THE EFFECTS OF UNIVERSITY EDUCATION ON INFORMAL EMPLOYMENT AND EARNINGS: EVIDENCE FROM THAILAND

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Abstract

Informal employment refers to work that falls outside the purview of official regulation. It plays a role in absorbing excess labor and offers employment flexibility. However, many informal activities are associated with reduced tax revenues and a lack of social security. As numerous formal sector jobs require a university degree, policymakers consider the provision of university education a policy instrument for reducing participation in the informal sector. This study aims to examine whether and to what extent university expansion policy affects university attainment, informal employment, and earnings.

The study estimates the effects of university opening in Thailand between 2004 and 2005 on university completion and informal employment. Using a difference-in-differences approach, we exploit the variation in university expansion exposure across provinces and birth cohorts as an exogenous source of university attainment variation. We find that the university expansion policy increases women's and men's university completion rates by 6% and 4%, reducing men's self-employment and agricultural work by 1–2% but has almost no impact on women. Although the increase in men's university containment is too small to apply instrumental-variable (IV) estimation, the enormous rise in women's university graduation in response to the university expansion is sufficiently significant. Women's IV results suggest that a university degree significantly reduces their irregular work and broadly-defined informality by 81% and 73%, respectively.

The results show profound gender differences in adjusting career choices for the university expansion. The opening shifts women from informal service sectors to formal jobs in education or public administration. In contrast, men tend to change employment status within the informal sector instead of moving to the formal sector. The data suggest many men leave agricultural sectors but remain working part-time.

The study expands the difference-in-differences approach to examining the heterogeneous effects of university opening by field of study. The results suggest that the university expansion policy induces workers not majoring in science, technology, engineering, and health/medicine (non-STEM majors) to leave informal jobs for higher pay in the formal sector. Every 10-ppts increase in university opening intensity reduces informality by 3% or less for young women and no more than 7% for young men. It increases women's and men's formal-sector hourly wages by 1%.

In contrast, the university opening induces young workers in STEM fields to work informally, and the effects are more evident for women than men. Every 10-ppts increase in university expansion intensity *increases* women's informality by 6–21% if in STE-majors (including science, technology, and engineering while excluding health/medicine fields) and by 20–50% if in health majors. The same estimates are below 8% for men in STE fields and 41% or less for those in health fields. Also, the university expansion decreases the university education returns for those in STEM fields. These counterintuitive results are because workers whose education choices would comply with a university opening tend to be particularly low in skills.

Most STEM university graduates work in non-STEM occupations. Compared to STEM occupations, those non-STEM jobs do not pay well even in the formal sector. Low

monetary payoffs to a university degree or a formal job have pushed many STEM workers into the informal sector. According to the previous literature, an increase in informal employment among STEM university graduates could result from a shortage of desirable STEM jobs (Cappelli, 2015), a mismatch between imported technologies and local STEM workers' skills (Acemoglu and Zilibotti, 2001), or skill obsolescence due to rapid technological changes (Deming and Noray, 2020).

Finally, the finding that university expansion successfully improves educational opportunities but has a limited effect on the informal sector's size raises concerns about whether the university expansion has effectively improved the labor market conditions.

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Chapter 1

Introduction

1.1 Motivation

Informal economies consist of workers without social protection and enterprises that do not contribute to social security, with both operating outside the tax system.[1] More than 60% of the world's employed population works in the informal sector. Statistics of the International Labor Organization (ILO, 2018b) show that approximately 90% of informal workers are in emerging or developing countries and that informal employment dominates most emerging economies. Although informal employment plays an essential role in absorbing excess labor and reducing unemployment,[2] this sizable informality might be a problem because it entails tax erosion and a lack of social security. The informal sector distorts tax collection, which results in the government imposing higher tax rates on the formal sector to sustain revenues. Also, labor laws and mandatory social security systems cannot fully cover informal workers who are subject to risky working conditions and unfair payments.[3] As the sizable informality may hinder economic

[1] The International Labor Organization (ILO, 2018a) defines informal workers as those whose "employment relationship is, in law or in practice, not subject to national labor legislation, income taxation, social protection or entitlement to certain employment benefits."

[2] Mottaleb and Sonobe (2013) suggest that informal employment is the primary driver for economic growth in East Asia's developing countries.

[3] International organizations have suggested policies to curb the issues concerning informality. The ILO has proposed measures to promote and realize the fundamental principles and rights at work for those in the informal economy and provide social security, maternity protection, and decent working conditions to all workers. It has also suggested that governments impose a minimum wage to support workers' living costs (ILO, 2015). Additionally, the World Bank has recommended policies, such as administrative simplification and registration cost reduction, to reduce formalization barriers. Its recommendations also promote access to financial support, information, and advisory services for businesses in the informal sector (World Bank, 2012).

development in the long run, downsizing the informal sector is a challenge for policymakers.

Decisions to enter the informal sector are idiosyncratic, although statistics have shown that informal workers earn as much as formal workers with similar traits (Pratap and Quintin, 2006). Some people may choose to work informally because the cost of formalization outweighs its benefits.[4] Informal work also offers flexibility and autonomy (Perry et al., 2007). Others might exit the formal economy due to a lack of credentials, such as a university degree, typically required for entering the formal labor market. As most formal jobs require a university degree, higher education provision becomes an alleged determinant for reducing informal sector employment.

1.2 The Niche and the Contribution of this Study

Most past studies on formalization-promoting policies have focused on *firm-based* decisions (e.g., Bruhn, 2011, 2013; Bruhn and McKenzie, 2014; Benhassine et al., 2018; Ulyssea, 2018). These studies find that the policies—such as increasing auditing or reducing registration fees or payroll taxes—lead to only a modest increase in business registration; they do not necessarily benefit the regulations-complying businesses after the transition but reduce the incumbent businesses' profits. Less attention has been paid to the *job-based* individualistic decision of whether to work formally or informally. Only one previous study that we are aware of has investigated workers' career choices concerning working in the formal and informal sectors. Meghir et al. (2015) find that tighter enforcement on formal firms that hire informal workers does not increase

[4] This could be because regulation might be too burdensome or because of state inefficiency or low institutional capacity, as they limit the benefits of formalizing. Regulation and tax evasion might be viewed as justifiable if the government is unable to realize the benefits of the tax collection or regulatory implementation.

unemployment and wages or improve working conditions. However, they have focused only on low-skilled, homogeneous workers in their study.

This dissertation is the first in the literature to investigate whether university expansion shifts the workforce's educational levels and sectoral choices using data from one of the largest informal economies, Thailand, with 56% of employees working informally (NSO, 2018). Assessing the effect of education expansion policy is challenging because community background and an individual's unobserved factors, such as ability and family background, can influence educational and career decisions.[5] The large-scale university expansion between 2004 and 2005 in Thailand offers a unique quasi-experimental research design. This study exploits the variation in university expansion exposure across provinces to identify the causal impact of the opening of new universities on the decisions to complete a university degree and work in the informal sector through a difference-in-differences estimation strategy. The estimated results could imply the causal interpretation for the effect of a university degree on informal employment. Additionally, the study examines whether the university expansion policy has different effects on university attainment by the field of major.

1.3 Summarizing the Findings

Chapter 2 applies a difference-in-differences approach by utilizing the variation in university expansion exposure across provinces and birth cohorts. The estimates suggest that university expansion affects younger cohorts' educational and career

[5] High-ability persons who self-select into universities have more job opportunities in the formal sector. The omission of unobservable ability could overestimate a university degree's causal impact on formal employment. On the other hand, those with a family business in the informal sector tend to continue working informally despite having a bachelor's degree, leading to an understatement of the causal impact. Overlooking these self-selection biases could lead to understating the impact of a university degree on formal employment.

decisions in provinces with a high university opening intensity. The university expansion significantly raises women's and men's university completion rates by 6% and 4%, respectively (first-stage results). It also increases the chances of completing overall higher education by 4% for women but not for men. We find no evidence that people switch from vocational to university education. Moreover, the university expansion policy reduces only men's self-employment and agricultural work by 1–2%. Its impacts on other informal employment measures of men and on women's informality are statistically insignificant (reduced-form results).

The ordinary least squares (OLS) estimates on the effect of a university degree on informal employment appear to be overstated compared to the reduced-form results, suggesting a necessity in applying the rigorous econometric strategy in estimating the effect of education on labor market outcomes. We cannot estimate the causal effect of university completion on *men's* informal employment because of weak first-stage and invalid exogeneity conditions for an instrumental variable (IV) method. Nevertheless, we can adopt the university opening intensity as an IV to estimate the university completion impact on *women's* informality. The IV estimates suggest that a university degree substantially reduces irregular work and broadly defined informal employment for women by 81% and 73%, respectively. Moreover, the university opening induces women to move from informal jobs in service industries to formal employment in public or education industries. We find little evidence that the policy impact results from migration.

Chapter 3 further examines whether the effects of university opening on labor market outcomes vary with the field of study, using a difference-in-differences method. The university opening policy induces young individuals in a certain field to complete a university degree in their field of study, except for women in health majors. It reduces

informal employment and increases formal-sector earnings for individuals in non-STEM majors. Among individuals with non-STEM background, every 10-ppts increase in university opening intensity reduces women's informality by 1–3 %, except for agricultural and part-time work, and decreases men's self-employment and agricultural employment by 3% and 7%, respectively. Additionally, the same impact increases hourly wages for women and men in the formal sector by about 1%.

In contrast, the university opening induces individuals in STEM majors to work in the informal sector, and the estimates are more explicit for STEM women than men. For women, every 10-ppts increase in university expansion intensity increases all types of informality by 6–21% if in STE-majors and by 20–50% if in health majors. For men in STE majors, the estimates are only statistically significant for agriculture and private-sector work, and the effects of a 10-ppts increase are below 8%. The same change increases informality for men in health majors by up to 41%.

We find that 54% of STEM university graduates work in non-STEM occupations. The university opening induces STEM individuals to work in non-STEM jobs in the informal sector, especially in the agricultural sector, partly because non-STEM jobs in the formal sector do not yield monetary benefits. Additionally, past studies have noted that the problem related to an increase in informal employment among individuals in STEM majors could result from a shortage of desirable STEM jobs (Cappelli, 2015), technology–skill mismatch (Acemoglu and Zilibotti, 2001), and skill obsolescence due to rapid technological changes (Deming and Noray, 2020).

1.4 Related Literature

Most empirical studies investigating the effects of higher education policy on educational and labor market outcomes have concentrated on developed countries. For example, Walker and Zhu (2008) and Devereux and Fan (2011) examine how higher education expansion in the United Kingdom affects an individual's earnings. Oppedisano (2011) evaluates the impact of higher education expansion in Italy on the enrollment and dropout rates and academic performance (the number of exams passed). Oppedisano (2014) further investigates the effect of the same policy on unskilled labor market outcomes and found no significant impact on employment, unemployment, and hourly wages. Additionally, several researchers analyze the effect of the availability of higher educational opportunities on education attainment (Currie and Moretti, 2003; Carneiro et al., 2011; Nybom, 2017).

Related studies in the developing world have utilized data from China and Russia and focused primarily on an individual's earning and labor force participation. Using data from China, Meng et al. (2013) and Xing et al. (2018) show that although gaining a higher education degree could significantly raise an individual's income, rapid higher education expansion is associated with an increase in unemployment rates among new college graduates. Kyui (2016) finds a strong, positive impact of higher education expansion on Russia's employment and wages.

1.4.1 The Effects of University Education on Non-Pecuniary Labor Market Outcomes

Intensive studies on the non-pecuniary effects of university education have noted that more educated people tend to make better decisions and have better life outcomes.

The overall increase in education has spillover effects on the economy (e.g., Acemoglu and Angrist, 1999; Moretti, 2004).[6] Moreover, empirical works related to labor market outcomes have suggested that higher-educated people are more likely to get a job (Cellini and Chaudhary, 2011; Jepsen, Troske, and Coomes, 2014) and have more job security (Kariya, 2011) than their less-educated counterparts. College graduates have higher job satisfaction than high school graduates do, although they tend to find their personal lives somewhat unsatisfying because of having no time for leisure activities (Oreopoulos and Salvanes, 2011). Notably, these studies have used data from developed countries, where career choice between formal and informal employment is not a concern. See, for example, Oreopoulos and Petronijevic (2013) for comprehensive reviews.

The non-monetary effects of university education in emerging economies have been somewhat overlooked, and past studies have also found mixed results. Kyui (2016) indicates that higher education attainment increases the chances of being employed. In contrast, most research utilizing China's data has suggested that completing higher education does not necessarily lead to better employment prospects; researchers have mostly found an increase in the unemployment rate among young college graduates (Meng et al., 2013; Li et al., 2014; Knight et al., 2017; Xing et al., 2018). These studies have still focused on individuals' labor force participation; the relative effect of education on formal versus informal employment is not their primary concern.

[6] Perez-Arce (2017) suggests that people who are more educated are more patient and tend to make better decisions, avoid risky behaviors, and have better life outcomes eventually. In addition, higher education can improve health, and this is transferrable to the next generation. De Walque (2007) shows that college graduates are less likely to smoke, and among those who smoke, they are more likely to stop. Buckles et al. (2016) explain that increasing the rate of college attainment would decrease the cumulative mortality rate because college-educated people tend to have healthy lifestyle behaviors and have greater access to financial and health resources. Currie and Moretti (2003) find a positive effect of maternal education on infant health, and suggest that the benefits of education can be transferred to the next generation. Moreover, the overall increase in highly educated individuals could benefit society due to the resultant improvement in civic participation and awareness (Dee, 2004) and economic performance (De Meulemeester and Rochat, 1995; Lin, 2004).

Past studies examining the linkage between higher education and informality are lacking. Jiménez et al. (2015) use country-level data (multi-country) and find that the informal entrepreneurship rate is negatively associated with tertiary education enrollment and is not affected by secondary education. They explain that secondary education does not provide sufficient management skills to help individuals cope with the complexities of setting up formal firms. Kolm and Larsen (2016) demonstrate that workers without tertiary education are more likely to work in the informal sector and that the availability of informal employment opportunities reduces any incentives to acquire higher education. To the best of our knowledge, only one study has estimated the effect of higher education on informal employment based on individual-level data. Kariya (2011) indicates that higher-educated people are more likely to get a full-time position, considered one kind of formal employment, with higher pay and more job security than their lower-educated counterparts are. However, this negative association is not necessarily causal because highly productive workers and those with a family business in the informal sector may self-select into the informal sector to avoid tax, regardless of whether they have a university degree or not.[7]

Surprisingly, almost no one has systematically analyzed the impact of a university degree on informal work in developing countries yet. With this paper, we aim to expand the understanding of how a university degree affects the personal decision to enter the informal sector, which is predominant in developing economies.

[7] See the evidence provided by Maloney (2004), Henley et al. (2009), and Günther and Launov (2012).

1.4.2 The Pecuniary Effects of University Education

Intensive empirical studies have estimated the pecuniary benefits of education, including the returns on both one additional year of schooling and a specific educational level, such as a university degree.[8] Evidence from the developed world has shown that an investment in university education yields a substantial return. Kane and Rouse (1995) find that bachelor's degree holders earn more than high school graduates with no post-secondary education, by 42% among men and 51% among women. Card (1995) shows that among individuals whose schooling is determined by a nearby college's presence, the return on education is about 12–14%. More recent research has further documented the returns on one additional year of higher education. For instance, Angrist and Chen (2011) find that the IV-estimated return on college ranges from 7.6% to 8.9% and is relatively higher than the estimated returns on schooling years. Doyle and Skinner (2016) show that each additional year of post-secondary attainment raises yearly earnings by 9.7%.

As studies on the return on education in the developed world have turned their attention to the university level, the literature has expanded to developing countries. However, the focus has remained mostly on primary/secondary education levels. The seminal work by Duflo (2001) examines primary school expansion in Indonesia and finds that the return on education is about 6.8% to 10.6%. Horowitz and Schenzler (1999) study the monetary returns to secondary education across genders and educational tracks in Suriname. Korwatanasakul (2019) estimates the returns on an additional year of schooling

[8] Whether the years of schooling or qualifications yield a higher benefit is unclear. Nevertheless, empirical works have shown that gaining qualifications has a larger effect on earnings compared to not having one, given equal years of schooling. For instance, Kane and Rouse (1995) show that receiving a college degree could yield higher earnings compared to having undergone equivalent years of schooling without completing a degree. Dickson and Smith (2011) find that, compared to the return on increased years of schooling, the returns on qualifications account for most of the returns on education and the labor market outcomes.

by exploiting the policy change in compulsory schooling in 1978, which relates only to the primary educational level.

Only two previous studies that we are aware of have attempted to examine higher education's economic benefits in Thailand. Hawley (2004) suggests that the yearly returns on education in the 1990s were 10% for men and 11% for women. The returns on university degree completion in addition to lower secondary school completion were as high as 260% for men and 322% for women. Using more recent data (2007–2010), Tangtipongkul (2015) finds that the return on a bachelor's degree is as high as 46%. However, these studies rely on OLS estimates using the Mincer earnings function; one problem is that the estimation often omits important unobservable variables, such as ability and family background. Omitting these variables leads to a biased assessment of the rate of return on education.

This study exploits the variation in university expansion exposure across provinces and uses a difference-in-differences approach to imply the causal effect of a university degree in a particular major on earnings. The findings contribute to the literature on the returns on education in Thailand, where university education's monetary benefits have remained unidentified.

1.4.3 The Developing World's Gender Gap in Education and Work

Many developing countries exhibit considerable gender inequality in education and employment, and the gaps discriminate against females. Grant and Behrman (2010) have shown that in the 1990s, much fewer girls attend schools, particularly in South Asia and Sub-Saharan Africa. The educational gaps narrow during the early 2000s, and women now have more chances to participate in the labor force. However, recent evidence from

the UNESCO Institute for Statistics (2019) shows that despite notable progress in ensuring universal educational access and completion, more girls than boys remain out of school.

The gender gap in educational attainment can have implications for labor market outcomes. Past studies have measured the return on investment in education and find that women receive a higher return on education than men in general. This finding reflects that females have lower base levels of education compared to males. See, for example, Psacharopoulos and Patrinos (2004; 2018) for comprehensive reviews. However, the higher return rate for women does not necessarily mean that women's wage is higher than men's; further, women often face unequal treatment on labor earnings.

Much of the research in the developing world has examined gender inequality in the labor markets and finds that the gender gap can be explained mainly by the difference in education and work experiences (Gustafsson and Li, 2000; Nordman et al., 2011; Canelas and Salazar, 2014; Lee and Wie, 2017). Although education helps narrow the gap, Yamamoto et al. (2019) find that well-educated females in Nepal's rural areas still lack employment opportunities and face significant unequal pays. Unlike research in developed countries, the developing world's studies neglect other sources of gender discrimination, such as academic majors and the role of parenthood.[9]

To fill the research gap in gender difference in the developing world, this study has examined whether the field of study affects university attainment decisions and career

[9] Regarding the literature on the gender wage disparities in developed countries, Black et al. (2008) find that one of the reasons behind the gender wage gap among the highly educated can be the college majors opted for. Women tend to choose subjects related to education, humanities, and fine arts, which are associated with lower-paying jobs after graduation. Goldin (2014) suggests that women in high-wage professions experience a wider gender gap because they are penalized for not working long. Women have to compromise with their working schedule due to other tasks, such as housework and child care.

choices differently for men and women. Table 1.1 indicates to what extent this study could fill the literature gaps.

1.5 Limitations

Given the limited number of observations in the *Informal Employment Survey*, the estimated effect of university completion on the official measure of informality, employment without social protection, is imprecise. Future research should re-estimate this part when the appropriate number of observations is available. Due to the limitation on earning data in the informal sector, this study cannot thoroughly examine how monetary factors affect an individual's education and career decisions. Future research should use more comprehensive data sources that include informal workers and further analyze the impact of other factors, such as desirable features of informal works and the issue of tax evasion. Additionally, this study has a limitation in accounting for the quality factors, although we note that university quality distorted due to rapid expansion could limit a university degree's effect on labor market performance. Lastly, the study solely uses Thailand's data. Therefore, the findings are highly context-specific, and generalizing the results and implications requires caution.

1.6 Organization of this Study

The dissertation is structured as follows: Chapter 2 describes the data and institutional details regarding the rapid university opening during 2004–2005 in Thailand and examines whether the university expansion affects individuals' educational attainment and career decisions. Chapter 3 estimates the heterogeneous effects of university opening on informal employment and earnings by gender and field of study.

Chapter 4 consists of the conclusion and a discussion on the policy implications and contributions.

TABLE 1.1 –LITERATURE GAP IN THE EFFECT OF UNIVERSITY EDUCATION ON LABOR MARKET OUTCOMES

	The effect of university education on employment	The effect of university education on earnings	The effect of university education on formal/informal employment	Gender difference in labor market outcomes (factor other than education)
Developed countries	Cellini and Chaudhary, 2011; Jepsen et al., 2014; Oppedisano, 2014	Kane and Rouse, 1995; Card, 1995; Walker and Zhu, 2008; Angrist and Chen, 2011; Carneiro et al., 2011; Devereux and Fan, 2011; Doyle and Skinner, 2016; Nybom, 2017	Kariya, 2011; Jiménez et al., 2015; Kolm and Larsen, 2016	Black et al., 2008; Goldin, 2014
Developing countries	Meng et al., 2013; Li et al., 2014; Kyui, 2016; Xing et al., 2018; Knight et al., 2017			
- Thailand		Hawley, 2004; Tangtipongkul, 2015		
- This study		Yes	Yes	Yes

Chapter 2

The Impact of University Opening on Informality and University Completion

A sizable informal sector implies lost tax revenue for the government and a lack of social safety nets for many workers. Consequently, enforcing tax compliance and easing entry into the formal sectors becomes one of the primary policy objectives. Past research has found that tax breaks and registration fee reduction are not cost-effective ways of downsizing the informal sector (see Section 1.3.1). Since formal jobs typically require a university degree, university education provision could be one policy tool for reducing informal work participation. Surprisingly, almost no one has systematically analyzed the effect of university expansion on informal employment in developing countries. With this chapter, we first fill this gap.

We examine whether the university openings between 2004 and 2005 have increased university completion and reduced informal employment in Thailand. Our empirical strategy utilizes the variation in exposure to the university expansion across birth cohorts and residential provinces. When the university expansion began, older cohorts who have completed university or passed the time for making the university-going decision could not benefit from the university expansion. In contrast, younger cohorts are more likely to change their educational and career decisions if they reside in the provinces with a higher number of university openings per local youth than in the regions with low or no university openings.

Our difference-in-differences estimates suggest that university expansion significantly increases women's and men's university completion rates by 6% and 4%, respectively. Surprisingly, our results also indicate that university expansion has little impact on informal employment. It reduces men's self-employment and agricultural work by only 1–2%, and the estimated impact on women informality is less than 1% and statistically insignificant. Further investigating the linkage between the university opening and career decisions, we find that the university opening induces women to move from informal jobs in service industries to formal employment in public or education industries. Men are less like to work informally in the agricultural sector; however, they appear to shift to informal jobs in other industries instead of entering the formal sector. We find little evidence that the policy impact results from migration.

The university expansion policy appears ineffective in reducing the informal sector's size possibly because the policy intensity is too low with less than 4 universities per million youths. Moreover, workers with university degrees may prefer to work informally to avoid regulation and taxation while enjoying desirable wage returns to education in the informal sector (Vivatsurakit and Vechbanyongratana, 2020) and flexible working conditions (Maloney, 1999). Another possibility is that the increased supply of university graduates fails to match the increased demand for high-skilled workers in quantity and quality. Social observers have concerns about low-quality education in universities (Kanjanapanyakom, 2011) and a weak university-industry linkage in curriculum design (Doner, Intarakumnerd, and Ritchie, 2013). Policies that intend to use university expansion as a remedy for large informal sectors require caution.

The rest of this chapter will unfold as follows: Section 2.1 describe the institutional details and data. Section 2.2 presents the identification strategy. Section 2.3 is devoted to

estimating the effects of university expansion on university completion and informal employment. Section 2.4 explores the potential mechanisms and Section 2.5 discusses the results.

