Revisiting the Returns to Education during the Rapid Structural and Rural Transformation in Thailand:
A Regression Discontinuity Approach

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Outline

1. Introduction, Research Motivation, and Contributions

1. Introduction, Research Motivation, and Contributions

- The fundamental importance of human capital formation in the process of economic development is well understood.

- However, quantitative magnitudes of the causal effects of education on earnings are still intensely debated in both the developed and developing country contexts.

- Recent studies from developed countries have shown that endogeneity bias in the conventional OLS estimates is quite substantial, and that there is a great deal of heterogeneity in returns to education within population.

- In developing countries, however, similar studies remain relatively scarce.

1. Introduction, Research Motivation, and Contributions

- This paper applies an IV estimation approach to the incidence of the change in the compulsory schooling law in 1978 in Thailand
  - A methodology with an increasing number of applications in developed countries but rarely found in developing countries.
- Our findings are in contrast with most of the recent studies exploiting similar institutional changes from developed countries.
  - OLS estimates > IV estimates
- It is possible that some of explanations for the empirical findings from developed countries may not apply in developing country contexts.
  - Positive ability bias rather than negative ability bias
- It is this lacuna in the literature that this paper intends to address.

1. Introduction, Research Motivation, and Contributions

- Research contributions
- Providing a better understanding regarding the relative magnitudes of the estimates from OLS and IV estimation
  - How and when the conventional "ability bias" matters in estimating returns to schooling
  - The impact of compulsory schooling in different settings
- Providing a better understanding on the process of Thai economic development and the interplay between the rates of return to schooling and the economic development process.
  - Implications to other developing countries

2. Mincer Model

2. Mincer Model

Mincerian earnings equation (Mincer 1958, 1974)

$$\log y_i = \beta_0 + \beta_1 S_i + \beta_2 X_i + \beta_3 X_i^2 + e_i$$

where

y_i : Incomes/earnings

β_1 : An educational premium for wages and/or an internal rate of return to schooling under a set of certain assumptions

S_i : Years of education an individual attended

X_i : Number of years an individual has worked after completing his/her education, and

e_i : A disturbance term

3. The Empirical Methodology and Data

3. The Empirical Methodology and Data

3.1 Empirical Methodology

- This paper applies IV estimation approach using the incidence of change in compulsory schooling law as an instrumental variable for estimating the returns to schooling (e.g., Oreopoulos, 2006).

- The incidence of the 1978 Primary Education Act in Thailand.

  - The Government expanded compulsory education from 4 years to 6 years of primary education.

  - The first cohorts that got affected by the law change are cohorts born in 1966-1972 (with a 5-years adjustment period).

3. The Empirical Methodology and Data

3.1 Empirical Methodology

- One additional complication: 5 Years adjustment period (1978-1982)
  - Some schools are ready but some schools are not.
  - By 1982, every student and every school must comply to the 1978 Compulsory Education Act.
  - Therefore, 1966-1972 cohorts are excluded from the analysis.

