Wage Compensation Differentials for Job Risk between Formal and Informal Workers

Miss Pinyada Suwannarat

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By	Miss Pinyada Suwannarat
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Thesis Advisor	Assistant Professor JESSICA MARY VECHBANYONGRATANA, Ph.D.

Accepted by the FACULTY OF ECONOMICS, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of Economics

..... Dean of the FACULTY OF ECONOMICS

(Associate Professor SITTIDAJ PONGKIJVORASIN, Ph.D.)

THESIS COMMITTEE

..... Chairman

(Assistant Professor TOUCHANUN KOMONPAISARN, Ph.D.)

..... Thesis Advisor

(Assistant Professor JESSICA MARY VECHBANYONGRATANA, Ph.D.)

..... External Examiner

(Assistant Professor Sasiwimon Warunsiri Paweenawat, Ph.D.)

ภิญญดา สุวรรณรัตน์ : ความแตกต่างของค่าชดเชยความเสี่ยงในการทำงานระหว่างแรงงานในระบบและแรงงานนอกระบบ. (Wage Compensation Differentials for Job Risk between Formal and Informal Workers) อ.ที่ปรึกษาหลัก : ผศ. ดร.เจสสิกา แมรี่ เวชบรรยงรัตน์

งานวิจัยฉบับนี้ประเมินความแตกต่างของค่าชดเชยความเสี่ยงจากการทำงานของแรงงานในระบบและแรงงานนอกระบบในประเทศไทย ซึ่งเป็นแรงงานที่ไม่ได้รับการคุ้มครองโดยกฎหมายแรงงาน โดยใช้ข้อมูลจากการสำรวจของสำนักงานสถิติแห่งชาติในช่วงปี 2555-2561 ควบคู่กับความเสี่ยงต่อการเสียชีวิตของแรงงาน จากการสำรวจของสำนักงานประกันสังคม ผลการศึกษาพบว่าอัตราความเสี่ยงต่อการเสียชีวิตมีผลเชิงบวกอย่างมีนัยสำคัญต่อค่าจ้างแรงงาน มูลค่าชีวิตทางสถิติของแรงงานในระบบเฉลี่ย 79.33 ล้านบาท เมื่อเทียบกับแรงงานนอกระบบพบว่ามีมูลค่าชีวิตทางสถิติเพียง 41.5 ล้านบาท นอกจากนี้ได้มีการวิเคราะห์ถึงความสัมพันธ์ระหว่างสภาพการทำงานที่ไม่ปลอดภัยจากสำรวจภาวะการทำงานของประชากรโดยสำนักงานสถิติแห่งชาติ ผลการศึกษาพบว่าค่าสัมประสิทธิ์ของปัญหาสภาพการทำงานที่ไม่ปลอดภัยของแรงงานในระบบมีค่าเป็นบวก ในขณะที่ค่าสัมประสิทธิ์ของแรงงานนอกระบบเป็นลบทั้งในการวิเคราะห์ด้วยวิธีการประมาณถดถอยแบบกำลังสองน้อยที่สุด (OLS) และการประมาณถดถอยควอนไทล์ (Quantile Regression) ในทุกการกระจายของค่าจ้างแรงงาน จากผลการศึกษาทั้งหมดที่กล่าวมาข้างต้นแสดงให้เห็นว่าเกิดความไม่เท่าเทียมกันในการเข้าถึงระบบการคุ้มครองแรงงานและความสามารถในการเจรจากับนายจ้าง ด้วยเหตุนี้ส่งผลให้เกิดความแตกต่างของค่าชดเชยความเสี่ยงสำหรับแรงงานในระบบและแรงงานนอกระบบ

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This research estimates compensating wage differentials for job risks for formal and informal workers in Thailand, the latter of whom are not covered by prevailing labor laws. Using data from the National Statistical Office's Thai Labor Force Survey for years 2012 to 2018 merged with job fatality risk collected by the Social Security Office, the results show that the fatality risk rate has a positive, significant effect on wages. The value of statistical life for the median formal workers is 79.33 million baht compared to 41.5 million baht for the median informal worker. Also, we analyze the relationship between self-reported unsafe work conditions in the Labor Force Survey with wages. The results showed that the coefficient on safety issues for formal workers is positive, while the coefficient for informal workers is negative for both OLS and quantile regression in all wage distribution. All the results show that there is inequality in access to labor protection and the ability to negotiate with employers. This results in the compensation wage differentials for formal and informal workers.

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Pinyada Suwannarat

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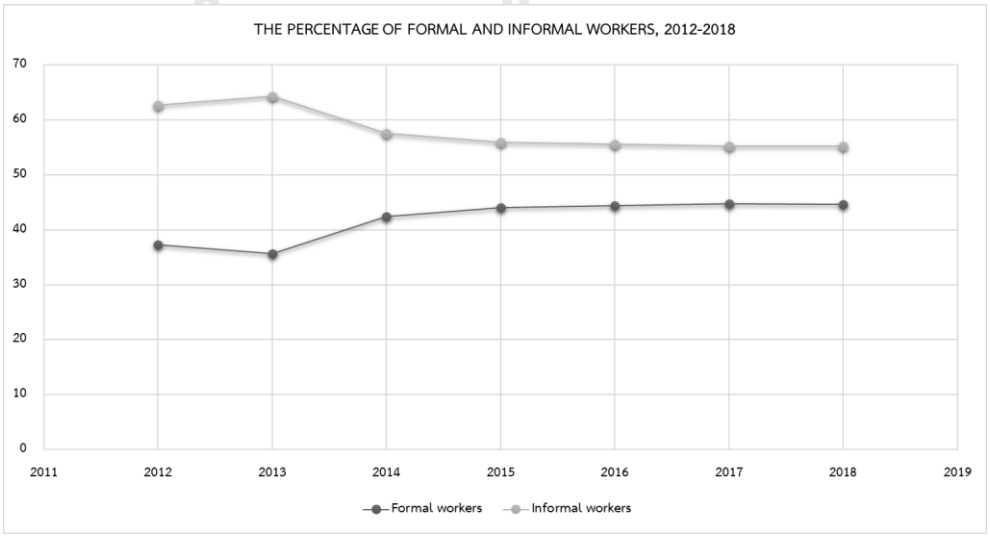
INTRODUCTION

1.1 Introduction

Employers reward workers for the performance of job duties and responsibilities with wages and benefits. Wages are set not only based on workers' productivity. Health, safety and job risk faced by workers are also taken into consideration. Employers usually pay compensating wage differentials—higher wages to compensate for job risk—for work that poses health and safety risks. Meanwhile, workers choose their employment opportunities based on wages and risk preferences.

Informal workers in Thailand are not covered by workplace protections under the Labor Protection Act (B.E. 2541) or through the social security fund (Department of Labour Protection and Welfare, 2018). Typically, they do not work at an employer's premises and are often classified as a freelance, a part-time worker, a home-based worker, a sub-contract worker, or a short-time worker (Kongtip et al., 2015). Currently, more than half of Thailand's workforce is informally employed, as shown in Figure 1 (National Statistical Office, 2016).

Figure 1. Percentage of formal and informal employment, 2012-2018



Source : Compiled by researcher from the National Statistical Office (NSO), 2012-2018.

The contrast between formal and informal workers is important. Without entitlements to workplace protections, informal workers may be subjected to higher levels of job risk and instability. Informal workers generally do not access to trade unions, which means they lack a voice and representation of their interests (Tawab, 2017). Additionally, job mobility may be low among informal workers who might have been forced to take on informal work due to a lack of formal employment opportunities. Due to the absence of protections and lack of job mobility, compensating wage differentials may not arise, leaving informal workers inadequately compensated for undertaking high-risk employment.

This thesis estimates the value of statistical life (VSL) for both formal and informal workers in Thailand. The study uses two data sources, including the 2012 to 2018 rounds of the Labor Force Survey (LFS) with the Informal Supplements collected by the National Statistical Office of Thailand, merged with accident data for 2017 and 2018 collected by the Office of Workmen's Compensation Fund, Social Security Office of Thailand. The study also estimates the compensation wage for job risk measured using self-reported safety conditions from the LFS in 2012 to 2018 collected by the National Statistical Office.

Furthermore, quantile regression analysis is used to estimate the impact of fatality risk at different locations across the wages distribution. We find that the number of job-related deaths averaged across industries and years was 0.038 per 1,000 formal workers, and approximately twice as many at 0.075 per 1,000 informal workers. The value of statistical life for the median formal workers is 79.33 million baht compared to 41.5 million baht for the median informal workers. Also, the coefficient on safety issues for formal workers is positive, while the coefficient for informal workers is negative for both OLS and quantile regressions across the entire wage distribution.

The plan of this paper is as follows. First, section II describes the background of informal workers in Thailand. Second, section III presents the theory and related literature on compensating wage differentials. Third, section IV describes the data and research methodology. Fourth, section V reports the research results, followed by conclusions and suggestions in section VI.

1.2 Objectives

1.2.1 To study the differences in job risk between formal and informal workers.

1.2.2 To estimate the differences in compensation wages for job risk between formal and informal workers.

1.2.3 To study the factors that affect the different wages between formal and informal workers.

1.3 Expected Results

1.3.1 There are differences in job risk between formal and informal workers.

1.3.2 The estimated compensation wages for job risk of formal workers are higher than for informal workers.

1.3.3 Factors associated with the problem of inequality among informal workers and accessibility to government benefits affect the differences in the compensation of risks that the workers receive.

CHAPTER II

BACKGROUND OF INFORMAL WORKERS

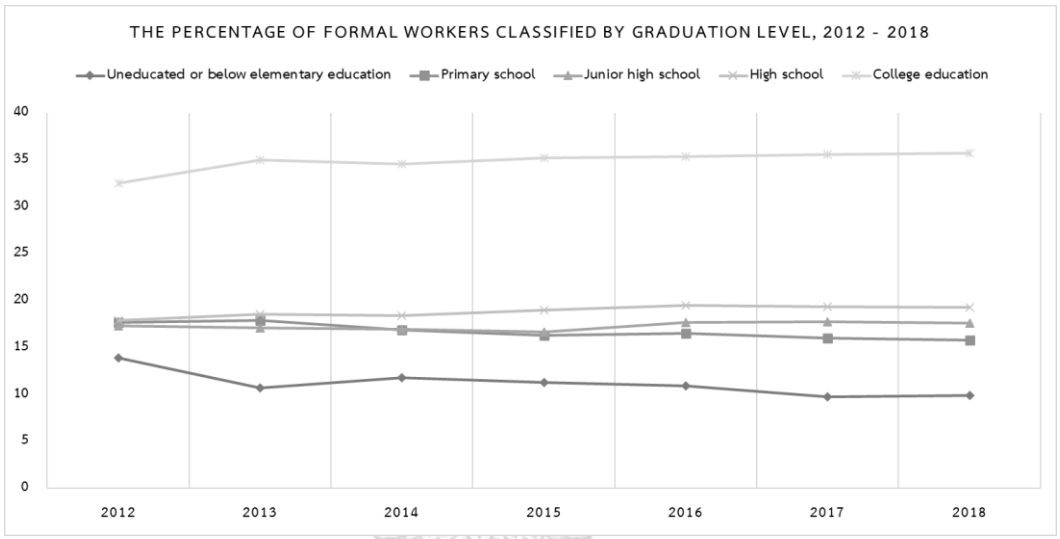
2.1 Informal Workers' Problems in Thailand.

