Employment Effects of Minimum Wages in a Dual Economy: Evidence from Thailand*

Saisawat Samutpradit†

October 8, 2021

Abstract

This study estimates the impact of a minimum wage increase on employment when minimum wage coverage is incomplete. Using as a natural experiment a 60 percent increase in the minimum wage in Thailand whereby 40 percent of workers were not covered by the legislation, we found that one percent increase in the minimum wage reduced low-skilled employment in the covered sector by 0.4 percent and increased employment in the uncovered sector by 0.2 percent. The official unemployment rate also decreased because the rise in the minimum wage lowered the probability of covered employment to such a large extent that workers instead turned to the uncovered sector. Although the average wage in the covered sector increased, it is unclear whether the increased labor supply in the uncovered sector suppressed wages because 70 percent of the wages in the uncovered sector were not observed.

JEL classification: J23, J38, J46, J62, J88
Keywords: minimum wages, employment, wages, informal labor markets, labor mobility

*I am indebted to my advisor Daiji Kawaguchi for his advice and encouragement, and I would also like to thank the National Statistics Office of Thailand for allowing access to the Labor Force Survey and the Informal Employment Survey, as well as Shintaro Yamaguchi, Andrew S. Griffen, Mari Tanaka, Xinwei Dong, Hikaru Kawarazaki, Nhat Thao Bach, and seminar participants at the Tokyo Labor Economic Conference, and the CREPE Applied Econometrics Conference for their helpful comments. Editing assistance has been provided by Philip C. MacLellan. All remaining errors are my own.

†Graduate School of Economics, the University of Tokyo, 7 Chome–3–1 Hongo, Bunkyo City, Tokyo, 113–0033, Email: s.sai914@gmail.com

1 Introduction

The implementation of a minimum wage is considered to be a common tool for improving the welfare of low-wage workers and alleviating poverty. This may be the case when the labor market is under monopsony or monopsonistic competition, where a minimum wage does not reduce employment, but in a competitive labor market, a minimum wage set above the equilibrium level will decrease employment. Therefore, whether the efficiency cost outweighs the redistribution benefits remains an empirical question. While there is a large literature on the impact of minimum wages in developed countries, there are many institutional aspects of developing economies that are different from developed countries. Firstly, because a larger share of the population is employed at minimum wage levels, a minimum wage policy is better understood as an anti-poverty policy. Secondly, as compliance may be imperfect, it is unclear to what extent minimum wages actually affect labor market outcomes. Thirdly, and most importantly, labor markets in developing countries are often segmented into formal and informal sectors, with the latter not covered by minimum wage legislation.

This study investigates the impact of an increase in minimum wages on employment in an economy where the legal coverage is incomplete. The analysis begins with a two-sector theoretical framework based on Mincer-Gramlich (Mincer, 1976; Gramlich et al., 1976) to account for a labor market that includes both formal and informal sectors. This model assumes workers are mobile across sectors, and there is no unemployment in the uncovered sector as the barrier to entry is low. This means if workers choose to be in the uncovered sector, they will be employed. On the other hand, if they choose to be in the covered sector, they may face unemployment. Workers are assumed to choose the sector by comparing expected returns. We extended the Mincer-Gramlich model by relaxing some assumptions and using comparative statics to show the following possible scenarios, depending on the elasticities of labor supply and demand: *formalization* (the uncovered sector shrinks and unemployment increases), *semi-informalization* (the uncovered sector expands and unemployment increases), and *informalization* (the uncovered sector expands and unemployment decreases).

Next, the theoretical prediction was estimated empirically, using a natural experiment from Thailand, a country in which approximately 40 percent of workers are employed in the uncovered sector. In Thailand, the minimum wage does not cover agricultural workers, domestic workers, and unpaid family workers. In 2012 and 2013, the country experienced politically motivated minimum wage hikes. During the 2011 General Election, a political party promised that it would increase the minimum wage to 300 Baht per day for all provinces and won the election. It implemented the campaign promise by increasing the minimum wages to 300 Baht in all provinces, regardless of the local economic growth. As a result, the provincial minimum wages increased by 60 percent on

average, requiring approximately 40 percent of wage earners in the covered sector to have their wages increase. Since the minimum wage increases were large, one would expect that the margin of adjustment through other channels would be more limited, increasing the magnitude of the impact on employment. Furthermore, since the amount of increase depended less on local labor market conditions, endogeneity issues could be mitigated.

The Thai Labor Force Survey from 2011 to 2015 was used as the main data set. It is a repeated cross-sectional household survey collected monthly by the National Statistics Office of Thailand. It contains individual-level data on work-related variables such as employment status, and if employed, industry, wages, and whether they identify themselves as an unpaid family worker. The final sample was restricted to individuals aged 15–60 years old.

We found that one percent increase in the minimum wage reduced the employment of individuals with primary school education in the covered sector by 0.4 percent, increased employment in the uncovered sector by 0.2 percent, and decreased unemployment. This result is consistent with the theoretical prediction of *informalization* that the minimum wage increase caused the probability of employment in the covered sector to fall by a large amount, inducing workers to migrate to the uncovered sector, and the reduction in the probability of employment was large enough that fewer individuals were willing to queue for jobs in the covered sector and instead entered the uncovered sector. Analyses by industry show that this effect was due to a reduction in employment in the manufacturing industry and an increase in the share of unpaid agricultural workers. At the intensive margin, there was no statistically significant impact on hours worked.

In addition to the employment effect, the effects on wages in the covered sector were also examined in order to confirm whether the minimum wage increase actually raised wages. As expected, the average wage in the covered sector increased following the minimum wage increased. Further, an analysis of the wage distribution showed that the density of workers in the covered sector earning below the new minimum wage decreased and the density at the minimum wage increased.

Next, the impact of minimum wages on wages in the uncovered sector was estimated, which is important because migration to the uncovered sector does not necessarily mean there is a welfare loss if wages in the uncovered sector do not decrease. However, estimating the impact on the uncovered wage in this data set was not straightforward since most of the workers in the uncovered sector were unpaid family workers and their wages were not observed. Among individuals whose wages were observed, the minimum wage hike increased the average wage. However, this result must be interpreted with caution, for while the employment analysis showed that the share of uncovered workers with observed wages was not affected by minimum wage hikes, the increase in the minimum wage also increased the share of the non-salaried part of the uncovered sector. By construction, these wages were not observed because they were unpaid family workers. Therefore, it

was difficult to assess whether an increase in labor supply suppressed wages. If workers were positively selected to have observed wages, the uncovered wage may decrease or remain unchanged.

Since 70 percent of uncovered wages were not observed, an alternative measure of welfare was adopted by examining the impact of minimum wages on the quality of employment. Using supplemental data from the Labor Force Survey to examine the changes in non-monetary employment benefits following the minimum wage increases, we found that the coverage rate of social security was reduced but there was no statistically significant impact on medical care benefits or work environment. This implies there is some welfare reduction from the minimum wage increase.

Minimum wage studies of developing countries find mixed results on employment in both the covered and uncovered sectors. While some find that minimum wages have little effect on covered employment (Lemos, 2009; Urzua and Saltiel, 2021), many find a negative impact.[1] Furthermore, studies that find a negative impact on covered employment often disagree on the effect on the uncovered sector. Some find that the uncovered sector expands (Comola and De Mello, 2011; Muravyev and Oshchepkov, 2016; Ham, 2018; Jales, 2018), while others find that it shrinks (Maloney and Nunez, 2000; Fajnzylber, 2001). Against this backdrop, this study provides a unified theoretical framework through which a minimum wage increase could either formalize or informalize the economy. While minimum wage increases raise wages in the covered sector, it also reduces the probability of employment. If individuals choose sectors by comparing the expected return in the covered sector to the certain return in the uncovered sector, when a decrease in the probability of employment dominates the positive effect from the wage increase, workers would move to the uncovered sector, and vice versa. Using a large minimum wage increase in Thailand as a natural experiment, this paper empirically found that the Thai economy *informalized*, suggesting that the reduction in the probability of employment dominated.

In addition to adding to the minimum wage literature in general, this study also contributes to the minimum wage studies in Thailand. Del Carpio et al. (2019) investigate the impact of minimum wages on covered and uncovered employment, but this is before the sharp minimum wage increases of 2012–2013. Lathapipat et al. (2016) and Samart and Kilenthong (2020) cover the 2012–2013 increases, and Lathapipat et al. (2016) find a decrease in overall employment and a small negative impact on employment in the uncovered sector. Their estimates, however, could be potentially biased due to sample selection issues.[2] Similarly, Samart and Kilenthong (2020) also find a small decrease in overall employment but pay less attention to the effects on uncovered employment. This

[1] Those studies include Maloney and Nunez (2000), Fajnzylber (2001), Comola and De Mello (2011), Muravyev and Oshchepkov (2016), Ham (2018), and Jales (2018).

[2] The main focus of the Lathapipat et al. (2016) study is to estimate the change in wage distributions. Therefore, the estimates on the uncovered sector could be biased if those with unobserved wages were dropped from the sample.

study helps to better understand the effect of minimum wages in Thailand by studying the impact of minimum wages during the large minimum wage hike and focusing on uncovered employment.

This paper is organized as follows: Section 2 describes the implementation of minimum wages in Thailand. Sections 3 and 4 present the conceptual framework and empirical data set. The results on employment and wages are presented in sections 5 and 6, and section 7 discusses non-monetary employment benefits. Section 8 concludes the paper.

2 Minimum Wages in Thailand

This section describes the implementation of minimum wages in Thailand, beginning with the coverage of minimum wage legislation, and then describing how minimum wages were determined before 2012 and how this was influenced by political events during the early 2010s.

One important characteristic of minimum wage legislation in Thailand is that it does not cover all occupations. The legal minimum wage does not cover government employees, domestic workers, agricultural workers, and unpaid family workers. Wages of government employees are determined by other legislation. Excluding government employees, uncovered workers comprise approximately 40 percent of the workers in the sample.[3]

Before 2012, minimum wages were determined by two levels of government, the Central Wage Committee and the Provincial Wage Subcommittees, with each comprised of employer, worker, and government representatives. After the Central Committee sets the general criteria for determining the minimum wage, it delegates the duty to the Provincial Subcommittees. Based on the given criteria, each Provincial Subcommittee proposes a provincial minimum wage to the Central Committee. The Central Committee reviews the proposal, decides the timing of the increase, and issues the decrees.

This system was, however, overridden temporarily after the 2011 general election. During the campaign period, Pheu Thai, one of the opposition parties, proposed that it would implement a national 300-baht minimum wage policy if it won the election which would increase the minimum wage in every province to 300 baht per day. Pheu Thai won the election and entered office in August 2011. It implemented its campaign promise by increasing the minimum wage in two steps, firstly in April 2012, and then in January 2013, with the first step increasing the average minimum wage by 39 percent and the second by 22 percent.[4] The second increase made the minimum wages of all provinces 300 baht.[5] From Figure 2, which shows a histogram of minimum wage differences one

[3]While our study defined the minimum wage coverage based on the legal coverage, several studies have also used coverage based on social security as a proxy for minimum wage coverage (Maloney and Nunez, 2000; Fajnzylber, 2001; Khamis, 2013).

[4]The minimum wage decrees were issued in November 2011 and October 2012.

[5]It is possible that the government may have implemented the 300-baht minimum wage policy by

quarter before and after the increases, we can see that most of the increases were around 55–60 percent and, despite their large scale, this policy shift was not expected before the election campaign that formed the new government. Figure A1 shows the Google interest index of the 300-baht minimum wage policy over time and while it is zero before July 2011, it peaks twice around the time of the two increases.

These increases greatly affected the Thai wage distribution. Before 2012, minimum wage increases were gradual and binding for only about 20 percent of workers, but in 2012 and 2013, the increases affected about 40 percent of workers in the covered sector (Figure A2). Such a drastic increase would limit firms' margin of adjustment through other channels, resulting in a potentially more discernable effect of minimum wages on employment than with most minimum wage increases in the literature.

3 A Two-Sector Model

This section offers a conceptual framework for analyzing the impact of an increase in the minimum wage in an economy where a portion of the labor force is not covered by the minimum wage legislation. Beginning with a review of the literature on partial coverage models, the paper then relaxes some assumptions of the Mincer-Gramlich model and uses comparative statics to show how the minimum wage increase affects employment and wages in both the covered and uncovered sectors.

Theoretical development of the impact of minimum wages on employment in economies with two distinct sectors originated with rural-urban migration model (Harris and Todaro, 1970), partial equilibrium models (Welch, 1974; Mincer, 1976; Gramlich et al., 1976; Brown et al., 1982), and job search models within a general equilibrium framework (Acemoglu, 2001), all of which typically consider economies with one sector not covered by minimum wage legislation. Adopting the general equilibrium framework, Harris and Todaro (1970) predict that when the minimum wage increases in the covered sector, some uncovered workers become more attracted to the covered sector and so production in the uncovered sector drops and the price of uncovered goods rises relative to that of covered goods. Consequently, the supply of covered goods drops, and the demand for labor is reduced. They conclude that minimum wage increases reduce employment in both covered and uncovered sectors.

Unlike the Harris-Todaro model, Welch (1974), Mincer (1976) and Gramlich et al. (1976) assumes minimum wage increase reduces labor demand in the covered sector. Welch (1974) predicts that, following a minimum wage increase, workers from the covered

directly influencing the Central Wage Committee, since prior to Decree 7, which enabled the 300-baht minimum wage in all provinces, Provincial Wage Sub-committees were mentioned in the accompanying documents of all Decrees as the relevant body proposing the minimum wages. However, Decree 7 makes no reference to the Provincial subcommittees, though Decrees 8 and 9 released in 2017 and 2018 again refer to the provincial subcommittees.

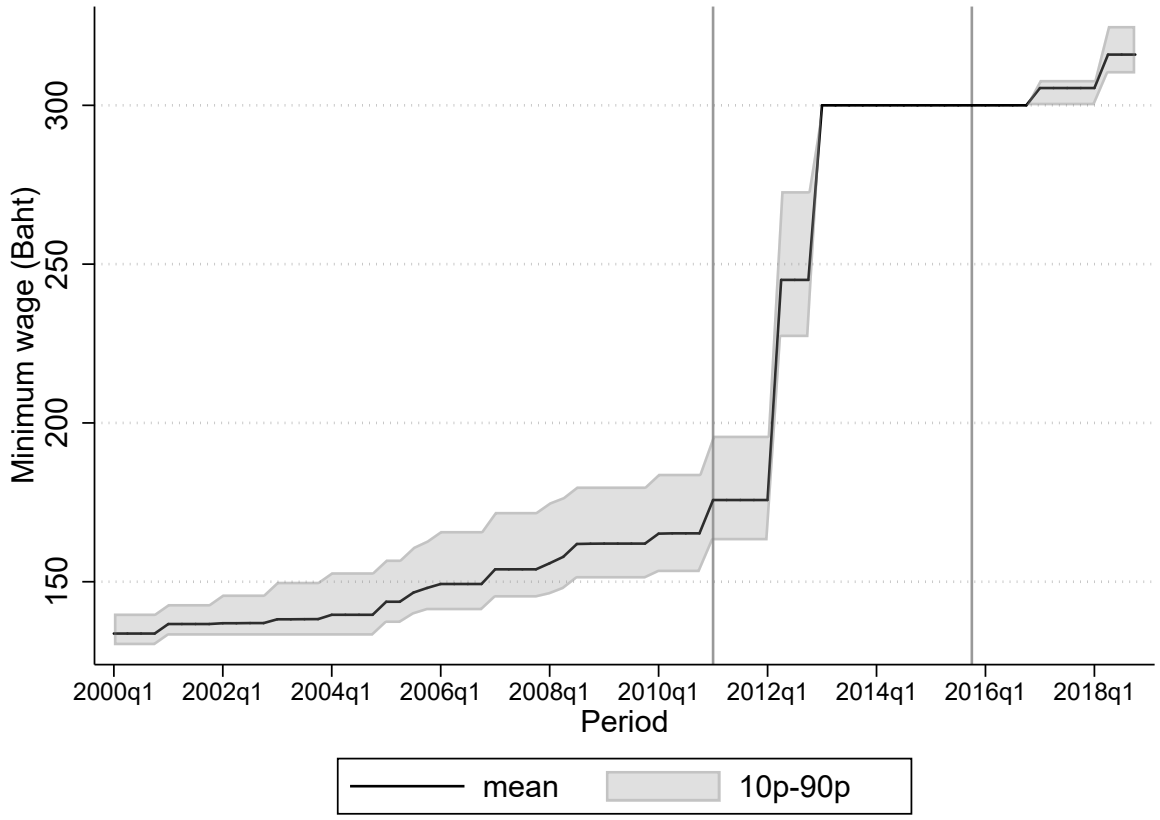

Figure 1: Minimum wages over time, Thailand (2000-2018)

Notes: This figure shows the time series of nominal provincial minimum wages over time. The solid line represents the national average and the grey area represents the 10th to 90th percentiles. The two vertical lines at 2011q1 and 2015q4 delineate the sample period used in this study.
Source: Minimum Wage Decrees, Ministry of Labor, Thailand

sector migrate to the uncovered sector and there is no unemployment. Mincer (1976) and Gramlich et al. (1976), allowing for unemployment in the covered sector and assuming minimum wage increase always increases unemployment, predict that whether the uncovered sector expands or shrinks depends on the labor demand elasticity. In these models, the uncovered sector is assumed to have a low barrier to entry, and there is no unemployment in the uncovered sector.