2.1 Data and Institutional Details

2.1.1 Previous Reforms Before the University Expansion

Before Thailand's *Third National Economic Development Plan* (1972-1976), the secondary school enrollment rate was 11.2 percent because only large districts had secondary schools. During the *Third Plan,* the Ministry of Education opened 473 secondary schools in the district/subdistrict level (Nitungkorn, 1988). In 1978, the Thai government further expanded the four-year compulsory education to the entire country and extended it to six-years (Knodel, 1997). This extension was under the *Primary Education Act*, which required children aged eight years old to enroll in primary education until completing primary education (grade 6) or turning 15 (Nakavachara, 2010). In the same year, the government restructured vocational education by providing a three-year upper vocational stream, parallel to the general upper secondary education. The system also offered associate degree programs that lasted two to four years, parallel to university education.

Motivated by the 1997–1998 Asian financial crisis, the government undertook more educational reforms soon after the crisis. The most relevant to this study is the *National Education Act* of 1999, enforced in 2002. The *Act* institutionalized 12 years of free primary and secondary education, out of which the first nine years are compulsory. This reform eventually led to the 2004–2005 university expansion.

To minimize the early reforms' influences, we include the cohorts born after 1964 (aged less than 12 in 1976 or younger than 39 in 2003) because they were subject to the six-year compulsory education and the secondary school expansion. Both policies pave the way for these cohorts to pursue higher education, especially when a university is available nearby. One concern is that the nine-year compulsory education expansion in 2002 affects the cohorts born in 1987 or later. Our regression analysis addresses this problem by including cohort-fixed effects and pre-reform trends in flexible ways (see Sections 2.2-2.3).

2.1.2 University Expansion during 2004–2005

Thailand's higher education system makes a distinction between associate's and bachelor's degrees. An associate's degree requires two years of study in teachers' colleges or polytechnics, while a bachelor's degree generally requires four years of study in universities and institutes.[10] After completing a two-year higher education program at the associate's degree level, an additional two years can lead to a bachelor's degree.[11]

Public colleges and universities play a significant role in providing higher education. Before the university expansion, over 80% of the students pursuing a *university degree* attended public universities. Those seeking a *vocational diploma* mostly attended teachers' colleges (the Rajabhat Institutes) or polytechnics (the Rajamangala Institutes of Technology), both publicly funded.[12] In 2003, Thailand boasted 41 Rajabhat

[10] There are some exceptions. Five years of study are required for obtaining degrees in the fields of architecture, painting, sculpture, graphic arts, and pharmacy, and six years are required for degrees in medicine, dentistry, and veterinary science.

[11] The number of students enrolling for a two-year bachelor's degree program account for only 3% of the associate's degree graduates in 2003.

[12] In 1992, King Bhumibol Adulyadej changed the name of the teachers' colleges to Rajabhat Institutes. This was to task the Rajabhat Institutes with the provision of educational programs at all levels, the conduction of research for local development, and the promotion of the academic and professional status of teachers. Similarly, Rajamangala Institutes of Technology constituted a combination of different vocational colleges before His Majesty, the King bestowed this name in 1988.

Institutes and 55 Rajamangala Institutes of Technology. Before being elevated to university status in 2004–2005, these institutes had been granting bachelor's degrees to teachers (Crocco, 2018) to meet the increasing demand for higher education and the surge in number of teaching positions at both primary and secondary school levels after the compulsory education expansion in 1999.

Rapid and large-scale university expansion occurred in Thailand between 2004 and 2005. Upon the enactment of the *Rajabhat University Act* in 2004 and the *Rajamangala University of Technology Act* in 2005, nearly half of the Rajabhat Institutes and the Rajamangala Institutes of Technology combined to become full-fledged, autonomous public universities. They started offering bachelor's degree courses in multiple fields (no longer limited to the area of education). Figure 2.1(a) illustrates how the number of universities nearly doubled from 75 in 2003 to 133 in 2005. Among the 58 universities opening during this period, 49 were upgraded from the Rajabhat Institutes or the Rajamangala Institutes of Technology. The remaining were newly established universities, including three public and six private universities. Also, 47 out of the 58 new universities are located outside Bangkok and surrounding areas, suggesting that the university expansion, to some extent, reduces educational inequality across provinces.[13]

From 2003 to 2005, we saw a surge in the number of students pursuing a university degree. The enrollments rose by nearly 30% during the expansion period, from 381,582 in 2003 to 492,500 in 2005 (Ministry of Education, 2007). It is noteworthy that neither the free/compulsory education reform in 1999 nor the switch from a vocational diploma

[13] Since the 1960s, the government has been trying to spread out the university education provision by opening several regional universities. Most of them are located in the administrative center of each region of Thailand. The four oldest regional universities are the Chiangmai University in the north, KhonKaen University in the north-east, Prince of Songkhla in the south, and the Burapha University in the east. Still, before 2004, 39 out of the 75 universities are clustered in Bangkok and its vicinities.

to a university degree is a primary driver for that surge in university enrollments. Figure 2.1(b) shows that both the lower and upper secondary school enrollment rates have already increased smoothly before the 1999 reform. This trend suggests that education reforms have not drastically changed individuals' secondary education attainment. This figure also indicates a slight decline in associate's degree enrollment rates in 2005, but it is disproportionately small compared to the massive increase in university degree attendance. Although educational attainment increases at all levels over time, a noticeable increase in the enrollment rates appear only during the university expansion period. Overall, these trends suggest that the university expansion attracts individuals who would otherwise not have pursued higher education or attended university.

The university openings may have encouraged university attainment. Since the Rajabhat Institutes or Rajamangala Institutes of Technology offer mainly teacher training and technological education, new universities can offer a broader range of courses and degree programs. After gaining university status, these former institutes start offering diversified programs in different disciplines, such as public administration, business administration, and mass communication. More general university majors attract a broader range of people, including adult students and graduates from the non-formal education system.[14] Additionally, the Rajabhat and Rajamangala Universities provide bachelor's degree programs in the evenings and weekends to suit working adults.

Moreover, the local university openings may have induced university attainment because the cost of attendance decreases with university proximity. As most of the new universities are public-funded, most of the attendance cost involves boarding and

[14] A significant number of students are adults and those who have graduated from the non-formal system aiming to obtain a higher education degree from a Rajabhat University (Tangkitvanich and Manasboonphempool, 2011).

transportation fees. With a new university nearby, individuals who could previously not afford university education due to budget constraints now have better chances of attaining a university degree (Nitungkorn, 2001).

The reform of 2004–2005 entails the most rapid university expansion in Thailand, and it raises quality concerns even before the policy change. The *National Education Act* of 1999 and its second amendment of 2002 addressed higher education's quality concerns by requiring every higher educational institution to be controlled and evaluated by government agencies. The first external assessment during the period 2001–2005 indicates that the newly established public universities are underperforming (Kanjanapanyakom, 2011). Of the four quality grades (low, fair, good, and excellent), 75% of public universities receive a good/excellent rating. In contrast, only 35% of the Rajabhat and Rajamangala Universities receive such grades.

In addition to the unequal quality of education provided by the newly established and existing universities, the quality of enrollees across universities also differs as per centralized examination results. The university admission process in Thailand is centralized; a union examination is conducted, and all applicants receive standardized scores. After each applicant submits the test scores and prioritizes a set of chosen programs, the system allocates them to universities. The range of accepted students' admission scores reflects the programs' competitiveness and applicants' quality. Comparing the admission scores of similar programs in the same province, we observe that the public universities have higher scores than the Rajabhat and Rajamangala Universities.[15]

[15] Using the range of admission scores in the Business Administration programs of Phitsanulok province in 2008, we find that the range of Naresuan University is 4547–7032, while that of Pibulsongkram Rajabhat University is 3120–5149. In Chiang Rai province,

2.1.3 Defining the Policy Intensity Using Province-level Statistics

The average number of new universities established per province is 0.76, given 58 universities were established in 37 of the 76 provinces during the expansion period. This simple average might have understated the expansion intensity because the most openings are in populous areas. Using the labor force surveys sampling weights, we derive the *weighted* average, approximately 2.3 per province. To further account for the effect of the cohort size on the access to local universities, we define the *university expansion intensity* as the number of universities opened between 2004 and 2005 for every 10,000 individuals of 14–25 years in the province. The weighted and unweighted means of the expansion intensity are 0.054 and 0.039; that is, 4 to 5 new universities per million youths. We report these statistics in Table 2.1.

Table 2.1 also reports the provincial-level statistics of 2003, when the university expansion was about to start. We see only 15% of the young people of 18–21 years attend university then. The entire population has, on average, 5 years of schooling. This average is about 6% higher than schooling years in 2001. Moreover, 79% of the population participate in the Universal Health Coverage Scheme (UHCS). Pre-expansion Gross Provincial Product (GPP) per capita and minimum wages are 79,194 Baht and 138 Baht, respectively.

2.1.4 Allocation of the New Universities

To examine the endogeneity of the university opening, we empirically test if the new universities' allocation depends on the factors that may have affected both education

the score range of Mae Fah Luang University is 3539–6815, while that of Rajamangala University of Technology Lanna (Chiang Rai Campus) is 2944–5190.

and employment. These underlying factors include the local trends in education, macroeconomic conditions, and contemporaneous policies, such as the UHCS introduced in 2001. Before the enactment of the UHCS, only workers in the formal sector received health insurance coverage. After the UHCS was introduced, informal workers, who were previously ineligible for the coverage, started receiving the benefits, with a copay as low as 30 Baht (less than 1 US dollar).[16] Due to a reduction in the relative benefits of formal employment, which typically requires a university degree, the introduction of the UHCS might have deterred some individuals from investing in university education, thus understating the impact of the university expansion on university attainment.

To address this concern, we examine whether university expansion is associated with *pre-expansion* provincial conditions, including the size of the young population, university enrollment, education levels/growth, GPP per capita, minimum wage, UHCS participation, and average characteristics of individuals in the provinces. As shown in Table 2.2, new universities tend to be allocated to areas with a larger young population; they are not necessarily concentrated in more educated or wealthier regions. Column (1) shows that one university opening is associated with a 47% increase in the population aged 14–25. With this result, we scale down the number of new universities by the youth population size when defining university expansion intensity.

Columns (2)–(4) suggest that the university opening is strongly associated with the pre-expansion rates of enrollment in the bachelor's degree programs. However, it only weakly correlates with the average schooling level or the change in schooling years from

[16] Before the UHCS was introduced, Thailand had four healthcare schemes: the Medical Benefits Scheme (MBS) for civil servants and state enterprise employees; the Social Security Scheme (SSS) for private company employees; the Medical Welfare Scheme (MWS) for the poor and vulnerable citizens; and the Voluntary Health Card Scheme (VHCS) for households ineligible for other schemes who agree to purchase a one-year health insurance card at the price of 500 Baht. The UHCS amalgamates the MWS and the VHCS and allows individuals who are not eligible for the MBS and SSS to register themselves in the system at no cost. Moreover, individuals who were previously insured by the MWS do not have to pay a 30-Baht copay when receiving treatment.

2001 to 2003. These results reflect that Rajabhat and Rajamangala Institutes offered bachelor's degree courses for teachers even before they gained university status in 2004–2005. Consequently, the average education in the high-intensity provinces is slightly higher than in others. Although the estimate of the change in schooling years is not statistically significant, its magnitude is not negligible. Therefore, our specification must consider the province-level bachelor's degree enrollment rate and the growth in education levels before the expansion.

In contrast, Columns (5)–(7) indicate that the GPP per capita, minimum wage, and UHCS participation are uncorrelated with the new universities' allocation. Nevertheless, we have included these pre-expansion economic conditions in our model specifications. Furthermore, the university opening is independent of individual characteristics, such as gender, urban/rural area, and marital status.

2.1.5 Labor Force Surveys and Informality Measures

Our master data files are Thailand's *Labor Force Surveys* (LFS) between 2006 and 2018 and its supplemental data ─ *Informal Employment Surveys* (IES) between 2011 and 2016. We separately match these two surveys with the pre-expansion provincial data by each respondent's residential province. Both surveys are somewhat similar in structure and share the same set of individual demographics, such as age, gender, current residence, educational attainment, and employment status. The surveys further include information about their occupation, wages/salaries, and hours of work for employed people. Each survey interview covers approximately 80,000 household heads and members to form a representative sample of the Thai population.

The IES has the unique mission of evaluating the policy of extending the social security coverage to informal workers. The questionnaire contains a question directly asking whether or not the respondent has social security from work. This feature allows us to identify informal workers, defined as those under *employment without social protection* by ILO. Another distinction between the two surveys is in terms of the sample size. The IES collects data only in the third quarter of the year (July–September), and only data starting from 2011 is available. On the other hand, the LFS has been undertaken in four rounds/quarters every year since 1998. Consequently, the LFS offers a more extensive and longer time-series of repeated cross-sectional data, improving estimation precision.

In this dissertation, we have presented evidence of how university opening impacts informality. We first use the IES to examine the expansion's impact on employment without social protection. Next, we use the LFS on a list of alternative measures for informality. The list includes self-employment, agricultural work, part-time job, irregular employment, broadly defined informal employment, and private-sector employment. See Table A2.1 for a definition of each measure. [17, 18]

Our study focuses on individuals born between 1965 and 1992, aged 11–38 in 2003, including cohorts at the university-going ages before the university expansion started. We exclude those aged 24–27 in 2003 who are unresponsive to the university expansion, as our analysis in Section 2.2.1 shows. To focus on university education, we also exclude respondents below 22 years at the interview time because they would most

[17] The surveys only collect earning data from those workers classified as employees. Therefore, employers, self-employed persons, and unpaid family workers do not report earning data (including type and amount of earnings). Nevertheless, when defining *irregular employment*, which relies on information about the type of earnings (whether they receive earnings on a monthly basis), we classify these non-employee workers as irregular employment.

[18] There are some variable-coding changes across surveys. We have provided details on how we manage these different codes when constructing the key variables in Table A2.2.

likely not have completed a bachelor's degree by then. We drop unemployed respondents and those not in the labor force (e.g., students, homemakers, and retired people) and those with missing education or work status information. Furthermore, we exclude respondents who live in Buengkan province (established in 2011) due to missing values for most of the province-level variables. We also exclude those born between 1965 and 1972 in Sakaeo, Amnatcharoen, and Nongbualamphu provinces (established in 1993) because of missing information on provincial-specific population growth when the respondents were 25 years of age. After all these considerations, we extract 373,701 observations from the IES and 2,910,952 from the LFS.

Table 2.3 suggests that about 53% of the IES sample work in the informal sector. Based on the LFS, 47% of the sample are self-employed, while 30% work in the agricultural industry. Part-timers, who work fewer than 35 hours per week, account for only 15% of our sample. Employees in irregular employment, who are not paid regularly in the form of monthly salary, account for about 60% of the sample. Using a combination of the informal-employment-related variables to define informality, we find that approximately 70% of the workers in our data are self-employed persons, agricultural workers, part-timers, or irregular workers. Last, workers who are not employees of the government or state-owned enterprises account for 90% of the sample.

Overall, the descriptive statistics of the two surveys are comparable. Relative to the IES, the LFS has slightly lower self-employment and agricultural employment rates and a slightly higher part-time worker percentage. This difference in statistics between LFS and IES is a result of the seasonal agrarian labor movement. The IES collects data during the rainy season of the third quarter when farming dominates labor activities. The LFS collects data during the dry season when many workers must shift jobs or work part-

time temporarily. Nevertheless, these differences are marginal—less than three percentage points.

It is worth noting that the seven measures of *informal employment* positively correlate with one another. Of the workers with no social security coverage (measure 1), 91% are self-employed (measure 2), 51% work in the agricultural sector (measure 3), and 99% work in the private sector (measure 7). However, these measures do not entirely overlap. For instance, although 76% of part-time workers are self-employed, only 18% of the self-employed people work fewer than 35 hours per week. Estimates in Table A2.3 depict the relationship between employment with no social protection and other alternative measures. Most informal workers defined by alternative measures (79–97%) have reported no social security from employers. Each measure is strongly associated with employment that does not provide social security coverage. The results suggest that these alternative measures can serve as proxies for the officially defined measure of informality.

To provide insight into the economic activities in the informal and formal sectors, Table A2.4 lists the top 10 occupations in each industry. Here, we have defined informal employment using a broad definition of informality (measure 6). Most of the informal employment involves jobs in agriculture, forestry, or fishery. Others include street vendors, services workers, and workers employed in construction and manufacturing. Most of these jobs do not require an educational qualification higher than upper secondary school. On the contrary, formal employment typically requires more sophisticated knowledge, and workers should at least complete an associate's degree.[19] Out of the top

[19] The NSO categorizes the major groups of occupation into four skill levels, ranging from the lowest skill level of 1 to the highest of 4. The skill level 3 qualification is equivalent to an associate's degree level, while the skill level 4 qualification is equivalent to a

10 occupations in the formal sector, eight are high-skilled jobs in healthcare, teaching, science, and engineering fields.

We have provided information about high-skilled occupations in Table A2.5. Among occupations belong to three major groups: managers, professionals, and technicians, and associate professionals, which are scored 3–4 in terms of the NSO skill level. We define high-skilled occupations as those with hourly wages above the group average. Workers in high-skilled occupations are more likely to hold a university degree.

Furthermore, Table 2.3 demonstrates that 47% of the sample are women, 41% live in the urban area, and only 17% possess a bachelor's degree. Most of the workers have no education or have merely completed primary education. The average number of schooling years is 9.4–9.6 years, equivalent to completing a lower secondary education (free and compulsory to Thai citizens). Schooling above the secondary level is not mandatory, although free of charge up to the upper secondary level. The education distribution in our sample is consistent with that in the 2010 population and housing census.

2.1.6 The Social Protection Limited to Formal Sector Workers

The primary difference between formal and informal employment is as follows: Formal workers have access to a regular income, health insurance, unemployment benefits if they lose their jobs, and a pension when they retire, while workers in the informal economy lack access to social security protection. Social benefits, such as health insurance, allow workers to access affordable healthcare and help them quickly return to work. Also, unemployment and maternity benefits help people cope with a temporary loss

bachelor's degree level or above. This study defines occupations in skill levels 3 and 4 as high-skilled occupations. The NSO occupation groupings and scoring are consistent with the International Standard Classification of Occupation, provided by the ILO.

of income. Due to the lack of such support and benefits, illnesses, accidents, or unemployment can cause informal workers and their families to experience hardships.

Social security benefits provided by formal-sector employers may incentivize people to accept formal work in either the public or the private sector. Since a formal job typically requires a university degree, an individual may decide to obtain eligibility for a formal position. Although informal workers have no social protection through their work, they choose to participate in the voluntary social security system under Article 40 of the *Social Security Office (SSO) Act*, which is established mainly for them. However, social protection for informal workers does not include unemployment and maternity benefits. It also provides low old-age pension amounts since workers receive no additional contribution from employers.

Another channel for getting social security coverage is marriage with a formal-sector worker. However, this option is valid only if the spouse works in the public sector. Government and state enterprise employees have the right to receive medical expenses for themselves and their parents, spouse, and children.[20] Moreover, these workers can get their first three lawful children's tuition fees reimbursed (the children must be under 25 years). Thus, a married individual may decide to work in the public sector to receive these benefits.

2.2 Empirical Strategy

Local university opening may affect an individual's education decision because of increased proximity to a university, lower costs of attendance, and increased varieties in

[20] A spouse can be either a husband or a wife. The number of children receiving this benefit should be no more than three. The child must be a lawful one and must not have reached the legal age or become sui juris, i.e., he/she must still be incompetent or quasi-incompetent in the care of an employee.

degree majors (Section 2.1.2). To what extent university expansion can affect individuals' education depends on their exposure to the expansion, which is jointly determined by their residential province and their age when it began. Individuals living in provinces highly exposed to university expansion are more likely to receive these benefits than others are.

We define *high-intensity provinces* as those where a regression residual of the university expansion intensity (Section 2.1.3) is positive and has at least one university opening. Figures 2.2(a) and (b) show that only in the high-intensity areas, we see the university completion rate increase and the informal employment percentage decrease after the reform.[21] Moreover, university opening is more likely to affect the cohorts who are sufficiently young to be exposed to the policy change than the older ones who have either completed university or passed the time for making the university-going decision. In what follows, we first empirically determine the cohorts potentially affected by the reform.

2.2.1 Determining the Potentially Affected Group

As universities impose no age cap for enrollment, a new university could motivate experienced workers to attain university education to upgrade their academic qualifications for securing a better position or higher wages.[22] Also, upper secondary school students might change their educational decision because of a new university

[21] Here we measure informal employment using the fraction of workers without social protection. To construct the trend in fractions of workers not covered by social security (our first definition of informal employment), we use the National Health Security Office statistics. The data records show the number of registrants by type of health insurance, including the Medical Benefits Scheme (MBS) for civil servants and state enterprise employees, the Social Security Scheme (SSS) for private company employees, and the UHCS for others. We define *formal-sector workers* as those protected by mandatory social security systems, namely the MBS and the SSS. In other words, informal workers are those who are in the labor force but are not members of the MBS or the SSS.

[22] While students on general education tracks can apply for a bachelor's degree program after completing upper secondary school, those on vocational education tracks also can enroll in university after completing an associate's degree; by the time of enrollment, students are at least 18 and 20 years old, respectively. By either track, university attendees are aged at least 18.

nearby. We empirically determine the age range of the potentially affected cohorts by first regressing the university completion indicator on university opening at each age from 11 to 37, using those aged 38 in 2003 as the reference group.[23]

Figure 2.3 indicates that the university opening has a stronger impact on younger cohorts' university completion. Women of 11–23 years are more likely to complete university than the reference group by 20 to 60 ppts. The same estimates are approximately 30 ppts or less for men. For men and women aged 24–27, the coefficients decrease to roughly 10 ppts and are either marginally or not significant. The coefficients fluctuate around zero for those aged 28 or above and mostly are insignificant, but they are not statistically distinguishable from those slightly younger.

To improve estimation precision, we further consider those aged 25–38 in 2003 as the reference group (instead of using only the cohort aged 38) and document the results in Columns (1) and (2) of Table A2.6. For women aged 23 or younger, the cohort-specific effects of university expansion are strongly positive, ranging from 15 ppts to 50 ppts. For men, most results are statistically significant, although no more than 23 ppts.

Motivated by these findings, we define individuals aged 11–23 in 2003 as the *young cohorts* or *potentially affected group* ($YOUNG = 1$), and those aged 28–38 as the *old cohorts* or comparison group ($YOUNG = 0$). Moreover, we exclude individuals aged 24–27 in 2003 from the analysis, as it is uncertain whether they are affected by the expansion. Table A2.7 displays our data structure and illustrates the association among the cohort-grouping, the respondents' age at reform, and birth year in IES 2011–2016 and LFS 2006–2018.

[23] We replace the young cohort indicator in Equation (2.1) with the full set of the dummies for ages 11-37. Each coefficient captures the effect of university expansion on the university completion rate for each cohort, taking the individuals aged 38 as the reference group.

2.2.2 The Econometric Model

Since the university expansion only affects the young cohorts in the provinces with the university openings, we use a difference-in-differences model for identifying the impact of the university expansion. We compare the university completion rates of the young versus old cohorts across the provinces with high- and low-intensity university expansion. Table 2.4 illustrates this strategy using a crude comparison. The results using IES and LFS are remarkably similar. Columns (1)(2) and (4)(5) show that the young cohorts complete university education with a higher probability by at least one third than the older fellows in all provinces, regardless of the policy intensity. The gap in university completion between young and old cohorts is approximately 50% wider in the high-intensity provinces than in the low-intensity provinces. Consequently, the difference-in-differences estimates suggest that individuals exposed to high expansion intensity have a higher university completion rate by 24% among women and 19% among men (0.053/0.22; 0.025/0.13).

Our empirical strategy assumes parallel trends in the university completion and informal employment rates between high- versus low-intensity areas if no university expansion. Figures 2.2(a) and (b) provide evidence supporting the hypothesis. Due to data limitation, we show the informality trend (measured by the fractions of workers with no social protection) only during the period between 2003 and 2008. We see a rapid drop in informal employment rates from 2005 to 2007 in high-intensity areas, but not in low-intensity regions. The informal employment rate in both types of provinces again progresses in the same direction afterward. These figures support the parallel trend

hypothesis and suggest that the difference occurs because of the variation in exposure to university expansion across provinces.

The observed change in the fraction of informal workers around 2005 does not appear to have been driven by provincial attributes. Instead, it is the university expansion that drives it. Figures 2.2(c) and (d) illustrate the trends in GPP per capita and minimum wages in both high- and low-intensity provinces. The figures confirm that these factors' trends move in the same direction throughout the period considered and do not show any change around the university expansion period.