The Ministry of Labor defines informal workers as people who are not officially given an employee status according to the Labor Protection Act (LPA). Typically, they are not hired by formal employers, usually have unstable wages and are either self-employed or temporary workers. Furthermore, informal workers do not have job security protection, equitable wages, or occupational safety and health (OSH) programs (Kongtip et al., 2015). In addition, informal workers in Thailand are those who work at the age of 15 and above who generally work without formal employment contracts and work for employers who often do not adhere to the labor laws. Often there are no exact wages or compensation, or enterprise owners without business registration such as self-employed persons or temporary workers. Specifically, Thailand's informal sector is mainly occupied by self-employed workers, freelance, and unregistered workers such as housemaids, farmers, street vendors, and construction workers (Leeahtam, Leurcharusmee, & Jatukannyaprateep, 2014). In particular, all workers who are not in the formal sector are included in the informal sector. The formal sector includes 1) government organized occupational benefits fund's members; 2) workers who have licenses for professional practices; and 3) enterprise owners with business registration (Kongtip et al., 2015). Therefore, due to the reason that informal workers are not protected by the labor protection law and do not have social security; informal workers mostly work with instability, potentially have unfair compensation, have less quality of health and safety at work, and usually face with life instability in old age.

From Figure 1, informal sector employment in Thailand was approximately 35 to 45 million or 55 to 65 percent of the workforce. A survey of informal workers from

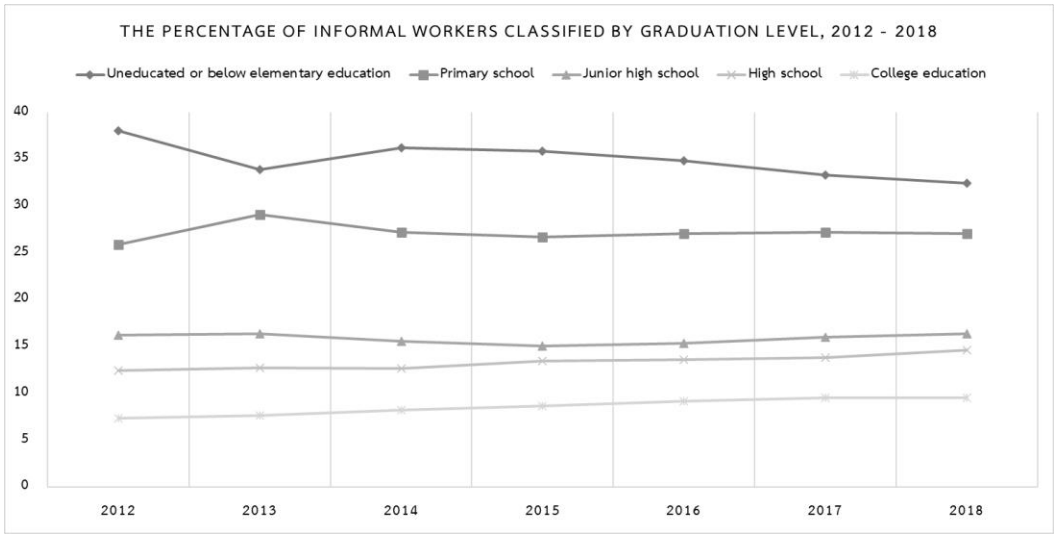
the National Statistical Office (NSO) found that there are persistently more informal workers than formal workers in Thailand between 2012 to 2018. During the years 2014 to 2018, there was an increase of formal labor workers, while there was a decline of informal workers, but the number of informal workers is still higher than formal workers.

Figure 2. Percentage of formal workers classified by education levels, 2012-2018



Source : Compiled by researcher from the the National Statistical Office (NSO), 2012-2018

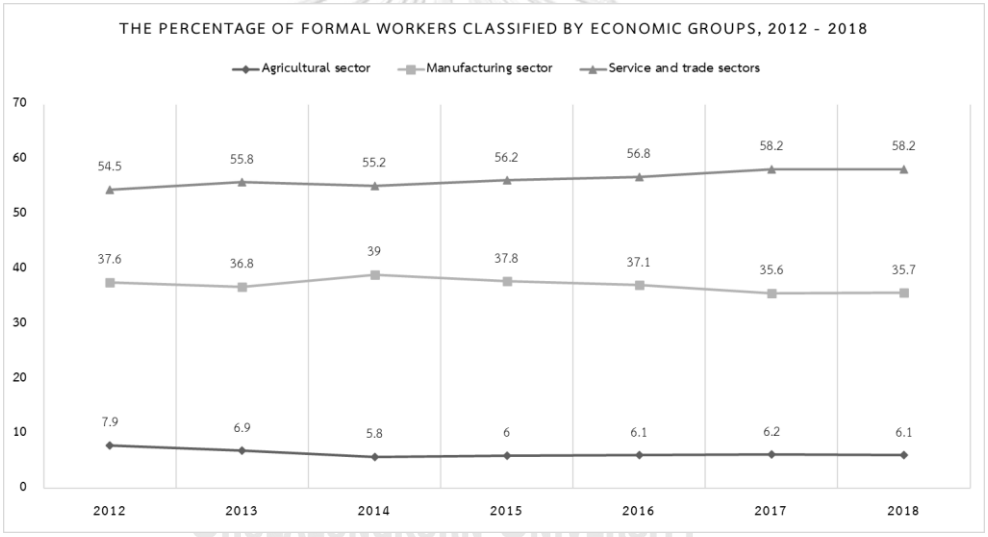
Figure 3. Percentage of informal workers classified by education levels, 2012-2018



Source : Compiled by researcher from the National Statistical Office (NSO), 2012-2018

From Figure 2, most formal workers are highly educated, with a proportion of approximately 35 percent and continues to increase in subsequent years, while most informal workers have a low level of education (see Figure 3). It is worth noting that from the year 2014 onwards, the proportion of informal workers who are uneducated or educated below elementary and primary school level has steadily decreased while the number of workers who are educated from the secondary school level has increased. However, the education level of informal workers is still largely at the primary level.

Figure 4. Percentage of formal workers classified by economic groups, 2012-2018



Source : Compiled by researcher from the National Statistical Office (NSO), 2012-2018

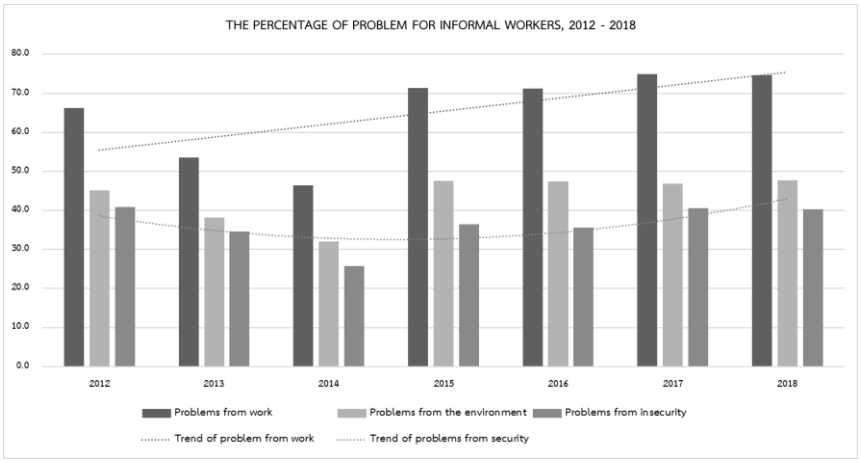
The types of economic activities for formal and informal workers from 2012 to 2018 of are considered in Figure 4 and 5, respectively. Figure 4 found that most formal workers – about 55 percent – work in service and trade sectors, and only around 6 to 7 percent of formal workers are in the agricultural sector. Meanwhile, up to 60 percent of informal workers are in the agricultural sector, as seen in Figure 5.

Figure 5. Percentage of informal workers classified by economic groups, 2012-2018

Source : Compiled by researcher from National Statistical Office (NSO), 2012-2018

The survey of informal workers by the National Statistical Office gathers information on who encountered at least one problem at work. Figure 6 illustrates that informal workers encounter the most problems from work itself, next are working environment problems, and the least common problems are unsafe work problems. When analyzing workers' working problems in Figure 6, the researcher found that the trend of problems is declining from 2012 to 2014. However, it can be seen that from 2015 onwards, the proportion of problems continue to increase until the current year.

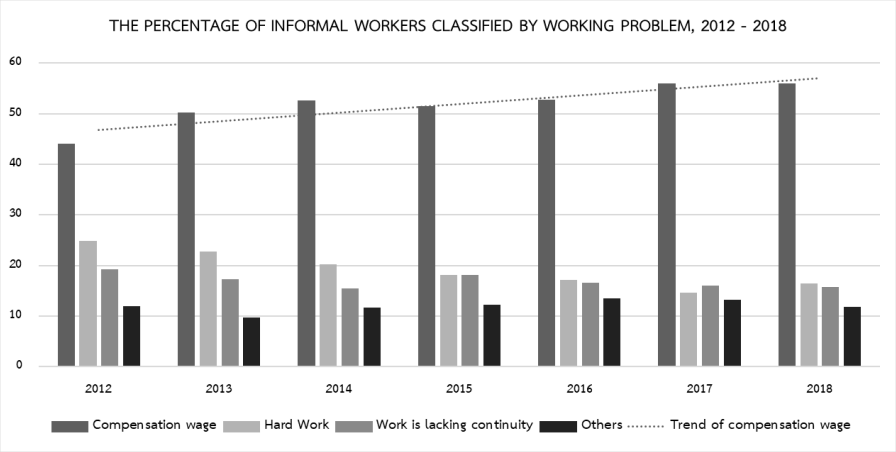
Figure 6. Percentage of problem for informal workers, 2012-2018



Source : Compiled by researcher from National Statistical Office (NSO), 2012-2018

Safety issues and unfair wages are among the top problems that most workers have to face, especially those informal workers who do not have any legal protections. The lack of protections causes these workers to face more severe and complex problems. For instance, they are not able to access many basic rights such as little or no welfare or dangerous working conditions, oppression, wages, etc. Thus, work conditions for informal workers is a major problem that the government needs to address.

