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The Impact of a Minimum Wage Increase on Employment, Wages and Expenditures of Low-Wage Workers in Vietnam¹

Nguyen Viet Cuong²

Abstract

This study provides empirical evidence on the impact of a minimum wage increase on employment, wages, and expenditures of workers in the formal sector who have wages below the minimum level in Vietnam. Using the difference-in-differences with propensity score matching and Vietnam Household Living Standard Surveys 2004 and 2006, the paper finds that the minimum wage increase reduced employment of low-wage workers in the formal sector. However, workers who lost formal sector jobs were able to find jobs in the informal sector. The effect of the minimum wage increase on wages and expenditures of workers is not statistically significant.

JEL Classification: J31; J23; D31

Keywords: Minimum wage, employment, income, Vietnam, difference-in-differences, propensity score matching.

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1. Introduction

A minimum wage is the lowest hourly, daily or monthly wage that a government requires employers to pay to employees. The main objectives of the minimum wage are to increase the living standards of laborers, especially the poor and vulnerable, and to prevent exploitation of laborers. In addition, the minimum wage has other positive effects such as promotion of laborers' work and productivity, reduction of people covered in subsidy programs, increasing consumption, aggregate demand and generation of multiplier effects (Freeman, 1994; Dowrick and Quiggin, 2003; Gunderson, 2005).

In addition to the positive effects, the minimum wage can have unexpected effects. The main negative effect is to increase unemployment, especially among unskilled and low-wage workers. In the traditional economic theory, an increase in labor cost will reduce demand for labor. It means that the increased minimum wage normally leads to unemployment (Hamermesh, 1986). Before 1990s, there was consensus on the adverse impacts of the minimum wage on employment. Most of the empirical studies in the USA at the time showed that a 10 percent increase in the minimum wage resulted in a 1 to 3 percent reduction in employment (see Brown et al., 1982; Brown, 1999 and Card and Krueger, 1995).

However, in the "new minimum wage research", there is no consensus on the direction of the effect of the minimum wage on employment (Bazen, 2000; Lemos, 2004; Neumark and Wascher, 2007). In the economic theory, the minimum wage can have negligible effects on employment if the minimum wage is close to the competitive wage, or employers have bargaining power so that the elasticity of labor demand is less sensitive to the labor cost (Dickens et al., 1995, and 1999). In the monopsony model, the increased minimum wage can lead to increase in employment.

Recent empirical findings on the impact of the minimum wage on employment are not consistent. Negative effects of the minimum wage on employment, especially for young workers are found in studies on the USA and developed countries (Neumark and Wascher, 1992, 1993, 1994, 1995, 2002, 2002 and 2003; Burkhauser et al., 2000; Campolieti et al., 2005; Magan and Johnston, 1999; Abowd et al., 1999; Singell and

Terborg, 2007). In developing countries, the minimum wage is also found to have adverse effects on employment (e.g, Bell, 1997; Gindling and Terrell, 2004; Rama, 2001; Harrison and Scorse, 2005). However, other studies found that the minimum wage had positive effects on employment such as Turner and Demirlp (2001), Reich and Hall (2001), Katz and Krueger (1992), Card (1992), Card and Krueger (1994, 2000), Dickens et al. (1999), Montenegro and Pages (2004), Rama (2001).³

Vietnam is a developing country which has achieved high economic growth, with annual GDP growth rates of around 6 percent over the past 10 years. Poverty rates have declined remarkably from 58 to 16 percent between 1993 and 2006. To improve the living standards of the low-wage workers, the government has increased the nominal minimum monthly wage from 120 to more than 650 thousand VND during the period 1994-2009.

There are continuing debates about positive and negative impacts of minimum wage increases in Vietnam. There are a large number of advocates of the minimum wages, who argue that the minimum wage should be increased to compensate low-wage workers for the loss in real wages caused by high inflation. Increased wages can lead to an increase in aggregate demand and economic growth, especially in the context of economic slowdown (e.g., see Dan Tri, 2009a; Thai-Uyen, 2009; Duy-Tuan, 2009). The government said that they consulted enterprises about minimum wages, and minimum wage increases would have small effects on production, business and employment (Duy-Tuan, 2009). On the contrary, there are critics that increased wage minimum can result in high inflation (e.g. Dan tri 2009b, Bao Moi, 2009). Increased minimum wages can increase production costs and unemployment, and add burdens to enterprises, especially when there is on-going economic stagnation (Thai-Uyen, 2009).

The above arguments against or in favor of minimum wage increases are often made without empirical evidence on impact evaluation of minimum wage increases. The question on the impacts of minimum wage increases on employment as well as income of workers in Vietnam remains unanswered so far.

The main objectives of the paper are to present summary statistics of workers below the minimum wage and to measure the impact of the minimum wage increase on

³ For detailed review of studies on the minimum wage and employment, see Neumark and Wascher (2007).

employment, income and consumption expenditure of workers in the formal sector including State and private enterprises and organizations. The method of impact measurement used in this paper is difference-in-differences with propensity score matching, and the data are from Vietnam Household Living Standard Surveys in 2004 and 2006. The paper is expected to make an empirical contribution to the minimum wage literature by providing evidence on the effect of the minimum wage increase in Vietnam. There are only a few studies on relations between minimum wages and employment in Asian developing countries, and Vietnam is a developing and transition country with economic conditions very similar to many countries in Asia.

The remainder of this paper is organized as follows. Section 2 introduces data sources used in this study. Section 3 presents data on the minimum wages in Vietnam. Section 4 describes the methodology. Section 5 presents the impact estimates of the minimum wage increase. Finally, section 6 concludes.

2. Data Set

The study relies on data from two recent Vietnam Household Living Standard Surveys (VHLSS), which were conducted by the General Statistical Office of Vietnam (GSO) with technical support from the World Bank (WB) in the years 2004 and 2006. The 2004 and 2006 VHLSSs cover 9188 and 9189 households, respectively. The samples are representative for the national, rural and urban, and regional levels. The 2004 and 2006 VHLSSs have a panel of 4216 households, for which data is available for both years.

For the both surveys, the time of data collection took place mainly in June and September. Around 45 and 35 percent of sampled households were surveyed in June and September, respectively. The remaining 20 percent of the sample were surveyed in other months, mainly in July and October.

The surveys collected information by means of household and community level questionnaires. Information on households includes basic demography, employment and labor force participation, education, health, wage, income, expenditure, housing, fixed

assets and durable goods, and participation of households in poverty alleviation programs.

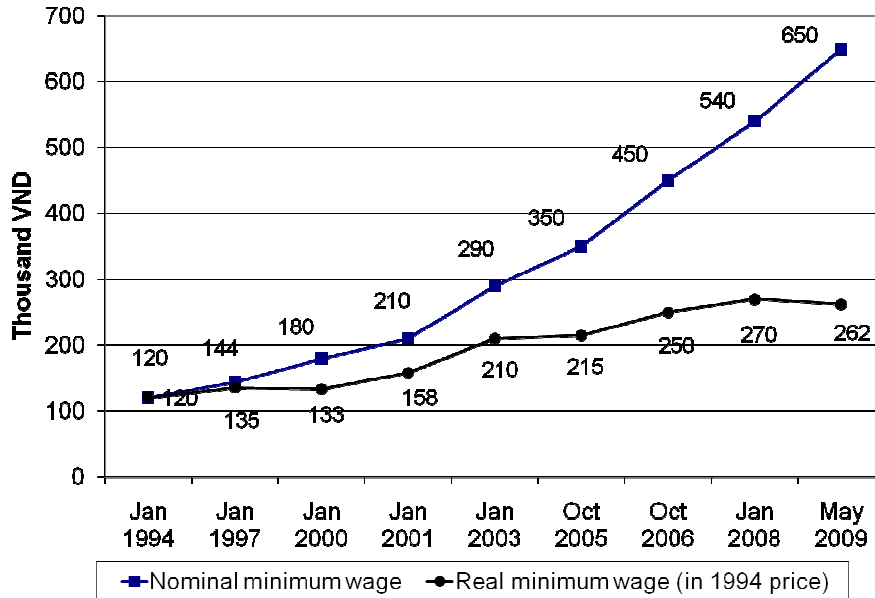
Expenditure and income per capita are collected using detailed questions. Expenditure includes food and non-food expenditure. Food expenditure includes purchased food and foodstuff and self-produced products of households. Non-food expenditure comprises expenditure on education, healthcare expenditure, expenditure on houses and commodities, and expenditure on power, water supply and garbage. Regarding income, household income can come from any source. Income includes income from agricultural and non-agricultural production, salary, wage, pensions, scholarship, income from loan interest and house rental, remittances and social transfers. Income from agricultural production comprises crop income, livestock income, aquaculture income, and income from other agriculture-related activities.

