Under the post-reform scenario, single males, single females, households without children, households with one child, households with two children and households with three children pay a smaller amount of income tax by about 423, 660, 1,260, 1,265, 1,522, and 915 baht, respectively. All of these numbers are statistical significance at the 1 percent level. The last column, disposable income, shows that all household types obtain some positive changes due to the

summation between increased gross income and decreased tax burden, but only single males without shows the statistically significant improvement.

TABLE 4.12: Change in incomes and taxes due to changes in non-transferable allowances

Household types	Gross income	Tax paid	Disposable income
(1) Male Individuals	.2036261***	-.4229567***	.6265828***
	(.0461572)	(.0111966)	(.0478823)
	[2592]	[2592]	[2592]
(2) Female Individuals	.1769653	-.6603493***	.8373145
	(1.591782)	(.0654067)	(1.553636)
	[2445]	[2445]	[2445]
(3) Households without children	.0363679	-1.260623***	1.296991
	(1.934578)	(.0719747)	(1.886033)
	[3824]	[3824]	[3824]
(4) Households with one child	.3746666	-1.265503***	1.64017
	(1.65278)	(.0452142)	(1.627184)
	[2115]	[2115]	[2115]
(5) Households with two children	.8255346	-1.522117***	2.347652
	(2.936973)	(.0707662)	(2.886963)
	[1292]	[1292]	[1292]
(6) Households with three children	.838324	-.9151959***	1.75352
	(3.888576)	(.0595006)	(3.854179)
	[227]	[227]	[227]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively.

The overall results of individual labour supply suggest that increases in gross income (shown in TABLE 4.12) are clearly related to changes in hours worked (shown in TABLE 4.11). Whilst unmarried males increase labour supply and earn gross income more than do unmarried females, the changed amounts of personal income tax and disposable income for males are smaller than those for females. With regards to unmarried males, the simulated results indicate that 41.71 percent of unmarried males are considered as winners since their disposable incomes are positively affected by the policy reform; the remaining observations are unaffected. However, the difference in disposable income between pre-reform and post-reform cases for any unmarried male does not exceed 5 percent. In terms of unmarried females, the results show that 51.45 percent of total unmarried females are winners (i.e., they earn more disposable income in the post-reform case relative to the pre-reform case). The remaining 48.55 percent of total unmarried females are losers as their disposable incomes decline in

the post-reform scenario compare to the pre-reform case. It is possible that some people reduce their hours worked due to the income effect exceeding the substitution effect. Nevertheless, none of the changes in disposable income for unmarried females exceeds a 5 percent threshold.

Regarding household labour supply, the first type of households is married couples without children. 50.10 percent of this household type are considered as winners since they gain more disposable income in the post-reform situation compared to the pre-reform one. The remaining households are identified as losers because their disposable incomes decline after the policy is executed. Those reducing hours worked because the income effect is greater than the substitution effect. Only one household without children obtain the exact same amount of disable income between pre-reform and post-reform scenarios. When a five-percent income change threshold is taken into account, none of these households is reported as either winners or losers.

Considering married couples with dependent children, 74.24 percent of them are indicated as winners since their disposable incomes in the post-reform situation are greater than those in the pre-reform case. 25.76 percent of them are considered as losers due to negative changes in disposable income. The winner-loser ratio for households with children is greater than other household types because of the benefits from child allowance. However, the results concerning a five-percent threshold of income changes show zero observations. This means that changes in disposable income of these households do not reach 5 percent.

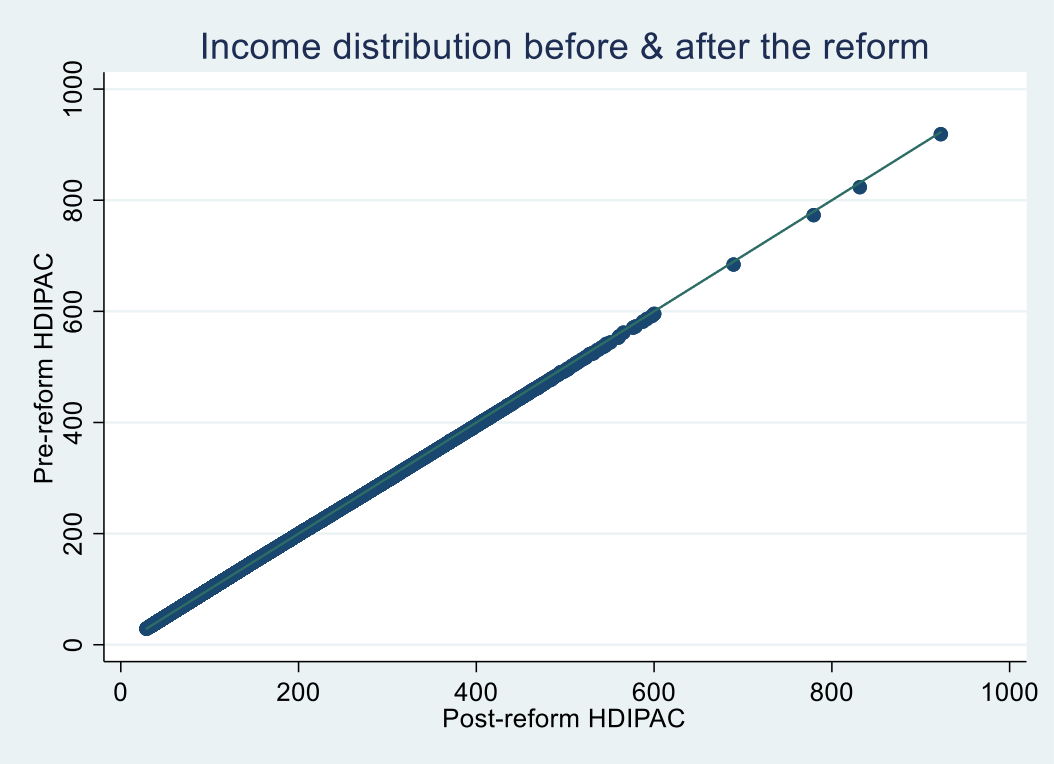
4.5.3.3 Effects on poverty: increases in non-transferable allowances

The simulated results regarding effects on poverty can be concluded that increasing non-transferable allowances does not significantly affect the poverty situation because the policy reforms do not influence working behaviour and disposable income of poor households with statistical significance; HDIPAC almost remains the same between pre-reform and post-reform scenarios. The result is not surprising since poor people do not pay tax; hence, reforming tax rules does not affect them.

Regarding the discrepancy between HDIPAC and the national poverty line, because the policy does not statistically change HDIPAC, the difference between pre-reform and post-reform cases are not significantly different.

4.5.3.4 Effects on the income distribution: increases in non-transferable allowances

FIGURE 4.7: Comparison of HDIPAC distributions due to rises in non-transferable allowances



The plot in FIGURE 4.7 shows that the policy reform, i.e., increasing non-transferable allowances, does not provide any distinct change throughout the HDIPAC distribution. However, whilst the policy seems unsuccessful in increasing disposable income at the lower end of the distribution, there are slight improvements of HDIPAC for households at the middle and the upper end of the distribution. This reform is hence ineffective in income inequality amelioration. This is not beyond expectations since increases in these allowances aim to have influences merely on tax payers, and the effects are not statistically significant. This implies that this type of policies affects only people who have incomes over a certain threshold (i.e., those who pay tax).