Table 2.2 suggests that the university opening might have depended on the bachelor's degree enrollment rate in 2003 and the change in the number of years of education between 2001 and 2003. Figure 2.2(e) also illustrates that the average education level in the high-intensity provinces is slightly higher than in the others. Therefore, our basic specification includes the pre-expansion provincial bachelor's degree enrollment rate and the change in education years as covariates.

The following are our econometric models for estimating the effect of university expansion on university completion and informal employment, respectively:

$$(2.1)\ S_{ijat} = \alpha\, YOUNG_a \times OPEN_j + \lambda_j + \lambda_a + \sigma_j \times a + W_j'\theta_a + X_{ijat}'\pi + \varepsilon_{ijat},$$

$$(2.2)\ Y_{ijat} = \delta\, YOUNG_a \times OPEN_j + \mu_j + \mu_a + \rho_j \times a + W_j'\varphi_a + X_{ijat}'\omega + u_{ijat}.$$

Here, S_{ijat} indicates whether a person i who lives in the province j and was aged a in 2003 has completed at least a bachelor's degree by the survey year t. Y_{ijat} indicates whether a person i who lives in province j and was aged a in 2003 works informally in the survey year t. We define the *intensity of university expansion* $OPEN_j$ as the number of universities established in the province j during the expansion period (2004–2005),

divided by 10,000 local youth aged 14–25 in the pre-expansion year (2003). $YOUNG_a$ indicates the young cohorts aged 11–23 in 2003. The coefficient α refers to the impact of university opening on the university completion rates of the young cohorts, considering individuals aged 28–38 in 2003 as the reference group.[24] Parameters (λ_j, λ_a) and (μ_j, μ_a) are the fixed effects for province j and age a, respectively. Parameters $\sigma_j \times a$ and $\rho_j \times a$ capture the province-specific linear cohort trends. The vector W_j includes province-specific characteristics of 2003, the year before the expansion; θ_a and φ_a indicate the cohort-specific effect of the pre-expansion provincial conditions. X_{ijat} denotes the individual *i*'s characteristics, including an urban dummy in the survey year *t,* survey year fixed effects, and the provincial-specific population growth in the past five years when the individual was aged 25. Finally, ε_{ijkt} is an error term.

2.3 Results

2.3.1 The First Stage: The Impact of University Opening on University Completion

Table 2.5 presents the estimated impact of university expansion on university completion using Equation (2.1). Columns (1)-(5) use the sample from LFS, and Columns (6)-(9) use the sample from IES. Both surveys suggest that the young cohorts who experienced the university opening in the province were more likely to have completed a university degree.

All the regressions in Table 2.5 include the full set of dummies for the province, age in 2003, survey-year, and urban, as well as the local population growth rate when

[24] We exclude those aged 24–27 from the analysis as this age group is more likely to include individuals who are already at university and mostly those unaffected by the university expansion.

individuals turned 25. With this basic set of control variables, the estimate in Column (1) shows that one other university built per 10,000 young people in a province increases the probability for the young cohorts to complete a university degree by 37 ppts for women and 27 ppts for men.

Column (2) adds the province-specific cohort linear trends to allow the outcome trends to vary across provinces. This province-specific trend makes the estimates drop by 51% and 30% for women and men, respectively (0.18/0.37-1; 0.19/0.27-1), suggesting that the province-specific trend parameters have captured a substantial portion of the effect on university opening on university completion.

We further control each cohort's university enrollment rate in 2003 and change in schooling years from 2001 to 2003 in Column (3). Although these factors have almost no impact on women's university completion, they decrease the men's estimate by 64% (0.07/0.19-1). It suggests that men living in the province with high or increasing education trends are more likely to complete a university degree. Our results may overstate if we fail to include the pre-expansion condition in education in the specification.

In Column (4), we control for pre-expansion UHCS participation in the province and allow the coefficient to vary across cohorts. This addition makes the estimated causal impact rise by 11% for among and 26% for men (0.22/0.19-1; 0.09/0.07-1). It implies that a high rate of universal health coverage may discourage people from attending a university, and omitting this factor may lead to an understated effect of university opening.

Additionally, our result may overstate the university expansion's impact on university attainment if individuals living in more affluent provinces have more opportunities to attain a university education. We remove this bias by including the cohort-specific effects of GPP per capita and minimum wages in 2003 in Column (5). The

first stage estimates remain almost unchanged. This finding is consistent with Figures 2.2(c) and (d), which indicate a parallel trend in economic development across provinces with high- versus low-expansion intensities.

The estimates using IES in Columns (6)-(9) share the same pattern as LFS that the estimate is robust after controlling for pre-expansion conditions in education and health coverage. However, the result becomes imprecise after adding the province-specific linear cohort trends. It is possibly because the number of observations in IES is not sufficient to apply the full benchmark model. In Section 2.3.3, we analyze the impact of the university opening on informal employment using the model in Column (8) and provide evidence in Table 2.8 that this model setting passes the placebo tests for IES.

The benchmark first-stage estimates in Column (5) suggest that women's university attainment has a slightly more pronounced response to university expansion than men's. An additional university opened per 10,000 local young people increases the university completion rate by 22 ppts for women and 9 ppts for men. Adjusting this effect for the intensity of university opening (0.053) and the average university completion rate of each gender, we find that the *policy impact* of the university expansion is *6% for women* and *4% for men* (0.22*0.053/0.21; 0.09*0.053/0.13), respectively. This disparate effect partly reflects the fact that before the university expansion, in general, women have a lower level of education than men do. The statistics from the labor force survey in 2003 indicate that among individuals aged 15–60, 43% of women do not complete primary education, while the same rate for men is 36%. The average number of years of schooling is 6.0 years for women and 6.4 years for men. The lower baseline education of women leads to a higher impact on their level of university attainment.

It is worth noting that associate's degree graduates account for less than 2% of the new university enrollments in 2004–2005, according to the official statistic published online in Table 15 of the Thailand Education Statistics Report in 2004 and 2005. The first stage results in Table 2.5 are unlikely to have been a consequence of a surge in associate's degree graduates pursuing a bachelor's degree.

Moreover, the university expansion could increase the university completion rate because opening a local university reduces the commuting time and the attendance costs for people living in those provinces. Also, elevated universities might have provided a broader range of university majors and specialized courses than teacher colleges and polytechnics, thus attracting a wider group of people, as mentioned in Section 2.1.2. We provide evidence in Table A2.8 that, compared to the older cohorts, the younger cohorts have a higher fraction of people completing a university degree in the other fields of study, such as science, technology, engineering, mathematics, and medicine (STEM). In contrast, the completion rates for teaching remain constant.

2.3.2 Robustness of the First Stage Estimates

As most universities opened between 2004 and 2005 were upgraded from teacher colleges and polytechnics, it is possible that the university expansion only makes individuals switch from vocational education to university education and does not increase overall educational attainment. This section examines whether university expansion affects other educational choices, including only post-secondary vocational education, vocational and university education, and upper secondary school or above.

We begin the analysis by determining the potentially affected cohorts for the university expansion impact on a particular educational level. Table A2.6 presents the

effect on each of the cohorts aged 11–24 in 2003 while taking those aged 25–38 in 2003 as the reference group.[25] The results suggest that the university opening likely affects the educational decision of the young cohorts within the age range of 14–23 in 2003, compared to those aged 25–38 in 2003. Nevertheless, to examine the aggregated effect, we apply the same definition of the potentially affected cohorts (aged 11–23 in 2003) and the reference group (aged 28–38 in 2003) as in the core analysis for simplicity and comparability of the estimated results.

Table 2.6 shows the effect of university opening on other education choices of the potentially affected group. Column (2) suggests that the university expansion does not affect the chance of completing only a vocational degree. Therefore, our estimates of increasing university completion are not driven by a switch between educational tracks. Column (3) indicates an increase in overall higher education completion by 4% for women (0.205*0.053/0.27). The evidence suggests that university expansion plays a prominent role in encouraging women who would otherwise not have pursued higher education to attain university education. We find no evidence of increasing higher education attainment for men. The lack of impact could explain why the university expansion impact on university degree completion is relatively weak for men compared to women. Moreover, Column (4) signifies that the university opening does not affect the probability of completing upper secondary school or above. This finding implies that the university expansion's impact on women is mainly inducing upper secondary students to go to university and get a degree.

[25] Figure A2.1 illustrates the cohort-specific effects of the university expansion for each educational choice. Overall, the coefficients fluctuate around zero for most of the older cohorts, while the estimated effects on the younger cohorts vary with the education level tested.

2.3.3 The Reduced-Form Results: The Impact of University Opening on Informality

We now turn our attention to informal employment. In Section 2.2.2, we have documented a drop in employment without social security in provinces with high-intensity university expansion. These rates are parallel in high- and low-intensity provinces before the university expansion. Moreover, the drop coincides with a sharp increase in the predicted university completion rate after 2005. This trend implies that university expansion could reduce informality by increasing an individual's opportunities for completing university education, a typical prerequisite for working in the formal sector. This section has systematically examined the impact of university expansion on informal employment using a difference-in-differences approach and exploit the variation in the intensity of exposure to the university expansion across cohorts and provinces.

To investigate the difference in the expansion's impact on the younger and older cohorts, we estimate the effects on each cohort aged 11–37 in 2003 and compare it to those aged 38 in 2003 by gender. Figure 2.4 shows that the impact of university expansion on irregular employment and broadly defined informal employment increases with age. The coefficients of cohorts aged between 19 and 27 are negative and likely to be statistically different from zero, especially for women. In contrast, those of the older cohorts fluctuate around zero and are not statistically significant. The results imply that the younger cohorts, more exposed to university expansion, tend to work regularly. The figure also illustrates the cohort-specific effects on self-employment. The coefficients of the younger cohorts are mostly negative, while those of the older cohorts fluctuate around zero. However, most of the estimates are imprecise (not statistically different from zero). The effects of university expansion on other informality measures, namely employment

without social protection, agricultural work, part-time employment, and private-sector employment, share a pattern similar to self-employment. We have presented the cohort-specific effects in Figure A2.2.

Panel A and D of Table 2.7 presents the estimated results of Equation (2.2), for which the seven informal employment measures constitute the dependent variables. Column (1) shows that the university expansion has almost no impact on whether one wants to be employed with or without social protection. Nevertheless, the estimates may be imprecise since the number of observations of the IES is relatively small; so, we explore the effects on other alternative measures of informal employment using the LFS. Columns (2)–(3) suggest that the university opening decreases men's self-employment and agricultural employment by 28–38% (-0.132/0.47 to -0.120/0.31) of the sample mean, which can be translated into a decrease of 1–2% in informality as the impact of university expansion policy. The estimate on self-employment is marginally significant at the 10% level.[26] The results imply that men may choose informal work because they cannot acquire other formal jobs. After receiving greater educational opportunities, they can move to other industries. The estimated effects on other informality measures are imprecise.

Surprisingly, the university expansion has no impact on women's informal employment, although it substantially increases women's university completion rate. We further examine the heterogeneous effects of university opening by field of study in the next chapter.

[26] 84% of agricultural workers are self-employed.

2.3.4 Placebo Tests

One concern regarding our identification strategy is the fact that the geographical location of new universities may not be random. The new universities, or even the pre-existing teacher colleges and polytechnics, may be located where demand for education has been rising or where the demand for formal employment is anticipated to grow. This demand-side factor could make our estimated results overstate. We address this concern by examining the effect of university expansion policy on the cohorts aged 28–38 in 2003 (fake treatment group) – the reference group of the core analysis who are unaffected by the university opening as indicated in Section 2.2.1 – while taking the older cohorts aged 39–47 in 2003 as the new reference group (fake control group). If the university opening has an impact on the fake treatment group, our estimates will be biased by the increased demand in education and formal labor before the reform.

Table 2.8 suggests that our benchmark model for IES and LFS has included a sufficient control. Accordingly, the university opening does not change the chance of completing a university degree and informal employment of the fake treatment group relative to the fake control group. For IES, the result in Panel A indicates that the specification with either the province-specific linear cohort trends or the cohort-specific effect of pre-expansion conditions can be employed to estimate the university expansion impact. For LFS, the specification must include both linear and non-linear controls, as Columns (3) and (4) of Panel B show. Omitting the province-specific linear cohort trends could lead to an overestimating effect on university completion for both genders while omitting the cohort-specific effect could cause a biased estimate for men's informality.

2.3.5 Interpretations

We further examine the relationship between a university degree and informal employment using the specification as our benchmark model. The OLS results presented in Panel B and E of Table 2.7 suggest that completing a university degree substantially reduces the probability of informal work. All estimates are significant at the 1% level. The informality measure that receives the lowest impact is part-time employment. A university degree decreases the chance of working part-time for women and men by 32% and 18% of the sample mean (-0.049/0.15; -0.025/0.14). At the other end, a university degree reduces irregular employment by 72% for women and 52% for men (-0.475/0.66; -0.358/0.69).

However, the OLS can be biased by unobserved factors, such as personal ability, taste, and family background, which could influence educational and career decisions. To isolate the causal effect of university completion on labor market outcomes, we exploit the university expansion as a natural experiment to construct an instrumental variable (IV) for university completion. We discuss the condition required for applying an IV method in Section 2.5.1.

The male sample does not pass the IV condition because the university opening appears to affect men's career decisions through other alternative pathways. Moreover, men have a weak first-stage result, so the reform's impact on self-employment and agricultural work (the reduced-form results) cannot imply the causal impact of a university degree on career choices.

In contrast to the effect of men, women pass the exogeneity condition for the IV and have a strong first-stage result. The IV results presented in Panel C of Table 2.7

demonstrate that a university degree considerably reduces women's irregular employment by 81% (-0.534/0.66) and broadly-defined informality by 73% (-0.499/0.68) but has no impact on other measures. Although the IV and OLS estimates on these two factors are not statistically distinguishable, the disparate effects on other informality measures signify that the OLS results overestimate the effect of a university degree in reducing informal employment. The least squared estimation may be biased because it provides the average effect of all samples, including high-ability individuals who find studying at the university level easier and likely get a full-time job in the formal sector. The IV estimation can mitigate this bias by capturing the effect only among individuals whose university attainment decision is altered by the university expansion policy.

Comparing the IV estimates with the reduced-form results, we find that the results are somewhat consistent. Although the reduced-form results suggest the university opening cannot significantly reduce women's informality, the estimated effects on irregular employment and broadly-defined informal employment are nearly statistically significant with the *p*-values of 0.107 and 0.117, respectively. In Chapter 3, we investigate the heterogeneous effect of university opening by gender and field of study using the reduced-form estimation.

2.4 Mechanisms

2.4.1 Changing Industries

One potential channel that the university expansion could lead to less informality is by changing sectors. The university opening may induce people to move from the less formal industries into more formal industries. We investigate the effect of university

opening on the chance of working in a specific industry – in general, and in particular work status. The results are in Table 2.9.

The university opening induces women to leave accommodation and foodservice industries and enter the public sector or take education-related jobs. We further investigate the work status in each industry in Panels B and C. The results suggest that the university opening policy decreases the women's probability of working informally in accommodation and food service industries by 6% (-0.087*0.053/0.08) while increasing formal employment in the public sector and education industries by 8% and 7%, respectively (0.053*0.053/0.03; 0.050*0.053/0.04).

In contrast to women, men are more likely to work in accommodation and food service industries while leaving the agricultural industry. Men's university expansion impact on work status in a particular industry is not as clear as women's. We see that men are less likely to work in informal agricultural jobs and as formal public administrators. However, we have found no evidence on which occupational and industrial choices male workers increase in particular.

2.4.2 Changing Formality within Sectors

The university opening may change the work status of informal workers into a more formal type of work. To investigate this possibility, first, we limit the sample to broadly-defined informal workers, which cover all informal workers who are relatively formal and relatively informal (e.g., full-time workers versus irregular workers in the agricultural sector). Then, we examine the effect of university opening on the interaction term between a dummy for formal work status and a dummy for informal employment. The coefficient captures the status change within the informal sector.

The results in Columns (1)–(3) of Table 2.10 show whether broadly-defined informal workers are more likely to be wage employees instead of being the own-account workers or unpaid workers in the family business. Columns (4)–(6) signify whether these informal workers tend to work in the non-agricultural sectors. For males, the university opening changes part-timers' work status by increasing their chance of working for regular wages or outside the agricultural sector. The within-sector shifts suggest that male workers do not indeed leave the informal sector. However, there is no evidence that the university opening induces women to shift into more formal jobs within the informal sector. Therefore, completing a university degree can be considered a means to reduce informal employment for women.

2.4.3 Migration

The university opening may decrease informal employment by inducing individuals to move to the university-opening areas, which may have greater job opportunities in the formal sector. We examine the feasibility of this mechanism by investigating the migration before and after the university expansion period. Although we cannot systematically analyze this possible channel due to data limitation, we provide indirect evidence using the published report of the NSO's migration surveys (National Statistical Office, 2002, 2007, 2008, 2009). We find that the fraction of migration due to educational reasons has decreased from 7% in 2002 to 5% in 2006 and 4% in 2007–2008. The fraction of migration due to work-related reasons has fluctuated around 22% throughout the period. Moreover, the migration flows at the regional and national levels indicate that people tend to move from urban to rural areas. These pieces of evidence suggest that this migration channel is unlikely.

2.4.4 Changing Training in University vs. Vocational Colleges

The difference in training offered in university and vocational college may lead to different career choices. Vocational college typically provides associate degree programs that are available as occupational or vocational degrees. Programs are designed aiming to prepare students for a specific skill for a particular career. Accordingly, students from these institutes usually enter vocational jobs in their majors, such as mechanics, electrical repair, and medical assistants. University may offer a bachelor's degree in the same major associate's degree at vocational college. However, bachelor's degree programs provide more advanced study and require more coursework credits than associate's degree programs.

Additionally, workers with a bachelor's degree can qualify for more management and leadership positions. For example, students taking a course for an associate degree in accountancy have to get about 90 credits and apply for jobs, such as accounting officers and clerks, after completion. Meanwhile, students have to complete approximately 120 credits for a bachelor's degree in accounting programs. However, they can apply for more advanced jobs, such as accounting managers, auditors, and accounting system planners. These careers tend to be in large companies, increasing their chance of getting stable, full-time employment.

2.5 Discussion

2.5.1 Further Investigation on the Exogeneity Conditions

Although the exogeneity assumption is untestable, we have examined the university opening instrument's validity by regressing the university opening on observed

covariates. Table 2.2 shows that the university opening is independent of average individual characteristics (gender, location of residence, and marital status) at the province-level. The result suggests that the universities were not allocated to the province with particular unobserved individual characteristics.

Our first stage and reduced-form specifications in Sections 2.3.1-2.3.3 include linear and nonlinear cohort trends specific to the province. Thus, we have controlled the demand-side factors such as population demand for higher education in the regression analysis. We discuss the necessity of controlling for both linear and nonlinear cohort trends in our placebo tests in Section 2.3.4.

Furthermore, since family income and values are not observable in LFS, our regression analysis includes few family background variables. If those individual attributes are correlated with the university opening, then our estimation might be biased. For example, if more affluent families are more likely than low-income families to migrate for proximity to a new university, then omitting family income would overstate our first stage and understate our IV results. Also, employment in the formal sector is appealing to some because of social security provisions. Because Thai's social security for married persons is extended to their spouse, marriage could likely be an alternative way to gain social protection, other than working in the formal sector. In case the university expansion provides more opportunities for young workers to obtain social protection through marrying university-trained workers in the formal sector, the exogeneity condition required for our IV estimation is valid. We discuss both migration and marriage channels in what follows.

A. Migration

One concern regarding our identification strategy is endogenous migration. On the one hand, if individuals have relocated to attend university, we may have overestimated university expansion's impact on university attainment. On the other hand, if the local youths who attained university education due to the university expansion have moved out to other provinces after graduation, we may have understated the policy's impact. A limitation of our data is that IES and LFS collect only the current residence of respondents. We had assumed that their residence locations at the interview time are the same as when the university expansion started.

Due to the data limitation, we cannot completely rule out these possible biases. However, indirect evidence suggests that our estimates are not sensitive to this problem. Data from NSO's migration surveys show that the number of citizens relocating for educational matters has decreased after the university expansion (National Statistical Office, 2002, 2007, 2008, 2009). The newly established universities are local, nonselective, ranked below the regional universities, so unlikely to induce many to relocate.

B. Marriage

Our IV estimates assume that the university opening affects an individual's career decision only through a university degree completion. A university degree reduces the likelihood of participating in the informal sector among individuals who attend a university because of the university opening, which helps increase an educational opportunity in terms of the variety of courses and the reduced university attending costs. With a university degree, individuals become eligible to apply for a formal job to receive additional formal employment advantages. That is, these workers are entitled to social

security and other employment benefits. If the university opening affects a career decision via different paths, our exogeneity condition will be invalid.

One such possible channel is through marriage with an employee in the public sector. Apart from getting a job in the formal sector themselves, individuals can indirectly obtain social protection through marriage with an employee in the public sector. Public-sector employees' social security systems provide coverage for workers' spouses, either husbands or wives. A new university nearby may discourage marriage since it reduces the cost of using a university degree to get a formal job for social security, making marriage more expensive than getting a degree. Moreover, marriage and motherhood status can affect career decisions, especially for women. Women usually take on a more significant share of domestic and parenting responsibilities than men and adjust their careers to meet family needs.[27] Women with children tend to opt for informal jobs, irrespective of having a university degree. The presence of this channel could also violate the exogeneity condition.

We test if the university expansion affects marital and motherhood status. Since the LFS offers information regarding spouses and children only in the 2006–2012 surveys, we limit the sample to these years. Table 2.11 indicates the positive association between university opening and marrying someone in the public sector for men. It is likely that men, who work in the informal sector, use marriage to get social protection. Thus, the university opening affects men's career decisions through the channel other than a university degree completion. However, we do not see similar evidence for women. We find that women have a lower probability of marrying and having a child, but the estimates

[27] Goldin and Mitchell (2017) find that women's career decision depends greatly on life events, such as giving birth. Mas and Pallais (2017) also find that women with children tend to choose jobs with work arrangements that are more conducive to maintaining their family life.

are not statistically significant. These effects on women's marital and parenthood status likely result from increased years of schooling. Therefore, we find no evidence that the university opening affects women's career decisions through other alternative pathways, and our exogeneity condition for women is valid.

2.5.2 Explaining the Small Impact of the University Expansion Policy on Informality

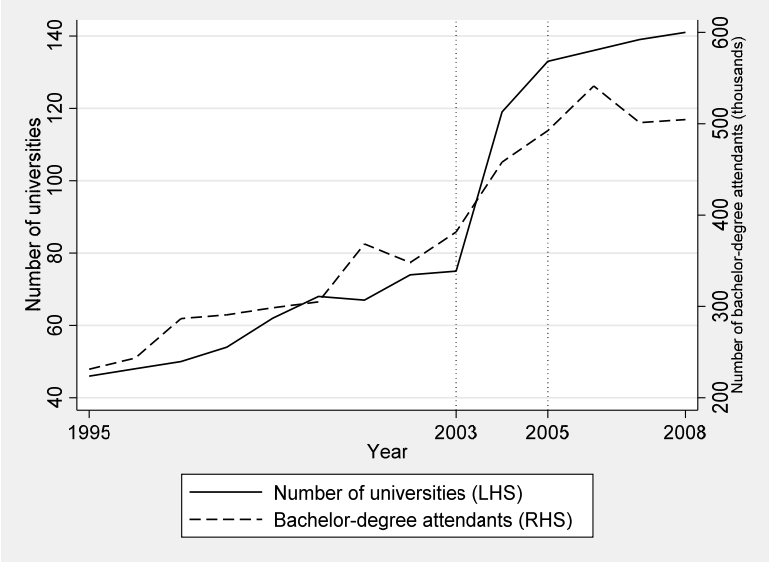
Our results show that university expansion reform increases university completion 6% for women and 4% for men. However, it decreases men's informal employment by only 1–2% and has almost no impact on women, although women who get a university degree because of this reform are substantially less likely to work informally by 73–81%. This subsection explores several potential possibilities for the lack of policy impact.

First, the reform appears ineffective in reducing the informal sector's size because the policy intensity is too low ─ less than four universities per million youths. At the individual level, a local university opening significantly increases a young men's informality by 12–13 ppts. These are substantial increases because the magnitudes account for 28–38% of the sample mean (-0.132/0.47; -0.120/0.31).