3. Minimum Wages and Wage Earners in Vietnam

3.1. Minimum Wage Adjustments

In Vietnam, the minimum wage is the lowest monthly wage for a simple worker in normal working conditions (Vu-Thieu, 2006). Vietnam has only minimum monthly wage. There is neither minimum daily nor hourly wage. The government adjusts the minimum wages when there is price inflation and economic growth. According to the Labor Law of Vietnam, the minimum wage is adjusted as the prices of commodities and services change. When the economy experiences high economic growth, the minimum wage is also increased to improve the living standard of workers. In addition, payment capacity of the State budget is considered when the minimum wage is adjusted, since wages of workers in the State sector are tied to the level of the minimum wage.

Figure 1. Minimum monthly wage in Vietnam (thousand VND)



Source: Government of Vietnam. 2006, 2008, and 2009

There have been 9 increases in the minimum monthly wage in Vietnam since 1993. The timing and the minimum wages are presented in Figure 1. It shows that the nominal minimum wage increased by 442 percent from 120 to 650 thousand VND during the period 1994-2009. However, the real minimum wage (in terms of the price of 1999) increased by 118 percent.

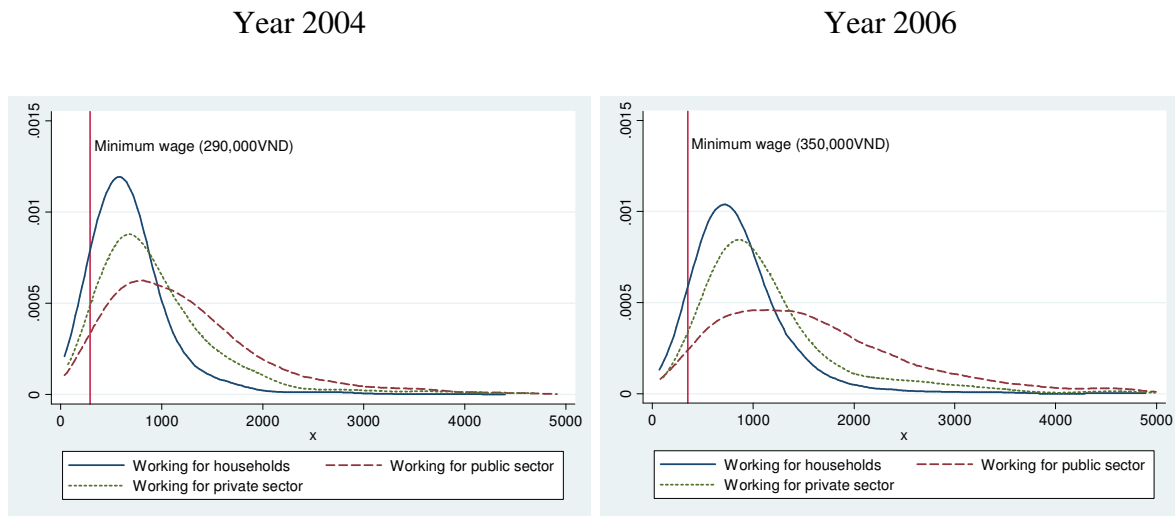
It should be noted that the minimum wages presented in Figure 1 are applied for the governmental sector and the domestic sector. Minimum wages applied for the foreign sector including foreign joint-venture enterprises, foreign-invested enterprises, international individuals, institutions and organizations are higher.

Since the available data are from VHLSSs 2004 and 2006, this paper will examine the impacts of minimum wage increase from 290 to 350 thousand VND in October 2005 on the income and employment of workers in the domestic sectors including public and private sectors. During the 2004-2006 period, there was no change in the minimum wages for the foreign and international sectors.

3.2. Minimum Wages and Workers' Wages

In this paper, wage earners are divided into formal and informal employment sectors. People who work for other households are called workers in the informal sector. These people often do not have labor contracts and are not enrolled in social insurance. People working for State and private enterprises/organizations are called workers in the formal sector.

Figure 2. Distribution of nominal monthly wage of workers by occupation sector



Source: Estimation VHLSSs in 2004 and 2006.

Although the minimum wage is applied for all laborers, there is no guarantee that all workers will be paid above the minimum wage, especially for workers in the informal sector. Figure 2 presents distribution of nominal monthly wage of workers from 15 to 60 years old in different sectors. This monthly wage is from the main employment of workers during the past 12 months. We do not consider wages from secondary employment, since most secondary employments are short-time and informal. It shows that there were a proportion of workers who received wages below the minimum wages.

Table 1 presents more detailed estimates on distribution and monthly wage of workers from 15 to 60 years old by employment sectors. It shows that the distribution of workers by employment sectors was almost unchanged during 2004-2006. In 2006, there were around 20 percent of people who were not involved in productive activities. They can be students, retired or unemployed workers. People who worked for their own

households accounted for 52.2 percent of the labor force. The percentage of people working for other households was 12.7 percent of the labor force. This group has the lowest average wages. The percentage of workers below the minimum wage in this group was 6.5 and 6.8 percent in 2004 and 2006, respectively.

The proportion of people working for State and private enterprises/organizations was 8.4 and 6.7 percent in 2006, respectively. Regarding wages, the State sector had the highest average wages, followed by the private formal sector. However, the private formal sector had a smaller fraction of workers below the minimum wage. The percentage of workers below the minimum wage in the formal private sector was 3.7 and 3 percent in 2004 and 2006, respectively. Meanwhile, there corresponding numbers for the State sector are 5.1 and 4.2 percent. The fact that there are a relatively large proportion of workers in the formal sectors having wages below the minimum level suggests that many employers do not comply with minimum wage regulations as well as the labor law.

Table 1. Distribution and nominal monthly wage of people involved in productive activities

	2004				2006			
	Percent	Monthly wage ('000 VND)	% with wage lower than 290,000 VND	% with wage lower than 350,000 VND	Percent	Monthly wage ('000 VND)	% with wage lower than 290,000 VND	% with wage lower than 350,000 VND
People from 15 to 60 years old								
Not working	18.6	-	-	-	20.0	-	-	-
Working for their households	54.3	-	-	-	52.2	-	-	-
Working for other households (informal sector)	12.8	671.9	6.5	11.4	12.7	738.7	6.8	15.2
Working for State sector (formal sector)	8.5	1091.3	5.1	7.6	8.4	1252.8	4.2	7.9
Working for private sector (formal sector)	5.9	918.9	3.7	7.6	6.7	985.0	3.0	6.7
Total	100	856.8	5.5	9.4	100	953.9	5.1	10.9
Number of obs.	25655				25708			

Source: Estimation from VHLSSs 2004 and 2006.

Table 1 also presents the percentage of workers below the minimum wage of the next period. In 2004, the proportion of workers below the level to which the minimum wage rose in the next year in the formal sector was 7.6 percent. This group can be mostly

affected by the minimum increase. This paper will measure impacts of the minimum wage increase on workers in the formal sector. For the informal sector, the corresponding number is 11.4. The paper does not evaluate the impact on this group, since the informal sector rarely follows the minimum wage regulations.⁴

Table 2 examines how the monthly wage and employment of workers below the minimum wage of the next period changes over time. Among workers employed in 2004, the proportion of people involved in productive activities in 2006 was 95.5 percent. This fraction for workers who had the 2004 monthly wages below 350 thousand VND in the informal and formal sectors was 90.6 and 97 percent, respectively. It is not clear that workers below the minimum wage in the formal sector were unemployed after the minimum wage increase. However, workers with wages below 350 thousand VND in 2004 tended to move out of the formal sector in 2006. Among workers in the formal sector in 2004, the fraction of those remaining in the formal sector in 2006 was 58.4 and 78.5 percent for workers with wages below and above the 350 thousand VND, respectively. This might be explained by two reasons. Firstly, it can be evidence that the minimum wage increase leads to unemployment in the formal sector. Secondly, low wages in the formal sector push workers to look for higher income jobs in the informal sector. As a result, if they find good jobs in the informal sector, they will move there.