4.5.4 Proposed tax restructure

This section provides explanations on the effects of the recently proposed set of policy reforms in which the government committee recommend that the proposed tax package reforms many aspects including an increase in the amount of taxable persons, elimination of the tax threshold, reduction of the number of tax brackets, expansion of income ranges in the tax brackets, and revision of personal income tax rates.

4.5.4.1 Labour supply responses: a proposed tax restructure

From TABLE A4.8 in Appendix 4.II, the proposed package of tax rule reforms negatively influences labour supply behaviour of people with statistical significance in general.

Regarding unmarried males without children, their hours worked decline by about 2.66 hours or 2 hours and 40 minutes on average. Investigating labour supply responses throughout the HDIPAC distribution shows that apart from the 10^{th} decile of the distribution, unmarried males generally decrease hours worked after the tax rules restructure, with statistical significance at the 1 percent level. The pattern of labour supply responses in the bottom half of the distribution is unclear, whilst single males tend to decrease their hours worked more across the upper half of the distribution. However, the labour supply response turns positive (but without statistical significance) at the 10^{th} decile of the disposable income distribution. These males usually offer shorter hours worked than others in the same income decile due to a larger amount of unearned income.

In terms of unmarried females, the overall labour supply response is about -1.29 hours or they decrease hours worked by about 1 hour and 17 minutes. The magnitude of the change in the female case is smaller than in the male case; the reason is possibly that the proposed rules affect the latter to a larger extent since, in the status quo scenario, males usually have more taxable income than do females. Exploring labour supply responses by disposable income decile reveals that the pattern of labour supply response of females is very similar to that of males. From the first decile to ninth decile

of the income distribution, females usually decrease their hours worked with statistical significance at least at the 5 percent level after the introduction of the policy. At the tenth income decile, female labour supply response is dramatically different from other deciles; unmarried females increase hours worked by about 3.81 or 3 hours and 48 minutes with statistical significance at the 1 percent level. The reason for this behavioural difference is identical to the case of unmarried males. 43.44 percent of unmarried females in the tenth decile increase their hours worked if the proposed tax rules are effective.

In the household labour supply setting, overall, both married males and females decrease hours worked by 0.64 hour (i.e., 38.4 minutes) and 1.72 hour (i.e., 1 hour and 43 minutes) with statistical significance at the 5 percent and 1 percent level, respectively. Besides the tenth income decile, the labour supply response patterns of both husbands and wives are similar; the negative response due to tax rule reforms is higher at the both ends of the disposable income distribution relative to other deciles in the middle. Married males and females behave differently at the upper end of the distribution. In fact, husbands decide to increase their hours worked by 1.64 hour or 1 hour and 34 minutes with statistical significance at the 1 percent level; however, wives decrease their hours worked by 3.16 hours or about 3 hours and 10 minutes with statistical significance at the 1 percent level. Observing the data reveals that the reason for why couples react oppositely in the tenth decile of the income distribution is possibly because of unearned income and the gender wage gap. Unearned income differentiates households in the upper end of the distribution from others; ranking households by unearned income identifies that husbands increase their hours worked if their wages are much higher than the spouses' wages. On the other hand, wives living in households with high disposable income (tenth decile) decrease their hours worked because the gender wage gap is large.

Changes in the tax brackets and tax rate are expected to have the biggest effect than other changes in the proposed tax package on the labour supply. The results in the arithmetical model indicate that the combination of eliminating the tax threshold, reducing a number of tax brackets, and revising tax

rates affect disposable income the most. A change in tax declaration threshold from the income basis to the age basis does not affect disposable income of people in the arithmetical model. This is because this change affect people who are older than 18 years old but earn less than the income thresholds (60,000 baht for single people and 120,000 baht for married couples); these people are very less likely to pay tax. The other change in the proposed tax package is eliminating joint taxation (i.e., all married couples need to declare income separately). This affects disposable income only slightly because the difference between separate and joint taxation is some parts of allowances which are small in relative to household income.

4.5.4.2 Winners-losers analysis: a proposed tax restructure

TABLE A4.9 in Appendix 4.II presents labour supply responses when the government applies the proposed personal income tax package by decile. Overall, the proposed reform affects households (all gross income, tax burden, and disposable income) negatively.

In terms of unmarried males, in general, gross income decreases by about 7.59 thousand baht; the income tax burden increases by approximately 29.52 thousand baht and these factors together cause decrease in disposable incomes by about 37.10 thousand baht. These changes are statistically significant at the 1 percent level. Investigating results by decile indicates that changes in gross incomes are in-line with labour supply responses although the increase in the personal income tax burden is quite consistent with incomes by decile. As a result, the magnitude of a decreased in disposable income for the first decile is greater than the second decile due to the elimination of the tax threshold. The decreased amount of disposable income for males in the tenth decile is smaller than that for the ninth decile because people at the top end of the distribution increase their hours worked and earn more gross income.

The results also suggest that 97.84 percent of the total unmarried males are negatively affected by the reform; 2.12 percent is consider as the winner as their disposable incomes increase due to the

proposed tax rules; only one male is found that his disposable income remain unchanged. By using 5 percent change in disposable income as thresholds, 97.45 percent of the male individuals are considered as losers. 2.08 percent of the observations gain disposable income by at least 5 percent under the revised tax setting; and all of these persons are categorised in the upper end of the distribution. 12 households or 0.46 percent are identified as neutral since their income changes do not reach 5 percent thresholds; these persons are scattered at the lower part and the upper end of the disposable income distribution.

Regarding the labour supply of unmarried females, as they generally decrease their hours worked, their gross incomes decline by about 570 baht without statistical significance. Overall, the personal tax income burden increases by about 30.31 thousand baht with statistical significance at the 1 percent level. These factors reduce disposable income by about 30.88 thousand baht with statistical significance at the 1 percent level. Effects on disposable income due to the tax reform change negatively along the disposable income distribution except the last decile at the upper end.

The winners-losers analysis indicates that most unmarried females (95.99 percent) are negatively affected by the policy reform. 3.8 percent are considered as winners whilst only 0.2 percent is unaffected by the reform at all. By adopting 5 percent change thresholds, 94.81 percent is classified as losers. 1.84 percent of single females manage to increase their incomes by at least 5 percent in the proposed tax rules. All of these individuals are those at the upper end of the income distribution. 3.35 percent of unmarried females are considered as unaffected because their disposable income changes lie within the 5 percent range. They are mostly living in the households at the tenth decile of the distribution whilst the remaining observations are distributed along the middle of the distribution.

The results of household labour supply indicate that in general the policy reform affect household income in negative ways. In fact, overall, household gross income declines by about 7.45 thousand baht, their tax burden rises by about 53.33 thousand baht, and their disposable income reduces by

about 60.78 thousand baht. All estimates are statistically significant at the 1 percent level. The pattern of changes in these monetary factors is similar to what is observed at the individual level.

Investigating the proportions of winners and losers indicates that 98.22 percent of married couples earn smaller disposable incomes in the post-reform setting whilst 1.78 percent gain some extra disposable income from the reform. Using 5 percent disposable income change threshold reveals similar results. 96.90 percent of couples are considered as losers whilst 0.79 and 2.31 percent are suggested as winners and unaffected households respectively. Winners are distributed at the upper part (decile 8 to 10) of the disposable income distribution; unaffected couples are found across the distribution.

