The Roles of Informality and Labor Mismatch on Returns to
Education in Thailand

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บทบาทของแรงงานนอกระบบและความไม่สอดคล้องกันในตลาดแรงงานต่อผลตอบแทนของ
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ตัณฑกา วิวัฒน์สุรกิจ : บทบาทของแรงงานนอกระบบและความไม่สอดคล้องกันในตลาดแรงงานต่อผลตอบแทน ของการศึกษาในประเทศไทย. (The Roles of Informality and Labor Mismatch on Returns to Education in Thailand) อ.ที่ปรึกษาหลัก : ผศ. ดร.เจสสิกา แมรี่ เวชบรรยงรัตน์

แม้ว่าประเทศไทยมีการเติบโตด้านเศรษฐจอย่างรวดเร็ว รวมถึงมีการลงทุนด้านการศึกษาอย่างต่อเนื่อง อย่างไรก็ตาม แรงงานจำนวนมากในประเทศไทยยังคงเป็นแรงงานนอกระบบ นอกจากนี้ มีแรงงานจำนวนมาก ที่ไม่สามารถหางานที่ตรงกับระดับ การศึกษา หรือสายงานที่เรียนมา ดังนั้น วิทยานิพนธ์ฉบับนี้ทำการศึกษาเรื่อง 1) ผลตอบแทนด้านการศึกษาของแรงงานนอกระบบใน ประเทศไทย 2) เหตุการณ์ความไม่สอดคล้องกันในแนวตั้งของการศึกษาและอาชีพ รวมถึงผลกระทบทางลบต่ออัตราค่าจ้างของแรงงาน นอกระบบในประเทศไทย 3) เหตุการณ์ความไม่สอดคล้องกันในแนวนอนของการศึกษาและอาชีพ รวมถึงผลกระทบทางลบต่ออัตรา ค่าจ้างของแรงงานไทยที่จบการศึกษาในระดับอุดมศึกษา

การศึกษาหัวข้อแรกใช้ข้อมูลสำรวจเศรษฐกิจและสังคมของครัวเรือนปี 2554 2556 และ 2558 เพื่อศึกษาอัตราค่าจ้าง แรงงานไทยต่อการศึกษาของแรงงานนอกระบบโดยใช้วิธี Instrumental Variable ซึ่งผลการศึกษาพบว่าผลตอบแทนต่อการศึกษา เพิ่ม 1 ปีของแรงงานนอกระบบอยู่ที่ร้อยละ 11-12 เปรียบเทียบกับร้อยละ 14 ของแรงงานในระบบที่ทำงานในบริษัทเอกชน

การศึกษาหัวข้อที่ 2 ด้านความไม่สอดคล้องกันในแนวตั้งของการศึกษาและอาชีพต่อแรงงานในระบบและนอกระบบ โดยใช้ ข้อมูลสำรวจเศรษฐกิจและสังคมของครัวเรือนปี 2554 2556 และ 2558 พบว่าผลกระทบทางลบต่ออัตราค่าจ้างของแรงงานไทย สูงสุดคือข้าราชการที่ร้อยละ 28.2 ในขณะที่ผลกระทบทางลบต่ออัตราค่าจ้างของแรงงานไทยต่ำสุดคือแรงงานที่ทำงานส่วนตัวที่ร้อยละ 3.9

การศึกษาหัวข้อสุดท้ายคือการศึกษาความไม่สอดคล้องกันในแนวนอนของการศึกษาและอาชีพ โดยใช้ข้อมูลปี 2554 ถึง 2559 ของฐานข้อมูลการสำรวจภาวะการทำงานของประชากร จากการวิจัยพบว่า แรงงานที่มีความไม่สอดคล้องกันในแนวนอนได้รับ ผลกระทบทางลบต่ออัตราค่าจ้างของแรงงานโดยที่จบการศึกษาระดับปริญญาตรีได้รับผลกระทบทางลบสูงสุดที่ร้อยละ 5.6 ในขณะที่ผู้ จบการศึกษาจากสายอาชีพ หรืออาชีวศึกษาได้รับผลกระทบทางลบร้อยละ 11.6

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สาขาวิชา	เศรษฐศาสตร์	ลายมือชื่อนิสิต ....
ปีการศึกษา	2562	ลายมือชื่อ อ.ที่ปรึกษาหลัก ....

Thailand has experienced rapid economic development and significant investments in education. Despite these trends, many Thai workers remain informally employed or cannot find jobs commensurate with their education level or university major in the labor market. Given these issues, this dissertation examines three interrelated questions: 1) What are the returns to education among the informally employed in Thailand? 2) What is the incidence of vertical education - occupation mismatch and its accompanying wage penalties among Thailand's informally employed? 3) What is the incidence of horizontal degree field - occupation mismatch and its penalties among Thailand's post-secondary school graduates?

The first study uses data from the 2011, 2013, and 2015 Thailand Household Socio-economic Surveys (SES) to estimate wage returns to years of education for informal workers using an instrumental variable (IV) approach to correct for ability bias. The results indicate that the return to an additional year of education for the informally employed is 11-12 percent, compared to 14 percent for formally employed private firm workers. Using the same data, the second study examines the incidence and implications of vertical mismatch among formal and informal workers in Thailand. Consistent with structural changes in the economy and increases in the supply of education, overeducation is most prevalent among the youngest cohort of workers across every employment sector. Despite increasing formalization of the economy, the incidence of informality remains high among the youngest cohort of workers, with overeducation prevalent among the informally employed. The overeducation wage penalties are highest in older cohorts, suggesting that penalties increase over one's career.

The final study examines horizontal mismatch in Thailand and its associated wage penalties. Using the 2011 to 2016 Thai Labor Force Surveys (LFS), this study finds that 40.7 percent of postsecondary graduates are horizontally mismatched. Bachelor's degree graduates face the largest penalties, at 15.6 percent on average, whereas mismatched workers with upper vocational degree credentials are penalized the least at 11.6 percent.

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Education provides numerous personal and social benefits. One approach to achieving better job opportunities and a better standard of living is to pursue higher education. As the job market becomes more challenging and competitive, it is becoming more important for individuals to pursue a higher education. Higher education offers both monetary and non-monetary benefits: opportunities to earn higher income, better labor market matches, and the chance to establish one's professional reputation and network. Furthermore, education benefits societies and countries as it is one of the most powerful tools for building human capital to drive a country's development and sustain economic growth. As Schultz (1961) claims, a country's development is the output of human capital.

On the other hand, education comes with costs beyond tuition, such as decreased or forgone income during the academic year as individuals spend most of their time studying instead of working. To decide whether to pursue more education than is required by law, individuals must balance the potential of earning more after graduation in comparison with their earning ability now with the opportunity cost of studying rather than entering the job market. In general, people select their level of education based on expected future returns in the labor market (Carneiro, Heckman and Vytlacil 2010).

Returns to education is defined as an increase in earnings from an additional year of education (Borjas 2004). The literature on returns to educations is large (Carneiro, Heckman and Vytlacil 2010; Dickson and Harmon 2011; Oreopoulos

2006; Oreopoulos and Petronijevic 2013., etc.) and has been conducted using various econometric models using different types of datasets. Overall, these works show that higher education leads to higher labor earnings. Table 1 illustrates the average returns to an additional year of schooling by education level and region calculated by Montenegro and Patrinos (2014), employing the International Income Distribution Database World Bank 2014, a large database comprised of available national household surveys covering the years 1970 to 2013.

From Table 1, the highest returns to secondary and tertiary levels of schooling are in the developing world (Sub-Saharan Africa and South Asia), while the highest returns to primary education belongs to the Middle East/North Africa. The lowest returns, on average, are in high-income countries where the majority of the population has achieved fairly high levels of education. Most importantly, the returns on additional year of study in many regions are highest at the tertiary level.

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Table 1: Average returns to schooling

Region	Total			Male			Female		
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
High Income	4.9	6.6	11.1	3.3	7.5	10.7	7.2	5.2	12.3
East Asia	13.6	5.3	14.8	12.6	5.8	15	9.5	6.4	15.8
Europe/Central Asia	13.9	4.7	10.3	12.1	4.2	9.8	11.9	6.4	12.2
Latin America	7.8	5.4	15.9	7.9	5.3	15.7	8.7	6.5	17.4
Middle East/N. Africa	16	4.5	10.5	12.7	4.3	10.2	21.4	7.4	13.5
South Asia	6	5	17.3	4.7	3.9	16.6	4.8	6.2	23.3
Sub-Saharan Africa	14.4	10.6	21	12.5	10.1	21	17.5	12.7	21.3
All economies	11.5	6.8	14.6	10.1	6.7	14.4	13.2	8.2	16.1

Source: Montenegro and Patrinos 2014

Given the high returns to education at all levels, it is not surprising that governments devote a significant amount of spending on education, including that of Thailand. The Thai government has enacted policies to increase education at all levels since the 1970s, which has resulted in an increase in the average level of education in the Thai population over time, as shown in Figure 1 below. This results in improvement to human capital in the country and, presumably, higher productivity and income. On the other hand, if the labor market transforms from an agriculturally based market to one that requires a highly educated workforce more slowly than the changes in the provision of higher education, the labor market may not be able to absorb highly educated workers, which would then create the problem of overeducation.

Figure 1: Average levels of education (years) on Thai populations 2004-2016
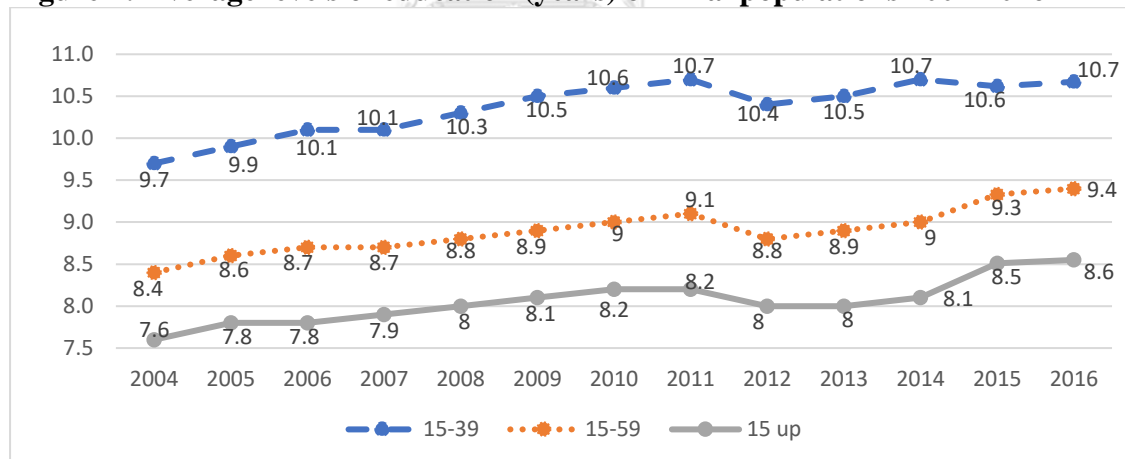
Source: National Statistical Office 2004-2011 and Office of the National Education Commission 2017

In Thailand, there are several studies related to returns to education (Hawley 2004; Moenjak and Worswick 2003; Srinang 2014; Tangtipongkul 2015; Warunsiri and McNown 2010) and a few studies regarding wage penalties due to educational

mismatch (Paweenawat and Vechbanyongratana 2015; Pholphirul 2017). Many unanswered questions still exist. Previous empirical work does not take into consideration another important part of Thai economy, which is informal workers. The informal sector includes units, which are not well organized, with the purpose of generating employment (ILO Resolution 1993). More details on the informal sector is found in Chapter 2. Based on the International Labor Organization ("ILO", n.d.), the informal economy accounts for half to three-quarters of all non-agricultural sectors in developing countries. Figure 2 shows the ratio of workers in the informal sector to total employment in Thailand. The proportion of informal workers has dropped from 62 percent in 2005 to 55 percent in 2017, but still remains the main sector of employment for Thai workers.

Figure 2: Contribution of Informal employment in Thailand
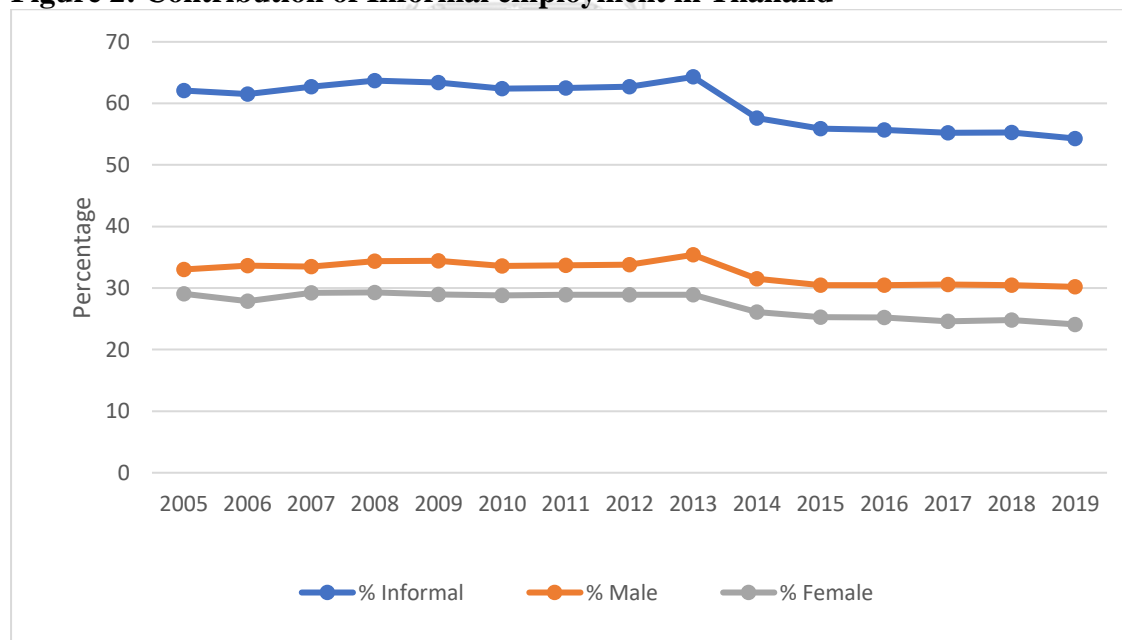
Source: National Statistical Office 2018

The rapid rise of educational attainment and the large number of informal workers in Thailand provide the backdrop for the three topics covered in this dissertation:

1. *Returns to education among the Informally Employed in Thailand*

Thailand's labor force is largely informal but returns to educational investments in the informal economy have not been addressed in previous papers. Thus, this chapter will estimate Mincerian returns to education in both the formal and informal economies, which should provide a clearer picture of the actual returns to education in Thailand. Moreover, ability bias will be taken into account.

2. *Vertical Education - Occupation Mismatch and its Wage Penalties among the Informally Employed in Thailand*

The focus of this chapter is the vertical mismatch of formal and informal workers, classified as government employees, formal private firm employees, informal private firm employees, and own-account workers. The chapter investigates mismatch rates and wage penalties by age cohorts because of the transformation of the Thai labor market and changes in education policies over time. The gender dimension is also considered.

3. *Horizontal Education – Occupation Mismatch: Incidence and Penalties in Thailand*

Another issue of increasing concern in Thailand is the prevalence and wage impacts of horizontal mismatch. This chapter addresses horizontal mismatch among graduates of vocational, bachelor's, and postgraduate programs and its accompanying penalties both overall and by academic major. More specifically, the comparison of

earnings between matched and mismatched workers who graduate from the same fields is discussed.

This dissertation is organized as follows. The discussion on the education system, informality, and labor market in Thailand will be discussed in Chapter 2. Chapter 3 presents the theoretical background for the following empirical chapters, particularly the theory of human capital, which is considered as the beginning point of all three research questions, and then cover the job competition model, which relates to education - occupation mismatch. Chapters 4, 5, and 6 present the three empirical case studies described above. Chapter 7 concludes the dissertation.
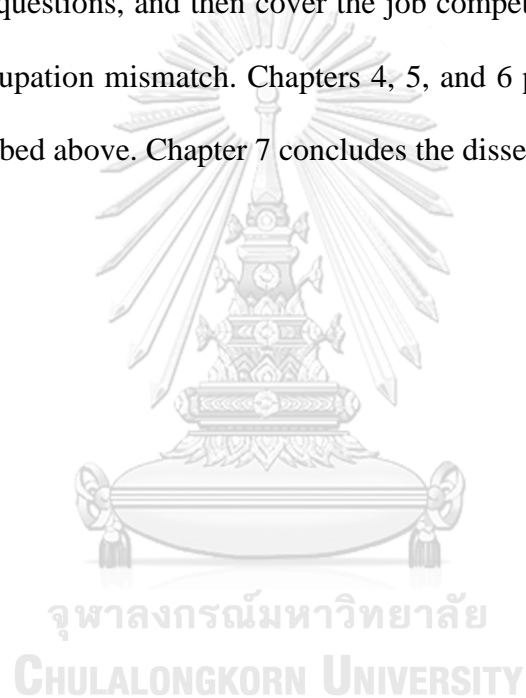
Chapter II: Education System in Thailand, Informality, and Development of the Thai Labor Market

Education System in Thailand

Significant changes in the education system accompanied the development of Thailand's economy starting in the 1970s. For example, since the 1970s, Thailand has increased the compulsory level of schooling from four to nine years and initiated a large expansion of secondary and tertiary education.[1] Also, based on the Third Five-Year Economic and Social Development Plan (1971-1976), secondary schools were established in every district (*amphoe*) across the country (Ministry of Education 1976). In 1980, the National Primary Education Act was implemented, which stated that all sub-districts (*tambon*) should be equipped with primary schools. Another major policy change in the Thai education system occurred in 2002 with an increase in compulsory education from six years to nine years. Currently, the Thai education system includes 12 years of basic education, including six years of compulsory education at the primary level, three years of compulsory education at the lower secondary level, and three years of non-compulsory but tuition-free education at the upper secondary level.

According to the National Education Act B.E. 2542 or 1999 (revised B.E. 2545 or 2002) and the Compulsory Education Act B.E. 2545 or 2002, formal education is divided into two levels: basic education and higher education (Yamwagee 2011).

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[1] Tertiary education includes post-secondary upper vocational training, four-year university education, and higher level degrees.

1. Basic Education

    a. Pre-elementary level

    b. Elementary level

Compulsory education was increased from four to six years, based on the Third Five-Year Economic and Social Development Plan (1971-1976). The six-year elementary level education is compulsory for Thai citizens. It includes basic literacy, numerical skills, and the cultivation of desirable behavior.

    c. Secondary level

This secondary level is divided into two sub-levels:

- Lower secondary: In 2002, there was major policy change in the Thai education system that the compulsory level of education was increased from six years to nine years, including a three-year course that develops students' ethics, knowledge, and abilities. It allows students to explore their desires, areas of interests, talents, and enables them to meet their proper careers.

- Upper secondary: a three-year course that is fundamental for students who will proceed to higher education. Its aims are to equip students for the labor market and elevate their entrepreneurship skills. This three-year course is non-compulsory but tuition-free education.

    i. Vocation-oriented: practical, skill-based education

    ii. Academic stream: general education schools, theory-oriented

2. Higher Education

a. Diploma level: one- to four-year course for students who have completed the upper secondary level. It aims to develop the students' knowledge and vocational skills.

b. Degree level, which can be classified as:

i. Undergraduate level: This four-year university degree is to develop students' abilities and disciplines. Students are expected to apply theories to practice.

ii. Graduate level: Comprises of the graduate diploma, master's degree, and doctoral degree levels. Students are practiced in their specialties and can bring theories to reality.

The education system in Thailand can be summarized as shown in Figure 3 below:

Figure 3: Level of Education in Thailand
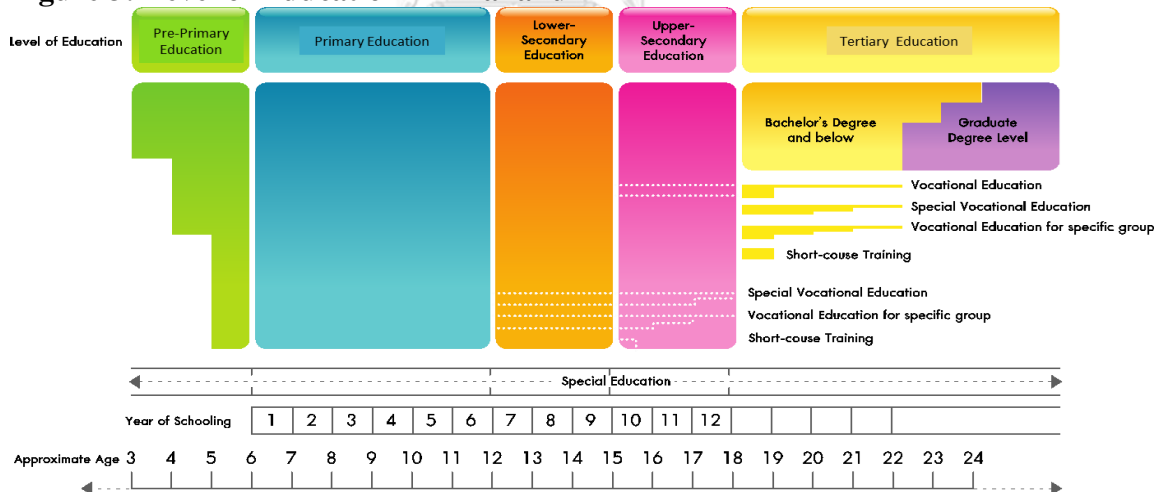
Source: Educational Statistics in Brief 2012 Bureau of Information and Communication Technology, Ministry of Education, cited in Office of the Education Council 2014

According to Aemkulwat (2010), the number of lower secondary school students increased by 18 percent and the number of upper secondary school students increased by 22 percent from 2002 to 2010. The number of vocational graduates also

rose by 1.2 million to 3 million between 1990 and 2010 (Aemkulwat 2010). Furthermore, Thailand saw a significant increase in the number of educational institutions at all levels, especially at the secondary and tertiary levels. For example, the number of higher education institutions rose from a handful in 1970 to 185 institutions in 2014 (Paweenawat and Vechbanyongratana 2015). The expansion of schools combined with changes in the compulsory education laws led to a steady increase in primary, secondary, and tertiary gross enrollment rates from 1971 to 2013, as shown in Figure 4. Primary education enrollment became universal in the 1980s, while secondary enrollment increased from 18 to 82 percent and tertiary enrollment from 3 to 50 percent since 1970. It is clear that as a result of the government's education policies, the average level of completed education among Thais has increased dramatically since the 1970s.

Figure 4: Gross Enrollment Rates in Thailand, 1971-2013
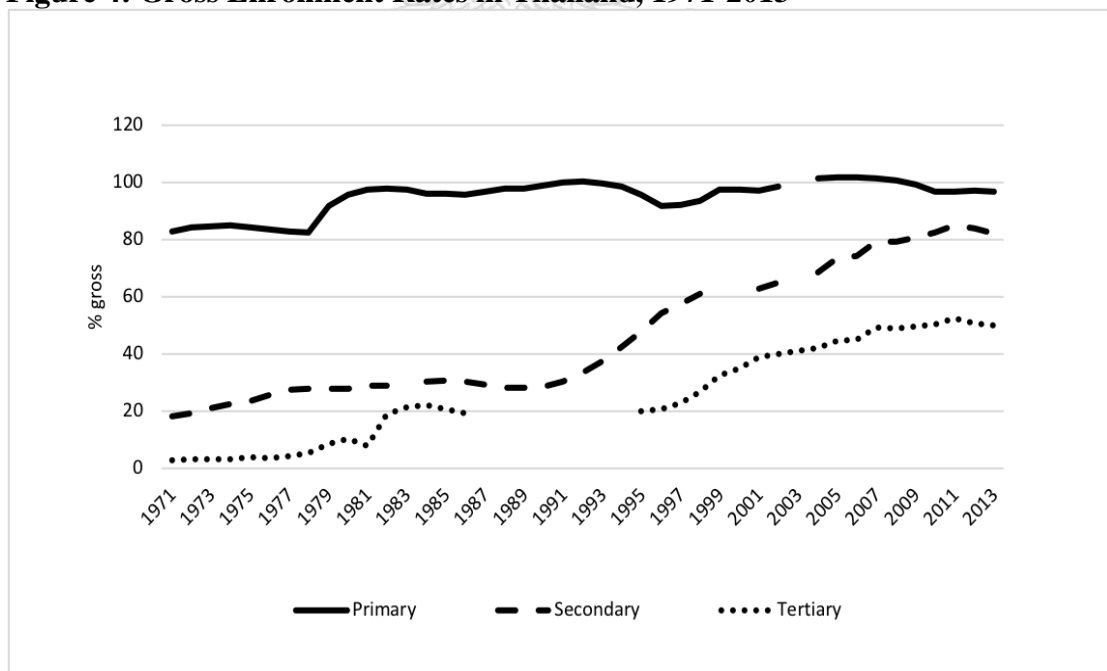
Note: Gaps are due to missing data for some years

Source: The World Bank (2019).

Development of the Thai Labor Market

In the past, Thailand was considered an agricultural country. However, a big shift began in the 1970s and Thailand experienced a rapid structural transformation. People started moving out of agriculture to work in urban cities, particularly Bangkok. In fact, Japanese investors came to Thailand in the late 1960s, mostly to assemble automobiles and household goods. Additionally, some investments went into labor-intensive manufacturing, such as textiles (Baker and Phongpaichit 2014). Following the world's oil crisis in 1973 and due to other external factors, Thailand began shifting toward export-oriented manufacturing in the 1980s, and exports increased by approximately 24 percent per year from 1984 to 1989 (Baker and Phongpaichit 2014). At the same time, foreign direct investment increased as many countries moved to invest in lower-wage countries. From the 1990s onward, the tourism and service sectors experienced growth in part due to the government's promotion of Thailand as a tourist destination (Kaosa-ard 2002). Figure 5 shows the contributions of each sector to total employment in Thailand between 1991 and 2018.

Figure 5: Thailand's Sectoral Employment Shares, 1991-2018

Figure 5 demonstrates that the agricultural sector saw a rapid decline in its contribution to employment, dropping from 60 to 32 percent over the 28-year period. At the same time, employment in the service sector rose rapidly from 22 to 45 percent, while the share of workers in manufacturing continued to rise during this period, albeit more slowly, from 18 to 23 percent.

In terms of industries, workers migrated from the agricultural to manufacturing and service sectors. Over the period of about 20 years from 1990, the share of workers in the agricultural sector dropped by more than 20 percent while the share in manufacturing and service sectors increased by six and ten percent respectively in the same period (Aemkulwat 2010). One of the major drivers of this change is the establishment of the Industrial Estate Authority of Thailand (IEAT) in 1979. This party is responsible for the development and establishment of industrial

estates consisting of industrial space, complete facilities, public utilities, and infrastructure (IEAT n.d.) and serves as a governmental mechanism to decentralize industries to provincial areas, to develop environmental standards for factories, to manage and organize the use of land, and to support exports. Moreover, the IEAT takes care of the Map Ta Phut Industrial Port, a high-capacity port fully equipped with services and facilities. This port is located in a strategic area and is the largest port in Thailand. Despite these structural shifts in the economy, much of the employment - including wage labor - remains informal.

Informality Despite Economic Development and Educational Investments

Definition of Informal Economy

Although different sources provide different definitions, the core explanation of "informal" is similar among them. Some define the informal sector as employment with no regulations concerning the non-payment of wages, overtime, lay-offs without compensation, health insurance, etc. (International Labor Organization n.d.). Informal employees are those in an employment relationship or who are self-employed, but are not subject to national labor legislation, income taxation, and social protection (International Labor Organization n.d.). In Thailand, the National Statistical Office ("NSO" 2017) defines informal employment as those workers who have no protection or social insurance in their jobs, while formal employment is classified as workers who have protections provided by their employers. Formal workers are defined as follows:

a) All government officers and employees

b) All state enterprises employees

c) All teachers in private schools, according to the Private School Act

d) Government officers, employees of other countries, or those who work in international organizations

e) All employees who have protection under Labor Legislation

f) Workers who have social security according to Social Security Act B.E. 2533 (1990), Section: 33, 39, 40[2] (Social Security Office, n.d.). Social Security, Section 33 states that an employee between 15 and 60 years old shall be an insured person.

It is frequently assumed that workers in informal employment have low productivity, work in inferior conditions, lack protection, and earn low wages (Herrera-Idarraga, Lopez-Bazo and Motellon 2012). Due to these issues, the ILO has encouraged governments to enact policies to formalize informal employment, such as through the ILO's Recommendation No. 204 concerning the transition from informal to formal economy. Widespread informality can lead to serious problems not only from an economic perspective, but also from social and political perspectives. According to Elgin and Sezgin (2017), large informal economies result in lower tax revenues that negatively affect the provision of public goods and services, lower productivity, and lower potential for economic growth.