On the other hand, Acemoglu (2001) uses a job search model to examine the impact of minimum wages on the composition of good and bad jobs. Good jobs are those that are more capital intensive and have higher pay. Unlike Welch (1974), Mincer (1976), and Gramlich et al. (1976), this model assumes that the minimum wage is binding only for bad jobs. According to the model, minimum wage increase raises the value of being unemployed, employers of bad jobs have to pay more to fill the vacancy, making them less profitable, resulting in fewer bad jobs. Moreover, if an endogenous search effort is assumed, an increase in the minimum wage can also reduce unemployment because it

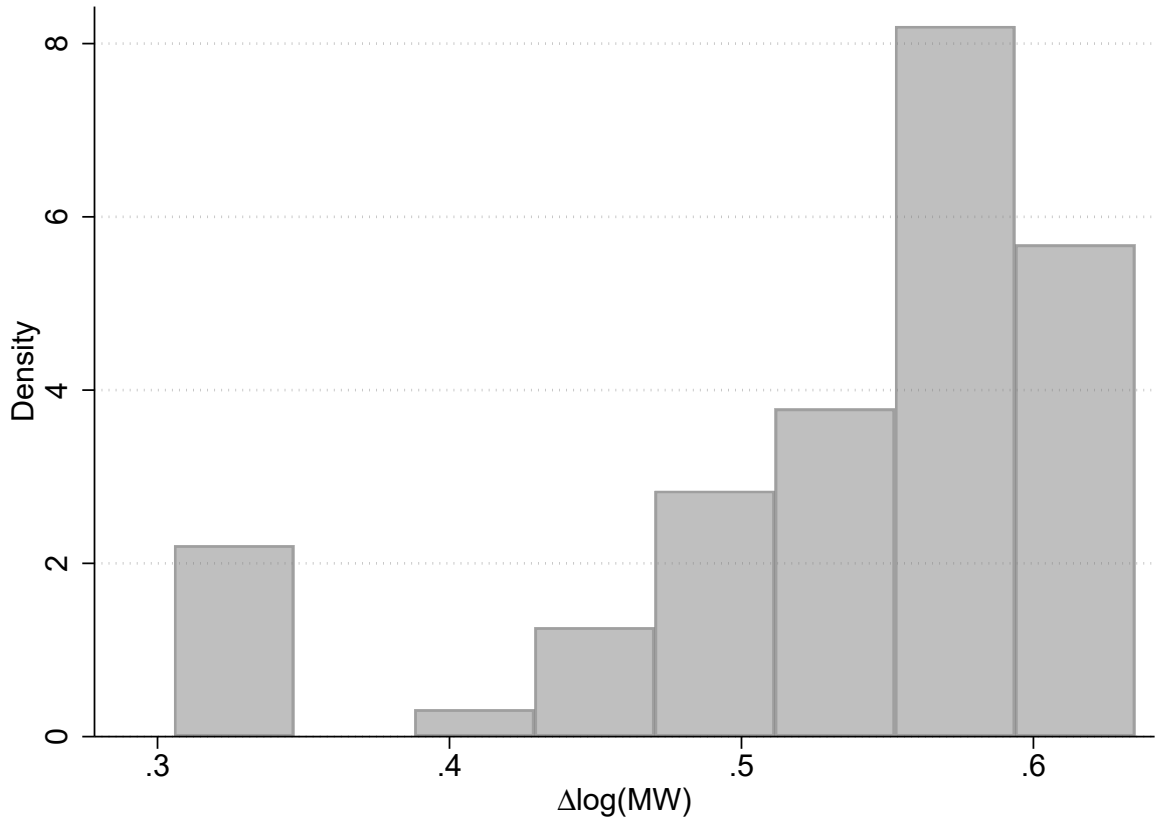

Figure 2: Minimum wage increase

Notes: This figure shows the histogram of the differences in the log of provincial minimum wages between 2012q1 and 2013q2. Minimum wages are measured in nominal Thai baht.
Source: Minimum Wage Decrees, Ministry of Labor, Thailand

encourages workers to search more. In contrast to the literature, however, in the Thai context, the minimum wage binds for the jobs with higher pay, that is the good jobs, not the bad ones. Another reason why an extension of Acemoglu (2001) may not be useful for examining Thailand is that an underlying assumption of Acemoglu's model is that there is friction in both sectors. However, the Thai uncovered sector is mostly comprised of unpaid family workers in which there is likely to be little search friction.

Against this backdrop, this section considers a partial equilibrium model based on Mincer (1976) and Gramlich et al. (1976), showing that with the assumption of a positive impact on unemployment relaxed, unemployment may also decrease within this simple partial equilibrium framework.

Suppose there is an economy where the minimum wage is imposed only on one sector. Workers are mobile across sectors and choose between an uncertain covered job and certain employment in the uncovered sector. In the covered sector, jobs are allocated randomly and workers may face unemployment. On the other hand, there is no unemployment in the uncovered sector.

Let the probability of getting a job in the covered sector be

$$P = \frac{D_c(w_m)}{D_c(w_m) + U}\,, \tag{1}$$

where w_m is the minimum wage, D_c the labor demand function in the covered sector, U unemployment, and $D_c(w_m) > 0$ and $U > 0$. Equation (1) assumes there is a complete turn-over in the covered sector.

Suppose there are no unemployment benefits and workers are risk neutral.[6] In equilibrium, the expected return in the covered sector must equal the return from working in the uncovered sector; that is,

$$Pw_m = w_u, \tag{2}$$

where w_u is the uncovered wage. When $S(\cdot)$ is the labor supply function, $S(w_u) = S(Pw_m)$ individuals supply their labor. Then,

$$S(w_u) = D_c(w_m) + D_u(w_u) + U, \tag{3}$$

where D_u is the uncovered labor demand.

Equations (1), (2), and (3) characterize the equilibrium of the partial coverage model. Intuitively, a minimum wage increase raises the return to employment in the covered sector, w_m, but reduces the probability of employment, P. Therefore, individuals may not necessarily prefer the covered sector to the uncovered sector. As a result, the uncovered sector may expand or shrink depending on the change in expected wages. Moreover, since $0 < P < 1$ by construction, equation (2) also entails $w_m > w_u$.[7]

Let η_c and η_u be labor demand elasticities in the covered and uncovered sectors and ϵ labor supply elasticity. Furthermore, assume $\eta_c \leq 0$, $\eta_u \leq 0$ and $\epsilon \geq 0$. For simplicity, consider only cases in which the labor supply is fixed, that is $\epsilon = 0$.[8]

Proposition 3.1. *Let $c = \frac{D_c}{D_u}$. When the labor supply is perfectly inelastic ($\epsilon = 0$) and labor demand elasticities in the covered and the uncovered sectors are negative and equal to one another ($\eta_c = \eta_u = \eta < 0$):*

1. *if labor demand is inelastic ($-1 \leq \eta < 0$), then the probability of employment in the covered sector decreases by a sufficiently small amount ($\frac{\partial P}{\partial w_m} \geq -\frac{P}{w_m}$), unemployment increases ($\frac{\partial U}{\partial w_m} > 0$), and wages in the uncovered sector increase ($\frac{\partial w_u}{\partial w_m} \geq 0$), a process of **formalization**;*

[6] Incorporating some degree of risk aversion does not change the implications of the model. See Appendix A.5 for an exercise that relaxes the risk neutrality assumption.

[7] The consequence of this is innocuous in the Thai context, where employment in the covered sector comes with higher average wages and fringe benefits such as employment insurance. To incorporate the possibility that $w_u > w_m$, it is necessary to allow for some degree of risk aversion.

[8] See Appendix A.4 for the case with endogenous labor supply.

2. *if labor demand is somewhat elastic* ($-\frac{1+c}{1-P} \leq \eta < -1$)*, then the probability of employment in the covered sector decreases more but is still bounded from below* ($-\frac{P}{w_m}(1+c) \leq \frac{\partial P}{\partial w_m} < -\frac{P}{w_m}$)*, unemployment increases* ($\frac{\partial U}{\partial w_m} \geq 0$)*, and wages in the uncovered sector decrease* ($\frac{\partial w_u}{\partial w_m} < 0$)*, a process of* ***semi-informalization****;*

3. *if labor demand is sufficiently elastic* ($\eta < -\frac{1+c}{1-P}$)*, then the probability of employment in the covered sector decreases by a large amount* ($\frac{\partial P}{\partial w_m} < -\frac{P}{w_m}(1+c)$)*, unemployment decreases* ($\frac{\partial U}{\partial w_m} < 0$)*, and wages in the uncovered sector decrease* ($\frac{\partial w_u}{\partial w_m} < 0$)*, a process of* ***informalization****.*

Proof. See Appendix A. □

Proposition 3.1 implies that whether formalization, semi-informalization, or informalization occurs will depend on the elasticity of demand for labor, which also determines the change in probability of employment. Formalization, a process in which the uncovered sector shrinks and unemployment increases, occurs when the demand elasticity for labor is small in absolute value. As the probability of employment drops by a small amount, the effect of the wage increase dominates the reduction in the probability of employment, making the covered sector more attractive. As a result, workers in the uncovered sector move to the covered sector to look for jobs.[9] On the other hand, informalization, whereby the uncovered sector expands and overall unemployment decreases, occurs when the probability of employment in the covered sector drops by a sufficiently large amount so that fewer individuals are willing to queue in the covered sector, causing unemployment to decrease. Semi-informalization, in which the uncovered sector expands but unemployment increases, is also possible when the probability of employment drops enough for workers to move to the uncovered sector but not enough to reduce the number of people queueing for jobs in the covered sector.

Next, we consider the case in which the demand for labor in the covered sector does not respond to an increase in minimum wages, which would correspond to monopsony or monopsonistic competition in the covered labor market.

Proposition 3.2. *When the labor supply and the labor demand in the covered sector are perfectly inelastic* ($\epsilon = 0$ *and* $\eta_c = 0$)*, for any negative uncovered labor demand elasticity* ($\eta_u < 0$)*, the probability of employment in the covered sector decreases by a sufficiently small amount* ($\frac{\partial P}{\partial w_m} > -\frac{P}{w_m}$)*, unemployment increases* ($\frac{\partial U}{\partial w_m} > 0$)*, and wages in the uncovered sector increases* ($\frac{\partial w_u}{\partial w_m} > 0$)*, a process of* ***formalization****.*

Proof. See Appendix A. □

[9] One implicit assumption is that workers are randomly assigned to jobs and that both the incumbents and the new entrants are equally likely to obtain the covered jobs.

Intuitively, when there is monopsony or monopsonistic competition in the labor market of the covered sector, demand for labor in the covered sector does not change even when the minimum wage increases, so more people queue for jobs in the sector, resulting in higher unemployment. However, despite the higher unemployment, the probability of employment does not fall substantially, so the benefits from higher wages still dominate and workers migrate to the covered sector. Meanwhile, in the uncovered sector, the lower labor supply causes wages to increase.

Finally, a special case is considered in which labor demand in the uncovered sector is not responsive to a change in wages.

Proposition 3.3. *When labor supply and demand in the uncovered sector are perfectly inelastic ($\epsilon = 0$ and $\eta_u = 0$):*

1. *if labor demand in the covered sector is inelastic ($-1 \leq \eta_c < 0$), then the probability of employment in the covered sector decreases by a sufficiently small amount ($\frac{\partial P}{\partial w_m} \geq -\frac{P}{w_m}$), unemployment increases ($\frac{\partial U}{\partial w_m} > 0$), and wages in the uncovered sector increase ($\frac{\partial w_u}{\partial w_m} \geq 0$), a process of **formalization**;*

2. *if labor demand in the covered sector is elastic ($\eta_c < -1$), then the probability of employment in the covered sector decreases by a sufficiently large amount ($\frac{\partial P}{\partial w_m} < -\frac{P}{w_m}$), unemployment increases ($\frac{\partial U}{\partial w_m} > 0$), and wages in the uncovered sector decrease ($\frac{\partial w_u}{\partial w_m} < 0$), a process of **semi-informalization**.*

Proof. See Appendix A. □

In this situation, although labor demand in the uncovered sector does not respond directly to an increase in the minimum wage, wages in the uncovered sector are still affected indirectly because uncovered wages and expected wages in the covered sector must be equal. When labor demand in the covered sector is more elastic, the probability of employment falls substantially so that the expected wage in the covered sector decreases. Therefore, in equilibrium, the uncovered wage also decreases.

As we have seen, this model reconciles the predictions of two strands of literature. The literature on minimum wages often assumes that workers move from the covered to the uncovered sector (Welch, 1974). On the other hand, development literature such as Harris and Todaro (1970) usually conclude that employment decreases in both the covered and uncovered sector. In contrast to the conflicting results of these two literatures, the version of the two-sector model presented here shows that both cases are possible. If the effect of the wage hike exceeds the effect of the decline in employment probability, workers are attracted to the covered sector, and vice versa.

This simple framework also highlights the need to investigate the economy-wide impact of minimum wages in developing countries because examining the impact of minimum

wages on only the covered sector does not provide a complete picture. Because of the presence of an uncovered sector, not only the sector the minimum wage is imposed on is affected, but the size of the uncovered sector and unemployment may also change.

This framework also provides an alternative explanation for the lighthouse effect which occurs when minimum wages in the covered sector also appear to raise wages in the uncovered sector. Many empirical studies support the existence of the lighthouse effect (Maloney and Nunez, 2000; Boeri et al., 2011), and some suggest that wages in the uncovered sector increase because the minimum wage serves as a reference for wage bargaining in the uncovered sector (Cunningham, 2007). However, other studies argue that any increase due to wage referencing should not exceed the direct effect of the labor supply shock. For instance, Fajnzylber (2001) interprets an increase in uncovered wages as the result of employers substituting covered workers with uncovered workers.[10] Similarly, Boeri et al. (2011), assuming a heterogeneous labor force, show that a minimum wage increase makes workers with relatively lower skills move from the uncovered to the covered sector, resulting in workers with higher skills in the uncovered sector. Similar to these studies, the above conceptual framework argues in favor of a wage increase due to a labor supply shock and shows that the uncovered wage can also increase even with a homogeneous labor force when a process of formalization occurs.

This model of a minimum wage increase with partial coverage may also be relevant in developed economies that have been experiencing a growth in online freelance jobs. A survey conducted by Upwork, an American freelancing platform, estimates that 56.7 million Americans freelanced in 2018, an increase of 6.5 percent from 2014 (Upwork, 2018). Since freelance jobs are generally not protected by a minimum wage, an increase in the minimum wage may also create downward pressure on the freelance piece rate.

4 Data

This section describes the data sets used, which include the Labor Force Survey (LFS) as the main data set and the Informal Employment Survey (IES), a supplemental survey of the LFS that was used for supplementary analysis.

4.1 Labor Force Survey

The main data set for this study was the LFS, a household survey collected monthly and released quarterly by the National Statistics Office of Thailand. It contains individual-level data on work-related variables. Since the large minimum wage increases took place in 2012 and 2013, the analysis sample was restricted to the period 2011 to 2015.

[10] However, since the minimum wage coverage in Thailand is determined by industry, I did not consider the substitution between covered and uncovered workers.

Additionally, the sample was restricted to individuals aged 15-60 since individuals younger than 15 were not asked work-related questions and 60 is the approximate retirement age in Thailand. Excluded from the example were public sector workers[11] and those who reported being enrolled in school. Table A5 reports the difference in baseline characteristics between the original data set and the analysis sample. Whereas studies on minimum wages in OECD countries tend to focus on youth (Neumark and Wascher, 1992; Pereira, 2003; Yuen, 2003; Hyslop and Stillman, 2007; Kalenkoski and Lacombe, 2008; Allegretto et al., 2011), prime-age workers receiving the minimum wage are prevalent in the Thai labor force (Table A1) and so both teenagers and prime-age individuals are included in this analysis.

In order to estimate the effect of a minimum wage increase by the human capital of workers, the sample was divided into four groups by a skill proxy, the highest level of educational attainment. Minimum wage workers were concentrated among individuals with less than primary school education, and this group of workers constituted more than 50 percent of the workforce. Panel A of Table 1 shows the summary statistics of the demographic variables, and the average age of individuals with a primary education or less is 45 years old, older than those with more education.

The theoretical model implies four main employment statuses: covered employment, uncovered employment, unemployment, and not in the labor force. Individuals are unemployed if they have been looking for work in the past 30 days before the time of the survey or if they are ready to work if a job is available. Individuals not in the labor force include those not ready to work during the seven days prior to the survey, seasonal workers, and business owners.[12] Other individuals are classified into either covered or uncovered employment,[13] with workers classified uncovered if they identify themselves as unpaid family workers or if they belong to the agricultural[14] or domestic service industries.

The daily wage variable was constructed from details on how workers were paid and their wage data. In the questionnaire, individuals were first asked if they received the wage hourly, daily, weekly, or monthly, and then they were asked the amount. Using the

[11]The rationale for dropping public sector workers is that their wages are not subject to the minimum wage legislation and are determined outside the market.

[12]Business owners were classified as not in the labor force because although they are employed, they are not participating in the labor market as workers, and conceptually, the uncovered sector is characterized by its lower barrier to entry.

[13]At baseline, the minimum wage coverage based on the legal coverage was used. However, there are also other studies that employ the coverage definition based on the social security coverage as a proxy for minimum wage coverage (Maloney and Nunez, 2000; Fajnzylber, 2001; Khamis, 2013). Our results in sections 5 and 7 implied these two definitions are closely related.

[14]During the sample period, agricultural workers who, besides farming activities, were also involved in manufacturing activities on the farm or full-time agricultural workers were also covered by the minimum wage legislation. However, based on the LFS alone, the difference between seasonal or full-time agricultural workers could not be distinguished. Nevertheless, since over 70 percent of workers in the agricultural industry are unpaid family workers, for this study, all workers in the agricultural industry were classified as uncovered workers. See Table A6 for the industry composition of the uncovered sector.

rule specified in the manual[15] published by the Central Wage Committee, the daily wage was calculated as follows:

$$\text{Daily wage} = \begin{cases} wage \times 8, & \text{for hourly-wage earners} \\ wage, & \text{for daily-wage earners} \\ wage/7, & \text{for weekly-wage earners} \\ wage/30, & \text{for monthly-wage earners} \end{cases}$$

Panel B of Table 1 shows the share of each employment status by minimum wage coverage and availability of wage data. By construction, the unemployed and those out of the labor force do not have wage data. Excluding those individuals, as shown in Panel C, wage data was missing for most of the workers in the uncovered sector since they identified themselves as unpaid family workers.