Table 2 shows that workers with low wages in 2004 had a very high fraction of having wages lower than the minimum wage in 2006. Among the workers who had the 2004 wages below 350 thousand VND, the fraction of workers having the 2006 wages below 350 thousand VND was 15.3 and 27.3 percent for the informal and formal sectors, respectively. However, workers with low wages in 2004 experienced higher average growth rates of wages and consumption expenditures than workers with high wages over the period 2004-2006.

⁴ Not only the minimum wage but also other regulations such as health insurance, social insurance, labor contracts are not often implemented in the informal sector.

Table 2. Employment, monthly wages and expenditure of workers with wages above and under 350 thousand VND

Workers from 15 to 60 years old	Wages in 2004 (thousand VND)	No. of Obs.	Percent	% people working in 2006	% people working in the formal sector in 2006	% workers with nominal wage below 350,000 VND in 2006	Monthly wage in 2004 ('000 VND)	Monthly wage in 2006 – in 2004 price ('000 VND)	% increase in monthly wage	Monthly expend. in 2004 ('000 VND)	Monthly expend. in 2006 – in 2004 price ('000 VND)	% increase in monthly expend.
Working for other households in 2004 (informal sector)	Wage < 350	169	6.4	90.6	10.7	15.3	261.9	546.6	108.7	252.9	314.9	24.5
	Wage ≥ 350	1069	41.3	95.6	9.1	4.4	741.7	759.1	2.3	300.9	343.6	14.2
Working for formal sectors in 2004	Wage < 350	112	4.3	97.0	58.4	27.3	246.8	532.8	115.9	383.6	426.0	11.1
	Wage ≥ 350	1206	48.0	95.9	78.5	1.1	1084.6	1289.3	18.9	621.0	679.8	9.5
Total		2556	100	95.5	44.7	4.0	885.5	1029.0	16.2	476.6	529.0	11.0

Note: Monthly wages and expenditure are in thousand VND and in the 2004 price.
Source: Estimation from VHLSSs 2004 and 2006.

Table 3. Month wages and expenditure of people involved in productive activities in formal and informal sectors

Working people from 15 to 60 years old	No. of Obs.	Percent	% workers with wage lower than 350,000 VND in 2006	Monthly wage in 2004 ('000 VND)	Monthly wage in 2006 ('000 VND)	% increase in monthly wage	Monthly expend. in 2004 ('000 VND)	Monthly expend. in 2006 ('000 VND)	% increase in monthly expend.
Working in informal sector in both 2004 and 2006	723	35.6	5.7	670.6	722.6	7.8	281.8	327.2	16.1
Working in informal sector in 2004 but formal sector in 2006	110	5.8	5.8	772.9	803.8	4.0	376.9	419.5	11.3
Working in formal sector in 2004 but informal sector in 2006	113	6.2	3.8	823.4	1037.9	26.1	419.0	467.2	11.5
Working in formal sector in both 2004 and 2006	1015	52.4	2.8	1051.2	1260.9	19.9	626.6	685.4	9.4
Total	1961	100	4.0	885.5	1029.0	16.2	476.6	529.0	11.0

Note: Monthly wages and expenditure are in thousand VND and in the current price.
Source: Estimation from panel data of VHLSSs 2004 and 2006.

Table 3 examines changes in wages and expenditure of workers in different employment sectors during the period 2004-2006. The real monthly wage of workers in the formal sector in both 2004 and 2006 increased by around 19.9 percent during 2004-2006. Workers who moved from the informal sector to the formal one experienced only an increase of 4 percent in monthly wages. On the contrary, workers who moved from the formal sector to the informal one increased their wages substantially by around 26.1 percent. Workers in the formal sector in both 2004 and 2006 also had a high growth rate of monthly wages, at 7.8 percent. Regarding consumption expenditure, workers with low wages had higher growth rates of consumption expenditure than workers with high wages during 2004-2006.

4. Methodology of Impact Evaluation

4.1. Parameter of Interest

The main objective of impact evaluation of a program is to assess the extent to what the program has changed outcomes of subjects. In this study, we aim to measure the effect of minimum wages on outcomes of workers in the formal sector. Denote D as a binary variable indicating exposure of a person to a minimum wage increase, i.e. D equals 1 if she can be affected by the minimum wage increase, and D equals 0 otherwise. In this paper, D equals 1 for workers who had employment in the formal sector and monthly wages below 350 thousand VND in 2004. These people are expected to be affected by the increase of minimum wage from 290 to 350 thousand VND in 2005. Further let Y denote the observed value of an interested outcome. This variable can have two potential values depending on the value of D , i.e. $Y = Y_1$ for $D = 1$, and $Y = Y_0$ for $D = 0$.⁵ For consistency with the literature of impact evaluation, in this paper, workers who are affected by or exposed to the minimum wage increase are sometimes called participants or treated, and workers who are not affected by the minimum wage increase are sometimes called non-

⁵ Y can be a vector of outcomes, but for simplicity let's consider a single outcome of interest.

participants or untreated. In addition, the minimum wage increase is sometimes called the program.

The most popular parameter of the program impact is Average Treatment Effect on the Treated (ATT) (Heckman et al., 1999), which is the expected impact of the program on the actual participants:⁶

$$ATT = E(Y_1 - Y_0 | D = 1) = E(Y_1 | D = 1) - E(Y_0 | D = 1) \quad (1)$$

This parameter can be varied across a vector of the observed variables X :

$$ATT_{(X)} = E(\Delta | X, D = 1) = E(Y_1 | X, D = 1) - E(Y_0 | X, D = 1) \quad (2)$$

Estimation of ATT is not straightforward, since $E(Y_0 | D = 1)$ is not observed and cannot be estimated directly. $E(Y_0 | D = 1)$ is called counterfactual which would have been the expected outcome of participants if they had not been affected by the minimum wage.

4.2. Difference-in-Differences with Matching Method

When panel data on the treatment and control groups before and after the treatment are available, the difference-in-differences estimator can be used to estimate the impact of the treatment program. The difference-in-differences estimator can be combined with matching to control differences in observed variables between the treatment and control groups. The basic idea of the matching method is to find a comparison group that has the same (or at least similar) distribution of the variables X as that of the treatment group⁷. Compared with difference-in-differences regression, the matching method has the main advantage that it does not require an assumption on the functional form of outcome. Thus it can avoid bias caused by misspecification of outcome functions.

⁶ There are other parameters such as average treatment effect (ATE), local average treatment effect, marginal treatment effect, or even effect of “non-treatment on non-treated” which measures what impact the program would have on the non-participants if they had participated in the program, etc.

⁷ There is a large amount of literature on matching methods of impact evaluation e.g. see Rubin (1977), Rosenbaum and Rubin (1983), Heckman et al. (1997), Dehejia and Wahba (1998), and Smith and Todd (2005).