Although informal work is generally thought of as inferior to formal work arrangements, several studies have found that informal employment may have private

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[2] The definition by the government included in the Social Security Act B.E.2533 (1990), Section 39, 40 states that the Act allows any person who has paid into the system for no less than 12 months and is terminated from employment to continue to be an insured person if they wish. However, these groups will be considered as informal workers in this study.

advantages for workers. For example, Park and Qu (2013) claim that individuals might decide to work informally if formal jobs offer inferior benefits compared to informal employment. Similarly, Gunther and Lannov (2012) find that some individuals leave formal work and seek informal work because earnings from informal work can exceed earnings individuals can generate from formal work, depending on occupation, opportunity, and other conditions. Moreover, Maloney (1999) states that individuals might find informal employment more desirable due to inefficiencies of protection. Given that informal employment may be preferable to formal employment along some dimensions, it is of interest to know if returns to investments in formal education are comparable for formal and informal workers within a largely informal economy.

Informality in Thailand

Despite the government's efforts to transform the Thai economy and significant investments in education, Thailand's labor market remains highly informal. Official statistics report 56 percent of workers were classified as informally employed in 2016, including informal employees working in firms and own-account workers (National Statistical Office 2018a). Based on the data used for the main analysis in this study, Figure 6 shows the share of formal and informal workers in the Thai economy in the year 2015 by birth cohort for workers born between 1951 and 1980.

Figure 6: Share of Formal and Informal Workers in Thailand by Birth Cohort, 2015
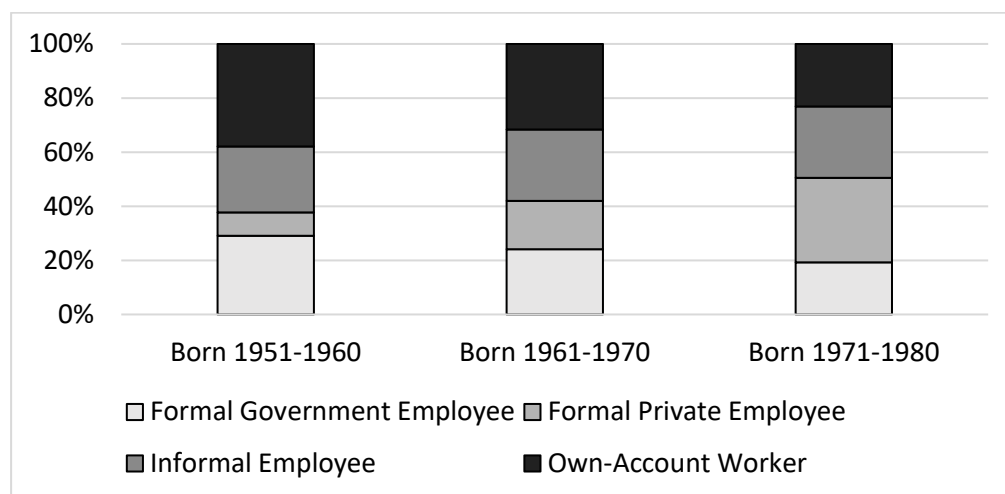
Source: Authors' calculations from the 2015 Thailand Socio-economic Survey.

Figure 6 shows that the proportion of workers who are informally employed is higher in the oldest generation of workers, but still stands at 49 percent for workers born between 1971 and 1980. Older workers are more likely to be self-employed workers, largely in agriculture. In contrast, the youngest workers are more likely to be employed in firms, but almost half of the private firm employees remain informally employed. The overall picture suggests that with structural changes within the Thai economy, younger workers are less likely to be self-employed in agriculture and more likely to work in private firms, but the probability of being informally employed remains high.

In a recent study of Thailand's informal workers, Dasgupta, Bhula-Or, and Fakthong (2015) compare earnings between the formally and informally employed in Thailand. They find that the earnings of informal workers are significantly lower than that of formal workers at 56.7 percent, and informally employed men generally command higher income than informally employed women. Not surprisingly, higher educated persons earn more in comparison to the less educated. Elgin and Sezgin

(2017) argue that the informal sector increases work opportunities for low productivity and unskilled persons who would not normally qualify to work in the formal sector. However, Dasgupta, Bhula-Or, and Fakthong (2015) find that the wage gap between formally and informally employed persons is lower among the more highly educated younger generation than the older generation, which suggests that informal employment in the Thai context may not represent inferior employment and that at least some informal employment rewards skills gained through education.

Informal employment is not distributed evenly across all occupations. Figure 7 shows the distribution of formal workers (government workers and formal private firm employees) and informal workers (informal private firm employees and own-account workers) who receive cash remuneration across occupational categories based on the 1-digit ISCO-08 occupational classifications.

Figure 7: Distribution of Formal and Informal Workers Across Occupational Categories, 2015
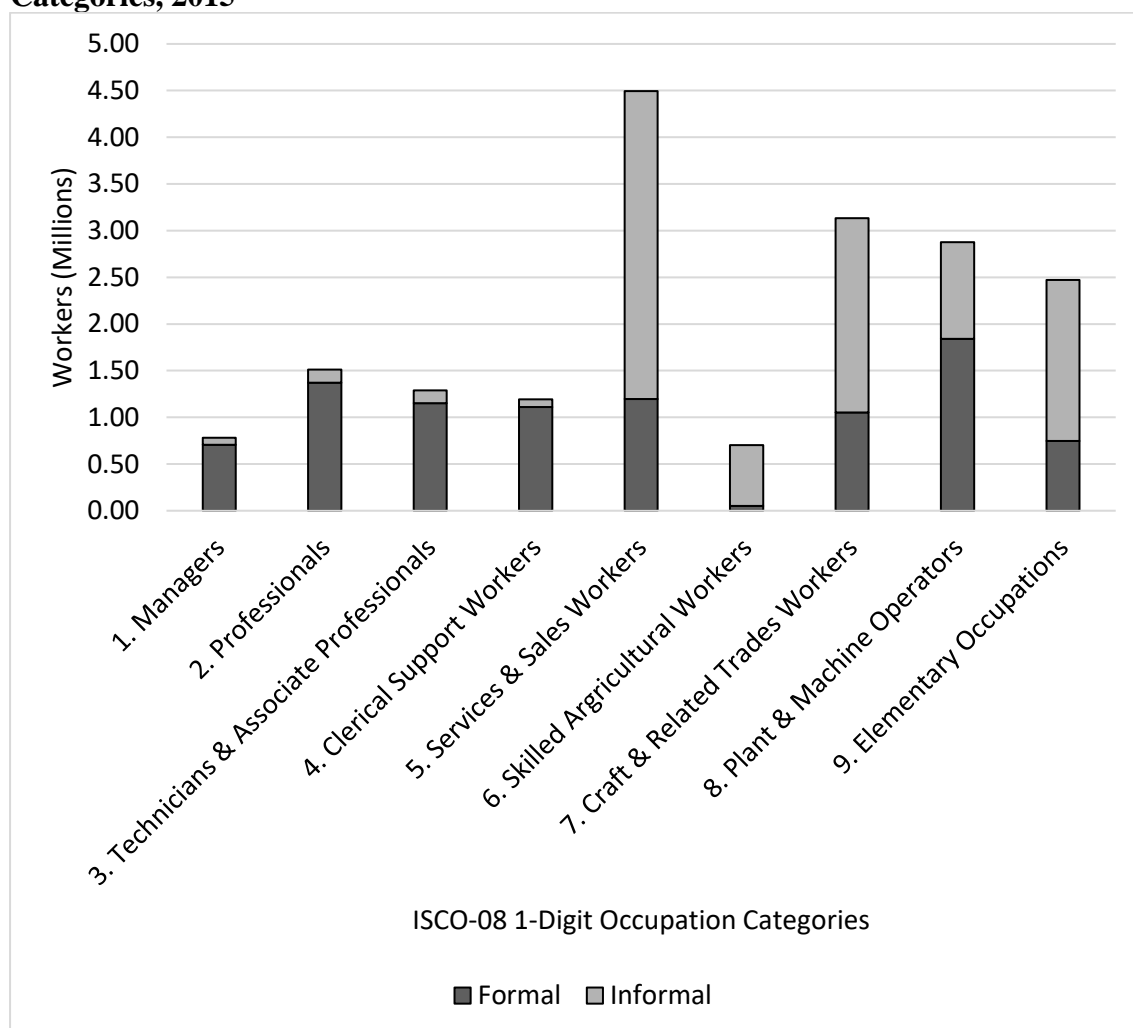
Source: Authors' calculations from the 2015 Thailand Socio-economic Survey.

Note: The tabulation includes only workers who receive labor income, including government workers, private firm employees, and own-account workers. The tabulations exclude employers and unpaid family workers.

Occupations requiring the highest levels of education and skill are located towards the left side, including managers, professionals, technicians, and associate professionals. These categories largely encompass civil servants and highly skilled workers in larger private firms, and thus workers employed in these occupations are generally formal. The occupational categories that require the least education and skills are located towards the right side, including craft and related trades workers,

plant and machine operators and assemblers, and elementary occupations. Informal workers are disproportionately represented in the occupational groups located on the right side of the graph. The one exception is the high number of formal workers in occupation category 8 - plant and machine operators and assemblers - which encompasses lower skilled factory work. The government's push to develop the manufacturing sector during the 1980s and 1990s attracted larger firms that the government subsequently required to register for tax (including employment tax) purposes, which explains why workers in occupation category 8 are largely formal. Despite the government's mandate that all firms hiring one or more workers must register their employees for social security, many smaller enterprises remain unregistered, often intentionally to avoid taxation and social security contributions. Own-account workers - who are informally employed by definition - generally work in lower skill occupational categories. In fact, approximately 95 percent of own-account workers are classified as working in occupation categories 5 through 9, making up a significant proportion of workers in these categories.

Although one finds informal workers are disproportionately represented in occupations requiring lower skill and education, it is important to note that within the Thai context one finds both formal and informal workers often performing the same jobs. For example, according to the 2016 Thai Labor Force Survey (LFS) Informal Supplement, informal workers engaged in the food, beverage, textile, and apparel manufacturing industries constituted 38, 32, 32, and 47 percent of the workers in these manufacturing subcategories, respectively (Vechbanyongratana et al. 2019).

Since the 1990s, there has been a movement of the labor force from a work status of "unpaid family workers" to a work status of "employees of private companies," which is demonstrated by an increase in the proportion of these employees by almost 12 percent within 20 years (Aemkulwat 2010). This implies the movement from the informal sector to the formal sector following the country's industrialization. However, even though Thailand experienced a major transformation of its economy over the past four decades, the country largely did not experience concurrent formalization of employment. The growth of formal private firm employment through the expansion of social security has been slow but has picked up in recent years. The number of private firm workers covered by Section 33 of the Social Security Act has grown from 8.6 million workers in 2008 to 10.8 million workers in 2017, which represents an increase from 23 to 29 percent of the total workforce. Despite efforts to expand formal employment, Thailand's informal workers continue to make significant contributions to the country's economy, with official figures putting the share of informal workers in the total workforce at 55 percent in 2018 (National Statistical Office 2018b).

Chapter III: Related Theory

This chapter summarizes the theories that underpin the three empirical chapters in this dissertation, which are the human capital theory, the job competition model, job signaling theory, and theory of informal work.

Theory of Human Capital

In the past, economic theory treated all workers as identical in productivity. However, many economists raised the point of view that different workers have different levels of productivity, which could be a result of human capital. Human capital is defined as knowledge, skills, attitudes, and other acquired traits contributing to production (Goode 1959). In other words, human capital is the drivers that make people more productive; in contrast to physical capital, human capital cannot be separated from persons. It includes the amount of acquired education, on-the-job training, other professional experience, etc. Consequently, workers with different levels of human capital earn different incomes. Since the early 1960s, researchers started to develop various theories of human capital and returns to education (Becker 1962; Mincer 1974; Schultz 1961). Becker[3] (1962) states that different investments

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[3] Becker has a complete theory of human capital and comes up with eight conclusions: 1. Earnings normally increase over time, but at a decreasing rate; 2. The relationship between unemployment rate and employment skills tends to be negative; 3. In less developed countries, firms tend to be more "paternalistic" toward employees compared to firms in more developed countries; 4. Younger persons tend to change jobs more frequently with more schooling and on-the-job training compared to older people; 5. For more skilled workers, the earnings distribution is positively skewed; 6. More talented individuals receive more education than others; 7. The extent of the market is the key factor limiting the division of labor; and 8. Comparing between human capital investors and physical capital investors, the first group tends to be more imprudent and has a higher chance of making mistakes.

affect future wealth, such as schooling, on-the-job training, medical care, vitamin consumption, and acquiring information about the economic system. Yet, the relative effects on earnings and consumption differ according to the amount of invested resources.

Although education provides numerous benefits and leads to better earnings, attending school has its own costs: direct costs like tuition, books, and transportation, and indirect costs like the opportunities lost if individuals decide to work instead of study further. Becker (1962) defines net earnings as follows:

$$W = MP - k \tag{1}$$

where W represents earnings while MP and k are the marginal product and direct school costs, respectively.

Employees would pay for education and receive lower or negative earnings during the period of education and the earnings are expected to increase at a later stage as Figure 8.

Figure 8: Earnings and Schooling
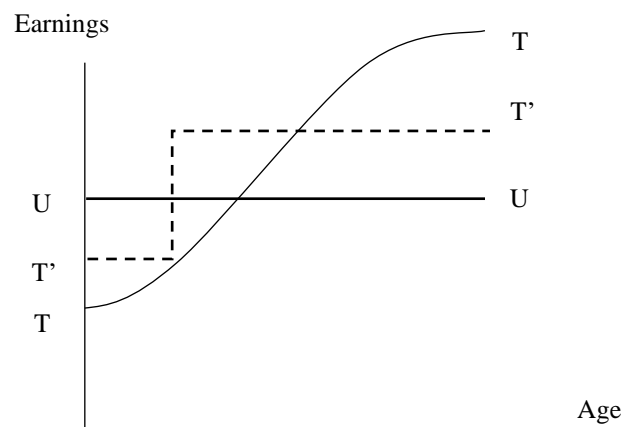
Source: Becker (1994)

In Figure 8, UU represents untrained persons that would receive the same earnings during their professional lives while trained persons would receive lower earnings during the training / studying period, but higher earnings at a later stage and greater than costs, which is returns to education as shown by T'T'. TT is the combined effect of UU and T'T' which in later age, the earnings are greater than untrained persons (Becker 1994). This theory implies that people invest only if expected future earnings outweighs the current cost of education. From an employee's point of view, this theory also demonstrates that in order to get higher pay, it is important to increase productivity, which is mainly the result of education, especially among new graduates.

Becker sets out the theory that individuals with higher human capital have higher earnings. Mincer (1974) develops an empirical method to test this theory and publishes the early model, Human Capital Earning function, which represents a combination of analyses of investment parameters and of income distribution as follows:

$$ln\,w = ln\,w_0 + \alpha ed + \beta_1 ex + \beta_2 ex^2 + \varepsilon \qquad (2)$$

where w is earnings (w_0 is the level of earnings of an individual with no education and no experience), ed and ex are years of schooling and years of potential labor market experience, respectively. The above model is considered as a foundation of many empirical studies on human capital because it captures potential experience as a standard regressor in the earnings regression (Lumieux 2003).

Job Competition Theory

Frequently, overeducation occurs due to the expectation of higher income with the completion of a higher degree of education when there is a limited supply of particular jobs. Becker's theory and the Mincerian model are therefore the starting point to show the relationship between earnings and the level of education. Both Becker's theory and the Mincerian model assert that education gives higher returns to individuals at the margin. However, there exists the case of overeducation in the real world where Becker's theory and the Mincerian model are no longer as relevant. One theory that could explain this phenomenon is the job competition theory by Thurow (1975) .

Thurow (1975) introduces a job competition theory which proposes that job applicants compete for opportunities to gain employment on the basis of relative training costs. This theory claims that individuals acquire education in order to get into the job queue that occurs due to competition among applicants. This is because, with higher education, fewer training courses are required, resulting in a better position in the job queue. Overeducation arises here due to the need to compete with others. Low-skilled individuals would get jobs with lower earnings than they should receive or may even be unemployed while high-skilled people get jobs that require lower skills and knowledge. As a result, they would get lower pay compared to workers who work in jobs that require the skills they attained in their education. However, it is rational for people to decide to study in higher education in order to secure their position in the labor queue (Thurow 1975).

Job Signaling Theory

This theory is introduced by Spence (1973). Job signaling occurs mainly from asymmetric information between employees or applicants and firms, where the employers have inadequate information on applicants, while the applicants have inadequate information on the scope of jobs. In this case, education can be a tool or device to help firms determine whether an individual matches with an available job. Firms decide which candidates to accept by predicting their capabilities, productivity, and potential to work in the firm's environment. From the employees' point of view, the firms or employers do not know them well, thus education plays a crucial role in signaling their skills and productivity as a worker. As discussed earlier, education comes with costs. Individuals would invest in education only if there are sufficient returns according to the offered wage schedule. Figure 9 illustrates the information feedback loop in the job market.

Figure 9: Information Feedback in the Job Market
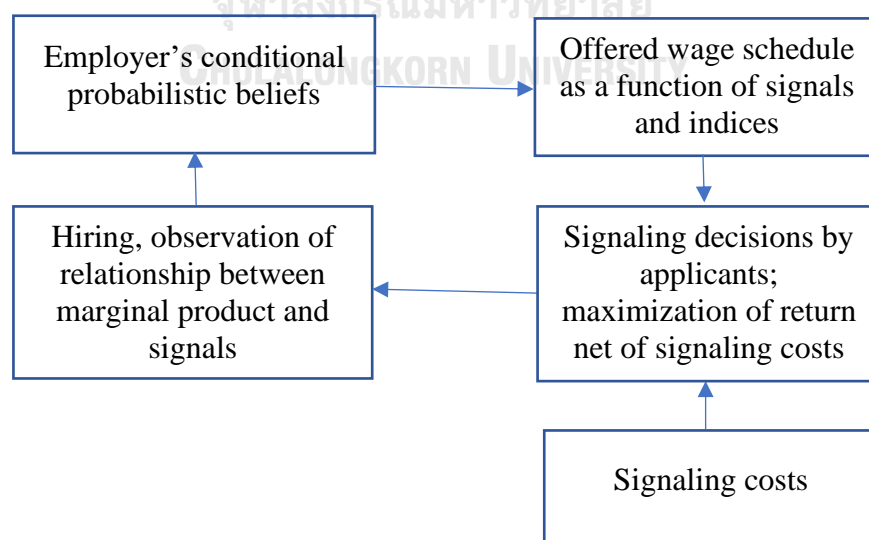
Source: Spence (1973)

Over time, there will be information feedback to the employers who will adjust wage schedules according to the latest information. This cycle is thus an equilibrium that regenerates itself at any point. As a result, overeducation could occur here as new graduates try to signal their capabilities to the employers in order to be hired and receive sufficient payoffs.

Informal Model

While there are many theories regarding human capital, overeducation, and wages, there are relatively few theories on education and informal labor markets. Kolm and Larsen (2016) develop a four-sector general equilibrium model to examine the equilibrium impact of underground activities on labor market outcomes and educational attainment in high-income countries. The four sectors include the formal and informal sectors for manual workers and the formal and informal sectors for highly educated workers. The study claims that underground activities reduce the desirability of studying further if there are opportunities in informal employment for low-educated workers. In other words, the less attractive it is to work as an informal worker, the more workers will decide to further education (Kolm and Larsen 2016). Specifically, higher punishment rates for the informal sector increases the numbers of educated workers. This is further strengthened if the tax rate is declining because the declining tax rate leads to higher earnings (Kolm and Larsen 2016). Moreover, Kolm and Larsen (2016) assert that the expected future earnings of pursuing higher education has to be positive in order to make at least some workers decide to study in higher education. Productivity is superior for highly educated workers; consequently, premiums for higher education are expected. However, there can be a loss if

concealment costs are higher for highly educated workers compared to the case where they decide against further study and have more attractive opportunities as manual workers. In this case, the incentive to study further declines (Kolm and Larsen 2016). The takeaway message is that overall, informal activities reduce the incentives to achieve higher education if there are opportunities for informal workers. Stricter enforcement of policies regarding informality reduces the attractiveness of being a low-educated while simultaneously creating new formal jobs.

The various theories discussed in this chapter are related to human capital, employment, and informal workers. The human capital theory is fundamental to all three study topics while the job competition and signaling theory would help to explain why individuals rationally invest in too much education, leading to overeducation and potentially large wage penalties. Moreover, the informal theory would help in understanding more on informal sector employment opportunities and educational choice. All of these mentioned theories and models would be a good support of the following empirical studies.

Chapter IV: Returns to Education among the Informally Employed in Thailand

Section 1: Introduction

Informal workers in Thailand currently make up more than half of the country's labor force and contribute significantly to the economy (National Statistical Office 2018b). The labor force has remained highly informal despite Thailand's emphasis on increasing access to education over the last four decades as a means to economic development. Although the government has progressively provided and required higher levels of compulsory education (nine years as of 2002), it is unclear whether workers in the informal sector see significant returns to increasing investments in formal education.

The purpose of this chapter is to estimate the returns to formal education among informally employed workers in Thailand, a country that is representative of other developing countries with largely informal labor forces. This study uses the Thailand Household Socio-Economic Surveys (SES) compiled by the National Statistical Office of Thailand for the years 2011, 2013, and 2015. Using an instrumental variable approach to account for the ability bias, this study finds that the wage returns to education among informally employed workers, own-account workers, and formally employed workers are 11.2, 11.9, and 14.6 percent per year of formal education, respectively. These results suggest that even among the informally employed, there are substantial private returns to formal education in a developing

country context, which raises questions about the conventional wisdom of pushing governments to formalize work.

Section 2: Related Literature

Education provides numerous monetary and non-monetary benefits to individuals and societies. From a societal point of view, formal education is a tool to increase human capital that in turn drives a country's economic development and sustained economic growth. Subsequently, a number of studies have been broadly conducted as education plays such a fundamental role in improving human capital which will drive and sustain a country's economic growth. Many studies employ the Mincerian model to find out returns to education. For individuals, additional education has been shown to lead to higher levels of labor income (Carneiro, Heckman and Vytlacil 2010; Dickson and Harmon 2011; Oreopoulos 2006; Oreopoulos and Petronijevic 2013).

Although the literature on returns to educations is large, most previous work has focused on developed countries due in part to a lack of sufficient data from developing economies. Some examples of work that specifically take into consideration returns to education in developing economies include Psacharopoulos and Patrinos (2004), which considered the returns to education in 98 countries, both developed and developing. They find the highest returns to education belong to low- and middle-income countries. Andrada and Galassi (2009) examine relationship between earnings and education in Argentina and Paraguay. The results show that the returns to education estimated using Argentinian data is 9.8 percent, lower than that if the Paraguay's data which equals to 11.9 percent. This is consistent with what Card (2001) states that the returns to education in less developed countries are likely to be

higher than in more developed countries. In an updated study by Montenegro and Patrinos (2014), the overall trends in returns to education remain the same with the highest returns to education in developing economies. Fink and Peet (2015) study returns to education in 61 low- and middle-income countries during 1985 to 2012 and report that the average return to education is at 6.5 percent, with lowest and highest returns of 1.9 and eight percent in Asia and in Latin America, respectively.

In Thailand, there are several recent studies on returns to various types of education. Moenjak and Worswick (2003) compare the returns to vocational and general secondary education, finding that returns to vocational education are significantly higher than for general education graduates. Hawley (2004) studies returns to education among young workers, finding that one additional year of education leads to 10 percent higher monthly earnings. In a more recent study on returns to education in Thailand, Tangtipongkul (2015) estimates the rates of returns to different educational levels, showing very large returns to tertiary education in the Thai labor market. All these studies use various versions of the Mincerian model, yet none take into account the ability bias.

Despite the Mincerian model is criticized by many researchers that it has drawbacks, several empirical studies still use this model and augment it with other variables in the model. The notable problem of the Mincerian model is that it omits a variable, that is, inherent ability differences among individual which leads to "ability bias" when running regression   (Blackburn and Neumark 1993; Card 1999). Supporters of this critique believe that individuals with higher abilities tend to receive higher level of education and earnings, consequently, this would make an upward bias result. In particular, Himaz and Aturupane (2015) explain this endogeneity of

variables as in the case that there are unobservable factors such as ability, motivation that correlate with both schooling and wages, then this may cause a bias which more likely to be upward. This is consistent with what Grilliches (1977) listed as three major hypotheses which cause the upward bias on the Mincerian model:

1) the "ability" variable is positively correlated with returns.

2) the correlation between excluded ability is positive with the schooling variable.

3) the ability variable is the only one that is omitted and all other assumptions hold.

Later, an instrumental variable (IV) estimation has been suggested to correct the ability bias. Nevertheless, this approach has limitations, specifically, problem on selecting a valid IV as if the selected instrument positively correlates with returns; then the estimates can even be more upward, compared to the conventional method (Ashenfelter, Harmon and Oosterbeek 2000). Card (2001) points out that the upward on IV results could occur because they estimate the effects of a small and rare group while the Ordinary Least Square (OLS) estimations measure effects of everyone. Later in 2006, Oreopoulos employs concept of Local Average Treatment Effects (LATE) to estimate the returns to schooling when compulsory minimum age-leaving schools law changed from leaving at 14 years old to be leaving at 15 years old in the United Kingdom. He finds that the LATE estimates from IV exceed OLS estimates which could be from many reasons, such as, individuals affected by the selected instrument might be more credit constrained or necessary to work immediately after leaving schools.

To date, Warunsiri and McNown (2010) is the only study on the returns to education in Thailand to correct for the ability bias. The paper employs both pseudo-panel approach and IV approaches. The instrument used in Warunsiri and McNown (2010) is whether or not a province had a university and/or a teacher training college, which theoretically reduces the cost of higher education and exogenously increases educational attainment for people living in those provinces. The return to education from the IV approach is 14.1 percent, which is larger than the baseline OLS estimate of 11.5 percent (Warunsiri and McNown 2010). This current study adds to the returns to education literature by considering wage returns among informal workers in Thailand. According to the study of Warunsiri and McNown (2010), their result implies that many individuals concern on the opportunity cost of attending colleges as described earlier. While the Student Loan organized by the Thai government was established in 1996. This means that ages of individuals in this dataset was 29 to 50 years old at the time of establishment of the Student Loan. This might be the reason why some of high ability individuals who were in the dataset might experience credit constraints which did not permit them to study in the colleges. This result is consistent with the empirical done by Oreopoulos (2006) and Meyer (2015) who find that the results of his study under the OLS approach show returns to education of one additional year of schooling is 7.12 percent while the result under the IV shows 27 percent. However, the study of Warunsiri and McNown (2010) contradicts with what many researchers found earlier. Specifically, this shows a reverse result compared to that explained by Grilliches (1977) that the correlation between "ability" is positively related with "education".

Since previous studies primarily consider developed economies where formal employment is nearly universal, returns to formal education among the informally employed remains largely in question. Although informal workers often comprise the majority of workers in developing countries, only a few studies on the Mincerian returns to education in informal employment exist. For example, studies by Akono and Nanfosso (2013) and Park and Qu (2013) estimate the returns to education for informal workers in Cameroon and China, respectively. In both studies, returns to education for informal workers were 4.2 per cent, which is lower than the estimated returns in the formal sector in both countries (Akono and Nanfosso 2013; Park and Qu 2013).

Contribution of the Study

This current study adds to the returns to education literature in two ways. First, thanks to available individual-level data on informal workers in Thailand, this is one of the few studies to estimate the returns to formal education in informal labour markets using nationally representative data. Second, unlike previous returns to education research on Thailand, this study takes into consideration the ability bias by using an augmented Mincerian model with instrumental variable method.

Section 3: Data Analysis and Methodologies

Data Analysis and Summary Statistics

The SES collected by the NSO has been employed in this study, covering the years 2011, 2013, and 2015. Although the SES is conducted every year, only the odd years collect detailed information on individual labor and business earnings needed

for the analysis. The sample includes formal and informal private firm employees and own-account workers born before between 1950 and 1981 (aged 31 to 65 years old at the time of the survey).[4] Younger workers are excluded because they were not directly affected by the central government policy to expand secondary education in the 1970s in addition to being largely subject to different compulsory education laws that increased compulsory education to nine years in 2002. Bangkok also has been excluded from the analysis for three reasons. First, the structure of Bangkok's economy is historically an outlier from the rest of the country, with fewer workers engaged in agriculture and more workers engaged in services and "white collar" work. Second, Bangkok was largely unaffected by the expansion of secondary schools due to the Third National Economic and Social Development Plan because the city already had an extensive secondary school system by the 1970s.[5] Finally, Bangkok is a magnet for migrant workers from other provinces. Unlike other regions in Thailand, Bangkok has a positive net migration flow, which means it is problematic to assume that current Bangkok workers lived in Bangkok at the time they were secondary school age (National Statistical Office 2020). For these reasons Bangkok has been excluded from the main analysis but provide OLS results for Bangkok in Appendix Table 2 for comparison.

Labor income for private firm employees and business income for own-account workers are converted to real terms based on the Consumer Price Index (CPI) announced by the Bank of Thailand for the base year of 2015 (Bank of Thailand

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[4] Government workers are excluded from the sample since salaries are defined by a rigid, uniform pay structure where completed formal education is part of the compensation formula. See Appendix Table 1 for the OLS and IV results of government workers.

[5] In fact, the number of secondary schools in Bangkok increased by 55 percent between 1964 and 1980, compared to an average increase in secondary schools of 224 percent across all other provinces (Ministry of Education, 1968-2001).