Panel D shows the industry composition of workers, and most employed individuals with primary education or less were employed in agriculture, trade services, or manufacturing.

4.2 Informal Employment Survey

In addition to the LFS data, a supplemental survey of the LFS called the Informal Employment Survey was used for supplementary analysis. The Informal Employment Survey is conducted annually in the third quarter of the LFS, covering all LFS respondents, and containing information on social security coverage, work safety, and self-reported problems at work. Summary statistics of this data set are reported in Table 2, and Panel A confirms that the demographic characteristics of individuals in this data set are similar to those in the LFS.

Table 2 also shows that low-skilled individuals appeared to have a lower quality of employment (Panel B), as they were less likely to be covered by social security or to have had their medical fees paid for in the past year. They were also more likely to be injured at work and to have reported unsafe work environment.

4.3 Provincial Minimum Wage Data

Provincial minimum wage data was obtained from the minimum wage decrees issued by the Wage Committee. The decrees have information on the implementation date and

[15] According to the manual for labor inspectors published in 2013, employers must pay daily-wage workers the daily minimum wage rate even if they work less than eight hours. If workers are paid monthly, employers must pay 30 days of minimum wages. However, as the committee does not specify the calculation rule for those paid weekly, we divided the weekly salary by seven to obtain a daily rate to be consistent with workers paid monthly and daily. This should not create substantial measurement error, since workers paid weekly comprise less than one percent of the sample (Table 1).

Table 1: Summary statistics of the Labor Force Survey

	(1) Primary or less		(2) Lower secondary		(3) Upper secondary		(4) College or above	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Panel A: Demographic variables								
Male	0.45	(0.50)	0.53	(0.50)	0.50	(0.50)	0.42	(0.49)
Age	45.39	(10.55)	33.68	(11.38)	35.64	(10.46)	38.16	(10.45)
Married	0.77	(0.42)	0.67	(0.47)	0.68	(0.47)	0.61	(0.49)
Panel B: Employment status by minimum wage coverage and wage observability								
Covered with wage	0.18	(0.38)	0.30	(0.46)	0.34	(0.47)	0.57	(0.49)
Covered without wage	0.02	(0.14)	0.02	(0.13)	0.01	(0.12)	0.01	(0.09)
Uncovered with wage	0.05	(0.21)	0.03	(0.16)	0.01	(0.11)	0.00	(0.06)
Uncovered without wage	0.23	(0.42)	0.22	(0.42)	0.19	(0.39)	0.10	(0.31)
Not in labor force	0.53	(0.50)	0.42	(0.49)	0.44	(0.50)	0.30	(0.46)
Unemployed	0.00	(0.05)	0.01	(0.09)	0.01	(0.09)	0.01	(0.11)
Panel C: Composition of uncovered sector								
Worker	0.27	(0.45)	0.18	(0.38)	0.12	(0.32)	0.05	(0.22)
Unpaid family worker	0.73	(0.45)	0.82	(0.38)	0.88	(0.32)	0.95	(0.22)
Panel D: Industry								
Agriculture	0.45	(0.50)	0.28	(0.45)	0.19	(0.39)	0.04	(0.20)
Mining	0.00	(0.05)	0.00	(0.05)	0.00	(0.05)	0.00	(0.05)
Manufacturing	0.16	(0.36)	0.24	(0.43)	0.26	(0.44)	0.16	(0.36)
Utilities	0.00	(0.05)	0.01	(0.07)	0.01	(0.10)	0.02	(0.14)
Trade & construction	0.32	(0.47)	0.38	(0.48)	0.39	(0.49)	0.28	(0.45)
Transport & social services	0.03	(0.18)	0.05	(0.22)	0.06	(0.23)	0.05	(0.23)
Business Services	0.00	(0.05)	0.01	(0.07)	0.02	(0.12)	0.07	(0.25)
Education & healthcare	0.02	(0.12)	0.02	(0.15)	0.07	(0.25)	0.38	(0.48)
Domestic service	0.02	(0.12)	0.01	(0.09)	0.01	(0.08)	0.00	(0.03)
Panel E: Hours worked per week								
Hours at main job	44.71	(13.48)	45.86	(13.30)	46.66	(12.75)	43.10	(10.87)
Panel F: Wage-related variables								
Daily wage (Baht)	277.66	(385.16)	303.09	(343.40)	347.25	(689.86)	725.69	(963.87)
MW worker (in 2011q1)	0.46	(0.50)	0.41	(0.49)	0.27	(0.44)	0.05	(0.22)
Hourly payment (share)	0.00	(0.05)	0.00	(0.05)	0.00	(0.04)	0.00	(0.03)
Daily payment (share)	0.70	(0.46)	0.51	(0.50)	0.30	(0.46)	0.04	(0.18)
Weekly payment (share)	0.00	(0.07)	0.00	(0.07)	0.00	(0.05)	0.00	(0.02)
Monthly payment (share)	0.29	(0.45)	0.48	(0.50)	0.69	(0.46)	0.96	(0.19)
Observations	1,295,456		394,202		366,903		420,889	

Notes: The table shows summary statistics of the sample by highest level of educational attainment. MW worker (in 2011q1) refers to the share of workers whose wage is below 1.05 of the prevailing minimum wage in the first quarter of 2011. Summary statistics of Panels A and B were obtained using the full sample whereas those in Panels D–E were computed conditional on being a worker or an unpaid family worker and those in Panel F were computed conditional on having observed wages.
Source: LFS 2011–2015

the new minimum wage imposed. For this analysis, the implementation month was used, as all new legal minimum wage decrees were implemented on the first day of the month throughout the sample period.

Table 2: Summary Statistics of the Informal Employment Survey

	(1) Primary or less		(2) Lower secondary		(3) Upper secondary		(4) College or above	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Panel A: Demographic variables								
Male (share)	0.45	(0.50)	0.52	(0.50)	0.50	(0.50)	0.42	(0.49)
Age	45.33	(10.56)	33.54	(11.32)	35.55	(10.41)	38.06	(10.38)
Married (share)	0.77	(0.42)	0.67	(0.47)	0.69	(0.46)	0.62	(0.49)
Panel B: Quality of employment								
Covered by social security	0.10	(0.30)	0.21	(0.41)	0.29	(0.45)	0.57	(0.50)
Paid medical fee	0.04	(0.20)	0.05	(0.23)	0.06	(0.25)	0.08	(0.27)
Unsafe work environment	0.09	(0.29)	0.08	(0.27)	0.06	(0.24)	0.02	(0.14)
Injury from work	0.17	(0.38)	0.13	(0.33)	0.10	(0.30)	0.04	(0.20)
Little rest period	0.00	(0.07)	0.01	(0.07)	0.01	(0.07)	0.00	(0.05)
Observations	376,090		114,937		106,883		121,814	

Notes: This table shows the summary statistics of the Informal Employment Survey 2011–2015 by highest level of educational attainment. Panel A reports the summary statistics of demographic variables, whereas Panel B reports summary statistics of variables related to employment quality. Workers are covered by social security if they are government employees, regular employees, or report having registered with the Social Security scheme. Unsafe work environment equals one if workers state a lack of safety from chemical components or mechanical equipment or danger to their vision or hearing as their main problem when asked about workplace safety. Injury from work equals one if workers have been injured from work within the past 12 months. Paid medical fees equal one if workers have been injured and the medical expenses were covered by the employer, health insurance company, or other types of social security, and zero if workers have been injured and the medical expenses were covered by themselves, family, friends, or other methods. Little rest period is equal to one if workers state little rest period as their main problem when asked about work characteristics.
Source: Informal Employment Survey 2011–2015

In addition to the LFS and the Informal Employment Survey, other public data sets were used to supply additional control variables such as the gross provincial product per capita, the intra-governmental transfer per capita, and the average provincial household debt. These data sources are described in Appendix C.

5 Impact on Employment

This section examines the impact of minimum wages on employment, first describing the empirical strategy, then discussing the results, and lastly checking the robustness of the results.

5.1 Empirical Strategy

Empirical studies on minimum wages usually begin by examining the impact of the implementation or increase in the minimum wage on wages. However, this task was not straightforward given that wage data was not reported for over 70 percent of workers in the uncovered sector. Those with missing wage data included unpaid family workers, most of which from the agricultural industry, while those with reported wages were hired labor in agricultural and domestic service industries (Table A6). Dropping observations with missing wage data also posed a problem since selection into the salaried part of the uncovered sector was likely to be non-random. To make the sample in the employment analysis consistent with that of the wage analysis, six employment statuses were considered: covered employment with wage observed, covered employment with wage unobserved, uncovered employment with wage observed, uncovered employment with wage unobserved, unemployment, and not in the labor force.

The sample was also divided into four groups according to the skill proxy, highest level of educational attainment: primary school education or less, lower secondary, upper secondary, and finally, college or higher.[16] The baseline estimation equation is as follows:

$$Y_{ipt}^{j} = \beta^{j} \log(MW_{pt}) + X_{it}\gamma + \mu_p + \rho_t + u_{pit}^{j}, \tag{4}$$

where Y_{ipt}^{j} equals 1 if individual i who resides in province p belongs to employment category j at time t. MW_{pt} is the minimum wage of province p at time t. Vector X_{it} includes individual human capital characteristics such as male and marriage dummy variables, age and square of age. Gross provincial product per capita was also included in X_{it} to capture province-specific labor demand shocks. μ_p and ρ_t correspond to time and province fixed effects.

5.2 Results and Discussion

Minimum wages were found to affect the employment and unemployment rate of individuals with primary school education or lower in both the covered and uncovered sectors. A one percent increase in the minimum wage reduced employment in the covered sector by 0.4 percent. Many of these individuals appeared to migrate to the uncovered sector, as a one percent increase in the minimum wage increased employment in the uncovered sector without wage data by 0.2 percent, and the unemployment rate also decreased. The effect on individuals not in the labor force was positive but not statistically significant (Table 3, Panel A).

[16] Another reason to divide the sample by educational attainment is that during 2011–2015, Thailand also went through several wage reforms. A notable intervention was when the government suggested a wage floor for college graduates. However, it remained only as a suggestion and was not enforced in the private sector.

Table 3: Employment effects by level of educational attainment

	(1) Covered with wage	(2) Covered no wage	(3) Uncovered with wage	(4) Uncovered no wage	(5) Unemployed	(6) NILF
Panel A: Primary or lower						
log(MW)	-0.073***	0.006	-0.000	0.045**	-0.004**	0.026
	(0.018)	(0.010)	(0.014)	(0.021)	(0.002)	(0.024)
Mean of dep. var.	0.178	0.019	0.047	0.227	0.003	0.526
Observations	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456
Adjusted R^2	0.120	0.010	0.017	0.077	0.006	0.069
Panel B: Lower-secondary						
log(MW)	0.012	-0.011	-0.018**	-0.028	-0.008**	0.053*
	(0.038)	(0.008)	(0.007)	(0.027)	(0.004)	(0.027)
Mean of dep. var.	0.304	0.018	0.026	0.222	0.008	0.423
Observations	394,202	394,202	394,202	394,202	394,202	394,202
Adjusted R^2	0.129	0.008	0.009	0.072	0.010	0.092
Panel C: Upper-secondary						
log(MW)	0.024	-0.006	0.002	-0.036*	-0.008	0.024
	(0.029)	(0.007)	(0.005)	(0.020)	(0.005)	(0.027)
Mean of dep. var.	0.336	0.014	0.013	0.186	0.008	0.442
Observations	366,903	366,903	366,903	366,903	366,903	366,903
Adjusted R^2	0.121	0.005	0.005	0.052	0.013	0.094
Panel D: College or higher						
log(MW)	-0.012	-0.019**	0.003	0.011	-0.002	0.019
	(0.024)	(0.008)	(0.003)	(0.012)	(0.008)	(0.018)
Mean of dep. var.	0.571	0.008	0.004	0.105	0.012	0.300
Observations	420,889	420,889	420,889	420,889	420,889	420,889
Adjusted R^2	0.026	0.003	0.003	0.029	0.033	0.035

Notes: The table shows the estimates of minimum wages on employment status by level of educational attainment: primary school or lower, lower-secondary school, upper-secondary school, and college or higher. All specifications include province and time fixed effects. Control variables include log of gross provincial product per capita, male dummy, marriage dummy, age, and square of age. Robust standard errors are clustered by province and shown in parenthesis. Significance levels are $^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$.
Source: LFS 2011–2015

As expected, the impact of the increase in minimum wages also varied across individuals with different levels of educational attainment. While those with a secondary school education were not displaced in the covered sector, they were crowded out in the uncovered sector, with the share of uncovered workers with observed wage data decreasing and those not in the labor force increasing (Table 3, Panel B). This suggests that some primary-school educated workers replaced hired labor as unpaid family workers. On the other hand, there was no statistically significant impact on upper secondary school or college graduates possessing an even higher level of educational attainment.

In addition to the impact on employment at the extensive margin, we also considered the effect on employment at the intensive margin but found no statistically significant change in hours worked by workers with primary school education or less (Table 4).

Table 4: Effect of minimum wage increase on hours worked by level of educational attainment

	(1)	(2)	(3)	(4)
	Hours worked/week			
	Covered with wage	Covered no wage	Uncovered with wage	Uncovered no wage
Panel A: Primary or lower				
$\log(MW)$	1.562	3.067	1.297	-3.610
	(1.304)	(2.626)	(3.439)	(2.828)
Mean of dep. var.	48.601	46.798	44.895	41.438
Observations	229,171	24,780	60,155	292,133
Adjusted R^2	0.091	0.098	0.109	0.190
Panel B: Lower-secondary				
$\log(MW)$	0.093	2.514	-0.824	-4.107
	(1.513)	(5.201)	(3.939)	(2.936)
Mean of dep. var.	49.237	47.131	43.985	41.375
Observations	118,917	6,954	10,062	87,151
Adjusted R^2	0.104	0.083	0.114	0.207
Panel C: Upper-secondary				
$\log(MW)$	1.093	6.909	5.584	-4.617
	(1.447)	(4.348)	(6.366)	(2.814)
Mean of dep. var.	48.550	46.718	44.809	43.384
Observations	122,739	4,992	4,775	68,196
Adjusted R^2	0.137	0.087	0.132	0.187
Panel D: College or higher				
$\log(MW)$	1.102	-11.664**	-7.237	0.122
	(0.871)	(5.559)	(5.711)	(2.069)
Mean of dep. var.	42.266	43.848	45.774	47.452
Observations	238,184	3,439	1,598	44,094
Adjusted R^2	0.212	0.083	0.070	0.135

Notes: The table shows the impact of the minimum wage increase on hours worked per week across sectors. All specifications include province and time-fixed effects. Control variables include log of gross provincial product per capita, male dummy, marriage dummy, age, and square of age. Robust standard errors are clustered by province and shown in parenthesis. Significance levels are $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.
Source: LFS 2011–2015

In order to offer a tangible image of the disemployment effect and migration toward the uncovered sector, the employment impact by industry was examined, and the results suggest that workers migrated from manufacturing to agriculture, as the share of individuals in manufacturing with observed wages fell by 4.3 percentage points while the share of individuals in agriculture with unobserved wages increased by 4.9 percentage points for one percent increase in minimum wage (Table 5).

To sum up, the increase in the minimum wage reduced the covered employment of individuals with primary school education or less, as well as the number of people looking for jobs, but their employment in the uncovered sector increased. Further, employment adjustments occurred only at the extensive margin, and estimation by industry indicates

that workers migrated from manufacturing to agriculture. As expected, there was little impact on workers with higher levels of educational attainment.

The results show that the increase in the minimum wage affected the employment composition of less-educated individuals in Thailand, which is different[17] from studies of OECD countries which have mostly found minimum wage effects among youth (Neumark and Wascher, 1992; Pereira, 2003; Yuen, 2003; Hyslop and Stillman, 2007; Kalenkoski and Lacombe, 2008; Allegretto et al., 2011). Unlike in developed countries, many adults in developing countries work at approximately the minimum wage, so instead of restricting the sample to a particular age group, developing country studies tend to examine the economy-wide impact.

The magnitude of the estimates on covered employment are similar to that of many existing studies in developing countries. For example, in Honduras, Gindling and Terrell (2007) find employment elasticity of -0.4 in large firms and Ham (2018) finds that minimum wages reduce salaried employment by an elasticity of -0.8. In Brazil, Jales (2018) finds minimum wage elasticity of about -0.2. These estimates are comparable to the estimated elasticity of about -0.4 in this study.[18] On the other hand, Lathapipat et al. (2016) cover the 300-Baht minimum wage policy and find that a one percent increase in the minimum wage reduced employment of individuals with less than secondary school education in the private sector by 2 percentage points. Assuming that the private employment rate of individuals with less than secondary school education is about 20 percent (LFS 2011–2015), this estimate translates to an employment elasticity of about -0.1. The difference in the implied elasticities can be attributed to the inclusion of individuals with higher educational attainment. Against the evidence for the negative effect on the covered sector, some studies have found a limited or positive employment effect such as Lemos (2009), Magruder (2013) and Urzua and Saltiel (2021).

Unlike in developed countries, developing countries often have a large sector not covered by minimum wage legislation. Therefore, in addition to the employment effect in the legally covered sector, studies in developing countries also estimate the effect on the size of the uncovered sector. Other studies of the uncovered sector in Thailand include Lathapipat et al. (2016) who, unlike the positive impact found in this study, find a negative and marginally significant effect on employment in the agricultural industry among individuals with less than secondary school education during 2002–2013. While the difference in the estimates could be attributed to the different sample periods and the inclusion of

[17]Appendix B examines heterogeneous employment effects by age and finds that minimum wages reduced employment in the covered sector for all age groups. The size of the estimated elasticities were also approximately the same across age groups.