In short, people in the ninth decile of their own groups are most affected by the proposed reform. People in the last decile manage to ameliorate negative effects of the reform on their disposable income because of unearned income in which they usually do not have the ceiling amount of allowable expenses. Hence, the taxable incomes of people with a high unearned income percentage are usually lower than those of people relying heavily on earned income. This allows people at the upper end of the distribution to earn more gross income from earned income whilst their tax burdens are not as large as those of people in the ninth decile. The winners-losers analysis suggest that the proposed tax restructure makes most people worse off, while some of them at the upper end of the distribution are better off.

4.5.4.3 Effects on poverty: a proposed tax restructure

Since the reform affect most of the households negatively, it is not surprising HDIPACs of some households fall below the national poverty line. In fact, 0.64 percent of the whole sample become poor households in the post-reform scenario (i.e., 0.72 percent of all households are poor under a proposed tax restructure).

With regards to the gap between HDIPAC and the national poverty line, the results indicate that the discrepancy is expanding in the post-reform situation. In fact, the average income of poor households under the pre-reform case is lower than the poverty line by 1.99 thousand baht whilst the average income of poor households under the post-reform setting falls behind the poverty line by about 2.08 thousand baht.

4.5.4.4 Effects on the income distribution: a proposed tax restructure

FIGURE 4.8: Comparison of HDIPAC distributions due to proposed tax rules

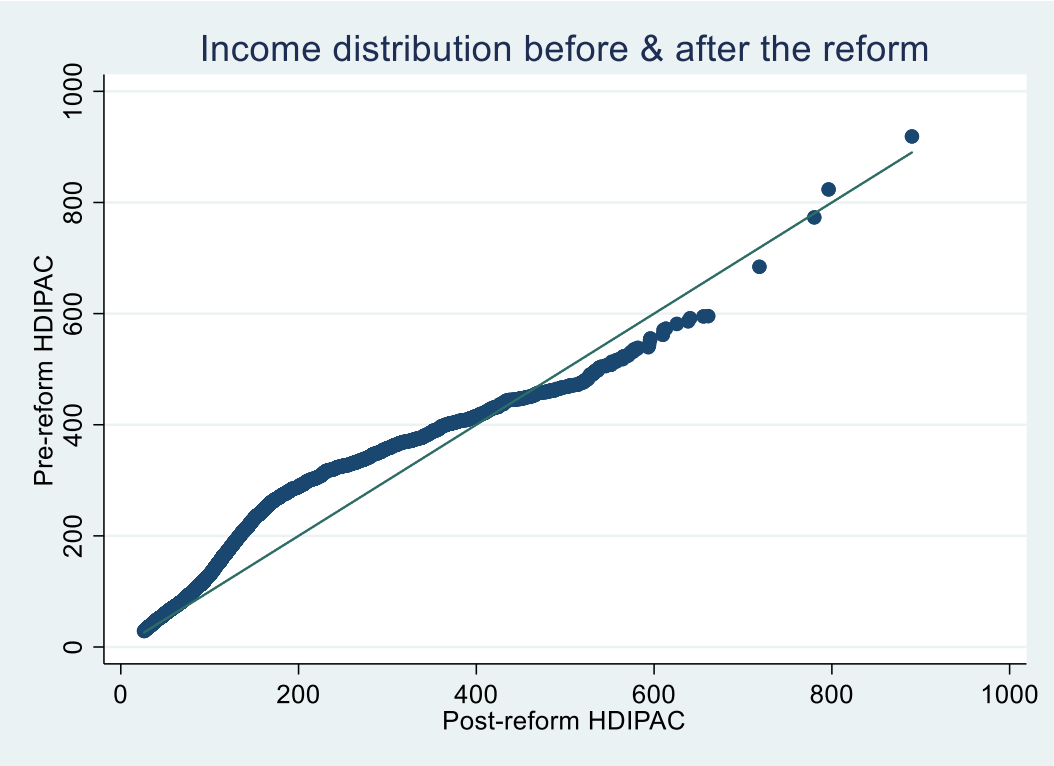


FIGURE 4.8 is quantile-quantile plot comparing HDIPAC distributions between pre-reform and post-reform situations for the whole HDIPAC distribution.

The plot presents some serious negative effects on HDIPAC at the bottom half of the distribution. The negative effects carry over to the middle part of the distribution as well. At some proportion in the upper half of the distribution, the negative effects become less critical. However, at the upper end to the distribution, households manage to gain HDIPAC after the government makes the tax reform effective. The plot clearly indicates that the revised tax package aggravates income inequality in

Thailand. This is because it decreases HDIPAC across the almost entire distribution, and most seriously at the lower half of the distribution, while it generally increases HDIPAC at the top of the distribution.

4.6 Conclusion

This chapter aims to study the effects of different policies on the economy using the microsimulation technique. Firstly, this chapter investigates the labour supply response due to a gross wage increase. Three different situations, namely, a 10 percent increase in male wages, a 10 percent increase in female wages, and a 10 percent increase in both genders wages, are simulated. The results suggest that in general female labour supply is more elastic than male labour supply as found in previous studies. Additionally, people tend to increase hours worked when their own wages increase whilst they response oppositely when their partners' wages rise. The findings are consistent with many existing studies.

This chapter also simulates different factual and counterfactual policies to investigate several economic aspects of each policy including the labour supply response, effects on pecuniary factors, winners-losers analysis, effects on poverty, and effects on the income distribution. The summary of the results and some conclusions for policy implications are as follows:

The perfect compliant rate of the minimum wage is the first policy considered in this study, as previous empirical work on the minimum wage in Thailand finds a low rate of policy compliance as well as ineffective law enforcement. In general, the simulated results show that the policy increases hours worked, gross incomes, tax burdens, and disposable incomes. The policy is targeted since only a proportion of people gain benefits from it. However, if the minimum wage is fully complied with, it can help to ameliorate economic problems including poverty and income inequality in Thailand because it increases disposable income of people at the bottom end of the HDIPAC distribution. Besides the amount of the minimum wages, the government is encouraged focusing on policy implementation and law enforcement to increase the rate of policy compliance. The results also

indicate that the minimum wage may have different effects across countries. This is because different countries have different income distribution regarding minimum wage workers (Atkinson et al., 2017; Müller and Steiner, 2013). In addition, the minimum wage has a smaller effect if a country has a larger amounts of mean-tested benefits, and vice versa (Müller and Steiner, 2013).

The effects of increases in non-transferable allowances is also simulated using the labour supply model. The results reveal that the policy scarcely influences people's labour supply behaviour. Although the policy aims to reduce income tax burden directly, it barely affect disposable income as well as economic situations including poverty and income inequality. In fact, HDIPAC of people at the middle and the upper parts of the distribution increase very slightly; however, the policy does not affect income of people at the lower end much at all. The government needs to sacrifice some revenue as a cost of the policy. The results suggest that policy makers need to consider whether the reform affects economic factors or not. An increase in tax allowances can be effective if it is large enough to affect labour supply behaviour as well as disposable income. Small changes in allowances might not help change labour supply behaviour or disposable incomes, but they possibly compensate some increased living costs. Policy makers also need to bear in mind that changing tax allowances affect only people who are eligible to pay tax (i.e., they have income greater than a certain amount depending on tax rules).