2020). Formal employees have been defined as private firm workers who are covered by Section 33 under the Social Security Act (1990), or other employer-provided welfare program.[6] Informal workers are defined as those in private firm employment without employer-provided social welfare, as well as those engaged in own-account work. The dataset includes observations on 53,044 workers who report labor income or business income in the case of own-account workers.[7]

Figure 10 presents to the sample's distribution of occupations classified by the 1-digit level International Standard Classification of Occupations, 2008, (ISCO-08) across worker type.

Figure 10 shows that formal workers in private firms make up the vast majority of workers in skilled occupations, which are located on the left side of the chart. In contrast, own-account workers are concentrated in service and sales work. Informal private firm workers and own-account workers make up the majority of workers in the lower skilled occupations located on the right side of Figure 10, with the exception of "plant and machine operators." Importantly, formal and informal private firm workers, as well as informal own-account workers, are all well-represented across the lower-skill occupations and are not necessarily segregated by skill.

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[6] There are three schemes under the Social Security Act (1990), including Section 33, Section 39, and Section 40. Section 33 refers to employer-provided social security, while Sections 39 and 40 are voluntary schemes.

[7] For own-account workers, business income is used instead of labor income. Since own-account workers are self-employed and do not have other employees, business income is comparable to labor income in this case.

Figure 10: Distribution of Occupations across Worker Type
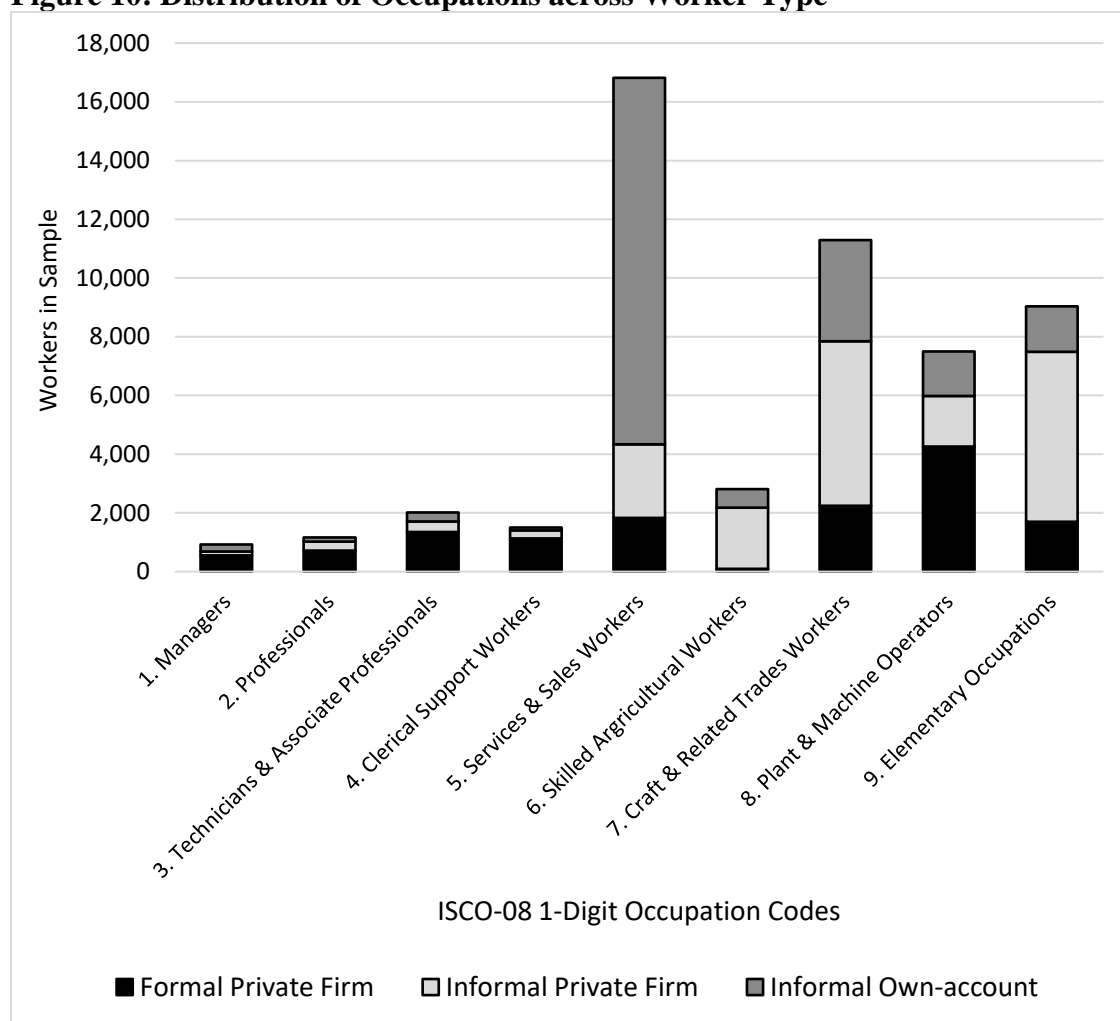
Source: Authors' calculations from the 2011, 2013, and 2015 Thailand Socio-Economic Surveys.

Table 2 shows summary statistics for the sample used in the analysis, stratified by worker type.

Table 2: Summary Statistics

	All (N=53,044)		Formal Private Firm Employee (N=13,870)		Informal Private Firm Employee (N=18,754)		Informal Own-Account Worker (N=20,420)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Real Monthly Total Income (2015 baht)	11,446	9,750	14,226	9,801	7,510	5,412	13,174	11,504
Years Education	7.804	4.375	10.032	4.452	6.308	3.574	7.666	4.368
Age	44.594	7.373	41.518	6.675	44.774	7.280	46.519	7.219
Female Indicator	0.495	0.500	0.480	0.500	0.428	0.495	0.567	0.496
Married Indicator	0.745	0.436	0.745	0.436	0.735	0.441	0.756	0.430
Municipal Area Indicator	0.625	0.484	0.622	0.485	0.542	0.498	0.704	0.457
Central Region Indicator	0.409	0.492	0.643	0.479	0.332	0.471	0.320	0.466
North Region Indicator	0.208	0.406	0.133	0.340	0.210	0.407	0.257	0.437
Northeast Region Indicator	0.211	0.408	0.107	0.309	0.237	0.426	0.256	0.436
South Region Indicator	0.173	0.378	0.116	0.321	0.220	0.415	0.168	0.374
Survey Year 2011	0.357	0.479	0.354	0.478	0.358	0.480	0.358	0.479
Survey Year 2013	0.322	0.467	0.332	0.471	0.318	0.466	0.317	0.465
Survey Year 2015	0.321	0.467	0.314	0.464	0.323	0.468	0.325	0.468
Secondary Schools per 100 km^2	0.472	0.535	0.756	0.692	0.378	0.412	0.364	0.435

Source: Authors' calculations from 2011, 2013, and 2015 Thailand Socio-economic Surveys.

Several differences stand out when comparing the means of our variables of interest across different types of workers. For the whole sample the mean years of schooling is 7.8 years, while for informally employed workers in private firms and own-account workers the means are only 6.3 and 7.7 years, respectively. In contrast, the average years of education are higher for formal private firm employees at 10 years. Real monthly labor earnings also diverge with the mean of the whole sample equal to 11,446 baht, which is significantly more than the mean for informally employed private firm workers at only 7,510 baht. The highest mean earnings among these three groups belong to formal private firm employee, at 14,226 baht, followed by own-account workers at 13,174 baht. The summary statistics are consistent with previous research that shows formal workers are more likely to have more education and higher incomes than informal workers (Dasgupta, Bhula-Or and Fakthong 2015).

Methodology

An augmented Mincerian model has been used to estimate the wage returns to education for formal employees in private firms, informal employees in private firm, and own-account workers.[8] The following baseline regression is first run for the entire sample, and then separately for each of the three types of workers:

$$\ln w_i = \beta_0 + \beta_1 ed_i + \beta_2 age_i + \beta_3 age_i^2 + \gamma X + \varepsilon_i \tag{3}$$

where $\ln w_i$ is the natural log of real monthly earnings of individual i, ed is years of education, and age and age^2 proxy for labor market experience. $\mathbf{X}$ represents a vector

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[8] For private firm employees, monthly labor income is used as the wage measure, while business income is used for own-account workers. Since own-account workers have no employees, business income is comparable to labor income for employees.

of individual characteristics, including gender, marital status, urban residence, region of residence, as well as a set of dummy variables that indicate the survey year.

Given the problem of the "ability bias" found in OLS wage regressions, an IV approach is employed. Warunsiri and McNown (2010) construct an IV from the locations of universities and/or teacher training colleges which could plausibly increase higher education attainment for individuals located close to these institutions. Chankrajang and Muttarak (2017) study green returns to education in Thailand also employing an IV approach to avoid the ability bias issue. They use the number of state primary school teachers per 1,000 children as a proxy for the supply of education. In a similar vein, this study uses the number of secondary schools (*mattayom suksa*) per 100 square kilometres in each province in the year individuals in the sample were 13 years old, which is the age students normally enter secondary school. There are two reasons why this instrument is chosen. First, the establishment of secondary schools was largely dictated by a central government policy that was applied uniformly across Thailand. In particular, the Third National Economic and Social Development Plan (1972 – 1976) called for secondary schools to be built in every district (*amphoe*) of the country (Ministry of Education 1976). Figure 10 shows the numbers of public secondary schools in Thailand from 1964 (before the policy) to 1994.

Figure 11: Numbers of Public Secondary Schools, 1964-1994
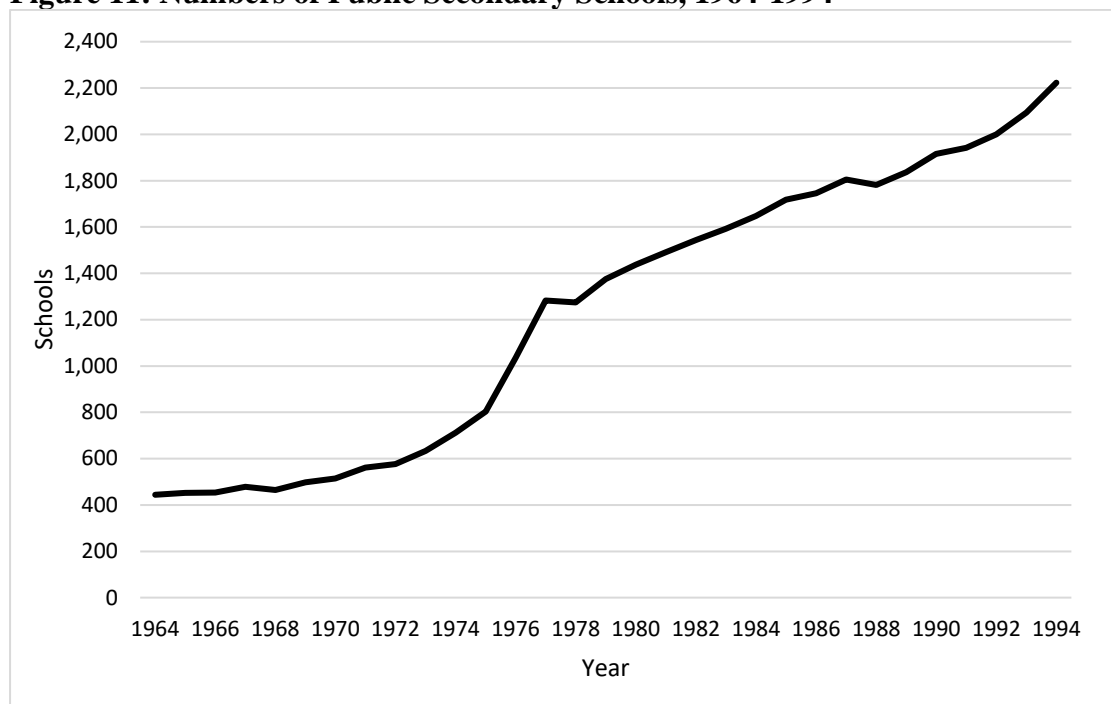
Source: Authors' computation from Ministry of Education Annual Statistics Report (Ministry of Education, 1968-2001).

The figure demonstrates that the increase in the number of secondary schools is slow in the 1960s but increased significantly after 1972 when the central government promulgated the Third Five-year National Economic and Social Development Plan (1972 - 1976).

The second reason for choosing this instrument is that the majority of individuals who were school-aged in the 1970s and 1980s have low levels of completed education. Compulsory education was only four to six years prior to 2002, which is reflected in the fact that 56 percent of the sample used in this study completed six years of primary education or less. Thus, better access to secondary schools due to the implementation of the central government policy could have plausibly encouraged families to invest in education beyond what was required by law. By measuring the density of secondary schools in each province from 1974 to

1994 when individuals in the sample were 13 years of age, this captures access to secondary education at the age when individuals would have entered secondary school. Equations (4) and (5) show the two-stage least squares approach instrumenting years of education with the number of secondary schools per 100 square kilometres.

$$\underline{Stage1}: Ed_i = \alpha_0 + \alpha_1 SchoolPerArea_i + \alpha_2 age_i + \alpha_3 age_i^2 + \gamma X_i + \epsilon_i \qquad (4)$$

$$\underline{Stage2}: \ln w_i = \beta_0 + \beta_1 \widehat{Ed}_i + \beta_2 age_i + \beta_3 age_i^2 + \delta X_i + \varepsilon_i \qquad (5)$$

All specifications are run with standard errors clustered at the province-year of birth level to account for within group correlation.

Section 4: Empirical Findings

OLS Baseline Model

The empirical results for the baseline OLS models are reported in Table 3.

Table 3: Returns to Education by Worker Type (OLS Estimates)

	(1)	(2)	(3)	(4)
		Formal Private	Informal	Informal Own-
	All	Firm	Private Firm	account
	Dependent Variable: ln Real Total Income			
Years of Education	0.050***	0.071***	0.049***	0.035***
	(0.001)	(0.001)	(0.001)	(0.002)
Informal Employee	-0.426***			
	(0.007)			
Own Account Workers	-0.070***			
	(0.008)			
Age	0.064***	0.046***	0.035***	0.075***
	(0.006)	(0.009)	(0.008)	(0.011)
Age^2	-0.001***	-0.000***	-0.000***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Female Indicator	-0.223***	-0.183***	-0.247***	-0.236***
	(0.006)	(0.008)	(0.008)	(0.012)
Married	0.100***	0.066***	0.089***	0.140***
	(0.006)	(0.009)	(0.009)	(0.013)
Municipal Area	0.089***	0.012	0.072***	0.176***
	(0.006)	(0.008)	(0.008)	(0.014)
Survey Year 2013	0.115***	0.169***	0.135***	0.062***
	(0.007)	(0.009)	(0.010)	(0.015)
Survey Year 2015	0.138***	0.167***	0.154***	0.110***
	(0.007)	(0.010)	(0.010)	(0.015)
Constant	7.379***	7.400***	7.628***	7.243***
	(0.141)	(0.199)	(0.177)	(0.261)
Regional Controls	Yes	Yes	Yes	Yes
Adj. R-Square	0.260	0.392	0.190	0.099
Observations	53,044	13,870	18,754	20,420

Notes: *** p<0.01 ** p<0.05 * p<0.1; Formal private firm employees are the excluded worker category in column 1; Clustered standard errors at the province-year of birth level in parentheses.

The baseline OLS model using the pooled sample reported in column (1) indicates that an increase in education by one year on average gives higher monthly earnings by five percent.[9] The baseline results also indicate that informal private firm employees and own-account workers on average earn 42.6 and seven percent less than formal private firm employees. In addition, women earn on average 22.3 percent less than men, while married individuals earn 10 percent more than workers who are single. Living in urban areas where there are more employment opportunities is

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[9] This estimate is significantly lower than the baseline OLS estimate of 11.5 percent found by Warunsiri and McNown (2010) because the current analysis excludes government workers who have high wage returns to education.

associated with higher wages by 8.9 percent on average. Interestingly, real earnings in 2013 and 2015 are significantly higher than the base year, 2011, by 11.5 and 13.8 percent, respectively. This is likely the result of a significant nationwide increase in the minimum wage in 2013.

Columns (2) to (4) report OLS regression results separately for the three different groups of workers. The coefficient estimates on years of education vary across the three groups. The highest return to education is 7.1 percent for formal private firm workers. The OLS estimates for returns to education for informal workers are modest at 4.9 percent for informal private firm workers and 3.5 percent for own-account workers. These relatively low returns could reflect low ability among the informally employed or low productivity in informal employment regardless of educational attainment. Similar to the results using the entire sample, women from all three employee groups have lower wages than men, particularly among informally employed women who face 24 to 25 percent lower earnings than informally employed men. Interestingly, there is an increase in informal worker wages after the implementation of the new minimum wage rates in 2013 by 13.5 percent even though informal workers are not subject to minimum wage laws in Thailand.

Instrumental Variable Model

As mentioned above, it is possible that the coefficient estimates reported in Table 3 could be biased upwards due to the "ability bias." To account for this possibility, a second estimation using an instrumental variable approach is run. The goal is to identify off variation in access to secondary education based on the

uniformly implemented central government policy described above that increased access to education across the country in the 1970s and 1980s. The first stage results (reported in Appendix Table 3), show that the instrument for years of education-the number of public secondary schools per 100 square kilometres in a province at the time the individual was 13 years of age-has a strong relationship with completed years of education and passes standard tests for weak instruments. Table 4 reports the IV results for the three groups of workers.

Table 4: Returns to Education by Worker Type (IV Estimates)

	(1)	(2)	(3)	(4)
		Formal Private	Informal	Informal Own-
	All	Firm	Private Firm	account
	Dependent Variable: ln Real Total Income			
Years of Education	0.136***	0.146***	0.112***	0.119***
	(0.015)	(0.015)	(0.030)	(0.036)
Informal Employee	-0.170***			
	(0.047)			
Own Account Workers	0.039*			
	(0.022)			
Age	0.080***	0.058***	0.049***	0.092***
	(0.007)	(0.011)	(0.010)	(0.014)
Age^2	-0.001***	-0.000**	-0.000***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Female Indicator	-0.190***	-0.179***	-0.239***	-0.164***
	(0.009)	(0.010)	(0.010)	(0.033)
Married	0.146***	0.120***	0.114***	0.189***
	(0.011)	(0.016)	(0.015)	(0.026)
Municipal Area	0.005	-0.042***	0.019	0.067
	(0.016)	(0.015)	(0.026)	(0.048)
Survey Year 2013	0.089***	0.133***	0.122***	0.040**
	(0.009)	(0.014)	(0.012)	(0.018)
Survey Year 2015	0.073***	0.103***	0.111***	0.046
	(0.014)	(0.018)	(0.023)	(0.031)
Constant	5.804***	6.059***	6.688***	5.714***
	(0.321)	(0.360)	(0.480)	(0.699)
Regional Controls	Yes	Yes	Yes	Yes
Observations	53044	13870	18754	20420

Notes: *** p<0.01 ** p<0.05 * p<0.1; Formal private firm employees are the excluded worker category in column 1; Clustered standard errors at the province-year of birth level in parentheses.

The resulting coefficient estimates for years of education in the IV specification are higher than for the OLS specification for the pooled sample and

among the three worker groups. For the pooled sample, the estimated return to an additional year of education is 13.6 percent, which is similar the previous IV estimates by Warunsiri and McNown (2010) of 14.1 percent. Formally employed private firm workers have a wage return of 14.6 percent. The estimated returns to education for informally employed workers and own-account workers are 11.2 and 11.9 percent, respectively. The IV results imply that returns to investments in formal education, even among the informally employed and own-account workers in Thailand, are substantial. Although the informally employed are less educated on average than the formally employed, the results here suggest that workers on average find substantial returns to the formal education that they do complete before entering the informal labor market.

The final analysis considers the returns to education by gender. In the previous IV results, women in the pooled sample earn 19 percent less than men, and as much as 23.9 percent less among informally employed private firm workers. Although it is clear that women on average earn less than men, it is not clear whether they have different wage returns to investments in formal education. The same OLS and IV specifications as above stratified by gender are run. Table 5 reports the OLS and IV coefficient estimates on years of education for men and women separately by worker type.[10]

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[10] The first stage results are reported in Appendix Table 4.

Table 5: Returns to Education by Worker Type by Gender (OLS and IV Estimates)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent Variable: ln Real Total Income							
	All		Formal Private Firm		Informal Private Firm		Informal Own-account	
	Male	Female	Male	Female	Male	Female	Male	Female
Years of Education (OLS)	0.051***	0.049***	0.071***	0.070***	0.045***	0.053***	0.038***	0.032***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Years of Education (IV)	0.122***	0.158***	0.119***	0.172***	0.106***	0.116***	0.116***	0.106*
	(0.017)	(0.022)	(0.020)	(0.018)	(0.030)	(0.044)	(0.038)	(0.061)
Observations	26,789	26,255	7,213	6,657	10,728	8,026	8,848	11,572

Notes: *** p<0.01 ** p<0.05 * p<0.1; Other controls include worker type (pooled regressions), age, age^2, marital status, urban residence, and region of residence; clustered standard errors at the province-year of birth level in parentheses.

Consider the pooled results for men and women in columns 1 and 2, respectively. The IV results indicate that men earn on average 12.2 percent higher labor income for each additional year of education, compared to 15.8 percent among women. This is consistent with previous work by Warunsiri and McNown (2010) that finds that women have higher returns to education than men due to the fact that women come from a lower baseline level of completed education. When considering at the returns to education within formal and informal work, it is found that women have much higher returns to education in formal employment compared to men (17.2 percent versus 11.9 percent). In informal employment, however, the returns to education are almost identical between men and women at 10.6 to 11.6 percent. Remarkably, men's returns to education across formal and informal employment is very consistent, ranging from 10.6 per cent for informal private firm work to 11.9 percent in formal private firm work. Women, however, find substantially higher returns to education in formal private firm employment at 17.2 percent compared to 11.6 percent in informal private firm work and 10.6 percent in own-account work. The more formal pay structures within formal employment may act to ensure that women are rewarded for their educational investments.

Returns to education across all samples are higher under the IV specification compared to the OLS results. Although the IV approach was originally adopted to solve the theorized upward bias in the OLS estimates caused by unobserved ability, the results from this study show that the OLS estimates are actually biased downwards, comparable to previously mentioned research, including Oreopoulos (2006) and Warunsiri and McNown (2010). The higher IV results are presumably due to high opportunity costs associated with further education and/or credit constraints

among low-income households. Grilliches (1977) theorizes that the downward bias is due to the high opportunity cost of gaining more schooling for high ability persons. In other words, the additional wages high ability individuals could gain from additional investments in formal education are less than the additional earnings they could reap from dropping out of school early and going to work right away. In labor markets that are dominated by agriculture and other lower skilled work where additional investments in education do not necessarily translate to higher earnings, the opportunity cost argument is a plausible explanation. The other potential channel is through credit constraints. The reduction in the cost of attending secondary education with the proliferation of schools across Thailand may have resulted in high ability youth from credit-constrained households gaining the opportunity to attend secondary school. Both of these channels are plausible in the case of Thailand given the structure of the labour market and the low-income status of the majority of Thai households in the 1970s and 1980s when the investment decisions on formal education were made for the individuals represented in the sample.

Section 5: Conclusion and Discussion

This chapter estimates the returns to education for informally employed workers in Thailand using an IV approach to solve the ability bias issue using nationally representative survey data. The results indicate that informal private firm workers and own-account workers have a 11.2 and 11.9 percent return to each additional year of education, respectively. The estimated returns to education among informal workers are not much lower than for formal workers at 14.6 percent. The small gap between returns to education for formal and informal workers are relatively

small as compared to the study using South African data and Chinese data done by Yamasaki (2012) and Park and Qu (2013), respectively, which have higher gaps between formal and informal workers. These substantial returns to formal investments in education for informal workers in Thailand are inconsistent with our priors based on earlier work on informal employment, such as by Dasgupta, Bhula-Or, and Fakthong (2015) and Elgin and Sezgin (2017), which point to low wages among workers with low levels of education. The results of this study indicate that opportunities in Thailand's informal labor market do in fact compensate for additional years of formal education and, presumably, skills.

Many countries, including Thailand, have made efforts to formalize their informal economies citing better work conditions for workers. While it is assumed that returns to formal education among informal workers is relatively low, this current study finds that the opposite is true, casting doubt that formal employment is significantly better than the informal employment at least on the dimension of wage returns to education. Beyond wages, informal workers in Thailand have access to some forms of social protection, such as universal health coverage, a universal non-contributory old-age pension, and a voluntary social security scheme. Social protection provided by the government combined with similar wage returns to formal education as found in the rest of the labor force means that informal workers in Thailand are not significantly disadvantaged compared to their formally employed counterparts. Although this chapter solves ability bias issue, however, there are other critiques on the Mincerian model which are measurement error and selection bias issues that are interested for future study.

Chapter V: Vertical Education-Occupation Mismatch and its Wage Penalties among the Informally Employed in Thailand

Section 1: Introduction

Over the past several decades, developing economies have emphasized the expansion of education and increasing educational attainment for its citizens as a means to achieve economic development. Despite rapidly increasing educational attainment, subsequent skilled job growth has often lagged behind. The combination of a rapidly growing educated workforce and slow growth of skilled employment can lead to a problem of "overeducation" – also called vertical mismatch – in developing countries, meaning that educated workers engage in employment that requires less formal education than they have acquired.

According to McGuinness, Pouliakas, and Redmond (2017), skill mismatch refers to different kinds of discrepancy between skills offered and skills needed in workplace. The ILO divides types of frequently found skills mismatch as follows:

Table 6: Types of Mismatch

Type	Description
Skill shortage (surplus)	Demand (supply) for a particular type of skill exceeds the supply (demand) of people with that skill
Skill gap	Type or level of skills is difference from that required of adequately perform the job
Vertical mismatch	The level of education or qualification is less or more than

	required
Overeducation (undereducation)	Workers have more (less) years of education than the job requires
Overqualification (underqualification)	Workers hold higher (lower) qualifications than the job requires
Horizontal mismatch	The type / field of education or skills is inappropriate for the job
Skills obsolescence	Skills previously used in a job are no longer required and / or skills have deteriorated over time

Source: McGuinness, Pouliakas, and Redmond (2017)

The existence of widespread informal employment in developing economies adds a layer of concern against increasing rates of overeducation. According to the ILO, own-account workers working in informal enterprises, as well as employees whose "employment relationships [are], in law or in practice, not subject to national labor legislation, income taxation, social protection or entitlement to certain employment benefits" are considered informally employed (ILO Resolution 2003). Informal employment is generally associated with low skill and low pay. Thus, in a developing country context where formal employment growth is often slow, low-skill informal employment may need to absorb a growing educated workforce, potentially exacerbating overeducation wage penalties.

This chapter evaluates the incidence of vertical mismatch and associated wage penalties/premiums across formal and informal employment in Thailand. Thailand is a representative case of a developing country with a rapidly expanding educated workforce alongside high rates of informal employment and slow formal employment growth. Since the government's supply of education and compulsory education laws vary across different generations of workers, an analysis on the incidence of vertical mismatch and associated wage penalties across age cohorts will be examined. In addition, this chapter analyzes the relationship between vertical mismatch and wage penalties/premiums across four types of workers, including formal government, formal private firm, informal private firm, and informal own-account workers.

The hypothesis is that the incidence of overeducation will be higher among younger cohorts due to rapid increases in compulsory education relative to skilled job growth. Likewise, the incidence of overeducation is expected to be higher in informal employment because the average skill level for informal jobs is low, while at the same time informal work increasingly absorbs Thailand's young, educated workforce. Another hypothesis is that overeducation wage penalties are relatively high for formal government employees compared to other types of workers because of the rigid compensation system that sets pay based on occupation and experience, but gives little additional reward for education completed beyond what is required for the position. In addition, the private sector is more flexible to allow overeducated employees to fully utilize their abilities and is more likely to pay based on capabilities (Dolton and Vignoles 2000). By extending the same logic, it is expected that workers in informal private firm employment and particularly in informal own-account work have lower overeducation wage penalties than formal government workers. However,

it is an empirical question whether formal or informal workers in private firms have higher overeducation wage penalties.

The analysis uses individual-level data from the 2011, 2013, and 2015 rounds of the Thai SES. Consistent with the hypothesis, it is found that the incidence of overeducation is most prevalent (29.3 percent) among the youngest cohort born between 1981 and 1990, and least prevalent (8.7 percent) among the oldest cohort born between 1951 and 1960. The results also show that high rates of overeducation in informal employment. This is particularly the situation among the youngest cohort, where 37.3 percent of informal workers in private firms and 50.1 percent of informal own-account workers are overeducated.

Using an augmented Mincerian wage regression, it is found that the overall overeducation wage penalty is 20.9 percent, while the undereducation wage premium is 10.2 percent. In general, it is found that overeducation wage penalties are higher in older cohorts, suggesting these penalties become larger later in one's career. The penalties and premiums are similar across men and women. As expected, wage penalties for government employees are relatively high at 28.2 percent, while the lowest penalties belong to informal own-account workers at 3.9 percent. As for employees in private firms, informal workers have consistently higher overeducation wage penalties than formal workers across all age cohorts. Educated young workers are increasingly absorbed into low-skill informal work in private firms and face large overeducation wage penalties. The inability of many young workers to capitalize on their educational investments in Thailand's formal labor market is a concern for future education and employment policy development in Thailand.