3. The Empirical Methodology and Data

Fraction Graduating at Most Four and Six Years of Education, 1986 - 2012

Source: Author's compilation based on Labour Force Survey 1986-2012
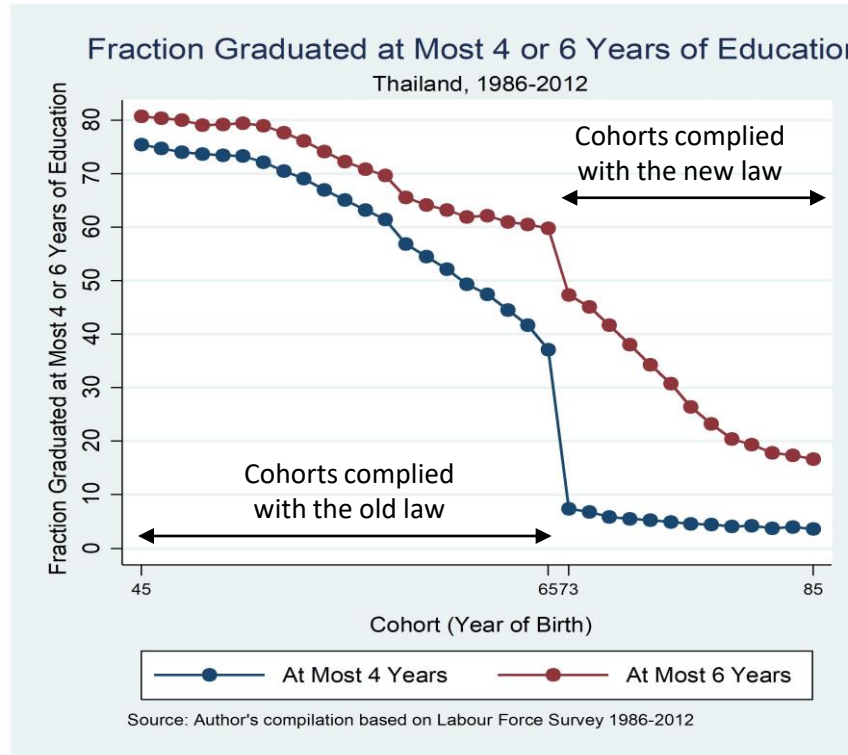
Note: The lower line shows the proportion of adults aged 15 to 60 from 1986 to 2012 LFSs who report the highest attained level of education is at most four years. The upper line shows the proportion of adult aged 15 to 60 who report the highest attained level of education is at most six years. The 1966 – 1972 cohorts were the first cohorts affected by the 1978 compulsory education law and in the 5-year adjustment period. The sharp drop of the fraction graduated at most four years of education from 40 per cent to 10 per cent is observed.

Source: Author's compilation based on LFS (1986-2012).

3. The Empirical Methodology and Data

3.1 Empirical Methodology

- The 1978 compulsory law change in Thailand affected a large proportion of the population, covering almost half the population of the fourth grade of primary education to stay in school for two more years (until grade six, the final grade of primary education).

- As a result, similar to the application by Oreopoulos (2006), the estimated LATE in this paper could arguably be closer to the population ATE than that of similar studies that affect only relatively small fractions of the population.

3. The Empirical Methodology and Data

3.2 Data

- Pooled 27 consecutive annual Thai Labor Force Survey (LFS), 1986-2012 conducted by the National Statistical Office (NSO)

- Only the data from the third quarter of the LFS is used in this study to control for the seasonal migration of agricultural labor.

- This study limits the sample to 1,307,988 wage workers aged 15–60 in the year of interview.

  – Minimum legal working age and usual retirement age

- The analysis is limited to individuals born between 1955 and 1985

- The set of variables: age, birth cohort, years of schooling, region of residence, area of residence, industrial sector, and estimated monthly wages.

3. The Empirical Methodology and Data

3.3 Econometric Specification

- **First stage least square regression:**

$$S_i = \pi_0 + \pi_1 F_i + \pi_2 C_i^1 + \pi_3 C_i^2 + \pi_4 C_i^3 + \pi_5 C_i^4 + \sum_{k=16}^{60} \pi_{6k} A_{ki} + \sum_{l=1}^{4} \pi_{7l} R_{li} + \varepsilon_i$$

- **Reduced form:**

$$\log y_i = \alpha_0 + \alpha_1 F_i + \alpha_2 C_i + \alpha_3 C_i^2 + \alpha_4 C_i^3 + \alpha_5 C_i^4 + \sum_{k=16}^{60} \alpha_{6k} A_{ki} + \sum_{l=1}^{4} \alpha_{7l} R_{li} + \theta_i$$

- **OLS regression:**

$$\log y_i = \gamma_0 + \gamma_1 \widehat{S_i} + \gamma_2 C_i^1 + \gamma_3 C_i^2 + \gamma_4 C_i^3 + \gamma_5 C_i^4 + \sum_{k=16}^{60} \gamma_{6k} A_{ki} + \sum_{l=1}^{4} \gamma_{7l} R_{li} + \vartheta_i$$

- **Second stage least square regression:**

$$\log y_i = \beta_0 + \beta_1 S_i + \beta_2 C_i^1 + \beta_3 C_i^2 + \beta_4 C_i^3 + \beta_5 C_i^4 + \sum_{k=16}^{60} \beta_{6k} A_{ki} + \sum_{l=1}^{4} \beta_{7l} R_{li} + e_i$$