Figure 7. Percentage of informal workers classified by working problem, 2012-2018



Source : Compiled by researcher from the National Statistical Office (NSO), 2012-2018

According to the survey of workers who encountered at least one problem at work, it is found that the work problems encountered by informal workers are highest in Figure 6. When examining the sub-problems, the results show that the most common problem encountered by labor is the problem of compensation for labor risks; approximately 50 percent of workers face this problem. Furthermore, the trend has increased since 2012, which means that this problem has not been resolved.

From the LFS Informal Supplements, the problem of unsafe work encountered by informal workers is an interesting issue, including the problem of compensation for work risk. In addition, the informal labor group is not fully protected by the government. Therefore, there is a need to study the compensation risk for both groups of workers.

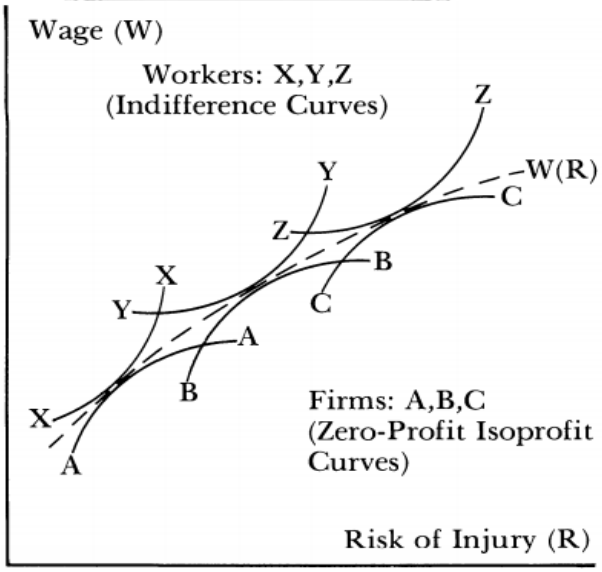
CHAPTER III

THEORY AND LITERATURE REVIEW

3.1 Theory of Compensating Wage Differential (CWD)

According to the theory, workers who work with the disagreeable condition usually demand higher wages, other things equal, because "the whole of the advantages and disadvantages of the different employments of labor and stock must, in the same neighborhood, be either perfectly equal or continually tending toward equality" (Adam Smith, 1937). Additionally, terms and conditions of acceptable wages such as work conditions, procedures, risks and obstacles that may occur in work must be accepted by both employers and employees before the employment. The conditions about increased wages are known as "the compensation wage for job risks." With this situation, hedonic wages theory by (Rosen, 1974) is the most suitable framework for analysis.

Figure 8. Compensating wage differentials for injury risk



Source : Smith, R.S. (1979).

The relationship between wages and job risks is illustrated in Figure 8. A, B, and C curves show the satisfaction of company A, B, and C in paying wages while X, Y, and Z curves show satisfaction in receiving wages of employees X, Y, and Z respectively. As the firms have different technologies, products and prices, they will also have different iso-profit curves. Within the figure, the point where A curve and X curve intersect is the point that company A and employee X are mutual satisfied. Thus, when there is more risk at work, wages should also be increased, that is how the companies are willing to pay at a given profit level.

The compensation wages depend on three things. First, utility maximization: compensating wage differentials will arise only if employees do not choose high paying jobs, but preferring lower paying but more pleasant jobs instead. Second, worker information: workers must consider their job characteristics. A company offering a “bad” job with no compensating wage differentials would have trouble in recruiting or retaining employees. Last, worker mobility: this includes the employees' movement across grades, positions, or occupation. In other words, it means job promotions and advancement, or change of job role that benefits the career growth. A compensating wage differential for risk of injury, for example, does not arise if workers are able to obtain only dangerous jobs (Ehrenberg & Smith, 2016). The compensation for the risk can occur if the workers are able to move to another work, but informal workers may not have the opportunity to move to other jobs. This is why the compensation for the risk of informal workers is expected to be lower than for formal workers.

3.2 Literature Review

Several researchers have previously estimated compensation for job risk in the workplaces across Asia. For example, Siebert and Wei (1998) estimated wage compensation for fatal job risk of manual workers in Hong Kong. The study concentrates on manual workers to reduce measurement error problems that arise from differences in the industry or average occupation risk. Siebert and Wei (1998) found that the value of statistical life for manual workers in Hong Kong was approximately 1.4 million USD in 1990. Furthermore, Madheswaran (2007) estimated the value of statistical life in India at approximately 360,000 USD in 1990, which was less than in other Asian contexts. A recent Thai specific paper by Witvorapong and Komonpaisarn (2019) calculates the value of statistical life by using the concept of utility optimization. Using individual-level data from the Thai Labor Force Survey, Witvorapong and Komonpaisarn (2019) estimated the mean and median values of statistical life for 2012 to 2014 across all formal workers in Thailand at approximately 1.21 and 0.66 million USD, respectively. On the other hand, there was also research that studied the compensation wage for the risk of informal workers in Thailand. Leeahtam et al. (2014), studied by using the unemployment risk in the quantile regression analysis, found that the compensating wage differentials in the lower and middle quantiles, but not the higher quantiles.

In addition, there was also research work that studied the differences in wage compensation for two groups of workers. Siebert and Wei (1994) measured compensating wage differentials for job risks for union and non-union workers in the UK. According to the research, most union workers work in safer jobs. Which may be the result of their higher wealth, instead of an increase in their knowledge. The estimated statistical value of a life was £18.8 million (around $36.28 million) in 1990 prices for union workers, with non-union workers was about 20 percent lower.

Similarly, Verhaest and Adriaenssens (2018) found a significant and substantial higher wage compensation for adverse working conditions in informal jobs.

There were a few papers in Thailand about the wage differences between formal and informal workers. Dasgupta, Bhula-or, and Fakthong (2015) found that informally employed workers have lower earnings at all levels, and the differences also increase with levels of earnings. Additionally, Vechbanyongratana and Yoon (2019) illustrated that there was a disparity of both formal and informal employment earnings. The findings indicated that with formal and informal employment, there were several interrelated complex factors that affected employment earnings such as genders, education, ages, and sectors of employment.

This research is potentially another explanation for the differences in wages. As the lack of labor protections for informal workers means that employers are not fully compensated for risk, this may be the reason why there are wage differences between formal and informal workers in Thailand that have not been explained before.

CHAPTER IV

DATA AND METHODOLOGY

4.1 Conceptual Framework Diagram

Figure 9. The Conceptual Framework Diagram

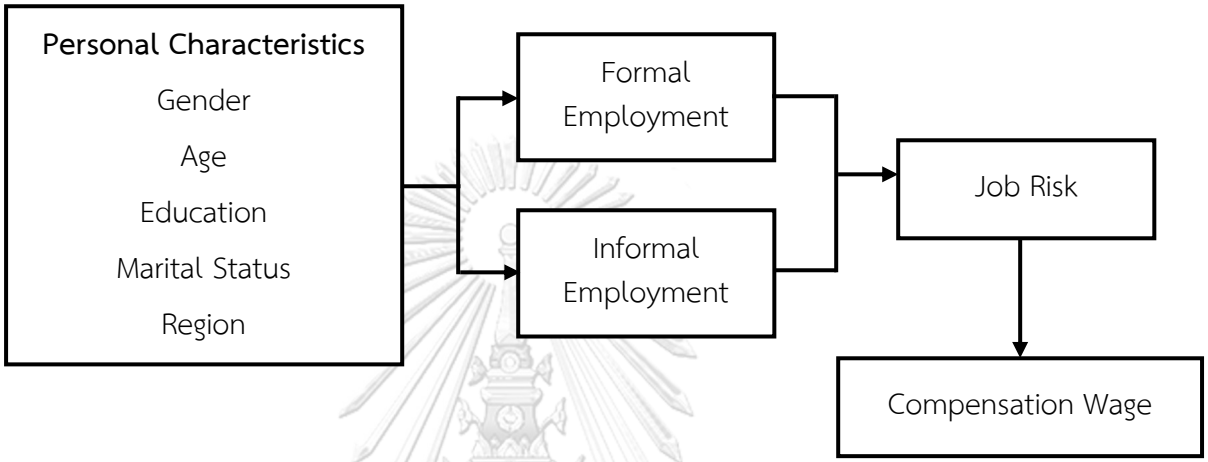


Figure 9 shows that personal characteristics will partially determine whether someone is formal or informal employed. For example, workers with a higher education level are more likely to be in the formal sector than informal sector (National Statistical Office, 2012, 2013, 2014, 2015, 2016, 2017, 2018). The previous research (Siebert & Wei, 1994) showed that formal and informal employment are associated with different levels of risk. Moreover, economic theory and previous research (e.g. Smith (1979), Siebert and Wei (1994), etc.) showed that the risk is associated with compensating wage differential. In other words, job risk of each worker affects the differences in compensation wage that workers should receive, which is an interesting variable in this research.

4.2 Data

The data used for this study comes from two sources. The first dataset is 2012 to 2018 rounds of the Thai Labor Force Survey collected by the National Statistical Office of Thailand providing individual-level information on worker wages,

industry, and other personal characteristics. The second dataset contains fatality risk by industry provided by the Office of Workmen's Compensation Fund, Social Security Office of Thailand for 2017 to 2018. The two datasets are merged using the standard 2-digit industry classification based on Thai Industrial Standard Classification (TSIC) by Ministry of Labor (Department of Employment, 2009), by using the first 2 digits of the industry code from the 5-digit industry code grouping in Labor Force Survey by the National Statistical Office, see in Table 1. In addition, the researcher uses self-reported workplace safety problems from the LFS Informal Supplement collected by the Labor Force Survey by the National Statistical Office in Table 2 to compare with the fatality risk data from the Social Security Office of Thailand.

We use the fatality risk by industry provided by the Office of Workmen's Compensation Fund, Social Security Office of Thailand for 2017 to 2018. This data only includes workers who are covered by social security, thus they are necessarily formal workers. The fatality risk rates provide more a specific measure of job risk than injury risk rates (Seibert and Wei, 1998). Thus, we take the average fatality risk for the two-year period in which data is available in each industry group of workers in Table 1.