Section 2: Related Literature

With the growth in educated workforces around the world and the unintended consequences of vertical education-occupation mismatch, several empirical studies on the incidence and implications of mismatch between attained and required levels of education have been published in recent years. One of the challenges in studying the wage impacts of vertical mismatch is how to quantify mismatch. Hartog (2000) summarizes three possible options as follows:

1. Job analysis: This method follows systematic evaluation by professional job analysts such as the United States Dictionary of Occupational Titles (United States Department of Labor) or recommendations of minimum required degree by Thailand's Ministry of Labor (e.g. Paweenawat and Vechbanyongratana 2015).

2. Worker self-assessment: Mismatch is directly evaluated by workers themselves. Surveys ask workers their opinion on the minimum education needed to perform their job (Dolton and Vignoles 2000; Duncan and Hoffman 1981; Sicherman 1991).

3. Realized matches: This method was introduced by Verdugo and Verdugo (1989). This study used the mean education level plus one standard deviation to determine the required level of education needed to perform a job. This is then compared with the actual level of education attained by each worker, which determines whether a worker has education that matches required education for their employment. Other studies apply this method but use a modal value

instead of the mean (Mendes de Oliveira, Santos and Kiker 2000). This current paper uses the modal method described here.

Different methods have different pros and cons such as bias occurred in self-assessment method. Definition from job analysts could be relatively broad, for instance, only 1-digit level is published by Thailand's Ministry of Labor. In the case of worker self-assessment, bias could occur as well, specifically, workers might have opinion that their works require high level of education than they supposed to be. However, an important factor to decide which method to be used is availability of data.

Duncan and Hoffman (1981) made significant contributions to the empirically measuring the impact of overeducation on wages by introducing the Over-, Required-, and Under-educated (ORU) model. In this model, overeducation or undereducation are determined by the difference in attained and required education. Earnings are regressed on required years of education, years of overeducation, and years of undereducation. Using the United States' 1976 Panel Study of Income Dynamics, Duncan and Hoffman (1981) find that 46 percent of individuals are perfectly matched while 42 percent of workers receive higher levels of education than required for their jobs. In addition, the results show that wages are determined mainly by the required education level and the coefficient of surplus education (overeducation) is positive and significant. This method has been used by scholars in several country contexts to estimate wage impacts of vertical mismatch, including Dolton and Vignoles (2000) using British data, by Hartog (2000) on the United States, Portugal, the Netherlands, Spain, and the United Kingdom, and by Johansson and Katz (2007) and Korpi and

Tahlin (2009) using Swedish data. All of these studies find that returns to required levels of schooling are higher than returns to surplus education, which is consistent with the original findings by Duncan and Hoffman (1981).

Several studies regress the natural log of wages on a series of dummy variables that identify workers as overeducated, undereducated, or matched educated. The expected sign on the overeducation dummy variable is negative since it is expected that workers who are overeducated for their job would earn less than a matched educated worker with the same amount of education. Verdugo and Verdugo (1989) pioneer this approach and found a 13 percent wage penalty among workers in the United States. A study using Australian data by Mavromaras et al. (2013) shows a 21.5 percent penalty among male workers aged 16-64 holding a university degree or equivalent. Similarly, a study using data from the United Kingdom by McGuinness and Sloane (2011) estimates a 31 to 39 percent wage penalty among early career university graduates.

There are two recent studies on overeducation wage penalties specific to Thailand. The first by Paweenawat and Vechbanyongratana (2015) analyses wage penalties among male university graduates. The average wage penalty was found to be 19 percent, but when stratified by cohort, younger workers were found to have higher overeducation wage penalties that can be explained by an increasing supply of young university graduates and a dearth of commensurate jobs in the market. Another study by Pholphirul (2017), estimates both vertical and horizontal mismatch (i.e. mismatch between degree and job) using Thailand's 2008 Labor Force Survey. For vertical mismatch, the author uses the modal value method to determine education-

occupation matches for each worker. The author finds that overeducated workers who completed compulsory lower secondary education or above on average face an 18.6 percent wage penalty.

Despite the existence of recent studies on Thailand, to date, no study takes into consideration potential systematic differences in the incidence and wage impacts of undereducation and overeducation across formal and informal workers. This is important to consider since a significant proportion of workers in Thailand's economy – and developing economies more generally – are in fact informally employed and not covered by relevant labor regulations. This chapter adds to the literature by determining the incidence of undereducation/overeducation and to estimate wage premiums/penalties associated with vertical education-occupation mismatch between formal and informal workers. Furthermore, this study considers the incidence of mismatch and the associated penalties and premiums across four cohorts of workers who were exposed to different education policies and early career labor market opportunities in Thailand's rapidly changing economy.

Contribution of the Study

This study evaluates the incidence of vertical mismatch and associated wage penalties/premiums across formal and informal employment in Thailand. Thailand is a representative case of a developing country with a rapidly expanding educated workforce alongside high rates of informal employment and slow formal employment growth. Since the government's supply of education and compulsory education laws vary across different generations of workers, the incidence of vertical mismatch and associated wage penalties across age cohorts have been analyzed. In addition, this

chapter analyzes the relationship between vertical mismatch and wage penalties/premiums across four types of workers, including formal government, formal private firm, informal private firm, and informal own-account workers.

Section 3: Data Analysis and Methodologies

Data Analysis and Summary Statistics

This study uses the Thailand SES for the years 2011, 2013, and 2015 to study vertical mismatch in formal and informal workers in Thailand. Formal employee is defined as government and private firm workers who are covered by the Civil Service Welfare Scheme, Section 33 coverage under the Social Security Act (1990), or other employer-provided welfare program. Informal workers are defined as those in private firm employment without employer-provided social welfare, as well as those engaged in own-account work.[11] The dataset includes observations on 104,137 workers who report labor income.[12] A total of 53,206 workers are classified as informally employed, of which 27,481 work in private firms and 25,725 are own-account workers.

The workers are coded into five education classifications that are harmonized with the 2008 International Standard Classification of Occupations (ISCO-08) skill level classifications (International Labor Organization 2008, 2012). Table 7 shows the

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[11] This study deviates slightly from the government's definition of informal employment by defining all own-account workers as informally employed even if they are coded as being covered by social security (less than 4 percent of own-account workers). Own-account workers with social security coverage are most likely registered for one of the voluntary social security schemes (Section 39 or 40). The coding does not impact the results.

[12] For own-account workers, business income has been used instead of labor income. Since own-account workers are self-employed and do not have other employees, business income is comparable to labor income in this case.

Thai National Statistical Office's harmonization of Thai education levels with the

ISCO-08 skill level classifications.

Table 7: Thai Education Classifications Harmonized with ISCO-08 Skill Level Classifications

Level	Description
0	Completed less than primary education
1	Completed primary education or the first stage of basic education
2	Lower secondary education, upper secondary education, and non-tertiary education (*Por Wor Chor*)
3	Higher educational institution following completion of secondary education for a period of 1–3 years (*Por Wor Sor* and *Por Wor Tor*)
4	Higher educational institution for a period of 3–6 years leading to the award of a first degree or higher qualification

Sources: International Labor Organization (2008, 2012) and National Statistical Office (2010).

The classification of overeducation, undereducation, and matched education for each individual is based on realized matches suggested by Verdugo and Verdugo (1989) and Mendes de Oliveira, Santos, and Kiker (2000). Following Mendes de Oliveira, Santos, and Kiker (2000), the modal educational category (0 to 4) within each occupation is used to determine "required education." After finding the modal educational category within each ISCO-08 occupation code at the 3-digit level, each worker's education level is then compared to the modal education level for their occupation to determine whether the worker is overeducated, undereducated, or matched educated.[13] For example, if a worker completed an upper secondary diploma (category 3), but works in a job that primarily employs workers with primary

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[13] If there is more than one modal value, the smaller value is selected. Also, the estimations are not sensitive to the method of constructing the vertical mismatch dummy variables. Using the median level of education in each occupational category yields qualitatively similar results to the modal method. Please see Appendix Table 5 for results using median level of education.

education (category 1), this worker would be considered overeducated for their current job. Table 8 reports summary statistics for the sample used in this study.

Table 8: Summary Statistics

Variable	All (N=104,137)		Formal Government (N=23,141)		Formal Private Firm Employee (N=27,790)		Informal Employee (N=27,481)		Own Account Worker (N=25,725)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Real Monthly Total Earnings (2015 baht)	14,178	12,095	21,855	15,206	14,810	10,279	7,759	5,711	13,448	11,716
Matched Educated (0/1)	0.506	0.500	0.703	0.457	0.551	0.497	0.431	0.495	0.362	0.480
Overeducated (0/1)	0.220	0.414	0.123	0.328	0.199	0.399	0.257	0.437	0.291	0.454
Undereducated (0/1)	0.274	0.446	0.174	0.379	0.250	0.433	0.312	0.463	0.348	0.476
Less than primary (0/1)	0.183	0.386	0.056	0.229	0.083	0.276	0.286	0.452	0.295	0.456
Primary (0/1)	0.201	0.401	0.054	0.226	0.153	0.360	0.340	0.474	0.235	0.424
Lower Secondary (0/1)	0.322	0.467	0.232	0.422	0.416	0.493	0.299	0.458	0.326	0.469
Upper Secondary (0/1)	0.067	0.250	0.074	0.262	0.110	0.313	0.029	0.167	0.055	0.229
Tertiary (0/1)	0.228	0.419	0.584	0.493	0.238	0.426	0.047	0.211	0.089	0.285
Potential Experience	25.311	12.529	23.369	11.404	19.500	11.129	27.411	12.461	31.090	11.869
Female (0/1)	0.484	0.500	0.480	0.500	0.493	0.500	0.416	0.493	0.550	0.498
Married (0/1)	0.699	0.459	0.723	0.447	0.653	0.476	0.684	0.465	0.743	0.437
Urban (0/1)	0.680	0.466	0.736	0.441	0.698	0.459	0.576	0.494	0.723	0.447
Bangkok (0/1)	0.089	0.285	0.045	0.207	0.184	0.388	0.049	0.216	0.070	0.254
Central (0/1)	0.344	0.475	0.246	0.431	0.508	0.500	0.305	0.460	0.297	0.457
North (0/1)	0.192	0.394	0.240	0.427	0.111	0.314	0.190	0.393	0.237	0.425
Northeast (0/1)	0.215	0.411	0.315	0.465	0.093	0.291	0.231	0.422	0.239	0.427
South (0/1)	0.160	0.367	0.154	0.361	0.104	0.306	0.224	0.417	0.158	0.364

Source: Authors' calculations from 2011, 2013, and 2015 Thailand Socio-economic Surveys.

Informal private firm employees and own-account workers on average have lower levels of education, with 62.6 percent and 53 percent having completed primary school or less, respectively. This is in contrast to formal government workers in which only 11 percent have completed primary school or less. Formal government workers are also significantly more likely to have completed higher education with 58 percent completing a bachelor's degree or higher compared to only 5 percent of informal private firm employees and 9 percent of own-account workers. Thus, it is not surprising that real monthly earnings for formal workers are on average significantly higher than for informal workers. Formal government employees and formal private firm employees earn on average 21,855 and 14,810 baht compared to 7,759 and 13,448 baht for informal employees and own-account workers, respectively.

Given generational differences in access to education and early career labor market opportunities, it is instructive to see the differences in completed education and the incidence of formal and informal employment stratified by birth cohort shown in Figures 12 and 13.

Figure 12: Educational Attainment by Birth Cohort
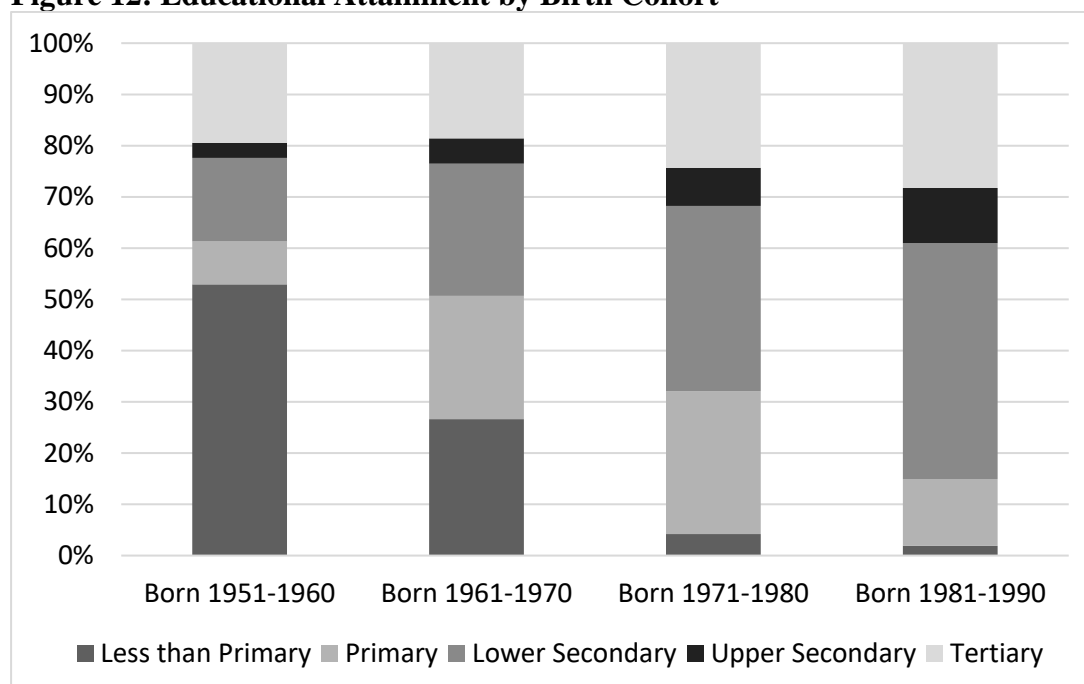
Source: Authors' calculations from 2011, 2013, and 2015 Thailand Socio-economic Surveys.

Figure 13: Employment Sector by Birth Cohort
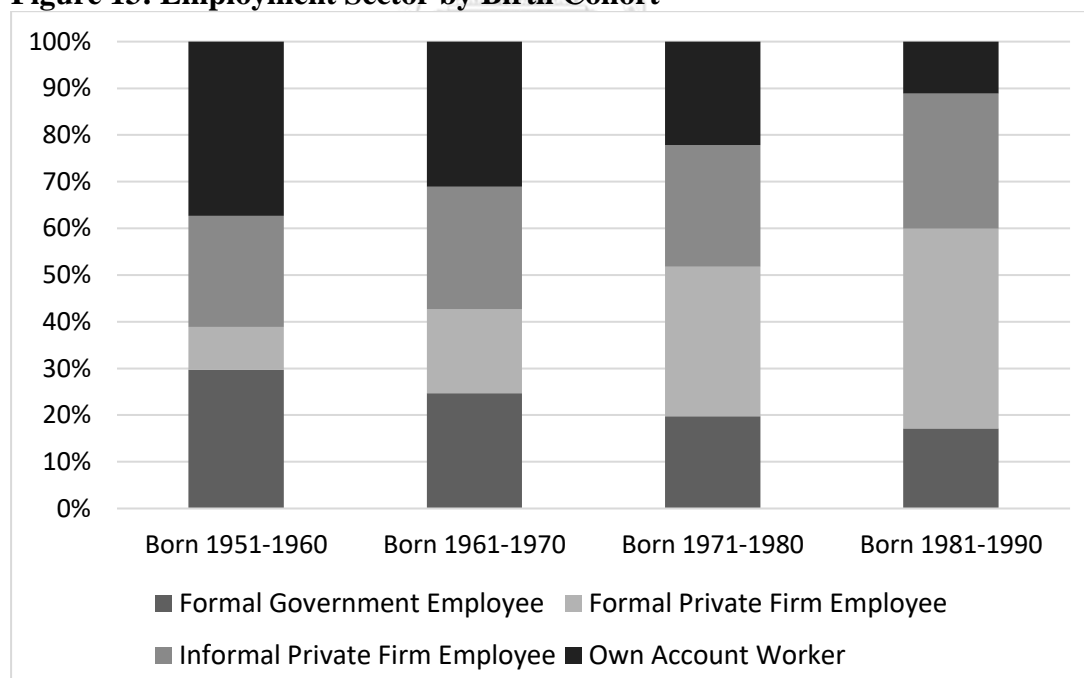
Source: Authors' calculations from 2011, 2013, and 2015 Thailand Socio-economic Surveys.

The overall picture is one of increasing educational attainment across successive birth cohorts. Among the oldest cohort, more than half of workers completed less than primary education and 39 percent completed lower secondary education or more. Among the youngest cohort, only two percent completed less than primary education while 85 percent completed lower secondary education or higher. Figure 13 indicates that there is declining informality across successive birth cohorts. The incidence of informality among employees and own-account workers is highest among the oldest cohort at 61 percent. However, despite rapid industrialization and structural change in the Thai economy, the rate of informal employment is still high among the youngest cohort at 40 percent. Interestingly, individuals in the youngest cohort are much less likely to be own-account workers and government employees than previous generations. The youngest workers are much more likely to be employed by private firms, but the incidence of informality among private firm workers is 40 percent.

The incidence of undereducation and overeducation for the entire sample stands at 27.4 and 22 percent, respectively, but differs across birth cohorts and employment sector, as illustrated in Figures 14 and 15.

Figure 14: Undereducated Workers by Birth Cohort and Employment Sector
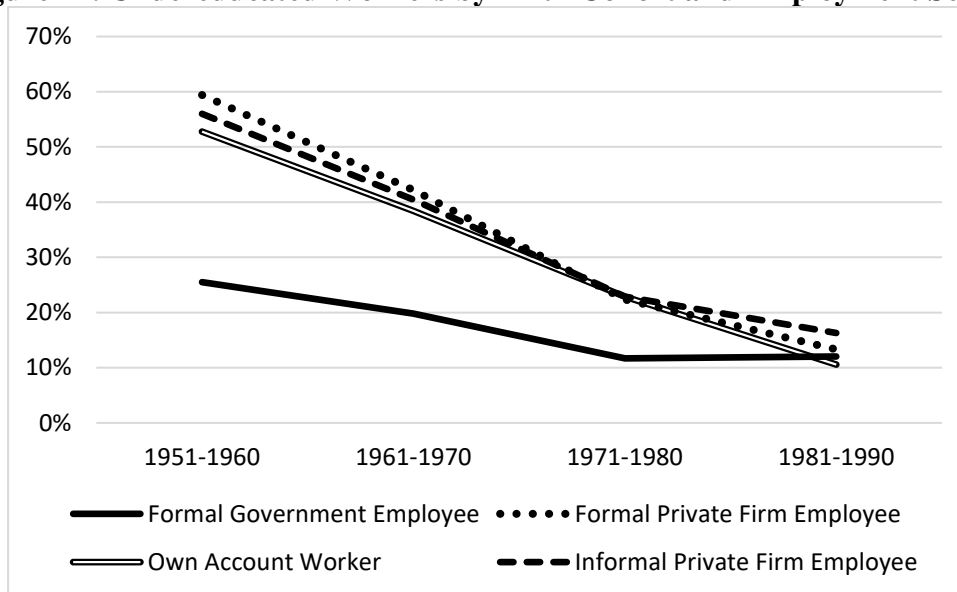
Source: Authors' calculations from 2011, 2013, and 2015 Thailand Socio-economic Surveys.

Figure 15: Overeducated Workers by Birth Cohort and Employment Sector
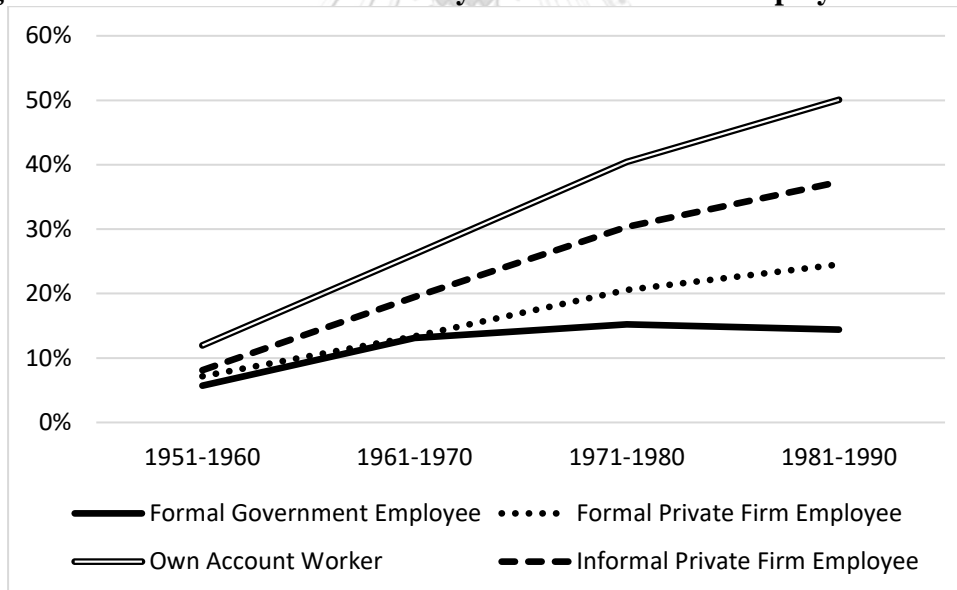
Source: Authors' calculations from 2011, 2013, and 2015 Thailand Socio-economic Surveys.

The proportion of undereducated workers has declined over successive birth cohorts for every work status, particularly for formal private firm employees, own-account workers, and informal private firm employees. This pattern is consistent with

increasing educational attainment among the younger cohorts due to more compulsory education and increased opportunities to complete secondary and tertiary education. The proportion of overeducated formal government workers is similar across cohorts. However, the incidence of overeducated formal and informal private firm employees and own-account workers has increased over successive cohorts, which is consistent with increasing levels of education. This is also consistent with the study done by Sicherman (1991) as his study shows that overeducated workers are relatively young, little work experience, and less on-the job training. Sicherman (1991) claims this as a process of searching the right jobs of workers. Although the youngest cohort is the least likely to be engaged in own-account work, the incidence of overeducation among those who are is high at 50 percent. Likewise, among the 30 percent of the youngest cohort employed informally by private firms, the incidence of overeducation is 32 percent.

Methodology

An augmented Mincerian wage regression model has been used to estimate the overeducation and undereducation wage penalties and premiums, respectively. An OLS model that includes dummy variables for overeducation and undereducation with matched education as the excluded category is run as:

$$\ln w_i = \alpha + \beta_1 OverEd_i + \beta_2 UnderEd_i + X_i'\gamma + \varepsilon_i \qquad (6)$$

The dependent variable, $\ln w_i$, is the natural log of real monthly earnings, X_i is a vector of individual characteristics, including potential work experience ($age - years\ of\ schooling - 6$) and potential work experience squared, and dummy

variables for level of education completed (primary, lower secondary, upper secondary, and tertiary), married, female, urban area, region (central, north, northeast, and south), and survey year. $OverEd_i$ is a dummy variable that indicates an individual's educational attainment is greater than the modal value of education found in their occupation, and $UnderEd_i$ is a dummy variable that indicates that an individuals' level of education is lower than the modal value for their occupation.

Regression (6) is first run using the pooled sample from 2011, 2013, and 2015, and then run separately by employment sector. The analysis is then repeated stratified by men and women to see whether there are any gendered differences in overeducation/undereducation wage penalties/premiums. The final analysis is stratified by birth cohorts and employment sector to see if the overeducation wage penalties and undereducation wage premiums diverge for individuals facing different compulsory education policies, educational access, and early career labor markets.

Section 4: Empirical Findings

The empirical results for the baseline pooled regression and regressions stratified by sector of employment are reported in Table 9.

Table 9: Overeducation Wage Penalties and Undereducation Wage Premiums in Thailand, OLS Regressions

	(1)	(2)	(3)	(4)	(5)
		Dependent Variable: Ln(Monthly Labor Income)		
		Formal Employment		Informal Employment	
	Pooled Baseline	Government Employee	Private Firm Employee	Private Firm Employee	Own-account Worker
Overeducated	-0.209***	-0.282***	-0.179***	-0.218***	-0.039**
	(0.005)	(0.011)	(0.007)	(0.008)	(0.015)
Undereducated	0.102***	0.133***	0.096***	0.180***	0.096***
	(0.006)	(0.014)	(0.008)	(0.008)	(0.015)
Elementary	0.175***	0.268***	0.096***	0.186***	0.064***
	(0.008)	(0.027)	(0.012)	(0.010)	(0.019)
Lower Secondary	0.495***	0.910***	0.447***	0.464***	0.237***
	(0.009)	(0.024)	(0.015)	(0.013)	(0.022)
Upper Secondary	0.866***	1.418***	0.838***	0.723***	0.376***
	(0.012)	(0.026)	(0.017)	(0.024)	(0.031)
Tertiary	1.264***	1.907***	1.134***	1.153***	0.571***
	(0.011)	(0.025)	(0.016)	(0.022)	(0.029)
Formal Employee	-0.015***				
	(0.005)				
Informal Employee	-0.352***				
	(0.006)				
Own Account Workers	-0.050***				
	(0.007)				
Potential Experience	0.040***	0.050***	0.028***	0.022***	0.024***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Potential Experience^2	-0.001***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female Indicator	-0.192***	-0.157***	-0.175***	-0.222***	-0.221***
	(0.004)	(0.007)	(0.005)	(0.006)	(0.010)
Married	0.086***	0.040***	0.049***	0.083***	0.137***
	(0.004)	(0.008)	(0.005)	(0.007)	(0.012)
Central	-0.167***	-0.139***	-0.158***	-0.309***	-0.177***
	(0.006)	(0.015)	(0.007)	(0.014)	(0.019)
North	-0.358***	-0.193***	-0.399***	-0.495***	-0.414***
	(0.007)	(0.015)	(0.010)	(0.014)	(0.020)
Northeast	-0.316***	-0.200***	-0.397***	-0.486***	-0.318***
	(0.007)	(0.015)	(0.010)	(0.014)	(0.020)
South	-0.209***	-0.121***	-0.276***	-0.326***	-0.207***
	(0.007)	(0.016)	(0.010)	(0.014)	(0.022)
Municipal Area	0.096***	0.169***	0.007	0.053***	0.174***
	(0.004)	(0.008)	(0.005)	(0.006)	(0.012)
Survey Year 2013	0.123***	0.075***	0.184***	0.154***	0.084***
	(0.004)	(0.008)	(0.006)	(0.007)	(0.012)
Survey Year 2015	0.145***	0.110***	0.201***	0.182***	0.124***
	(0.004)	(0.008)	(0.006)	(0.007)	(0.012)
Constant	8.411***	7.436***	8.640***	8.504***	8.835***
	(0.015)	(0.030)	(0.019)	(0.024)	(0.043)
F-Statistic	4585.753	1804.615	1241.079	516.355	192.903
Adj. R-Square	0.427	0.559	0.458	0.281	0.111
Observations	104137	23141	27790	27481	25725

Notes: *** $p<0.01$ ** $p<0.05$ * $p<0.1$; Robust standard errors in parentheses.
Source: Authors' calculations from 2011, 2013, and 2015 Thailand Socio-economic Surveys.

The average overeducation wage penalty and undereducation wage premium are 20.9 percent and 10.2 percent, respectively. The 20.9 percent wage penalty is comparable to the previous estimate of 19 percent in the study by Pholphirul (2017) using the 2008 LFS. The overeducation wage penalties differ across employment sectors. The largest overeducation wage penalty is in the formal government sector at 28.2 percent. The high penalty may reflect the rigidity of the Thai civil service system where remuneration is strictly tied to occupation and experience. A government worker with high levels of education would be paid similarly with a government worker with lower academic credentials working in the same position. At 21.8 percent, informal private firm workers have higher overeducation wage penalties than formal private firm workers (17.9 percent). Interestingly, own-account workers have the lowest overeducation wage penalties at 3.9 percent. This may reflect the nature of own-account work in which workers are their "own boss," allowing them flexibility to work according to their own productivity regardless of occupation.

Table 9 indicates that on average—after controlling for a full set of covariates—women earn 19.2 percent less than men. The results stratified by employment sector show that the gender wage differentials are smaller within formal work (15.7 to 17.5 percent) compared to informal work (22.1 to 22.2 percent). Given that women appear to be at a wage disadvantage compared to men, it is of interest to know whether women and men experience different overeducation/undereducation wage penalties/premiums. Table 10 reports the regression results stratified by gender.