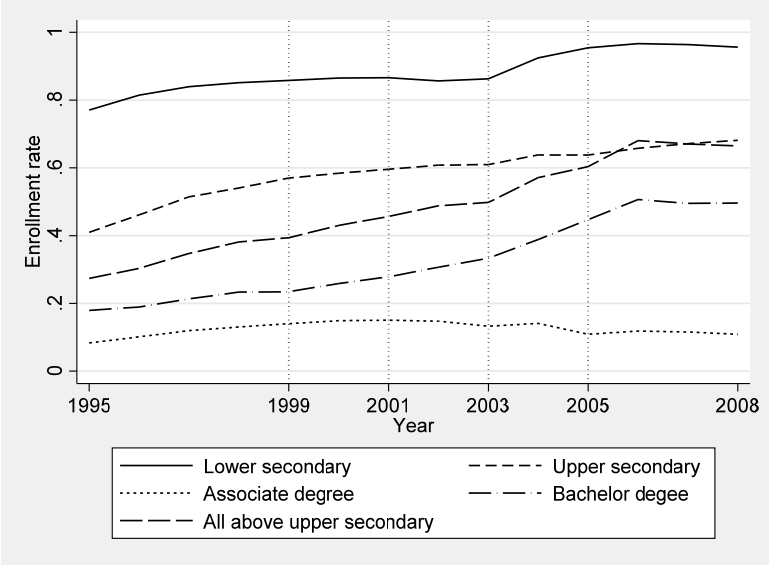
Second, some university graduates may intentionally own non-registered businesses or work independently to avoid regulation and evade the tax system. Past studies suggest that tax burden or bureaucratic complexity increase informality (Bruhn, 2011; Goel and Nelson, 2016; Ihrig and Moe, 2004; Dabla-Norris et al., 2008). Informal workers are outside the purview of labor regulations to avoid paying taxes and contributing to social security systems. These workers may not perceive the value of joining social security systems. They can access other free or nearly free public-supported social protection, such as a universal old-age allowance and the UHCS. Moreover, wage

returns to education among informal workers in Thailand are substantial, as suggested by Vivatsurakit and Vechbanyongratana (2020). A combination of the pleasant educational returns and the bundle of non-contributory social protection for informal workers may encourage university graduates to choose the informal sector over the formal sector.

Additionally, university graduates may also prefer desirable non-wage informal work features, which tend to provide more flexibility in location and autonomy, allowing individuals to better balance work and personal life (Maloney, 1999). Mas and Pallais (2017) suggested that women, particularly those with young children, prioritize family responsibilities over paid work. They tend to choose to work from home and avoid irregular work schedules, such as working during evenings and weekends and weekends on-call duty. They may also decide to do part-time jobs or put in fewer hours in a career that allows high returns, such as pharmacists (Goldin, 2014).



(a) The number of universities and university attendants



(b) The enrollment rate by level of education

FIGURE 2.1 – THE NUMBER OF UNIVERSITIES AND UNIVERSITY ATTENDANTS AND THE ENROLLMENT RATE BY LEVEL OF EDUCATION BETWEEN 1995 AND 2008

Notes: Figure 2.1(a) presents the number of universities (solid line) and first-year bachelor's degree students (dashed line) between 1995 and 2008. Dotted vertical lines indicate the period of university expansion. Figure 2.1(b) compares the enrollment rate for lower secondary and upper secondary levels, associate degree level, bachelor degree level, and all levels above the upper secondary. The enrollment rate is the ratio between the number of students and the population of the age group officially corresponding to that level of education: ages 12–14 for lower secondary level, ages 15–17 for lower secondary level, and ages 18–21 for associate-degree, and bachelor-degree level.

Source: The number of universities, university attendants, and students by level of education is from the *Educational Statistics in Brief 1995–2008*, published by the Ministry of Education, and the population in terms of age is from the official statistics registration systems published by the Department of Provincial Administration.

TABLE 2.1 – DESCRIPTIVE STATISTICS, PROVINCIAL LEVELS

	Unweighted		Weighted by LFS sampling weights	
	Mean (1)	Standard deviation (2)	Mean (3)	Standard deviation (4)
University opening and policy intensity between 2004 and 2005:				
Number of universities opened	0.763	1.404	2.281	3.594
university expansion intensity	0.039	0.049	0.053	0.048
Cohort size and educational attainment in 2003:				
Population aged 14–25 in tens of thousands	15.566	13.371	30.481	29.819
Average years of schooling	5.259	0.873	5.810	1.344
Change in years of schooling growth from 1997 to 2003	0.063	0.055	0.054	0.048
Bachelor-degree enrollment rate	0.150	0.481	0.517	0.946
Local conditions at province in 2003:				
Universal Health Coverage Scheme (UHCS) participation rate	0.785	0.077	0.753	0.090
Gross Provincial Product (GPP) per capita in tens of thousands	7.919	8.804	11.848	11.648
Minimum wage in Thai Baht	138.3	10.3	144.3	14.8
Sample size	76		2,910,952	

Notes: The table reports the means and standard deviations of characteristics of provincial-level variables. We exclude Bueng-Kan province from the analysis due to missing values. The university expansion intensity is the ratio of the number of universities established between 2004 and 2005 per 10,000 young people aged 14–25 in 2003 in the province of residence. The bachelor degree enrollment rate is the ratio between the number of bachelor degree students and the population aged 18–21. The UHCS participation rate is the number of UHCS participants divided by the province's total population in 2003. The GPP per capita is a factor used to reflect the economic development of each province. The minimum wage as of December 2003 is a daily wage imposed only on workers in the formal sector.

Source: The official statistics registration systems published by the Department of Provincial Administration; the educational statistics in brief 1995–2008 published by the Ministry of Education; the universal health coverage statistics published by the National Health Security Office; the GPP published by the Office of the National Economic and Social Development Board; the National Wage Committee's Notification published by the Ministry of Labor.

TABLE 2.2 – ALLOCATION OF UNIVERSITY OPENINGS DURING 2004–2005, PROVINCIAL-LEVEL STATISTICS

	Dependent variables = Provincial attributes predetermined in 2003							
Regressors:	Population aged 14–25 (1)	Bachelor-degree enrollment rate (2)	Average years of schooling (3)	Change in years of schooling, 2001-2003 (4)	Log (GPP per capita) (5)	Log (minimum wage) (6)	UHCS participation rate (7)	Average urban (8)
Number of university openings	7.213***	0.009	-0.021	-0.003	-0.094	-0.002	-0.002	-0.020
	(1.659)	(0.068)	(0.161)	(0.010)	(0.145)	(0.013)	(0.016)	(0.021)
Number of university openings, squared	0.097	0.019***	0.028**	0.000	0.023*	0.002*	-0.001	0.008***
	(0.143)	(0.006)	(0.014)	(0.001)	(0.013)	(0.001)	(0.001)	(0.002)
Adjusted R^2	0.71	0.31	0.15	0.03	0.04	0.10	0.03	0.37
Sample mean (unweighted)	15.57	0.15	5.26	0.06	10.91	4.93	0.79	0.24

Notes: We report the regression results of a quadratic function of the number of university openings between 2004 and 2005 for a given provincial attribute in 2003 (the year before the expansion). The bottom of the table reports the sample means of characteristics of provincial-level variables. We exclude Bueng-Kan province from the analysis due to missing values. The bachelor degree enrollment rate is the ratio between the number of bachelor degree students and the population aged 18–21. We calculate the average years of schooling using LFS and the code in TA2.2. The UHCS participation rate is the number of UHCS participants divided by the province's total population in 2003. The GPP per capita is a factor used to reflect the economic development of each province. The minimum wage as of December 2003 is a daily wage imposed only on workers in the formal sector. The sample size is 76. Robust standard errors are in parentheses. We calculate the unweighted average using provincial-level statitics with 76 observations while the weighted average using the LFS 2006-2018 data, weighted by the sampling weights with 2,910,952 observations. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

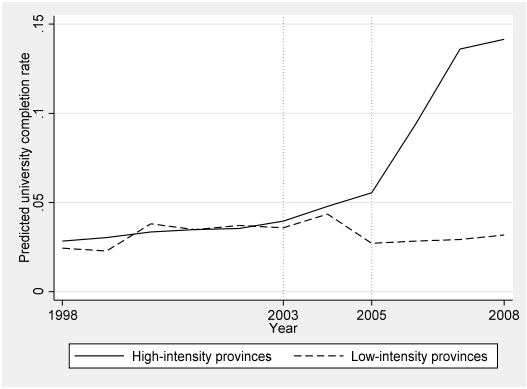
Source: The official statistics registration systems published by the Department of Provincial Administration; the educational statistics in brief 1995–2008 published by the Ministry of Education; the universal health coverage statistics published by the National Health Security Office; the GPP published by the Office of the National Economic and Social Development Board; the National Wage Committee's Notification published by the Ministry of Labor.

TABLE 2.3 – DESCRIPTIVE STATISTICS, INDIVIDUAL LEVELS

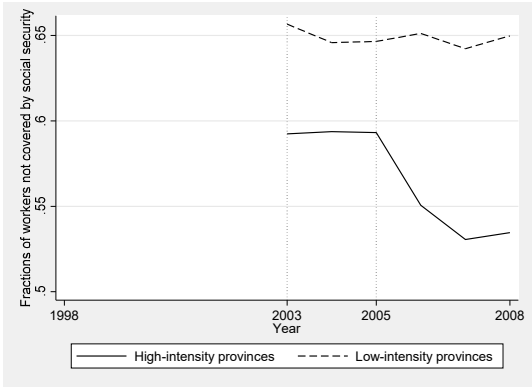
	Informal Employment Survey 2011–2016			**Labor Force Survey 2006–2018**								
	Whole sample			Whole sample			Women			Men		
	Mean (1)	SD (2)	N (3)	Mean (4)	SD (5)	N (6)	Mean (7)	SD (8)	N (9)	Mean (10)	SD (11)	N (12)
Individual attributes:												
Female	0.47	0.50	373,701	0.47	0.50	2,910,952	1.00	0.00	1,427,761	0.00	0.00	1,483,191
Urban	0.42	0.49	373,701	0.41	0.49	2,910,952	0.42	0.49	1,427,761	0.40	0.49	1,483,191
Married	0.70	0.46	373,701	0.70	0.46	2,910,952	0.72	0.45	1,427,761	0.68	0.47	1,483,191
Educational attainment:												
Completed bachelor's degree or above	0.17	0.38	373,701	0.17	0.38	2,910,952	0.22	0.41	1,427,761	0.13	0.34	1,483,191
Completed vocational school only	0.06	0.24	373,701	0.06	0.24	2,910,952	0.05	0.22	1,427,761	0.07	0.25	1,483,191
Completed upper secondary school only	0.19	0.39	373,701	0.18	0.39	2,910,952	0.17	0.37	1,427,761	0.20	0.40	1,483,191
Completed lower secondary school only	0.19	0.39	373,701	0.18	0.38	2,910,952	0.16	0.36	1,427,761	0.20	0.40	1,483,191
Completed less than primary school	0.39	0.49	373,701	0.41	0.49	2,910,952	0.41	0.49	1,427,761	0.40	0.49	1,483,191
Years of schooling	9.58	4.42	373,701	9.42	4.46	2,910,952	9.62	4.70	1,427,761	9.24	4.23	1,483,191
Informality indicators:												
Employment without social protection	0.53	0.50	373,701	NA	NA	NA	NA	NA	NA	NA	NA	NA
Self-employment	0.50	0.50	375,224	0.47	0.50	2,910,952	0.48	0.50	1,427,761	0.47	0.50	1,483,191
Agricultural employment	0.31	0.46	375,224	0.30	0.46	2,910,952	0.28	0.45	1,427,761	0.31	0.46	1,483,191
Part-time employment	0.12	0.33	373,712	0.15	0.35	2,903,971	0.15	0.36	1,428,484	0.14	0.35	1,475,487
Irregular employment	0.68	0.47	375,224	0.68	0.47	2,910,952	0.66	0.47	1,427,761	0.69	0.46	1,483,191
Broadly-defined informal employment	0.69	0.46	375,224	0.70	0.46	2,910,952	0.68	0.47	1,427,761	0.72	0.45	1,483,191
Private-sector employment	0.90	0.30	375,224	0.90	0.30	2,910,952	0.89	0.31	1,427,761	0.91	0.29	1,483,191
Earnings:												
Hourly wages (baht)	23,871	111,000	178,544	19,534	89,233	1,455,873	19,573	89,847	698,024	19,500	88,694	757,849
Monthly earnings (baht)	111	511	177,687	99	478	1,443,296	101	493	691,498	97	465	751,798
Log (hourly wages)	9.33	0.78	178,544	9.24	0.78	1,455,873	9.24	0.79	698,024	9.24	0.77	757,849
Log (monthly earning)	4.04	0.76	177,687	3.96	0.80	1,443,296	3.97	0.81	691,498	3.95	0.78	751,798

Notes: The table reports the means and standard deviations of characteristics of individuals born between 1965 and 1992 (aged 11–38 in 2003) and aged 22 or older at the interview time. These descriptive statistics do not count the cohorts aged 24-27 in 2003. Also, we exclude respondents who lived in Bueng-Kan province from the analysis due to missing values of provincial-level variables. Statistics use sampling weights.

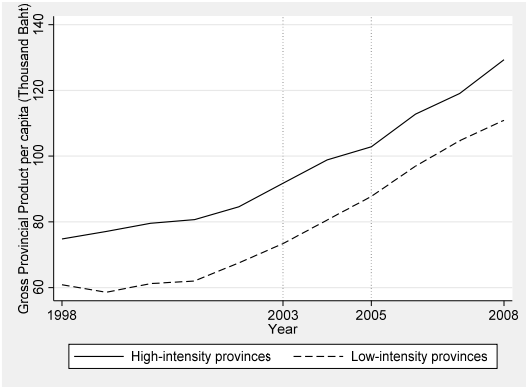
Source: The Informal Employment Survey 2011–2016 and the Labor Force Survey 2006–2018.



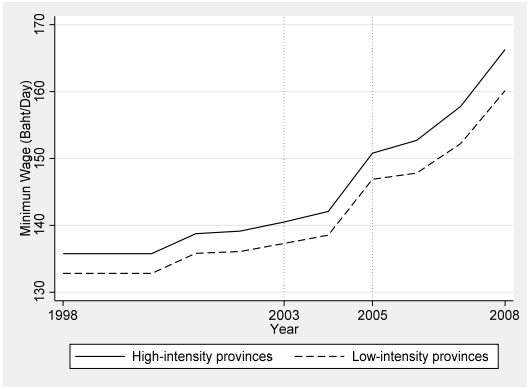
(a) Trends in predicted university completion rates



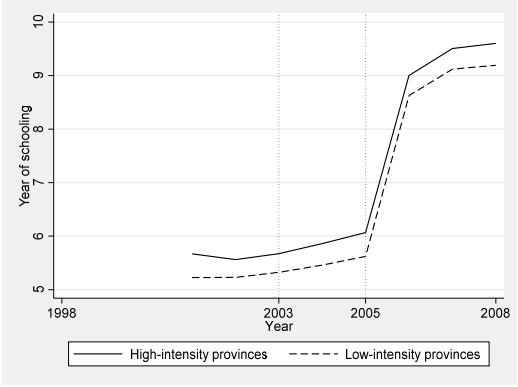
(b) Trends in fractions of workers not covered by social security



(c) Trends in gross provincial product per capita



(d) Trends in minimum wages



(e) Trends in years of schooling

FIGURE 2.2 – TRENDS IN PREDICTED UNIVERSITY COMPLETION RATES, FRACTIONS OF WORKERS NOT COVERED BY SOCIAL SECURITY, GPP PER CAPITA, MINIMUM WAGES, AND YEARS OF SCHOOLING, BY THE INTENSITY OF UNIVERSITY EXPANSION IN PROVINCES, 1998–2008

Notes: The figure compares the key variables between provinces with high-intensity university expansion (solid line) and provinces with low-intensity university expansion (dashed line). Dotted vertical lines indicate the period of university expansion. The predicted university completion equals the number of first-year bachelor's degree students four years ago, a standard period for bachelor's degree courses. The fractions of workers not covered by social security are the number of workers protected by mandatory social security systems, namely the MBS and the SSS, to total workers in the labor force.

Sources: the educational statistics in brief 1995–2008 published by the Ministry of Education; the universal health coverage statistics published by the National Health Security Office; the GPP published by the Office of the National Economic and Social Development Board; the National Wage Committee's Notification published by the Ministry of Labor.

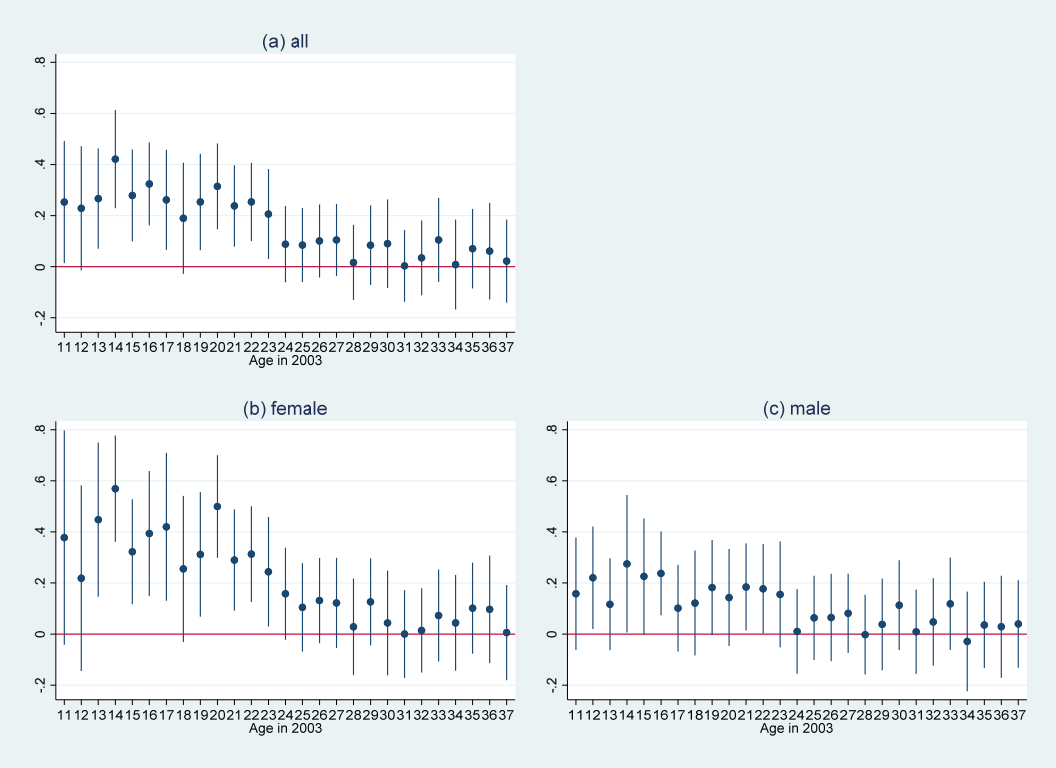


FIGURE 2.3 – THE EFFECTS OF UNIVERSITY EXPANSION ON BACHELOR'S DEGREE COMPLETION BY GENDER AND BIRTH COHORT

Notes: The figures present the coefficients of the interaction term between age dummies and university expansion intensity. We take the oldest cohort (aged 38 in 2003) as the reference group, whose effect of university expansion is indicated by the red line. (a) includes all samples and a female dummy as a covariate, while in (b) and (c), we restrict the sample to female and male, respectively. All specifications include an urban dummy, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific growth of population from age 20 to 25, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). The sample size is 3,491,281, 1,713,367, and 1,777,914, respectively. The markers represent coefficients, and vertical spikes represent a 95% confidence interval. Standard errors are clustered at the province-cohort level. Statistics use sampling weights.

Source: The Labor Force Survey 2006–2018.

TABLE 2.4 – UNCONDITIONAL FIRST-STAGE ESTIMATES

	Bachelor's degree completion					
	Informal Employment Survey 2011-2016			**Labor Force Survey 2006-2018**		
	University expansion intensity			University expansion intensity		
	High	Low	Difference	High	Low	Difference
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Women						
Cohorts aged 11–23 in 2003	0.375***	0.245***	0.130***	0.375***	0.247***	0.129***
	(0.004)	(0.003)	(0.005)	(0.002)	(0.001)	(0.002)
Cohorts aged 28–38 in 2003	0.190***	0.113***	0.077***	0.187***	0.112***	0.076***
	(0.003)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)
Difference	0.185***	0.132***	0.053***	0.188***	0.135***	0.053***
	(0.005)	(0.003)	(0.006)	(0.002)	(0.001)	(0.002)
Sample size	63,852	119,812	183,664	505,862	921,899	1,427,761
Panel B: Men						
Cohorts aged 11–23 in 2003	0.206***	0.112***	0.094***	0.205***	0.112***	0.093***
	(0.004)	(0.002)	(0.004)	(0.001)	(0.001)	(0.001)
Cohorts aged 28–38 in 2003	0.156***	0.087***	0.069***	0.148***	0.085***	0.063***
	(0.003)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)
Difference	0.050***	0.025***	0.025***	0.057***	0.027***	0.030***
	(0.004)	(0.003)	(0.005)	(0.002)	(0.001)	(0.002)
Sample size	64,847	125,190	190,037	516,900	966,291	1,483,191

Notes: The table compares the average completion rate between cohorts aged 11–23 in 2003, who potentially benefit fully from the university expansion, and cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. High-intensity provinces refer to provinces in which the residual of a regression of the number of universities on the number of young people is positive and has at least one university opening during the same period. Robust standard errors are in parentheses. Statistics use sampling weights. *** denotes significance at the 1 percent level.

Source: The Informal Employment Survey 2011–2016 and the Labor Force Survey 2006–2018.

TABLE 2.5 – OLS ESTIMATED EFFECTS OF UNIVERSITY EXPANSION ON BACHELOR'S DEGREE COMPLETION (FIRST-STAGE)

	Labor Force Survey 2006-2018					**Informal Employment Survey 2011-2016**			
Dependent variable = Completing a bachelor's degree	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Women									
Potentially affected group	0.37***	0.18**	0.19**	0.22***	0.22***	0.34***	0.35***	0.35***	0.23
× university expansion intensity	(0.05)	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.14)
First-stage F-stat	67	5	6	9	10	25	33	36	3
Adjusted R-squared	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Sample size					1,427,761				183,664
University completion rate					0.21				0.22
Panel B: Men									
Potentially affected group	0.27***	0.19***	0.07	0.09	0.09*	0.15***	0.16***	0.16***	-0.13
× university expansion intensity	(0.04)	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.11)
First-stage F-stat	44	9	1	2	3	8	12	13	1
Adjusted R-squared	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Sample size					1,483,191				190,037
University completion rate					0.13				0.13
Provincial-specific linear cohort trends	No	Yes	Yes	Yes	**Yes**	No	No	**No**	Yes
Cohort-specific effect of pre-expansion conditions in provinces:									
Bachelor-degree enrollment rate in 2003	No		Yes	Yes	**Yes**	Yes	Yes	**Yes**	Yes
Change in years of schooling, 2001-2003	No		Yes	Yes	**Yes**	Yes	Yes	**Yes**	Yes
Participation rate in UHCS in 2003	No			Yes	**Yes**		Yes	**Yes**	Yes
GPP per capita in 2003	No				**Yes**			**Yes**	Yes
Minimum wage in 2003	No				**Yes**			**Yes**	Yes

Notes: The table demonstrates the effects of the university expansion on bachelor's degree completion rate by comparing the cohorts aged 11–23 in 2003 with that of the cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. Columns (1)–(5) estimate the effects using the Labor Force Survey 2006–2018, and Columns (6)–(8) estimate the effects using the Informal Employment Survey 2011–2016. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, and survey-year fixed effects. See the variable definitions in Table 2.1. Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Source: The Informal Employment Survey 2011–2016 and the Labor Force Survey 2006–2018.