The Thai government committee, which is appointed by the Prime Minister's Office, proposed a package of tax restructure. This chapter selects some issues including a change in the income declaration threshold, elimination of joint taxation, and revision of tax brackets and rates to simulate the effects of these hypothetical changes. The results suggest that the policy generally has a negative impact on labour supply and gross incomes. In addition, the policy reform increases the overall tax burden of households which helps a government earn more revenue from personal income tax. Combining effects on gross income and tax burden yields a decrease on disposable income significantly. Therefore, a government may adopt this policy in slowing down an economy if needed.

In addition, the policy exacerbates the poverty concern and possibly expands the income gap between the lower and upper ends of the income distribution. The results also suggest that restructuring tax brackets and rates affects the labour supply response and other pecuniary factors more than other changes in the proposed tax package. This implies that since a tax-benefit restructure policy affects labour supply and financial factors of people across the HDIPAC distribution, the government has to consider this policy type very carefully.

4.7 Appendix 4.I: The results of labour supply elasticity

TABLE A4.1: Labour supply response for 10% wage increase at the individual level

	Single males	Single females
Total	.3307225***	.4947338***
	(.1068394)	(.1183232)
	[2592]	[2445]
Decile 1	.8299069***	1.933583***
	(.1992616)	(.266451)
	[260]	[245]
Decile 2	.803247***	1.956291***
	(.1872882)	(.2587732)
	[259]	[244]
Decile 3	.5383815***	1.449049***
	(.1435548)	(.1976877)
	[259]	[245]
Decile 4	.4548381***	.384094**
	(.1296121)	(.1568854)
	[259]	[244]
Decile 5	.3167821***	.0627625
	(.1209508)	(.1462492)
	[259]	[245]
Decile 6	.3099452***	-.01797
	(.1160585)	(.1372864)
	[260]	[244]
Decile 7	.222396**	.0307303
	(.1064204)	(.1824577)
	[259]	[245]
Decile 8	.2407749**	-.1715009
	(.1043397)	(.150812)
	[259]	[244]
Decile 9	-.0056878	-.2779661**
	(.1103389)	(.1226026)
	[259]	[245]
Decile 10	-.4052058**	-.4047035**
	(.1845691)	(.1766275)
	[259]	[244]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

TABLE A4.2: Married male labour supply response due to a 10% increase in males' wages

	Total	2-member	3-member	4-member	5-member
Total	.2527185*** (.039318) [7458]	.1292634*** (.0375335) [3824]	.3524721*** (.0452251) [2115]	.4157407*** (.0512254) [1292]	.4751357*** (.0618692) [227]
Decile 1	.3318857*** (.0531182) [746]	.0390961 (.0354956) [25]	.3424424*** (.0567142) [403]	.3273004*** (.052592) [240]	.3852938*** (.0646373) [78]
Decile 2	.183847*** (.0369745) [746]	.0313398 (.0348939) [329]	.2937841*** (.047725) [225]	.3055948*** (.0493952) [156]	.3629133*** (.0595471) [36]
Decile 3	.0956972*** (.0326908) [746]	.0184654 (.0333703) [468]	.2076866*** (.0387587) [161]	.2325826*** (.0441366) [102]	.372487*** (.060018) [15]
Decile 4	.1014293*** (.0332636) [746]	.0029206 (.0331319) [441]	.2216282*** (.0395111) [185]	.264179*** (.0461708) [103]	.3627439*** (.0628881) [17]
Decile 5	.0923902*** (.0342041) [745]	-.0007556 (.0348343) [448]	.2208466*** (.0396058) [201]	.2512917*** (.0458927) [84]	.3058825*** (.0576275) [12]
Decile 6	.0712921** (.0352166) [746]	-.014547 (.0365502) [484]	.1901115*** (.0383531) [160]	.2849486*** (.0455118) [88]	.3379541*** (.0552996) [14]
Decile 7	.0633754* (.0370164) [746]	-.0119608 (.0385787) [501]	.1640116*** (.0380482) [149]	.2769617*** (.045352) [89]	.5975784*** (.0786137) [7]
Decile 8	.2263884*** (.0448391) [745]	.0757638* (.0429462) [401]	.3361893*** (.0500188) [199]	.4819937*** (.0601172) [128]	.5694832*** (.0708825) [17]
Decile 9	.5292318*** (.069504) [747]	.3365888*** (.0633779) [297]	.6175975*** (.0747739) [259]	.6843155*** (.0832907) [171]	.9196789*** (.1095398) [20]
Decile 10	.8318033*** (.087837) [745]	.82816*** (.0951865) [430]	.8140393*** (.0862588) [173]	.842989*** (.0942127) [131]	1.120389*** (.1262805) [11]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

TABLE A4.3: Married female labour supply response due to a 10% increase in males' wages

	Total	2-member	3-member	4-member	5-member
Total	-.8894429***	-.8067587***	-.9352216	-1.040113***	-.9982406***
	(.0564362)	(.0538398)	(.0604468)	(.0674587)	(.0704568)
	[7458]	[3824]	[2115]	[1292]	[227]
Decile 1	-.5013794***	-.419893***	-.4900876***	-.5199245***	-.528776***
	(.0474108)	(.0396848)	(.047208)	(.0489927)	(.0524293)
	[746]	[25]	[403]	[240]	[78]
Decile 2	-.5339734***	-.4669435***	-.5544315***	-.6153405***	-.6660982***
	(.0466497)	(.042187)	(.050271)	(.0545433)	(.0600618)
	[746]	[329]	[225]	[157]	[36]
Decile 3	-.540306***	-.4821042***	-.6154063***	-.6523101***	-.7884979***
	(.0451873)	(.0418614)	(.0520496)	(.0546451)	(.0673705)
	[746]	[468]	[161]	[102]	[15]
Decile 4	-.5715812***	-.494897***	-.6920356***	-.6516047***	-.7651856***
	(.0463298)	(.0418953)	(.0559441)	(.0547634)	(.0677699)
	[746]	[439]	[185]	[103]	[17]
Decile 5	-.6214043***	-.5317239***	-.7494807***	-.7495844***	-.9269361***
	(.0485431)	(.0439065)	(.0586447)	(.0609794)	(.0633309)
	[745]	[448]	[201]	[84]	[12]
Decile 6	-.6909984***	-.5781327***	-.8340992***	-.994801***	-1.047871***
	(.0526125)	(.0470924)	(.0630832)	(.0725952)	(.0799402)
	[746]	[484]	[161]	[88]	[14]
Decile 7	-.7835453***	-.6927542***	-.9072241***	-1.040405***	-1.383217***
	(.0591443)	(.0555256)	(.0681974)	(.0729804)	(.1100175)
	[746]	[501]	[149]	[89]	[7]
Decile 8	-1.13098***	-.9541976***	-1.228027***	-1.440803***	-1.832175***
	(.0757554)	(.0727225)	(.0806817)	(.0907447)	(.1137805)
	[746]	[401]	[199]	[128]	[17]
Decile 9	-1.555124***	-1.332526***	-1.616752***	-1.770753***	-2.21901***
	(.0896647)	(.0884531)	(.0935768)	(.1045916)	(.162659)
	[746]	[297]	[259]	[171]	[20]
Decile 10	-1.965651***	-1.938505***	-2.00139	-1.977669	-2.321619
	(.1240337)	(.1289799)	(.1319186)	(.1481933)	(.1825604)
	[745]	[430]	[173]	[131]	[11]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

TABLE A4.4: Married male labour supply response due to a 10% increase in females' wages