Table 10: Overeducation Wage Penalties and Undereducation Wage Premiums in Thailand by Gender, OLS Regressions

		(1)	(2)	(3)	(4)	(5)
			Dependent Variable: Ln(Monthly Labor Income)			
			Formal Employment		Informal Employment	
		Pooled Baseline	Government Employee	Private Firm Employee	Private Firm Employee	Own-account Worker
Men	Overeducated	-0.197***	-0.257***	-0.212***	-0.209***	-0.033
		(0.007)	(0.014)	(0.011)	(0.010)	(0.021)
	Undereducated	0.125***	0.177***	0.170***	0.189***	0.078***
		(0.008)	(0.017)	(0.014)	(0.010)	(0.023)
	F-Statistic	2439.892	1065.543	636.293	265.740	104.933
	Adj. R-Square	0.423	0.544	0.448	0.250	0.121
	Observations	53735	12025	14077	16056	11577
Women	Overeducated	-0.219***	-0.275***	-0.180***	-0.221***	-0.051**
		(0.008)	(0.022)	(0.010)	(0.013)	(0.022)
	Undereducated	0.081***	0.106***	0.048***	0.162***	0.109***
		(0.008)	(0.027)	(0.010)	(0.012)	(0.021)
	F-Statistic	2471.883	904.934	686.816	256.025	69.467
	Adj. R-Square	0.433	0.587	0.472	0.290	0.074
	Observations	50402	11116	13713	11425	14148

Notes: *** p<0.01 ** p<0.05 * p<0.1; robust standard errors in parentheses. Other controls: education, potential experience, potential experience^2, married, urban, region, and survey year.
Source: Authors' calculations from 2011, 2013, and 2015 Thailand Socio-economic Surveys.

Despite the fact that women have a wage disadvantage when controlling for personal characteristics, women experience similar wage penalties and premiums as men. Overall, the wage penalty for men is 19.7 percent compared to 21.9 percent for women, while the undereducation wage premiums are 12.5 and 8.1 percent for men and women, respectively. The wage penalties are also similar across all four employment sectors. The similarities in overeducation wage penalties may be due in part to the fact that men and women in the Thai labor market have similar worker characteristics, including labor force participation and educational attainment.

As mentioned previously, many of the oldest workers were required to complete only four years of compulsory schooling and entered into the labor market

when Thailand was just beginning its structural transformation and was still primarily an agricultural economy. In contrast, the youngest cohort in the sample was required to complete six to nine years of compulsory education with access to free education through secondary school and expanded tertiary education opportunities. The economy in which younger workers entered the job market was much more diversified with a broader range of occupations requiring various skill levels. Given that the oldest and youngest workers faced very different education policies and labor market conditions resulted in lower incidences undereducation and higher incidences of overeducation in younger cohorts, it is of interest to see whether older and younger workers face different undereducation wage premiums and overeducation wage penalties. Table 11 reports regression results across employment sector and birth cohort.
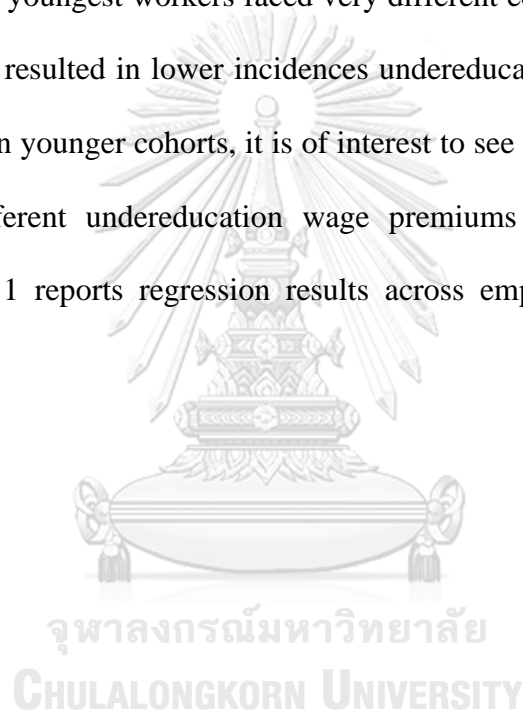
Table 11: Overeducation Wage Penalties and Undereducation Wage Premiums

in Thailand, OLS Regressions by Cohorts

		(1)	(2)	(3)	(4)
		Dependent Variable: Ln(Monthly Labor Income)			
		Formal Employment		Informal Employment	
		Government Employee	Private Firm Employee	Private Firm Employee	Own-account Worker
All Workers	Overeducated	-0.282***	-0.179***	-0.218***	-0.039**
		(0.011)	(0.007)	(0.008)	(0.015)
	Undereducated	0.133***	0.096***	0.180***	0.096***
		(0.014)	(0.008)	(0.008)	(0.015)
	F-Statistic	1804.615	1241.079	516.355	192.903
	Adj. R-Square	0.559	0.458	0.281	0.111
	Observations	23141	27790	27481	25725
Born 1951-1960	Overeducated	-0.456***	-0.322***	-0.338***	-0.145***
		(0.040)	(0.055)	(0.045)	(0.045)
	Undereducated	0.276***	0.236***	0.221***	0.120***
		(0.030)	(0.032)	(0.019)	(0.027)
	F-Statistic	377.877	103.247	91.303	38.519
	Adj. R-Square	0.596	0.535	0.318	0.096
	Observations	5048	1562	4045	6348
Born 1961-1970	Overeducated	-0.358***	-0.217***	-0.243***	-0.027
		(0.020)	(0.020)	(0.018)	(0.026)
	Undereducated	0.108***	0.122***	0.166***	0.061**
		(0.023)	(0.016)	(0.013)	(0.024)
	F-Statistic	572.910	380.047	158.260	81.911
	Adj. R-Square	0.556	0.534	0.290	0.112
	Observations	7645	5598	8113	9631
Born 1971-1980	Overeducated	-0.234***	-0.175***	-0.211***	0.004
		(0.017)	(0.012)	(0.013)	(0.026)
	Undereducated	0.031	0.103***	0.181***	0.153***
		(0.026)	(0.013)	(0.015)	(0.033)
	F-Statistic	284.011	475.371	156.470	48.318
	Adj. R-Square	0.445	0.461	0.272	0.096
	Observations	6237	10138	8231	7012
Born 1981-1990	Overeducated	-0.151***	-0.150***	-0.191***	-0.093**
		(0.021)	(0.010)	(0.013)	(0.038)
	Undereducated	-0.019	-0.007	0.131***	-0.012
		(0.026)	(0.012)	(0.017)	(0.058)
	F-Statistic	115.388	345.815	109.281	13.920
	Adj. R-Square	0.322	0.388	0.228	0.070
	Observations	4211	10492	7092	2734

Notes: *** p<0.01 ** p<0.05 * p<0.1; robust standard errors in parentheses. Other controls: education, potential experience, potential experience^2, married, urban, region, and survey year.
Source: Authors' calculations from 2011, 2013, and 2015 Thailand Socio-economic Surveys.

The first two columns in Table 11 show results across four birth cohorts in formal government and formal private firm employment, while columns (3) and (4) show the results for informal workers in private firms and own-account work. The results show that along with the decrease in the incidence of undereducation, the undereducation wage premium is lower for formally employed workers in younger cohorts. Similar to workers in formal employment, informally employed private firm workers and own-account workers generally have decreasing undereducation wage premiums across successive birth cohorts. The youngest generation of workers born in the 1980s, for which undereducation is rare, have no undereducation wage premiums with the exception of a small premium in informal private firm work.

Despite the increase in the incidence of overeducation over successive birth cohorts, the overeducation wage penalty is lower for younger workers in formal government employment, formal private firm employment, and informal private firm employment. Since the survey data used for the analysis was collected between 2011 and 2015, this study observes wages for each of the cohorts at different points within their careers. The high overeducation wage penalties in the oldest cohort and relatively low wage penalties in the youngest cohort likely reflect different earnings trajectories for overeducated versus matched educated workers. For example, a university graduate who spends their career in restaurant service (overeducated) will likely have a shallower earnings trajectory than a university graduate who works as an accountant (matched educated) over their careers. This scenario would result in larger overeducation wage penalties later in one's career. For the youngest cohort of formal workers, the overeducation wage penalty is relatively modest at around 15 percent. However, the wage penalties *within* each cohort are higher for informally employed

private firm workers than for formally employed private firm workers. This is an important observation considering that informal work in private firms continues to absorb a large number of the younger workers (see Figure 12) who are more likely to be overeducated than in previous generations (see Figure 13).

As for informal own-account work, there is no clear pattern across generations. Most own-account workers are employed in services and crafts and related trades (ISCO-08 occupational categories 5 and 7). Although the overeducation wage penalty is 14.5 percent among the oldest cohort born in the 1950s, the cohorts born in the 1960s and 1970s face no overeducation wage penalties. Although only 11 percent of the youngest cohort is employed as own-account workers, 50 percent are overeducated and face a wage penalty of 9.3 percent.

The workers are not randomly assigned to be overeducated, matched educated, or undereducated for their jobs, which could bias the coefficient estimates. There are relevant unobservable factors, such as low ability or degree completion from low-quality institutions, that cannot be corrected for using the existing data, potentially leading to overestimated wage penalties for overeducated persons who in fact work at their correct level of productivity. Although this study cannot directly solve the ability bias in this present study, previous work on overeducation wage penalties shows that even when taking into account unobserved individual heterogeneity, the negative impact of overeducation on wages generally does not disappear. For example, Korpi and Tahlin (2009) employ a fixed-effect approach using panel data from Sweden. Their results suggest that even after accounting for unobservable personal characteristics, returns to years of education beyond what is required for the job are

positive and significant, suggesting that the OLS estimates are not merely capturing differences in unobserved ability. A study by Mavromaras et al. (2013) employs fixed effect and random effect models to panel data and finds that unobservable individual heterogeneity cannot explain all of the negative impact of overeducation and over-skilling among working-age Australian men. Papers by McGuinness and Benneett (2007) and Paweenawat and Vechbanyongratana (2015) use a quantile approach to show that overeducation occurs at all points along the wage/ability distribution, which suggests that overeducation is not synonomous with low ability in Northern Ireland and Thailand, respectively. Specifically in the case of Thailand, overeducated male university graduates born between 1966 and 1985 face large overeducation wage penalties at all points along the ability distribution, which is consistent with an imbalance between the number of university graduates and jobs available and in the economy (Paweenawat and Vechbanyongratana 2015). Results from previous related studies give us some level of confidence that our estimated coefficients on the undereducation and overeducation variables are not entirely driven by the ability bias and do in fact capture in part the relationship between vertical education-occupation mismatch and wages in formal and informal employment.

Section 5: Conclusion and Discussion

Since the 1970s, Thailand has enacted a variety of policies to pursue economic development. These policies include increasing compulsory education from four years to nine years, providing free education through upper secondary school, and expanding higher education opportunities. The government also worked to change the structure of the economy, transforming it from a largely informal agriculturally based

economy to a formalized industrial and service-based economy. While the former has resulted in dramatic increases in the average educational attainment of the populace, the latter, while diversifying job opportunities, has failed to fully formalize work, leaving the majority of Thailand's workers still engaged in informal employment.

This chapter estimates the incidence of and wage premiums/penalties associated with vertical education-occupation mismatch across formal and informal employment over four cohorts of workers. This study adds to the existing literature by considering the consequences of vertical mismatch in a developing country context where the labor force is largely informal. The paper also extends Pholphirul's (2017) earlier work on Thailand by going beyond the mean wage impact of vertical mismatch on wages by taking into consideration informality and generational differences in education and early career labor market conditions. Informal workers continue to make large contributions to the Thai economy, thus understanding the interaction of vertical mismatch and its consequences within formal and informal employment is important for pinpointing potential inefficiencies in education and labor market policies and helping to develop potential solutions.

This study has shown that the Thai government's education and economic policies have led to an increase in the incidence of overeducation among younger cohorts of workers, which is especially pronounced among informal workers. This implies that employment opportunities in Thailand do not match with its increasingly educated populace. Although the youngest cohort born between 1981 and 1990 is more likely to be formally employed than in previous generations, 40 percent of this cohort is still absorbed into informal employment, of which 41 percent are classified

as overeducated. Overeducated informal workers in private firms face the highest overeducation wage penalties within the youngest birth cohort.

Dissonance between formal job development and government education policies is an issue that policymakers in developing economies need to heed. Thailand's current approach to education that encourages students to complete high levels of general education without the promise of formal employment commensurate with their educational qualifications incurs costs to both individuals (i.e. time costs, wage penalties, and potentially forced entry into informal employment) and society (i.e. inefficient education spending and potential losses of tax revenues from unregistered employees). The government may want to consider better aligning its curriculum and degree offerings with formal job development.

At present, the Thai government is focused on increasing high-skilled job opportunities. Thailand has introduced the "Thailand 4.0" policy, which is aimed at advancing the development of the country through (Royal Thai Embassy 2018). As a part of its strategy, the government has identified ten target industries for development.[14] One of the government's current target industries, for example, is automobile manufacturing. The development of vocational education aimed at filling formal technical jobs within automobile manufacturing would 1) better target the amount of education an individual needs to complete, thus minimizing time and monetary costs of education, and 2) channel young workers into well-matched formal employment. If the government is successful in moving Thailand 4.0 forward and creating more high-skilled, formal employment that is commensurate with academic

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[14] https://www.eeco.or.th/en/content/targeted-industries

credentials, vertical education-occupation mismatch and its penalties would be expected to decline. Time will tell whether this or other government policies to develop more formal sector high-skill jobs will help alleviate the high incidence of informality among younger workers and allow them to earn at their potential.

Finally, it is acknowledged that the limitations of the above analysis given the use of cross-sectional data might lead to a bias in the results. However, given results from previous related research using panel data and particularly the research by Paweenawat and Vechbanyongratana (2015) that shows that overeducation occurs across the entire ability distribution in Thailand, this study's results are not entirely driven by the ability bias.

Chapter VI: Horizontal Education - Occupation Mismatch: Incidence and Penalties in Thailand

Section 1: Introduction

Nowadays, many graduates work in fields different from their post-secondary major fields of study. For example, it is common for Thai engineering graduates to work in non-engineering occupations, such as finance. Students might initially decide to study engineering due to the belief that engineering prepares them with transferable skills that other majors do not. Furthermore, social norms in Thailand dictate that "good students" should study medicine and engineering regardless of their individual preferences and interests (Piromruen 2014).

There might be several reasons why graduates do not work in the fields that they studied, whether they desire to work in other fields after graduation or lack opportunities to work in fields consistent with the degree they attained. This type of mismatch--called horizontal education-occupation mismatch--has become an important problem in many countries, including Thailand. Since the government subsidizes higher education with the expectation that graduates will work in their fields of study, high rates of horizontal mismatch may represent a potential waste of public resources. Additionally, if mismatch is due to imbalances between jobs available and post-secondary degrees awarded, and horizontal mismatch is associated with lower wages, then the personal returns to investments in higher education may be in question.

This chapter examines horizontal mismatch in Thailand and its associated wage penalties. Using a dataset compiled from the 2011 to 2016 third quarter rounds of the LFS collected by the NSO of Thailand, the incidence of horizontal mismatch for graduates at the upper vocational, bachelor's, and post-graduate levels have been calculated. A probit model is used to examine contributions of both field of study and personal characteristics to the probability of mismatch. Finally, the wage penalties and premiums associated with mismatch in each degree field are examined.

Based on previous work by Robst (2007), the hypothesis of this empirical study is that workers who earn degrees aimed at career training, such as teaching, engineering, and medicine, will have a lower incidence of horizontal mismatch than workers without specific training. Furthermore, similar to the case of vertical mismatch, wage returns for the horizontally mismatched group is expected to be lower compared to the matched group. Finally, mismatch wage penalties are expected to be higher for degrees aimed at specific career training compared to general degrees. This is due to the fact that the skills gained from majors targeted at specific careers do not transfer proportionately to all occupations; therefore, having more transferable skills from more general fields would lead to smaller wage penalties (Robst 2007).

This chapter is organized as follows: Section 2 reviews literature related to horizontal mismatch, Section 3 presents the data and methodology, and the empirical findings and conclusions are presented in sections 4 and 5.

Section 2: Related Literature

Students, in general, make decisions on their majors based on their interests and expected future earnings. According to Nordin, Persson, and Rooth (2010), apart from expected earnings, students decide on the area of study based on additional factors, such as their level of risk aversion and preferences for job environment and characteristics. However, Sloane (2002) notes that job mismatch might occur even though the level of schooling is proper, but the type of education is not. In other words, it is common that after graduation only some graduates work and succeed in the job field that they studied while others go to work in fields not related to their major. Information about the labor market and labor market conditions at graduation are contributors to horizontal mismatch. Jovanovic (1979) states, for example, that temporary mismatch can occur from inefficiencies in the labor market as a result of imperfect information. Another reason for mismatch stems from economic conditions when students graduate from their degree program. For example, graduates who enter the labor force during economic downturns are likely to accept jobs that are not related to their field of study (Wolbers 2003).

Horizontal mismatch is also a function of the transferability of skills gained from one's degree program. Shaw (1987) asserts that the degree of skill transferability depends on skills required for particular jobs and what individuals acquired in their studies. For instance, engineering graduates might be able to work in the finance field, but not in the medical field. Wolbers (2003) also claims that some fields, such as health sciences, equip students with specific skills which could result in a lower probability for graduates in this field to find jobs outside of health sciences. Similarly, Robst (2007) shows that majors with more general skills, such as social sciences,

liberal arts, and languages, are more likely to be mismatched, while majors that provide more specific skills, such as computer science, engineering, and architecture, have a lower probability to be mismatched in the United States.

Previous research also finds that the degree level is associated with horizontal mismatch. A study by Robst (2007) finds that the chance of being mismatched declines with higher and more recent degrees, such as master's and doctoral degrees. Similarly, vocational degrees that teach students specific skills lead to lower mismatch (Somer, Cabus and Groot 2019). Some workers may even strategically accept jobs that do not match their area of degree study. For example, Sicherman and Galor (1990) find that graduates sometimes accept mismatched jobs in order to improve their skills through on-the-job training and then expect to move within companies.

We are concerned about horizontal mismatch because there may be associated negative impacts on individual returns to educational investments. In a pioneering study using United States' data, Robst (2007) finds that horizontal mismatch is associated with lower wages. Specifically, the study finds that horizontally mismatched men face penalties from 2.9 to 11.9 percent, while women face penalties from 2.1 to 10.1 percent. Nordin, Persson, and Rooth (2010) also examine the income penalties for horizontal mismatch in Sweden, distinguishing between men and women with higher education degrees. The results show that the mismatched men are penalized by 20 percent when compared with matched men who have the same major, while mismatched women are penalized by 12 percent on average. These results are different than what is found from the United States' by Robst (2007) where

mismatched American men are penalized almost half of what Swedish men experience, while the penalty for women in both countries is about the same. Moreover, Bender and Heywood (2011) study horizontal mismatch using United States' micro-panel data for individuals who earned doctoral degrees in engineering or science fields and they find that the penalty is smaller than 2 percent for workers in the early career stage, but this penalty increases to 5 percent in later stages. In the case of perfect mismatch, the penalty increases from 5 percent in the early career stage to almost 20 percent in later stage as compared to matched workers.

Not all studies find large horizontal mismatch wage penalties. In contrast to earlier studies, Zhu (2014) finds that the average horizontal mismatch wage penalties in China exist, but are relatively small, ranging from 1.2 to 1.5 percent. The rationale behind the findings is that, in contrast to European and American higher education, the Chinese education system equips students with general skills that are transferable across a wide range of occupations (Zhu 2014).

There are relatively few studies on horizontal job mismatch and associated penalties for developing countries. To date, there is only one study on horizontal mismatch that on Thailand. Pholphirul (2017) studies horizontal mismatch and its impacts using data from the 2008 Thai Labor Force Survey. The findings show that the degree of horizontal mismatch varies by degree. A full 96.2 percent of individuals with physical science majors are indicated as horizontally mismatched, whereas the lowest mismatch rate belongs to those with health science majors. In terms of penalties, the results show a negative relationship between income and mismatched persons from 5.6 to 19.8 percent for social science, biological science, and physical

science. The magnitude of penalties depends on major. The results show that there is an existing horizontal mismatch problem in Thailand.

Contribution of the study

This study adds to the existing literature on horizontal mismatch in developing countries and Thailand in particular. The current study goes beyond previous work by Pholphirul (2017) to examine the returns and penalties of mismatch by major at three different levels of post-secondary education: upper vocational, bachelor's, and post-graduate. It is important to study each level separately because some levels are geared towards specific career training. Also, the admissions processes are different for the three levels. One would expect higher levels of mismatch in graduates from institutions with competitive admissions where many students do not study their first choice of major, such as at the bachelor's degree level in Thailand. Thus, this study is different than the previous one in that it allows us to see whether bachelor's degree have higher mismatch rates and penalties when compared to upper vocational and post-graduate degrees.

Section 3: Data Analysis and Methodologies

Data Analysis and Summary Statistics

The dataset used in the study on horizontal mismatch is compiled from the 2011 to 2016 third quarter rounds of the LFS collected by the NSO. The dataset includes individuals aged 20 to 60 who graduated with an upper vocational degree, bachelor's degree, or post-graduate degree. Subsample analysis is conducted by

stratifying degree type because the entrance system and teaching approach are different between upper vocational and bachelor's degree. For upper vocational degrees, the competition to get into the program is relatively low compared to getting into a four-year university program. Also, the teaching approach for upper vocational programs focuses on career training whereas universities focus more on theory and less on direct career training. Following Robst (2007), the sample is also stratified by gender because men and women tend to select different majors of study and careers.[15]

Similar to the previous chapter on vertical mismatch, one significant concern is how to measure mismatch. Somers, Cabus, and Groot (2019) explain two dominant approaches to measurement as follows.

1. Subjective employee assessment of the appropriateness of education:

    a. Whether specific skills from education are required for their particular job

    b. Whether their field of study is related to their current occupation

    c. Whether the individuals are trained for their jobs

2. Objective evaluation of whether skills from the study are related to skills required for particular jobs

In the absence of data on worker self-assessments, this study uses the objective measurement method. Each individual is determined to be horizontally matched or mismatched based on their listed major field of study (classified by 2-digit International Standard Classification of Education (ISCED) fields of education) and their primary occupation. Matches were determined using the recommended majors

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[15] Note that majors that have fewer than 30 observations per degree level/gender are dropped from the sample.

for various occupations designated by the Department of Employment, the Ministry of Labor of Thailand. Please note that for occupations that are not included in the list prepared by the Department of Employment, the author made subjective judgements on which majors were the best match with the listed occupations. The list of matched occupations and degree fields can be found in Appendix Table 6. Using this information, a dummy variable was constructed to equal 1 if an individual is horizontally mismatched and 0 otherwise[16].

The summary statistics for demographic and geographic characteristics are reported in Table 12.

Table 12: Summary Statistics
Table 12a: Upper Vocational Degree

Variable	All (18,408)		Male (10,596)		Female (7,812)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Matched (0/1)	0.543	0.498	0.515	0.500	0.581	0.493
Mismatched (0/1)	0.457	0.498	0.485	0.500	0.419	0.493
Real Monthly Total Earnings (2015 baht)	14,689	12,781	16,082	13,719	12,799	11,113
Age (0/1)	34.646	9.452	35.112	9.461	34.014	9.404
Gender (0/1)	0.424	0.494				
Marital Status (0/1)	0.635	0.481	0.651	0.477	0.613	0.487
Urban (0/1)	0.663	0.473	0.660	0.474	0.668	0.471
Bangkok (0/1)	0.073	0.260	0.072	0.258	0.074	0.262
Central (0/1)	0.427	0.495	0.438	0.496	0.413	0.492
North (0/1)	0.175	0.380	0.176	0.381	0.173	0.379
Northeast (0/1)	0.168	0.374	0.166	0.372	0.170	0.375
South (0/1)	0.157	0.364	0.148	0.355	0.170	0.376

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[16] Matching is done as perfectly matched and perfectly mismatched because the information on recommended majors for each occupation prepared by the Ministry of Labor does not allow for partial mismatch. In that case, highly subjective judgement is required; thus, the matching in this study is determined only perfectly matched and mismatched.

Table 12b: Bachelor's Degree

Variable	All (62,056)		Male (23,002)		Female (39,054)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Matched (0/1)	0.597	0.490	0.453	0.498	0.682	0.466
Mismatched (0/1)	0.402	0.490	0.547	0.498	0.318	0.466
Real Monthly Total Earnings (2015 baht)	24,211	18,054	26,795	19,624	22,689	16,878
Age (0/1)	38.544	10.190	39.890	10.220	37.751	10.090
Gender (0/1)	0.629	0.483				
Marital Status (0/1)	0.600	0.490	0.674	0.469	0.555	0.497
Urban (0/1)	0.739	0.439	0.755	0.430	0.731	0.444
Bangkok (0/1)	0.115	0.319	0.125	0.331	0.109	0.312
Central (0/1)	0.310	0.462	0.301	0.459	0.314	0.464
North (0/1)	0.194	0.395	0.197	0.398	0.192	0.394
Northeast (0/1)	0.212	0.409	0.220	0.414	0.208	0.406
South (0/1)	0.169	0.375	0.157	0.363	0.177	0.382

Table 12c: Post-graduate Degree

Variable	All (10,989)		Male (4,879)		Female (6,110)	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Matched (0/1)	0.639	0.480	0.584	0.493	0.683	0.465
Mismatched (0/1)	0.361	0.480	0.416	0.493	0.317	0.465
Real Monthly Total Earnings (2015 baht)	37,401	20,842	42,372	23,500	33,432	17,460
Age (0/1)	42.946	9.079	44.902	9.045	41.384	8.799
Gender (0/1)	0.566	0.967				
Marital Status (0/1)	0.644	0.479	0.770	0.421	0.543	0.498
Urban (0/1)	0.812	0.390	0.823	0.381	0.804	0.397
Bangkok (0/1)	0.147	0.354	0.144	0.351	0.149	0.356
Central (0/1)	0.249	0.432	0.233	0.423	0.262	0.440
North (0/1)	0.218	0.413	0.222	0.415	0.216	0.411
Northeast (0/1)	0.263	0.440	0.282	0.450	0.248	0.432
South (0/1)	0.123	0.328	0.119	0.324	0.126	0.331

Source: Authors' calculations from 2011 - 2016 Thai Labor Force Surveys.

From Tables 12a, 12b, and 12c, it is clear that average earnings of post-graduate program graduates (37,401 Baht) is higher than for bachelor's (24,211 Baht) and vocational (14,689 Baht) program graduates, while average earnings for men are greater than for women in every degree. Men graduate from vocational degrees at higher rates than women, while the opposite occurs in bachelor's degree and post-graduate programs. Individuals who live in urban areas are more likely to have completed higher education. The mismatch rate for bachelor's degree graduates is 40.2 percent, while mismatch for post-graduate program graduates is slightly lower at 36.1 percent. Career-oriented vocational degree holders have higher mismatch rates than others at 45.7 percent. This finding is inconsistent with Levels, Van der Velden, and Di Stasio (2014) who employ data from 20 European countries and find that students who are from vocational schools are more likely to be matched than others. However, this pattern is consistent with Wolbers (2003) who claims that having vocational degree is not related to being horizontally matched. Looking at gender, the results show that women have lower mismatch rates in every degree level, particularly at the bachelor's degree level where the mismatch rate between men and women differs by more 22.9 percent. One reason for this could be that a large proportion of women study education, which leads to directly to a teaching occupation.

Tables 13a, 13b, and 13c show the mismatch rates classified by majors and gender for upper vocational, bachelor's and post-graduate program graduates, respectively.

Table 13: Mismatch Rates by Major of Study and Gender

Table 13a: Vocational Degree

ISCED	Major	Male		Female	
		Mismatch (%)	Obs.	Mismatch (%)	Obs.
14	Education	84.25	127	58.33	120
21	Arts	80.56	72		
31	Social Science and Behavioral Science	97.50	40		
34	Business	41.90	1,191	24.54	5,433
48	Computer Science	98.58	632	99.47	1,319
52	Engineering	42.63	7,251	72.08	154
54	Production and Production Process	85.00	40	81.25	48
58	Architecture	45.73	737	64.81	54
62	Agricultural, Forestry, and Fishery	75.27	368	85.58	104
64	Veterinary Sciences	39.71	68		
72	Health Sciences	39.71	68	20.82	245
81	Personal Services	67.14	70	69.55	335

Table 13b: Bachelor's Degree

ISCED	Major	Male		Female	
		Mismatch (%)	Obs.	Mismatch (%)	Obs.
14	Education	20.57	4,220	12.27	10,204
21	Arts	81.01	574	92.1	620
22	Humanities	95.82	311	97.97	936
31	Social Science and Behavioral Science	94.74	2,376	96.50	2,028
32	Journalism and Information Technology	95.17	476	89.57	786
34	Business	36.80	5,005	15.29	14,818
38	Law	82.48	1,849	72.38	554
42	Biological Sciences	95.82	239	95.74	376
44	Physical Sciences	97.13	348	94.61	408
46	Mathematics and Statistics	96.67	90	97.98	198
48	Computer Science	80.76	1,180	93.13	1,631
52	Engineering	54.38	3284	78.06	319
54	Production and Production Process	72.31	130	91.94	186
58	Architecture	49.46	839	55.22	134
62	Agricultural, Forestry, and Fishery	64.46	878	67.86	501
64	Veterinary Sciences	96.55	116	98.44	64

| 72 | Health Sciences | 17.78 | 872 | 6.95 | 4,474 |
| 81 | Personal Services | 64.65 | 215 | 81.40 | 817 |

Table 13c: Post-graduate Degree

		Male		Female	
ISCED	**Major**	**Mismatch (%)**	**Obs.**	**Mismatch (%)**	**Obs.**
14	Education	8.34	1834	8.21	2448
21	Arts	93.02	43	100.00	54
22	Humanities	100.00	36	97.94	97
31	Social Science and Behavioral Science	79.42	695	87.31	607
32	Journalism and Information Technology	100.00	45	97.80	91
34	Business	44.40	1,160	27.53	1,845
38	Law	66.82	211	54.21	107
42	Biological Sciences	95.56	45	97.14	70
44	Physical Sciences	97.01	67	87.06	85
48	Computer Science	66.35	104	78.22	101
52	Engineering	72.06	340	69.49	59
58	Architecture	69.14	81		
62	Agricultural, Forestry, and Fishery	60.66	61	55.00	60
72	Health Sciences	21.66	157	21.4	486

Source: Authors' calculations from 2011 - 2016 Thai Labor Force Surveys.
Note: Missing data indicates cells with fewer than 30 observations.