From Table 1, it is found that the workers with the highest life-risk ratio are workers in electricity, gas, steam and air conditioning supply industry, which has a fatality rate of 0.29 that means 29% of these workers die. While the industrial workers in the public administration and defense, compulsory social security, human health and social work activities, activities of households as employers, undifferentiated goods and services producing activities of households for own use, and activities of extraterritorial industry, do not find any fatality risk at all.

Table 1. The mean of fatality risk rate in each industry group of workers

Section	Divisions	Industry	Fatality Risk[a]
A	01-03	Agriculture, forestry and fishing	0.0378
B	05-09	Mining and quarrying	0.2172
C	10-33	Manufacturing	0.0339
D	35	Electricity, gas, steam and air conditioning supply	0.2894
E	36-39	Water supply; sewerage, waste management and remediation activities	0.1298
F	41-43	Construction	0.2122
G	45-47	Wholesale and retail trade; repair of motor vehicles and motorcycles organizations and bodies	0.0467
H	49-53	Transportation and storage	0.1994
I	55-56	Accommodation and food service activities	0.0208
J	58-63	Information and communication	0.0207
K	64-66	Financial and insurance activities	0.0295
L	68	Real estate activities	0.0156
M	69-75	Professional, scientific and technical activities	0.0224
N	77-82	Administrative and support service activities	0.0421
O	84	Public administration and defense; compulsory social security	0.0000
P	85	Education	0.0234
Q	86-88	Human health and social work activities	0.0000
R	90-93	Arts, entertainment and recreation	0.0691
S	94-96	Other service activities	0.0356
T	97-98	Activities of households as employers; undifferentiated goods and services producing activities of households for own use	0.0000
U	99	Activities of extraterritorial	0.0000

Source : Office of Workmen's Compensation Fund, Social Security Office.

[a] Units of measure are the probability of an extra death per 1,000 policy years on each job.

Another risk rate used is self-reported unsafe work conditions in the Labor Force Survey, which can clearly compare the job risks of formal and informal workers. This research is divided into groups of formal and informal workers by using the question in LFS as follows: First, the question on social security asks whether a worker is covered and, if yes, which section of the social security scheme they are covered by. Workers covered by section 33 are considered formal workers, while workers covered by sections 39 and 40, as well as those who responded that they are not covered in the social security system, are considered informal workers. Second, the researcher uses the question on the status of workers to help classify workers as formal or informal. The study focuses on government, state enterprise,

and private employees. State enterprise employees and government employees who are permanent employees were counted as formal workers. If there is no answer to the social security question for private-sector employees, I treat this person as "not covered," and thus are counted as informal workers. Table 2 shows the statistics for workers who experience problems with safety at work collected by the National Statistical Office. The question asked on the survey is, "Do workers experience safety problems at work?" Workers with safety problems of any type were coded as "1" while those who did not report any safety problems were coded as "0." It is found that the workers with the most safety problems are workers in the construction industry, which has a probability of unsafe work at approximately 16 and 27 per 100 for formal and informal workers, respectively. The labor groups that experienced the fewest problems regarding work safety is financial and insurance activities industry. The average is about 0.02 or 2 per 100 workers, both in the formal and informal sector. From table 2 in the last column shows the differences in the unsafe working conditions of both groups' workers. It can be seen that informal workers are at higher risk than formal workers in most industrial groups. The construction industry has the largest difference in risk. Next is the manufacturing industry. There are only two industrial groups in which informal workers are at a higher risk: mining and quarrying and Arts, entertainment, and recreation industry, but the differences in this risk are only a little. Also, it can be seen that the financial and insurance activities industry, the risk of formal and informal workers is no different. The row showing the weighted average risk of formal and informal workers demonstrates the risks of both groups of workers at the macro level. The weighted average risk of formal workers is 0.06 or 6 per 100 workers, while informal workers is 0.18 or 18 per 100 workers. Therefore, the informal sector has much higher risk than formal workers. The researcher also tested the differences in probability of unsafe work with both groups by using a t-test method. The results show that the probability that the workers will encounter safety

problems is significantly higher for informal workers than for formal workers (p-value = 0.0001).

Table 2. The mean of unsafe working conditions in each industry group of workers

Section	Industry	Problem with unsafety[a]		Diff[b]
		Formal Workers	Informal Workers	
A	Agriculture, forestry and fishing	0.13	0.21	-0.08
B	Mining and quarrying	0.11	0.09	+0.02
C	Manufacturing	0.08	0.18	-0.10
D	Electricity, gas, steam and air conditioning supply	0.08	0.13	-0.05
E	Water supply; sewerage, waste management and remediation activities	0.08	0.11	-0.03
F	Construction	0.16	0.27	-0.11
G	Wholesale and retail trade; repair of motor vehicles and motorcycles organizations and bodies	0.07	0.13	-0.06
H	Transportation and storage	0.06	0.08	-0.02
I	Accommodation and food service activities	0.08	0.13	-0.05
J	Information and communication	0.04	0.05	-0.01
K	Financial and insurance activities	0.02	0.02	0
L	Real estate activities	0.04	0.06	-0.02
M	Professional, scientific and technical activities	0.04	0.09	-0.05
N	Administrative and support service activities	0.04	0.09	-0.05
O	Public administration and defense; compulsory social security	0.04	0.08	-0.04
P	Education	0.03	0.07	-0.04
Q	Human health and social work activities	0.04	0.05	-0.01
R	Arts, entertainment and recreation	0.08	0.06	+0.02
S	Other service activities	0.07	0.11	-0.04
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.06	0.08	-0.02
U	Activities of extraterritorial	0.04	0.05	-0.01
	Average Risk	0.07	0.10	-0.03
	Weighted Average Risk	0.06	0.18	-0.12
	T-test	-4.7935		
	P-value	0.0001***		

Source : The Thai Labor Force Survey collected by the National Statistical Office of Thailand, 2012-2018.

Note : *** p < 0.01, ** p < 0.05, * p < 0.10.; [a] Units of measure are the probability of unsafe work on each job.; The probability of unsafe work-related problems is calculated from the average of dummy variables, which are 1 when workers face work-related safety problems and 0 when workers do not encounter work-related safety problems.; [b] The differences in unsafe working conditions of formal and informal workers, calculated from the risk for formal workers minus informal workers in each industry.

4.3 Empirical Approach

The theory of compensating wage differentials (CWDs) developed by Thaler and Rosen (1976) is used in the research. A compensating wage differential is defined as the additional wage a firm must pay to attract an employee to work for a job with unpleasant characteristics such as elevated risk of injury or death, holding worker characteristics constant. The estimation of CWDs has generally been carried out by using the following hedonic wage equation:

$$w = a_0 + a_1 x + a_2 p + e$$

where w is a wage; x is a vector of individual and job characteristics, including the usual human capital variables; p is a measure of job risk; and e is an error term. The partial derivative, dw/dp (a2 when the equation is linear), is the estimated marginal CWD for a job of risk p (Siebert and Wei, 1994).

The coefficient on job risk is often converted into a measure called as value of statistical life (VSL) using the Thaler-Rosen formula:

$$1000 \times \mathrm{AE} \times \frac{\partial \mathrm{lnwage_i}}{\partial \mathrm{jobrisk_i}}$$

where AE is the mean value of annual earning (Thaler and Rosen, 1976). The calculation from Thaler-Rosen formula tells us, given the risk of fatality and prevailing wage rates, the monetary value of one life saved.

We use the natural log of total monthly labor income as a dependent variable, in which we control the minimum wages for formal workers. An independent variable of interest is the risk of workers, which come from 2 sources: the risk of death calculated from the Workmen's Compensation data in Table 2, and the probability of unsafe working conditions in each industry group of workers in Table 1. The risk variables from these 2 sources will analyze the equation separately but will use the same model for the analysis. There is also the control for a person's

demographic characteristics, including age, gender, marital status, education, and region of residence. As formal and informal workers have different legal protections and often have different working conditions, it is plausible that they also face different fatality risks. However, due to data limitations, measures of fatality risk only come from formal employment; the research simplifies that formal and informal workers in the same industry face the same fatality risk. Besides, explanations of variables used in this research are shown in Table 3.

To estimate the relationship between job risk and wages, we first use an ordinary least squares wage regression to analyze the average relationship between job risk and wages as follows:

$$lnwage_i = \alpha + \beta x_i + \gamma jobrisk_i + \varepsilon_i$$

where $lnwage_i$ is the natural logarithm of monthly total wage, x_i is the vector of explanatory variables described above, and $jobrisk_i$, the independent variable of interest, is the measure of job risk the individual faces in their industry. To capture the relationship between job risk and wages at different points along the wage distribution, quantile regression approach is used; conforms with Leeahtam et al. (2014) and Witvorapong and Komonpaisarn (2019), where ϕ denotes the quantile:

$$lnwage_i = \alpha_\phi + \beta_\phi x_i + \gamma_\phi jobrisk_i + \varepsilon_{\phi i}$$

The strength of quantile regression analysis compared to the mean regression is its flexibility. As the quantile approach can estimate the impact of fatality risk at different locations across the wage distribution, which allow the determination on whether CWDs have different magnitudes at high and low wages. The job risk coefficients are then converted to value of statistical life estimates using Thaler-Rosen formula.

Table 3. The detail of definition of variables

Variables	Definition	Type of variables	Note
$lntotalwage_i$	The natural log of total monthly labor income of worker i	Quantitative Variable	Baht
$jobrisk_i$	The fatality risk rate in the workplace per 1,000 workers per year	Quantitative Variable	Rate per 1,000 workers per year
$unsafeprob_i$	The probability of unsafe working conditions	Quantitative Variable	Rate per worker
$gender_i$	Gender of workers i	Qualitative Variable	1 = Male 0 = Female
age_i	Age of workers i	Quantitative Variable	Years
$region_i$	Region of worker i	Qualitative Variable	1 = Bangkok 2 = Central 3 = North 4 = Northeast 5 = South
$education_i$	Education of workers i	Qualitative Variable	1 = Primary school and no education 2 = Lower/Upper secondary level education 3 = Post-secondary education 4 = Bachelor degree education 5 = MA / PhD
$married_i$	Marital status of worker i	Qualitative Variable	1 = Married 0 = Otherwise

4.4 The Expected Sign

The expected sign of coefficient in the variables, which used in this study, are presented in Table 4.