	Total	2-member	3-member	4-member	5-member
Total	-.2052379***	-.2128115***	-.187963***	-.2193654	-.1582007
	(.0242569)	(.0241872)	(.0254948)	(.0301855)	(.0297949)
	[7458]	[3824]	[2115]	[1292]	[227]
Decile 1	.0317322*	-.0415146***	.0370639**	.0272242	.0415323**
	(.0171856)	(.0149679)	(.017638)	(.017915)	(.0204368)
	[746]	[25]	[403]	[240]	[78]
Decile 2	-.0124245	-.0534963***	.020992	.0167186	.0277866
	(.0149801)	(.0148368)	(.017416)	(.0181768)	(.0202782)
	[746]	[329]	[225]	[156]	[36]
Decile 3	-.0496916***	-.0680266***	-.0195329	-.0250508	.0310975
	(.014747)	(.0150769)	(.0155901)	(.0178119)	(.0216673)
	[746]	[468]	[161]	[102]	[15]
Decile 4	-.0584592***	-.0808231***	-.0331853*	-.0148413	-.0176272
	(.0154839)	(.0153538)	(.0169869)	(.0190667)	(.0234728)
	[746]	[441]	[185]	[103]	[17]
Decile 5	-.0748224***	-.0916754***	-.0463004***	-.0447323**	-.1340158***
	(.0158525)	(.0159184)	(.0171154)	(.0181899)	(.0268614)
	[745]	[448]	[201]	[84]	[12]
Decile 6	-.096552***	-.1079087***	-.0788011***	-.0681065***	-.0856036***
	(.0164065)	(.0165664)	(.0176849)	(.0186729)	(.0221456)
	[746]	[484]	[160]	[88]	[14]
Decile 7	-.1215151***	-.123733***	-.1111477***	-.1268511***	-.1156055***
	(.0175214)	(.0173929)	(.0183511)	(.0222131)	(.0244761)
	[746]	[501]	[149]	[89]	[7]
Decile 8	-.2242968***	-.1608891***	-.2562353***	-.3497177	-.401755***
	(.0264099)	(.0209177)	(.0334597)	(.043092)	(.0446361)
	[745]	[401]	[199]	[128]	[17]
Decile 9	-.5045646***	-.3088601***	-.5989001***	-.6608329***	-.8530393***
	(.0511279)	(.0362542)	(.0615247)	(.0697075)	(.1108001)
	[747]	[297]	[259]	[171]	[20]
Decile 10	-.9422225***	-.9677599***	-.9441395***	-.8371846***	-1.164701***
	(.0928584)	(.1038315)	(.0923307)	(.0924463)	(.145553)
	[745]	[430]	[173]	[131]	[11]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

TABLE A4.5: Married female labour supply response due to a 10% increase in females' wages

	Total	2-member	3-member	4-member	5-member
Total	.8758556*** (.08362) [7458]	.5384286*** (.0791009) [3824]	1.142079*** (.0942264) [2115]	1.335972 (.1044362) [1292]	1.460828 (.1242152) [227]
Decile 1	1.003104*** (.1046116) [746]	.2870621*** (.0747444) [25]	1.001368*** (.1064598) [403]	1.026179*** (.1069457) [240]	1.170575*** (.1248696) [78]
Decile 2	.7412298*** (.0881253) [746]	.2983871*** (.0757547) [329]	1.045395*** (.1137204) [225]	1.114881*** (.1189015) [156]	1.268131*** (.1378897) [36]
Decile 3	.533805*** (.0789578) [746]	.2966112*** (.0758311) [468]	.8428915*** (.0968332) [161]	.990808*** (.11265) [102]	1.509105*** (.1621596) [14]
Decile 4	.5931565*** (.082806) [746]	.2860335*** (.0762467) [441]	.9398495*** (.1024449) [185]	1.153968*** (.1240571) [103]	1.38959*** (.1604321) [17]
Decile 5	.5739492*** (.0841351) [745]	.2920035 (.0799386)*** [448]	.9725869*** (.106099) [201]	1.05324*** (.1197909) [84]	1.067705*** (.1214598) [12]
Decile 6	.5477434*** (.0859773) [746]	.2964688*** (.0842671) [484]	.9117489*** (.1024594) [160]	1.160877*** (.1194566) [88]	1.220617*** (.1289702) [14]
Decile 7	.5488769*** (.0887453) [746]	.3454707*** .0903282 [501]	.8277656*** (.0932171) [150]	1.150235*** (.1141969) [88]	1.524768 (.1366372) [7]
Decile 8	.953878*** (.0993636) [745]	.55584*** (.1001421) [401]	1.2285*** (.1011826) [199]	1.651918*** (.123733) [128]	1.872366*** (.1399187) [17]
Decile 9	1.508648*** (.12198) [747]	1.016349*** (.1173476) [297]	1.727562*** (.1287279) [259]	1.911409*** (.1341022) [171]	2.540756*** (.164252) [20]
Decile 10	1.754194*** (.1176101) [745]	1.66631*** (.1216335) [430]	1.795008*** (.1178943) [173]	1.943921*** (.1290866) [131]	2.288265*** (.150038) [11]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

TABLE A4.6: Married male labour supply response when (partners' wages increase by 10 %)

	Total	2-member	3-member	4-member	5-member
Total	.0570549 (.0443109) [7458]	-.0734417 (.0450079) [3824]	.1732841*** (.0474653) [2115]	.2061097*** (.0516831) [1292]	.3240825*** (.0618643) [227]
Decile 1	.3585682*** (.061986) [746]	-.0023585 (.0476036) [25]	.3745705*** (.0659302) [403]	.3492735*** (.0617347) [240]	.4201697*** (.074783) [78]
Decile 2	.1687515*** (.046204) [746]	-.0218423 (.0464085) [329]	.3101872*** (.0571677) [225]	.3170558*** (.0586619) [156]	.3839433*** (.0696759) [36]
Decile 3	.0451891 (.0426026) [746]	-.0489315 (.0447151) [468]	.1853543*** (.0472486) [161]	.2043719*** (.0528213) [102]	.3948686*** (.0699163) [15]
Decile 4	.0420918 (.0431327) [746]	-.076939* (.0445299) [441]	.18554*** (.0472911) [185]	.2451989*** (.054836) [103]	.3382469*** (.0718344) [17]
Decile 5	.0170707 (.0440702) [745]	-.0914026** (.0462873) [448]	.1713381*** (.0471434) [201]	.2041237*** (.0535998) [84]	.1733918*** (.0627741) [12]
Decile 6	-.0247548 (.0450684) [746]	-.1208635** (.0480131) [484]	.1106291** (.0457371) [160]	.2141262*** (.0514571) [88]	.2490801*** (.0607064) [14]
Decile 7	-.056251 (.0465701) [746]	-.1333749*** (.0494752) [501]	.0542675 (.0451975) [149]	.1504768*** (.0505778) [89]	.4827569*** (.0815884) [7]
Decile 8	.0109483 (.0504313) [745]	-.0805584 (.0508565) [401]	.0912243* (.0528757) [199]	.147822** (.0602982) [128]	.1991486*** (.0706821) [17]
Decile 9	.054353 (.0685565) [747]	.0432446 (.0650306) [297]	.0552304 (.0732049) [259]	.0639971 (.0782192) [171]	.1254927 (.0913375) [20]
Decile 10	-.0456676 (.0962166) [745]	-.0721829 (.1028978) [430]	-.0641551 (.0940527) [173]	.0584679 (.1028003) [131]	.0414365 (.1250568) [11]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