TABLE 2.6 – OLS ESTIMATED EFFECTS OF THE INTENSITY OF THE UNIVERSITY EXPANSION ON EDUCATION

	Outcome variables:			
Regressors:	University degree or above (1)	Vocational degree only (2)	Vocational, university degree or above (3)	Upper secondary school or above (4)
Panel A: Women				
Potentially affected group	0.223***	0.019	0.205***	0.104
× university expansion intensity	(0.070)	(0.051)	(0.074)	(0.082)
Policy impact	6%	2%	4%	1%
Adjusted R-squared	0.12	0.04	0.13	0.18
Sample size	1,427,761	1,116,372	1,427,761	1,427,761
Sample mean	0.21	0.07	0.27	0.43
Panel B: Men				
Potentially affected group	0.093*	-0.010	0.065	0.040
× university expansion intensity	(0.053)	(0.049)	(0.062)	(0.077)
Policy impact	4%	-1%	2%	1%
Adjusted R-squared	0.08	0.03	0.08	0.10
Sample size	1,483,191	1,282,873	1,483,191	1,483,191
Sample mean	0.13	0.08	0.20	0.39
Provincial-specific linear cohort trends	Yes	Yes	Yes	Yes
Cohort-specific effect of pre-expansion conditions in provinces	Yes	Yes	Yes	Yes

Notes: The table demonstrates the effects of the university expansion on education by comparing the cohorts aged 11–23 in 2003 with the cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. Column (2) excludes individuals who have completed a higher level of education than a vocational degree. The estimates show the effects of university expansion on completing a particular educational level, compared to the reference group, consisting of individuals who have completed a lower level of education or have no education. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. *** and * denote significance at the 1 and 10 percent levels, respectively.

Source: The Labor Force Survey 2006–2018.

FIGURE 2.4 – THE EFFECTS OF UNIVERSITY EXPANSION ON INFORMAL EMPLOYMENT BY GENDER AND BIRTH COHORT

Notes: The figures illustrate the effect of university expansion on informal employment, including self-employment, irregular employment, and broadly-defined informal employment. The figures present the coefficients of the interaction term between age dummies and university expansion intensity. We take the oldest cohort (aged 38 in 2003) as the reference group, whose effect of university expansion is indicated by the red line. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). The markers represent coefficients, and vertical spikes represent a 95% confidence interval. Standard errors are clustered at the province-cohort level. Statistics use sampling weights.

Source: The Labor Force Survey 2006–2018.

TABLE 2.7 – ESTIMATED EFFECTS OF UNIVERSITY EXPANSION AND UNIVERSITY COMPLETION ON INFORMAL EMPLOYMENT

		Outcome variables:						
Regressor :		Employment without social protection (1)	Self-employment (2)	Agricultural employment (3)	Part-time employment (4)	Irregular employment (5)	Broadly-defined informal employment (6)	Private-sector employment (7)
Women								
Panel A: Reduced-form (OLS)								
Potentially affected group		0.025	-0.066	-0.017	-0.035	-0.119	-0.111	-0.034
× university expansion intensity		(0.063)	(0.065)	(0.054)	(0.039)	(0.074)	(0.071)	(0.046)
	Adjusted R-squared	0.23	0.18	0.28	0.09	0.18	0.18	0.02
Panel B: Correlation (OLS)								
Completing a bachelor's degree		-0.300***	-0.262***	-0.190***	-0.049***	-0.475***	-0.431***	-0.347***
		(0.009)	(0.007)	(0.010)	(0.004)	(0.009)	(0.008)	(0.011)
	Adjusted R-squared	0.28	0.22	0.31	0.10	0.33	0.30	0.21
Panel C: Instrumental variable (2SLS)								
Completing a bachelor's degree		0.072	-0.298	-0.077	-0.160	-0.534*	-0.499*	-0.155
		(0.183)	(0.273)	(0.238)	(0.183)	(0.289)	(0.279)	(0.194)
	Sample size	183,664	1,427,761	1,427,761	1,428,484	1,427,761	1,427,761	1,427,761
	Sample mean	0.52	0.47	0.28	0.15	0.66	0.68	0.89
	First-stage F-stat	36	10	10	10	10	10	10
Men								
Panel D: Reduced-form (OLS)								
Potentially affected group		-0.068	-0.132*	-0.120**	-0.029	-0.057	-0.026	0.012
× university expansion intensity		(0.065)	(0.068)	(0.057)	(0.038)	(0.065)	(0.061)	(0.042)
	Adjusted R-squared	0.18	0.12	0.25	0.09	0.14	0.14	0.02
Panel E: Correlation (OLS)								
Completing a bachelor's degree		-0.215***	-0.149***	-0.157***	-0.025***	-0.358***	-0.328***	-0.252***
		(0.005)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
	Adjusted R-squared	0.20	0.13	0.26	0.09	0.21	0.20	0.10
	Sample size	190,037	1,483,191	1,483,191	1,475,487	1,483,191	1,483,191	1,483,191
	Sample mean	0.53	0.47	0.31	0.14	0.69	0.71	0.91
	First-stage F-stat	13	3	3	3	3	3	3
Provincial-specific linear cohort trends		No	Yes	Yes	Yes	Yes	Yes	Yes
Cohort-specific effect of prior conditions in provinces		Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table compares the OLS and IV estimates on the effects of the university expansion and university completion on informal employment. For the IV estimation, we use the interaction term between a dummy for the potentially affected group and university expansion intensity as an instrumental variable. We exclude those aged 24–27 in 2003 from the analysis. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Source: The Informal Employment Survey 2011–2016 for employment without social protection and the Labor Force Survey 2006–2018 for other measures.

TABLE 2.8 – PLACEBO TESTS

	Outcome variables:					
Reference group = aged 39-47 in 2003	Completing a bachelor's degree (1)	Informal employment (2)	Completing a bachelor's degree (3)	Informal employment (4)	Completing a bachelor's degree (5)	Informal employment (6)
Informal Employment Survey 2011-2016 (Informal employment = Employment without social protection)						
Panel A: Women, N=181,985						
Cohorts age 28-38 in 2003	0.009	0.033	-0.067	0.078	-0.032	-0.081
× university expansion intensity	(0.046)	(0.061)	(0.081)	(0.109)	(0.100)	(0.115)
Sample mean	0.13	0.67	0.13	0.67	0.13	0.67
Panel B: Men, N=192,861						
Cohorts age 28-38 in 2003	0.044	0.051	-0.125	-0.213*	-0.101	-0.021
× university expansion intensity	(0.045)	(0.060)	(0.093)	(0.113)	(0.103)	(0.127)
Sample mean	0.11	0.63	0.11	0.63	0.11	0.63
Labor Force Survey 2006-2018 (Informal employment = Broadly-defined informal employment)						
Panel C: Women, N=1,517,688						
Cohorts age 28-38 in 2003	0.059***	-0.084***	0.041	0.030	0.047	-0.023
× university expansion intensity	(0.020)	(0.029)	(0.034)	(0.043)	(0.051)	(0.056)
Sample size	1,517,688	1,517,688	1,517,688	1,517,688	1,517,688	1,517,688
Sample mean	0.13	0.79	0.13	0.79	0.13	0.79
Panel D: Men, N=1,530,961						
Cohorts age 28-38 in 2003	0.077***	-0.055*	0.037	0.079*	0.047	0.152***
× university expansion intensity	(0.021)	(0.028)	(0.038)	(0.047)	(0.042)	(0.057)
Adjusted R-squared	0.07	0.11	0.07	0.11	0.07	0.11
Sample mean	0.11	0.76	0.11	0.76	0.11	0.76
Provincial-specific linear cohort trends	No	No	**Yes**	**Yes**	**Yes**	**Yes**
Cohort-specific effect of pre-expansion conditions in province	**Yes**	**Yes**	**Yes**	**Yes**	No	No

Notes: The table demonstrates the effects of the university expansion on bachelor's degree completion rate and informal employment by comparing the cohorts aged 28–38 in 2003 with that of the cohorts aged 39–47 in 2003. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, and survey-year fixed effects. The cohort-specific effects of the pre-expansion provincial-level conditions include bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage. Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Source: The Informal Employment Survey 2011–2016 and the Labor Force Survey 2006–2018.

TABLE 2.9 – OLS ESTIMATED EFFECTS OF UNIVERSITY EXPANSION ON CHANGING INDUSTRIES

	Industries:					
	Agriculture (1)	Manufacturing and trade (2)	Accommodation and food service (3)	Public administration and defence (4)	Education (5)	Others (6)
Women, N=1,427,761						
Panel A: Dependent variable = Industry						
Potentially affected group	-0.017	-0.065	-0.086**	0.050*	0.066**	0.053
× university expansion intensity	(0.054)	(0.067)	(0.041)	(0.029)	(0.033)	(0.050)
Adjusted R-squared	0.28	0.11	0.03	0.01	0.01	0.06
Sample mean	0.278	0.37	0.10	0.04	0.04	0.17
Panel B: Dependent variable = Industry ×Formality						
Potentially affected group	-0.001	0.035	0.000	0.053**	0.050*	-0.027
× university expansion intensity	(0.006)	(0.064)	(0.022)	(0.026)	(0.029)	(0.035)
Adjusted R-squared	0.00	0.11	0.05	0.01	0.01	0.07
Sample mean	0.002	0.13	0.02	0.03	0.04	0.10
Panel C: Dependent variable = Industry ×Informality						
Potentially affected group	-0.017	-0.100	-0.087**	-0.003	0.015	0.080**
× university expansion intensity	(0.054)	(0.062)	(0.034)	(0.009)	(0.011)	(0.034)
Adjusted R-squared	0.29	0.04	0.02	0.00	0.00	0.01
Sample mean	0.28	0.25	0.08	0.00	0.01	0.07
Men, N=1,483,191						
Panel D: Dependent variable = Industry						
Potentially affected group	-0.120**	0.067	0.059*	-0.039	0.006	0.027
× university expansion intensity	(0.057)	(0.079)	(0.031)	(0.030)	(0.018)	(0.066)
Adjusted R-squared	0.25	0.12	0.03	0.02	0.00	0.05
Sample mean	0.314	0.33	0.05	0.05	0.02	0.24
Panel E: Dependent variable = Industry ×Formality						
Potentially affected group	-0.007	0.043	0.035	-0.047*	0.010	-0.015
× university expansion intensity	(0.008)	(0.056)	(0.022)	(0.027)	(0.015)	(0.041)
Adjusted R-squared	0.01	0.11	0.04	0.02	0.00	0.07
Sample mean	0.005	0.13	0.01	0.05	0.02	0.08
Panel F: Dependent variable = Industry ×Informality						
Potentially affected group	-0.113**	0.024	0.024	0.007	-0.004	0.042
× university expansion intensity	(0.057)	(0.056)	(0.022)	(0.008)	(0.007)	(0.052)
Adjusted R-squared						
Sample mean	0.31	0.20	0.03	0.00	0.00	0.16
Provincial-specific linear cohort trends	Yes	Yes	Yes	Yes	Yes	Yes
Cohort-specific effect of pre-expansion conditions in province	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table presents the effects of the university expansion on industry choices by comparing the cohorts aged 11–23 in 2003 with the cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ** and * denote significance at the 5 and 10 percent levels, respectively.

Source: The Labor Force Survey 2006–2018.

TABLE 2.10 – OLS ESTIMATED EFFECTS OF UNIVERSITY EXPANSION ON INCREASED FORMALITY GIVEN INFORMAL EMPLOYMENT

	Outcome variable:					
	Work as wage employees ×			**Work in non-agricultural sectors ×**		
	Agricultural employment	Part-time employment	Irregular employment	Self-employment	Part-time employment	Irregular employment
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Women						
Potentially affected group	0.052	0.011	-0.013	0.058	-0.029	-0.008
× university expansion intensity	(0.039)	(0.040)	(0.080)	(0.088)	(0.045)	(0.079)
Adjusted R-squared	0.05	0.03	0.11	0.12	0.03	0.23
Sample size	1,004,430	997,409	1,004,430	1,004,430	997,409	1,004,430
Sample mean	0.06	0.07	0.27	0.35	0.08	0.56
Panel B: Men						
Potentially affected group	-0.012	0.109***	0.113	-0.013	0.071*	0.111
× university expansion intensity	(0.041)	(0.040)	(0.082)	(0.076)	(0.042)	(0.077)
Adjusted R-squared	0.06	0.03	0.09	0.16	0.02	0.22
Sample size	1,071,282	1,061,611	1,071,282	1,071,282	1,061,611	1,071,282
Sample mean	0.08	0.07	0.31	0.29	0.07	0.54
Provincial-specific linear cohort trends	Yes	Yes	Yes	Yes	Yes	Yes
Cohort-specific effect of pre-expansion conditions in provinces	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table presents the effects of the university expansion on increased formality given informal employment by comparing the cohorts aged 11–23 in 2003 with the cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. *** and * denote significance at the 1 and 10 percent levels, respectively.

Source: The Labor Force Survey 2006–2018.

TABLE 2.11 – OLS ESTIMATED EFFECTS OF UNIVERSITY EXPANSION ON MARITAL AND PARENTHOOD STATUS (LFS 2006-2012)

	Outcome variables:		
	Spouse working in the public sector (1)	Married (2)	Having a child (3)
Panel A: Women			
Potentially affected group	-0.007	-0.129	-0.109
× university expansion intensity	(0.039)	(0.084)	(0.098)
Policy impact	-0.8%	-0.8%	0.0%
Adjusted R-squared	0.02	0.10	0.19
Sample size	715,458	715,458	715,458
Sample mean	0.04	0.73	0.41
Panel B: Men			
Potentially affected group	0.102***	0.087	0.151
× university expansion intensity	(0.031)	(0.101)	(0.097)
Policy impact	23.5%	0.6%	0.0%
Adjusted R-squared	0.02	0.15	0.23
Sample size	730,966	730,966	730,966
Sample mean	0.02	0.68	0.34
Provincial-specific linear cohort trends	Yes	Yes	Yes
Cohort-specific effect of pre-expansion conditions in province	Yes	Yes	Yes

Notes: The table demonstrates the effects of the university expansion on marriage and having a child by comparing the impact of the cohorts aged 11–23 in 2003 with those aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. *** denotes significance at the 1 percent level.

Source: The Labor Force Survey 2006–2012.

Appendix

TABLE A2.1 – ALTERNATIVE DEFINITIONS OF INFORMAL EMPLOYMENT

Category		Description
1	Employment without social protection	Employment that offers not social security protection, namely the Medical Benefits Scheme for civil servants and the Social Security Scheme for private company workers.
2	Self-employment	Employment in which individuals report their employment status as an employer, an own-account worker without employees, an unpaid family worker, and a cooperation member.
3	Agricultural employment	Employment in which work is related to a plantation, animal husbandry, forestry, salt-field, and fishing.
4	Part-time employment	Employment in which individuals work fewer than 35 hours per week (underemployment).
5	Irregular employment	Employment in which individuals receive no monthly earnings but receive earnings based on hours, days, weeks, a specific project, or something undefinable (e.g., business owners, unpaid family workers). This category also includes workers who do not report their earning types.
6	Broadly-defined informal employment	Workers in any of categories 2–5 of informal employment.
7	Private-sector employment	Employment in which individuals report their employment status other than employees of the government and state-owned enterprise.

TABLE A2.2 – CODES ACROSS SURVEY YEARS

Variables	Description	Code 1			Code 2		
Panel A: Highest grade completed							
		The 2006 Survey			**The 2007-2018 Surveys**		
		Group	Grade	Year	Group	Grade	Year
Primary education and lower	No education	01	00	0	01	000	0
	Less than elementary	02	01-09,84-86	0	02	110, 211-215, 241-242, 251-255	0 - 6
	Elementary	03	10, 12-14, 35, 37, 38, 71, 72, 87	6	03	210, 240, 250	6
Lower secondary	Lower secondary	04	15, 17, 18, 36, 39, 40, 41, 73-75, 88, 89	9	04	310, 320, 330, 340, 350	9
Upper secondary	Upper Secondary level						
	- General	05	19, 21, 23-27, 46, 48, 51-54, 60, 62, 66, 67, 76, 78-80, 90-93	12	05	410, 430, 440, 450	12
	- Vocational	06	11,16,20,29,42-45,47,49,63-65	12	06	420, 460	12 -13
	- Teacher training	07	58	12	07	420	12
Post-secondary	Post-secondary education (Associate Degree)						
	- General	08	22	14	08	510	14
	- Higher technical education	09	50,55,56,82	14	09	520	14
	- Teacher training	10	59,61,77	14	10	510,520	14
Bachelor degree or above	University education						
	- General	11	30-33,81,83,94	16			
	- Higher technical education	12	57	16			
	- Teacher training	13	68-70	16			
	Bachelor degree education						
	- General				11	610, 630, 640, 650, 660	16
	- Higher technical education				12	610	16
	- Teacher training				13	610,660	16 -17
	Master degree level				14	710, 730, 750, 760,	18 - 19
	Doctoral degree level				15	810, 830, 850, 860, 870	21 - 24

Panel B: Self-employment			
		The 2006-2012 Surveys	**The 2013-2018 Surveys**
		Employment status	Employment status
Self-employment	Employer	1	1
	Own-account worker	2	2
	Unpaid family member	3	3
	Independent contractors		7
	Member of producers' cooperative	7	8

Panel C: Agricultural employment			
		The 2011 Survey	**The 2012-2018 Surveys**
		Industry	Industry
Agricultural employment	Agriculture, hunting and forestry	0111, 0112, 0113, 0114, 0115, 0116, 0119, 0121, 0122, 0123, 0124, 0125, 0126, 0127, 0128, 0129, 0130, 0141, 0142, 0143, 0144, 0145, 0146, 0149, 0150, 0161, 0162, 0163, 0164, 0170, 0210, 0220, 0230, 0240 Survey year 2006-2010: 0111-0113, 0121-0122, 0130, 0140, 0150, 0200	01111, 01112, 01113, 01114, 01115, 01121, 01122, 01131, 01132, 01133, 01134, 01135, 01136, 01139, 01140, 01150, 01161, 01169, 01191, 01192, 01193, 01194, 01199, 01210, 01221, 01222, 01223, 01224, 01225, 01226 01227, ..., 02400
	Fishing	0311, 0312, 0321, 0322 Survey years 2006-2010: 0500	03111, 03112, 03113, 03114, 03115, 03119, 03121, 03122, 03129, 03211, 03212, 03213, 03214, 03219, 03221, 03222, 03223, 03224, 03225, 03229

TABLE A2.3 – THE CORRELATION BETWEEN EMPLOYMENT WITHOUT SOCIAL PROTECTION AND EACH INFORMALITY MEASURE

	Regressors:					
Dependent variable:	Self-employment (1)	Agricultural employment (2)	Part-time employment (3)	Irregular employment (4)	Broadly-defined informal employment (5)	Private-sector employment (6)
Employment without social protection	0.819***	0.458***	0.229***	0.661***	0.646***	0.527***
	(0.003)	(0.004)	(0.004)	(0.006)	(0.006)	(0.008)
Mean value of employment without social protection	0.53	0.53	0.53	0.53	0.53	0.53
Percent of employment without social protection among informal workers	96%	91%	80%	76%	75%	57%
P-value	0.000	0.000	0.000	0.000	0.000	0.000
Provincial-specific linear cohort trends	Yes	Yes	Yes	Yes	Yes	Yes
Cohort-specific effect of pre-expansion conditions in province	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The table shows the regression results of each informality measure on employment without social protection. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). The sample size is 373,701. Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. *** denotes significance at the 1 percent level.

Source: The Informal Employment Survey 2011-2016.

TABLE A2.4 – TOP-TEN INFORMAL AND FORMAL OCCUPATIONS

Occupation	Percent of informal workers	Average hourly wages		Percent of a STEM university degree		Percent of STEM majors		Percent of a university degree	
		Women	Men	Women	Men	Women	Men	Women	Men
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Top-ten Informal Occupations									
Subsistence Farmers, Fishers, Hunters and Gatherers	100%	32	58	0%	0%	0%	3%	1%	1%
Market-oriented Skilled Agricultural Workers	99%	60	63	0%	1%	1%	5%	2%	3%
Street and Related Sales and Services Workers	99%	38	30	1%	1%	2%	6%	5%	3%
Market-oriented Skilled Forestry, Fishery and Hunting Workers	99%	32	74	0%	0%	1%	3%	1%	1%
Agricultural, Forestry and Fishery Labourers	99%	42	44	0%	0%	0%	2%	0%	0%
Building and Related Trades Workers (excluding Electricians)	90%	42	51	0%	0%	1%	5%	1%	1%
Labourers in Mining, Construction, Manufacturing and Transport	86%	46	47	0%	0%	1%	3%	1%	1%
Sales Workers	83%	66	73	2%	4%	4%	15%	16%	16%
Food Processing, Woodworking, Garment and Other Craft and Related Trades Workers	80%	55	62	1%	2%	3%	10%	7%	7%
Handicraft and Printing Workers	77%	46	66	1%	2%	1%	8%	3%	5%
Top-ten occupations (average)	**93%**	**54**	**55**	**1%**	**1%**	**2%**	**6%**	**7%**	**5%**
Panel B: Top-ten Formal Occupations									
Health Professionals	9%	177	232	88%	70%	90%	72%	96%	94%
Administrative and Commercial Managers	13%	313	368	6%	17%	7%	21%	90%	86%
Science and Engineering Professionals	15%	220	214	53%	71%	55%	77%	90%	90%
Chief Executives, Senior Officials and Legislators	15%	140	139	2%	3%	4%	8%	32%	19%
Customer Services Clerks	15%	128	109	5%	5%	7%	17%	62%	39%
Information and Communications Technology Professionals	15%	256	201	76%	72%	76%	75%	98%	95%
Teaching Professionals	16%	164	201	10%	21%	11%	22%	95%	95%
Business and Administration Professionals	16%	184	218	6%	9%	7%	13%	90%	83%
General and Keyboard Clerks	16%	110	103	7%	9%	12%	22%	56%	44%
Business and Administration Associate Professionals	18%	161	199	4%	7%	6%	15%	74%	66%
Top-ten occupations (average)	**15%**	**158**	**188**	**15%**	**23%**	**17%**	**29%**	**76%**	**68%**
All occupations (average)	**70%**	**94**	**91**	**4%**	**4%**	**5%**	**13%**	**21%**	**13%**

Notes: The table shows the first ten occupations, sorted by the percent of informal (formal) workers to total employment. Here, we use broadly-defined informal employment. Formal workers are those not classified as self-employment, agricultural employment, part-time employment, and irregular employment. We measure the average hourly wage in Thai Baht. Statistics use sampling weights.

Source: The Labor Force Survey 2006–2018.

TABLE A2.5 – OCCUPATIONS BY SKILL LEVELS (HOURLY WAGE)

	Within-occupation statistics								
	Average hourly wages			Percent of a STEM university degree		Percent of STEM majors		Percent of a university degree	
	All	Female	Male	Women	Men	Women	Men	Women	Men
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TOTAL	179	168	192	16%	21%	18%	33%	76%	57%
High-skilled occupations (hourly wage>mean):									
Administrative and Commercial Managers	338	313	368	6%	17%	7%	21%	90%	86%
Production and Specialized Services Managers	239	246	236	6%	12%	8%	23%	42%	31%
Information and Communications Technology Professionals	220	256	201	76%	72%	76%	75%	98%	95%
Hospitality, Retail, and Other Services Managers	219	193	245	4%	11%	5%	21%	46%	50%
Legal, Social and Cultural Professionals	216	191	234	3%	4%	4%	8%	78%	69%
Science and Engineering Professionals	215	220	214	53%	71%	55%	77%	90%	90%
Business and Administration Professionals	195	184	218	6%	9%	7%	13%	90%	83%
Health Professionals	188	177	232	88%	70%	90%	72%	96%	94%
Less-skilled occupations (hourly wage<mean):									
Information and Communications Technicians	175	194	169	45%	45%	52%	63%	74%	67%
Teaching Professionals	175	164	201	10%	21%	11%	22%	95%	95%
Business and Administration Associate Professionals	171	161	199	4%	7%	6%	15%	74%	66%
Chief Executives, Senior Officials and Legislators	139	140	139	2%	3%	4%	8%	32%	19%
Legal, Social, Cultural and Related Associate Professionals	123	116	135	5%	8%	6%	17%	70%	51%
Science and Engineering Associate Professionals	122	83	136	13%	22%	19%	59%	34%	35%
Health Associate Professionals	106	106	105	17%	20%	28%	36%	34%	40%

Notes: The table shows high- and low- skilled occupations, sorted average hourly wages of the given occupation. The list consists of occupations from three major groups: (1) managers, (2) professionals, and (3) technicians and associate professionals, all scored 3–4 of the NSO skill level. We define high-skilled occupations as those with hourly wages above the group average. We measure the average hourly wage in Thai Baht. Statistics use sampling weights.

Source: The Labor Force Survey 2006–2018.