[18]Del Carpio et al. (2019) study the impact of the minimum wage in Thailand in the early 2010s before the 300-Baht minimum wage policy was instituted. Using a logit model, they obtain a marginal effect of -0.2 for primary school graduates. However, since the average employment rate is not reported, employment elasticity can not be precisely computed. Nonetheless, if the employment rate did not change much between the early and late 2010s, their estimate of labor demand is more elastic than our estimates

individuals with lower-secondary education, it could also be due to the positive selection of uncovered workers in the sample. Since the main focus of Lathapipat et al. (2016) is to estimate the change in the wage distribution, the sample in the accompanying employment analysis could be constituted of only those with observed wage data. Therefore, if that is the case, their estimates would be generally comparable to the slightly negative estimate we found for the uncovered sector with observed wages in this study.

International evidence on the uncovered sector appears to be mixed. Among studies that find a negative impact on employment in the covered sector, Ham (2018), Muravyev and Oshchepkov (2016), and Jales (2018) find positive employment effects in the uncovered sector in Honduras, Russia, and Brazil. These results, however, contradict findings in Maloney and Nunez (2000) and Fajnzylber (2001) in which the uncovered sectors shrink.

These conflicting empirical findings can nonetheless be explained by the theoretical framework presented in section 3. Like Ham (2018), Muravyev and Oshchepkov (2016), and Jales (2018), the empirical results from the Thai natural experiment correspond to the theoretical case of informalization in which minimum wage expands the uncovered sector and decreases unemployment because the probability of employment decreases by a sufficiently large amount so that it dominates the positive effect from wage increase, causing individuals to stop queuing for jobs in the covered sector and instead move to the uncovered sector. The theoretical prediction also implies that the uncovered sector could shrink as in Maloney and Nunez (2000) and Fajnzylber (2001) if the wage effect dominates.

Our estimation results imply that labor demand in Thailand is sufficiently elastic for minimum wages to push workers to the uncovered sector and reduce unemployment. Marshall's rule of derived demand suggests that labor demand is more elastic if output demand is more elastic, if labor's share of total production cost is high, or if the substitution elasticity between labor and capital or intermediate inputs is high. In line with this theoretical prediction, Cengiz et al. (2019) and Harasztosi and Lindner (2019) find a negative employment effect in tradable industries. Harasztosi and Lindner (2019) find output demand elasticity is high in exporting and tradable industries but the substitution between capital and low-skilled labor varies little across industries. In 2010, Thai manufacturing and agricultural products accounted for about 80 and 20 percent of total export values, and both industries have been found to be labor intensive in Thailand(Arnold and Hewison, 2005; Kusakabe and Pearson, 2010; Kohpaiboon et al., 2012; Goto and Endo, 2014).[19]

[19]It is, however, beyond the scope of this study to rigorously recover the exact parameter estimate for the labor demand elasticity for the following reasons. Firstly, the data is not suitable for this task. Since the LFS is a household survey data, the estimate reflects the aggregate demand elasticity from many employers with different production technologies instead of only employers who are affected by the minimum wage increase. Secondly, the simple model also imposes several assumptions that may not reflect the reality. By relaxing some of these assumptions, it can be shown that the threshold for labor demand elasticity that determines which scenario occurs change. For instance, by incorporating some

5.3 Robustness Checks

This section describes the robust checks conducted on the employment of individuals with primary education or lower by analyzing the pre-trends and controlling for some time-variant province-specific variables. This is followed by an investigation as to whether other relevant policies might have been implemented by the new government at the same time as the 300-baht minimum wage policy that might have affected the results.

5.3.1 Estimating Pre-trends

A common concern when estimating the effect of a minimum wage on employment is the potential endogeneity of the minimum wage policy, as policymakers may determine the amount of the minimum wage increase by considering the local labor market conditions (Baskaya and Rubinstein, 2015; Kawaguchi and Mori, 2021). If this is the case, the assumption of exogeneity is violated and the estimates become biased. To ensure that the exogeneity assumption holds, the linear pre-trend of the minimum wage increase on employment growth rate was estimated before the increases in 2012–2013. The analysis here departs from the conventional event-study method of examining the pre-trend that includes leads and lags of the minimum wage because the two-step nature of the minimum wage hikes in April 2012 and January 2013 makes it conceptually difficult to attribute the change in employment to current, past, or future minimum wage levels. Instead, a more intuitive approach was used by regressing the provincial long-term employment growth between 2004 and 2011 on the amount of minimum wage increase between 2011 and 2015, controlling for the growth rate of the control variables between 2004 and 2011.

Figure 3 plots the relationship between the employment growth that was not explained by provincial characteristics and the amount of minimum wage increase. As there is no statistically significant correlation between the minimum wage increase amount during the time of the 300-baht minimum wage policy and the long-term employment growth rates, which implies that the amount of the increases were not determined based on trends in local employment.

5.3.2 Controlling for time-variant province-specific variables

Another threat to identification is that there may be some unobserved province-specific time-variant omitted factors that correlate with minimum wage levels. An omitted variable bias may occur if provinces with a larger minimum wage increase also have lower covered-sector or higher uncovered-sector demand for labor. Since employment of high school graduates was not affected by the minimum wage increase (Table 3), it was as-

degree of risk aversion, the threshold of demand elasticity shifts upward. This suggests that a less elastic labor demand could also induce informalization. See Appendix A.5 for an example that relaxes the risk neutrality assumption.

Figure 3: Relationship between minimum wage increase between 2011 and 2015 and employment change between 2004 and 2011

Notes: The horizontal axis shows the residuals from regressing the minimum wage growth rate between 2011 and 2015 on the change in gross provincial product per capita, male share, share of married individuals, average age, and square of average age between 2004–2011. The vertical axis is the change in the employment status of individuals with primary school education or less between 2004 and 2011 at the provincial level. Since Beungkan province did not become an administrative unit before 2012, its data was not available and hence omitted from the analysis. The coefficient and its corresponding standard error are shown in the subtitle of each figure. ($N = 76$)

sumed that labor demand shocks were identical between less-educated and more educated workers after province and time effects are removed. Then, the covered and uncovered employment rates of high school graduates were included as additional controls, and the minimum wage effects on workers with educational attainment less than primary school were re-estimated. The estimates were robust to this additional control, suggesting that the change in labor demand was not substantially correlated with the amount of the minimum wage increase (Panels A–B of Table A7).

5.3.3 Examining the Impact of Relevant Simultaneous Policies

Next, since the Pheu Thai government implemented several policies promoting the development of rural areas which could potentially conflate the effects from the minimum wage policy, we conducted an additional investigation of these policies, which included the construction and maintenance of irrigation systems, a loan deferment policy for poor

households, and a rice pledging scheme.

The first policy examined is the provision of funds to construct and maintain the irrigation system to help farmers, which could potentially conflate the effects of minimum wages by pulling workers toward agriculture. The relevance of this policy was examined by controlling for intra-government transfers per capita,[20] most of which is used to construct and maintain the local infrastructure. The estimates were robust to the inclusion of the transfers (Panel C of Table A7), suggesting that the transfers and minimum wage were not correlated.

The second policy examined is the loan deferment policy, which allowed households with loans of less than 500,000 baht to be eligible for a suspension of payments for three years. Households who wanted to participate could register from May 2012 and begin deferring from September 2012. Since minimum wage increases were first implemented in April 2012, the employment effects could possibly be contaminated by the deferment policy. As it is well-known that Thai households face financial constraints that discourage them from investment and entrepreneurial activities (Paulson and Townsend, 2004), loosening the financial constraint borne by existing borrowers in agricultural households could result in increased labor input and migration toward the industry. To address this concern, the interaction terms between the log of average household debt per household[21] in 2011 and time dummy variables were added to the estimation specification. As the estimates were robust to the inclusion of these additional controls (Panel D of Table A7), this suggests that the loan deferment policy was also not relevant to the 300-baht minimum wage policy.

Another policy that could potentially pull workers into agriculture is the Rice Pledging Scheme. Starting from November 2011, five months before the first minimum wage hike, the central government began buying rice grain from farmers above the market price. Each province would be exposed to this policy differently because of different agricultural industry concentrations. To address this issue, the interaction between the share of agricultural employment in 2011 and time dummy variables were included in the estimation equation. The effect on covered employment became less negative but still statistically different from zero, while that of the uncovered sector became more positive (Panel E of Table A7). This suggests the impact of the minimum wage increase did not disappear after controlling for the effect of the Rice Pledging Scheme, and the estimates here serve as lower and upper bounds of the baseline estimates.

[20] Intra-governmental transfer data was obtained from the Budget Bureau of Thailand, and the provincial population data from the National Statistics Office. See details on the construction of the per capita variable in Appendix C.

[21] Average debt per household is released by the National Statistics Office at provincial level annually.

Table 5: Effect of minimum wage increase on employment by industry

	(1)	(2)	(3)	(4)
	Primary or lower		Lower-secondary	
	Wage Observed	Wage Unobserved	Wage Observed	Wage Unobserved
Panel A: Mining				
log(MW)	0.001	-0.000	0.003*	0.000
	(0.001)	(0.000)	(0.002)	(0.000)
Mean of dep. var.	0.001	0.000	0.001	0.000
Observations	1,295,456	1,295,456	394,202	394,202
Adjusted R^2	0.002	0.002	0.003	0.001
Panel B: Manufacturing				
log(MW)	-0.043***	0.008	0.059*	-0.009
	(0.014)	(0.008)	(0.033)	(0.007)
Mean of dep. var.	0.054	0.011	0.118	0.010
Observations	1,295,456	1,295,456	394,202	394,202
Adjusted R^2	0.117	0.011	0.156	0.009
Panel C: Utilities				
log(MW)	-0.000	-0.000	-0.001	-0.000
	(0.001)	(0.000)	(0.003)	(0.000)
Mean of dep. var.	0.001	0.000	0.003	0.000
Observations	1,295,456	1,295,456	394,202	394,202
Adjusted R^2	0.001	0.000	0.005	0.000
Panel D: Trade and Construction				
log(MW)	-0.021	-0.003	-0.018	-0.002
	(0.014)	(0.003)	(0.022)	(0.003)
Mean of dep. var.	0.101	0.006	0.142	0.005
Observations	1,295,456	1,295,456	394,202	394,202
Adjusted R^2	0.051	0.006	0.049	0.004
Panel E: Transport and social services				
log(MW)	-0.009	0.002	-0.026**	0.000
	(0.007)	(0.002)	(0.011)	(0.002)
Mean of dep. var.	0.012	0.002	0.023	0.003
Observations	1,295,456	1,295,456	394,202	394,202
Adjusted R^2	0.012	0.002	0.013	0.002
Panel F: Business Services				
log(MW)	-0.000	-0.000	0.002	0.001
	(0.001)	(0.000)	(0.003)	(0.001)
Mean of dep. var.	0.001	0.000	0.003	0.000
Observations	1,295,456	1,295,456	394,202	394,202
Adjusted R^2	0.000	0.000	0.002	0.000
Panel G: Education and healthcare				
log(MW)	-0.001	-0.001	-0.008*	-0.000
	(0.003)	(0.000)	(0.004)	(0.001)
Mean of dep. var.	0.007	0.000	0.014	0.000
Observations	1,295,456	1,295,456	394,202	394,202
Adjusted R^2	0.002	0.000	0.008	0.000
Panel G: Agriculture				
log(MW)	-0.005	0.049**	-0.011*	0.021
	(0.014)	(0.022)	(0.006)	(0.022)
Mean of dep. var.	0.039	0.175	0.021	0.139
Observations	1,295,456	1,295,456	394,202	394,202
Adjusted R^2	0.019	0.079	0.013	0.092
Panel H: Domestic service				
log(MW)	0.005	0.001	-0.007**	0.000
	(0.003)	(0.000)	(0.002)	(0.000)
Mean of dep. var.	0.007	0.000	0.004	0.000
Observations	1,295,456	1,295,456	394,202	394,202
Adjusted R^2	0.012	0.000	0.005	0.000

Notes: The table shows the impact of an increase in the minimum wage on employment by industry. All specifications include province- and time-fixed effects. Control variables include log of gross provincial product per capita, male dummy, marriage dummy, age, and square of age. Robust standard errors are clustered by province and shown in parenthesis. Significance levels are $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.
Source: LFS 2011–2015

6 Impact on Wages

Following the investigation of the effect of a minimum wage hike on employment in the previous section, this section turns to the effect on wages in both the covered and uncovered sectors. While section 5 shows that minimum wage increases pushed workers from the covered sector to the uncovered sector, in addition to the employment effect, it is important to study the impact on wages in both sectors. In the covered sector, it is necessary to confirm whether the minimum wage increase actually raised the covered wage. As for the uncovered sector, while the migration to the sector does not indicate immediate welfare loss, if wages in the uncovered sector did not decrease substantially after the labor supply increased, then the minimum wage policy would be less destructive to the welfare of uncovered workers.

6.1 Empirical Strategy

The impact of minimum wages on wages was determined by examining the change in average wage and wage distributions in each sector, with the former estimation equation similar to (4). For wage distribution effects, following Cengiz et al. (2019), the impact of the minimum wage increase on the average change in the density of provincial wage distributions was estimated at each wage bin, with bin width set at 20 baht to ensure sufficient observations in each bin and with the wage distributions binned at each quarter relative to the new minimum wage level. The estimation equation is specified as follows:

$$\Delta \frac{E^j_{bpt}}{N_{pt}} = \sum_{b=-10}^{5} \beta^j_b D_b + \delta_p + \delta_t + \epsilon_{bpt}, \tag{5}$$

where

$$\Delta \frac{E^j_{bpt}}{N_{pt}} \equiv \frac{E^j_{bpt}}{N_{pt}} - \frac{E^j_{bp,t-1}}{N_{p,t-1}}. \tag{6}$$

N_{pt} is the total number of observations in province p at time t. When $j \in \{\text{covered}, \text{uncovered}\}$, E^j_{bpt} is the number of type j workers with less than primary school education whose wage falls into wage bin b.[22] Therefore, $\Delta \frac{E^j_{bpt}}{N_{bpt}}$ corresponds to the density change at wage bin b from period t and $t-1$. D_b represents each wage bin dummy, and δ_p and δ_t correspond to province and time fixed effects. β_b is the parameter of interest and captures the average change in the wage distribution at the time of the minimum wage increase.

As the observations used in estimating equation (5) were limited to the quarter in which the minimum wage increased, to check whether there was any placebo effect, changes in the wage distribution one quarter before the minimum wage hike were also estimated, using the following estimation equation:

[22]This method is preferred over the kernel density estimate in order to obtain a sharp distinction between bins above and below the minimum wage level.

$$\Delta \frac{E^j_{bp,t-1}}{N_{p,t-1}} = \sum_{b=-10}^{5} \beta^j_b D_b + \delta_p + \delta_t + \epsilon_{bpt}, \tag{7}$$

where $\frac{E_{bp,t-1}}{N_{p,t-1}}$ is the change in density one quarter before the minimum wage increase. Figures A3 and A4 show the wage distributions in the covered and uncovered sectors, illustrating the idea behind the estimation. The figures show wage distributions change after the minimum wage increase, but not one quarter before that.

6.2 Impact on Wages in the Covered Sector

Beginning with the impact on the average wage, we found that a one percent increase in the minimum wage raised the average wage of workers with primary school education or less by 0.2 percent and secondary school graduates by 0.3 percent. However, the wages of more educated workers remained the same (Column 1 of Table 6). Overall, the results indicate that the minimum wage increase did increase the wages of the lowest-skilled covered workers.

Next, the wage effects were examined by industry, since differences in the average industry wage could lead to heterogeneous effects across industries. Wages in the manufacturing industry increased the most at 0.47 percent for a one percent minimum wage increase, which is perhaps not surprising since manufacturing had the highest employment loss (Table 5). On the other hand, industries with higher average wages such as mining and business services experienced neither an increase in average wage nor a dis-employment effect (Panels A – G of Table 7).

Lastly, the effects of the minimum wage increase on wage distributions was estimated, and the results show that the density of workers below the new minimum wage level decreased while the density above increased. Similar to the results for the average wage, this suggests that actual wages in the covered sector complied with the increase in the minimum wage, particularly when we also note that the placebo estimates show little change in the wage distribution one quarter before the increase (Figure 4).

We also note a spillover effect in the covered sector (Figure 4), as wage density continued increasing up to around 100 baht above the minimum wage level. This spillover effect has also been found in other developing countries (Cunningham, 2007), but the spillover is more muted in Thailand, remaining salient up to about one-third in excess of the minimum wage, while it has been observed at up to nine times the minimum wage in Brazil, seven times in Mexico, and three times in Colombia (Cunningham, 2007). Nonetheless, the spillover suggests that skilled and unskilled laborers were substitutes, and the substitution effect dominated the scale effect. As a result, wages of those higher up in the distribution were bid up due to the increased demand.

Table 6: Wage effects by educational attainment

	(1) log($wage$)	(2)
	Covered with wage	Uncovered with wage
Panel A: Primary or lower		
log(MW)	0.231***	0.109*
	(0.037)	(0.059)
Mean of wage (Baht)	288.537	236.225
Observations	230,811	60,567
Adjusted R^2	0.264	0.232
Panel B: Lower-secondary		
log(MW)	0.273***	0.326***
	(0.036)	(0.123)
Mean of wage (Baht)	307.334	253.042
Observations	119,692	10,147
Adjusted R^2	0.284	0.211
Panel C: Upper-secondary		
log(MW)	0.160***	0.037
	(0.050)	(0.137)
Mean of wage (Baht)	350.520	263.433
Observations	123,454	4,815
Adjusted R^2	0.299	0.287
Panel D: College or higher		
log(MW)	-0.041	0.799**
	(0.035)	(0.391)
Mean of wage (Baht)	727.553	447.627
Observations	240,263	1,607
Adjusted R^2	0.444	0.252

Notes: The table shows the impact of a minimum wage increase on covered and uncovered sector wages. Control variables include log of gross provincial product per capita, male and marriage dummy variables, age, and square of age. The specification includes time- and province-fixed effects. Robust standard errors are clustered by province and shown in parenthesis. Significance levels are $^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$.
Source: LFS 2011–2015

6.3 Impact on Wages in the Uncovered Sector

Again beginning with the impact on the average wage in the uncovered sector, a one percent increase in the minimum wage raised the wages of workers with a primary school education or less by 0.1 percent and lower-secondary school graduates by 0.3 percent (Table 6). The analysis by industry shows that wages in agriculture appear unaffected while wages in the domestic service industry increased by 0.2 percent (Panels H–I of Table 7).