TABLE A4.7: Married female labour supply response (both partners' wages increase by 10 %)

	Total	2-member	3-member	4-member	5-member
Total	.0077422 (.087828) [7458]	-.2420762*** (.0856644) [3824]	.2229786** (.0948037) [2115]	.3165756*** (.1057865) [1292]	.4529749*** (.1239313) [227]
Decile 1	.4834599*** (.1095542) [746]	-.130593 (.0901468) [25]	.4928415*** (.1113073) [403]	.4880857*** (.1124906) [240]	.6175671*** (.1299406) [78]
Decile 2	.1992472** (.0968712) [746]	-.1654239* (.0899242) [329]	.4765123*** (.1184907) [225]	.4811898*** (.1224959) [156]	.5772776*** (.1420243) [36]
Decile 3	-.0077819 (.0894631) [746]	-.1812188** (.0883231) [468]	.2171174** (.102816) [164]	.3302947*** (.1175748) [102]	.6906079*** (.1577546) [15]
Decile 4	.0199489 (.091956) [746]	-.2031653** (.0879386) [441]	.2356879** (.105772) [185]	.4926482*** (.1266107) [103]	.5960435*** (.1561595) [17]
Decile 5	-.0478508 (.0931989) [745]	-.2326375** (.0913056) [448]	.2087625* (.1075863) [201]	.298623** (.1219285) [84]	.127265 (.1277503) [12]
Decile 6	-.1416511 (.095896) [746]	-.2722611*** (.0962724) [484]	.0695287 (.1056333) [160]	.1469619 (.1207291) [88]	.1460996 (.1348405) [14]
Decile 7	-.2269801** (.0993611) [746]	-.3350586*** .1024912 [501]	-.075426 (.1007275) [149]	.1006582 (.1145985) [89]	.116728 (.1527232) [7]
Decile 8	-.1641539 (.1048111) [745]	-.3808707*** (.1084367) [401]	.010286 (.1075583) [199]	.2210939* (.1252705) [128]	.0051494 (.1489254) [17]
Decile 9	.015609 (.1237949) [747]	-.2859212 (.117916) [297]	.1922456 (.1330573) [259]	.2302849 (.1480672) [171]	.3704108* (.1958125) [20]
Decile 10	-.0528218 (.1699245) [745]	-.1211526 (.1798545) [430]	-.0374264 (.1739259) [173]	.1352853 (.1847298) [131]	.1359807 (.2328642) [11]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

4.8 Appendix 4.II: The results of the recently proposed tax reform

TABLE A4.8: Labour supply response due to proposed tax restructure

	Single males	Single females	Married males	Married females
Total	-2.658091*** (.4868457) [2592]	-1.287904*** (.3906604) [2445]	-.6404871** (.2544013) [7458]	-1.721599*** (.457833) [7458]
Decile 1	-2.448605*** (.4942047) [260]	-1.893211*** (.2547314) [245]	-.9878512** (.4592703) [746]	-2.283126*** (.7650591) [746]
Decile 2	-2.73148*** (.5427526) [259]	-2.672868*** (.3579042) [244]	-.8292736** (.3380049) [746]	-1.730463*** (.6323459) [746]
Decile 3	-2.383433*** (.4932505) [259]	-2.841122*** (.3903083) [245]	-.5952269* (.3084115) [746]	-1.211843** (.562655) [746]
Decile 4	-2.431952*** (.4965116) [259]	-1.559479*** (.3866234) [244]	-.6952668** (.275249) [746]	-1.432424*** (.5076879) [746]
Decile 5	-2.324229*** (.5095503) [259]	-1.055266** (.4157841) [245]	-.7411013*** (.272291) [745]	-1.239659** (.4856405) [745]
Decile 6	-2.662971*** (.5442864) [260]	-1.048962** (.4614599) [244]	-.7340012*** (.2689066) [746]	-.9763982** (.4777079) [746]
Decile 7	-2.996503*** (.5845841) [259]	-1.749782** (.8411063) [245]	-.7256874*** (.2739366) [746]	-.7070424 (.4855742) [746]
Decile 8	-3.979061*** (.6754987) [259]	-1.815664* (1.021545) [244]	-1.269216*** (.3498672) [745]	-1.428085** (.6177953) [745]
Decile 9	-4.86549*** (.8173969) [259]	-2.039714** (.8335744) [245]	-1.467699*** (.5462961) [747]	-3.049491*** (.9255456) [747]
Decile 10	.2420192 (.4926035) [259]	3.8099*** (.6833909) [244]	1.643645*** (.6068345) [745]	-3.156565*** (.8448503) [745]

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

TABLE A4.9: Changes on financial factors due to proposed tax restructure

Policy changes	Unmarried males	Unmarried females	Married couples
Overall	[2592]	[2445]	[7458]
Gross income	-7.586629***	-.5708419	-7.451187***
	(1.497408)	(1.497334)	(2.16393)
Tax burden	29.51763***	30.3135***	53.32573***
	(1.042136)	(1.192371)	(1.245192)
Disposable income	-37.10426***	-30.88434***	-60.77691***
	(.9256018)	(1.302215)	(1.688174)
Decile 1	[260]	[245]	[746]
Gross income	-5.002087***	-2.841729***	-6.202023***
	(1.002585)	(.3826625)	(2.014154)
Tax burden	9.61147***	2.468067***	16.3241***
	(.4329957)	(.1924675)	(.3903711)
Disposable income	-14.61356***	-5.309796***	-22.52612***
	(.6577612)	(.3075256)	(1.740957)
Decile 2	[259]	[244]	[746]
Gross income	-6.157664***	-4.530743***	-5.275757***
	(1.221059)	(.6070386)	(1.657701)
Tax burden	12.24104***	4.105987***	19.60927***
	(.475441)	(.2376773)	(.3456515)
Disposable income	-18.39871***	-8.636729***	-24.88503***
	(.8434899)	(.5063488)	(1.394608)
Decile 3	[259]	[245]	[746]
Gross income	-5.549052***	-5.589382***	-3.961726**
	(1.134124)	(.7571729)	(1.543808)
Tax burden	14.3232***	6.84019***	23.64601***
	(.4180738)	(.2377899)	(.338195)
Disposable income	-19.87225***	-12.42957***	-27.60774***
	(.7999746)	(.6560842)	(1.283137)
Decile 4	[259]	[245]	[746]
Gross income	-6.171804***	-3.481945***	-5.030162***
	(1.228854)	(.772768)	(1.454226)
Tax burden	16.93439***	11.45527***	26.79033***
	(.4306568)	(.3073577)	(.3407698)
Disposable income	-23.10619***	-14.93722***	-31.8205***
	(.8810894)	(.6018953)	(1.185274)
Decile 5	[259]	[245]	[745]
Gross income	-6.287498***	-2.577047***	-5.278727***
	(1.343396)	(.8993604)	(1.528905)
Tax burden	20.01675***	15.40176***	33.45857***
	(.4593588)	(.3464203)	(.3725019)
Disposable income	-26.30424***	-17.97881***	-38.7373***
	(.9756863)	(.7207292)	(1.240564)

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

TABLE A4.9: Changes on financial factors due to proposed tax restructure (Continue)