TABLE A2.6 – OLS ESTIMATED COHORT-SPECIFIC EFFECTS OF UNIVERSITY EXPANSION ON EDUCATION

Age in 2003 × university expansion intensity		University degree or above		Vocational degree only		Vocational, university degree or above		Upper secondary school or above	
		Women	Men	Women	Men	Women	Men	Women	Men
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	11	0.313	0.114	-0.085	-0.091	0.216	0.018	0.135	-0.010
		(0.204)	(0.086)	(0.099)	(0.107)	(0.216)	(0.128)	(0.232)	(0.202)
	12	0.154	0.176***	0.048	-0.085	0.150	0.081	0.175	-0.119
		(0.173)	(0.073)	(0.085)	(0.073)	(0.172)	(0.106)	(0.144)	(0.158)
	13	0.383***	0.072	-0.141	0.030	0.242	0.089	0.071	-0.105
		(0.139)	(0.058)	(0.099)	(0.089)	(0.170)	(0.076)	(0.201)	(0.116)
	14	0.505***	0.231**	-0.108	-0.099	0.369***	0.118	0.290*	0.081
		(0.083)	(0.117)	(0.101)	(0.084)	(0.102)	(0.156)	(0.158)	(0.186)
	15	0.258***	0.182**	-0.266***	-0.009	0.051	0.146	0.065	0.091
		(0.082)	(0.091)	(0.063)	(0.108)	(0.095)	(0.103)	(0.119)	(0.131)
	16	0.329***	0.193***	-0.158**	-0.163**	0.173	0.026	0.075	-0.035
		(0.106)	(0.043)	(0.079)	(0.064)	(0.114)	(0.065)	(0.185)	(0.133)
	17	0.355***	0.057	-0.123	0.011	0.216	0.050	0.192	0.014
		(0.132)	(0.049)	(0.084)	(0.059)	(0.149)	(0.067)	(0.153)	(0.105)
	18	0.191	0.077	-0.105	-0.092*	0.084	-0.013	0.192**	0.027
		(0.130)	(0.077)	(0.074)	(0.055)	(0.140)	(0.086)	(0.097)	(0.088)
	19	0.247**	0.138**	-0.180***	-0.036	0.084	0.088	0.119	0.158*
		(0.106)	(0.063)	(0.062)	(0.054)	(0.101)	(0.087)	(0.097)	(0.090)
	20	0.435***	0.099	-0.112*	-0.084**	0.300***	0.013	0.298***	0.099
		(0.079)	(0.065)	(0.061)	(0.041)	(0.081)	(0.072)	(0.081)	(0.081)
	21	0.225***	0.140***	-0.047	-0.052	0.165*	0.073	0.171***	0.165**
		(0.076)	(0.050)	(0.075)	(0.043)	(0.098)	(0.058)	(0.078)	(0.072)
	22	0.248***	0.133***	0.010	0.056	0.224**	0.155**	0.129	0.094
		(0.069)	(0.054)	(0.079)	(0.059)	(0.092)	(0.076)	(0.082)	(0.069)
	23	0.179**	0.111	0.150***	0.026	0.258***	0.110	0.252***	0.027
		(0.087)	(0.078)	(0.053)	(0.051)	(0.081)	(0.075)	(0.079)	(0.089)
	24	0.093	-0.034	0.001	-0.036	0.071	-0.069	0.069	-0.028
		(0.064)	(0.045)	(0.041)	(0.039)	(0.060)	(0.050)	(0.072)	(0.052)
Adjusted R-squared		0.11	0.08	0.03	0.03	0.12	0.08	0.16	0.09
Sample size		1,713,367	1,777,914	1,326,659	1,529,631	1,713,367	1,777,914	1,713,367	1,777,914
University completion rate		0.219	0.133	0.067	0.078	0.272	0.201	0.438	0.396

Notes: The table displays the effect of the university expansion on each of the younger cohorts aged 11–24 in 2003, compared to the older cohorts aged 25–38 in the same year. Column (2) excludes individuals who have completed a higher level of education than a vocational degree. The estimates show the effects of university expansion on completing a particular educational level, compared to the reference group, consisting of individuals who have completed a lower level of education or have no education. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Source: The Labor Force Survey 2006–2018.

TABLE A2.7 – THE ASSOCIATION BETWEEN COHORT GROUPING, BIRTH COHORT, AND AGE IN EACH SURVEY-YEAR

Cohort grouping	Age in 2003	Birth year	Age in survey-year: 2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Young	11	1992	14	15	16	17	18	19	20	21	**22**	**23**	**24**	**25**	**26**
Young	12	1991	15	16	17	18	19	20	21	**22**	**23**	**24**	**25**	**26**	**27**
Young	13	1990	16	17	18	19	20	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Young	14	1989	17	18	19	20	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
Young	15	1988	18	19	20	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Young	16	1987	19	20	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**
Young	17	1986	20	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
Young	18	1985	21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**
Young	19	1984	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**
Young	20	1983	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**
Young	21	1982	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**
Young	22	1981	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**
Young	23	1980	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**
Old	28	1975	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**
Old	29	1974	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**
Old	30	1973	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**
Old	31	1972	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**
Old	32	1971	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**
Old	33	1970	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**
Old	34	1969	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**
Old	35	1968	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
Old	36	1967	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**
Old	37	1966	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**
Old	38	1965	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**

Notes: The table shows the data structure and the association among the cohort-grouping, the respondents' age at reform, and birth year in IES 2011–2016 and LFS 2006–2018. This study primarily focuses on individuals born between 1965 and 1992 (aged 11–38 in 2003) and aged 22 or older at the interview time. It also excludes those aged 24–27 in 2003. The cohorts included in the main analysis are in bold.

TABLE A2.8 – DISTRIBUTION OF UNIVERSITY MAJORS, BY COHORT

	% Completing a university degree		
	Women	Men	Total
Panel A: The older cohorts			
STEM	14%	27%	20%
Law and business management	47%	36%	42%
Social Sciences	7%	11%	9%
Education	19%	10%	15%
Others	14%	15%	14%
Total	100%	100%	100%
Total number of workers	133,243	111,837	245,080
Panel B: The younger cohorts			
STEM	19%	38%	26%
Law and business management	46%	28%	39%
Social Sciences	6%	8%	7%
Education	11%	7%	10%
Others	18%	19%	18%
Total	100%	100%	100%
Total number of workers	166,859	99,612	266,471

Notes: STEM majors are programs in Science, Technology, Engineering, and Medicine. Statistics use sampling weights.

Source: The Labor Force Survey 2006–2018.

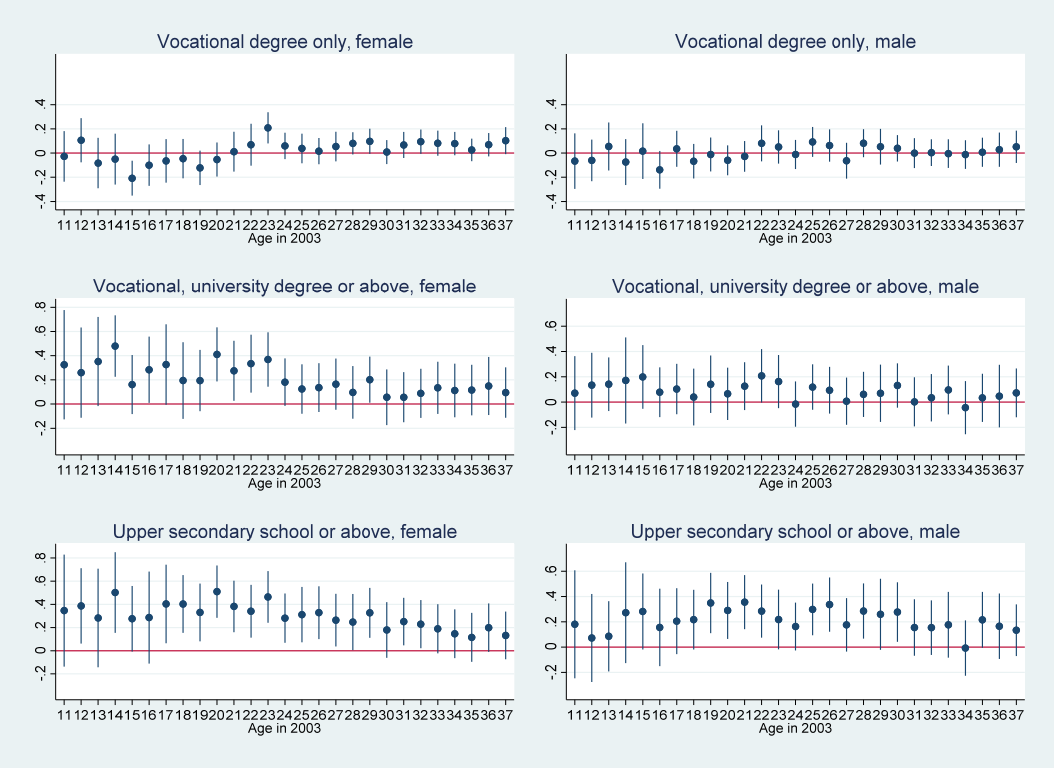


FIGURE A2.1 – EFFECTS OF UNIVERSITY EXPANSION ON EDUCATION BY GENDER AND BIRTH COHORT

Notes: The figures illustrate the effect of university expansion on education, including only post-secondary vocational education, vocational and university education, and upper secondary school or above. The figures present the coefficients of the interaction term between age dummies and university expansion intensity. We take the oldest cohort (aged 38 in 2003) as the reference group, whose effect of university expansion is indicated by the red line. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). The markers represent coefficients, and vertical spikes represent a 95% confidence interval. Standard errors are clustered at the province-cohort level. Statistics use sampling weights.

Source: The Labor Force Survey 2006–2018.

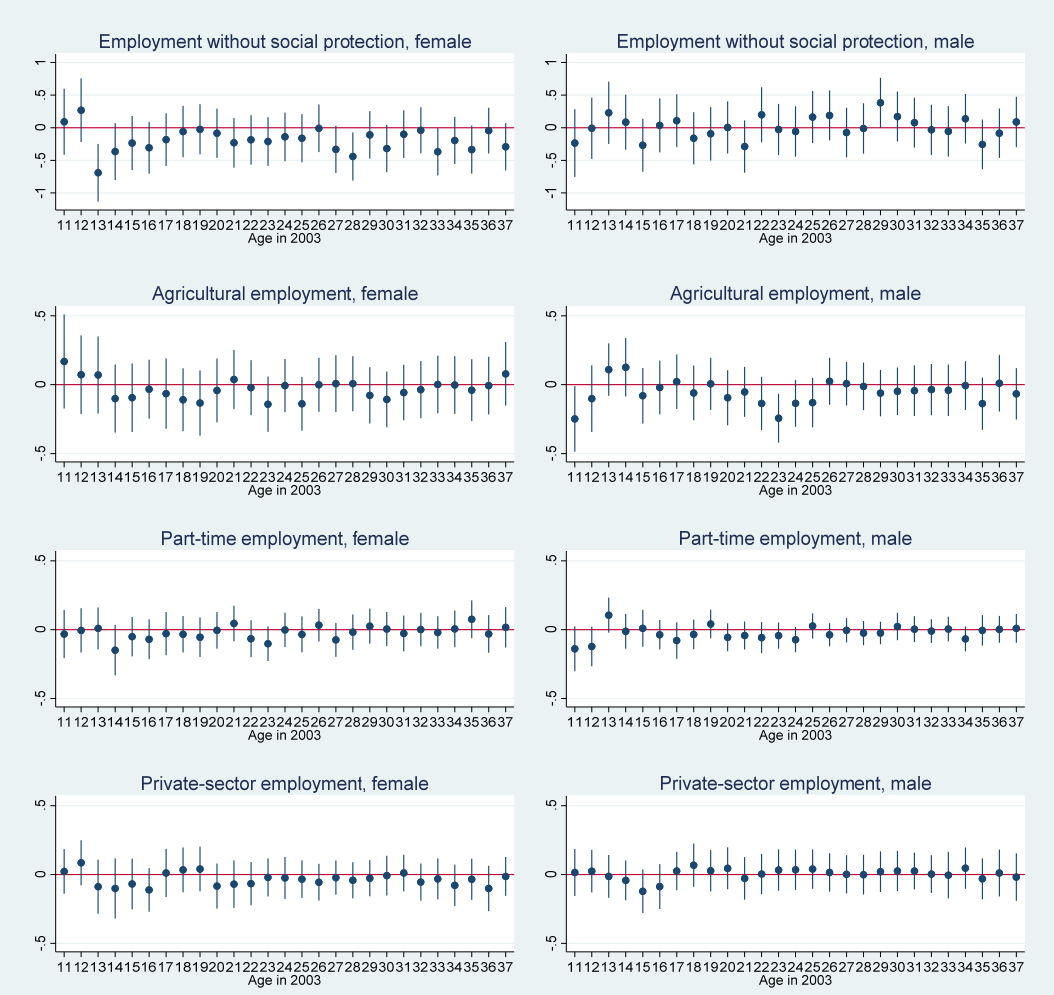


FIGURE A2.2 – THE EFFECTS OF UNIVERSITY EXPANSION ON INFORMAL EMPLOYMENT BY GENDER AND BIRTH COHORT

Notes: The figures illustrate the effect of university expansion on informal employment, including employment without social protection, agricultural employment, part-time employment, and private-sector employment. The figures present the coefficients of the interaction term between age dummies and university expansion intensity. We take the oldest cohort (aged 38 in 2003) as the reference group, whose effect of university expansion is indicated by the red line. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). The markers represent coefficients, and vertical spikes represent a 95% confidence interval. Standard errors are clustered at the province-cohort level. Statistics use sampling weights.

Source: The Informal Employment Survey 2011–2016 for employment without social protection and the Labor Force Survey 2006–2018 for other measures.

Chapter 3

Heterogeneous Effects of University Opening by Gender and Field of Study

In recent decades, women have made significant steps towards equality with men in education across OECD countries (Bertrand, 2020). Women in the developing world also have surpassed men in university graduation (Blau and Kahn, 2017), even in many low-income countries (Becker, Hubbard, and Murphy, 2010). As Chapter 2 has shown, Thailand's university opening between 2004 and 2005 has a more substantial impact on women's university completion than men's. We see the female workforce have more schooling years and higher university completion rates than their male counterpart.

Although the global gender gap in education is closing, women in both developed and developing worlds continue to experience inequality in the labor markets. As Blau and Kahn (2017) have noted, the persisting gender wage gap has little to do with human capital accumulation in recent decades. Instead, the gender differences in *occupation and industry choices* explain most the gender wage inequality. Black et al. (2008) and Goldin (2014) suggest college majors and parenthood's role, respectively, be the most prominent reason behind the gender wage gap in the developed world.

Past research on gender inequality in developing countries highlights the gender gap in education and work experiences (Gustafsson and Li, 2000; Nordman et al., 2011; Canelas and Salazar, 2014; Lee and Wie, 2017). Little is known about how the field of study affects college-going and career choices differently for men and women in the

developing world. To fill this research gap, we examine whether the relationship between informality and university attainment depends on the field of study, separately for women and men. To address university attainment's endogeneity, we exploit the university expansion as an exogenous source of variation in university completion, as in the previous chapter. We expand the first stage and reduced-form models in Equations (2.1) and (2.2) to allow for heterogeneous effects by the field of study.

Our first-stage results show that the university opening induces women and men in each field of study to complete a university degree in that field, except for women majoring in health. The estimated effects are vital for individuals majoring in STE and non-STEM, allowing us to imply the causal effect of a university degree on career choices for these fields, but not for women and men with a health background.

The reduced-form results suggest that the university opening induces individuals in non-STEM majors to leave in the informal sector and increases their formal-sector earnings. Every 10-ppts increase in university opening intensity reduces non-STEM women's informal employment by 1–3 %, except for agricultural and part-time work, and decreases men's self-employment and agricultural work by 3% and 7%, respectively. It also increases earnings by 2% for women and 3–4% for men. However, a university degree in STE pushes individuals majoring in STE into the informal sector. The effects are more noticeable for women than men. Every 10-ppts increase in university expansion intensity increases agricultural work by 21% and 8% and increases private-sector employment by 6% and 2% for STE women and men, respectively. Moreover, it also raises other informality measures of STE women by 6–8% of the sample mean but has no further impact on STE men's informal employment.

We find that more than half of STEM university graduates work in non-STEM fields. The university opening does not provide earning potential of STEM individuals working formally in non-STEM jobs. The lack of monetary return may push STEM individuals into the informal sector, particularly in the agricultural sector. It is worth noting that the university opening does increase the chance of working in and formal-sector earnings of high-skilled STE occupations for STE individuals. However, these jobs account for only 1% of the workforce.

Past literature has noted several plausible causes to increasing informality among workers in STEM fields: a shortage of desirable STEM jobs (Cappelli, 2015), a mismatch between imported technologies and local STEM workers' skills (Acemoglu and Zilibotti, 2001), or skill obsolescence due to rapid technological changes (Deming and Noray, 2020). For STEM women, skill obsolescence issues can be particularly challenging because their skills might get obsoleted after taking a maternal leave. This study estimates how university attainment in a specific field, such as STEM, can affect men's and women's career choice and occupation choice differently.

We have structured the present chapter as follows. The next section describes the descriptive statistics by gender and field of study. Section 3.2 and Section 3.3 present our identification strategy and empirical results. We further discuss the potential reasons the university opening increases informal employment for people majoring in STEM in Section 3.4.

3.1 Descriptive Statistics by Gender and Field of Study

STEM-major workers with a university degree account for 26% of the young cohorts (i.e., those potentially affected by the university opening) and 20% of the old cohorts, as documented in Table A2.8. The university-trained workforce with STEM training grows relatively slowly among women than among men. The STEM percentage rises from 14% to 19% among female university graduates from the old to young cohorts. The same statistics increase from 27% to 38% among male graduates. In contrast, we see reductions across cohorts in other fields, including Education, Social Sciences, and Law and Business Management.

To investigate the distinctive role of the medical training in pursuing a medical profession, we further classify STEM majors into two: STE (science, technology, engineering, and mathematics fields, including manufacturing and construction) and (2) Health (including nursing, dental, medicine, medical services, and social care and work). Table 3.1 presents the descriptive statistics of the LFS sample by gender and the field of study. [28] Although no more than 21% of STE-major workers are female (=6433/(6433+24518)), women's university completion rate *doubles* men's. In contrast, women account for as high as 80% of the workforce in health majors (31,897/(31,897+7,434)), and their university completion rate is 92%, about the same as men's in the same field.

[28] The data source is Thailand's Labor Force Surveys (LFS) between 2006 and 2018. The survey details are in Section 2.1.5. We do not use the Informal Employment Survey between 2011 and 2016 because the number of observations is insufficient to apply the model with both the provincial-specific linear cohort trends and the cohort-specific effect of pre-expansion conditions, as presented in Table 2.5.

Workers in STE and health majors account respectively for 8.3% and 1.4% of the workforce.[29] In this small fraction of workers in STEM, their schooling years almost double those in non-STEM majors. Moreover, workers in STEM are substantially less likely to work informally than those in non-STEM. For example, less than 16% and 11% of males and females in health majors enter the informal sector. In contrast, as high as 76% and 70% of men and women informally working if they are in non-STEM majors.

The limitation of the LFS is that the self-employed do not report their earnings; therefore, we can observe an individual' only among employees either in the public (government and state-owned enterprise) or private sectors. These employees are classified as formal workers under measure 2 of informality. We define earnings as the sum of wages, bonuses, and other fringe benefits. We exclude 295 formal employees who report zero earnings from the analysis, although including them with a proxy value of 1 baht does not affect the results.

Among the formal employees, individuals in STE or health majors tend to earn more than the non-STEM. Moreover, men in health majors have higher average earnings than the female counterpart. 73% of men in health fields work in high-skilled health-related occupations, such as medical doctors and health professionals. Only 57% of women in health fields work in these jobs, and the rest work in low-skilled positions, such as medical assistants and life science technicians.

[29] In other words, 90% are in non-STEM majors or have their highest grade completed at the lower secondary school level or below, not required to choose a field of study.

3.2 Empirical Strategy — An Expanded Model

Using a simple modification of the difference-in-differences model in Chapter 2, we estimate the university opening's impact on university complication and informal employment. Also, we extend the model to investigate the impact on informal employment related to a particular field – as in Equation (3.3). For ease of exposition, we denote $YOUNG_a \times OPEN_j$ by Z_{aj}. We focus on three fields: STE, health, and non-STEM, denoted respectively by STE_i, $HEALTH_i$, and $NSTEM_i$. The reference group covers those with no particular field while attaining upper secondary school.

$$(3.1)\ S_{ijat} = STE_i(\alpha_1 + \alpha_2 Z_{aj}) + HEALTH_i(\alpha_3 + \alpha_4 Z_{aj}) + NSTEM_i(\alpha_5 + \alpha_6 Z_{aj}) + \lambda_j + \lambda_a + \sigma_{1j} \times a + W_j' \theta_{1a} + X_{ijat}' \pi_1 + \varepsilon_{ijatf},$$

$$(3.2)\ Y_{ijat} = STE_i(\beta_1 + \beta_2 Z_{aj}) + HEALTH_i(\beta_3 + \beta_4 Z_{aj}) + NSTEM_i(\beta_5 + \beta_6 Z_{aj}) + \gamma_j + \gamma_a + \sigma_{2j} \times a + W_j' \theta_{2a} + X_{ijat}' \pi_2 + u_{ijat}.$$

As in the previous chapter, S_{ijat} indicates whether a person *i* in the province *j* and aged *a* in 2003 has completed at least a bachelor's degree by the survey year *t*. The outcome variable, Y_{ijat}, indicates whether a person *i* who lives in province *j* and was aged *a* in 2003 works informally in the survey year *t*.

To examine how the field of study chosen in upper secondary school affects an individual's decision to gain a university degree in a specific major, we set the education outcome as the interaction between the university completion indicator S_{ijat} and a field-specific dummy in Equation (3.1). Also, when investigating how college major affects informality *in a specific occupation*, we set the outcome Y_{ijat} as the interaction between

informality and occupation dummies in Equation (3.2). All specifications include the same set of control variables, as in the benchmark model in Chapter 2.

3.3 Results

3.3.1 Heterogeneous Effects on Completing a University Degree in a Particular Filed

The university opening policy increases university completion in a certain field only for the young cohorts in that field, except for women in *health* majors. Table 3.2 shows that one additional university opened per 100,000 local youths increases the probability for youths in STE majors to complete university education in STE by approximately 11 ppts for females and 7 ppts for males (Column (1)). For those in non-STEM fields, it also increases the university graduation rates by 3 ppts for females and 2 ppts for males (Column (3)). As the university expansion strongly increases men in health fields to gain a university degree in health, surprisingly, it *does not* induce women in health majors to complete a university degree in health majors (Column (2)) or any other fields (Columns (1) and (3)).

The reason why increased access to university cannot attract more women in health majors to get a health degree has two folds. First, as high as 92% of women in health majors obtain a university degree (Table 3.1). Women in health fields are relatively high-achieving, able to obtain a university degree *regardless of a university nearby*. Second, health professions are highly skilled occupations; their average hourly wage is nearly 30% higher than that of STE professions (Table 3.1). For those who would complete a university education only if there is a university nearby, the monetary return on a health degree is too low to make the educational investment worthwhile.

Notably, while the university opening *increases* youths in non-STEM to get a non-STEM degree with a higher probability by 2 to 3 ppts, it *reduces* the probability for those in STEM majors to get a non-STEM degree, the university opening strongly *reduces* their probability to get a *non-STEM* degree, as Column (3) of Table 3.2 shows. One extra university nearby per 100,000 youths increases university completion rates for women in STEM by 10 to 13 ppts and men in STEM by 3 to 7 ppts. These estimates are all statistically significant at conventional levels. It could be the case that those young people in STEM majors respond to a new university nearby (typically with a variety of university programs) by switching to a non-STEM major for getting a university degree in a non-STEM field.

As mentioned in Section 3.1, LFS has no earnings information of the self-employed. This study can estimate the impact of university opening on earnings only among employees in the public or private sectors, and about 1% of these employees do not report their earnings. When limiting the sample to formal employees who report earning, we see the estimates in Columns (4)–(6) similar to those in Columns (1)–(3), although the sample size reduces by one-half. The robustness of the results suggests that the university opening is uncorrelated with the reasons for missing earning data. Survey respondents may refuse to report earnings if they want to avoid being tracked by the authorities or unable to provide reliable amounts due to uncertain income sources.

3.3.2 Heterogeneous Effects of University on Earnings and Occupation Choice

The university opening has different effects on university attainment by the field of major. It also has heterogeneous impacts on earnings and informal employment, as

Table 3.3 shows. By looking into the reduced-form results, we get a better understanding of how university attainment in a given major potentially affects labor market outcomes. The results suggest that university attainment can induce workers in non-STEM majors to enter the formal sector for higher pay but pushes those in STEM majors into the shadow. These impacts are particularly evident among women in STEM majors. We expand these results below.