To describe the method, let Y_0^{2004} denote the outcome in 2004, i.e., before the 2005 minimum wage increase. After the minimum wage increase, the potential outcomes in 2006 are denoted by Y_0^{2006}, Y_1^{2006} corresponding to the states of no minimum wage increase and minimum wage increase. The $ATT_{(X)}$ after the minimum wage increase is defined as:

$$ATT_{(X)} = E(Y_1^{2006}|X, D = 1) - E(Y_0^{2006}|X, D = 1) \quad (3)$$

The difference-in-differences with matching relies on an assumption that conditional on X , the difference in the expectation of outcomes between the participants and non-participants is unchanged before and after the minimum wage increase, i.e.:

$$E(Y_0^{2004} | X, D = 1) - E(Y_0^{2004} | X, D = 0) = E(Y_0^{2006} | X, D = 1) - E(Y_0^{2006} | X, D = 0). \quad (4)$$

Under this assumption, the conditional parameter $ATT_{(X)}$ can be identified by the matching method, since:

$$\begin{aligned} ATT_{(X)} &= E(Y_1^{2006}|X, D = 1) - E(Y_0^{2006}|X, D = 1) - [E(Y_0^{2006}|X, D = 0) - E(Y_0^{2004}|X, D = 0)] \\ &\quad + [E(Y_0^{2006}|X, D = 1) - E(Y_0^{2004}|X, D = 1)] \\ &= [E(Y_1^{2006}|X, D = 1) - E(Y_0^{2006}|X, D = 0)] - [E(Y_0^{2004}|X, D = 1) - E(Y_0^{2004}|X, D = 0)] \end{aligned} \quad (5)$$

The unconditional parameter is also identified, since:

$$ATT = \int_{X|D=1} ATT_{(X)} dF(X|D = 1). \quad (6)$$

To estimate the program impact, the non-participants are matched with the participants based on their variables X before and after the program. The matched non-participants will form a control group. To find a control group who has similar variables X , we require a so-called common support assumption:

$$0 < P(D = 1 | X) < 1, \quad (7)$$

which states that there are non-participants who have the X variables similar to those of the participants.

A problem in the matching is how to match non-participants with participants. There will be no problem if there is a single conditioning variable X . However, X are often a vector of variables, and finding “close” non-participants to match with

participants is not straightforward. Since a paper by Rosenbaum and Rubin (1983), a widely-used way to find the matched sample is the propensity score matching.⁸ Non-participants and participants are matched based on the closeness of the propensity score, which is equal to the probability of being assigned into the program. In this paper, the matching based on the propensity score is employed.

In addition, depending on the number of non-participants are matched with a participant, we can have different matching estimators. In this paper, we use nearest-neighbors and kernel matching to examine the sensitivity the impact estimates. The matching estimator is based on equation (5). It is equal to the difference in differences in outcomes between the treatment group and the control group before and after the minimum wage increase. The formulas of the estimators are presented in Appendix 2. The standard errors are calculated using bootstrap techniques.⁹

5. Impact Estimation

5.1. Definition of Treatment and Control Groups

In this paper, we estimate the impact of the minimum wage increase in 2005 on employment, monthly wage and consumption expenditure on workers who worked in the formal sectors (State and private) and had monthly wages below 350 thousand VND in 2004.¹⁰ These workers are expected to be exposed to the effect of the minimum wage

⁸ Other matching methods can be subclassification (see, e.g., Cochran and Chambers, 1965; Cochran, 1968) and covariate matching (Rubin, 1979, 1980).

⁹ This bootstrap is implemented by repeatedly drawing samples from the original sample of the VHLSS panel data. Since the VHLSSs sample selection follows stratified random cluster sampling, communes (i.e., primary sampling units) instead of households are bootstrapped in each stratum (Deaton, 1997). In other words, the bootstrap is made of communes (i.e., clusters) within strata. The number of replications is 500. We also tried to bootstrap households instead of communes, and the results of both possibilities are very similar.

Abadie and Imbens (2006) show that bootstrap can give invalid standard errors for the nearest neighbor matching estimator. However, there has not been evidence on the validity of standard errors for other matching estimators using bootstrap. Most empirical studies rely on the bootstrap to estimate standard errors of matching estimators.

¹⁰ As mentioned in the previous section, we do not evaluate the impact on workers in the informal sector, since the informal sector rarely follows the labor regulations such as contract, insurance and minimum wages.

increase. The treatment group does not include workers in the foreign sector, since there was no adjustment of minimum wages for this sector during the 2004-2006 period.

There are two control groups. The first control group is workers who were in the formal sector and had monthly wages from 350 to 650 thousand VND in 2004. The matching is performed between workers with monthly wages below and above 350 thousand VND. This way is similar to method based on discontinuity design (see, e.g., Van der Klaauw, 2002; Hahn, et al., 2001). Ideally, we should have the control group and treatment group just around 350 thousand VND. However, there are few observations around the 350 thousand VND level in the data set, and we have to use all the observations below 350 thousand VND as the treatment group and all the observations from 350 to 650 thousand VND as the control group. The number of observations in the treatment and control groups is 112 and 351, respectively.¹¹ It should be noted that the number of observations in the treatment groups is relatively small, and as a result the estimation results should be interpreted with caution on the representativeness of the sampled observations.

Estimating the effect of minimum wages on wages is challenging due to lack of a clean control group. Using the control group from the formal sector can underestimate effects of the minimum wage increase on monthly wages, since workers above 350 thousand VND in the formal sector, especially in the State sector can be also affected by the minimum wage increase. In some State enterprises and organizations, wage of a worker can be set up equal to a wage coefficient multiplied by the minimum wage. For example, a worker who has a wage coefficient of 5 will receive wage equal to the minimum wage multiplied by 5. If the minimum wage increases from 290 to 350 thousand VND, her wage will automatically increase from 1450 to 1750 thousand VND (even that her wage before the minimum wage increase is much higher than the new minimum wage).

The second control group is constructed from the wage earners in the informal sector in both 2004 and 2006. The number of observations in this control group is 99. The

¹¹ We examined the sensitivity of the impact estimates to the definition of the control group by changing the wage level to define the control group from 650 thousand VND to 600 and to 500 thousand VND. The results are quite similar. We do not present results of impact estimations using these other treatment groups in this paper. However, the results can be provided on request.

treatment group in this case includes workers in formal sectors in both 2004 and 2006. As a result, the number of observations in the treatment group is only 64. This control group is expected to be affected negligibly by the minimum wage increase. In addition, the control group includes those who had monthly wages below 350 thousand VND in 2004 so that they can have similar wages at the baseline as the control group. However, estimation results using this control group should be interpreted with great caution. Workers in the informal sector often do not have written labor contracts, and the minimum wage is not formally applied in the informal section. However, it is possible that when the minimum wage increases, workers in the informal sector will ask an increase in their wages. As a result, the control group can be also affected by the minimum wage increase.

We do not include self-employed workers in any control group, since the definition of employment can be different between self-employed workers and employed workers and there is no data on wages for self-employed workers. All individuals in the treatment and control groups are from 15 to 60 years old in 2004. In this paper, we do not estimate impacts separately for the State or private sectors, since the number in each sector is very small.

The 2004 data are regarded as the baseline data of the 2005 minimum wage increases, while the 2006 data are regarded as the post-treatment data of the minimum wage increase. It should be noted that the minimum wages were also increased in October 2006 (section 3.1). However, as mentioned in section 2, the 2006 VHLSS was mainly conducted in June and September 2006. Thus the 2006 VHLSS was not affected by the minimum wage increase in October 2006.

It should be noted that the treatment group and the first control group differ in the 2004 wages, while the treatment group and the second control group differ in terms of employment sector (formal versus informal sector). Thus the treatment group and the two control groups can differ in both observed and unobserved characteristics. Matching can eliminate the difference in observed characteristics, and difference-in-differences estimation can eliminate the difference in time-invariant unobserved characteristics between the treatment and control groups. The main assumption for the difference-in-

differences with matching method is that there is no difference in the expectation of time-variant unobserved variables between the treatment and control groups.

The estimates will be biased if the above assumption does not hold. For example, suppose that non-cognitive skills have a positive effect on employment, and low-wage workers in the treatment groups have lower non-cognitive skills than high-wage workers in the first control group. If the gap in non-cognitive skills between the treatment and control groups tends to increase overtime, then our difference-in-differences will overestimate the effect of the minimum wage increase. It means that without the minimum wage increase, low-wage workers are still more likely to lose job than high-wage workers. Similarly, the treatment group and the second control group can differ in time-variant unobserved variables, which can cause our estimates biased. However, it is expected that most important unobserved variables such working motivation and non-cognitive skills are time-invariants during a not so long time period 2004-2006.