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Table 13a shows that the highest mismatch rate for upper vocational graduates belongs to computer science for both men (98.6 percent) and women (99.5 percent), while the lowest mismatch rate is in health sciences for both genders at 39.7 percent for men and 20.8 percent for women.

As can be seen in Table 13b, there are seven and nine majors at the bachelor's degree level with mismatch rates greater than 90 percent for both men and women respectively. The degrees with the highest mismatch rates are primarily in the fields of humanities, social sciences, and pure sciences. Although previous work by Robst

(2007) suggests that career-specific degrees generally have lower levels of mismatch, we still find that several career-focused degrees, such as law, computer science, and veterinary science, have high rates of mismatch. In Table 12 we found the unexpected result that career-oriented vocational degree graduates have higher mismatch rates compared to bachelor's degree graduates. Table 13a shows that much of the mismatch is due to high rates of mismatch for vocational graduates who major in computer science. In fact, 99.2 percent of computer science graduates are mismatched with their occupation, whereas other upper vocational majors that provide training in specific skills, such as engineering for both genders and architecture in men, have lower mismatch rates compared to bachelor's degree. Surprisingly, the results from Table 13c show that 100 percent of men and 97.9 percent of women who have journalism and information technology majors at the post-graduate level are mismatched.

Methodology

The methodology used in this study follows Robst (2007) and Nordin, Persson, and Rooth (2010). After cleaning the data and constructing the mismatch indicator variable (mismatched is 1 and matched is 0), a probit regression is employed to study the relationship between personal characteristics and the probability of being mismatched. The probit regression is as follows:

$$\Pr(MM)_{ij} = X_{ij}\beta + Z_j\alpha + \varepsilon_{ij} \tag{7}$$

The subscript i is for the individual and subscript j is for the degree. MM equals 1 if the individual is horizontally mismatched with their job, X_{ij} is a vector of

demographic characteristics, including gender, marital status, regions, age, age squared, and living in urban area, and Z_j is a vector of degree programs..

In the second part of the analysis I look at the relationship between horizontal mismatch and wages. The wage regression is as follows:

$$\ln w_{ij} = \beta_0 + \beta_1 MM_{ij} + \Sigma\gamma_j Z_j + \Sigma\alpha_i X_{ij} + \varepsilon_{ij} \tag{8}$$

lnw_{ij} denotes the natural log of monthly wages of individual i, and MM is the mismatch dummy variable.[17] In order to examine wage penalties associated with different majors, an additional regression that includes interaction terms, Z_j*MM_{ij}, is run, where Z_j is the vector of degrees.

$$\ln w_i = \alpha_0 + \alpha_1 MM_{ij} + \Sigma\gamma_j Z_j + \Sigma\delta_{ij} MM_{ij} Z_j + \Sigma\beta_i X_i + \varepsilon_{ij} \tag{9}$$

All three equations – (7), (8), and (9) – are run for each degree level (upper vocation, bachelor's, and post-graduate) followed by separate regressions for men and women.

Section 4: Empirical Findings

The probit regression in (7) relates individual characteristics to being mismatched. The results are reported in Table 14a, 14b, and 14c for vocational degree, bachelor's degree, and post-graduate degree respectively.

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[17] Monthly wage includes monthly labor income plus the annual bonus divided by 12.

Table 14: Relationship between Individual Characteristics and Horizontal Mismatch (Probit Regressions)

Table 14a: Vocational Degree

VARIABLES	(1) All	(2) Male	(3) Female
Age	0.017***	0.026***	0.008
	(0.003)	(0.004)	(0.005)
Age Square	-0.000***	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Municipal Area Indicator	-0.010	0.004	-0.040***
	(0.009)	(0.011)	(0.015)
Female Indicator	-0.081***		
	(0.013)		
Married Indicator	0.019**	0.014	0.014
	(0.009)	(0.012)	(0.014)
Central Region Indicator	-0.010	-0.076***	0.111***
	(0.017)	(0.021)	(0.028)
North Region Indicator	0.052***	0.031	0.098***
	(0.018)	(0.023)	(0.030)
Northeast Region Indicator	0.072***	0.089***	0.052*
	(0.018)	(0.023)	(0.030)
South Region Indicator	0.027	0.031	0.037
	(0.018)	(0.024)	(0.030)
Survey Year 2012	0.001	-0.005	0.009
	(0.014)	(0.017)	(0.023)
Survey Year 2013	0.049***	0.053***	0.048**
	(0.014)	(0.018)	(0.023)
Survey Year 2014	0.019	0.018	0.024
	(0.014)	(0.018)	(0.024)
Survey Year 2015	0.035**	0.042**	0.020
	(0.014)	(0.018)	(0.023)
Survey Year 2016	0.019	0.031*	0.004
	(0.014)	(0.018)	(0.023)
Education	0.372***	0.373***	0.359***
	(0.025)	(0.042)	(0.036)
Arts	0.412***	0.362***	
	(0.030)	(0.050)	
Social & Behavior Science	0.489***	0.471***	
	(0.013)	(0.024)	
Business	0.032	0.008	0.033
	(0.032)	(0.064)	(0.037)
Computer	0.624***	0.544***	0.715***
	(0.005)	(0.009)	(0.008)

Engineering	0.145***	0.062	0.420***
	(0.033)	(0.062)	(0.026)
Production & Production Process	0.447***	0.430***	0.464***
	(0.020)	(0.035)	(0.024)
Architecture	0.164***	0.053	0.380***
	(0.034)	(0.064)	(0.042)
Agricultural, Forestry & Fishery	0.394***	0.298***	0.482***
	(0.021)	(0.049)	(0.017)
Personal Services	0.385***	0.268***	0.422***
	(0.021)	(0.066)	(0.023)
Observations	18,408	10,596	7,812

***p<0.01, **p<0.05, *p<0.1; standard errors in parentheses;

Table 14b: Bachelor's Degree

	(1)	(2)	(3)
VARIABLES	All	Male	Female
Age	0.012***	0.023***	0.007***
	(0.002)	(0.003)	(0.003)
Age Square	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
Municipal Area Indicator	0.001	0.008	-0.004
	(0.006)	(0.009)	(0.007)
Female Indicator	-0.125***		
	(0.005)		
Married Indicator	0.014**	0.049***	-0.006
	(0.005)	(0.009)	(0.006)
Central Region Indicator	0.062***	0.082***	0.041***
	(0.009)	(0.012)	(0.011)
North Region Indicator	0.089***	0.100***	0.069***
	(0.009)	(0.013)	(0.012)
Northeast Region Indicator	0.084***	0.103***	0.060***
	(0.009)	(0.013)	(0.012)
South Region Indicator	0.076***	0.091***	0.058***
	(0.010)	(0.014)	(0.012)
Survey Year 2012	0.001	0.001	0.005
	(0.008)	(0.013)	(0.010)
Survey Year 2013	0.010	0.026**	-0.001
	(0.008)	(0.012)	(0.010)
Survey Year 2014	0.006	0.030**	-0.011
	(0.008)	(0.012)	(0.010)
Survey Year 2015	0.025***	0.038***	0.012

	(0.008)	(0.013)	(0.010)
Survey Year 2016	0.015*	0.033***	-0.003
	(0.008)	(0.012)	(0.010)
Education	0.119***	0.054**	0.129***
	(0.011)	(0.021)	(0.012)
Arts	0.599***	0.417***	0.704***
	(0.003)	(0.006)	(0.004)
Humanities	0.621***	0.430***	0.725***
	(0.003)	(0.004)	(0.003)
Social & Behavior Science	0.670***	0.516***	0.751***
	(0.003)	(0.005)	(0.003)
Journalism & IT	0.611***	0.437***	0.702***
	(0.003)	(0.004)	(0.004)
Business	0.207***	0.223***	0.163***
	(0.010)	(0.018)	(0.011)
Law	0.586***	0.451***	0.647***
	(0.004)	(0.006)	(0.008)
Biological Science	0.605***	0.427***	0.704***
	(0.003)	(0.004)	(0.003)
Physical Science	0.608***	0.433***	0.703***
	(0.003)	(0.004)	(0.004)
Maths & Statistics	0.601***	0.420***	0.702***
	(0.003)	(0.004)	(0.003)
Computer	0.622***	0.430***	0.728***
	(0.003)	(0.006)	(0.003)
Engineering	0.467***	0.346***	0.662***
	(0.009)	(0.013)	(0.008)
Production & Production Process	0.580***	0.380***	0.693***
	(0.005)	(0.012)	(0.005)
Architecture	0.421***	0.293***	0.564***
	(0.013)	(0.015)	(0.025)
Agricultural, Forestry & Fishery	0.524***	0.366***	0.627***
	(0.007)	(0.010)	(0.010)
Veterinary Science	0.598***	0.421***	0.698***
	(0.003)	(0.004)	(0.003)
Personal Services	0.581***	0.367***	0.681***
	(0.004)	(0.012)	(0.005)
Observations	62,056	23,002	39,054

***p<0.01, **p<0.05, *p<0.1; standard errors in parentheses;

Table 14c: Post-graduate Degree

VARIABLES	(1) All	(2) Male	(3) Female
Age	0.026***	0.008	0.034***
	(0.006)	(0.010)	(0.008)
Age Square	-0.000***	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)
Municipal Area Indicator	-0.000	0.000	-0.003
	(0.014)	(0.022)	(0.018)
Female Indicator	-0.042***		
	(0.012)		
Married Indicator	-0.018	0.032	-0.039***
	(0.012)	(0.022)	(0.014)
Central Region Indicator	0.093***	0.106***	0.077***
	(0.018)	(0.028)	(0.024)
North Region Indicator	0.143***	0.184***	0.105***
	(0.020)	(0.029)	(0.026)
Northeast Region Indicator	0.099***	0.105***	0.101***
	(0.019)	(0.029)	(0.025)
South Region Indicator	0.173***	0.213***	0.131***
	(0.022)	(0.033)	(0.030)
Survey Year 2012	0.022	0.001	0.037
	(0.019)	(0.028)	(0.025)
Survey Year 2013	0.019	0.018	0.022
	(0.019)	(0.028)	(0.025)
Survey Year 2014	-0.007	-0.022	0.010
	(0.018)	(0.028)	(0.024)
Survey Year 2015	-0.052***	-0.055**	-0.046**
	(0.017)	(0.026)	(0.022)
Survey Year 2016	-0.049***	-0.037	-0.053**
	(0.017)	(0.027)	(0.022)
Education	-0.220***	-0.237***	-0.189***
	(0.021)	(0.041)	(0.023)
Arts	0.668***	0.621***	
	(0.009)	(0.017)	
Humanities	0.678***		0.726***
	(0.007)		(0.010)
Social & Behavior Science	0.606***	0.560***	0.676***
	(0.016)	(0.032)	(0.018)
Journalism & IT	0.679***		0.726***
	(0.006)		(0.010)
Business	0.167***	0.264***	0.108***

	(0.023)	(0.046)	(0.026)
Law	0.427***	0.456***	0.386***
	(0.030)	(0.041)	(0.051)
Biological Science	0.667***	0.626***	0.718***
	(0.009)	(0.014)	(0.012)
Physical Science	0.644***	0.635***	0.661***
	(0.014)	(0.012)	(0.026)
Computer	0.543***	0.496***	0.614***
	(0.025)	(0.041)	(0.032)
Engineering	0.518***	0.521***	0.560***
	(0.023)	(0.033)	(0.047)
Architecture	0.481***	0.485***	
	(0.043)	(0.045)	
Agricultural, Forestry & Fishery	0.368***	0.369***	0.377***
	(0.045)	(0.066)	(0.065)
Observations	10,989	4,798	6,056

***p<0.01, **p<0.05, *p<0.1; standard errors in parentheses;

The likelihood of being mismatched is higher in older people, which is consistent with the study by Robst (2007). The reason could be that older people receive on-the-job training over their career, so they are well-equipped for their job responsibilities. For vocational and bachelor's degrees, married people are more likely to be mismatched, while the coefficient on married for post-graduate graduates is not significant. This is possible because married people have more responsibilities, such as taking care of family, particularly children, so they may need to accept any job available, even if it is mismatched. This result is inconsistent with what was found by Robst (2007). As compared to individuals who live in Bangkok, people in other regions are more likely to be mismatched for those who graduate from bachelor's and post-graduate programs, while only people from the North and Northeast tend to be mismatched for individuals who have vocational degrees. This is likely due to more limited labor market opportunities outside of Bangkok.

The results reported in Table 14 also show that mismatch varies among different majors and degrees. The omitted major across all degrees is health sciences since it generally has the lowest rate of mismatch. From Table 14a, the highest rates of mismatch at the upper vocational level belong to computer science (62.4 percent) and social sciences and behavioral sciences (48.9 percent). The lowest rates of mismatch occur for graduates holding degrees in business, engineering, and architecture, which experience mismatch rates at 3.2, 14.5, and 16.4 percent higher than for health sciences.

Considering bachelor's degree graduates, there are several majors where the probability to be mismatched compared to health sciences is greater than 60 percent, as shown in Table 14b. These majors include social and behavioral sciences (67 percent), computer science (62.2 percent), humanities (62.1 percent), journalism and information technology (61.1 percent), physical science (60.8 percent), biological science (60.5 percent), and mathematics and statistics (60.1 percent). This result seems to contradict Robst's (2007) findings as his research shows that majors with more general skills seem to be more mismatched compared to majors with specific skills. The results from this study show high mismatch in both social sciences and sciences. This, in fact, reflects the reality of the Thai economy where the number of jobs in science fields are relatively few compared to other fields. The lowest prevalence rates of mismatch for bachelor's degree holders are in education (11.9 percent) and business (20.7 percent), which are career-oriented fields that match with occupations widely available in the Thai economy.

Lastly, the results of post-graduate degrees from Table 14c show that education majors have 22 percent lower mismatch than health sciences graduates. This is only one major and degree that the probability of mismatch is lower than health sciences. However, many majors that have more than 60 percent prevalence rate of mismatch when compared to health sciences, including journalism and information technology (67.9 percent), humanities (67.8 percent), arts (66.8 percent), biological science (66.7 percent), physical science (64.4 percent), and social and behavioral science (60.6 percent). On the other hand, apart from education mentioned previously, business at the post-graduate level reports relatively low prevalence of mismatch compared to health sciences at 16.7 percent.

In terms of gender, the prevalence rates of mismatched men who have upper vocational degrees, as compared to health sciences, are highest on computer science, 54.4 percent, and lowest on personal services at 26.8 percent. Similar to the case of women who have upper vocational degrees, the prevalence rate of mismatch on computer science is high as 71.5 percent while the lowest is education, 35.9 percent. For bachelor's degree, the least prevalence rate of mismatch is education in both men and women at 5.4 and 12.9 percent, respectively. For the major that has the highest probability to be mismatched is social and behavioral sciences for both genders. Interestingly, education shows negative coefficients in post-graduate degree in both men (23.7 percent) and women (18.9 percent). This implies that the probability of mismatch is lower than health sciences in both genders. The highest rates of mismatch for men and women having post-graduate degrees are in physical sciences (63.5 percent) and humanities and journalism and information technology (72.6 percent).

Overall, the hypothesis that workers who earn degrees with more career training have a lower probability to be mismatched is correct in some cases. As seen from Table 14, education, engineering, and architecture have lower probabilities than pure sciences like biological science, physical sciences, and mathematics and statistics that equip students more with theory and time spent in laboratory. Although some majors are career oriented, if there is little demand for those fields, the probability to be mismatched would be high, such as with veterinary science and computer science.

Table 15a, 15b, and 15c reports the results for the wage regression specified in equation (8) across the three degrees levels and stratified by gender.

Table 15: Mismatch Penalties and Returns to Degree Programs (OLS Regressions)
Table 15a: Vocational Degree

VARIABLES	(1) All	(2) Male	(3) Female
Mismatch	-0.116***	-0.109***	-0.137***
	(0.008)	(0.010)	(0.012)
Age	-0.000	0.006	-0.003
	(0.003)	(0.004)	(0.004)
Age Square	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Female Indicator	-0.136***	-	-
	(0.011)		
Married Indicator	0.105***	0.138***	0.047***
	(0.007)	(0.011)	(0.010)
Municipal Area Indicator	0.037***	0.044***	0.031***
	(0.007)	(0.010)	(0.010)
Central Region Indicator	-0.107***	-0.073***	-0.157***
	(0.014)	(0.019)	(0.020)
North Region Indicator	-0.324***	-0.307***	-0.343***
	(0.015)	(0.021)	(0.021)
Northeast Region Indicator	-0.352***	-0.373***	-0.325***
	(0.015)	(0.021)	(0.021)
South Region Indicator	-0.274***	-0.267***	-0.286***
	(0.015)	(0.021)	(0.021)

Survey Year 2012	0.065***	0.091***	0.031*
	(0.011)	(0.016)	(0.016)
Survey Year 2013	0.127***	0.141***	0.114***
	(0.012)	(0.016)	(0.017)
Survey Year 2014	0.125***	0.131***	0.116***
	(0.012)	(0.016)	(0.017)
Survey Year 2015	0.156***	0.160***	0.156***
	(0.012)	(0.016)	(0.016)
Survey Year 2016	0.166***	0.164***	0.169***
	(0.012)	(0.016)	(0.016)
Education	-0.435***	-0.457***	-0.399***
	(0.039)	(0.071)	(0.047)
Arts	-0.425***	-0.426***	-
	(0.060)	(0.080)	
Social & Behavior Science	-0.452***	-0.455***	-
	(0.077)	(0.094)	
Business	-0.404***	-0.383***	-0.416***
	(0.026)	(0.059)	(0.028)
Computer	-0.343***	-0.355***	-0.336***
	(0.029)	(0.061)	(0.031)
Engineering	-0.333***	-0.322***	-0.248***
	(0.028)	(0.058)	(0.044)
Production & Production Process	-0.282***	-0.141	-0.376***
	(0.055)	(0.094)	(0.067)
Architecture	-0.359***	-0.351***	-0.392***
	(0.031)	(0.060)	(0.064)
Agricultural, Forestry & Fishery	-0.468***	-0.465***	-0.468***
	(0.034)	(0.063)	(0.050)
Personal Services	-0.433***	-0.326***	-0.448***
	(0.034)	(0.081)	(0.036)
Constant	9.542***	9.332***	9.611***
	(0.056)	(0.090)	(0.073)
Observations	18,408	10,596	7,812
R-squared	0.282	0.284	0.240

***p<0.01, **p<0.05, *p<0.1; standard errors in parentheses; excluded degree category is health

sciences.

Table 15b: Bachelor's Degree

VARIABLES	(1) All	(2) Male	(3) Female
Mismatch	-0.156***	-0.130***	-0.195***
	(0.005)	(0.008)	(0.007)
Age	0.007***	0.014***	0.002
	(0.002)	(0.003)	(0.002)
Age Square	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Female Indicator	-0.091***		
	(0.004)		
Married Indicator	0.043***	0.089***	0.022***
	(0.004)	(0.008)	(0.005)
Municipal Area Indicator	0.066***	0.064***	0.065***
	(0.004)	(0.008)	(0.005)
Central Region Indicator	-0.159***	-0.163***	-0.153***
	(0.007)	(0.011)	(0.008)
North Region Indicator	-0.291***	-0.329***	-0.267***
	(0.007)	(0.012)	(0.009)
Northeast Region Indicator	-0.240***	-0.290***	-0.208***
	(0.007)	(0.012)	(0.009)
South Region Indicator	-0.275***	-0.306***	-0.256***
	(0.007)	(0.012)	(0.009)
Survey Year 2012	0.044***	0.047***	0.044***
	(0.006)	(0.011)	(0.008)
Survey Year 2013	0.106***	0.099***	0.110***
	(0.006)	(0.011)	(0.008)
Survey Year 2014	0.099***	0.072***	0.116***
	(0.006)	(0.011)	(0.008)
Survey Year 2015	0.122***	0.097***	0.138***
	(0.006)	(0.011)	(0.008)
Survey Year 2016	0.127***	0.104***	0.141***
	(0.006)	(0.011)	(0.008)
Education	-0.319***	-0.304***	-0.321***
	(0.007)	(0.018)	(0.008)
Arts	-0.319***	-0.383***	-0.236***
	(0.015)	(0.026)	(0.020)
Humanities	-0.243***	-0.338***	-0.180***
	(0.015)	(0.032)	(0.017)
Social & Behavior Science	-0.322***	-0.347***	-0.273***
	(0.010)	(0.020)	(0.013)
Journalism & IT	-0.265***	-0.270***	-0.236***

	(0.015)	(0.028)	(0.018)
Business	-0.427***	-0.397***	-0.433***
	(0.007)	(0.017)	(0.008)
Law	-0.213***	-0.218***	-0.208***
	(0.012)	(0.020)	(0.020)
Biological Science	-0.183***	-0.238***	-0.128***
	(0.020)	(0.035)	(0.025)
Physical Science	-0.151***	-0.155***	-0.127***
	(0.018)	(0.031)	(0.024)
Maths & Statistics	-0.104***	-0.128**	-0.068**
	(0.028)	(0.053)	(0.033)
Computer	-0.312***	-0.300***	-0.295***
	(0.011)	(0.022)	(0.014)
Engineering	-0.149***	-0.172***	0.020
	(0.011)	(0.018)	(0.026)
Production & Production Process	-0.253***	-0.306***	-0.200***
	(0.027)	(0.045)	(0.034)
Architecture	-0.294***	-0.296***	-0.275***
	(0.016)	(0.023)	(0.039)
Agricultural, Forestry & Fishery	-0.324***	-0.321***	-0.306***
	(0.014)	(0.023)	(0.021)
Veterinary Science	-0.143***	-0.158***	-0.103*
	(0.035)	(0.047)	(0.056)
Personal Services	-0.300***	-0.409***	-0.246***
	(0.016)	(0.036)	(0.018)
Constant	9.567***	9.444***	9.555***
	(0.033)	(0.059)	(0.039)
Observations	62,056	23,002	39,054
R-squared	0.448	0.412	0.460

***$p<0.01$, **$p<0.05$, *$p<0.1$; standard errors in parentheses; excluded degree category is health sciences.

Table 15c: Post-graduate Degree

VARIABLES	(1) All	(2) Male	(3) Female
Mismatch	-0.127***	-0.150***	-0.111***
	(0.010)	(0.015)	(0.014)
Age	0.031***	0.032***	0.035***
	(0.004)	(0.007)	(0.006)
Age Square	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)
Female Indicator	-0.105***	-	-
	(0.008)		
Married Inditor	0.027***	0.044***	0.014
	(0.009)	(0.017)	(0.010)
Municipal Area Indicator	0.049***	0.051***	0.050***
	(0.010)	(0.016)	(0.013)
Central Region Indicator	-0.233***	-0.222***	-0.243***
	(0.013)	(0.021)	(0.017)
North Region Indicator	-0.326***	-0.336***	-0.317***
	(0.014)	(0.022)	(0.018)
Northeast Region Indicator	-0.269***	-0.293***	-0.250***
	(0.014)	(0.022)	(0.018)
South Region Indicator	-0.318***	-0.357***	-0.290***
	(0.015)	(0.024)	(0.020)
Survey Year 2012	0.020	0.014	0.029
	(0.014)	(0.020)	(0.018)
Survey Year 2013	0.043***	0.037*	0.051***
	(0.013)	(0.020)	(0.018)
Survey Year 2014	0.058***	0.059***	0.060***
	(0.013)	(0.020)	(0.017)
Survey Year 2015	0.072***	0.073***	0.074***
	(0.013)	(0.020)	(0.017)
Survey Year 2016	0.103***	0.083***	0.119***
	(0.013)	(0.020)	(0.017)
Education	-0.177***	-0.263***	-0.149***
	(0.017)	(0.035)	(0.019)
Arts	-0.137***	-0.192***	-0.130**
	(0.044)	(0.072)	(0.056)
Humanities	-0.161***	-0.336***	-0.106**
	(0.039)	(0.077)	(0.044)
Social & Behavior Science	-0.204***	-0.306***	-0.152***
	(0.020)	(0.037)	(0.025)
Journalism & IT	-0.143***	-0.341***	-0.063
	(0.038)	(0.071)	(0.046)

Business	-0.192***	-0.258***	-0.174***
	(0.018)	(0.035)	(0.020)
Law	-0.091***	-0.159***	-0.080*
	(0.028)	(0.044)	(0.041)
Biological Science	-0.093**	-0.209***	-0.043
	(0.041)	(0.070)	(0.050)
Physical Science	-0.077**	-0.103*	-0.086*
	(0.037)	(0.061)	(0.046)
Computer	-0.116***	-0.173***	-0.111**
	(0.033)	(0.053)	(0.043)
Engineering	0.070***	-0.019	0.182***
	(0.027)	(0.041)	(0.054)
Architecture	-0.089*	-0.158***	-
	(0.048)	(0.057)	
Agricultural, Forestry & Fishery	-0.218***	-0.323***	-0.169***
	(0.040)	(0.062)	(0.053)
Constant	9.403***	9.436***	9.198***
	(0.092)	(0.154)	(0.119)
Observations	10,989	4,879	6,110
R-squared	0.422	0.403	0.394

***p<0.01, **p<0.05, *p<0.1; standard errors in parentheses; excluded degree category is health sciences.

The results in Table 15 show that horizontal mismatch, on average, leads to negative returns relative to matched workers, ranging from 11.6 to 15.6 percent. On average, upper vocational degree graduates are penalized the lowest among the three different degree levels, whereas bachelor's degree graduates are penalized the most. Compared to the omitted degree category of health sciences, the returns to other majors at every degree level are lower. When looking at the upper vocational degree, the lowest returns to a degree is agriculture at 46.8 percent lower than health sciences, followed by social and behavioral sciences (45.2 percent), and education (43.5 percent). Table 15b shows that for bachelor's degree, health sciences graduates also earn more than other majors. The lowest returns compared to health sciences are business and agriculture at 42.7 percent and 32.4 percent lower, while the highest

returns are mathematics and statistics, veterinary science, and engineering at 10.4 percent, 14.3 percent, and 14.9 percent lower, respectively, compared to health sciences

As shown in Table 15c, returns to education for post-graduate degrees, in general, shows the least divergence in wage income from health sciences compared to other two degrees. The highest returns to education are engineering (7 percent), which is higher than health sciences. Apart from engineering, other majors with similar wage returns to health sciences include physical science, architecture, and law, which are majors that have 7.7, 8.9 percent, 9.1 percent lower wages compared to health sciences. The lowest wage returns belong to agricultural and social and behavioral sciences, at 21.8 and 20.4 percent lower than health sciences.

The final analysis considers wage penalties by majors, as specified in equation (9). The results are reported as the linear combination between the mismatch dummy coefficient (α_1) and the coefficients on the interaction term between mismatch and major of study (δ_{ij}). The purpose of this exercise is to determine whether some majors incur greater mismatch penalties than other majors. The resulting mismatch estimates by major and gender reported in Figures 15 to 17 are the average penalties by major compared to a matched health sciences major.