Where:
y_i : Monthly wages of individual$_i$
S_i : Years of schooling of individual$_i$
$\widehat{S_i}$: The fitted value estimated from the first stage least square regression.
F_i: A dummy variable indicating whether individual$_i$ experienced the 1978 compulsory education law
C_i : A birth cohort of individual$_i$
A_i : Age dummies
R_i : Regional dummies
ε_i, θ_i , e_i , ϑ_i : disturbance terms

4. Empirical Results

4 Empirical Results and Discussions

- ## Empirical results: First stage

	(1)	(2)	(3)	(4)	(5)
			First Stage		
		Dependent Variable: Number of Years of Schooling			
Compulsory Education	4.356***	4.294***	4.259***	4.270***	4.046***
	(0.392)	(0.391)	(0.365)	(0.364)	(0.313)
Fixed Effects:					
Regional Controls	No	Yes	Yes	Yes	Yes
Birth Cohort	Quartic	Quartic	Quartic	Quartic	Quartic
Additional Controls:	None	None	Age Dummy	Age Dummy	Age Dummy
				Gender	Gender
					Urban
Initial sample size	1,308,519	1,308,519	1,308,519	1,308,519	1,308,519
R-squared	0.091	0.104	0.128	0.129	0.184

Note: The dependent variables are number of years of schooling. Each regression includes controls for a birth cohort quartic polynomial, regional dummies (except for the models with explicit region variables), and an indicator whether a cohort faced a new compulsory education law (six years of compulsory education). Column (3) to (5) also include age dummy variables. Each regression includes the sample of 15 to 60 years old from the 1986 through 2012 LFSs. Data are first aggregated into cell means and weighted by cell size. Regressions are clustered by birth cohort, regions, and industrial sectors of employment. Robust standard errors in parentheses. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.
Source: Author's compilation based on LFS (1986–2012).

Interpretation:
- The compulsory education variable is statistically significant and robust across different specifications.
- The compulsory education leads to 4 additional years of schooling.
- Some existing studies from developed countries have also found that the impact of compulsory schooling law change went beyond the additional years of schooling imposed by the law change (e. g., Oreoupolos, 2003).

4 Empirical Results and Discussions

- ## Empirical results: Reduced form

	(1)	(2)	(3)	(4)	(5)
			Reduced Form		
		Dependent Variable: Log Monthly Wages			
Compulsory Education	0.354***	0.343***	0.355***	0.348***	0.310***
	(0.0590)	(0.0559)	(0.0585)	(0.0592)	(0.0497)
Fixed Effects:					
Regional Controls	No	Yes	Yes	Yes	Yes
Birth Cohort	Quartic	Quartic	Quartic	Quartic	Quartic
Additional Controls:	None	None	Age Dummy	Age Dummy	Age Dummy
				Gender	Gender
					Urban
Initial sample size	1,308,519	1,308,519	1,308,519	1,308,519	1,308,519
R-squared	0.017	0.082	0.126	0.134	0.200

Note: The dependent variables are log monthly wages. Each regression includes controls for a birth cohort quartic polynomial, regional dummies (except for the models with explicit region variables), and an indicator whether a cohort faced a new compulsory education law (six years of compulsory education). Column (3) to (5) also include age dummy variables. Each regression includes the sample of 15 to 60 years old from the 1986 through 2012 LFSs. Data are first aggregated into cell means and weighted by cell size. Regressions are clustered by birth cohort, regions, and industrial sectors of employment. Robust standard errors in parentheses. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.
Source: Author's compilation based on LFS (1986–2012).

Interpretation:
- The compulsory education variable is statistically significant and robust across different specifications.
- Compulsory education has a very large effect on the monthly wage. It yields approximately 30% increase in the monthly wage.
- The relatively large reduced form effects are consistent with the relatively large effects on the years of schooling in the first stage regression results.