5.2. Propensity Score Estimation

The first step in measuring the impact of the minimum wage increase is to predict the propensity score, i.e., the probability of having monthly wage below 350 thousand VND. Since the dependent variable is binary, a logit regression is used. The main problem in the estimation is how to select explanatory variables. The explanatory variables include age, sex, married, ethnicity, education and occupation, households' land, regional and urban variables. To ensure the explanatory variables be exogenous to the minimum wage increase, all of them are before the minimum wage increase, i.e., in the 2004 VHLSS. The variables are described in Table A.1 of Appendix 1. In order to control for inflation, we have deflated all outcome variables in terms of 2004 prices.

Table A.2 presents the logit regressions. The full models use all the available explanatory variables, while the partial models keep only variables which are statistically significant at 10% (using stepwise regressions).¹² The partial models are used for prediction of propensity scores. Two samples are used: (i) the first with both treatment

¹² Both backward and forward stepwise regressions results in the same models.

and control groups from the formal sector; (ii) the second with the treatment group from the formal sector and the control group from the informal sector.

Explanatory variables in the logit regressions have expected signs. For the first sample, age has a negative sign, while age squared has a positive sign (Table A.2). It means that the probability of having wages below the minimum wages tend to increase when workers are young, and then decrease when workers become older. Female are more likely to have wages below the minimum wages than male. Ethnic minority workers are more likely to have wages below the minimum wages than Kinh (Vietnamese) workers. The second sample in Table A.2 shows that workers who are married and have higher education are more likely to work in the formal sector. On the contrary, workers who are unskilled and agricultural are more likely to work in the informal sector.

To examine the common support, Figure A.1 of the propensity score is produced. There are many untreated workers having similar propensity scores as the treated workers. It should be noted that the use of the predicted propensity score is mainly aimed to overcome the multidimensionality problem of matching by the explanatory variables (covariates). The quality of a constructed comparison group should be assessed by testing whether the distribution of characteristics covariates is similar between the comparison and treatment groups given the predicted propensity score. Thus, we test the equality of the mean of covariates between the treatment and comparison using t-test, and we cannot reject the equality of the mean of X between the treatment and matched groups.¹³

5.3. Impact Estimation

Table 4 presents impacts of the minimum wage increase in 2005 on employment of the workers in the formal sector and with wage below the 350 thousand VND in 2004 using three matching estimators including 5 nearest neighbors and kernel matching with

¹³ The results of balancing test for these estimators are not presented in this paper. However, the test results are provided for reviewers and can also be provided for readers on request. We relied on the Stata command called “psmatch2” to perform the matching estimators. However, we do not use the original command for the estimation, since the command does not allow sampling weights. We revised the command to allow for sampling weights. We also estimated the impacts without sampling weights. The results are very similar to those using the sampling weights.

bandwidth of 0.01 and 0.05. It shows that the impact of the minimum wage increase on overall employment is very small and not statistically significant. However, the minimum wage increase has negative and statistically significant effects on employment in the formal sectors. Workers with low wages tend to lose jobs in the formal sector and find jobs in the informal sector.

For additional robust analysis, we run parametric difference-in-differences regressions (Table A.3). Similarly to the matching method, the minimum wage increase is found to have a negative effect on employment in the formal sector but not a significant effect on overall employment.

However, the finding on employment effects should be interpreted with caution. The impact of the minimum wage increase can be overestimated if workers with too low wages want to quit work in the formal sector to work for their households or other households. The difficulty in interpretation results from the difference in wages between the treatment group and the control group (the treatment group has wages below the level of 350 thousand VND, whereas the control group has wages from this level and above).

To examine this issue, we compute the growth rate of monthly wages during 2004-2006 for workers who had the 2004 wages below 350 thousand VND and remained in the formal sector for both 2004 and 2006, and for workers who had the 2004 wages below 350 thousand VND and switched from in the formal sector in 2006 to the informal sector in 2004. If workers moving from formal to informal sectors to seek higher income jobs, we would expect that they would have higher growth rate of wages than those sticking to the formal sector. The corresponding growth rates are around 120 and 112 percent, respectively. Workers who switched from in the formal sector to the informal sector experienced a higher growth rate than workers who remained in the formal sector. However, this difference is not statistically significant.

Table 4. The impact on employment: control group from the formal sector

Outcomes and matching schemes	2004			2006			Diff-in-diff
	Treated	Matched Control	Diff	Treated	Matched Control	Diff	
	(1)	(2)	(3)=(1)-(2)	(4)	(5)	(6)=(4)-(5)	(7)=(6)-(5)
<i>Have job (%)</i>							
Five nearest neighbors matching	100.0 [0.0]	100.0 [0.0]	0.0 [0.0]	97.0*** [1.5]	95.8*** [2.2]	1.2 [2.5]	1.2 [2.5]
Kernel matching: bandwidth = 0.01	100.0 [0.0]	100.0 [0.0]	0.0 [0.0]	97.0*** [1.5]	95.9*** [1.8]	1.1 [2.3]	1.1 [2.3]
Kernel matching: bandwidth = 0.05	100.0 [0.0]	100.0 [0.0]	0.0 [0.0]	97.0*** [1.5]	95.5*** [1.4]	1.5 [2.0]	1.5 [2.0]
<i>Have formal sector jobs (%)</i>							
Five nearest neighbors matching	100.0 [0.0]	100.0 [0.0]	0.0 [0.0]	58.3*** [4.6]	69.4*** [4.9]	-11.2* [6.8]	-11.2* [6.8]
Kernel matching: bandwidth = 0.01	100.0 [0.0]	100.0 [0.0]	0.0 [0.0]	58.3*** [4.6]	69.2*** [4.3]	-10.9* [6.3]	-10.9* [6.3]
Kernel matching: bandwidth = 0.05	100.0 [0.0]	100.0 [0.0]	0.0 [0.0]	58.3*** [4.6]	70.0*** [3.2]	-11.8** [5.7]	-11.8** [5.7]

Note: The treated are workers who worked in the formal sector and had monthly wages below 350,000 VND in 2004. The matched control is also workers in the formal sector in 2004 and had monthly wages from 350,000 to 650,000 VND in 2004. The treated and matched groups have been matched based on the closeness of propensity scores.

Columns (1) and (2) report the mean outcomes of the treatment group and the matched control group in 2004, respectively. Column (3) is the difference in the mean outcome between the treatment and control groups in 2004. Similarly, columns (4) and (5) present the mean outcomes of the treatment group and the matched control group in 2006, respectively. Column (6) is the difference between columns (4) and (5). Column (7) is the difference between columns (3) and (6). The difference-in-differences estimator is presented by equation (A.3) in Appendix 2.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Standard errors in bracket (Standard errors are calculated using bootstrap with 500 replications. Standard errors are also corrected for sampling weights and cluster correlation).

Source: Estimation from panel data of VHLSSs 2004 and 2006.

In addition, we examine the transition from the formal to informal sector by running a difference-in-differences regression of probability of having a formal job on wages in 2004 using a sample, which including laborers in the formal sector in 2004 with monthly wage between 350,000 VND and 1,000,000 VND in 2004. Employment of these workers was expected not affected by the minimum wage increase. If low-wage workers are more likely to move to the informal sector, the effect of wages in 2004 should be negative. However, we found a positive and not significant effect of the 2004 wages on the probability of remaining employed in the formal sector. Thus there is not strong

evidence that low-wage workers were moving from the formal to informal sector for higher income.

Table 5 presents the impact estimates on monthly wages. For the both control groups, the effect of minimum wages on monthly wages is not statistically significant. Construction of a clean control group for measurement of the effect on wages is challenging. As presented, wages on some workers in the control group which include workers in the formal sector having wages above 350 thousand VND can also be affected by the minimum wage increases. The control group which includes worker in the informal sector might not be valid, since they can be different from the control group in terms on time-variant unobserved variables.