Figure 16: Upper Vocational Graduate Mismatch Penalties by Major and Gender
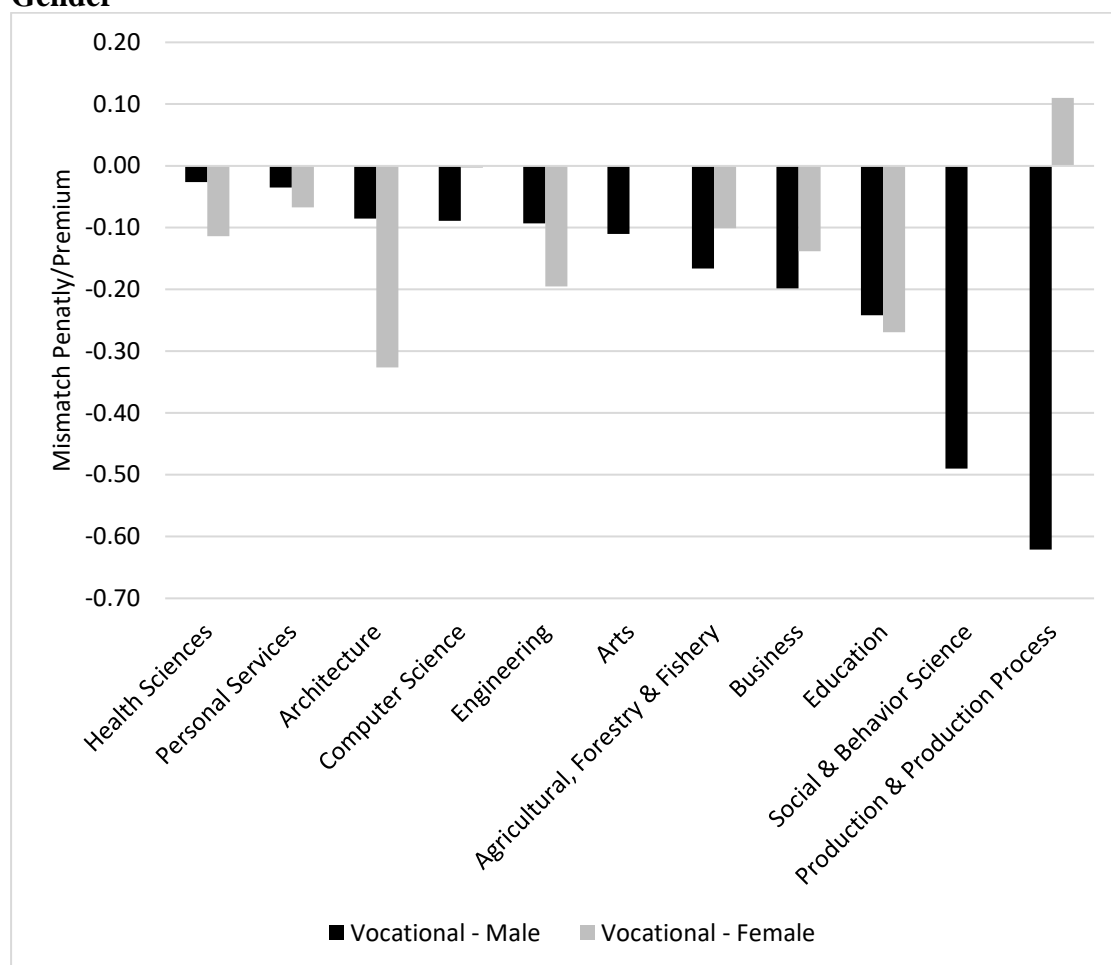
Source: Authors' calculations from 2011 - 2016 Thai Labor Force Surveys.
Note: Full regression results are report in Appendix Table 7

Figure 17: Bachelor's Degree Graduate Mismatch Penalties by Major and Gender
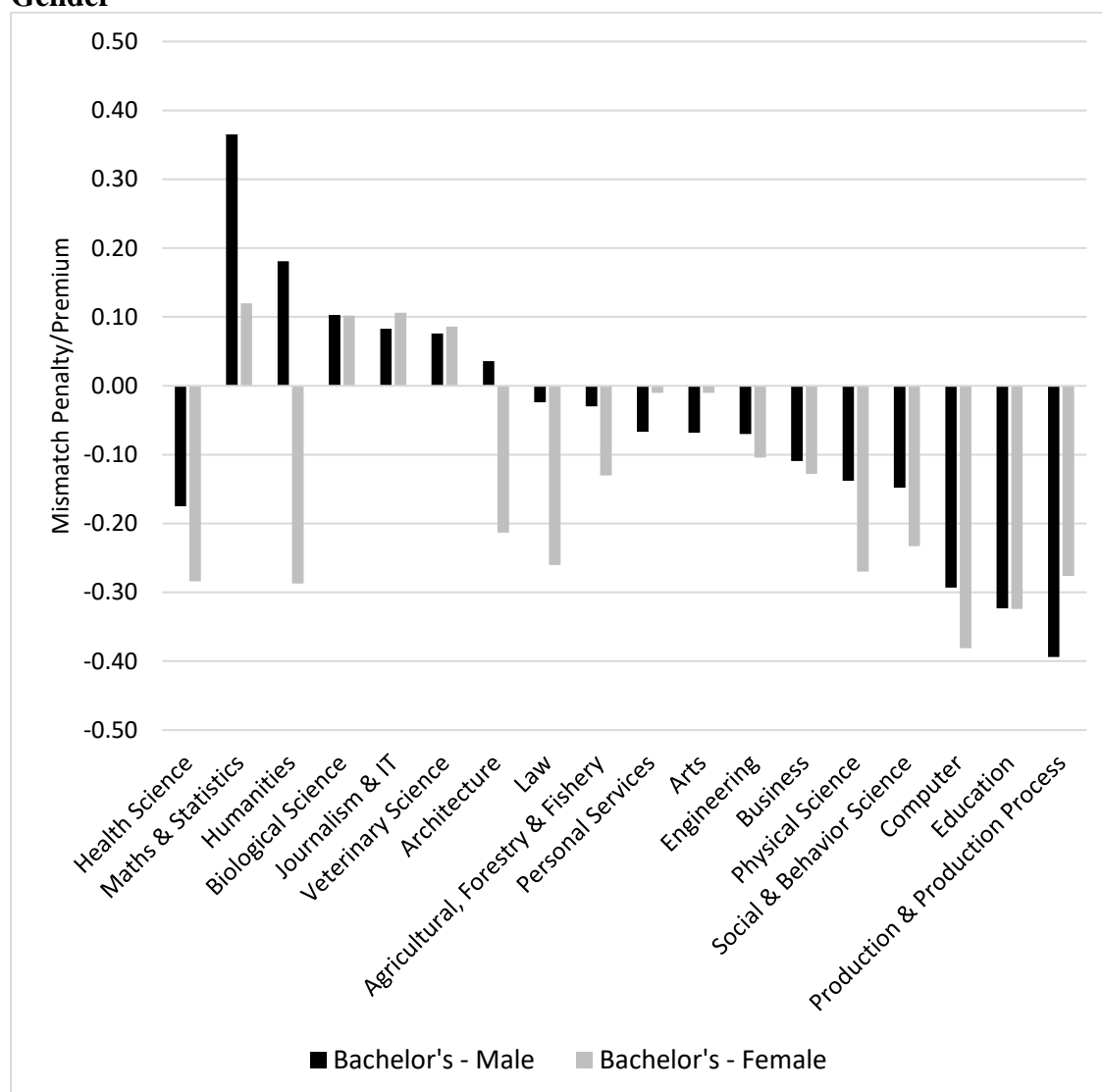
Source: Authors' calculations from 2011 - 2016 Thai Labor Force Surveys.
Note: Full regression results are report in Appendix Table 7

Figure 18: Post-graduate Degree Graduate Mismatch Penalties by Major and Gender
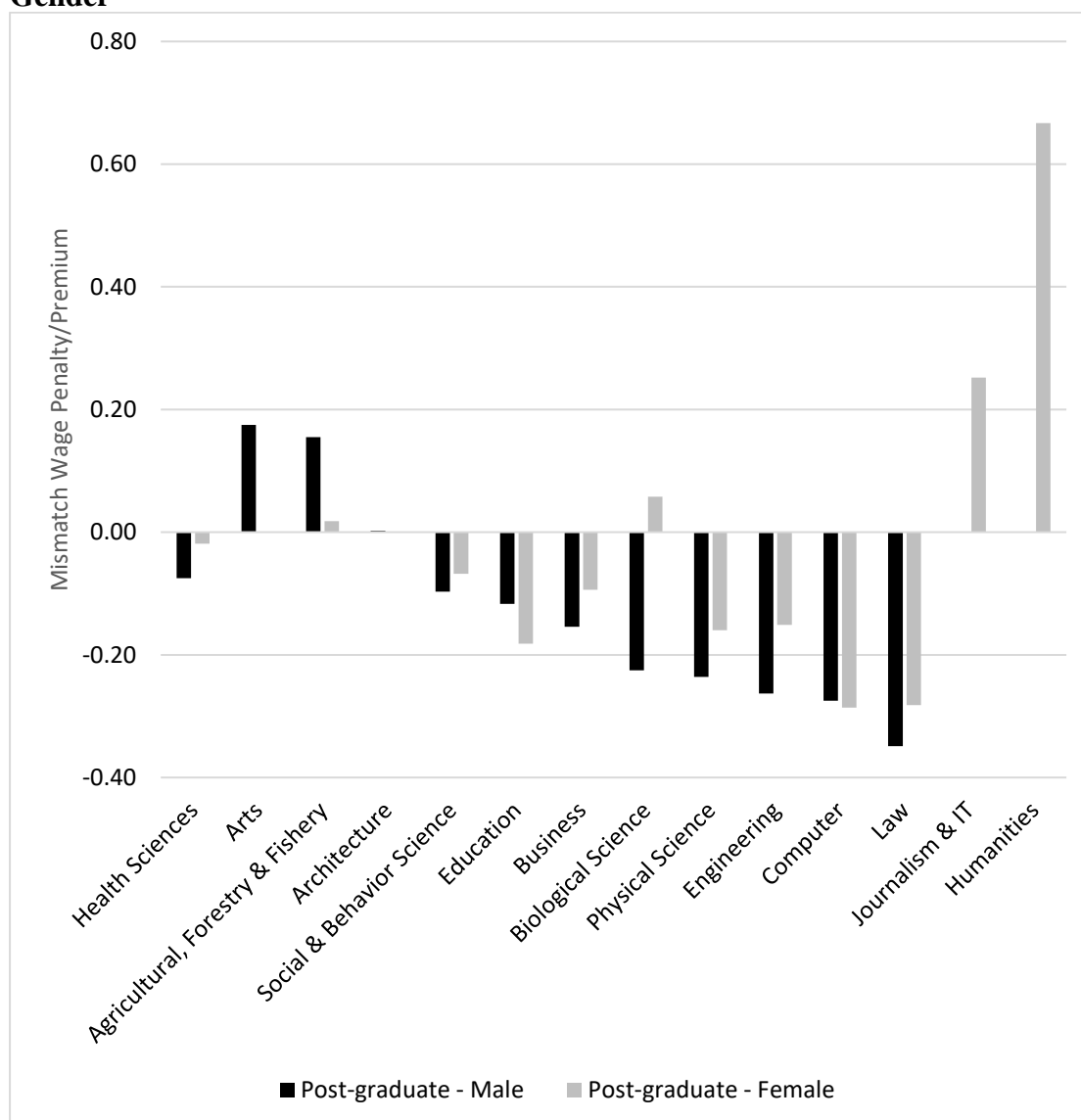
Source: Authors' calculations from 2011 - 2016 Thai Labor Force Surveys.
Note: Full regression results are report in Appendix Table 7

Upper Vocational Degree

As shown in Figure 16, the highest horizontal mismatch penalties for men are 62.1 percent if their major is production and production process. However, women in with a major in the same field have a *premium* of 11 percent if they are mismatched. The highest mismatch penalty for women is persons who have a background in

architecture (32.6 percent) while men in the same major are penalized by only 8.5 percent. The lowest penalties for mismatched men are those who studied health sciences, 2.6 percent.

Bachelor's Degree

Interestingly enough, several majors have a mismatch *premium* for both genders. For instance, horizontal mismatch premiums are found in mathematics and statistics (36.5 percent for men and 12 percent for women), biological sciences (10.3 percent for men and 10.2 percent for women), journalism and information and technology (8.3 percent for men and 10.6 percent for women), and veterinary science (7.6 percent for men and 8.6 percent for women). The highest penalties for mismatched men belong to men who majored in production and production process and education, while the highest penalties for women are those who have majors in computer science and education. It is noticeable that personal services, arts, and engineering are the majors that have relatively low mismatch penalties for both men and women.

Post-graduate Degree

Similar to the bachelor's degree, some majors have premiums for mismatched persons, including majors in arts, agriculture, journalism and information technology, and humanities. The highest penalty for mismatched persons belongs to those who studied law at 34.9 and 28.2 percent for men and women, respectively. This is not surprising since law at the post-graduate level gives relatively high returns compared to other majors, as can be seen in Table 15. Comparing between men and women, the penalties are varied according to majors. For instance, women who have education

and computer science majors are more penalized than men, while men who majored in business, engineering, physical sciences, and law are penalized more compared to women.

As Figures 16, 17, and 18 indicate, horizontally mismatched people in many majors experience penalties, which is consistent with Robst (2007) and Pholphirul (2017). However, there are some majors that have mismatch *premiums*. Horizontal mismatch premiums can occur for several reasons. For instance, an individual may earn more in a mismatched job if they complete a degree in a major that is not widely available in the job market, or if the earnings from that field are relatively low relative compared to other fields with demand for workers who have related skills. As claimed by Zhu (2014), graduates are able to adapt their skills to mismatched jobs quickly if they are equipped with a combination of general and specific human capital trainings in institutions. In this case, working in mismatched areas does not result in income penalties. Graduates in some majors may rationally mismatch because their skills are transferable or on-the-job training results in wage premiums.

The results partially support the hypothesis that the mismatch penalties are higher for degrees aimed at specific career training compared to general degrees. For instance, business and engineering generally have lower wage penalties, while education and computer science have high penalties. Engineering in the Thai context is considered to have transferable skills. As mentioned in the beginning of this chapter, many Thai students pursue engineering because they believe that this program will equip them with better knowledge and skills that are transferable to other occupations than others majors.

Section 5: Conclusion and Discussion

This chapter studies horizontal mismatch of Thai graduates with upper vocational degrees, bachelor's degrees, and post-graduate degrees. Using data from the nationally representative Thai LFS for the years 2011 to 2016, I find that the mismatch rate is high in humanities, biological sciences, physical sciences, mathematics and statistics, and veterinary sciences. This is inconsistent with previous research by Robst (2007) that uses the United States' data, but consistent with earlier work on Thailand by Pholpirul (2017) that uses Thai data from 2008. The logic behind this would be the fact that there are not many jobs related to the above majors available in Thailand while there are many jobs in pure sciences available in developed countries. It is worth noting that some career-oriented vocational majors have high mismatch rates, especially computer science. This implies that the career programs are not addressing actual occupations in the economy. It is found that only 14 percent of vocational graduates who have majors in technician studies that work in matched fields in 2013 because they are not able to meet the standards required for the technician positions (Chenphuengpawn and Rakkiatwong 2019). The lowest mismatch rates are in health sciences and education.

In terms of mismatch across different degree levels, it is varied among different majors. Also, the mismatch rates for men and women are mixed. Considering the probability of mismatch as compared to a matched health sciences major, it is found that every major in every degree, except individuals who have post-graduate degree in education, have higher probability to be mismatched, while women seem to have higher prevalence rate of mismatch than men overall.

This chapter also examines returns to education for each major in each degree and it is found that every major in all degrees, except engineering at the post-graduate level, has lower returns than health sciences. Not surprisingly, medicine is one of the most popular majors that students decide to study in Thailand (Piromruen 2014). This study indicates that in general, mismatched people are worse off compared to those who work in matched fields, and women are penalized at higher rates than men. Considering each degree, both men and women who studied education but are horizontally mismatched are penalized at the highest rates in upper vocational degrees. Similarly, when considering the bachelor's degree, mismatched persons who have education degrees are penalized relatively highly, but the highest penalty for men is in the production and production process major, while the highest penalties for women is computer science. Lastly, for post-graduate degrees, the highest penalties go to mismatched men with a law major, while the highest penalties for mismatched women are for law and computer science. Surprisingly, some majors at the bachelor's degree and post-graduate degree levels have mismatch premiums.

Overall, this is a waste of resources at both the private and society levels. As mentioned previously, Thai students must choose a major before getting into university even though many do not know exactly what field they are interested in. They then make choices according to examination scores, popularity of the majors, and the reputation of the institutions. This is a major reason of horizontal mismatch in Thailand. Thus, it is necessary for policymakers to pay attention to this issue and to find an alternative way to help students discover where their interests lie before selecting majors or to find out whether it is possible for students to change their majors after admission into universities.

Chapter VII: Conclusion

This dissertation considers three interrelated topics: education, informality, and wages in Thailand. Informal workers make important contributions to the Thai economy, but to date there are few studies on education that pays particular attention to informal workers. The first empirical chapter on returns to education for informally employed persons in Thailand used an IV approach to solve for ability bias. The results show that the returns to education for informal private firm employees and own-account workers are not significantly lower than formal private firm employees. Given that Thailand provides alternative forms of voluntary social security, the "30 baht" universal health coverage, and a universal pension for older persons to informal workers, informal work may not be as inferior to formal work in Thailand along several dimensions.

The second topic focuses on vertical education--occupation mismatch for formal and informal workers. It is found that the highest incidence of being vertically mismatched belongs to own-account workers, followed by informal private firm employees, formal private firm employees, and formal government employees respectively. In terms of birth cohorts, undereducated workers have declined over successive birth cohorts for every work status while the overeducated workers have increased over successive birth cohorts in every employment sector. The overall wage penalty for overeducation is estimated to be 20.9 percent, and there is evidence that the penalties are larger later in one's career. In addition to that, the penalties are highest among government officers and lowest for own-account workers. This is likely due to rigid wage structures within the civil service system in contrast to

flexibility in informal work to work to one's own potential. Comparing private firm employees, the results show that the overeducated penalties of informal private firm employees are higher than formal private firm employees. The higher penalty might reflect lack of opportunity or ability to get the right jobs so these overeducated persons have to accept jobs from informal private firm which require less skills.

The last empirical chapter analyzes the incidence and wage penalties/premiums for horizontal degree field--occupational mismatch for post-secondary vocational, bachelor's, and postgraduate degree holders. It is found that horizontal mismatch rates are greater than 90 percent for several majors with wage penalties for mismatched persons as compared to their colleagues who work in the fields that they attained in their studies for most majors.

As the Thai government spends substantial resources on education every year, policymakers should pay attention to the aforementioned issues in order to minimize opportunity loss and wasted resources. Because returns to education is comparable between formal and informal workers, together with appropriate protections and welfare for informal workers in Thailand, it is less attractive for informal workers to move to work as formal workers. This, therefore, impacts tax collection. It is important for the government to impose other policies in order to collect taxes; otherwise, the majority of tax collection would come from formal workers alone, which account for less than half of total employment. As stated by Kolm and Larsen (2016), a reduced income tax rate could persuade workers to pursue formal employment, but the tax rate has to be sufficient to assure a balanced government budget. This can potentially lead to slower development as funds may not be available

for productive development projects. For instance, this impacts a country's on improving health, education, important infrastructure, and other public goods (Akitoby 2018).

The results from the studies on both vertical and horizontal mismatch show there exists high mismatch rates and significant wage penalties. The government should consider supporting the development of economic sectors that can absorb highly educated high-skill workers, which would help reduce the overeducation problem. In terms of horizontal mismatch, it is doubtful whether skills taught and standards of institutions are relevant in the job market given the high levels of horizontal mismatch. Thus, collaboration between institutions and private firms is necessary to ensure that the institutions equip their students with adequate knowledge and skills in order to transition successfully into the workplace. Furthermore, the admissions process to universities should be reconsidered to reduce the incidence of horizontal mismatch. For example, universities might allow students to explore different fields of study before they are required to decide which major to commit to. Also, secondary schools could collaborate with companies and request students to attend internship programs before they are required to select their major of study. These would reduce the incidence of horizontal mismatch and potentially make higher education more efficient.

This dissertation highlights the fundamental issues relating to education, informality, and labor market mismatch. Further study on effective policy options to combat problems associated with education--occupation mismatch--should be considered in the future. It is hoped that the government and institutions of higher

education can develop appropriate approaches to make more efficient use of scarce resources in developing our educated labor force.

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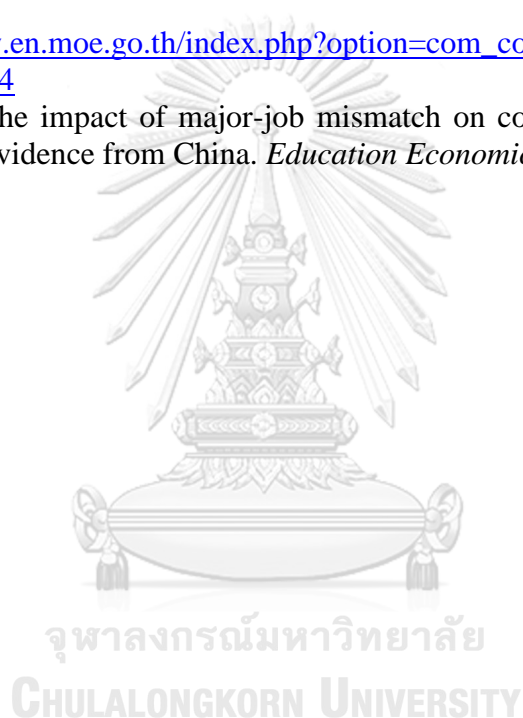
Appendices

Appendix 1: Returns to Education of Formal Government Employees

	(1)	(2)
	OLS	IV
Dependent Variable: ln Real Total Income		
Years of Education	0.122***	0.195**
	(0.001)	(0.090)
Age	0.028***	0.047*
	(0.007)	(0.026)
Age^2	0.000*	-0.000
	(0.000)	(0.000)
Female Indicator	-0.074***	-0.191
	(0.008)	(0.144)
Married	0.054***	0.068***
	(0.010)	(0.020)
Municipal Area	0.180***	0.069
	(0.010)	(0.138)
Survey Year 2013	0.045***	0.024
	(0.010)	(0.028)
Survey Year 2015	0.040***	0.015
	(0.010)	(0.033)
Constant	6.474***	5.057***
	(0.146)	(1.756)
	Yes	Yes
Adj. R-Square	0.555	
Observations	17583	17583

Clustered standard errors at the province-year of birth level in parentheses.

Appendix 2: Returns to Education by Worker Type in Bangkok (OLS Estimates)

	(1)	(2)	(3)	(4)
		Formal	Informal	Informal
	All	Private Firm	Private Firm	Own-account
	Dependent Variable: ln Real Total Income			
Years of Education	0.074***	0.095***	0.066***	0.030***
	(0.002)	(0.002)	(0.005)	(0.005)
Informal Employee	-0.262***			
	(0.023)			
Own Account Workers	-0.067***			
	(0.023)			
Age	0.051***	0.061***	0.005	0.045
	(0.014)	(0.013)	(0.024)	(0.037)
Age^2	-0.000***	-0.001***	0.000	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)
Female Indicator	-0.165***	-0.137***	-0.266***	-0.172***
	(0.018)	(0.019)	(0.035)	(0.042)
Married	0.068***	0.053***	0.083***	0.099*
	(0.015)	(0.012)	(0.029)	(0.050)
Survey Year 2013	0.118***	0.111***	0.209***	0.073
	(0.017)	(0.020)	(0.028)	(0.048)
Survey Year 2015	0.142***	0.122***	0.196***	0.151***
	(0.019)	(0.021)	(0.029)	(0.052)
Constant	7.601***	7.015***	8.476***	8.301***
	(0.298)	(0.272)	(0.530)	(0.809)
Adj. R-Square	0.342	0.490	0.339	0.063
Observations	5769	3278	975	1516

Notes: *** p<0.01 ** p<0.05 * p<0.1; Formal private firm employees are the excluded worker category in column 1; Clustered standard errors at the province-year of birth level in parentheses.

Appendix 3: First-stage Regressions for IV Analysis

	(1)	(2)	(3)	(4)
		Formal	Informal	Informal
	All	Private Firm	Private Firm	Own-account
		Dependent Variable: Years of Education		
Secondary Schools per 100 km2	0.537***	0.606***	0.522***	0.464***
	(0.060)	(0.088)	(0.077)	(0.083)
Informal Employees	-2.874***			
	(0.052)			
Own Account Workers	-1.192***			
	(0.054)			
Age	-0.199***	-0.194**	-0.220***	-0.209***
	(0.035)	(0.088)	(0.043)	(0.050)
Age^2	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.001)	(0.000)	(0.001)
Female Indicator	-0.376***	-0.065	-0.137***	-0.832***
	(0.035)	(0.073)	(0.050)	(0.057)
Married	-0.522***	-0.702***	-0.380***	-0.583***
	(0.040)	(0.084)	(0.056)	(0.065)
Municipal Area	0.987***	0.749***	0.840***	1.303***
	(0.037)	(0.080)	(0.049)	(0.058)
Survey Year 2013	0.287***	0.501***	0.184***	0.249***
	(0.042)	(0.091)	(0.060)	(0.069)
Survey Year 2015	0.729***	0.850***	0.660***	0.725***
	(0.043)	(0.095)	(0.061)	(0.068)
Constant	17.857***	17.858***	14.659***	17.699***
	(0.791)	(1.883)	(0.974)	(1.138)
Regional Controls	Yes	Yes	Yes	Yes
Adj. R-Square	0.273	0.156	0.185	0.216
Observations	53044	13870	18754	20420
Weak IV Test				
Cragg-Donald Wald F-statistics	215.598	108.743	64.884	38.851
Stock-Yogo critical value at 10%	16.38	16.38	16.38	16.38

Notes: *** p<0.01 ** p<0.05 * p<0.1; Formal private firm employees are the excluded worker category in column 1; Clustered standard errors at the province-year of birth level in parentheses.

Appendix 4: First-stage Regressions for IV Analysis

	(1) All Male	(1) All Female	(2) Formal Private Firm Male	(2) Formal Private Firm Female	(3) Informal Private Firm Male	(3) Informal Private Firm Female	(4) Informal Own-account Male	(4) Informal Own-account Female
				Dependent Variable: Years of Education				
Secondary Schools per 100 km2	0.568***	0.477***	0.587***	0.637***	0.575***	0.458***	0.556***	0.382***
	(0.077)	(0.067)	(0.119)	(0.094)	(0.096)	(0.120)	(0.125)	(0.104)
Informal Employees	-2.832***	-2.853***						
	(0.067)	(0.075)						
Own Account Workers	-0.841***	-1.473***						
	(0.074)	(0.074)						
Age	-0.135***	-0.277***	-0.055	-0.347***	-0.125**	-0.348***	-0.121	-0.313***
	(0.045)	(0.045)	(0.111)	(0.114)	(0.052)	(0.067)	(0.076)	(0.063)
Age^2	-0.001	-0.000	-0.002	0.001	-0.001	0.001**	-0.001	0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Married	-0.293***	-0.817***	-0.258**	-1.090***	-0.184**	-0.689***	-0.526***	-0.705***
	(0.057)	(0.054)	(0.116)	(0.112)	(0.075)	(0.089)	(0.120)	(0.079)
Municipal Area	0.915***	1.055***	0.508***	1.006***	0.788***	0.899***	1.435***	1.203***
	(0.049)	(0.049)	(0.103)	(0.112)	(0.063)	(0.074)	(0.089)	(0.071)
Survey Year 2013	0.265***	0.309***	0.512***	0.478***	0.189**	0.186**	0.159	0.300***
	(0.057)	(0.056)	(0.118)	(0.123)	(0.079)	(0.092)	(0.104)	(0.087)
Survey Year 2015	0.673***	0.802***	0.737***	0.996***	0.595***	0.770***	0.709***	0.722
	(0.059)	(0.057)	(0.129)	(0.126)	(0.080)	(0.093)	(0.104)	(0.086)
Constant	15.713***	20.091***	14.658***	21.303***	12.187***	18.041***	14.662***	20.169***
	(0.999)	(1.001)	(2.358)	(2.411)	(1.169)	(1.526)	(0.173)	(1.468)
Regional Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R-Square	0.257	0.296	0.150	0.172	0.177	0.201	0.171	0.245
Observations	26789	26255	7213	6657	10728	8026	8848	11572
Weak IV Test								
Cragg-Donald Wald F-statistics	128.198	80.372	55.116	55.809	45.443	21.294	26.457	13.596
Stock-Yogo critical value at 10%	16.38	16.38	16.38	16.38	16.38	16.38	16.38	16.38

Notes: *** p<0.01 ** p<0.05 * p<0.1; Formal private firm employees are the excluded worker category in column 1; Clustered standard errors at the province-year of birth level in parentheses.

Appendix 5: Overeducation Wage Penalties and Undereducation Wage Premiums in Thailand, OLS Regressions (Median)

	(1)	(2)	(3)	(4)	(5)
			Dependent Variable: Ln(Monthly Labor Income)		
		Formal Employment		Informal Employment	
	Pooled Baseline	Government Employee	Private Firm Employee	Private Firm Employee	Own-account Worker
Overeducated_Median	-0.262***	-0.304***	-0.183***	-0.244***	-0.169***
	(0.005)	(0.010)	(0.006)	(0.010)	(0.016)
Undereducated_Median	0.147***	0.133***	0.101***	0.207***	0.261***
	(0.007)	(0.014)	(0.008)	(0.011)	(0.020)
Elementary	0.208***	0.276***	0.123***	0.232***	0.208***
	(0.009)	(0.027)	(0.013)	(0.013)	(0.022)
Lower Secondary	0.616***	0.951***	0.498***	0.586***	0.495***
	(0.010)	(0.025)	(0.016)	(0.017)	(0.028)
Upper Secondary	0.978***	1.446***	0.879***	0.828***	0.686***
	(0.012)	(0.026)	(0.018)	(0.026)	(0.036)
Tertiary	1.381***	1.930***	1.188***	1.267***	0.878***
	(0.012)	(0.026)	(0.017)	(0.025)	(0.034)
Formal Employee	0.005				
	(0.005)				
Informal Employee	-0.327***				
	(0.006)				
Own Account Workers	-0.016**				
	(0.007)				
Potential Experience	0.040***	0.049***	0.028***	0.023***	0.023***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Potential Experience Squared	-0.001***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female Indicator	-0.199***	-0.160***	-0.184***	-0.237***	-0.209***
	(0.004)	(0.007)	(0.005)	(0.006)	(0.010)
Married	0.088***	0.041***	0.050***	0.089***	0.142***
	(0.004)	(0.008)	(0.005)	(0.007)	(0.012)
Central	-0.171***	-0.141***	-0.163***	-0.318***	-0.178***
	(0.006)	(0.015)	(0.007)	(0.014)	(0.019)
North	-0.359***	-0.194***	-0.398***	-0.497***	-0.414***
	(0.007)	(0.015)	(0.010)	(0.014)	(0.020)
Northeast	-0.319***	-0.199***	-0.399***	-0.488***	-0.320***
	(0.007)	(0.015)	(0.010)	(0.014)	(0.020)
South	-0.204***	-0.120***	-0.276***	-0.315***	-0.211***
	(0.007)	(0.016)	(0.010)	(0.014)	(0.021)
Municipal Area	0.097***	0.167***	0.007	0.059***	0.176***
	(0.004)	(0.008)	(0.005)	(0.006)	(0.012)
Survey Year 2013	0.122***	0.076***	0.183***	0.152***	0.084***
	(0.004)	(0.008)	(0.006)	(0.007)	(0.012)
Survey Year 2015	0.146***	0.110***	0.201***	0.183***	0.127***
	(0.004)	(0.008)	(0.006)	(0.007)	(0.012)
Constant	8.314***	7.437***	8.615***	8.412***	8.642***
	(0.016)	(0.031)	(0.019)	(0.026)	(0.046)
F-Statistic	4685.199	1875.480	1229.627	477.698	208.330
Adj. R-Square	0.432	0.565	0.460	0.267	0.120
Observations	104137	23141	27790	27481	25725

Notes: *** p<0.01 ** p<0.05 * p<0.1; Robust standard errors in parentheses.