Policy changes	Unmarried males	Unmarried females	Married couples
Decile 6	[260]	[244]	[746]
Gross income	-7.980928***	-2.94684**	-5.142924***
	(1.58801)	(1.169963)	(1.619578)
Tax burden	23.48966***	20.35074***	42.09331***
	(.52876)	(.4015203)	(.4209367)
Disposable income	-31.47059***	-23.29758***	-47.23623***
	(1.158872)	(.957897)	(1.309206)
Decile 7	[259]	[245]	[746]
Gross income	-10.12159***	-6.253403**	-5.345339***
	(1.915012)	(2.926235)	(1.919946)
Tax burden	28.77919***	32.12983***	53.73038***
	(.6445346)	(1.422761)	(.550015)
Disposable income	-38.90078***	-38.38323***	-59.07571***
	(1.400571)	(1.70022)	(1.520893)
Decile 8	[259]	[244]	[745]
Gross income	-15.81004***	-8.103316*	-13.35446***
	(2.626812)	(4.583921)	(3.549396)
Tax burden	36.49714***	49.24546***	80.4912***
	(1.024362)	(1.993634)	(1.354077)
Disposable income	-52.30717***	-57.34878	-93.84565***
	(1.79936)	(2.891106)	(2.561744)
Decile 9	[259]	[245]	[747]
Gross income	-25.23191***	-13.49674**	-26.02982***
	(4.236139)	(5.367631)	(6.973035)
Tax burden	55.45613***	80.68043***	119.0846***
	(1.894871)	(2.419987)	(3.559187)
Disposable income	-80.68805***	-94.17716***	-145.1144***
	(2.649375)	(3.477807)	(4.781343)
Decile 10	[259]	[244]	[747]
Gross income	12.43783***	44.22709***	1.140478
	(4.419219)	(6.938004)	(8.886532)
Tax burden	77.92748***	80.51482***	118.0378***
	(5.709172)	(7.222469)	(6.519476)
Disposable income	-65.48965***	-36.28773***	-116.8974***
	(8.003235)	(12.40861)	(10.38797)

S.E. in parentheses; the number of observation in square brackets; *, **, and *** indicate statistical significance at 10%, 5%, and 1% respectively

Chapter 5 Conclusion

5.1 Summary of findings

This thesis comprises three pieces of empirical work on labour supply and policy simulation. All essays are based on Thailand as a developing country with some serious economic concerns, namely, slow economic growth, which is closely related to the middle-income trap, and high income inequality. They have happened in many countries and become global issues interested by international organisations such as World Bank. Nonetheless, the number of studies investigating labour supply in developing countries are very limited. This thesis takes this opportunity to investigate labour supply in Thailand with policy simulation using the microsimulation technique to fulfil the body of the literature.

The first essay presented in Chapter 2 focuses on labour supply at the extensive margin in Thailand. The dataset covers four periods (2009, 2011, 2013, and 2015) of cross-sectional data from the HSES. The structural binary probit model is applied to overcome the selection bias due to unobserved wages of non-workers. The two-stage Heckman selection model is adopted to yield predicted wages for the whole sample. The model covers a comprehensive list of factors such as individual and household characteristics. In general, the results are consistent with the existing literature. Some unconventional results are found because of socio-economic differences across countries.

One of the focused factors is a dummy variable which captures the effect of the agricultural sector as a proxy of the informal sector on labour force participation since it plays an important role in the labour market in many developing countries. The results reveal that if a household has any farming business, females are less likely to participate in the formal labour market.

Another main focus is whether the set of income restructuring policies (i.e., increases in minimum wages, monthly salaries, and rice prices) influence labour supply at the extensive margin. The results imply that the policies negatively affect labour force participation for both genders. There are possible

reasons why increases in minimum wages affect labour force participation negatively. First, the policies decreased the labour demand since increases minimum wages imply higher production costs. Second, the policy has a low rate of compliance owing to ineffective law enforcement. Third, most people earning minimum wages are already active in the market. An increase in monthly salary for workers with a university degree in the public sector does not really affect the labour force participation because the salary is not the key factor in working as public servants in Thailand; other factors (e.g., health care benefits) overcome the monthly salary. In addition, the policy does not spill over to the private sector because people graduated from a university are oversupply (the largest group of unemployed people are those with a university degree). The rice-pledging scheme, in which the government pledges rice at over the market price, also affects the formal labour market negatively since people consider farming income as (unearned) household income.

The final focused factor in Chapter 2 is the debt constraints. Besides housing debt, this study also includes two new types of debt, i.e., educational and consumption debts into a study focusing labour force participation. The results suggest that the amount of debts overall increase the possibility of being active in the formal labour market for both genders; however, the degrees of changes are different across genders. The housing influences labour force participation of males more than that of females; however, other types of debt show the opposite results.

Chapter 3 investigates different discrete hours labour supply models to find the preferred models for individual and family labour supply. A recent dataset (HSES) is adopted in the estimation to explore recent labour supply decisions in Thailand. Whilst the predicted hourly wages are obtained using the two-stage Heckman selection model similar to the previous chapter, household disposable income at each hours alternative are calculated using tax-benefit rules. Four models of individual labour supply and six models of household labour supply are estimated; they are different in the degree of flexibility, such as incorporation of observed and unobserved preference heterogeneity. All models include a fixed cost variable capturing a working status of each individual; incorporation of the fixed cost into a

model help prevent under-predicted and over-predicted results at some hours alternatives as suggested by previous empirical studies.

Overall, the estimation provides the results which are consistent with the theoretical predictions and existing empirical studies. Some criteria are applied to select the preferred model at each labour supply level; they include the proportion of negative marginal utility of income, the proportion of the sample satisfying the quasi-concave condition, the proportion of the observations satisfying the monotonicity condition, the log-likelihood ratio test, and the consistency between individual and household labour supply levels. Regarding individual labour supply, this chapter estimates models for males and females separately. The results suggest that the most flexible model is preferred for both genders. In terms of the household labour supply, the sample includes married couples with and without children. The results indicate that the most flexible model is also preferred for household labour supply. This model includes a new variable capturing the fixed costs when both partners are working to the existing literature; the results indicate that the variable is statistically significant for family labour supply. People living in the capital city has more fixed costs in working than others living outside; however, the fixed costs are reduced if both partners decide to be active in the market.

This chapter also performs robustness checks for the preferred models. Overall, the results show that the preferred model are robust and provide consistent results across different checks. The results also suggest that the preferred models fit the most recent datasets (2013 and 2015) best.

The final empirical study in this thesis, Chapter 4, explores the effects of different simulated policies through the labour supply models estimated in the Chapter 3. This chapter adopts the arithmetical model (personal income tax rules) and behavioural model (estimation results of the preferred models for year 2013 and 2015) from Chapter 3 for microsimulation analysis. It covers labour supply response as well as pecuniary factors, namely, gross income, tax burden, and disposable income. Additionally, a winner-loser analysis is carried out by identifying the number of households which gains disposable

income as a result of the simulated policy. This chapter also investigates macroeconomic impacts including poverty and income redistribution.