As for effects on the uncovered wage distribution, we again find an increase not at the minimum wage level but about 50 baht below (Figure 5), and results by industry show that the increase occurred below the minimum wage levels in both the agricultural and

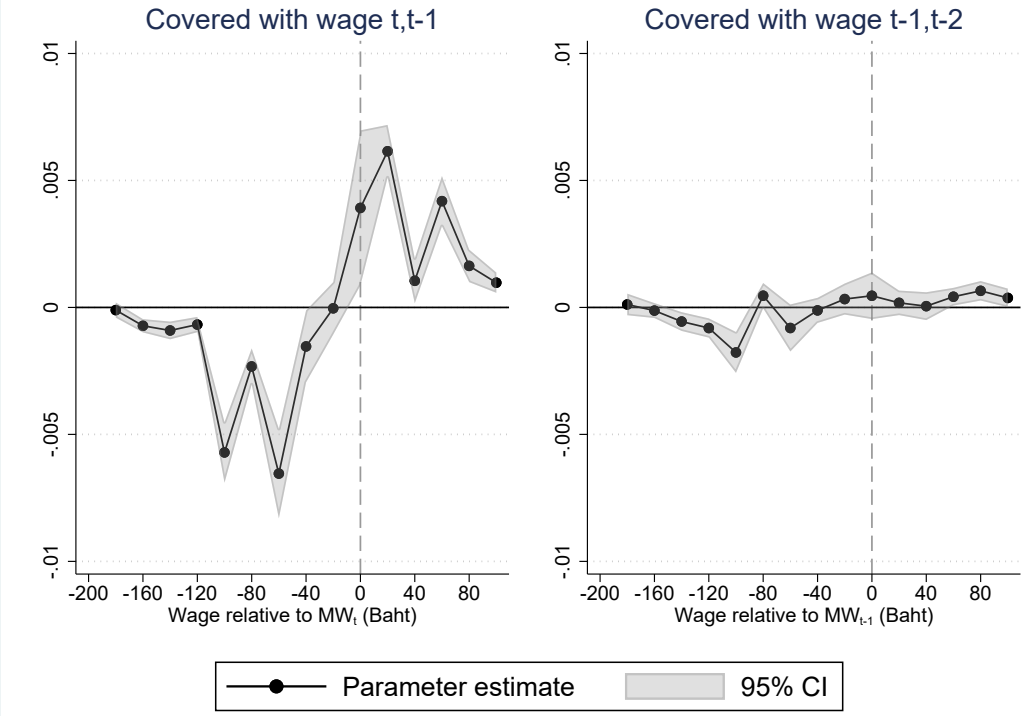

Figure 4: Average change in wage distribution of covered workers with observed wage data

Notes: These figures show the β_b parameter estimates and the 95 percent confidence intervals calculated from robust standard errors clustered at the province level. Supposing that the provincial minimum wage increased in period t, the left panel shows the estimates using the sample from period t and $t-1$ and the right panel using $t-1$ and $t-2$. Bin -10, which corresponds to 200 baht below minimum wage, is the omitted category.

domestic service industries (Figures A5 and A6).

However, these results should be interpreted with caution for Table 3 shows that an increased labor supply was found only for those without wage data. Since those without observed wages were likely to be unpaid family workers with an implicit return to labor, the effect on their wages is ambiguous.

Another concern is that selection into the wage sample was likely to be non-random. The development literature has distinguished between unpaid and salaried workers in agricultural households (De Janvry et al., 1991; Sadoulet et al., 1998) who choose between supplying their own labor or hiring additional labor from outside the household, with these two types of worker being qualitatively different. If individuals were selected into the wage analysis sample positively,[23] it may be the case that the minimum wage might have had

[23]Sadoulet et al. (1998) support the possibility of positive selection into the wage sector. Using data from Mexico, they find that high-skilled family members are more likely to work off the farm. On the other hand, Rizov and Swinnen (2004) argue that the selection will be negative or positive depending on the skill level. Using data on rural Hungarian households, they find that at lower skill levels, an increase in education is likely to lead to better managerial skills but at higher skill levels, the benefits from employment in the wage sector dominate.

a zero or negative impact on the uncovered wage.

Although a common approach to addressing the problem of non-random attrition is to impose bounds on the estimates with Horowitz-Manski bounds (Horowitz and Manski, 2000) or Lee bounds (Lee, 2009), given that wages were observed for less than 20 percent of the uncovered sector at each education level (Table 1), the bounds would not be tight enough to identify the direction of change in the uncovered sector.

Another approach adopted by several studies is to treat the unobserved wage issue not as a selection problem but to instead use information from the production function. Jacoby (1993) and Skoufias (1994) structurally estimate the shadow wages of unpaid workers from the production function in agricultural households by assuming allocative efficiency; that is, wage and marginal product of labor are equal. Barrett et al. (2008), using a subsample of households that have both wage and self-employed labor, test the allocative efficiency assumption and find that wages are smaller than the marginal product of labor and that the wedge between the two is driven by a systematic difference in household characteristics. Although they propose a method for reducing the prediction error by exploiting these systematic differences, the LFS unfortunately does not contain information on farm production and so estimating the effect of minimum wages on shadow wages shall be left for future studies.

Nevertheless, it is still unclear why employment in the salaried part of the uncovered sector is unaffected by the minimum wage increase. One possibility is that salaried uncovered wages increase with the minimum wage as a reference price, but since the increase up to minimum wage level is not legally binding, employers are able to increase the wage only partially, up to the level they can afford (Cunningham, 2007).

In conclusion, the welfare impact from the wage analyses remains ambiguous. Minimum wage increases increased wages and reduced employment in the covered sector, and the displaced workers appeared to migrate to the uncovered sector. However, since the wages of most of the workers in the uncovered sector were not observed, it is unclear to what extent changes in the official minimum wage affected their wages. In the following section, an alternate measure of welfare is investigated which considers the impact of minimum wages on employment quality.

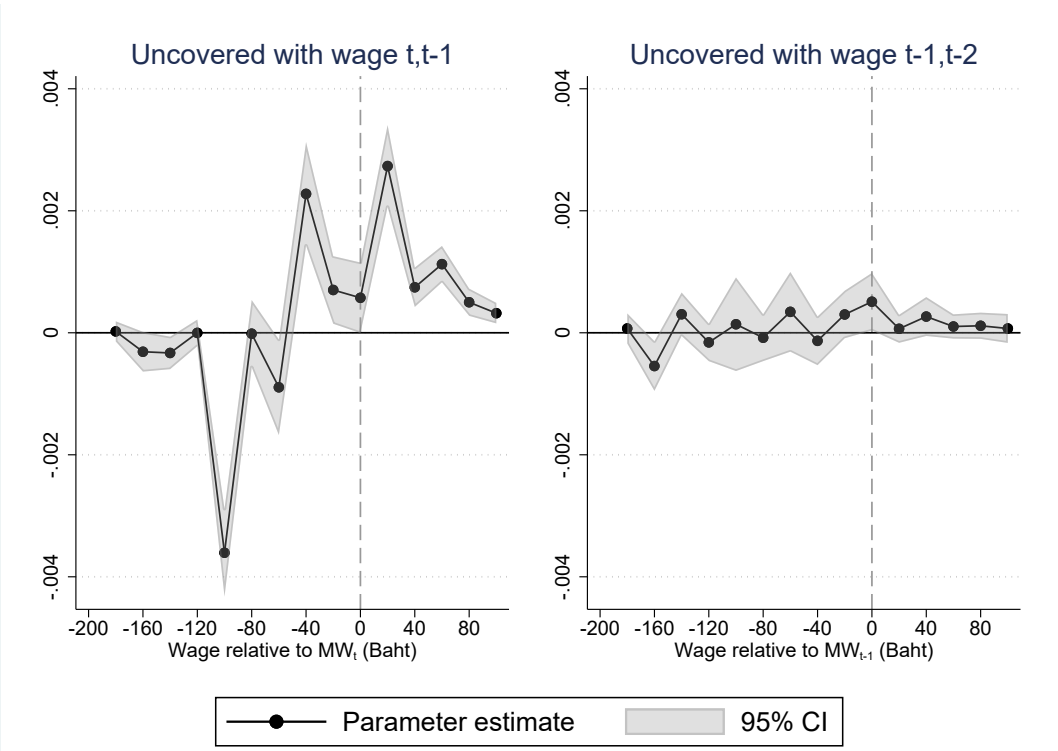

Figure 5: Average change in wage distribution of uncovered workers with observed wage data

Notes: These figures show the β_b parameter estimates and their 95 percent confidence intervals calculated from robust standard errors clustered at province level. Supposing that the provincial minimum wage is increased in period t, the left panel shows the estimates using a sample from periods t and $t-1$ and the right panel from $t-1$ and $t-2$. Bin -10, which corresponds to 200 baht below minimum wage, is the omitted category.

Table 7: Wage effects by industry

	(1) log($wage$)	(2)
	Primary or lower	Lower-secondary
Panel A: Mining		
log(MW)	-0.210	0.231
	(0.352)	(1.273)
Mean of dep. var.	314.319	383.476
Observations	1,427	493
Adjusted R^2	0.278	0.397
Panel B: Manufacturing		
log(MW)	0.468***	0.423***
	(0.039)	(0.055)
Mean of dep. var.	290.097	308.486
Observations	70,345	46,578
Adjusted R^2	0.303	0.324
Panel C: Utilities		
log(MW)	-0.606	0.312
	(0.477)	(0.498)
Mean of dep. var.	391.655	512.915
Observations	1,638	1,139
Adjusted R^2	0.307	0.541
Panel D: Trade and Construction		
log(MW)	0.204***	0.318***
	(0.040)	(0.041)
Mean of dep. var.	284.754	293.498
Observations	131,071	56,001
Adjusted R^2	0.317	0.307
Panel E: Transport and social services		
log(MW)	0.246**	0.172
	(0.105)	(0.115)
Mean of dep. var.	300.103	344.491
Observations	16,074	9,037
Adjusted R^2	0.194	0.237
Panel F: Business Services		
log(MW)	0.407	0.479
	(0.275)	(0.378)
Mean of dep. var.	303.865	351.012
Observations	1,092	1,091
Adjusted R^2	0.201	0.302
Panel G: Education and healthcare		
log(MW)	-0.298*	-0.194*
	(0.167)	(0.115)
Mean of dep. var.	286.110	319.666
Observations	9,164	5,353
Adjusted R^2	0.242	0.315
Panel H: Agriculture		
log(MW)	0.025	0.238*
	(0.071)	(0.127)
Mean of dep. var.	240.427	255.875
Observations	51,150	8,411
Adjusted R^2	0.231	0.215
Panel I: Domestic service		
log(MW)	0.223***	0.158
	(0.081)	(0.187)
Mean of dep. var.	213.399	239.314
Observations	9,417	1,736
Adjusted R^2	0.270	0.274

Notes: The table shows the impact of a minimum wage increase on wages by industry, for lower-skilled workers who have attained a lower-secondary school education or lower. Control variables include log of gross provincial product per capita, male and marriage dummy variables, age and age squared. This specification includes time- and province-fixed effects. Robust standard errors are clustered by province and shown in parenthesis. Significance levels are $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.
Source: LFS 2011–2015

7 Impact on Employment Quality

Lastly, the impact of minimum wages on the quality of employment was investigated. While it was unclear from the wage effect analysis whether an increase in the labor supply in the uncovered sector bid down wages because most uncovered wages were not observed, we can observe the impact on employment quality as an alternate measure of welfare. Migration to the uncovered sector may not generate a welfare loss if non-monetary benefits from the covered and uncovered jobs are similar. Using a supplemental data set of the LFS, this section examines the impact of the minimum wage increase on social security coverage, the probability of having medical costs paid for, subjective work safety, the probability of being injured at work, and the probability of reporting little rest.

7.1 Institutions related to the Quality of Employment

Workers in Thailand (excluding public workers, who are subject to different regulations) are eligible for the Universal Health Coverage Scheme (UHCS) and the Social Security Scheme (SSS). The UHCS provides health related benefits, while the SSS covers a broader range of health benefits and child allowance.

Benefits from the SSS are available to workers in both the covered and uncovered sectors as well as the non-employed under a contributory scheme. Workers in registered establishments contribute five percent of their salary and enjoy the full benefits of the SSS while the non-employed or workers in unregistered establishments are allowed to contribute less for fewer benefits. For instance, the latter do not receive child allowance or cash benefits for child birth.[24] Since individuals outside the covered sector are usually more budget-constrained, it is unclear whether they can afford to make contributions, so the following section examines how a minimum wage increase affects SSS coverage.

Another important pillar of the Thai social security system is the UHCS, which provides basic health benefits for individuals regardless of their place of work, but UHCS benefits are somewhat inferior to those from the SSS. For instance, the use of medicines on the Essential Medicines List is only free of charge to individuals insured under the SSS, and some researchers have expressed concerns about the inequality of benefits and discriminatory treatment under the different schemes (TDRI, 2013; 2016). If a minimum wage increase caused individuals to switch schemes due to a disemployment effect, there could be a change in the share of individuals who received free health care service, though it is also possible that the situation remained unchanged if required medical treatment covered by SSS was also included in the UHCS. The following section investigates the impact of the minimum wage increase on the share of individuals who received free health care service.

[24] See Appendix D for a detailed description of the Thai social security system.

Table 8: Impact on employment quality

	(1) Social security	(2) Paid medical fee	(3) Work injury	(4) Unsafe work environment	(5) Little rest period
Panel A: Primary or lower					
log(MW)	-0.072***	-0.035	0.008	0.008	0.002
	(0.020)	(0.061)	(0.079)	(0.049)	(0.007)
Mean of dep. var.	0.101	0.039	0.173	0.094	0.005
Observations	332,646	27,188	157,109	157,109	157,109
Adjusted R^2	0.139	0.032	0.086	0.097	0.004
Panel B: Lower-secondary					
log(MW)	0.054	0.074	-0.022	-0.026	-0.003
	(0.039)	(0.094)	(0.056)	(0.042)	(0.006)
Mean of dep. var.	0.211	0.049	0.129	0.078	0.005
Observations	102,196	7,563	58,611	58,611	58,611
Adjusted R^2	0.155	0.034	0.072	0.076	0.004
Panel C: Upper-secondary					
log(MW)	0.044	0.164	-0.044	0.006	-0.015**
	(0.034)	(0.120)	(0.049)	(0.032)	(0.006)
Mean of dep. var.	0.286	0.060	0.101	0.061	0.005
Observations	95,013	5,355	52,867	52,867	52,867
Adjusted R^2	0.140	0.044	0.065	0.058	0.006
Panel D: College or above					
log(MW)	-0.036	-0.064	0.016	-0.002	-0.002
	(0.053)	(0.135)	(0.029)	(0.013)	(0.003)
Mean of dep. var.	0.568	0.074	0.041	0.021	0.002
Observations	107,176	3,042	73,811	73,811	73,811
Adjusted R^2	0.032	0.074	0.053	0.023	0.003

Notes: Using data from the Informal Employment Survey 2011–2015, the table shows the impact of minimum wages on employment quality by educational level. Workers have access to social security if they are government employee, regular employee, or report having registered with the Social Security Scheme. Paid medical fee equals one if workers have been injured and the medical expenses were covered by the employer, health insurance company, or other types of social security, and zero if workers have been injured and the medical expenses were covered by themselves, family, friends, or other methods. Unsafe work environment equals one if workers state a lack of safety from chemical components or mechanical equipment, or danger to their vision or hearing as their main problem when asked about work safety. Injury from work equals one if workers have been injured from work within the past 12 months. Little rest period is equal to one if workers state little rest as their main problem when asked about work characteristics. Control variables include log of gross provincial product per capita, male and marriage dummy variables, age, and age squared. This specification includes both time- and province-fixed effects. Robust standard errors are clustered by province and shown in parenthesis. Significance levels are $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.
Source: Informal Employment Survey 2011–2015

7.2 Results and Discussion

Considering the impact of minimum wages on SSS coverage, estimates show that a one percent increase in the minimum wage reduced the SSS coverage rate of individuals with a primary-school education or less by 0.7 percentage points. This negative effect did not

appear for other groups with higher educational attainment (Table 8). The results indicate that higher minimum wages lowered fringe benefits that come with employment in the covered sector such as paid leave, child allowance, maternity leave, and death benefits.

The size of the estimated coefficient is comparable to that of minimum wage on employment in the covered sector shown in Table 3, which implies that the estimates in the main analysis are robust to various definitions of minimum wage coverage. While the baseline analysis here utilized the legal definition, several studies have used coverage based on social security as a proxy for minimum wage coverage (Maloney and Nunez, 2000; Fajnzylber, 2001; Khamis, 2013). The results here suggest that coverage by social security and by minimum wage legislation are closely related.

Next, the impact of minimum wages on health benefits was examined, and the results support the hypothesis that medical treatment by SSS and UHCS was substitutable. The increase in the minimum wage did not decrease the share of injured workers who had their medical fee covered by the SSS or their employer (Column 2 of Table 8). This also supports previous findings that hospitals do not discriminate between patients from different schemes and rarely give medicines not on the Essential Medicines List to insurers under the SSS although they are eligible for the treatment free of charge (TDRI, 2013).