Table 5. The impact on monthly wages

Outcomes and matching schemes	2004			2006			Diff-in-diff
	Treated	Matched Control	Diff	Treated	Matched Control	Diff	
	(1)	(2)	(3)=(1)-(2)	(4)	(5)	(6)=(4)-(5)	(7)=(6)-(5)
<i>Control group from the formal sector</i>							
Five nearest neighbors matching	246.5*** [8.8]	498.0*** [9.2]	-251.5*** [12.4]	531.7*** [32.9]	749.5*** [55.3]	-217.8*** [65.8]	33.7 [63.9]
Kernel matching: bandwidth = 0.01	246.5*** [8.8]	499.3*** [7.6]	-252.8*** [11.6]	531.7*** [32.9]	754.9*** [60.2]	-223.2*** [68.7]	29.6 [67.4]
Kernel matching: bandwidth = 0.05	246.5*** 8.8	497.2*** 6.1	-250.7*** [10.2]	531.7*** [32.9]	758.0*** [42.1]	-226.3*** [54.0]	24.4 [52.1]
<i>Control group from the informal sector</i>							
Five nearest neighbors matching	248.6*** [9.7]	241.4*** [16.4]	7.2 [19.0]	508.6*** [37.1]	580.2*** [131.2]	-71.6 [133.4]	-78.8 [142.4]
Kernel matching: bandwidth = 0.01	248.6*** [9.7]	251.0*** [13.9]	-2.4 [16.6]	508.6*** [37.1]	589.6*** [99.1]	-81.0 [103.7]	-78.6 [109.0]
Kernel matching: bandwidth = 0.05	248.6*** [9.7]	238.4*** [15.8]	10.2 [18.1]	508.6*** [37.1]	585.9*** [120.9]	-77.3 [123.7]	-87.6 [132.7]

Note: For the upper panel of the table, the treated are workers who worked in the formal sector and had monthly wages below 350,000 VND in 2004. The matched control is also workers in the formal sector in 2004 and had monthly wages from 350,000 to 650,000 VND in 2004.

The lower panel of the table uses the sample of workers in workers in both the formal and informal sectors who have monthly wages in 2004 below 350,000 VND. The treatment group includes informal workers, while the control group includes informal workers.

The columns in this table have the same interpretation as columns in Table 4.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Standard errors in bracket (Standard errors are calculated using bootstrap with 500 replications. Standard errors are also corrected for sampling weights and cluster correlation).

Source: Estimation from panel data of VHLSSs 2004 and 2006.

Finally, Table 6 presents the impact estimates on per capita monthly expenditure. It shows that impacts on expenditure are quite small and not statistically significant. Consumption expenditure per worker is calculated by dividing household expenditure by household size. Thus it is difficult for the change in wages of some members to have significant impacts on a household's consumption, especially when the proportion of people having jobs in the formal sector is rather small in Vietnam.

Table 6. The impact on monthly per capita expenditure

Outcomes and matching schemes	2004			2006			Diff-in-diff
	Treated	Matched Control	Diff	Treated	Matched Control	Diff	
	(1)	(2)	(3)=(1)-(2)	(4)	(5)	(6)=(4)-(5)	(7)=(6)-(5)
<i>Control group from the formal sector</i>							
Five nearest neighbors matching	383.6*** [30.6]	409.9*** [27.7]	-26.3 [38.2]	426.0*** [27.2]	459.8*** [32.6]	-33.8 [39.0]	-7.5 [35.3]
Kernel matching: bandwidth = 0.01	383.6*** [30.6]	420.7*** [21.8]	-37.1 [35.6]	426.0*** [27.2]	471.5*** [27.4]	-45.5 [36.9]	-8.4 [33.1]
Kernel matching: bandwidth = 0.05	383.6*** [30.6]	391.1*** [16.2]	-7.5 [33.1]	426.0*** [27.2]	467.0*** [21.5]	-41.0 [32.6]	-33.5 [29.8]
<i>Control group from the informal sector</i>							
Five nearest neighbors matching	395.9*** [36.9]	303.4*** [39.7]	92.5* [49.4]	441.6*** [33.3]	397.2*** [58.2]	44.5 [62.6]	-48.0 [47.8]
Kernel matching: bandwidth = 0.01	395.9*** [36.9]	295.0*** [36.1]	100.9*** [47.4]	441.6*** [33.3]	379.9*** [50.5]	61.8 [55.9]	-39.1 [46.4]
Kernel matching: bandwidth = 0.05	395.9*** [36.9]	302.3*** [38.9]	93.6* [49.6]	441.6*** [33.3]	395.0*** [62.3]	46.7 [65.7]	-47.0 [52.3]

Note: For the upper panel of the table, the treated are workers who worked in the formal sector and had monthly wages below 350,000 VND in 2004. The matched control is also workers in the formal sector in 2004 and had monthly wages from 350,000 to 650,000 VND in 2004.

The lower panel of the table uses the sample of workers in workers in both the formal and informal sectors who have monthly wages in 2004 below 350,000 VND. The treatment group includes informal workers, while the control group includes informal workers.

The columns in this table have the same interpretation as columns in Table 4.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Standard errors in bracket (Standard errors are calculated using bootstrap with 500 replications. Standard errors are also corrected for sampling weights and cluster correlation).

Source: Estimation from panel data of VHLSSs 2004 and 2006.

6. Conclusions

Since the year 1993, there have been 9 adjustments of the minimum monthly wage in Vietnam. All of these adjustments are increases in the minimum wage. The main reason for the minimum wage increase is to compensate for high inflation and to increase welfare of the low-wage workers. However, this positive effect can be mitigated if the minimum wage increases can result in unemployment. This paper is the first attempt to measure the impact of the minimum wage increase on employment, wages and expenditures of workers who are below the minimum wage and working in the formal sector, i.e. State and private enterprises/organizations in Vietnam.

Using data from VHLSSs 2004 and 2006, the paper found that there were a large proportion of workers receiving wage below the minimum wage. The proportion of workers below the minimum wage in the formal private sector was 3.7 and 3 percent in 2004 and 2006, respectively. Meanwhile, there corresponding numbers for the State sectors are 5.1 and 4.2 percent. In the informal sector (i.e., households are employers), the proportion of workers below the minimum wage in this group was 6.5 and 6.8 percent in 2004 and 2006, respectively.

Next, the paper measures impacts of the minimum wage increase in 2005 on employment, monthly wages and consumption expenditure of the workers in the formal sector and having wages below 350 thousand VND in 2004 using the difference-in-differences with propensity score matching. It is found that that the impact on overall employment is very small and not statistically significant. However, the minimum wage increase has a negative and statistically significant effect on employment in the formal sectors. Workers with low wage can lose the job in the formal sector because of the minimum wage increase.

There are several policy implications resulting from this study's findings. Firstly, there are still a relatively large proportion of workers in the formal sector who are paid below the minimum wage. These workers might not have labor contract or be registered to Vietnam Social Securities. If the minimum wages are not effective for low-income workers, increasing minimum wages will mainly benefit workers who are working in the

State sector with labor contracts and being paid high wages (tied to the minimum wage level). The government should have more measures and regulations to enforce the labor law and the minimum wages so that not only enterprises but also individuals and households are not allowed to pay their employers below the minimum wages. Secondly, although increased minimum wages did not increase unemployment as a whole, it is found that workers below the minimum wages lost formal sector jobs. Thus attention should be paid to low-wage workers in the formal workers to protect them from minimum-wage. Thirdly, although the informal sector will be shrunk because of economic transition, it can still play a role in mitigating the adverse effect of economic shocks. When there is an employment shock, people who lost employment in the formal sector can find work in the informal sector, at least in the short-run.