Table 4. The expected sign of coefficient in each variable

Coefficient of each variables	Sign	Definition
$jobrisk_i$	+	When workers are at increased risk from work. Causing higher wages as well. Rosen (1986); Verhaest and Adriaenssens (2018) said in a perfectly competitive labor market, poor working conditions, and other adverse job amenities are expected to be compensated by higher wages.
$gender_i$	+	Males will receive higher wages than females. As workers get higher earnings, the gender effect on the earnings becomes smaller. Part of this can perhaps be explained by the educational qualifications which at higher levels of earnings, play a key role in reducing the earning gaps as women with higher human capital endowments reduce the gender earnings differentials (Dasgupta et al., 2015).
age_i	+ , -	Age doesn't affect salaries, but there are times when firms need a younger person who can do the work better than an older person (Zepa, 2006). On the other hand, Dasgupta et al. (2015) said the age of workers represents years of experience of the worker and older workers are more likely to earn more than younger ones.
$region_i$	+ , -	Workers receiving high earnings tend to stay and work in Bangkok, rather than in other regions (Dasgupta et al., 2015).
$education_i$	+ , -	Higher education levels will receive increase earning. The personnel in unionized firms that have higher ability is under greater pressure to recognize and reward the ability to offset higher union pay (Siebert & Wei, 1994).
$married_i$	+ , -	Witvorapong and Komonpaisarn (2019) said married is positively associated with real annual income. Similarly, Siebert and Wei (1998) find it is quite usual for there to be a premium to marriage for men. In contrast to Schultz (2005); Paweenawat and McNown (2014) said married people face a higher opportunity and time cost of work and are likely to have lower hours of work, labor force participation, and earnings.

4.5 Hypotheses

3.5.1 The relationship of fatality risk to wages.

H_0 : The fatality risk rate has no significant effect on wages.

H_1 : The fatality risk rate has a significant effect on wages.

3.5.2 The differences of compensation wage for job risk of labor.

H_0 : The estimation of wage compensation for job risk of formal workers are less than or equal to informal workers.

H_1 : The estimation of wage compensation for job risk of formal workers are greater than informal workers.

CHAPTER V
RESULTS

The summary statistics for the data used in the analysis stratified by formal and informal workers are presented in Table 5. Slightly more than half of the sample is formal workers; 212,840 (63.21%) and 123,883 (36.79%) of formal and informal workers respectively. Splitting up the sample depending on the social security status and working status, informal workers are more likely to have primary or less education at approximately 62.74 percent. On the other hand, most formal workers have higher education levels, with approximately 38.24 percent completing bachelor and MA/Ph.D. degrees. The proportion of male and female workers is similar. In the informal sector, the proportion of male workers is slightly more than female workers. The average age of the cross-sectional sample are 38.85 and 39.01 years old for formal and informal workers, respectively. The majority of the respondents is married; 66.84 percent for formal workers and 64.61 percent for informal workers. Most respondents from both labor groups are in the central region, 41.78 percent and 33.98 percent, respectively. Additionally, the information reported on the total wage, which is the sum of both monetary and non-monetary wages that workers received, shows the average total wages for 2012 to 2018 were 16,403.71 THB and 7,460.36 THB for formal and informal workers, respectively. The probabilities of unsafe working conditions were 0.06 and 0.18. Similarly, the fatality risk rates were 0.038 cases and 0.075 per 1,000 people for formal and informal workers, respectively. It can be seen that the probability of safety problems and fatality risk of informal workers is twice as high as for formal workers, suggesting they work in higher risk occupations. In particular, if safety is a normal good, people with high (unobserved) ability will have high earnings; they will also choose low risk (Siebert & Wei, 1994). Similarly, Viscusi (1979); Siebert and Wei (1994) said that formal workers are sometimes said to have better knowledge both of workplace risks, and

preferences of inframarginal workers. On the other hand, the average wages of informal workers are lower than for formal workers.

Table 5. Summary Statistics of the Main Variables for Formal and Informal workers

Variables	Formal Workers		Informal Workers		Description
	Mean	Std Dev	Mean	Std Dev	
Annual income	196,840.30	136,991.20	89,524.30	43,232.15	Annual income of workers
Total wage	16,403.71	11,417.96	7,460.36	3,602.68	Monthly total wage of workers
Fatality Risk	0.0379	0.0532	0.0746	0.0760	Fatality risk rate per 1,000 workers per year
Unsafe Prob	0.0595	0.0267	0.1761	0.0664	Probability of unsafe working conditions per worker
Workers	0.6321	0.4822	0.3679	0.4822	The proportion of formal and informal workers
Male	0.5070	0.4999	0.5839	0.4929	Dummy = 1 if male
Age	38.8451	10.8453	39.0108	13.1310	Age of workers
Bangkok (reference)	0.1035	0.3046	0.0393	0.1944	Dummy = 1 if Bangkok
Central	0.4178	0.4932	0.3398	0.4737	Dummy = 1 if central
North	0.1622	0.3686	0.1719	0.3773	Dummy = 1 if north
Northeast	0.1710	0.3765	0.1831	0.3868	Dummy = 1 if northeast
South	0.1455	0.3526	0.2658	0.4418	Dummy = 1 if south
No Edu (reference)	0.1706	0.3762	0.6274	0.4835	Dummy = 1 if primary school and no education
Sec Edu	0.3520	0.4776	0.3048	0.4603	Dummy = 1 if lower/upper secondary level education
Post Sec Edu	0.0949	0.2931	0.0253	0.1570	Dummy = 1 if post-secondary education
Bachelor	0.3213	0.4669	0.0399	0.1958	Dummy = 1 if bachelor degree education
MA/PhD	0.0611	0.2395	0.0025	0.0499	Dummy = 1 if MA / PhD
Married	0.6684	0.4708	0.6461	0.4782	Marriage dummy = 1 if married

Note: Sample size is 212,840 (63.21%) and 123,883 (36.79%) for formal and informal workers respectively.

Sources: The National Statistical Office of Thailand.

The Office of Workmen's Compensation Fund, Social Security Office of Thailand.

These summary statistics of the main variables are the representative of formal and informal sector in Thailand, provided by the national representative of Labor Force Survey and the Office of Workmen's Compensation Fund, Social Security Office of Thailand that is widely used in policy planning by the government.

Table 6. The average total wage in each industry group of workers

Section	Industry	Average total wage[a]	
		Formal Workers	Informal Workers
A	Agriculture, forestry and fishing	10,719.32	5,761.09
B	Mining and quarrying	14,704.53	8,597.16
C	Manufacturing	12,392.78	7,348.05
D	Electricity, gas, steam and air conditioning supply	26,541.91	8,703.50
E	Water supply; sewerage, waste management and remediation activities	16,684.06	7,008.95
F	Construction	14,601.23	7,683.30
G	Wholesale and retail trade; repair of motor vehicles and motorcycles organizations and bodies	12,183.86	7,979.39
H	Transportation and storage	16,626.28	9,601.23
I	Accommodation and food service activities	12,559.56	8,042.85
J	Information and communication	23,768.97	11,269.57
K	Financial and insurance activities	22,131.63	14,508.03
L	Real estate activities	15,782.37	9,137.40
M	Professional, scientific and technical activities	19,701.64	9,785.35
N	Administrative and support service activities	11,898.66	8,690.53
O	Public administration and defense; compulsory social security	17,273.85	7,416.24
P	Education	26,093.07	10,495.59
Q	Human health and social work activities	18,634.04	8,019.08
R	Arts, entertainment and recreation	12,017.09	8,149.27
S	Other service activities	12,665.43	7,183.37
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	10,416.08	7,919.88
U	Activities of extraterritorial	18,184.87	12,241.89
	Total	16,403.71	7,460.36

Source : Compiled by researcher from Labor Force Survey, 2012-2018

[a] Units of measure are Baht per month on each job.

Table 6 shows the comparison of the average monthly total wage of formal and informal workers in each industry. We found that formal workers receive higher wages than informal workers in all industry groups. The group with the highest wage

difference is electricity, gas, steam, and air conditioning supply industry, followed by the education industry, while the groups with similar wages are activities of households as employers; undifferentiated goods-and services-producing activities of households for own use and administrative and support service activities.

Tables 7 and 8 report regressions that progressively add controls in order to illustrate sensitivity of the coefficient on the risk variable.

Table 7. A Specification test model of formal workers

Dependent variable : ln(totalwage)						
Variables	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]	Model 5[e]	Model 6[f]
Unsafeprob	-6.495***	-6.564***	-5.215***	-5.506***	0.287***	0.279***
	(0.0449)	(0.0451)	(0.0440)	(0.0447)	(0.0364)	(0.0364)
Male	-	0.038***	-0.001***	0.002***	0.102***	0.100***
		(0.0024)	(0.0023)	(0.0023)	(0.0017)	(0.0017)
Age	-	-	0.0157***	0.016***	0.019***	0.019***
			(0.0001)	(0.0001)	(0.0001)	(0.0001)
Central	-	-	-	-0.258***	-0.144***	-0.148***
				(0.0039)	(0.0030)	(0.0029)
North	-	-	-	-0.301***	-0.266***	-0.272***
				(0.0045)	(0.0034)	(0.0034)
Northeast	-	-	-	-0.314***	-0.269***	-0.277***
				(0.0045)	(0.0033)	(0.0035)
South	-	-	-	-0.249***	-0.194***	-0.199***
				(0.0046)	(0.0034)	(0.0035)
Sec Edu	-	-	-	-	0.323***	0.322***
					(0.0026)	(0.0026)
Post Sec Edu	-	-	-	-	0.551***	0.551***
					(0.0035)	(0.0035)
Bachelor	-	-	-	-	0.933***	0.937***
					(0.0028)	(0.0028)
MA/PhD	-	-	-	-	1.288***	1.292***
					(0.0042)	(0.0042)
Married	-	-	-	-	-	0.043***
						(0.0019)
Constant	9.907***	9.892***	9.223***	9.477***	8.331***	8.329***
	(0.0029)	(0.0031)	(0.0055)	(0.0064)	(0.0060)	(0.0060)
R^2	0.0896	0.0907	0.1720	0.1944	0.5480	0.5491

Note : *** p < 0.01, ** p < 0.05, * p < 0.10; [a] The model only controlled risk variable (unsafe working conditions).; [b] The model controlled risk variable, and gender.; [c] The model controlled risk variable, gender, and age.; [d] The model controlled the dependent variable, risk variable, gender, age, and region.; [e] The model controlled risk variable, gender, age, region, and education. ; [f] The full model used for analysis in this research.