Lastly, we investigated whether minimum wages deteriorated the work environment. Since employers in the covered sector would be subject to higher marginal costs, they could conceivably attempt to reduce costs by manipulating the work environment. Similarly, since most of the workers in the uncovered sector are unpaid family workers, there could be fewer visits from labor inspectors, resulting in their work environment not meeting the labor standard. As the minimum wage increase pushed workers to the uncovered sector, it is possible that the overall work environment may have worsened, but this hypothesis was not supported by the empirical results. Minimum wages appear to have had little impact on the share of workers reporting work injury, unsafe environment, or little rest period as their main problem at work (Columns 3–5 of Table 8).

Overall, the results of the employment quality analysis show that the minimum wage affected employment quality by reducing the coverage rate of social security but did not affect other aspects of employment. Nevertheless, this implies some degree of welfare loss, and since social security is a means of transferring income from high to low earners, a decrease in the social security coverage rate suggests that the minimum wage increase was somewhat less redistributive than expected in Thailand.

8 Conclusion

This study estimated the impact of minimum wages on employment in the context of an economy with a sector not covered by the minimum wage legislation using as a natural experiment a policy shift in Thailand that increased minimum wages by about 60 percent

during the early 2010s. We found that the covered sector shrank, the uncovered sector expanded, and the unemployment rate also decreased. Increased average wages in the covered sector confirm that the minimum wage was complied with in the covered sector, but it is unclear whether the expansion of the uncovered sector bid down wages since most wages in the uncovered sector were unobserved. Beyond the direct monetary benefit of higher wages for those who were able to remain in the covered sector, we found that migration to the uncovered sector also lowered social security coverage, implying some degree of welfare loss.

These empirical results correspond to the theoretical prediction of *informalization* in which the uncovered sector expands and the unemployment rate falls. As the probability of employment in the covered sector decreased by a sufficiently large amount, workers displaced from the covered sector migrated to the uncovered sector. Moreover, this probability of employment became so low that workers previously queuing for covered jobs gave up and instead became employed in the uncovered sector, resulting in a lower unemployment rate.

A limitation of this study is that the effect on uncovered wages remains ambiguous, mainly because 70 percent of wages in the uncovered sector were not observed. Further, although selection into the salaried and unpaid parts of the uncovered sector was likely to have been non-random, adopting bounded estimates would not be useful here due to the unobserved wages. Missing wages in the agricultural industry could potentially be recovered in future studies through farm input data that could predict shadow wages from marginal productivities.

References

Acemoglu, D. (2001). Good Jobs versus Bad Jobs. *Journal of Labor Economics*, 19(1):1–21.

Allegretto, S. A., Dube, A., and Reich, M. (2011). Do Minimum Wages really Reduce Employment? Accounting for Heterogeneity and Selectivity in State Panel Data. *Industrial Relations: A Journal of Economy and Society*, 50(2):205–240.

Arnold, D. and Hewison, K. (2005). Exploitation in Global Supply Chains: Burmese Workers in Mae Sot. *Journal of Contemporary Asia*, 35(3):319–340.

Barrett, C. B., Sherlund, S. M., and Adesina, A. A. (2008). Shadow Wages, Allocative Inefficiency, and Labor Supply in Smallholder Agriculture. *Agricultural Economics*, 38(1):21–34.

Baskaya, Y. S. and Rubinstein, Y. (2015). Using Federal Minimum Wages to Identify

the Impact of Minimum Wages on Employment and Earnings across the US States. *Working Paper*.

Boeri, T., Garibaldi, P., and Ribeiro, M. (2011). The Lighthouse Effect and Beyond. *Review of Income and Wealth*, 57:S54–S78.

Brown, C., Gilroy, C., and Kohen, A. (1982). The Effect of the Minimum Wage on Employment and Unemployment. *Journal of Economic Literature*, 20(2):487–528.

Cengiz, D., Dube, A., Lindner, A., and Zipperer, B. (2019). The Effect of Minimum Wages on Low-wage Jobs. *The Quarterly Journal of Economics*, 134(3):1405–1454.

Comola, M. and De Mello, L. (2011). How Does Decentralized Minimum Wage Setting Affect Employment and Informality? The Case of Indonesia. *Review of Income and Wealth*, 57:S79–S99.

Cunningham, W. (2007). *Minimum Wages and Social Policy: Lessons from Developing Countries*. The World Bank.

De Janvry, A., Fafchamps, M., and Sadoulet, E. (1991). Peasant Household Behaviour with Missing Markets: some Paradoxes Explained. *The Economic Journal*, 101(409):1400–1417.

Del Carpio, X. V., Messina, J., and Sanz-de Galdeano, A. (2019). Minimum Wage: Does it Improve Welfare in Thailand? *Review of Income and Wealth*, 65(2):358–382.

Fajnzylber, P. (2001). Minimum Wage Effects throughout the Wage Distribution: Evidence from Brazil's Formal and Informal Sectors. *Cedeplar Working Paper*.

Gindling, T. and Terrell, K. (2007). Minimum Wages and the Welfare of Workers in Honduras. *IZA Discussion Paper*.

Goto, K. and Endo, T. (2014). Labor-intensive Industries in Middle-income Countries: Traps, Challenges, and the Local Garment Market in Thailand. *Journal of the Asia Pacific Economy*, 19(2):369–386.

Gramlich, E. M., Flanagan, R. J., and Wachter, M. L. (1976). Impact of Minimum Wages on Other Wages, Employment, and Family Incomes. *Brookings Papers on Economic Activity*, 1976(2):409–461.

Ham, A. (2018). The Consequences of Legal Minimum Wages in Honduras. *World Development*, 102:135–157.

Harasztosi, P. and Lindner, A. (2019). Who Pays for the Minimum Wage? *American Economic Review*, 109(8):2693–2727.

Harris, J. R. and Todaro, M. P. (1970). Migration, Unemployment and Development: a Two-sector Analysis. *The American Economic Review*, 60(1):126–142.

Horowitz, J. L. and Manski, C. F. (2000). Nonparametric Analysis of Randomized Experiments with Missing Covariate and Outcome Data. *Journal of the American Statistical Association*, 95(449):77–84.

Hyslop, D. and Stillman, S. (2007). Youth Minimum Wage Reform and the Labour Market in New Zealand. *Labour Economics*, 14(2):201–230.

Jacoby, H. G. (1993). Shadow Wages and Peasant Family Labour Supply: an Econometric Application to the Peruvian Sierra. *The Review of Economic Studies*, 60(4):903–921.

Jales, H. (2018). Estimating the Effects of the Minimum Wage in a Developing Country: A Density Discontinuity Design Approach. *Journal of Applied Econometrics*, 33(1):29–51.

Kalenkoski, C. M. and Lacombe, D. J. (2008). Effects of Minimum Wages on Youth Employment: the Importance of Accounting for Spatial Correlation. *Journal of Labor Research*, 29(4):303–317.

Kawaguchi, D. and Mori, Y. (2021). Estimating the Effects of the Minimum Wage using the Introduction of Indexation. *Journal of Economic Behavior & Organization*, 184:388–408.

Khamis, M. (2013). Does the Minimum Wage have a Higher Impact on the Informal than on the Formal Labour Market? Evidence from Quasi-experiments. *Applied Economics*, 45(4):477–495.

Kohpaiboon, A., Kulthanavit, P., and Jongwanich, J. (2012). Structural Adjustment and International Migration: an Analysis of the Thai Clothing Industry. *Oxford Development Studies*, 40(2):231–260.

Kusakabe, K. and Pearson, R. (2010). Transborder Migration, Social Reproduction and Economic Development: A Case Study of Burmese Women Workers in Thailand. *International Migration*, 48(6):13–43.

Lathapipat, D., Poggi, C., et al. (2016). From Many to One: Minimum Wage Effects in Thailand. *PIER Discussion Papers*, 41.

Lee, D. S. (2009). Training, Wages, and Sample Selection: Estimating Sharp Bounds on Treatment Effects. *The Review of Economic Studies*, 76(3):1071–1102.

Lemos, S. (2009). Minimum Wage Effects in a Developing Country. *Labour Economics*, 16(2):224–237.

Magruder, J. R. (2013). Can Minimum Wages Cause a Big Push? Evidence from Indonesia. *Journal of Development Economics*, 100(1):48–62.

Maloney, W. F. and Nunez, J. (2000). *Measuring the Impact of Minimum Wages: Evidence from Latin America*. The World Bank.

Mincer, J. (1976). Unemployment Effects of Minimum Wages. *Journal of Political Economy*, 84(4, Part 2):S87–S104.

Muravyev, A. and Oshchepkov, A. (2016). The Effect of Doubling the Minimum Wage on Employment: Evidence from Russia. *IZA Journal of Labor & Development*, 5(1):6.

Neumark, D. and Wascher, W. (1992). Employment Effects of Minimum and Subminimum Wages: Panel Data on State Minimum Wage Laws. *ILR Review*, 46(1):55–81.

Paulson, A. L. and Townsend, R. (2004). Entrepreneurship and Financial Constraints in Thailand. *Journal of Corporate Finance*, 10(2):229–262.

Pereira, S. C. (2003). The Impact of Minimum Wages on Youth Employment in Portugal. *European Economic Review*, 47(2):229–244.

Rizov, M. and Swinnen, J. F. (2004). Human Capital, Market Imperfections, and Labor Reallocation in Transition. *Journal of Comparative Economics*, 32(4):745–774.

Sadoulet, E., De Janvry, A., and Benjamin, C. (1998). Household Behavior with Imperfect Labor Markets. *Industrial Relations: A Journal of Economy and Society*, 37(1):85–108.

Samart, W. and Kilenthong, W. (2020). Effect of Minimum Wage on Changes in the Thai Labor Market. *PIER Discussion Papers*, 137.

Skoufias, E. (1994). Using Shadow Wages to Estimate Labor Supply of Agricultural Households. *American Journal of Agricultural Economics*, 76(2):215–227.

TDRI (2013). Developing Guidelines for the Health Insurance System. Technical report.

TDRI (2016). The Harmonization of Thailand Health Insurance Systems. Technical report.

Upwork (2018). New 5th Annual "Freelancing in America" Study Finds that the U.S. Freelance Workforce, Now 56.7 Million People, Grew 3.7 Million Since 2014.

https://www.upwork.com/press/releases/freelancing-in-america-2018. Accessed: 2021-05-13.

Urzua, S. and Saltiel, F. A. (2021). Does an Increasing Minimum Wage Reduce Formal Sector Employment? Evidence from Brazil. *Economic Development and Cultural Change*.

Welch, F. (1974). Minimum Wage Legislation in the United States. *Economic Inquiry*, 12(3):285–318.

Yuen, T. (2003). The Effect of Minimum Wages on Youth Employment in Canada A Panel Study. *Journal of Human Resources*, 38(3):647–672.

A The Two-sector Model

This appendix presents the proofs of Propositions 3.1, 3.2, and 3.3 and introduces supplementary models that endogenously determine labor supply (Section A.4) and incorporate some degree of risk aversion (Section A.5).

A.1 Proof of Proposition 3.1

Proof. First, investigate how the probability of employment, uncovered wage, and unemployment are affected by the minimum wage hike by taking the derivative of (1), (2), and (3) with respect to w_m.

$$\frac{\partial P}{\partial w_m} = \frac{D_c}{(D_c + U)^2}\left(\frac{\eta_c U}{w_m} - \frac{\partial U}{\partial w_m}\right), \tag{A1}$$

$$\frac{\partial w_u}{\partial w_m} = P + w_m \cdot \frac{\partial P}{\partial w_m}, \tag{A2}$$

$$\frac{\partial U}{\partial w_m} = -\eta_c \cdot \frac{D_c}{w_m} + \left(\frac{\epsilon S}{w_u} - \frac{\eta_u D_u}{w_u}\right)\frac{\partial w_u}{\partial w_m}, \tag{A3}$$

Suppose $\epsilon = 0$ and $\eta_c = \eta_u = \eta < 0$. Then, by (A1), (A2), and (A3),

$$\frac{\partial P}{\partial w_m} = \frac{\eta(c + P)}{w_m\left(\frac{c}{P} - \eta\right)} \tag{A4}$$

By (A4), when $\eta > -1$, $\frac{\partial P}{\partial w_m} > -\frac{P}{w_m}$. It immediately follows from (A2) and (A3) that $\frac{\partial w_u}{\partial w_m} > 0$ and $\frac{\partial U}{\partial w_m} > 0$.

The second and third parts of the proposition can also be shown in the same manner. □

A.2 Proof of Proposition 3.2

Proof. By (A1), (A2), and (A3),

$$\frac{\partial P}{\partial w_m} = \frac{D_c}{(D_c + U)^2} \cdot \eta_u \cdot \frac{D_u}{w_u} \left(P + w_m \cdot \frac{\partial P}{\partial w_m} \right). \tag{A5}$$

Observe that for any $\eta_u < 0$, if $\frac{\partial P}{\partial w_m} \leq -\frac{P}{w_m}$, the RHS of (A5) becomes greater or equal to zero, a contradiction. Therefore, it must be that $\frac{\partial P}{\partial w_m} > -\frac{P}{w_m}$. Then by (A2) and (A3), it immediately follows that $\frac{\partial w_u}{\partial w_m} > 0$ and $\frac{\partial U}{\partial w_m} > 0$. □

A.3 Proof of Proposition 3.3

Proof. By (A1), (A2), and (A3),

$$\frac{\partial P}{\partial w_m} = \frac{P\eta_c}{w_m}. \tag{A6}$$

Observe that if $\eta_c \geq -1$, then $\frac{\partial P}{\partial w_m} \geq -\frac{P}{w_m}$ and $\frac{\partial w_u}{\partial w_m} \geq 0$; and if $\eta_c < -1$, then $\frac{\partial P}{\partial w_m} < -\frac{P}{w_m}$ and $\frac{\partial w_u}{\partial w_m} < 0$. Moreover, since $\eta_c < 0$, $\frac{\partial U}{\partial w_m} > 0$ always holds. □

A.4 Two-sector Model with Endogenous Labor Supply

In Section 3, labor supply was fixed and only allowed workers to move across sectors. Here, that assumption is relaxed and workers are allowed to drop out of the labor force. We find that the conclusions of this model allowing for endogenous labor supply are similar to the baseline case in which the labor supply is fixed.

As in the baseline case, assume $\eta_c = \eta_u = \eta < 0$. However, now let $\epsilon > 0$. By (A1), (A2), and (A3),

$$\frac{\partial P}{\partial w_m} = -\frac{P}{w_m} \cdot \frac{-\eta + P\epsilon + \epsilon - \frac{\eta P}{c}}{1 + P\epsilon + \epsilon - \frac{\eta P}{c}}. \tag{A7}$$

Similar to the baseline case, $\frac{\partial w_u}{\partial w_m} > 0$ if and only if $\frac{\partial P}{\partial w_m} > -\frac{P}{w_m}$. Observe from (A7) that whether the uncovered sector expands or shrinks depends only on values of η.

Since $\epsilon > 0$, the equality between labor supply and demand is now different from the baseline case. By (A3), it can be shown that $\frac{\partial U}{\partial w_m} > 0$ if and only if

$$\frac{\partial P}{\partial w_m} < -(1 - \kappa)\frac{P}{w_m},$$

where

$$\kappa = \frac{\eta}{\epsilon\left(1 + \frac{1}{P}\right) - \eta c} < 0.$$

Proposition A.1. *Let $c = \frac{D_c}{D_u}$. When the labor supply elasticity is strictly positive ($\epsilon > 0$), and labor demand elasticities in the covered and uncovered sectors are negative and equal to one another ($\eta_c = \eta_u = \eta < 0$),*

1. *if labor demand is inelastic ($-1 < \eta < 0$), then for any $\epsilon > 0$, the probability of employment in the covered sector decreases by a sufficiently small amount ($\frac{\partial P}{\partial w_m} > -\frac{P}{w_m}$), unemployment increases ($\frac{\partial U}{\partial w_m} > 0$), and wages in the uncovered sector increase ($\frac{\partial w_u}{\partial w_m} > 0$); that is,* ***formalization****;*

2. *if labor demand is unit elastic ($\eta = -1$), then for any $\epsilon > 0$, the probability of employment reduces by $\frac{\partial P}{\partial w_m} = -\frac{P}{w_m}$, unemployment decreases ($\frac{\partial U}{\partial w_m} < 0$), and wages in the uncovered sector are unchanged ($\frac{\partial w_u}{\partial w_m} = 0$);*

3. *if labor demand is somewhat elastic ($-\frac{1+c}{c} < \eta < -1$), and labor supply elasticity, ϵ, satisfies $0 < \epsilon \leq \psi$, then $-(1-\kappa)\frac{P}{w_m} \leq \frac{\partial P}{\partial w_m} < -\frac{P}{w_m}$, unemployment decreases ($\frac{\partial U}{\partial w_m} \leq 0$), and wages in the uncovered sector decrease ($\frac{\partial w_u}{\partial w_m} < 0$); that is,* ***informalization****;*

4. *if labor demand is somewhat elastic ($-\frac{1+c}{c} < \eta < -1$), and labor supply elasticity satisfies $\epsilon \geq \psi$, then $\frac{\partial P}{\partial w_m} \leq -(1-\kappa)\frac{P}{w_m}$, unemployment increases ($\frac{\partial U}{\partial w_m} \geq 0$), and wages in the uncovered sector decrease ($\frac{\partial w_u}{\partial w_m} < 0$); that is,* ***semi-formalization****;*

5. *if labor demand is sufficiently elastic ($\eta \leq -\frac{1+c}{c}$), then for any $\epsilon > 0$, $\frac{\partial P}{\partial w_m} < -(1-\kappa)\frac{P}{w_m}$, unemployment increases ($\frac{\partial U}{\partial w_m} > 0$), and wages in the uncovered sector decrease ($\frac{\partial w_u}{\partial w_m} < 0$); that is,* ***semi-informalization****,*

where

$$\psi = \frac{\eta(1 + c(\eta + 1)}{(\eta + 1)(1 + 1/P)},$$

and

$$\kappa = \frac{\eta}{\epsilon\left(1 + \frac{1}{P}\right) - \eta c} < 0.$$

As in the baseline case, when labor demand is inelastic, formalization occurs for any labor supply elasticity. Moreover, semi-informalization and informalization may occur if labor demand is elastic, depending on the values of labor supply elasticity.