4 Empirical Results and Discussions

- ## Empirical results: OLS

	(1)	(2)	(3)	(4)	(5)
			OLS		
			Dependent Variable: Log Monthly Wages		
Year of Schoolings	0.113***	0.111***	0.112***	0.112***	0.109***
	(0.00184)	(0.00172)	(0.00186)	(0.00182)	(0.00165)
Fixed Effects:					
Regional Controls	No	Yes	Yes	Yes	Yes
Birth Cohort	Quartic	Quartic	Quartic	Quartic	Quartic
Additional Controls:	None	None	Age Dummy	Age Dummy Gender	Age Dummy Gender Urban
Initial sample size	1,308,519	1,308,519	1,308,519	1,308,519	1,308,519
R-squared	0.527	0.567	0.603	0.614	0.621

Note: The dependent variables are log monthly wages. Each regression includes controls for a birth cohort quartic polynomial, regional dummies (except for the models with explicit region variables), and an indicator whether a cohort faced a new compulsory education law (six years of compulsory education). Column (3) to (5) also include age dummy variables. Each regression includes the sample of 15 to 60 years old from the 1986 through 2012 LFSs. Data are first aggregated into cell means and weighted by cell size. Regressions are clustered by birth cohort, regions, and industrial sectors of employment. Robust standard errors in parentheses. ***, **, and * indicate $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively.
Source: Author's compilation based on LFS (1986–2012).

Interpretation:
- The years of schooling variable is statistically significant and robust across different specifications.
- The rates of return to schooling are approximately 11%.

4 Empirical Results and Discussions

- ## Empirical results: IV

	(1)	(2)	(3)	(4)	(5)
			IV		
			Dependent Variable: Log Monthly Wages		
Years of Schooling	0.0818*** (0.00772)	0.0799*** (0.00680)	0.0832*** (0.00767)	0.0807*** (0.00790)	0.0767*** (0.00751)
Fixed Effects:					
Regional Controls	No	Yes	Yes	Yes	Yes
Birth Cohort	Quartic	Quartic	Quartic	Quartic	Quartic
Additional Controls:	None	None	Age Dummy	Age Dummy Gender	Age Dummy Gender Urban
Initial sample size	1,308,519	1,308,519	1,308,519	1,308,519	1,308,519
R-squared	0.487	0.528	0.571	0.575	0.584

Note: The dependent variables are log monthly wages. Each regression includes controls for a birth cohort quartic polynomial, regional dummies (except for the models with explicit region variables), and an indicator whether a cohort faced a new compulsory education law (six years of compulsory education). Column (3) to (5) also include age dummy variables. Each regression includes the sample of 15 to 60 years old from the 1986 through 2012 LFSs. Data are first aggregated into cell means and weighted by cell size. Regressions are clustered by birth cohort, regions, and industrial sectors of employment. Robust standard errors in parentheses. ***, **, and * indicate p < 0.01, p < 0.05, and p < 0.1, respectively.
Source: Author's compilation based on LFS (1986–2012).

Interpretation:
- The year of schooling is statistically significant and robust across different specifications.
- The returns to schooling from IV estimation are around 8%.

4.3 Empirical Results and Discussions

- IV estimates are lower than OLS estimates by the order of 20 percent.

- Consistent with a few other studies from developing countries (e.g., China, Turkey), and Behrman's (1999) view.

- In contrast, IV estimates of the returns to schooling are substantially higher than OLS estimates in developed countries.

4.3 Empirical Results and Discussions

- Why IV estimates are much higher than OLS estimates (in developed countries)
  - Negative correlation between schooling and the returns to schooling
- Card (1999) argues that a negative correlation between schooling and the returns to schooling (and thus lower OLS estimates than IV estimates) could arise if ability differences are "not too important" in the determination of the years of schooling.
  - Unless resource (financial) constraints are severe, parents could make every effort to educate their children regardless of their ability in developed societies.
- Such a story appears to be plausible in explaining why the positive ability bias is absent in developed counties while it could be relatively more important in developing countries.

4.3 Empirical Results and Discussions

- Heckman et al. (2006) argue that ability is multidimensional, where different types of ability or skills and different levels of schooling are required by different types of jobs in different industries.

- According to this view, "individuals sort themselves across schooling levels in such a way that the best individuals in one schooling level are the worst in the other, and vice versa" (Heckman et al., 2006; 374).

- In relatively industrialized and diversified economies, such a story would be quite plausible.

- In less diversified and predominantly low-skilled economies, however, such possibilities may be arguably less plausible. Based on the single dimensional skill/ability space view, on the other hand, the conventional positive ability bias in the determination of schooling could become quite important.