Table 8. A Specification test model of informal workers

Dependent variable : ln(totalwage)						
Variables	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]	Model 5[e]	Model 6[f]
Unsafeprob	-1.006***	-1.362***	-1.313***	-1.186***	-0.636***	-0.665***
	(0.0199)	(0.0203)	(0.0203)	(0.0199)	(0.0201)	(0.0201)
Male	-	0.183***	0.176***	0.180***	0.184***	0.186***
		(0.0027)	(0.0027)	(0.0027)	(0.0026)	(0.0026)
Age	-	-	-0.003***	-0.003***	-0.001***	-0.001***
			(0.0001)	(0.0001)	(0.0001)	(0.0001)
Central	-	-	-	-0.304***	-0.283***	-0.290***
				(0.0067)	(0.0065)	(0.0065)
North	-	-	-	-0.472***	-0.470***	-0.476***
				(0.0071)	(0.0068)	(0.0068)
Northeast	-	-	-	-0.460***	-0.453***	-0.462***
				(0.0070)	(0.0068)	(0.0068)
South	-	-	-	-0.440***	-0.428***	-0.437***
				(0.0068)	(0.0066)	(0.0066)
Sec Edu	-	-	-	-	0.092***	0.092***
					(0.0029)	(0.0029)
Post Sec Edu	-	-	-	-	0.269***	0.271***
					(0.0079)	(0.0079)
Bachelor	-	-	-	-	0.545***	0.551***
					(0.0066)	(0.0066)
MA/PhD	-	-	-	-	0.987***	0.991***
					(0.0245)	(0.0245)
Married	-	-	-	-	-	0.062***
						(0.0026)
Constant	8.989***	8.945***	9.041***	9.401***	9.165***	9.156***
	(0.0037)	(0.0037)	(0.0052)	(0.0078)	(0.0082)	(0.0082)
R^2	0.0202	0.0543	0.0595	0.1099	0.1696	0.1734

Note : *** p < 0.01, ** p < 0.05, * p < 0.10; [a] The model only controlled risk variable (unsafe working conditions).; [b] The model controlled risk variable, and gender.; [c] The model controlled risk variable, gender, and age.; [d] The model controlled the dependent variable, risk variable, gender, age, and region.; [e] The model controlled risk variable, gender, age, region, and education. ; [f] The full model used for analysis in this research.

From Table 7, it is found that the control of only risk variables, gender, age, and region in models 1 to 4 of the formal workers that the coefficient on job risk is negative. However, when controls are added for education in model 5, the coefficient of risk changes to positive. It can be seen that educational variables have a great effect on changing coefficient of risk. Similarly, as Table 8, when the education is controlled the coefficient on job risk remains negative, but the magnitude becomes smaller. Therefore, the researcher uses the variables in model 6

to analyze in this research since it provides the most complete picture on the coefficient of risk. Also, there are the highest r-square values. That is, independent variables can explain variation in the dependent variable most.

First, the researcher estimates wage functions by OLS, then estimates by quantile regressions at the 10th, 25th, 50th, 75th, and 90th quantiles while treating job risk as exogenous. Tables 9 and 10 report the results from a model that uses fatality risk as a job risk for both formal and informal workers, respectively. As can be seen from Table 9 and 10, although most of the estimated coefficients have the predicted sign and are statistically significant at high level. The estimated coefficient of the hedonic wage regression variables, in both regressions of formal and informal workers, are consistent with previous literatures. The coefficient of fatality risk rate of workers tends to be positive and significant for both formal and informal workers; 0.642 and 0.622 for formal and informal workers, respectively. This means the 1-unit increase of fatality risk leads to the increase of wages by 64.2 percent and 62.2 percent for formal and informal workers, respectively. It can be seen that informal workers receive lower increasing wages than formal workers significantly. Moreover, age, which reflects the workers' work experience, has a positive effect on wage of formal workers while has a negative effect on wage of informal workers. Individuals with higher education tend to receive higher wage compared with no education (Reference group). Male workers on average have significantly higher wages than female workers. The effects of the region have a significant negative impact on wages in the central, north, northeast, and south compared with Bangkok (Reference group). In addition, the marital status of the workforce also has a positive effect on wages, which means that married workers will receive significant higher wages.

Table 9. Coefficient of fatality risk estimates from OLS and quantile regressions of formal workers, 2012-2018

Variables	Dependent variable : ln(totalwage)					
	OLS	Quantile regression				
		10th	25th	50th	75th	90th
Fatality Risk	0.642***	0.387***	0.356***	0.511***	0.684***	1.018***
	(0.0163)	(0.0306)	(0.0234)	(0.0199)	(0.0294)	(0.0393)
Male	0.093***	0.052***	0.071***	0.093***	0.104***	0.122***
	(0.0017)	(0.0024)	(0.0017)	(0.0014)	(0.0017)	(0.0025)
Age	0.019***	0.007***	0.011***	0.018***	0.024***	0.026***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
Central	-0.140***	-0.154***	-0.126***	-0.120***	-0.133***	-0.162***
	(0.0029)	(0.0035)	(0.0026)	(0.0033)	(0.0042)	(0.0046)
North	-0.265***	-0.347***	-0.281***	-0.243***	-0.223***	-0.246***
	(0.0034)	(0.0031)	(0.0033)	(0.0041)	(0.0039)	(0.0060)
Northeast	-0.265***	-0.377***	-0.289***	-0.227***	-0.208***	-0.234***
	(0.0034)	(0.0052)	(0.0048)	(0.0046)	(0.0045)	(0.0044)
South	-0.192***	-0.288***	0.201***	-0.158***	-0.149***	-0.170***
	(0.0034)	(0.0041)	(0.0030)	(0.0038)	(0.0051)	(0.0041)
Sec Edu	0.326***	0.199***	0.206***	0.303***	0.360***	0.363***
	(0.0026)	(0.0040)	(0.0029)	(0.0025)	(0.0032)	(0.0041)
Post Sec Edu	0.552***	0.347***	0.385***	0.518***	0.583***	0.596***
	(0.0035)	(0.0051)	(0.0063)	(0.0038)	(0.0041)	(0.0038)
Bachelor	0.941***	0.609***	0.771***	0.948***	0.999***	0.970***
	(0.0026)	(0.0053)	(0.0034)	(0.0026)	(0.030)	(0.0042)
MA/PhD	1.299***	1.149***	1.234***	1.316***	1.257***	1.179***
	(0.0040)	(0.0107)	(0.0060)	(0.0041)	(0.0038)	(0.0049)
Married	0.044***	0.034***	0.037***	0.037***	0.034***	0.032***
	(0.0019)	(0.0017)	(0.0015)	(0.0012)	(0.0023)	(0.0033)
Constant	8.312***	8.555***	8.526***	8.347***	8.313***	8.463***
	(0.0050)	(0.0069)	(0.0086)	(0.0059)	(0.0058)	(0.0074)
R^2 / Pseudo R^2	0.5522	0.1756	0.2462	0.3596	0.4205	0.4237

Notes: *** p < 0.01, ** p < 0.05, * p < 0.10; For OLS regression, linearized standard errors in parentheses.; For quantile regressions, analytic/robust standard errors in parentheses.; R-squared value for OLS regression and Pseudo R-squared values for quantile regressions.; N = 212,840

Table 10. Coefficient of fatality risk estimates from OLS and quantile regressions of informal workers, 2012-2018

Variables	Dependent variable : ln(totalwage)					
	OLS	Quantile regression				
		10^{th}	25^{th}	50^{th}	75^{th}	90^{th}
Fatality Risk	0.622***	1.474***	0.971***	0.476***	0.204***	0.036***
	(0.0171)	(0.0289)	(0.0167)	(0.0191)	(0.0159)	(0.0248)
Male	0.135***	0.141***	0.144***	0.124***	0.110***	0.137***
	(0.0026)	(0.0067)	(0.0038)	(0.0035)	(0.0019)	(0.0044)
Age	-0.001***	-0.005***	-0.003***	-0.001***	0.001***	0.003***
	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0002)
Central	-0.312***	-0.406***	-0.308***	-0.241***	-0.276***	-0.294***
	(0.0065)	(0.0111)	(0.0043)	(0.0049)	(0.0058)	(0.0099)
North	-0.504***	-0.627***	-0.524***	-0.442***	-0.422***	-0.466***
	(0.0068)	(0.0132)	(0.0060)	(0.0058)	(0.0065)	(0.0099)
Northeast	-0.496***	-0.679***	-0.515***	-0.413***	-0.395***	-0.441***
	(0.0068)	(0.0134)	(0.0057)	(0.0052)	(0.0060)	(0.0096)
South	-0.456***	-0.687***	-0.539***	-0.372***	-0.323***	-0.316***
	(0.0066)	(0.0090)	(0.0037)	(0.0052)	(0.0048)	(0.0077)
Sec Edu	0.113***	0.089***	0.085***	0.088***	0.107***	0.134***
	(0.0029)	(0.0080)	(0.0045)	(0.0036)	(0.0021)	(0.0046)
Post Sec Edu	0.318***	0.343***	0.282***	0.264***	0.263***	0.365***
	(0.0079)	(0.0153)	(0.0112)	(0.0069)	(0.0062)	(0.0193)
Bachelor	0.627***	0.611***	0.552***	0.530***	0.669***	0.756***
	(0.0064)	(0.0106)	(0.0055)	(0.0073)	(0.0077)	(0.0087)
MA/PhD	1.082***	1.102***	1.067***	1.086***	1.076***	1.129***
	(0.0245)	(0.0280)	(0.0432)	(0.0217)	(0.0368)	(0.0114)
Married	0.054***	0.093***	0.062***	0.054***	0.034***	0.041***
	(0.0026)	(0.0051)	(0.0034)	(0.0031)	(0.0023)	(0.0039)
Constant	9.044***	8.697***	8.882***	9.044***	9.211***	9.326***
	(0.0077)	(0.0117)	(0.0063)	(0.0069)	(0.0093)	(0.0108)
R^2 / Pseudo R^2	0.1749	0.1135	0.0978	0.0871	0.0927	0.1450

Notes: *** p < 0.01, ** p < 0.05, * p < 0.10; For OLS regression, linearized standard errors in parentheses.; For quantile regressions, analytic/robust standard errors in parentheses.; R-squared value for OLS regression and Pseudo R-squared values for quantile regressions.; N = 123,883

Although OLS seems to be a reasonable method to estimate the condition wage, it fails to capture the differences across the wage distributions. As shown in Table 9 and 10, although the sign of the estimated coefficients are consistent with those from OLS, their values vary across quantiles. The quantile regressions are illustrated in Tables 9 and 10, which show some common results. Males earn significantly higher wages than females in the 10th, 25th, 50th, 75th, and 90th quantiles. Moreover, gender has a great impact in higher quantiles for formal workers. Age has a positive and significant effect on wages in all quantiles of formal workers, but has a negative effect on informal workers. Education has a positive effect and the effect becomes stronger in higher quantities. Nevertheless, the marital status variable has a positive effect in all quantities, and has a greater impact on informal workers.