Unlike the baseline case, in the current framework, individuals not only may choose between sectors but also may choose whether to drop out of the labor force. The role of the endogenous labor supply can be seen in the third and fourth parts of Proposition A.1. Holding the value of labor demand elasticity constant, when the labor supply is more elastic, it is easier for workers to drop out of the labor force. As a result, the probability of employment in the covered sector reduces by moreq and so unemployment increases.

A.5 Two-sector Model with Risk Aversion

In Section 3, workers were assumed to be risk neutral. This appendix shows that by assuming some degree of risk aversion, the overall implication of the baseline model remains

unchanged and the associated labor demand elasticity for each scenario shifts upward.

To incorporate some degree of risk aversion, let the utility function be

$$U(x) = \frac{x^{1-\theta}}{1-\theta},$$

where θ is the degree of relative risk aversion. Higher θ means individuals are more risk averse and $\theta = 0$ corresponds to the risk neutrality of the baseline case. Since there are no unemployment benefits, it is further assumed that $0 < \theta < 1$ to prevent the expected utility of choosing the covered sector from tending toward $-\infty$. The equality between expected utilities in the two sectors becomes

$$P w_m^{1-\theta} = w_u^{1-\theta}. \tag{A8}$$

Then,

$$\frac{\partial w_u}{\partial w_m} = \left(\frac{w_m}{w_u}\right)^{-\theta} \left(P + \frac{w_m}{1-\theta} \cdot \frac{\partial P}{\partial w_m}\right). \tag{A9}$$

Equation (A9) implies that the probability reduction threshold that determines whether the uncovered sector expands or shrinks is $-\frac{P(1-\theta)}{w_m}$, which is greater than $-\frac{P}{w_m}$ in the risk neutral case. This suggests that when there is some degree of risk aversion, a small reduction in the probability of employment could be enough to push workers to the uncovered sector. Consider the case in which $\epsilon = 0$ and $\eta_c = \eta_u = \eta < 0$. Since $\frac{\partial P}{\partial w_m}$ can be written as a function of η, it can be shown that formalization occurs when

$$\eta > -(1-\theta). \tag{A10}$$

This implies that the η threshold in the model that incorporates risk aversion is less negative than that of the model that assumes risk neutrality, and how much the threshold deviates from -1 depends on the degree of risk aversion. Risk averse individuals prefer the certain income from the uncovered sector. Therefore, the threshold for η is less negative.

Similarly, the threshold of the poverty reduction to make unemployment decrease becomes $-\frac{P}{w_m}(c+1)(1-\theta)$, which is greater than $-\frac{P}{w_m}(c+1)$ in the risk neutral case. Therefore, the condition for informalization to occur is

$$\eta < -\frac{1+c}{1-P}(1-\theta), \tag{A11}$$

which means that when individuals are risk averse, the demand elasticity that reduces unemployment is less negative than what is implied in the risk-neutral case.

The above observations can be concluded in the following proposition.

Proposition A.2. *Let* $c = \frac{D_c}{D_u}$. *Assume a utility function of the following form:*

$$U(x) = \frac{x^{1-\theta}}{1-\theta} \ ,$$

where θ *is the degree of relative risk aversion and* $0 < \theta < 1$. *When the labor supply is perfectly inelastic, that is* $\epsilon = 0$, *and labor demand elasticities in the covered and the uncovered sectors are negative and equal to one another, that is* $\eta_c = \eta_u = \eta < 0$,

1. *if labor demand satisfies* $-(1-\theta) \leq \eta < 0$, *then the probability of employment in the covered sector decreases by a sufficiently small amount,* $\frac{\partial P}{\partial w_m} \geq -\frac{P}{w_m}(1-\theta)$, *unemployment increases,* $\frac{\partial U}{\partial w_m} > 0$, *and wages in the uncovered sector increase,* $\frac{\partial w_u}{\partial w_m} \geq 0$ *(formalization);*

2. *if labor demand satisfies* $-\frac{1+c}{1-P}(1-\theta) \leq \eta < -(1-\theta)$, *then the probability of employment in the covered sector decreases more but is still bounded from below,* $-\frac{P}{w_m}(1+c)(1-\theta) \leq \frac{\partial P}{\partial w_m} < -\frac{P}{w_m}(1-\theta)$, *unemployment increases,* $\frac{\partial U}{\partial w_m} \geq 0$, *and wages in the uncovered sector decrease,* $\frac{\partial w_u}{\partial w_m} < 0$ *(semi-informalization); and*

3. *if labor demand satisfies* $\eta < -\frac{1+c}{1-P}(1-\theta)$, *then the probability of employment in the covered sector decreases by a large amount,* $\frac{\partial P}{\partial w_m} < -\frac{P}{w_m}(1+c)(1-\theta)$, *unemployment decreases,* $\frac{\partial U}{\partial w_m} < 0$, *and wages in the uncovered sector decrease* $\frac{\partial w_u}{\partial w_m} < 0$ *(informalization).*

Table A1: Share of minimum wage workers by age

	(1) All	(2) Primary or less	(3) Lower secondary	(4) Upper secondary	(5) College or above
15-30 years old	0.16	0.21	0.22	0.19	0.05
31-40	0.11	0.17	0.19	0.10	0.02
41-50	0.09	0.15	0.10	0.07	0.01
51-60	0.06	0.10	0.08	0.03	0.00
Total	0.11	0.16	0.19	0.14	0.02

Notes: This table shows the share of workers in the covered sector with wages within 5 percent above or below the minimum wage by age and educational attainment using data from the first quarter of LFS 2011. Individuals without wage data were excluded.
Source: LFS 2011q1

B Heterogeneous Impact by Age

Section 5 shows the impact of minimum wages on employment by educational attainment, pooling across age groups. This appendix focuses on those with primary school education or less, and confirms that the main results in Section 5 were not driven by any particular age group.

Firstly, looking at the descriptive statistics on the share of minimum wage workers across age groups, we see that minimum wage workers are more represented not only by those 15–30 years old but also by those in their 30s. This pattern is especially strong in the less educated group.

Next, the effects on employment in the covered sector were confirmed to be negative for all age groups, with the size of the coefficients on covered employment yielding similar employment elasticities of about -0.4 to -0.5 across age groups but movement to the uncovered sector was found only in older individuals. Among individuals 15–30 years old, there was an increase in the share of those out of the labor force, but little change in the share of the uncovered sector (Table A2). This difference could be attributed to the difference in labor supply elasticities. The results suggest that younger workers were less attached to the labor market than older workers, for while older individuals coped with displacement by moving to the uncovered sector, younger individuals moved out of the labor force. This is consistent with the theory on life cycle labor supply: since younger workers have a lower wage, the price of their leisure is lower.

Finally, wage effects were verified by age, with a one percent increase in minimum wage raising wages of workers in the covered sector by about 0.25 percentage points for those younger than 50 years old (Table A3). This result suggests that there was a spillover effect across age groups, consistent with the results in Figure 4 from the analysis of wage distribution. While older individuals were employed at a higher wage, they also enjoyed

Table A2: Employment effects by age: primary school education or lower

	(1) Covered with wage	(2) Covered no wage	(3) Uncovered with wage	(4) Uncovered no wage	(5) Unemployed	(6) NILF
Panel A: 15–30 years old						
log(MW)	-0.165***	0.060***	-0.003	-0.027	-0.009	0.143***
	(0.038)	(0.021)	(0.025)	(0.043)	(0.009)	(0.043)
Mean of dep. var.	0.336	0.024	0.067	0.252	0.011	0.310
Observations	135,309	135,309	135,309	135,309	135,309	135,309
Adjusted R^2	0.141	0.010	0.021	0.085	0.010	0.069
Panel B: 31–40 years old						
log(MW)	-0.136***	0.013	0.005	0.076**	-0.008**	0.049
	(0.034)	(0.017)	(0.020)	(0.032)	(0.003)	(0.037)
Mean of dep. var.	0.251	0.027	0.058	0.249	0.003	0.412
Observations	239,743	239,743	239,743	239,743	239,743	239,743
Adjusted R^2	0.121	0.013	0.016	0.071	0.002	0.026
Panel C: 41–50 years old						
log(MW)	-0.084***	-0.017*	-0.003	0.076***	0.001	0.028
	(0.029)	(0.009)	(0.017)	(0.027)	(0.002)	(0.033)
Mean of dep. var.	0.172	0.020	0.046	0.234	0.002	0.527
Observations	445,771	445,771	445,771	445,771	445,771	445,771
Adjusted R^2	0.082	0.010	0.015	0.093	0.002	0.026
Panel D: 51–60 years old						
log(MW)	-0.055**	-0.003	-0.001	0.049**	-0.002	0.012
	(0.021)	(0.006)	(0.013)	(0.019)	(0.001)	(0.034)
Mean of dep. var.	0.102	0.014	0.036	0.202	0.001	0.645
Observations	474,633	474,633	474,633	474,633	474,633	474,633
Adjusted R^2	0.058	0.009	0.014	0.112	0.001	0.039

Notes: This table shows the estimates of minimum wages on employment status by age, with the sample restricted to individuals with primary school education or lower. All specifications include province and time fixed effects. Control variables include log of gross provincial product per capita, male and marriage dummy variables, age and age squared. Significance levels are $^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$.
Source: LFS 2011–2015

the benefits of the minimum wage, as their average wages increased by about the same amount.

Table A3: Wage effects by age: primary education or lower

	(1) Covered with wage	(2) Uncovered with wage
Panel A: 15–30 years old		
log(MW)	0.253***	0.167
	(0.049)	(0.107)
Mean of wage (Baht)	264.540	231.766
Observations	45,531	9,096
Adjusted R^2	0.258	0.212
Panel B: 31–40 years old		
log(MW)	0.271***	0.245*
	(0.044)	(0.126)
Mean of wage (Baht)	285.169	238.286
Observations	60,228	13,857
Adjusted R^2	0.216	0.215
Panel C: 41–50 years old		
log(MW)	0.258***	0.046
	(0.057)	(0.072)
Mean of wage (Baht)	295.219	238.955
Observations	76,489	20,424
Adjusted R^2	0.197	0.219
Panel D: 51–60 years old		
log(MW)	0.123**	0.022
	(0.059)	(0.096)
Mean of wage (Baht)	304.688	233.679
Observations	48,563	17,190
Adjusted R^2	0.131	0.195

Notes: This table shows the estimates of minimum wages on wage by age, with the sample restricted to individuals with primary school education or lower. All specifications include province and time fixed effects. Control variables include log of gross provincial product per capita, male and marriage dummy variables, age, and age squared. Significance levels are $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$.
Source: LFS 2011–2015

C Other Data Sources

In addition to the LFS and the Informal Employment Survey, the following public data sets were also used in this study.

C.1 Gross Provincial Product per Capita

Data on gross provincial product per capita was obtained from the Office of the National Economic and Social Development Council. The figures were measured in real terms with 2002 as the base year. Annual provincial population data was obtained from the Department of Provincial Administration (DOPA).

C.2 Intra-governmental Transfer per Capita

Intra-governmental transfers per capita was included as an additional control variable in Section 5.3 and was constructed from reports by the Budget Bureau of Thailand containing the total budget transferred from the central government to provincial governments in each fiscal year. This number was converted to transfers per capita by dividing it by the total provincial population obtained from the National Statistics Office. However, there was an overlapping problem because the Thai fiscal year of year t begins from September of year $t-1$, so it was assumed that policymakers decided the budget based on the population at the time of budget announcement and divided the budget of fiscal year t by the total population of calendar year $t-1$. The reports also contain information on how the budget is used, and the 2020 report of the Budget Bureau indicates that the majority of the budget transfers to the local governments are for construction and maintenance of local infrastructure such as roads, dams, and bridges.

C.3 Household debt

Average debt per household in 2011 was used as an additional control variable in Section 5.3. This provincial-level data was obtained from the National Statistics Office.

D Thai Social Security System

All individuals in Thailand are eligible for some level of social protection. However, the transaction cost and level of benefits received differ across types of employment (Table A4). The Thai social security system is built upon three pillars: the Universal Coverage Scheme, the Social Security Scheme, and the Social Security for Public Employees. The Universal Coverage Scheme is the basic social security system for which all Thai residents are eligible and which provides only health-related benefits. On the other hand, the

Table A4: Social security costs and benefits by types of insurer

	(1)	(2)	(3)	(4)
	Type of workers			
	Article 33	Article 39	Article 40	None-insurer
Panel A: Cost				
Registration	Immediate	Required	Required	Required
Monthly payment	5 percent of salary	432 baht	70–100 baht	0 baht
Panel B: Benefits				
Medical care	Medical fee and paid vacation	Medical fee[1]	Medical fee[1]	Medical fee[1]
Childbirth benefits	delivery cost and cash benefits	delivery cost and cash benefits	delivery cost	delivery cost
Disability benefits	Available	Available	Available	Available
Death benefits	Lump sum payment≥50000 baht	Lump sum payment≥50000 baht	Lump sum payment≤23000 baht	N/A
Child allowance	Available	Available	Available[2]	N/A
Old-age pension	Available	Available	Available[3]	N/A

[1] Participants of the Universal Coverage Scheme are eligible for only partial medical service. For instance, they cannot use medicines not on the Essential Medicine List without an additional payment.
[2] After 2015
[3] For insurers who contribute 100 baht per month

Notes: This table compares the costs and benefits of social security between types of insurers.

Social Security Scheme and Social Security for Public Employees cover a broader range of benefits but are only immediately available to public and private employees working in registered establishments. The self-employed, business owners, or workers in non-registered establishments may register with the Social Security Office by themselves, but they become eligible only for partial benefits.

Public employees are eligible for the most generous social security plan. Similarly, private employees are also immediately covered by the Social Security Scheme under Article 33 if they are employed at establishments registered with the Social Security Office. The benefits include medical care, childbirth benefits, disability benefits, death benefits, child allowance, and old-age pension. In exchange, they are required to contribute 5 percent of their salary but not more than 750 baht per month. This amount is deducted directly from their salary and matched by another 5 percent paid by the establishment.

On the other hand, the self-employed, business owners, or workers in non-registered establishments are eligible for social security benefits under Article 40 only if they register and contribute 70 or 100 baht per month. Unlike the Article-33 recipients, they are eligible to only partial access to medical care, disability benefits, death benefits, and old-age pension. They are, however, not eligible for child allowance.

Displaced workers from the private sector are also eligible for social security benefits. They may register for the Social Security Scheme under Article 39 and contribute 432 baht per month to be eligible for the same benefits as when they were employed in the

covered sector. They may also register as self-employed contribute 70–100 baht per month and accept fewer benefits.

E Table and Figure Appendix

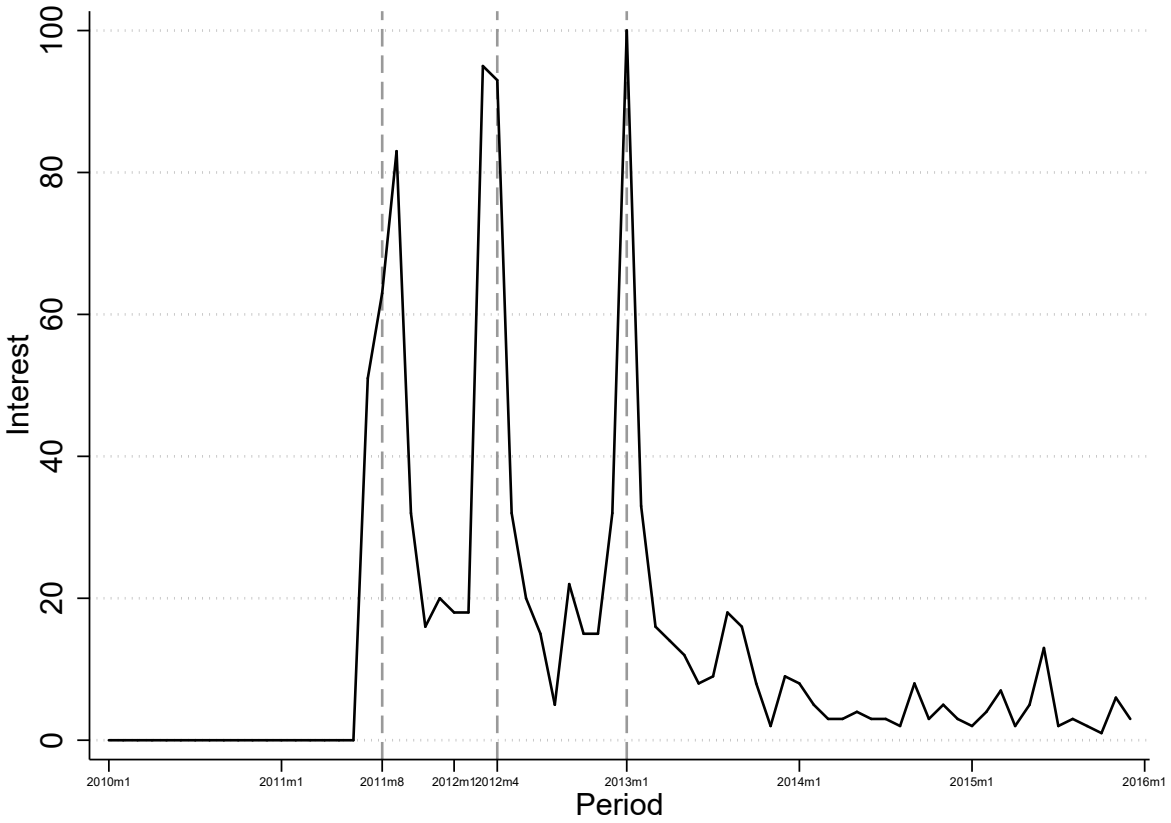

Figure A1: Interest over time of the 300-baht minimum wage policy

Notes: This figure shows the Google interest index of the 300-baht minimum wage policy from January 2010 to December 2015 in Thailand. The keyword used to measure interest is "Kharang 300" or "300-baht wage", a colloquial term for the 300-baht minimum wage. A value of 100 is the peak popularity for the term and a score of 0 means there was not enough data for this term. The dash lines correspond to the time of the election, and the first and second minimum wage hikes.