As Columns (1)–(6) indicate, every 10-ppts increase in university expansion intensity induces young women to work informally with 6–21% higher probability if in STE fields (0.552/10/0.892 to 0.591/10/0.278) and 20–50% higher probability if in health majors (1.750/10/0.892 to 1.387/10/0.278). All the estimates in various informality measures are statistically significant. In contrast, the same estimates for the male counterpart are smaller in magnitude or insignificant in statistics. The impact of a 10-ppts increase in university expansion intensity is below 8% for young men in STE-majors (0.255/10/0.314) and only statistically significant for agriculture and private-sector employment. For men in health fields, the opening increases informality by up to 41 percent (1.290/10/0.314) and mostly significant at conventional levels.

University attainment, induced by the university opening, appears to push men and women in STEM majors into the shadow economy, probably because of *reduced* pays in the formal sectors. Columns (7) and (8) indicate that every 10-ppts increase in university opening intensity *decreases* formal hourly wages for young workers in STEM majors by 1.2% to 3.3% for females and below 1% for males. For workers in STEM fields, particularly health-major women, entering the informal sector is sensible since university training cannot increase their formal pay and cannot increase their chance to get a

university degree in health either. Given that the first stage results in Table 3.2 are near zero, few females in health fields would comply with a university opening. Among the few female compliers, are low skilled, not able to get compliers

Although university opening appears to induce men in health majors to get a health degree, they are more likely to work informally because the monetary return to skills is not attractive in the formal sector, as shown in Section 3.4.

As for men and women in non-STEM majors, in contrast, the university opening induces them to work formally for higher formal earnings because of a higher probability to get a university degree in non-STEM fields (recall Table 3.2). As suggested in Columns (1) to (6) of Table 3.3, every 10-ppts increase in university opening intensity reduces informality by 3% or less for women (-0.096/10/0.892 to -0.189/10/0.660) and no more than 7% for men (-0.233/10/0.314). The impact on earnings for men and women is a 1% increase in hourly wages but has no impact on monthly earnings. The effects on all the informality and earning measures imply that the university opening induces non-STEM women to work formally for regular pay or in the public sector. Those jobs may not pay well but provide more flexibility or fewer working hours.

The estimated effect on hourly wages should be interpreted with caution. Because we derive hourly wages from monthly earnings divided by total hours worked, the measure may be sensitive to the accuracy of the self-reported number of hours worked. For example, formal workers may report the number from their statutory work contract instead of actual hours worked.

Finally, we report the OLS estimated relationship between university degree attainment and labor market outcomes by field of study, using Equation (3.2). Panels B

and D of Table 3.3 indicate that a university degree appears to increase formality and formal earnings, regardless of gender or the field of study. One exception is that a university degree in health seems to *increase* women's agricultural work and has no impact on part-time jobs. For men, completing a university degree in STE and non-STEM also reduce informal employment, with one exception that a STE degree marginally increases part-time employment. Most estimates of a university degree in health are imprecise partly because the men majoring in health account for only 0.5% of the male sample. However, we find that, like women, a university degree in health increases agricultural employment. Nevertheless, a university degree in any field strongly men's earnings.

Comparing the OLS estimates of a specific university degree with the implied reduced-form results, we find that the OLS estimates tend to overestimate the impact on a university degree in reducing informality and increasing earnings. It is particularly true for STE-major individuals and health-major women, where the OLS and reduced-form estimates show an opposite sign. The reduced-form estimation captures the effect of university opening on the potentially affected cohorts. Meanwhile, the OLS estimation provides the average effect of all samples, including individuals who intend to get a university degree to apply for a formal job, regardless of the local university's presence, and high-ability individuals who earn high incomes irrespective of competing university. The contrast results indicate a possible bias of the OLS estimates and suggest a necessity in applying the rigorous econometric strategy in estimating the effect of education on labor market outcomes. Nevertheless, we could consider the OLS estimates as the upper bound monetary returns to a university degree.

Furthermore, we estimate the return rate on an additional schooling year using the OLS estimation with a similar specification as in Equation (2.2). The result in Table A3.1 shows that an additional schooling year paid a return of around 8–10% to women and 8% to men. Although our OLS estimate is regarded as the upper bound result, it appears lower than the estimates from Mincer's earnings functions. Past research on Thailand's educational return commonly finds the return rate on an additional schooling year to be about 10–14%.[30] For comparison, we also employ the Mincer earnings function as Hawley (2004) to estimate Column (3). The estimated Mincer's regressions suggest return rates of 15% for women and 10% for men, both significant at the one percent level and considerably higher than our OLS estimates. Our specification yields lower return rates because it includes the complete set of dummies for birth cohorts and survey years, a more stringent setting than controlling for a quadratic function of years of potential experience. The finding suggests that the formal sector's return on education is not as substantial as previously understood.

3.4 Potential Reasons Why University Opening Induces Workers in STEM Fields to Work Informally

Our estimates in Section 3.3 suggest that the university opening induces non-STEM-major individuals to complete a university degree in non-STEM and eventually reduce their informal employment and increase formal-sector earnings. It also induces

[30] Although the estimates from other studies are not fully comparable to our estimates due to the difference in the sample selection, control variables included, and data years, previous studies have found higher return rates to an additional schooling year. Hawley (2004) finds that one more year of education increases monthly income by 10–11%. Warunsiri and McNown (2010) and Korwatanasakul (2019) indicate that the rate of return on education on hourly wages is 11.5% and 11%, respectively. However, Tangtipongkul (2015) estimates that the return rate is as high as 13–14%.

STE-major individuals and health-major men to complete a university degree in their field. However, these people are more likely to work in the informal sector and have not received earning potential from the formal job. This section further investigates occupational choices and earnings for each field of study and discusses the related literature explaining this phenomenon.

3.4.1 Mismatch between Career Choice and Field of Study

This section examines the effect of university opening given a particular field of study on career decisions. The reduced-form result indicates how a university degree in a specific field can affect occupation choices in the same and other fields. Table 3.4 reports the impact on STE- and health-related occupations, and Table 3.5 presents the impact on other (non-STEM) occupations. The results suggest that occupation choices of individuals with a university degree in STE and health might not as flexible as those in non-STEM majors.

Table 3.4 suggests that, for men and women in STE majors, the university opening induces workers with STE backgrounds to work formally in high-skilled STE occupations. The university opening has no impact on men's occupation choices in health, although it increases men's university completion in this field of study. However, workers in STE and health occupations are few, no more than 4% of the workforce.[31] As 96% of workers are in *non-STEM occupations*, we focus our discussion on university opening's impact for each field of study on occupation choices in non-STEM, as Table 3.5 presents.

[31] The distribution of workers by field of study and occupation is in Table A3.2.

About 54% of STEM university graduates work in non-STEM occupations. We find that, for STEM individuals, the university opening decreases the probability of formal employment in non-STEM careers. In contrast, it tends to induce STEM individuals to work informally in non-STEM occupations, particularly as agricultural workers. Every 10-ppts increase in university opening intensity increases the chance of working in informal agricultural jobs by 9–22% for individuals majoring in STE (0.267/10/0.308; 0.606/10/0.277) and by 41–50% for those majoring in health (1.267/10/0.308; 1.386/10/0.277). As formal jobs typically require a university degree, the results imply that STEM-major individuals have a limitation in utilizing their degree for getting a formal position in other fields of study. They eventually become agricultural workers in the informal sector. Unfortunately, we cannot investigate whether STEM university graduates are more productive than others due to data limitations.

For individuals in non-STEM majors, the results in Table 3.5 suggest that the university opening induces women to leave non-STEM occupations in the informal sector and enter the formal sector. They tend to be teachers or administrators either in the public or private sector. Every 10-ppts increase in university opening intensity increases the chance of working in formal, non-STEM occupations by 7% (0.207/10/0.287). Unlike women, the university opening does not affect formal and informal non-STEM occupations of men in non-STEM majors. Nevertheless, the university opening decreases their chance of agricultural work in the informal sector, consistent with our finding in Section 2.4.1.

Moreover, the university opening induces non-STEM men to work as business and public administrators and teachers. Additionally, the university opening induces non-

STEM individuals to work in STE occupations. The fraction of non-STEM individuals working in STEM jobs is minimal. Table 3.4 suggests that non-STEM women typically work in health-related jobs and non-STEM men low-skilled STE jobs (e.g., equipment operators and safety inspectors).

3.4.2 Monetary Reasons

Another potential reason for the lower impact of university opening on informal employment of STEM individuals is that they do not gain as much educational return in the formal sector as in the informal sector. As earnings in the informal sector are unobservable in the LFS, we can only examine whether formal employment provides earning potential to workers in a particular field of study. We replace the outcome variable Y_{ijatf} in Equation (3.3) with the log value of monthly earnings of formal work in field *f*.

The results reported in Table 3.6 suggest that the university opening does not lead *STEM-major* individuals to receive earning gains from non-STEM jobs in the formal sector. If entering the non-STEM field, individuals with STE background typically work as general clerks and salespersons, not considered high-pay jobs. The lack of earning benefits discourages them from participating in formal jobs in non-STEM fields. In contrast, the university opening increases earning potentials for high-skilled STE jobs in the formal sector. Every 10-ppts increase in university opening intensity increases monthly earnings of high-skilled STE jobs by 45% for women and 35% for men in STE majors. This finding could explain the increase in formal high-skilled STE jobs among STE women and men in Table 3.4. Despite this monetary benefit, many STE graduates

work in the informal sector or other fields. We discuss other non-monetary reasons in Section 3.4.3.

One distinctive finding for women in health-related majors is they appear to earn a substantial monetary return from low-skilled health jobs but not from high-skilled health jobs. The results align with the previous evidence that the university opening does not increase the university completion on women majoring in health and decreases the chance of working in health-related jobs, particularly in high-skilled jobs in the formal sector. It suggests that the decision of health-major women is driven mainly by monetary reasons. Unlike women, the university opening does affect earning potentials of health-major men. Although it could explain why there is no increase in health occupation participation among these men, it is still puzzling since the university opening increases the university completion of men in the health field. Nevertheless, the number of men studying in health majors is only one-fourth of women in the same field of study and accounts for less than 1% of the workforce.

3.4.3 Non-Monetary Reasons

Past studies investigate the problem related to the STEM labor force and suggest that it could result from a shortage of desirable STEM jobs, technology-skill mismatch, or skill obsolescence due to rapid technological changes.

First, individuals with STEM degrees do not work in STEM occupations because of the absence of available STEM jobs and that the compensation for STEM jobs is below market levels. Accordingly, many workers are more educated than their job requirements (Cappelli, 2015). Our estimate in Section 3.4.2 suggests that the university opening

increases the fraction of STE-major individuals working in high-skilled STE occupations and receiving substantial earning potentials. However, high-skilled STE jobs account for only 1% of the workforce. The limited availability of desirable jobs may lead STE individuals in this field to work in other occupations that do not require their university degrees.

Second, Acemoglu and Zilibotti (2001) demonstrate that less developed countries adopt technologies developed by more affluent countries, but their workforces do not possess the skills required to operate those technologies. Due to this technology-skill mismatch, university graduates majoring in STEM may have to work informally because most STEM-related jobs are in the formal sector. In Thailand, Doner, Intarakumnerd, and Ritchie (2013) demonstrate that a weak university-industry linkage has made R&D efforts and workers' skills provided through university training not fit with the business needs, particularly in the field of science and technology.

Last, STEM university graduates may exit STEM jobs sooner than other majors in other industries because of rapid technological changes. Deming and Noray (2020) find that the higher-ability college graduates in STEM exit STEM careers earlier than other college-trained workers. The authors link this phenomenon to the obsolescence of STEM skills learned in school and STEM industries' rapid and frequent changes in skill requirements. Skill obsolescence might have forced STEM-major individuals to work in sectors unrelated to STEM, resulting in low monetary benefits. The issue of skill obsolescence may be more challenging for women. For example, suppose STEM women leave their job temporarily to give birth. In that case, they may find it is difficult to get back to their STEM job in the formal sector after the maternal leave since their skills have

already obsolete due to rapid technological changes. The combination of skill obsolescence and motherhood penalty could explain why the university opening impact on pushing STEM-major individuals into the informal sector is more substantial for women and men.

TABLE 3.1 – DESCRIPTIVE STATISTICS BY FIELD OF STUDY, INDIVIDUAL LEVELS

	Field of study								
	STE			Health			Non-STEM		
	Men	Women	Women /men	Men	Women	Women /men	Men	Women	Women /men
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Educational attainment:									
Completed bachelor's degree or above	0.31	0.62	2.00	0.90	0.92	1.02	0.10	0.19	1.87
Completed vocational school only	0.59	0.73	1.23	0.88	0.79	0.90	0.02	0.05	3.18
Years of schooling	14.1	15.2	1.08	16.1	16.0	0.99	8.5	9.3	1.09
Informality percentage:									
Employment without social protection	0.35	0.27	0.77	0.08	0.07	0.92	0.57	0.53	0.94
Self-employment	0.34	0.24	0.71	0.11	0.06	0.57	0.49	0.49	1.00
Agricultural employment	0.11	0.05	0.48	0.02	0.01	0.33	0.35	0.29	0.84
Part-time employment	0.09	0.09	0.96	0.05	0.05	0.89	0.15	0.15	1.04
Irregular employment	0.42	0.31	0.73	0.12	0.07	0.59	0.74	0.68	0.93
Broadly-defined informal employment	0.45	0.35	0.77	0.16	0.11	0.69	0.76	0.70	0.93
Private-sector employment	0.85	0.75	0.88	0.28	0.23	0.82	0.92	0.91	0.99
Earnings:									
Hourly wages (baht)	126	132	1.04	219	169	0.77	88	95	1.08
Monthly earnings (baht)	24,972	24,095	0.96	43,076	33,394	0.78	17,666	18,358	1.04
Log (hourly wages)	4.35	4.38	1.01	4.92	4.76	0.97	3.86	3.91	1.01
Log (monthly earning)	9.65	9.59	0.99	10.20	10.09	0.99	9.14	9.18	1.00
Sample size:									
Informal Employment Survey	24,518	6,433		852	3,787		164,667	173,444	
Labor Force Survey:	191,146	49,212		7,434	31,897		1,284,611	1,346,652	
Part-time employment	189,534	48,736		7,425	31,862		1,276,561	1,340,142	
Log hourly wages	116,932	34,265		6,445	29,480		647,158	639,790	
Log monthly earning	117,491	34,570		6,464	29,628		652,724	645,920	

Notes: The table reports the means and standard deviations of characteristics of individuals born between 1965 and 1992 (aged 11–38 in 2003) and aged 22 or older at the interview time. These descriptive statistics do not count the cohorts aged 24-27 in 2003. Also, we exclude respondents who lived in Bueng-Kan province from the analysis due to missing values of provincial-level variables. *STE majors* are programs in science, technology, engineering, and mathematics fields, including manufacturing and construction. *Health majors* are programs in nursing, dental, medicine, medical services, and social care and work. *Non-STEM majors* are programs not in any of STE and health majors. Statistics use sampling weights.

TABLE 3.2 – HETEROGENEOUS EFFECTS OF UNIVERSITY EXPANSION ON COMPLETING A UNIVERSITY DEGREE IN A PARTICULAR FILED

	The full sample			**The earning sample**		
	Completing a bachelor's degree ×			Completing a bachelor's degree ×		
	STE	Health	Non-STEM	STE	Health	Non-STEM
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Women						
Potentially affected group × university	1.123***	-0.003	-1.018***	0.983***	-0.001	-0.831***
expansion intensity × STE	(0.174)	(0.005)	(0.172)	(0.177)	(0.008)	(0.165)
Potentially affected group × university	-0.033**	-0.034	-1.336***	-0.007	-0.040	-1.052***
expansion intensity × Health	(0.017)	(0.093)	(0.149)	(0.021)	(0.093)	(0.131)
Potentially affected group × university	-0.027*	0.003	0.294***	-0.008	0.008	0.276***
expansion intensity × Non-STEM	(0.016)	(0.005)	(0.060)	(0.021)	(0.008)	(0.078)
STE	0.565***	0.000***	-0.211***	0.621***	0.001***	-0.291***
	(0.010)	(0.000)	(0.006)	(0.011)	(0.000)	(0.006)
Health	0.000	0.922***	-0.178***	-0.001*	0.926***	-0.275***
	(0.000)	(0.004)	(0.005)	(0.000)	(0.004)	(0.004)
Adjusted R-squared	0.62	0.92	0.12	0.66	0.92	0.11
Sample size	1,427,761	1,427,761	1,427,761	691,498	691,498	691,498
University completion rate	0.022	0.014	0.178	0.035	0.026	0.272
Panel B: Men						
Potentially affected group × university	0.672***	-0.001	-0.342***	0.595***	-0.002	-0.248**
expansion intensity × STE	(0.182)	(0.002)	(0.113)	(0.191)	(0.003)	(0.117)
Potentially affected group × university	-0.239***	0.414***	-0.663***	-0.253***	0.368***	-0.431***
expansion intensity × Health	(0.058)	(0.147)	(0.120)	(0.070)	(0.156)	(0.121)
Potentially affected group × university	-0.140***	-0.001	0.205***	-0.178***	-0.002	0.230***
expansion intensity × Non-STEM	(0.050)	(0.002)	(0.053)	(0.063)	(0.003)	(0.067)
STE	0.279***	0.000***	-0.110***	0.318***	0.000***	-0.140***
	(0.010)	(0.000)	(0.005)	(0.011)	(0.000)	(0.006)
Health	-0.002***	0.892***	-0.103***	-0.002***	0.896***	-0.143***
	(0.001)	(0.008)	(0.004)	(0.001)	(0.009)	(0.004)
Adjusted R-squared	0.30	0.90	0.07	0.33	0.91	0.08
Sample size	1,483,191	1,483,191	1,483,191	751,798	751,798	751,798
University completion rate	0.040	0.003	0.087	0.056	0.005	0.117

Notes: The table reports the heterogeneous effects of the university expansion on completing a university degree in a particular filed by comparing the cohorts aged 11–23 in 2003 with that of the cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

TABLE 3.3 – HETEROGENEOUS EFFECTS OF UNIVERSITY EXPANSION AND UNIVERSITY COMPLETION ON INFORMAL EMPLOYMENT AND EARNINGS

	Informal employment:						Formal earnings:	
	Self-employment (1)	Agricultural employment (2)	Part-time employment (3)	Irregular employment (4)	Broadly-defined informal employment (5)	Private-sector employment (6)	Log (hourly wages) (7)	Log (monthly earnings) (8)
Women								
Panel A: Reduced-form (OLS)								
Potentially affected group × university expansion intensity × STE	0.302***	0.591***	0.112*	0.521***	0.479***	0.552***	-1.244***	-1.352***
	(0.109)	(0.116)	(0.059)	(0.120)	(0.114)	(0.117)	(0.210)	(0.185)
Potentially affected group × university expansion intensity × Health	1.782***	1.387***	0.365***	1.813***	1.790***	1.750***	-3.263***	-3.561***
	(0.167)	(0.151)	(0.103)	(0.214)	(0.222)	(0.273)	(0.274)	(0.282)
Potentially affected group × university expansion intensity × Non-STEM	-0.115*	-0.071	-0.049	-0.189***	-0.178***	-0.096**	0.237**	0.150
	(0.064)	(0.054)	(0.039)	(0.071)	(0.068)	(0.045)	(0.119)	(0.109)
STE	-0.136***	-0.147***	-0.036***	-0.287***	-0.265***	-0.178***	0.492***	0.420***
	(0.007)	(0.007)	(0.003)	(0.007)	(0.007)	(0.007)	(0.017)	(0.014)
Health	-0.453***	-0.269***	-0.106***	-0.631***	-0.614***	-0.712***	0.973***	1.062***
	(0.009)	(0.009)	(0.004)	(0.010)	(0.010)	(0.011)	(0.013)	(0.015)
Panel B: Correlation (OLS)								
Completing a bachelor's degree × STE	-0.136***	-0.033***	-0.016***	-0.223***	-0.197***	-0.186***	0.579***	0.455***
	(0.009)	(0.007)	(0.005)	(0.009)	(0.008)	(0.010)	(0.015)	(0.014)
Completing a bachelor's degree × Health	-0.062***	0.019**	0.011	-0.050***	-0.051***	-0.074***	0.459***	0.444***
	(0.014)	(0.009)	(0.008)	(0.016)	(0.017)	(0.021)	(0.023)	(0.023)
Completing a bachelor's degree × Non-STEM	-0.252***	-0.190***	-0.046***	-0.466***	-0.421***	-0.323***	0.936***	0.776***
	(0.007)	(0.010)	(0.004)	(0.009)	(0.008)	(0.011)	(0.013)	(0.012)
STE	-0.101***	-0.148***	-0.031***	-0.243***	-0.227***	-0.121***	0.355***	0.310***
	(0.007)	(0.006)	(0.004)	(0.008)	(0.008)	(0.006)	(0.010)	(0.009)
Health	-0.397***	-0.286***	-0.114***	-0.632***	-0.605***	-0.663***	0.739***	0.785***
	(0.015)	(0.011)	(0.008)	(0.017)	(0.017)	(0.023)	(0.023)	(0.024)
Sample size	1,427,761	1,427,761	1,428,484	1,427,761	1,427,761	1,427,761	691,498	698,024
Sample mean	0.475	0.278	0.153	0.660	0.682	0.892	4.0	9.2

TABLE 3.3 – HETEROGENEOUS EFFECTS OF UNIVERSITY EXPANSION AND UNIVERSITY COMPLETION ON INFORMAL EMPLOYMENT AND EARNINGS (CONTINUED)

	Informal employment:						Formal earnings:	
	Self-employment (1)	Agricultural employment (2)	Part-time employment (3)	Irregular employment (4)	Broadly-defined informal employment (5)	Private-sector employment (6)	Log (hourly wages) (7)	Log (monthly earnings) (8)
Men								
Panel C: Reduced-form (OLS)								
Potentially affected group × university expansion intensity × STE	-0.110	0.255**	0.016	0.044	0.097	0.146**	-0.887***	-0.925***
	(0.082)	(0.108)	(0.050)	(0.083)	(0.080)	(0.059)	(0.152)	(0.135)
Potentially affected group × university expansion intensity × Health	1.422***	1.290***	0.247	1.407***	1.416***	1.849***	-0.989	-1.120
	(0.220)	(0.219)	(0.162)	(0.281)	(0.295)	(0.412)	(0.778)	(0.761)
Potentially affected group × university expansion intensity × Non-STEM	-0.154**	-0.233***	-0.044	-0.117*	-0.090	-0.045	0.348***	0.368***
	(0.068)	(0.060)	(0.039)	(0.063)	(0.060)	(0.042)	(0.113)	(0.105)
STE	-0.071***	-0.146***	-0.031***	-0.248***	-0.237***	-0.082***	0.476***	0.463***
	(0.004)	(0.007)	(0.002)	(0.004)	(0.004)	(0.003)	(0.010)	(0.008)
Health	-0.394***	-0.303***	-0.086***	-0.615***	-0.596***	-0.677***	1.099***	1.116***
	(0.011)	(0.011)	(0.006)	(0.013)	(0.013)	(0.013)	(0.017)	(0.019)
Panel D: Correlation (OLS)								
Completing a bachelor's degree × STE	-0.084***	-0.013**	0.005*	-0.146***	-0.127***	-0.109***	0.618***	0.500***
	(0.005)	(0.006)	(0.003)	(0.005)	(0.005)	(0.007)	(0.014)	(0.013)
Completing a bachelor's degree × Health	0.034	0.066***	0.011	0.024	0.009	0.049	0.466***	0.455***
	(0.029)	(0.023)	(0.022)	(0.032)	(0.035)	(0.031)	(0.043)	(0.047)
Completing a bachelor's degree × Non-STEM	-0.154***	-0.178***	-0.027***	-0.379***	-0.345***	-0.281***	0.946***	0.833***
	(0.007)	(0.010)	(0.003)	(0.009)	(0.008)	(0.011)	(0.013)	(0.012)
STE	-0.064***	-0.149***	-0.034***	-0.246***	-0.236***	-0.078***	0.365***	0.373***
	(0.003)	(0.005)	(0.002)	(0.004)	(0.004)	(0.002)	(0.006)	(0.006)
Health	-0.399***	-0.341***	-0.092***	-0.641***	-0.605***	-0.703***	0.793***	0.798***
	(0.028)	(0.023)	(0.023)	(0.031)	(0.036)	(0.028)	(0.034)	(0.041)
Sample size	1,483,191	1,483,191	1,475,487	1,483,191	1,483,191	1,483,191	751,798	757,849
Sample mean	0.470	0.314	0.141	0.694	0.715	0.910	4.0	9.2