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Appendix 1: Tables and Figures

Table A.1. Mean and standard deviation of variables in the 2004 VHLSS

Variables	Type	The sample of workers in formal sector who had monthly wages in 2004 below 650,000 VND		The sample of workers in formal and informal sectors who had wages monthly in 2004 below 350,000 VND	
		Mean	Standard Deviation	Mean	Standard Deviation
Married (yes = 1)	Binary	0.629	0.483	0.470	0.501
Age	Discrete	32.7	11.2	30.7	13.1
The square of age	Discrete	1194.5	795.4	1112.0	914.9
Sex (male = 1, female =0)	Binary	0.578	0.494	0.498	0.502
Educational degree (yes = 1)					
Less than secondary education	Binary	0.269	0.444	0.495	0.502
With secondary degree	Binary	0.432	0.496	0.340	0.475
With technical degree or post-secondary	Binary	0.299	0.458	0.165	0.373
Main occupation (yes = 1)					
Agriculture/forestry/fishery	Binary	0.063	0.243	0.174	0.381
Unskilled workers	Binary	0.253	0.435	0.398	0.491
Household variables					
Ethnic minorities (yes = 1)	Binary	0.088	0.283	0.105	0.307
Area of annual crop land per capita (1000 m2)	Continuous	0.532	0.978	0.307	0.508
Aquaculture surface per capita (1000 m2)	Continuous	0.026	0.253	0.016	0.161
Regional dummy variables					
Red River Delta	Binary	0.248	0.433	0.302	0.461
North East	Binary	0.177	0.382	0.069	0.255
North West	Binary	0.029	0.167	0.022	0.149
North Central Coast	Binary	0.100	0.300	0.102	0.304
South Central Coast	Binary	0.130	0.337	0.053	0.224
Central Highlands	Binary	0.033	0.178	0.042	0.202
South East	Binary	0.122	0.328	0.085	0.280
Mekong River Delta	Binary	0.161	0.368	0.324	0.470
Urban areas (yes = 1)	Binary	0.316	0.465	0.306	0.462
Number of observations		463		163	

Note: The first sample used to compute estimates in this table includes laborers in the formal sector with age from 15 to 60 and monthly wages in 2004 below 650 thousand VND. The second sample includes laborers in the formal and informal sectors with age from 15 to 60 and monthly wages in 2004 below 350 thousand VND.

Mean and standard deviation are also corrected for sampling weights.

Source: Estimation from panel data of VHLSSs 2004 and 2006.

Table A.2. Logit regression of propensity score

Explanatory variables	The sample of workers in formal sector who had monthly wages in 2004 below 650,000 VND		The sample of workers in formal and informal sectors who had monthly wages in 2004 below 350,000 VND	
	Full model	Model with significant variables	Full model	Model with significant variables
Married	0.1966 [0.3257]		1.5028* [0.8479]	1.2752** [0.5118]
Age	-0.1489* [0.0773]	-0.1144* [0.0691]	-0.05 [0.1530]	
The square of age	0.0021** [0.0010]	0.0017* [0.0010]	0.0008 [0.0020]	
sex (male = 1, female =0)	-0.5442** [0.2589]	-0.5112** [0.2534]	0.1488 [0.5360]	
Lower or upper secondary	0.3212 [0.3169]		1.4036** [0.5929]	1.0394* [0.5755]
Technical degree or post secondary	-0.0909 [0.3571]		2.2060** [0.9748]	1.5653** [0.6652]
Agriculture/forestry/fishery	-0.278 [0.6532]		-4.6483*** [1.1001]	-3.5864*** [0.8426]
Unskilled workers	-0.3458 [0.3146]		-1.6943*** [0.6373]	-1.6630*** [0.5785]
Ethnic minorities (yes = 1)	1.9255*** [0.4700]	1.7718*** [0.4335]	1.0833 [1.0788]	
Area of annual crop land per capita (1000 m2)	-0.4069* [0.2174]	-0.4055** [0.1918]	0.0641 [0.7435]	
Aquaculture surface per capita (1000 m2)	0.1741 [0.4145]			
Red River Delta	Omitted			
North East	-0.652 [0.4064]	-0.6020* [0.3586]	1.5951 [1.0363]	
North West	-0.4134 [0.8444]		-1.5256 [1.5186]	
North Central Coast	0.2509 [0.3922]		2.2944** [0.9814]	1.5629* [0.9104]
South Central Coast	-0.7200* [0.4140]	-0.7487** [0.3761]	0.7864 [1.3364]	
Central Highlands	-1.2979 [0.8739]	-1.3914* [0.7903]	-1.499 [1.1486]	
South East	-1.0070** [0.5081]	-1.0144** [0.4522]	1.9496 [1.2361]	
Mekong River Delta	-0.3851 [0.3931]		0.3309 [0.6655]	
Urban areas (yes = 1)	0.0283 [0.2852]		-0.9099 [0.6141]	
Constant	1.7397	1.1782	-1.0037	-1.0108*

Explanatory variables	The sample of workers in formal sector who had monthly wages in 2004 below 650,000 VND		The sample of workers in formal and informal sectors who had monthly wages in 2004 below 350,000 VND	
	Full model	Model with significant variables	Full model	Model with significant variables
	[1.2852]	[1.1093]	[2.5626]	[0.6053]
Observations	463	463	163	163
R-squared	0.08	0.06	0.42	0.36

Note: In the sample of workers in the formal sector who have monthly wages in 2004 between 0 and 650,000 VND, the treatment group includes workers having monthly wages below 350,000 VND, and the control group includes workers having wages equal to or above 350,000 VND. Thus the dependent variable is a dummy variable indicating ‘monthly wage below 350,000VND’.

In the sample of workers in workers in both the formal and informal sectors, the treatment group includes informal workers having monthly wages below 350,000 VND, and the control group includes informal workers having monthly wages below 350,000 VND. Thus the dependent variable is a dummy variable indicating ‘workers in the formal sector’.

Robust standard errors in brackets. Standard errors are also corrected for sampling weights and cluster correlation.

* significant at 10%; ** significant at 5%; *** significant at 1%.

Source: Estimation from panel data of VHLSSs 2004 and 2006.

Table A.3. Difference-in-differences regressions: marginal effects

Explanatory variables	Sample of workers in the formal sector with monthly wage below 650,000 VND		Sample of workers in the formal sector with monthly wage from 350,000 to 1,000,000 VND	
	Dependent variables is 'employed'	Dependent variables is 'employed in formal sector'	Dependent variables is 'employed'	Dependent variables is 'employed in formal sector'
Below minimum wages (yes = 1) * Year 2006	0.00011 [0.00075]	-0.11992* [0.06764]		
Married	0.00759 [0.01124]	0.09154 [0.06271]	0.03323 [0.02343]	-0.02394 [0.05123]
Age	0.00055 [0.00067]	0.02435 [0.01494]	0.00761** [0.00384]	0.03367** [0.01357]
The square of age	-0.00001 [0.00001]	-0.00040** [0.00020]	-0.00011** [0.00005]	-0.00047** [0.00018]
Sex (male = 1, female =0)	0.00003 [0.00063]	-0.05118 [0.05080]	0.00783 [0.00861]	-0.06830* [0.03796]
Lower or upper secondary	-0.00255 [0.00304]	0.12148* [0.06349]	-0.01076 [0.01190]	0.09031* [0.05026]
Technical degree or post secondary	-0.00283 [0.00477]	0.20678*** [0.06350]	-0.01608 [0.01839]	0.19837*** [0.05326]
Agriculture/forestry/fishery	-0.00113 [0.00379]	-0.11741 [0.11797]	-0.01651 [0.03440]	-0.06492 [0.09574]
Unskilled workers	-0.00720 [0.00913]	-0.16804*** [0.06166]	-0.02845 [0.02227]	-0.12188** [0.05578]
Ethnic minorities (yes = 1)		0.13180 [0.09363]		0.05125 [0.08395]
Area of annual crop land per capita (1000 m2)	0.00601 [0.00715]	0.03550 [0.02663]	0.02779** [0.01220]	0.01958 [0.02033]
Aquaculture surface per capita (1000 m2)		-0.55322*** [0.21325]		-0.08989 [0.05727]
Red River Delta	Omitted		Omitted	
North East	-0.00047 [0.00180]	-0.01488 [0.07123]	0.01033 [0.00853]	0.06470 [0.05940]
North West		-0.16179 [0.17774]		0.02575 [0.14194]
North Central Coast	-0.00103 [0.00228]	-0.00365 [0.09499]	0.00817 [0.00893]	0.01562 [0.07668]
South Central Coast	0.00029 [0.00088]	0.04525 [0.08601]	0.01354 [0.00854]	0.06123 [0.06850]
Central Highlands	-0.13933 [0.18670]	-0.12995 [0.20826]	-0.08938 [0.11636]	-0.05403 [0.14621]
South East	0.00052 [0.00078]	0.03312 [0.08677]	-0.00818 [0.01703]	-0.03264 [0.07176]
Mekong River Delta	0.00080	0.08461	0.00755	0.03829