The impact of fatality risk rates from SSO on wages is used to calculate the compensation wage in detail in the next table. Regarding to the interested variables related to the compensating wage differentials. The OLS and quantile regression results at the 10th, 25th, 50th, 75th, and 90th quantiles based on cross-sectional samples for the coefficients of fatality risk rate, and summary of the workers' value of statistical life are presented in Table 11.

Table 11. Coefficients of fatality risk rate variables and Compensation wage of workers

Dependent variable : log total monthly wage

Sample		Formal Workers			Informal Workers		
		Coefficients of fatality	Annual Income	VSL (THB)	Coefficients of fatality	Annual Income	VSL (THB)
OLS		0.642***	196,840.30	126,371,472.60	0.622***	89,524.30	55,684,114.60
Quantile Regression	10th	0.387***	84,590.71	32,736,604.77	1.474***	45,591.81	67,202,327.94
	25th	0.356***	110,619.40	39,380,506.40	0.971***	70,282.99	68,244,783.29
	50th	0.511***	155,244.50	79,329,939.50	0.476***	87,116.19	41,467,306.44
	75th	0.683***	228,369.10	155,976,095.30	0.204***	103,084.10	21,029,156.40
	90th	1.018***	427,794.80	435,495,106.40	0.036***	152,844.90	5,502,416.40

Notes: *** p < 0.01, ** p < 0.05, * p < 0.10; other controls include age, gender, marital status, education, and region of residence; value of statistical life = annual income (THB) * coefficients of fatality risk rate * 1000.

The results from the OLS formal and informal wage functions show that both groups receive significant positive wage compensation for fatality risk. However, the Table 11 illustrates the higher rate for formal workers (0.642) than informal workers (0.622). In a perfectly competitive labor market, poor working conditions and other adverse job amenities are expected to be compensated by higher wages (Rosen, 1986; Verhaest & Adriaenssens, 2018); in contrast, the results of this research are opposite. The researcher found that in every specification, there is a positive and significant coefficient on fatality risk for both formal and informal workers. At the median, the coefficients on fatality risk are 0.511 and 0.476 for formal and informal workers, respectively, resulting in 79.33 million and 41.47 million baht per year of the values of statistical life. In other words, the firms that offer jobs involving an extra death probability have to spend more than 79.33 million and 41.47 million baht per year to reduce death probability to zero for formal and informal workers, respectively. The results for the 25th, 50th, and 75th percentiles of coefficient on fatality risk go up for formal workers but go down for informal workers. This is because, on average, formal workers have higher ability, and more workers require greater safety. Thus, both the employer and employees benefit by negotiating safer working conditions when the employees have higher earnings. On the other hand, unsafe working conditions are usually more prevalent among jobs with low skill requirements and low wages (Oh & Shin, 2003; Rommel, Varnaccia, Lahmann, Kottner, & Kroll, 2016; Verhaest & Adriaenssens, 2018). Since informal workers generally have lower wages and ability, level of demand for safe jobs is lower, resulting in bargaining that brings about a greater level of accidents (Siebert & Wei, 1994).

Earnings depend on many factors apart from working conditions, so it is important to hold these other factors constant. The omitted-variable problem derives from the fact that wealthier individuals (unobserved variables) are less likely

to choose jobs with unfavorable working conditions. Wealth and skill (e.g., education) are correlated, and since more skilled individuals also have higher earnings, failure to control properly for skill will bias downward the CWD estimate (Siebert & Wei, 1998).

The fatality risk in the formal sector may not be a fair measure for the informal sector, as the fatality risk uses SSO data that is only for a formal sector, while an informal sector is a problem to estimate as it is unable to measure the risk of labor clearly. This research has a measurement error problem by using the fatality risk rate that assumes that the fatality risks of formal and informal workers are equal in the same industry. The main problem is omitted variable bias, this problem may cause the estimated data to overestimate. Which the data does not have sufficient good Instrumental variables (IV). Instrumental variables estimation is not used to analyze in this research. Therefore, the research proposes to use the new measure based on job risk variables from LFS, which has been described in Table 1. The relationship between the probability of unsafe work and wages is analyzed by using the risk data from the Labor Force Surveys (LFS) in Table 1, which represent the risks that workers receive in each industry, in which formal and informal workers are at different risks altogether. Furthermore, wage functions are estimated by OLS, and then are estimated by quantile regression at the 10th, 25th, 50th, 75th, and 90th quantiles, respectively. The results are reported in Table 12 and Table 13.

Tables 12 and 13 report the results from a model that uses unsafe work conditions as a job risk for both formal and informal workers, respectively.

Table 12. Coefficient of unsafe probability estimates from OLS and quantile regressions of formal workers, 2012-2018

Variables	Dependent variable : ln(totalwage)					
	OLS	Quantile regression				
		10th	25th	50th	75th	90th
Unsafeprob	0.279***	0.924***	0.337***	0.146***	0.029***	0.335***
	(0.0364)	(0.0543)	(0.0323)	(0.0468)	(0.0534)	(0.0670)
Male	0.100***	0.054***	0.074***	0.098***	0.113***	0.136***
	(0.0017)	(0.0025)	(0.0017)	(0.0018)	(0.0017)	(0.0029)
Age	0.019***	0.007***	0.011***	0.018***	0.024***	0.026***
	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Central	-0.148***	-0.160***	-0.131***	-0.126***	-0.138***	-0.173***
	(0.0029)	(0.0040)	(0.0035)	(0.0034)	(0.0042)	(0.0030)
North	-0.272***	-0.345***	-0.282***	-0.249***	-0.233***	-0.259***
	(0.0034)	(0.0073)	(0.0046)	(0.0048)	(0.0060)	(0.0064)
Northeast	-0.277***	-0.375***	-0.291***	-0.235***	-0.220***	-0.252***
	(0.0035)	(0.0050)	(0.0047)	(0.0039)	(0.0045)	(0.0037)
South	-0.199***	-0.288***	0.203***	-0.164***	-0.157***	-0.183***
	(0.0035)	(0.0055)	(0.0045)	(0.0044)	(0.0059)	(0.0055)
Sec Edu	0.322***	0.201***	0.204***	0.303***	0.355***	0.357***
	(0.0026)	(0.0044)	(0.0036)	(0.0034)	(0.0033)	(0.0042)
Post Sec Edu	0.551***	0.351***	0.385***	0.518***	0.579***	0.595***
	(0.0035)	(0.0061)	(0.0048)	(0.0046)	(0.0035)	(0.0044)
Bachelor	0.937***	0.622***	0.773***	0.944***	0.988***	0.967***
	(0.0028)	(0.0054)	(0.0044)	(0.0031)	(0.0038)	(0.0036)
MA/PhD	1.292***	1.167***	1.236***	1.311***	1.246***	1.174***
	(0.0042)	(0.0064)	(0.0051)	(0.0050)	(0.0049)	(0.0072)
Married	0.043***	0.034***	0.036***	0.037***	0.035***	0.033***
	(0.0019)	(0.0029)	(0.0016)	(0.0017)	(0.0024)	(0.0034)
Constant	8.329***	8.500***	8.519***	8.363***	8.353***	8.494***
	(0.0060)	(0.0094)	(0.0072)	(0.0060)	(0.0075)	(0.0081)
R^2 / Pseudo R^2	0.5491	0.1760	0.2454	0.3582	0.4183	0.4187

Notes: *** p < 0.01, ** p < 0.05, * p < 0.10; For OLS regression, linearized standard errors in parentheses.; For quantile regressions, analytic/robust standard errors in parentheses.;

R-squared value for OLS regression and Pseudo R-squared values for quantile regressions.; N = 212,840

Table 13. Coefficient of unsafe probability estimates from OLS and quantile regressions of informal workers, 2012-2018

Variables	Dependent variable : ln(totalwage)					
	OLS	Quantile regression				
		10th	25th	50th	75th	90th
Unsafeprob	-0.665***	-0.721***	-0.476***	-0.463***	-0.528***	-0.876***
	(0.0201)	(0.0433)	(0.0261)	(0.0184)	(0.0238)	(0.0309)
Male	0.186***	0.207***	0.197***	0.160***	0.138***	0.175***
	(0.0026)	(0.0047)	(0.0040)	(0.0043)	(0.0021)	(0.0033)
Age	-0.001***	-0.006***	-0.003***	-0.001***	0.001***	0.003***
	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0002)
Central	-0.290***	-0.398***	-0.295***	-0.233***	-0.260***	-0.258***
	(0.0065)	(0.0074)	(0.0050)	(0.0058)	(0.0057)	(0.0086)
North	-0.476***	-0.613***	-0.497***	-0.423***	-0.411***	-0.430***
	(0.0068)	(0.0090)	(0.0056)	(0.0066)	(0.0063)	(0.0095)
Northeast	-0.462***	-0.657***	-0.484***	-0.388***	-0.382***	-0.403***
	(0.0068)	(0.0079)	(0.0041)	(0.0056)	(0.0061)	(0.0085)
South	-0.437***	-0.699***	-0.536***	-0.357***	-0.316***	-0.283***
	(0.0066)	(0.0110)	(0.0065)	(0.0069)	(0.0056)	(0.0101)
Sec Edu	0.092***	0.076***	0.093***	0.081***	0.087***	0.117***
	(0.0029)	(0.0058)	(0.0053)	(0.0036)	(0.0024)	(0.0042)
Post Sec Edu	0.271***	0.306***	0.251***	0.231***	0.235***	0.321***
	(0.0079)	(0.0128)	(0.0099)	(0.0074)	(0.0099)	(0.0204)
Bachelor	0.551***	0.502***	0.488***	0.482***	0.615***	0.677***
	(0.0066)	(0.0099)	(0.0091)	(0.0085)	(0.0095)	(0.0118)
MA/PhD	0.991***	0.970***	1.017***	1.008***	1.039***	1.049***
	(0.0245)	(0.0507)	(0.0233)	(0.0206)	(0.0357)	(0.0368)
Married	0.062***	0.098***	0.066***	0.052***	0.041***	0.053***
	(0.0026)	(0.0056)	(0.0041)	(0.0038)	(0.0032)	(0.0047)
Constant	9.156***	8.910***	8.989***	9.118***	9.284***	9.424***
	(0.0082)	(0.0163)	(0.0129)	(0.0065)	(0.0059)	(0.0119)
R^2 / Pseudo R^2	0.1734	0.0996	0.0884	0.0852	0.0959	0.1544

Notes: *** p < 0.01, ** p < 0.05, * p < 0.10; For OLS regression, linearized standard errors in parentheses.; For quantile regressions, analytic/robust standard errors in parentheses.; R-squared value for OLS regression and Pseudo R-squared values for quantile regressions.; N = 123,883

Table 12 and 13 found the result in OLS model, the coefficient of unsafe probability are 0.279 and -0.665 for formal and informal, respectively. This means the 1-unit increase in unsafe probability causes the increase of wages by 27.9 percent for formal workers, while causes the decrease of 66.5 percent for informal workers. Similarly, for the results apply to quantile regressions in all distribution of wage, it can be seen that the coefficient of unsafe work conditions of formal workers is positive, while it is negative for informal workers. Thus, it means that if the probability of unsafe problems increases, the wages of formal workers will also increase; while the wages of informal workers will decrease. Similar to Siebert and Wei (1994), the coefficient for nonfatal risk tends to be negative but insignificant; a non-fatal risk does not affect wage changes. On the other hand, it is different from Verhaest and Adriaenssens (2018) which found a substantially higher wage premium for hazardous and physically demand working conditions in informal jobs. They argue that these labor market imperfections, and in particular minimum wages, mainly affect the function of the formal labor market. Consequently, CWD for hazardous or demanding jobs is higher at work in the informal segment, and also in the physical and unsafe working conditions which most are among the jobs that require low skills (Oh & Shin, 2003; Rommel et al., 2016; Verhaest & Adriaenssens, 2018).