Notes: The table reports the heterogeneous effects of the university expansion and university completion on informal employment and the log value of earning outcomes by comparing the cohorts aged 11–23 in 2003 with that of the cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

TABLE 3.4 – HETEROGENEOUS EFFECTS OF UNIVERSITY EXPANSION ON OCCUPATION CHOICES IN STE AND HEALTH FIELDS

	Occupation in Science, Technology, and Engineering:					Occupation in Health:				
	All	High-skilled	Low-skilled	Formal	Informal	All	High-skilled	Low-skilled	Formal	Informal
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Women										
Potentially affected group × university	0.473***	0.454***	0.019	0.453***	0.020	-0.042*	-0.026	-0.015	-0.033	-0.009
expansion intensity × STE	(0.169)	(0.143)	(0.047)	(0.160)	(0.023)	(0.024)	(0.017)	(0.019)	(0.022)	(0.009)
Potentially affected group × university	0.009	0.042	-0.033	0.022	-0.013	-0.348**	-0.721***	0.373***	-0.329**	-0.019
expansion intensity × Health	(0.056)	(0.045)	(0.025)	(0.055)	(0.010)	(0.154)	(0.151)	(0.103)	(0.162)	(0.053)
Potentially affected group × university	-0.062***	-0.033***	-0.029	-0.055***	-0.007	0.027**	0.017**	0.010	0.027**	0.000
expansion intensity × Non-STEM	(0.022)	(0.012)	(0.019)	(0.020)	(0.009)	(0.013)	(0.009)	(0.012)	(0.012)	(0.007)
STE	0.115***	0.071***	0.044***	0.100***	0.015***	0.015***	0.010***	0.005***	0.014***	0.000
	(0.008)	(0.007)	(0.003)	(0.007)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.000)
Health	-0.001	0.000	-0.001	0.001	-0.001***	0.839***	0.750***	0.090***	0.790***	0.049***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.006)	(0.007)	(0.004)	(0.007)	(0.003)
Adjusted R-squared	0.06	0.07	0.02	0.06	0.01	0.53	0.63	0.02	0.54	0.01
Sample size	1,426,431	1,426,431	1,426,431	1,426,431	1,426,431	1,426,431	1,426,431	1,426,431	1,426,431	1,426,431
Sample mean	0.015	0.006	0.009	0.012	0.004	0.021	0.013	0.007	0.018	0.003
Panel B: Men										
Potentially affected group × university	0.304**	0.340***	-0.036	0.254**	0.050**	-0.002	0.002	-0.004	-0.007	0.005
expansion intensity × STE	(0.129)	(0.106)	(0.041)	(0.117)	(0.020)	(0.009)	(0.006)	(0.007)	(0.009)	(0.004)
Potentially affected group × university	-0.208**	-0.092	-0.116**	-0.184**	-0.024	0.193	0.386	-0.193	0.200	-0.006
expansion intensity × Health	(0.086)	(0.062)	(0.053)	(0.082)	(0.023)	(0.328)	(0.349)	(0.213)	(0.375)	(0.140)
Potentially affected group × university	0.006	-0.035	0.040*	0.003	0.002	0.003	0.003	0.000	-0.001	0.005
expansion intensity × Non-STEM	(0.040)	(0.030)	(0.022)	(0.037)	(0.011)	(0.008)	(0.005)	(0.006)	(0.008)	(0.003)
STE	0.158***	0.063***	0.095***	0.140***	0.017***	0.001***	0.000	0.001***	0.001***	0.000
	(0.005)	(0.005)	(0.002)	(0.005)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Health	0.014***	0.004**	0.010***	0.015***	-0.002**	0.708***	0.554***	0.153***	0.639***	0.069***
	(0.004)	(0.002)	(0.003)	(0.004)	(0.001)	(0.012)	(0.013)	(0.010)	(0.013)	(0.006)
Adjusted R-squared	0.12	0.07	0.06	0.11	0.01	0.33	0.39	0.03	0.33	0.02
Sample size	1,481,785	1,481,785	1,481,785	1,481,785	1,481,785	1,481,785	1,481,785	1,481,785	1,481,785	1,481,785
Sample mean	0.037	0.014	0.023	0.031	0.006	0.005	0.003	0.003	0.004	0.001

Notes: The table reports the heterogeneous effects of the university expansion on occupation choices in STE and health fields by comparing the cohorts aged 11–23 in 2003 with that of the cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. Here, we use broadly-defined informal employment. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

TABLE 3.5 – HETEROGENEOUS EFFECTS OF UNIVERSITY EXPANSION ON OCCUPATION CHOICES IN NON-STEM FIELDS

	Occupation in non-STEM:												
				Formal employment:					Informal employment:				
	All	High-skilled	Low-skilled	All occupations	Education and administration	Sales/service workers	Agricultural workers	Others	All occupations	Education and administration	Sales/service workers	Agricultural workers	Others
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Panel A: Women, N=1,426,431													
Potentially affected group ×	-0.431**	-0.147**	-0.284*	-0.902***	-0.627***	-0.198**	-0.005	-0.071	0.470***	-0.219***	-0.085	0.606***	0.169**
UEI × STE	(0.171)	(0.058)	(0.168)	(0.222)	(0.153)	(0.084)	(0.003)	(0.055)	(0.111)	(0.060)	(0.091)	(0.116)	(0.076)
Potentially affected group ×	0.339**	-0.187**	0.526***	-1.480***	-0.934***	-0.365***	-0.006	-0.175***	1.820***	-0.131***	0.410***	1.386***	0.155**
UEI × Health	(0.149)	(0.080)	(0.138)	(0.190)	(0.152)	(0.074)	(0.004)	(0.048)	(0.216)	(0.036)	(0.089)	(0.149)	(0.069)
Potentially affected group ×	0.035	0.027	0.008	0.207***	0.156***	0.025	-0.008**	0.034	-0.171**	0.005	-0.049	-0.066	-0.063
UEI × Non-STEM	(0.027)	(0.028)	(0.037)	(0.063)	(0.053)	(0.040)	(0.003)	(0.042)	(0.069)	(0.025)	(0.059)	(0.053)	(0.048)
STE	-0.130***	0.024***	-0.154***	0.151***	0.194***	-0.027***	0.000***	-0.016***	-0.281***	0.038***	-0.058***	-0.150***	-0.112***
	(0.008)	(0.004)	(0.010)	(0.011)	(0.007)	(0.005)	(0.000)	(0.003)	(0.007)	(0.003)	(0.005)	(0.007)	(0.005)
Health	-0.838***	-0.010***	-0.829***	-0.176***	-0.086***	-0.059***	-0.001***	-0.031***	-0.662***	-0.025***	-0.230***	-0.268***	-0.139***
	(0.006)	(0.002)	(0.006)	(0.007)	(0.004)	(0.003)	(0.000)	(0.002)	(0.009)	(0.002)	(0.003)	(0.009)	(0.003)
Adjusted R-squared	0.34	0.04	0.19	0.16	0.09	0.04	0.00	0.08	0.21	0.01	0.04	0.29	0.06
Sample mean	0.964	0.044	0.920	0.287	0.165	0.080	0.001	0.042	0.677	0.041	0.220	0.277	0.138
Panel B: Men, N=1,481,785													
Potentially affected group ×	-0.302**	-0.325***	0.023	-0.342**	-0.192***	-0.214***	-0.004	0.068	0.040	-0.168***	-0.099	0.267***	0.041
UEI × STE	(0.129)	(0.043)	(0.123)	(0.156)	(0.057)	(0.052)	(0.008)	(0.096)	(0.077)	(0.034)	(0.062)	(0.106)	(0.071)
Potentially affected group ×	0.015	-0.234	0.249	-1.424***	-0.510**	-0.349***	-0.012	-0.553***	1.439***	0.023	0.082	1.267***	0.067
UEI × Health	(0.326)	(0.181)	(0.240)	(0.303)	(0.252)	(0.097)	(0.011)	(0.096)	(0.245)	(0.073)	(0.098)	(0.211)	(0.089)
Potentially affected group ×	-0.009	0.069**	-0.078**	0.087	0.100***	-0.023	-0.007	0.018	-0.096	0.051*	0.091**	-0.226***	-0.011
UEI × Non-STEM	(0.040)	(0.028)	(0.046)	(0.070)	(0.037)	(0.035)	(0.007)	(0.057)	(0.060)	(0.026)	(0.046)	(0.058)	(0.058)
STE	-0.159***	0.036***	-0.195***	0.034***	-0.015***	-0.002***	0.078***	0.078***	-0.254***	0.027***	-0.019***	-0.147***	-0.115***
	(0.005)	(0.002)	(0.006)	(0.002)	(0.002)	(0.000)	(0.005)	(0.005)	(0.004)	(0.001)	(0.003)	(0.007)	(0.004)
Health	-0.722***	0.040***	-0.762***	0.057***	-0.032***	-0.003***	-0.080***	-0.080***	-0.664***	-0.017***	-0.110***	-0.298***	-0.240***
	(0.011)	(0.008)	(0.010)	(0.010)	(0.004)	(0.001)	(0.005)	(0.005)	(0.010)	(0.003)	(0.004)	(0.011)	(0.003)
Adjusted R-squared	0.15	0.04	0.12	0.03	0.02	0.00	0.08	0.08	0.18	0.02	0.02	0.26	0.04
Sample mean	0.958	0.050	0.908	0.249	0.078	0.054	0.003	0.115	0.709	0.042	0.123	0.308	0.235

Notes: The table reports the heterogeneous effects of the university expansion on occupation choices in non-STEM fields by comparing the cohorts aged 11–23 in 2003 with that of the cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. Here, we use broadly-defined informal employment, and *UEI* means university expansion intensity. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

TABLE 3.6 – HETEROGENEOUS EFFECTS OF UNIVERSITY EXPANSION ON EARNING IN A PARTICULAR FORMAL JOB

	Log (monthly earnings) ×								
	Occupation in STE:			Occupation in Health:			Occupation in Non-STEM:		
	All	High-skilled	Low-skilled	All	High-skilled	Low-skilled	All	High-skilled	Low-skilled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Women, N=696,782									
Potentially affected group × university expansion intensity × STE	4.101**	4.501***	-0.400	-0.558*	-0.354	-0.204	-4.834***	-1.481**	-3.352*
	(1.873)	(1.600)	(0.557)	(0.314)	(0.226)	(0.250)	(1.823)	(0.675)	(1.783)
Potentially affected group × university expansion intensity × Health	0.119	0.431	-0.312	-5.754***	-9.257***	3.503***	2.112	-1.195	3.307***
	(0.610)	(0.493)	(0.297)	(1.561)	(1.610)	(1.032)	(1.493)	(0.919)	(1.253)
Potentially affected group × university expansion intensity × Non-STEM	-0.913***	-0.483***	-0.430*	0.489**	0.352**	0.137	0.590	0.339	0.251
	(0.294)	(0.179)	(0.242)	(0.199)	(0.141)	(0.176)	(0.371)	(0.366)	(0.468)
STE	1.533***	0.958***	0.575***	0.198***	0.144***	0.053***	-1.312***	0.198***	-1.509***
	(0.096)	(0.085)	(0.036)	(0.021)	(0.016)	(0.013)	(0.093)	(0.043)	(0.108)
Health	-0.034***	-0.005	-0.029***	8.934***	8.037***	0.897***	-7.836***	-0.246***	-7.590***
	(0.012)	(0.007)	(0.010)	(0.060)	(0.071)	(0.042)	(0.052)	(0.025)	(0.053)
Adjusted R-squared	0.08	0.08	0.03	0.60	0.67	0.03	0.33	0.04	0.18
Sample mean	0.3	0.1	0.2	0.4	0.2	0.1	8.6	0.6	8.0
Panel B: Men, N=756,574									
Potentially affected group × university expansion intensity × STE	1.755	3.529***	-1.774***	-0.181	0.017	-0.198*	-2.481*	-2.714***	0.234
	(1.431)	(1.243)	(0.524)	(0.137)	(0.094)	(0.111)	(1.376)	(0.472)	(1.274)
Potentially affected group × university expansion intensity × Health	-0.985	-0.471	-0.514	2.095	5.324	-3.229	-2.169	-2.482	0.313
	(1.019)	(0.743)	(0.664)	(3.833)	(3.899)	(2.332)	(3.608)	(2.081)	(2.455)
Potentially affected group × university expansion intensity × Non-STEM	0.735	-0.109	0.844**	-0.074	0.023	-0.097	-0.286	0.578	-0.864
	(0.536)	(0.406)	(0.341)	(0.131)	(0.089)	(0.105)	(0.521)	(0.360)	(0.595)
STE	2.417***	0.990***	1.427***	0.011***	-0.002	0.013***	-1.963***	0.181***	-2.144***
	(0.068)	(0.069)	(0.033)	(0.005)	(0.002)	(0.004)	(0.064)	(0.022)	(0.065)
Health	0.114***	0.043*	0.071*	7.728***	6.048***	1.680***	-6.725***	0.430***	-7.155***
	(0.049)	(0.024)	(0.038)	(0.122)	(0.139)	(0.106)	(0.115)	(0.088)	(0.088)
Adjusted R-squared	0.16	0.09	0.08	0.39	0.42	0.04	0.13	0.04	0.12
Sample mean	0.65	0.25	0.40	0.09	0.05	0.04	8.49	0.47	8.02

Notes: The table reports the heterogeneous effects of the university expansion on the log value of monthly earnings in a particular career in the formal sector by comparing the cohorts aged 11–23 in 2003 with that of the cohorts aged 28–38 in 2003. We exclude those aged 24–27 in 2003 from the analysis. All specifications include an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

Appendix

TABLE A3.1 – OLS ESTIMATED EFFECTS OF SCHOOLING YEAR ON EARNINGS AMONG FORMAL WORKERS

		Our model		**Hawley (2004)**
		Log (hourly wages)	Log (monthly earning)	Log (monthly earning)
Regressor :		(1)	(2)	(3)
Panel A: Women				
Years of schooling		0.095***	0.084***	0.146***
		(0.000)	(0.000)	(0.003)
	Adjusted R-squared	0.469	0.445	0.446
	Sample mean	4.0	9.2	9.2
	Sample size	691,498	698,024	698,024
Panel B: Men				
Years of schooling		0.081***	0.076***	0.101***
		(0.000)	(0.000)	(0.003)
	Adjusted R-squared	0.416	0.420	0.418
	Sample mean	4.0	9.2	9.2
	Sample size	751,798	757,849	757,849
Provincial-specific linear cohort trends		Yes	Yes	-
Cohort-specific effect of pre-expansion conditions in provinces:		Yes	Yes	-

Notes: The table reports the effects of an additional schooling year on the log value of earning outcomes. We exclude those aged 24–27 in 2003 and formal employees with zero income (295 observations) from the analysis. In Column (1)-(2), the specification includes an urban dummy, provincial population growth, province fixed effects, age fixed effects in 2003, survey-year fixed effects, provincial-specific linear cohort trends, and cohort-specific effects of the pre-expansion provincial-level conditions (including bachelor-degree enrollment rate, change in years of schooling, universal health coverage scheme participation, gross provincial product per capita, and minimum wage). In Column (3), the specification includes experience and its square, an urban dummy, a public sector employment dummy, region fixed effects, and educational attainment fixed effects. Standard errors are in parentheses and are clustered at the province-cohort level. Statistics use sampling weights. ***, **, and * denote significance at the 1, 5, and 10 percent levels, respectively.

TABLE A3.2 – DISTRIBUTION OF OCCUPATIONS, BY FIELD OF STUDY

	All workers				Workers with a university degree			
	Occupation in:				Occupation in:			
	STE	Health	Non-STEM	Total	STE	Health	Non-STEM	Total
Panel A: Whole sample								
STE majors	18%	1%	81%	100%	34%	1%	65%	100%
Health majors	1%	81%	17%	100%	1%	83%	16%	100%
Non-STEM majors	1%	0%	98%	100%	4%	1%	95%	100%
Panel B: Women								
STE majors	15%	2%	82%	100%	22%	3%	75%	100%
Health majors	1%	84%	15%	100%	1%	85%	14%	100%
Non-STEM majors	1%	1%	98%	100%	2%	1%	96%	100%
Panel C: Men								
STE majors	19%	0%	81%	100%	40%	1%	60%	100%
Health majors	3%	72%	26%	100%	2%	72%	25%	100%
Non-STEM majors	1%	0%	98%	100%	7%	1%	92%	100%

Notes: We exclude individuals aged 24–27 in 2003. Statistics use sampling weights.

Conclusion

4.1 Conclusion

This study examines the effect of university expansion policy on an individual's university completion and career decisions by exploiting variation in policy exposure across provinces and birth cohorts and uses these estimates to imply the causal link between a university degree and informal employment. University education could reduce informality, especially among individuals who may undertake informal work due to scarce opportunities to complete university education, a typical prerequisite for working in the formal sector.

Our results suggest that the university opening substantially induces women to attend university, and a university degree increases their chance of being employed with regular earnings. Women with a university degree are more likely to work related to education or public administration. For men, the university opening also increases university completion and decreases self-employment and agricultural employment, but these estimates cannot be interpreted as a causal effect due to a weak first-stage result. Moreover, men appear to change employment status within the informal sector instead of moving to the formal sector. For example, although they move out from the agricultural sector, they still work in part-time jobs.

The effects of university opening on labor market outcomes vary with field of study and gender. The university expansion policy reduces informal sector participation and increases earnings for individuals in non-STEM majors. In contrast, it induces

individuals in STEM majors to enter the informal sector. The effects are more pronounced for women than men. More than a half of STEM university graduate works in the non-STEM occupations. These jobs in the formal sector cannot increase their earning potential, and they eventually work in informal non-STEM jobs. Past literature suggests that the potential reasons for an increase in informality among STEM university graduates could be associated with a shortage of desirable STEM jobs, mismatch of imported technologies with local STEM workers' skills, or skill obsolescence due to rapid technological changes (Acemoglu and Zilibotti, 2001; Cappelli, 2015; Deming and Noray, 2020).

Perhaps surprisingly, the 2004-5 university expansion reform only reduces informal employment by 1–2% for men and has almost no impact on women. The small impact of the reform is due to the positive impact of a university degree on informal jobs for STEM individuals, canceling out the reduction effect on non-STEM individuals' informality. With only 4–5 universities that opened for every one million youths, the 2004-5 reform intensity is too low to reduce the informal sectoral size substantially. Moreover, past studies suggest that individuals may intentionally work informally to avoid regulation and evade the tax system as well as enjoying considerable earnings and desirable non-wage features of informal jobs (Bruhn, 2011; Maloney, 1999; Vivatsurakit and Vechbanyongratana, 2020). The latter reason is particularly true for women with children, who tend to choose jobs that better fit their family responsibilities, which could lessen a university degree's impact on women's career choices (Bertrand, Goldin, and Katz, 2010; Mas and Pallais, 2017).

4.2 Policy Recommendations

This study shows that promoting university education (especially opening new *non-STEM* university programs) effectively reduces informal sector participation and increases earning potential. Our results call attention to the policies to encourage university attendance. In addition to the university expansion in 2004–2005, the Thai government has established the Education Loan Fund to financially support higher education access for students of disadvantaged economic status. Oreopoulos and Petronijevic (2013) discuss that students may be reluctant to take on debt, although student loans are available. Further assistance in getting through the application process and providing comprehensive information about associated expenses and anticipated future earnings could help support student's decision to invest in university education.

However, the study indicates problems associated with STEM labor force that a university degree substantially increases women's informal employment and raises men's self-employment and agricultural employment. The majority of STEM individuals work in non-STEM occupations. Plausible explanations in the literature for many university graduates working in the informal sector include a shortage of high-paying STEM jobs, skill mismatch, and skill obsolescence due to rapid technological changes. Policymakers could enhance graduates' transition from university to jobs that can utilize their degree. For example, the government could support policies to promote strategic collaboration between universities and employers and improve educational quality so that the supply of

university graduates could better match the labor market demand for high-skilled workers in quantity and quality.[32]

The problem related to workers in STEM fields is more pronounced for women than men. This gender difference has important policy implications. Women may suffer from the motherhood penalty. Family and tax policies that can make formal employment more attractive to highly-skilled STEM females will reduce informal sectoral size. According to the previous literature, these policies include providing childcare and early education to workers in the formal sector (Olivetti and Petrongolo, 2017) and removing the marriage penalty from the upper-income tax structure to encourage highly skilled females to work formally after marriage (Selin, 2014). See Bertrand (2020) for comprehensive reviews.

Apart from reducing informal employment, the university expansion increases local youths' education at the university level. The presence of a university in the province of residence minimizes the cost of attending university and encourages young people to pursue education up to the university level. As the effect of university opening is notably higher on women's educational attainment than men's, this study shows that university expansion appears to play a role in improving gender equality in education.

4.3 Contribution to Literature

This study empirically tests and proposes a policy to reduce informal employment, which has focused on the *job-based* individualistic decision. This approach differs from

[32] Past studies have shown a relatively low quality of newly opened university compared to other public universities and a weak linkage between university and industry in Thailand (Kanjanapanyakom, 2011; Doner, Intarakumnerd, and Ritchie, 2013).

most of the studies concerning formalization-promoting policies that rely on *firm-based* decisions. This study contributes to the literature on the non-pecuniary effects of university education in developed countries. Rather than examining the results on the labor force participation in general, it analyzes the impact of a university degree induced by the university expansion policy on informal employment. This issue is essential since the informal economy is predominant and considered a problem in developing economies, but studies aiming to understand an individual's decision to enter the informal sector are scarce.

This study also examines the pecuniary effects of university education. Although intensive research has investigated Thai's return to education, most of the studies rely on Mincer's earnings functions, which may suffer a possible bias from omitting unobservable variables. With more rigorous controls, our OLS estimation is also likely overstated. However, the upper bound estimate of the return to education is much lower than the previous studies, suggesting that the return to education of formal jobs in Thailand is not as substantial as previously understood.

Moreover, this study signifies that the field of study affects career choices associated with university completion induced by the university expansion policy differently between women and men. Our findings fill the literature on gender disparity in the developing world, which mostly explains the gap using education attainment and work experiences.

4.4 Limitations and Future Research

A number of challenges remain to be addressed in future research. First, the study finds almost no significant impact of university completion on the official measurement of informal employment, namely employment without social protection, although it resembles other informality measures. One possibility for the lack of impact is the limited number of observations in IES 2011–2016, which is only one-eighth of those in LFS 2006–2018. Future research should re-estimate the effect on employment without social protection when the appropriate number of observations is available.

Second, we cannot observe whether a university degree generates earning gains for individuals who choose informal employment because our data sources have no information on self-employed earnings. Future research may use other data sources, such as the *Household Socio-Economic Survey*, that collect information about informal workers' earnings. It is worth noting that estimating the return to a university degree among formal and informal workers separately with the data available for both these sectors may not have been appropriate since informality is endogenous. Future research can apply the model, which includes interaction terms.

Third, the limited educational impact on informal employment could result from inferior university quality due to the rapid expansion, skill mismatch/obsolete, motherhood penalty among female workers, or other desirable informal work features, such as flexible work schedule and a channel of tax evasion. Given data limitations, further investigation on those possibilities awaits future research.

Fourth, our estimated results indicate the effect among individuals who would complete university education only when there was a university opened nearby and tend

to have low skills. This possibility may lead to a low impact of education on labor market outcomes. Additionally, our specifications have added rigid controlling factors, including both linear and non-linear cohort trends. Future research may select a shorter range of potentially affected cohorts to help avoid the impact from former education policies without extensive controls.

Fifth, although this study has examined the effect of a university degree on women's informal employment using an IV method, it faces a limitation in applying the same identification strategy to the male sample. The exogeneity condition is invalid since the university opening affects men's career decisions through alternative pathways. For a more comprehensive understanding, future work has to search for an instrumental variable that could be applied to both genders.

Finally, this study is an empirical work using Thailand's data, which makes it highly context-specific. Therefore, generalizing the findings and implications requires caution. Nevertheless, the study discovers the causal link between reducing informality and promoting university education. As many developing countries are promoting higher-education expansion, the findings in this study provide an accurate policy evaluation that can equip the policymaker to plan and implement education policies and justify allocating budgets to education relative to other government expenditures.

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