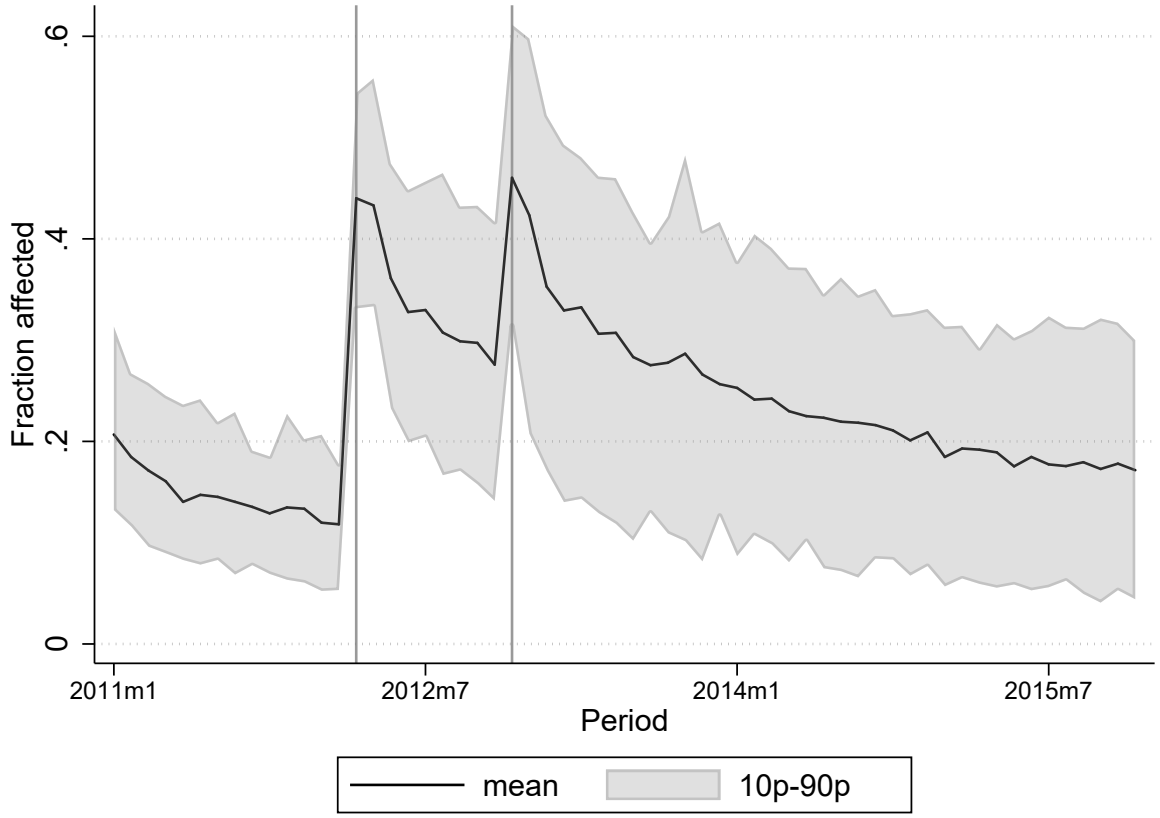

Figure A2: Share of affected workers

Notes: This figure shows the share of affected workers over time, with affected workers defined as the share of workers in the covered sector with wages below the next quarter minimum wage. Only individuals with valid wage data were included. The solid line represents the national average and the grey area corresponds to the 10th to 90th percentile range.
Source: Labor Force Survey 2011–2015

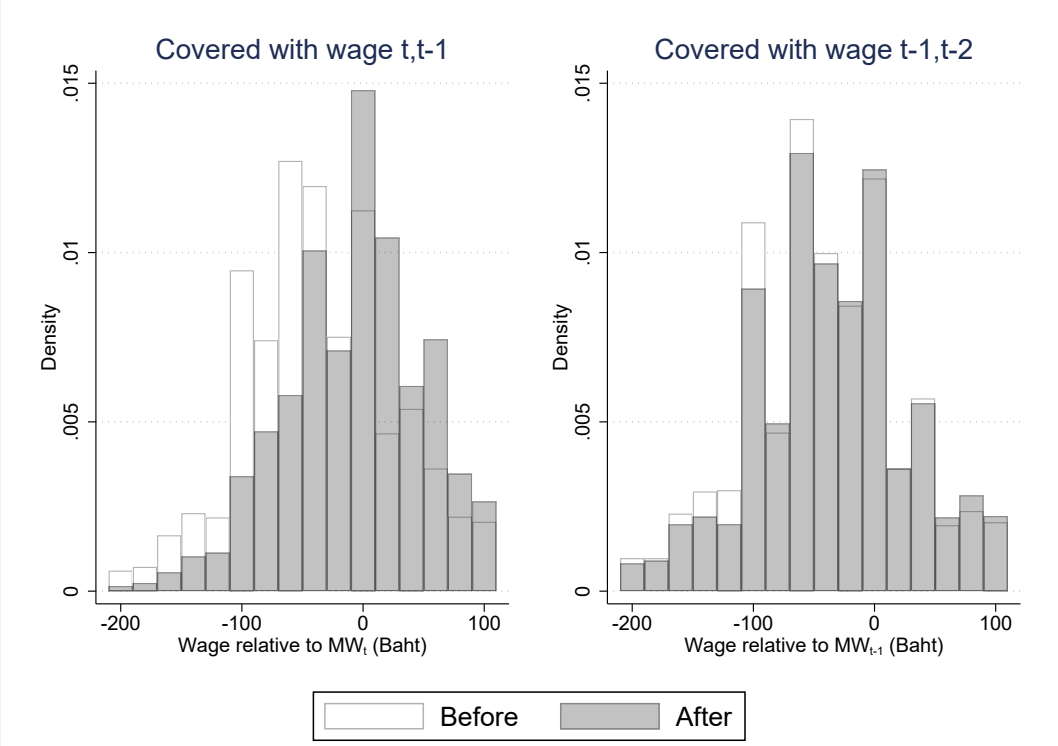

Figure A3: Wage distribution in the covered sector

Notes: These figures show wage distributions in the covered sector before and after the minimum wage increase (left panel), and those two quarters before the increase (right panel).

Figure A4: Wage distribution in the uncovered sector

Notes: These figures show wage distributions in the uncovered sector before and after the minimum wage increase (left panel), and those two quarters before the increase (right panel).

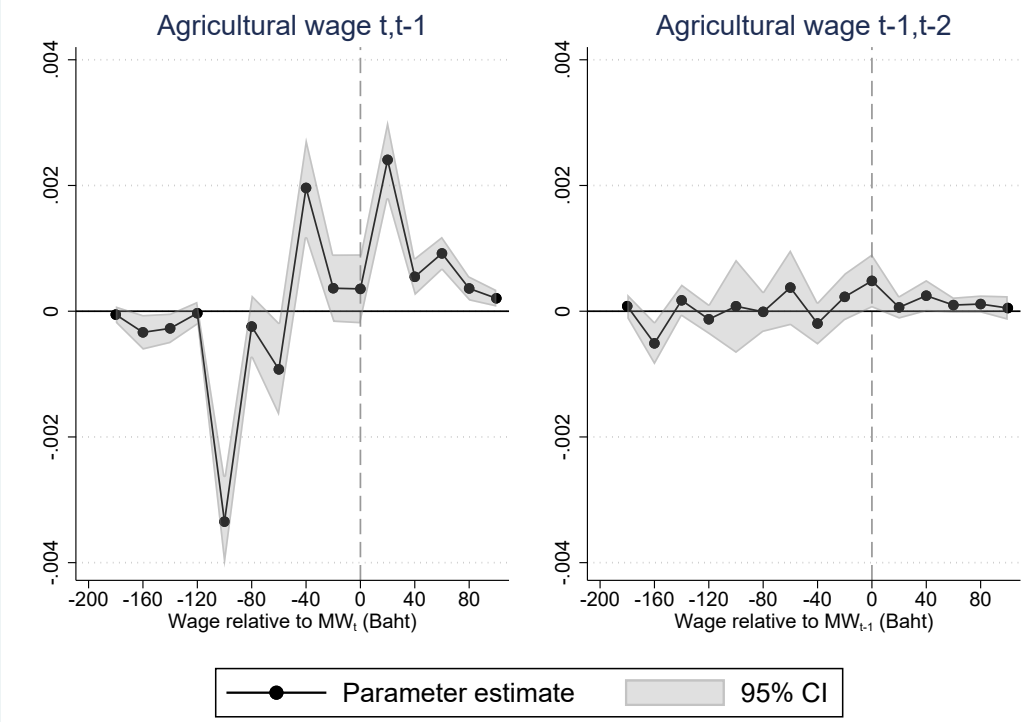

Figure A5: Average change in wage distribution of agricultural workers with observed wage data

Notes: These figures show the β_b parameter estimates and their 95 percent confidence intervals calculated from robust standard errors clustered at the province level. Supposing the provincial minimum wage is increased in period t, the left panel shows the estimates using a sample from period t and $t-1$ and the right panel shows the estimates using a sample from period $t-1$ and $t-2$. Bin -10, which corresponds to 200 baht below minimum wage, is the omitted category.

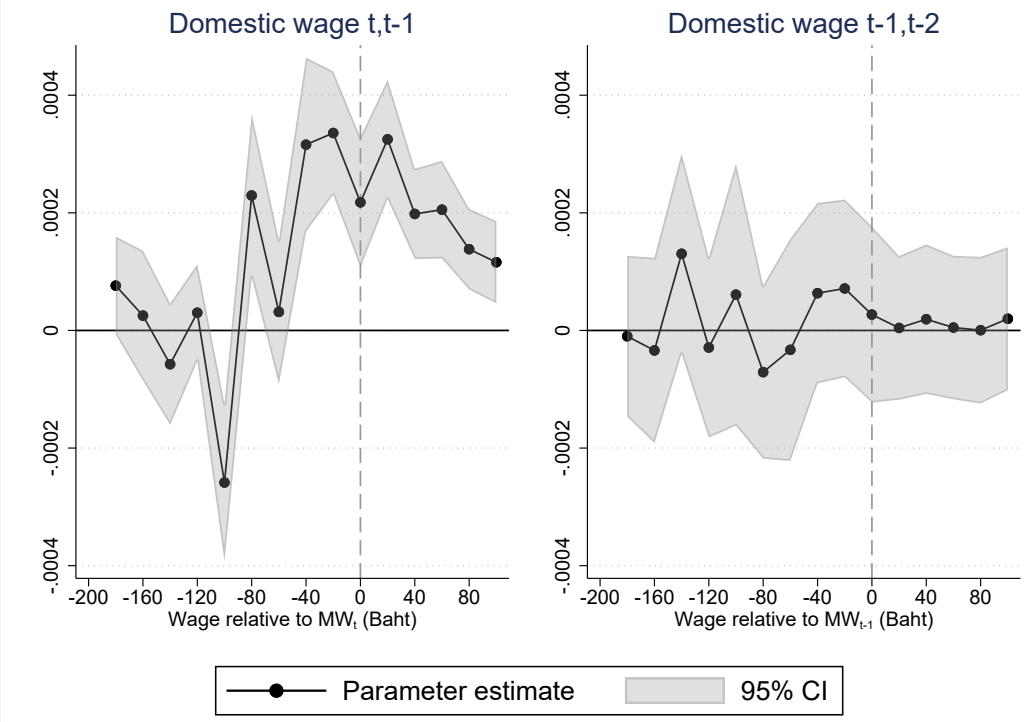

Figure A6: Average change in wage distribution of domestic workers with observed wage data

Notes: These figures show the β_b parameter estimates and their 95 percent confidence intervals calculated from robust standard errors clustered at the province level. Supposing the provincial minimum wage is increased in period t, the left panel shows the estimates using a sample from period t and $t-1$ and the right panel shows the estimates using a sample from period $t-1$ and $t-2$. Bin -10, which corresponds to 200 baht below minimum wage, is the omitted category.

Table A5: Sample construction summary

	(1) Count	(2) Mean	(3) SD	(4) Min	(5) Max
Panel A: Original sample					
Male	4,449,485	0.48	(0.50)	0	1
Age	4,449,485	37.76	(21.75)	0	98
Panel B: Keep prime-age workers					
Male	2,874,177	0.47	(0.50)	0	1
Age	2,874,177	38.80	(12.98)	15	60
Panel C: Drop individuals in education					
Male	2,618,681	0.47	(0.50)	0	1
Age	2,618,681	40.88	(11.65)	15	60
Panel D: Drop civil servants					
Male	2,493,122	0.47	(0.50)	0	1
Age	2,493,122	40.82	(11.74)	15	60
Panel E: Drop missing industry data					
Male	2,491,681	0.47	(0.50)	0	1
Age	2,491,681	40.82	(11.74)	15	60
Panel F: Drop missing educational attainment data					
Male	2,477,450	0.47	(0.50)	0	1
Age	2,477,450	40.85	(11.74)	15	60

Notes: This table shows the difference in baseline characteristics across samples. Panel A includes all individuals who were enumerated in the survey; Panel B corresponds to the sample after dropping individuals younger than 15 years old or older than 60 years old; Panel C to that after dropping individuals reported enrolling in school; Panel D to that after dropping individuals employed in the governmental or international organizations; Panels E and F to that after dropping individuals with missing industry or educational attainment data.
Source: LFS 2011–2015

Table A6: Composition of the uncovered sector by industry

	(1) Primary or less		(2) Lower secondary		(3) Upper secondary		(4) College or above	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Panel A: Paid workers								
Agriculture	0.25	(0.43)	0.16	(0.37)	0.10	(0.30)	0.04	(0.20)
Domestic service	0.03	(0.16)	0.02	(0.13)	0.02	(0.13)	0.01	(0.08)
Panel B: Unpaid family workers								
Agriculture	0.54	(0.50)	0.49	(0.50)	0.43	(0.49)	0.23	(0.42)
Mining	0.00	(0.01)	0.00	(0.02)	0.00	(0.02)	0.00	(0.02)
Manufacturing	0.03	(0.16)	0.04	(0.21)	0.05	(0.23)	0.07	(0.26)
Utilities	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.01)
Trade & construction	0.15	(0.36)	0.27	(0.45)	0.38	(0.48)	0.61	(0.49)
Transport & social services	0.01	(0.08)	0.02	(0.12)	0.02	(0.15)	0.03	(0.18)
Business Services	0.00	(0.01)	0.00	(0.02)	0.00	(0.03)	0.00	(0.05)
Education & healthcare	0.00	(0.01)	0.00	(0.02)	0.00	(0.03)	0.01	(0.08)
Domestic service	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Observations	354,137		97,611		73,191		45,756	

Notes: This table shows the composition of the uncovered sector by industry and level of educational attainment.
Source: LFS 2011–2015

Table A7: Employment effects (Robustness checks): Primary or lower

	(1) Covered with wage	(2) Covered no wage	(3) Uncovered with wage	(4) Uncovered no wage	(5) Unemployed	(6) NILF
Panel A: Cov. high-school emp.						
log(MW)	-0.075***	0.005	-0.000	0.047**	-0.004**	0.026
	(0.018)	(0.010)	(0.014)	(0.021)	(0.002)	(0.024)
Mean of dep. var.	0.178	0.019	0.047	0.227	0.003	0.526
Observations	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456
Adjusted R^2	0.121	0.010	0.017	0.077	0.006	0.069
Panel B: Uncov. high-school emp.						
log(MW)	-0.075***	0.005	0.000	0.049**	-0.004**	0.024
	(0.018)	(0.010)	(0.014)	(0.021)	(0.002)	(0.023)
Mean of dep. var.	0.178	0.019	0.047	0.227	0.003	0.526
Observations	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456
Adjusted R^2	0.121	0.010	0.017	0.078	0.006	0.069
Panel C: Cov. high-school emp. + intergov. transfer						
log(MW)	-0.074***	0.005	0.000	0.047**	-0.004**	0.025
	(0.018)	(0.010)	(0.014)	(0.022)	(0.002)	(0.024)
Mean of dep. var.	0.178	0.019	0.047	0.227	0.003	0.526
Observations	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456
Adjusted R^2	0.121	0.010	0.017	0.077	0.006	0.069
Panel D: Cov. high-school emp. + intergov. transfer + loan policy						
log(MW)	-0.075***	0.005	0.000	0.049**	-0.004**	0.025
	(0.018)	(0.010)	(0.015)	(0.022)	(0.002)	(0.024)
Mean of dep. var.	0.178	0.019	0.047	0.227	0.003	0.526
Observations	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456
Adjusted R^2	0.121	0.010	0.017	0.077	0.006	0.069
Panel E: Cov. high-school emp. + intergov. transfer + loan policy + rice policy						
log(MW)	-0.064**	-0.011	-0.020	0.090*	-0.008*	0.013
	(0.028)	(0.014)	(0.025)	(0.046)	(0.004)	(0.042)
Mean of dep. var.	0.178	0.019	0.047	0.227	0.003	0.526
Observations	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456	1,295,456
Adjusted R^2	0.121	0.010	0.017	0.078	0.006	0.070

Notes: This table shows estimates from various robustness checks of the main results. All specifications include province and time fixed effects. For all specifications, control variables include log of gross provincial product per capita, male and marriage dummy variables, age, and age squared. Significance levels are $^{*}p < 0.1,^{**}p < 0.05,^{***}p < 0.01$.
Source: LFS 2011–2015