There are some assumptions for compensating wage differentials to arise violation from the basics of CWD, which are job information, utility maximization, and job mobility (Ehrenberg & Smith, 2016). The compensation for the risk can be occurred if the workers are able to move to another work, but informal workers may have fewer opportunities to change to better jobs and they also lack a voice and representation for their interests (Tawab, 2017). This may explain why the coefficient on unsafe conditions is negative for informal workers.

CHAPTER VI
CONCLUSIONS AND SUGGESTIONS

Using worker data from 2012 to 2018 Thai Labor Force Surveys and risk rate of workers from two sources; fatality risk rates calculated from the Workman's Compensation Fund at the Social Security Office, and self-reported unsafe work conditions from the Labor Force Survey. This study used the standard wage equation approach to estimate the compensation wage of formal and informal workers in Thailand. OLS and quantile regressions are used to estimate the coefficient on industry risk rates at the mean, and the 10th, 25th, 50th, 75th and 90th percentiles of income distribution for formal and informal workers.

From the model of fatality risk rate, the research found a positive and significant compensating wage differential for job risk in Thailand across both formal and informal workers, and across wage distribution. At the median wage, the estimated statistical value of life is approximately 79.33 and 41.47 million THB for formal and informal workers, respectively. This result, therefore, suggests that the market penalizes firms with poor accident records (Siebert & Wei, 1998).

The estimated value of a statistical life can be served as a useful indicator for decision making on government safety policies, including environment and transport policies (Siebert and Wei, 1998). Additionally, the research found that the market compensates for fatality risk for informal workers, but at a lower level than for formal workers at most points along the wage distribution.

From the model of unsafe work conditions, the coefficient on safety issues for formal workers is positive, while the coefficient for informal workers is negative for both OLS and quantile regressions in all wage distribution. There is inequality in the accessibility to labor protection and the ability to negotiate with employers. The Office of the Permanent Secretary (2018) has an informal labor-management action plan 2017-2021 with a vision that "informal labor has income security, get thorough

social protection, and lead to a sustainable good quality of life," which has a strategic issue to strengthen social security and expand protection to all informal workers. The protection of informal workers is still a weakness because the laws protecting informal workers do not cover all occupations. In addition, existing law enforcement is not as strong as it should be. Therefore, the government should enact informal labor protection laws that are consistent with the valuable work of the International Labour Organization, and with cooperation from all relevant sectors. Also, the government should develop labor safety policies in order to reduce fatality risk for all types of workers. Finally, Thailand should consider transitioning more workers to formal work, which can improve existing disparities in compensation wages in Thailand.

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VITA

NAME	Pinyada Suwannarat
DATE OF BIRTH	1 February 1996
PLACE OF BIRTH	Hadyai, Songkhla
INSTITUTIONS ATTENDED	Thammasat University, B.Sc.

APPENDIX

Table 14. Summary the literature related to this research

Researcher	Objective	Variables	Model	Results
Research that studies on wage compensation for both 1 and 2 labor groups : [a] 1 group , [b] 2 groups				
Siebert, W. S. & Wei, X. (1998).[a]	Estimated wage compensation for fatality risk in Hong Kong.	The 1991 Population Census of Hong Kong merged with job fatality data collected by the Labour Department. **Dependent variables** - Log of monthly salary **Independent variables** - Fatality rate - Age - Married - Education - Nationality dummy - Industry dummy	Use a two-stage least squares (TSLS) with an instrumental equation for job risk analysis, and the Thaler and Rosen formulas to assess the value of statistical life (VSL).	1. There is a positive and significant compensating wage differential for job risk for manual workers in HK. 2. The estimated 'statistical value of a life' is approximately HK$10.8m in 1990 prices (about US$1.4m).
Madheswaran, S. (2007).[a]	Estimation of value of statistical life (VSL) that reflects the risk of	**Dependent variable** - The worker's after-tax hourly wage rate. **Independent variables**	Use only the ordinary least square (OLS) to estimate the wage	1. Indian workers receive increased wage differential for high-risk jobs.

	labor in India.	- Three job risk variables - Years of schooling completed - Years worked fulltime since started work - Worker's social status - Union status - Total workforce of the firm where he works - Worker status - Regional - Age of worker	equation.	2. The value of a statistical life in India to be approximately Rs. 15 million.
Witvorapong, N. & Komonpaisarn, T. (2019).[a]	Estimate the value of statistical life (VSL) in Thailand.	**Dependent variable** - The natural logarithmic value of inflation-adjusted annual income **Independent variables** - Fatality risks - Gender - Head of household - Married	Use the population-weighted ordinary least-square (OLS), and quantile regression conditional on the 10th, 25th, 50th	1. The mean and median VSLs are estimated to be approximately 1.21 and 0.66 million in 2011 USD, respectively. 2. The mean income elasticity is 1.488,

		- Age - Education - Private sector - Skilled workers - Industry - Region	(median), 75th, 90th percentiles to analyze the relationship of risk on wages.	indicating the Thai VSL is income elastic.
Leeahtam et.al. (2014).[a]	The informal labor wage determination survey in Chiang Mai, focusing on the compensation of wage differences from receiving work-related risks by using unemployment risk.	**Dependent variable** - An hourly wage in its natural log form **Independent variables** - Gender - Age - Education - Work status - Agriculture - Hazard - Unemployment Risk - IMR	Use the quantile regression analysis with multi-level sample selection.	1. The compensating wage differentials in the lower and middle quantiles, but not the higher quantiles. 2. With unemployment risk, the workers not only are not compensated for their occupational hazards, but also face with an inefficient job matching outcomes.

Siebert, W. S. & Wei, X. (1994).[b]	Study the measures for the compensation wage differentials for job risks for union and nonunion workers.	**Dependent variable** - The logarithm of after-tax weekly earnings **Independent variables** - Age - Education - Years of work experience and its square - Months of tenure and its square - Weekly overtime hours worked - Number of dependent children - Dummies for whether a union member - Married - Employment sector - Establishment size - Region	Use the two-stage least squares (2SLS) to predict p in wage equations, estimate the wage functions by ordinary least squares (OLS), and re-estimate the wage equation by using the instrument method to predict the job risk variables.	1. There are significant compensating wage differentials for fatal accident risk for both unionized and nonunionized male manual worker groups. 2. The estimated statistical value of a life is 8.8m pound for union workers, with nonunion workers about 20% lower.
Verhaest, D. & Adriaenssens. S.	Test whether the compensation	Data from a large-scale survey on student employment among students	Use the linear regression to	1. While informal student jobs pay, on

(2018).[b]	wage for poor working conditions is most often found in informal workers compared to formal workers.	in secondary education in Flanders. **Dependent variable** - The natural log of the hourly wage of student **Independent variable** - The student's personal characteristics, social background and human capital along with interaction terms between these variables and the time dummy. - Gender - Age - Foreign background - Province - Economic activity of the father - Most recent occupation of the father **Control variables** - Educational career are year of class - Educational track - The organize authority of the school	analyze objectives in this research.	average, lower wages than formal jobs, we do find a substantially higher wage premium for hazardous and physically demanding working conditions in informal jobs. 2. While informal student jobs pay, on average, lower wages than formal jobs, we do find a significantly and substantially higher wage compensation for adverse working conditions in informal jobs.

		- School size		
Research that studies on wage differences between formal and informal workers.				
Dasgupta, S., Bhula-Or, R., & Fakthong, T. (2015).	Assess the earnings gap between informal and informal employment in Thailand.	Using a sample of workers that includes both wage and self- employed workers. **Dependent variable** - Natural log of total monthly earnings **Independent variables** - Gender - Age - Education level - Area of living and working - Type of industry - Type of jobs	Use the quantile regression method with the income function to understand the factors that explain the difference of income in each quantile distributions.	1. Informally employed workers systematically present lower earnings at all earnings levels, and the difference increases with level of earnings. 2. The estimated marginal effect of gender on earnings is negative and remains more or less constant across the different quartiles, while returns to education are positive and increase with income quartiles.

				3. The premium of working in services or manufacturing is higher at the lower end of the income distribution and the non-farm self-employed worker is likely to earn more than others.
Vechbanyongratana, J. & Yoon, Y. (2019).	Examine the difference on wages between formal and informal workers in Thailand between 2011-2016.	**Dependent variable** - The natural log of wage **Independent variables** - Regions - Sex - Occupation - Age - Education	Using a simple dummy variable quantile LAD regression with two-way and three-way interactions, which allows us to trace the wage gap between formal and informal	1. The central region recorded the lowest formal wages while the Northeast had the lowest informal wages. However, the wage gap has remained high in Bangkok and the North region (except in 2014), and more recently the

			workers over time using survey weights.	gap has surged noticeable in the South. 2. Wage gaps between formal and informal work is generally higher among higher among women than men. 3. The wage gap between formal and informal work has been highest for higher paid occupations, and smaller for lower paying occupations. 4. The formal-informal wage gap is highest for university graduates but has recently

				declined for the lowest education category and reversed for those with MA/PhD, in recent years.