Before policy simulation, labour supply elasticities of gross wages are estimated. The results are consistent with most previous studies from developed countries. Female labour supply is found to be more elastic than male labour supply in general. This chapter focuses three different policy reforms. First, this chapter simulates the perfect compliance rate of the national minimum wage to investigate the effect of the national minimum wage introduced in 2012. The results of this hypothetical policy indicates that the policy implication is very important in improving the living standard of poor people as well as ameliorating income inequality in Thailand. The next policy simulation is a part of the actual tax rule adjustment in 2017. The results reveal that the policy reform affects mainly the tax burden (i.e., the amount of personal income tax paid decrease for all types of households). Nevertheless, it does not significantly impact poverty and income inequality. The last policy simulation is the personal income tax package recently proposed by the sub-committee, under the Thai law reforming committee, in September 2018. The results of this counterfactual policy suggest that in general, the package affects labour supply and gross income negatively; it also increases tax burdens on average. As a result, the disposable income of most households decreases drastically. The main cause is the changes in tax brackets and tax rates. In addition, the policy is found to intensify the poverty and to possibly expand the income gap between the both ends of the income distribution.

5.2 Policy implications, limitations, and future research

The results in Chapter 2 provide further understanding of labour force participation in Thailand as a developing country. The results indicate that an increase in wage rates promotes labour force participation whilst an increase in unearned income has the opposite effect. Base on the findings, the government may consider issuing a policy to reallocate labour force across sectors by increasing wage rates in preferred sectors. For example, if the government aims to allocate labour force from the

covered sector to the formal sector, it can raise wage rates in the formal labour market; people will participate in a better paying market. This implication can be also applied for reallocating labour force across industries (e.g., automotive part manufacturing, tourism, and software development) by increasing wages in specific industries. On the other hand, the government needs to be cautious in introducing any welfare program which affects unearned income because it may discourage people from working. The significance of the informal sector on labour supply at the extensive margin reminds policy makers to form a policy that possibly affects the formal market with caution. For example, the rice-pledging scheme, which raise the rice prices by at least 50 percent, may partially explicate why the income restructure policy package generally has a negative effect on the probability of labour force participation. An amount of household debts is positively related to labour force participation. Nevertheless, the excessive amount of debt constraints can make a decline in workforce productivity if non-workers with serious indebtedness need to take any job regardless their skills and job requirements. The government needs to be more careful when the household debts increase excessively.

The future research could be improved by focusing on two following aspects. First, variables for financial obligation are possible to have econometric problems including sample selection, unobserved heterogeneity, and endogeneity bias (Atalay et al., 2016). Some econometric techniques (e.g. instrumental variables and a structural binary probit model) could be applied to deal with these possible problems. Second, the first empirical essay focuses mainly on the formal labour market. A multinomial choice model can be applied to investigate the occupational choices (i.e., workers, own-accounts, business owners, farmers, non-participant, and etc.); this will help a researcher to understand the whole labour market from a broader perspective.

The key contribution of Chapter 3 is focusing on the academic applications. This chapter is one of the most comprehensive studies regarding labour supply in a developing country. In fact, this essay investigates individual and household labour supply models and covers a large spectrum in terms of

model flexibility. The most flexible model is preferred for individual and household levels. This implies that labour supply decision is highly complicated; it also requires a lot of computational capacity to estimate the flexible model. The estimation results of models allow one to simulate interested policy reforms to investigate the effects on the economy as shown in the final empirical chapter. Nonetheless, policy makers can directly adopt the results as labour supply behaviour for policy implications. For example, regarding household labour supply, the large proportion of the fixed costs for people living in the capital city is possibly the transportation costs. The traffic congestion in Bangkok is one of the worst cities around the world[35]. Investment in public transportation can help reduce the transportation costs (pecuniary and non-pecuniary terms) which, in turn, increase labour supply in general. Another example of policy implications can be drawn from effects of having a young children on income and leisure. Households with young children requires more income and both males and females are likely to sacrifice their leisure hours for hours worked. The government may improve the child care system in order to facilitate labour supply behaviour response affected by a policy. An appropriate child care system possibly reduce working fixed costs.

Regarding possibilities for future research, Chapter 3 focusing on labour supply in a developing can be improved to some extents. Comprehensive datasets could make some improvements for labour supply research in the future as the HSES has some drawbacks for labour supply studies. For example, it does not provide some certain income types at an individual level and it provides total amounts of incomes rather than detailed information for each sub-category. In addition, information on allowances and exemptions is missing from the HSES. If the questionnaire was more consistent with income tax rules and regulations, the calculated disposable income would be more realistic. The HSES also collects data on a cross-sectional basis. Panel data provides the possibility to study dynamic labour

[35] According to INRIX, Bangkok is ranked the 15th of the world's worst traffic congestion cities in 2017.

supply which would allow the investigation of labour supply behaviour in multiple periods because people do not make a once-and-for-all decision for labour supply.

Chapter 3 covers various models with different degrees of flexibility and the result of preferred models imply that the labour supply decision is vastly complicated. Nonetheless, it does not incorporate correlations between arguments (e.g. income and leisure) into any model. Previous studies such as those by Creedy et al. (2002), Duncan and Harris (2002), and Kabátek et al. (2014) allow correlations between arguments and find significant results. Including the correlations can improve the labour supply models of developing countries in the future. One can also consider to incorporate some interesting factors (e.g., health status and debt constraints) into a discrete hours labour supply model. For example, Duncan et al. (2013) include physical and mental statuses as observed characteristics into a discrete hours labour supply of sole parents in Australia.

The empirical study in Chapter 3 mainly aims to investigate labour supply behaviour of people assumed to select whether to work or not and how many hours they want to supply. However, the models do not account for the effects of labour demand. A researcher may also consider including the labour demand effects into the analysis. Peichl and Siegloch (2012) show that incorporation of labour demand effects can offset the positive labour supply effect by about 25 percent. Löffler et al. (2014a) estimate labour supply and demand separately; the demand side model accounts for possible restrictions because of labour demand as well as identifies the partial equilibrium of the labour market after the reactions of labour supply.

The final essay adopts labour supply behaviour in the previous chapter to explore the effects of individual policy. The results provide some important policy implications. First, the policy implementation is very important for policy effectiveness. Second, the policy related to tax-benefit rules does not affect everyone; for example, in Thailand, many people do not pay personal income tax because their taxable income is lower than the tax threshold. Third, increases in allowances can be

effective if the total amount is large enough; this indicates why policy simulation is important for the policy formation process. Finally, the results show that any policy related to income and personal income tax has impacts on labour supply and financial factors. It is crucial that the policy makers need to consider the effects of a policy thoughtfully before issuing it. In addition, adjustment of tax brackets and rates cause a large change in labour supply and pecuniary factors (gross incomes, tax burdens, and disposable incomes) to most people; a policy affecting the tax structure requires very cautious consideration.

One limitation of the microsimulation is linked with the limitation in Chapter 3. In point of fact, the simulation in Chapter 4 focus only on the supply side of the labour market. Future research may consider incorporating labour demand and price effects into the policy simulation since they may offset a significant proportion of the labour supply effect as found in Peichl and Siegloch (2012) and Löffler et al. (2014a).

In Chapter 4, three main policies are simulated to analyse the effects on economic issues. Other interesting policies can be simulated in the future research in order to find a proper set of policies to alleviate economic concerns. A set of policies, which help improve household income for the entire distribution or the large part of the distribution, should be taken into consideration. These policies will help reduce the poverty rate as well as preventing a middle income country from the middle-income trap situation.

Future work may consider simulating a policy package which aims to specifically mitigate the income inequality concern. Whilst the minimum wage with effective implementation can increase the household income of people at the bottom part of the distribution, having another policy which targets to increase the tax burden of the top end of the distribution will be an effective policy combination for helping improve income equality in an economy.

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