Appendix 6: Matching between occupation code and major of study code

Occupation Code	Occupation List	Major Code (ISCED)	Major Description
1111	Legislators	38	Law
1112	Senior government officials	34 /31	Business / Social & Behavior Science
1113	*Village chiefs / Tradition leaders*	*34*	*Business*
1114	Senior officials of special-interest organizations	34	Business
1120	Managing directors and chief executives	34	Business
1211	Finance managers	34	Business
1212	Human resource managers	34	Business
1213	Policy and planning managers	34	Business
1219	*Business services and administration managers not elsewhere classified*	*34*	*Business*
1221	Sales and marketing managers	34	Business
1222	Advertising and public relations managers	34 /32	Business / Journalism & IT
1223	Research and development managers	34 / 42 / 44 / 46 / 48 / 52 / 54 / 58	Business / Biological Science / Physical Science / Math & Statistics / Computer / Engineering / Production & Production Process / Architecture
1311	Agricultural and forestry production managers	62 / 34	Agricultural, Forestry & Fishery / Business
1312	Aquaculture and fisheries production managers	62 /34	Agricultural, Forestry & Fishery / Business
1321	Manufacturing managers	54 / 34	Production & Production Process / Business
1322	Mining managers	54 / 34	Production & Production Process / Business
1323	Construction managers	58	Architecture
1324	Supply, distribution and related managers	34	Business

1330	Information and communications technology service managers	34 / 48 / 52	Business / Computer / Engineering
1341	Childcare services managers	76	Social Services
1342	Health services managers	72	Health Science
1343	Aged care services managers	34 / 72 / 76 / 81	Business / Health Science / Social Services / Personal Services
1344	Social welfare managers	76	Social Services
1345	Education managers	14	Education
1346	Financial and insurance services branch managers	34	Business
1349	*Professional services managers not elsewhere classified*	*34*	*Business*
1411	Hotel managers	81	Personal Services
1412	*Restaurant managers*	*81*	*Personal Services*
1420	Retail and wholesale trade managers	34	Business
1431	Sports, recreation and cultural center managers	34 / 81	Business / Personal Services
1439	Services managers not elsewhere classified	34	Business
2111	Physicists and astronomers	44	Physical Science
2112	Meteorologists	44	Physical Science
2113	Chemists	44	Physical Science
2114	Geologists and geophysicists	44	Physical Science
2120	Mathematicians, actuaries and statisticians	46	Math & Statistics
2131	Biologists, botanists, zoologists and related professionals	42	Biological Science
2132	Farming, forestry and fisheries advisers	62	Agricultural, Forestry & Fishery
2133	Environmental protection professionals	62 / 54	Agricultural, Forestry & Fishery / Production & Production Process
2141	Industrial and production engineers	54	Production & Production Process
2142	Civil engineers	52	Engineering
2143	Environmental engineers	52	Engineering
2144	Mechanical engineers	52	Engineering
2145	Chemical engineers	52	Engineering
2146	Mining engineers, metallurgists and related professionals	54	Production & Production Process

2149	Engineering professionals not elsewhere classified	52	Engineering
2151	Electrical engineers	52	Engineering
2152	Electronics engineers	52	Engineering
2153	Telecommunications engineers	52	Engineering
2161	Building architects	58	Architecture
2162	Landscape architects	58	Architecture
2163	Product and garment designers	21	Arts
2164	Town and traffic planners	58	Architecture
2165	Cartographers and surveyors	58	Architecture
2166	Graphic and multimedia designers	21	Arts
2211	Generalist medical practitioners	72	Health Science
2212	Specialist medical practitioners	72	Health Science
2221	Nursing professionals	72	Health Science
2222	Midwifery professionals	72	Health Science
2230	*Traditional medicine*	*72*	*Health Science*
2240	Assistant of medical doctor	72	Health Science
2250	Veterinarians	64	Veterinarian Science
2261	Dentists	72	Health Science
2262	Pharmacists	72	Health Science
2263	Environmental and occupational health and hygiene professionals	72	Health Science
2264	Physiotherapists	72	Health Science
2265	Dieticians and nutritionists	72	Health Science
2266	Audiologists and speech therapists	72	Health Science
2267	Ergotherapists	72	Health Science
2269	Chiropractors and other related professionals	72	Health Science
2310	University and higher education teachers	14	Education
2320	Vocational education teachers	14	Education
2330	Secondary education teachers	14	Education
2341	Primary school teachers	14	Education
2342	Early childhood teachers	14	Education
2351	Education methods specialists	14	Education
2352	Special needs teachers	14	Education
2353	Other language teachers	14	Education
2354	Other music teachers	14 / 21	Education / Arts
2355	Other arts teachers	14 /21	Education / Arts
2356	Information technology trainers	48 / 52	Computer / Engineering
2359	Teaching professionals not elsewhere classified	14	Education
2411	Accountants	34	Business

2412	Financial and investment advisers	34	Business
2413	Financial analysts	34	Business
2421	Management and organization analysts	34	Business
2422	Policy administration professionals	34	Business
2423	Personnel and careers professionals	34	Business
2424	Training and staff development professionals	34	Business
2431	Advertising and marketing professionals	34	Business
2432	Public relations professionals	34 / 32	Business / Journalism & IT
2433	*Technical and medical sales professionals (excluding ICT)*	*72*	*Health Science*
2434	Information and communications technology sales professionals	48 / 52	Computer / Engineering
2511	Systems analysts	48	Computer
2512	Software developers	48	Computer
2513	Web and multimedia developers	48	Computer
2514	Applications programmers	48	Computer
2519	Software and applications developers and analysts not elsewhere classified	48	Computer
2521	Database designers and administrators	48	Computer
2522	Systems administrators	48	Computer
2523	Computer network professionals	48	Computer
2529	Database and network professionals not elsewhere classified	48	Computer
2611	Lawyers	38	Law
2612	Judges	38	Law
2619	Legal professionals not elsewhere classified	38	Law
2621	Archivists and curators	32	Journalism & IT
2622	Librarians and related information professionals	32	Journalism & IT
2631	Economics	31	Social & Behavior Science
2632	Sociologists, anthropologists and related professionals	31	Social & Behavior Science
2633	Philosophers, historians and political scientists	31	Social & Behavior Science
2634	Psychologists	31	Social & Behavior Science
2635	*Social work and counselling professionals*	*76*	*Social Services*

2636	Religious professionals	22	Humanities
2641	Authors and related writers	22	Humanities
2642	Journalists	21	Arts
2643	Translators, interpreters and other linguists	22	Humanities
2651	Visual artists	21	Arts
2652	Musicians, singers and composers	21	Arts
2653	Dancers and choreographers	21	Arts
2654	Film, stage and related directors and producers	21	Arts
2655	Actors	21	Arts
2656	Announcers on radio, television and other media	21	Arts
2659	Creative and performing artists not elsewhere classified	21	Arts
3111	Chemical / physical science technicians	44	Physical Science
3112	Civil engineering technicians	58	Architecture
3113	Electrical engineering technicians	52	Engineering
3114	Electronics engineering technicians	52	Engineering
3115	Mechanical engineering technicians	52	Engineering
3116	Chemical engineering technicians	52	Engineering
3117	Mining and metallurgical technicians	54	Production & Production Process
3118	Draughtspersons	58	Architecture
3119	*Physical and engineering science technicians not elsewhere classified*	*44*	*Physical Science*
3121	Mining supervisors	54	Production & Production Process
3122	Manufacturing supervisors	54	Production & Production Process
3123	Construction supervisors	58	Architecture
3131	Power production plant operators	52	Engineering
3132	Incinerator and water treatment plant operators	52	Engineering
3133	Chemical processing plant controllers	52	Engineering
3134	Petroleum and natural gas refining plant operators	52	Engineering
3135	Metal production process controllers	52	Engineering

3139	Process control technicians not elsewhere classified	52	Engineering
3141	Life science technicians (excluding medical)	42	Biological Science
3142	Agricultural technicians	62	Agricultural, Forestry & Fishery
3143	Forestry technicians	62	Agricultural, Forestry & Fishery
3151	Ships engineers	52	Engineering
3152	Ships deck officers and pilots	84	Transportation Services
3153	Aircraft pilots and related associate professionals	84	Transportation Services
3154	Air traffic controllers	84	Transportation Services
3155	Air traffic safety electronics technicians	84	Transportation Services
3211	Medical imaging and therapeutic equipment technicians	72	Health Science
3212	Medical and pathology laboratory technicians	72	Health Science
3213	Pharmaceutical technicians and assistants	72	Health Science
3214	Medical and dental prosthesis technicians	72	Health Science
3221	Nurses	72	Health Science
3222	Midwifery professionals	72	Health Science
3230	Traditional and complementary medicine associate professionals	72	Health Science
3240	Veterinary technicians and assistants	64	Veterinary Science
3251	Dental assistants and therapists	72	Health Science
3252	Health registration officer and technicians	72	Health Science
3253	Health officers of society	76	Social Services
3254	Dispensing opticians	72	Health Science
3255	Physical therapists	72	Health Science
3256	Medical assistants	72	Health Science
3257	Environmental and occupational health inspectors and associates	85	Environmental Protections
3258	Ambulance workers	72	Health Science
3259	Health associate professionals not elsewhere classified	72	Health Science
3311	Securities and finance dealers and brokers	34	Business
3312	Credit and loans officers	34	Business
3313	Accounting associate professionals	34	Business

3314	Math and statistics professionals	46	Math & Statistics
3315	Valuers and loss assessors	34	Business
3321	Insurance representatives	34	Business
3322	Commercial sales representatives	34	Business
3323	Buyers	34	Business
3324	Trade brokers	34	Business
3331	Clearing and forwarding agents	34	Business
3332	*Conference and event planners*	*34*	*Business*
3333	Employment agents and contractors	34	Business
3334	Real estate agents and property mangers	34	Business
3339	Business services agents not elsewhere classified	34	Business
3341	Office supervisors	34	Business
3342	Legal secretaries	34	Business
3343	Administrative and executive secretaries	34	Business
3344	Medical secretaries	34	Business
3351	Customs and border inspectors	38	Law
3352	Government tax and excise officials	38	Law
3353	Government social benefits officials	38	Law
3354	Government licensing officials	38	Law
3355	Police inspectors and detectives	86	Safety Services
3359	Regulatory government associate professionals not elsewhere classified	86	Safety Services
3411	Legal and related associate professionals	38	Law
3412	Social work associate professionals	76	Social Services
3413	Religious associate professionals	22	Humanities
3421	Athletes and sports players	81	Personal Services
3422	Sport coaches, instructors and officials	81	Personal Services
3423	Fitness and recreation instructors and program leaders	81	Personal Services
3431	Photographers	21	Arts
3432	Interior designers and decorators	58	Architecture
3433	Gallery, museum and library technicians	32	Journalism & IT
3434	Chefs	81	Personal Services
3435	Arts related workers	21	Arts
3511	Information and communication technology operations technicians	52	Engineering
3512	Information and communication	52	Engineering

	technology user support technicians		
3513	Computer network and systems technicians	48	Computer
3514	Web technicians	48	Computer
3521	Broadcasting and audio-visual technicians	21	Arts
3522	Telecommunications engineering technicians	52	Engineering
4110	General office clerks	34	Business
4120	General secretaries	34	Business
4131	Typists and word processing operators	34	Business
4132	Data entry clerks	34	Business
4211	Bank tellers and related clerks	34	Business
4212	*Bookmakers, croupiers and related gaming workers*	*34*	*Business*
4213	Pawnbrokers and money-lenders	34	Business
4214	Debt collectors and related clerks	34	Business
4221	Travel consultants and clerks	81	Personal Services
4222	Contact center information clerks	34	Business
4223	Telephone switchboard operators	34	Business
4224	Hotel receptionists	81	Personal Services
4225	Enquiry clerks	34	Business
4226	Receptionists (general)	34	Business
4227	*Survey and market research interviewers*	*34*	*Business*
4229	Client information workers not elsewhere classified	34	Business
4311	Accounting and bookkeeping clerks	34	Business
4312	Statistical, finance and insurance clerks	34	Business
4313	Payroll clerks	34	Business
4321	Stock clerks	34	Business
4322	Production clerks	34	Business
4323	Transport clerks	34	Business
4411	Library clerks	32	Journalism & IT
4412	Mail carriers and sorting clerks	34	Business
4413	*Coding, proof-reading and related clerks*	*34*	*Business*
4414	*Form-filling clerks*	*34*	*Business*
4415	*Filing and copying clerks*	*34*	*Business*
4416	Personnel clerks	34	Business
4419	Other clerks	34	Business
5111	Travel attendants and travel stewards	84	Transportation Services
5112	Transport conductors	84	Transportation

			Services
5113	Travel guides	81	Personal Services
5120	Cooks	81	Personal Services
5131	Waiters	81	Personal Services
5132	Bartenders	81	Personal Services
5141	Hairdressers	81	Personal Services
5142	Beauticians and related workers	81	Personal Services
5151	Cleaning and housekeeping supervisors in offices, hotels and other local kinds of activity units	81	Personal Services
5152	Domestic housekeepers	81	Personal Services
5153	Building caretakers	81	Personal Services
5161	Astrologers, fortune-tellers and related workers	22	Humanities
5162	Personal service staffs	81	Personal Services
5163	Undertakers and embalmers	81	Personal Services
5164	Pet groomers and animal care workers	64	Veterinary Science
5165	Driving instructors	81	Personal Services
5169	Personal services workers not elsewhere classified	81	Personal Services
5211	Stall and market salespersons	34	Business
5212	Street food salespersons	34	Business
5221	Shopkeepers	34	Business
5222	Shop supervisors	34	Business
5223	Shop sales assistants	34	Business
5230	Cashiers and ticket clerks	34	Business
5241	Fashion and other models	21	Arts
5242	Sales demonstrators	34	Business
5243	Door to door salespersons	34	Business
5244	Contact center salespersons	34	Business
5245	Service station attendants	34	Business
5246	Food service counter attendants	34	Business
5249	Sales workers not elsewhere classified	34	Business
5311	Childcare workers	76	Social Services
5312	Teachers aides	14	Education
5321	Health care assistants	72	Health Science
5322	Home-based personal care workers	81	Personal Services
5329	Personal care workers in health services not elsewhere classified	72 / 81	Health Science / Personal Services
5411	Fire-fighters	86	Safety Services
5412	Police officers	86	Safety Services
5413	*Prison guards*	*86*	*Safety Services*
5414	Security guards	86	Safety Services
5419	Protective services workers not	86	Safety Services

	elsewhere classified		
6111	Field crop and vegetable growers	62	Agricultural, Forestry & Fishery
6112	Tree and shrub crop growers	62	Agricultural, Forestry & Fishery
6113	Gardeners, horticultural and nursery growers	62	Agricultural, Forestry & Fishery
6114	Mixed plants producers	62	Agricultural, Forestry & Fishery
6121	Livestock and dairy producers	62	Agricultural, Forestry & Fishery
6122	Poultry producers	62	Agricultural, Forestry & Fishery
6123	Apiarists and sericulturists	62	Agricultural, Forestry & Fishery
6129	Animal producers not elsewhere classified	34	Business
6130	Mixed crop and animal producers	62	Agricultural, Forestry & Fishery
6210	Forestry and related workers	62	Agricultural, Forestry & Fishery
6221	Aquaculture workers	62	Agricultural, Forestry & Fishery
6222	Fishery workers	62	Agricultural, Forestry & Fishery
6223	Deep sea fishery workers	62	Agricultural, Forestry & Fishery
6224	Hunters and trappers	62	Agricultural, Forestry & Fishery
6310	Plants producers	62	Agricultural, Forestry & Fishery
6320	Herdsman	62	Agricultural, Forestry & Fishery
6330	Plants producers and herdsman	62	Agricultural, Forestry & Fishery
6340	Plants producers, herdsman, and	62	Agricultural,

	fishermen		Forestry & Fishery
7111	Construction workers	58	Architecture
7112	Bricklayers and related workers	58	Architecture
7113	Stonemasons, stone cutters, splitters and carvers	58	Architecture
7114	Concrete placers, concrete finishers and related workers	58	Architecture
7115	Carpenters and joiners	58	Architecture
7119	Building frame and related trades workers not elsewhere classified	58	Architecture
7121	Roofers	58	Architecture
7122	Floor layers and tile setters	58	Architecture
7123	Plasterers	58	Architecture
7124	Insulation workers	58	Architecture
7125	Glaziers	58	Architecture
7126	Plumbers and pipe fitters	58	Architecture
7127	Air conditioning and refrigeration mechanics	58	Architecture
7131	Painters and related workers	58	Architecture
7132	Spray painters and varnishers	58	Architecture
7133	Building structure cleaners	58	Architecture
7211	Metal moulders and coremakers	52	Engineering
7212	Welders and flame cutters	52	Engineering
7213	Sheet metal workers	52	Engineering
7214	Structural metal preparers and erectors	52	Engineering
7215	Riggers and cable splicers	52	Engineering
7221	Blacksmiths, hammersmiths and forging press workers	52	Engineering
7222	Toolmakers and related workers	52	Engineering
7223	Metal working machine tool setters and operators	52	Engineering
7224	Metal polishers, wheel grinders and tool sharpeners	52	Engineering
7231	Motor vehicle mechanics and repairers	52	Engineering
7232	Aircraft engine mechanics and repairers	52	Engineering
7233	Agricultural and industrial machinery mechanics and repairers	52	Engineering
7234	Bicycle and related repairers	52	Engineering
7311	Precision-instrument makers and repairers	52	Engineering
7312	Musical instrument makers and tuners	54	Production & Production Process
7313	*Jewelry and precious metal*	*54*	*Production &*

	workers		*Production Process*
7314	Potters and related workers	54	Production & Production Process
7315	Glass makers, cutters, grinders and finishers	54	Production & Production Process
7316	Sign writers, decorative painters, engravers and etchers	54	Production & Production Process
7317	Handicraft workers in wood, basketry and related materials	21	Arts
7318	Handicraft workers in textile, leather and related materials	21	Arts
7319	Handicraft workers not elsewhere classified	21	Arts
7321	Pre-press technicians	21	Arts
7322	Printers	21	Arts
7323	Print finishing and binding workers	21	Arts
7411	Building and related electricians	52	Engineering
7412	Electrical mechanics and fitters	52	Engineering
7413	Electrical line installers and repairers	52	Engineering
7421	Electronics mechanics and servicers	52	Engineering
7422	Information and communications technology installers and servicers	52	Engineering
7511	Butchers, fishmongers and related food preparers	81	Personal Services
7512	Bakers, pastry-cooks and confectionery makers	81	Personal Services
7513	Dairy product makers	81	Personal Services
7514	Fruit, vegetables and related preservers	81	Personal Services
7515	Food and beverage tasters and graders	81	Personal Services
7516	Tobacco leaf producers	54	Production & Production Process
7521	Wood dying and chemical treatment workers	52	Engineering
7522	Cabinet makers and related workers	52	Engineering
7523	Wood workers	52	Engineering
7531	Tailors, dressmakers, furriers and hatters	21	Arts
7532	Garment and related patternmakers and cutters	21	Arts

7533	Seamstress	21	Arts
7534	Upholsterers and related workers	54	Production & Production Process
7535	Pelt dressers, tanners and fellmongers	54	Production & Production Process
7536	Shoemakers and related workers	54	Production & Production Process
7542	Shotfirers and blasters	54	Production & Production Process
7543	Product graders and testers (excluding food and beverages)	34	Business
7544	Fumigators and other pest and weed controllers	62	Agricultural, Forestry & Fishery
7549	Craft and related workers not elsewhere classified	52	Engineering
8111	Miners and quarriers	54	Production & Production Process
8112	Mineral and stone processing plant operators	54	Production & Production Process
8113	Well drillers and borers and related workers	54	Production & Production Process
8114	Cement, stone and other mineral products machine operators	54	Production & Production Process
8121	Metal processing plant operators	54	Production & Production Process
8122	Steel processing plant operators	54	Production & Production Process
8131	Chemical products plant and machine operators	54	Production & Production Process
8132	Photographic products machine operators	54	Production & Production Process
8141	Rubber products machine operators	54	Production & Production Process
8142	Plastic products machine operators	54	Production & Production Process
8143	Paper products machine operators	54	Production & Production

			Process
8151	Fiber preparing, spinning and winding machine operators	54	Production & Production Process
8152	Weaving and knitting machine operators	54	Production & Production Process
8153	Sewing machine operators	54	Production & Production Process
8154	Bleaching, dyeing and fabric cleaning machine operators	54	Production & Production Process
8155	Fur and leather preparing machine operators	54	Production & Production Process
8156	Shoemaking and related machine operators	54	Production & Production Process
8157	*Laundry machine operators*	*54*	*Production & Production Process*
8159	Textile, fur and leather products machine operators not elsewhere classified	54	Production & Production Process
8160	Food and related products machine operators	54	Production & Production Process
8171	Pulp and papermaking plant operators	54	Production & Production Process
8172	Wood processing plant operators	54	Production & Production Process
8181	Glass and ceramics plant operators	54	Production & Production Process
8182	*Steam engine and boiler operators*	*54*	*Production & Production Process*
8183	*Packing, bottling and labelling machine operators*	*54*	*Production & Production Process*
8189	Machine controllers	52	Engineering
8211	Mechanical machinery assemblers	52	Engineering
8212	Electrical and electronic equipment assemblers	52	Engineering
8219	Assemblers not elsewhere classified	52	Engineering
8311	Locomotive engine drivers	84	Transportation Services

8312	Railway brake, signal and switch operators	84	Transportation Services
8321	Motorcycle drivers	84	Transportation Services
8322	Car, taxi, van and motorcycle drivers	84	Transportation Services
8331	Bus and tram drivers	84	Transportation Services
8332	Heavy truck and lorry drivers	84	Transportation Services
8341	Mobile farm and forestry plant operators	54	Production & Production Process
8342	Earthmoving and related plant operators	54	Production & Production Process
8343	Crane, hoist and related plant operators	54	Production & Production Process
8344	Lifting truck operators	54	Production & Production Process
8350	Ships deck crew and related workers	84	Transportation Services
9111	Domestic cleaners and helpers	81	Personal Services
9112	Cleaners and helpers in offices, hotels and other local kinds of activity units	81	Personal Services
9121	Hand wash labors	81	Personal Services
9122	Vehicle cleaners	81	Personal Services
9123	Window cleaners	81	Personal Services
9129	Other cleaning workers	81	Personal Services
9211	Crop farm laborers	62	Agricultural, Forestry & Fishery
9212	Livestock farm laborers	62	Agricultural, Forestry & Fishery
9213	Mixed crop and livestock farm laborers	62	Agricultural, Forestry & Fishery
9214	Garden and horticultural laborers	62	Agricultural, Forestry & Fishery
9215	Forestry laborers	62	Agricultural, Forestry & Fishery
9216	Fishery and aquaculture laborers	62	Agricultural, Forestry & Fishery
9311	Mining and quarrying laborers	54	Production &

			Production Process
9312	Civil engineering laborers	52	Engineering
9313	Building construction laborers	54	Production & Production Process
9321	Hand packers	54	Production & Production Process
9329	Manufacturing laborers not elsewhere classified	54	Production & Production Process
9331	Hand and pedal vehicle drivers	54	Production & Production Process
9332	*Animal vehicle drivers*	*54*	*Production & Production Process*
9333	Freight handlers	54	Production & Production Process
9334	Shelf fillers	54	Production & Production Process
9411	Fast food cookers	81	Personal Services
9412	Kitchen helpers	81	Personal Services
9520	Sellers along roads (except ready to eat food)	34	Business
9611	Garbage and recycling collectors	54	Production & Production Process
9621	*Messengers, package deliverers and luggage porters*	*34*	*Business*
9622	Odd job persons	81	Personal Services
9623	*Meter readers and vending-machine collectors*	*34*	*Business*
9629	*Elementary workers not elsewhere classified*	*34*	*Business*

Source: Ministry of Labor (2015)

Note: Italic is author's subjective judgement on which majors were the best match with occupations

Appendix 7: Lincom Results

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Vocational			Bachelor			Post Graduate Education		
	All	Male	Female	All	Male	Female	All	Male	Female
Education	-0.253***	-0.242**	-0.269***	-0.319***	-0.323***	-0.324***	-0.153***	-0.117***	-0.182***
	(0.064)	(0.115)	(0.078)	(0.011)	(0.018)	(0.013)	(0.022)	(0.035)	(0.028)
Arts	-0.103	-0.110		-0.029	-0.068	-0.010	0.160	0.175	
	(0.135)	(0.140)		(0.039)	(0.050)	(0.066)	(0.232)	(0.245)	
Humanities				-0.076	0.181	-0.287***	0.617**		0.667**
				(0.081)	(0.134)	(0.102)	(0.282)		(0.274)
Social & Behavior Science	-0.450	-0.490		-0.174***	-0.148***	-0.233***	-0.076***	-0.097**	-0.068
	(0.459)	(0.477)		(0.033)	(0.043)	(0.053)	(0.029)	(0.039)	(0.047)
Journalism & IT				0.100**	0.083	0.106**	0.185		0.252
				(0.046)	(0.100)	(0.051)	(0.282)		(0.274)
Business	-0.153***	-0.198***	-0.138***	-0.112***	-0.109***	-0.128***	-0.117***	-0.154***	-0.094***
	(0.013)	(0.028)	(0.013)	(0.008)	(0.014)	(0.010)	(0.016)	(0.025)	(0.020)
Law				-0.090***	-0.024	-0.260***	-0.316***	-0.349***	-0.282***
				(0.023)	(0.029)	(0.042)	(0.046)	(0.060)	(0.075)
Biological Science				0.103	0.103	0.102	-0.082	-0.225	0.058
				(0.091)	(0.152)	(0.113)	(0.201)	(0.296)	(0.275)
Physical Science				-0.223***	-0.138	-0.270***	-0.148	-0.236	-0.160
				(0.082)	(0.151)	(0.097)	(0.115)	(0.294)	(0.124)
Math & Statistics				0.216	0.365	0.120			
				(0.174)	(0.277)	(0.223)			
Computer	-0.047	-0.089	-0.003	-0.329***	-0.293***	-0.381***	-0.277***	-0.275***	-0.286***
	(0.114)	(0.158)	(0.160)	(0.026)	(0.035)	(0.043)	(0.062)	(0.085)	(0.093)

Engineering	-0.089***	-0.093***	-0.195**	-0.063***	-0.070***	-0.104*	-0.248***	-0.263***	-0.151
	(0.011)	(0.011)	(0.076)	(0.015)	(0.017)	(0.060)	(0.044)	(0.050)	(0.109)
Production & Production Process	-0.166	-0.621***	0.110	-0.321***	-0.394***	-0.276**			
	(0.128)	(0.209)	(0.156)	(0.069)	(0.092)	(0.119)			
Architecture	-0.100***	-0.085**	-0.326***	0.005	0.036	-0.213***	0.006	0.002	
	(0.032)	(0.035)	(0.120)	(0.029)	(0.033)	(0.077)	(0.095)	(0.098)	
Agricultural, Forestry & Fishery	-0.169***	-0.166***	-0.101	-0.067***	-0.030	-0.130***	0.082	0.155	0.018
	(0.050)	(0.057)	(0.118)	(0.026)	(0.033)	(0.042)	(0.073)	(0.107)	(0.100)
Veterinary Science				0.091	0.076	0.086	-0.035		
				(0.206)	(0.240)	(0.445)			
Personal Services	-0.057	-0.035	-0.067	-0.008	-0.067	-0.010			
	(0.049)	(0.120)	(0.050)	(0.034)	(0.067)	(0.040)			
Observations	18408	10596	7812	62056	23002	39054	10989	4879	6110

Notes: *** p<0.01 ** p<0.05 *
p<0.1

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