Explanatory variables	Sample of workers in the formal sector with monthly wage below 650,000 VND		Sample of workers in the formal sector with monthly wage from 350,000 to 1,000,000 VND	
	Dependent variables is 'employed'	Dependent variables is 'employed in formal sector'	Dependent variables is 'employed'	Dependent variables is 'employed in formal sector'
Urban areas (yes = 1)	[0.00112] 0.00053 [0.00082]	[0.06734] 0.08105 [0.04965]	[0.00883] 0.00616 [0.00826]	[0.06219] 0.08505* [0.04378]
Log of wages in 2004 (thousand VND)			-0.01500 [0.01919]	0.05331 [0.07662]
Observations	463	463	643	643
R-squared	0.438	0.090	0.246	0.087

Note: This table presents the difference-in-differences regression. The standard difference-in-difference regressions is:

$$Y = \beta_0 + TD\beta_1 + T\beta_2 + D\beta_3 + X\beta_4 + \varepsilon ,$$

where Y is outcome (employment, wage and expenditure in this case), T is a year dummy, with a one for 2006 and zero for 2004, D is dummy variable indicating monthly wage below 350,000 VND (or wages below 650,000 VND in the second sample) , X is the vector of control variables. The difference-in-difference estimator is the coefficient of interaction between T and D, i.e., β_1 . When the dependent variable is employment which is dummy, a probit model is used. However, since the probit model is non-linear, the variables TD and T in difference-in-differences are dropped. In addition, we report the marginal effects of explanatory variables in this table, since the original coefficients in the probit model do not have clear economic meaning.

There are two samples in this table. The first sample includes laborers in the formal sector in 2004 with age from 15 to 60 and monthly wages below 650,000 VND. The treatment group is workers with monthly wages below 350,000 VND. The second sample includes laborers in the formal sector in 2004 with age from 15 to 60 and monthly wage between 350,000 VND and 1,000,000 VND. The treatment group is workers who had monthly wage in 2004 below 650,000 VND, and the control are those having monthly wage in 2004 equal to or above 650,000 VND.

Robust standard errors in brackets. Standard errors are also corrected for sampling weights and cluster correlation.

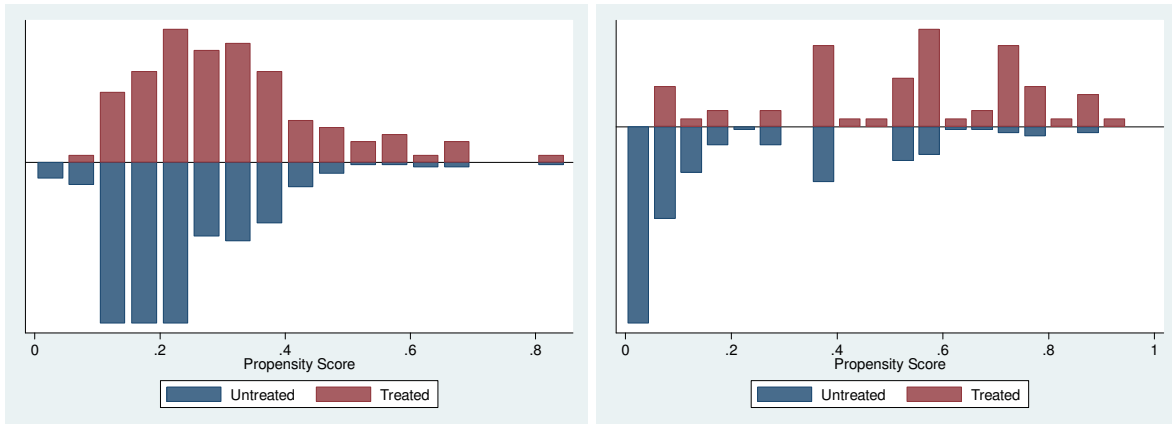
* significant at 10%; ** significant at 5%; *** significant at 1%.

Source: Estimation from panel data of VHLSSs 2004 and 2006.

Figure A.1. Propensity score of the treatment and control groups

The sample of workers in the formal sector who had wages in 2004 between 0 and 650,000 VND)

The sample of workers in the formal and informal sectors who had wages in 2004 between 0 and 350,000 VND



Note: In the sample of workers in the formal sector who have monthly wages in 2004 between 0 and 650,000 VND, the treatment group includes workers having monthly wages below 350,000 VND, and the control group includes workers having wages equal to or above 350,000 VND. In the sample of workers in workers in both the formal and informal sectors, the treatment group includes informal workers having monthly wages below 350,000 VND, and the control group includes informal workers having monthly wages below 350,000 VND.

Source: Estimation from panel data of VHLSSs 2004 and 2006.

Appendix 2: Propensity score matching estimators

The control group is constructed by matching each participant i (workers exposed to the minimum wage increase) in the treatment group with one or more non-participants (workers not exposed to the minimum wage increase) j whose propensity scores are closest to the propensity score of the participant i . For a participant i , denote n_{ic} as the number of non-participants j who are matched with this participant, and $w(i, j)$ the weight attached to the outcome of each non-participant. These weights are defined non-negative and sum up to 1, i.e.:

$$\sum_{j=1}^{n_{ic}} w(i, j) = 1. \quad (\text{A.1})$$

The estimator of ATT is expressed as follows:

$$A\hat{T}T = \frac{1}{n_p} \left\{ \sum_{i=1}^{n_p} \left[Y_{li}^{2006} - \sum_{j=1}^{n_{ic}} w(i, j) Y_{0j}^{2006} \right] - \sum_{i=1}^{n_p} \left[Y_{0i}^{2004} - \sum_{j=1}^{n_{ic}} w(i, j) Y_{0j}^{2004} \right] \right\} \quad (\text{A.2})$$

where n_p is the number of the participants in the data sample. Y_{li}^{2006} and Y_{0j}^{2006} are the observed outcomes of participant i and matched non-participant j in 2006 (after the minimum wage increase in 2005), respectively. Y_{0i}^{2004} and Y_{0j}^{2004} are the observed outcomes of participant i and non-participant j in 2004 (before the minimum wage increase in 2005), respectively. (A.2) can be written as follows:

$$A\hat{T}T = \left[\frac{1}{n_p} \sum_{i=1}^{n_p} Y_{li}^{2006} - \frac{1}{n_p} \sum_{i=1}^{n_p} \sum_{j=1}^{n_{ic}} w(i, j) Y_{0j}^{2006} \right] - \left[\frac{1}{n_p} \sum_{i=1}^{n_p} Y_{0i}^{2004} - \frac{1}{n_p} \sum_{i=1}^{n_p} \sum_{j=1}^{n_{ic}} w(i, j) Y_{0j}^{2004} \right] \quad (\text{A.3})$$

The terms in equation (A.3) correspond with the means of treated and matched controls in 2004 and 2006 in Table 4.

If each participant is matched with the one non-participant with the minimum value of $d(i, j)$ (where $d(i, j)$ is the distance between the propensity scores of participant i and that of non-participant j), the weight $w(i, j)$ equals 1 for all pairs of matches. This is called one nearest neighbor matching. When more than one non-participants are matched with each participant (or vice versa), we need some ways to define the weights attached to each non-participant.

A number of methods use equal weights for all matches. N-nearest neighbors matching involves matching each participant with n non-participants whose have the closest propensity scores. Each matched non-participant will receive weight $w(i, j) = 1/n$. However, it could be reasonable to assign different weights to different non-participants depending on metric distances between their covariates and the covariates of the matched participant (see, e.g., Heckman, et al., 1997; Smith and Todd, 2005). The kernel matching method matches a participant with one or many non-participants depending on a kernel function G and a selected bandwidth h . In this paper, we used an Epanechnikov kernel with bandwidth of 0.05.