4.3 Empirical Results and Discussions

- Thus, based on both Card (1999) and Heckman et al. (2006)'s views of why positive ability bias may not be important in developed countries, the role of conventional positive ability bias in OLS estimates of the returns to schooling can become relatively more important in developing country contexts, which is consistent with our empirical results.

- Theoretically, it is not obvious that parents in poor households invest more in human capital of better endowed (higher ability) children, thereby enhancing, rather than compensating, inequality among children in endowments (Becker, 1991).

- Behrman, Pollak and Taubman (1982) show that whether parents compensate or enhance inter-sibling inequality depends on parental preferences (utility function) over their relative priority on ensuring equity among their children.

- Our empirical findings appear to be consistent with the possibility that parental preferences toward equity among children are not strong.

5. Conclusion

5. Conclusion

- Compulsory schooling law played a role in enhancing human capital investment in the eve of the rapid structural transformation in the 1980s
  - IV estimation: 8%, while OLS somewhat overestimates (by 20%) such returns
- Our findings are in sharp contrast with most of the recent studies exploiting similar institutional changes from developed countries
  - Developed countries: OLS < IV; negative ability bias
- The conventional notion of "ability bias" is more likely to arise in developing countries
  - Parents could be forced to keep only those (among many) of their children with higher ability in school, thereby reinforcing (rather than compensating) inequality among children within the household.

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Thank You Very Much For Your Attention

2. Mincer Model

- Since the years of schooling is an endogenous variable, the association of schooling with earnings does not necessarily represent causal effects
  - Ability of children, heterogeneity in family backgrounds and heterogeneity in school quality (e.g., Behrman, 1999).
  - Interestingly, a number of recent studies, mostly from developed countries, find that ability bias may not be very serious (e.g., Card, 1999; Heckman et al., 2006)

2. Mincer Model

- The LATE interpretations based on the IV estimates exploiting changes in compulsory schooling suggest the possibility of negative ability bias
  - Exogenous constraints, such as credit constraints (Oreopoulos, 2006) and off-setting forces from attenuation bias and/or discount rate bias (Card, 1999; Lang, 1993)
  - Theoretical model of schooling choice: Ability differences may not be important in explaining schooling outcomes (Card, 1999)
  - Multi-dimensionality of ability or skill space (Heckman et al., 2006)

2. Mincer Model

- However, our findings are in contrast with most of the recent studies exploiting similar institutional changes from developed countries.

- It is possible that some of those explanations for the empirical findings may not apply in developing country contexts

- It is this area in the literature that this paper intends to address.

3. The Empirical Methodology and Data

Table 1 The Identification of the First Cohorts Affected by the 1978 Compulsory Education

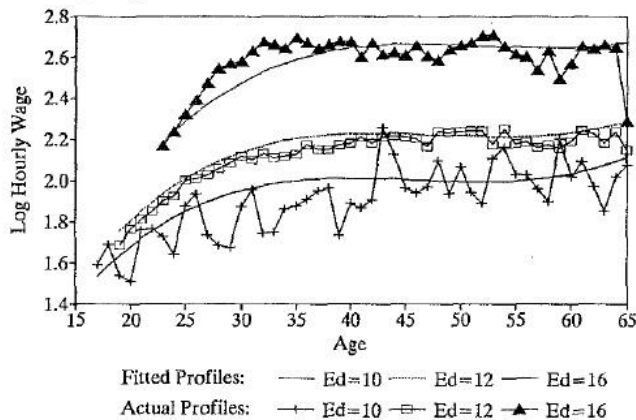| Cohort	Year													
	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
School Grade										1	2	3	4	5
1969					0	1	2	3	4	5	6	7	8	9
1968				0	1	2	3	4	5	6	7	8	9	10
1967			0	1	2	3	4	5	6	7	8	9	10	11
1966		0	1	2	3	4	5	6	7	8	9	10	11	12
1965	0	1	2	3	4	5	6	7	8	9	10	11	12	13

Source: Author's compilation.

4.1 Age-Wages Profile: The Mincer Function is Alive and Well


a. Hourly Wage Profiles for Men

Fitted Profiles: — Ed=10 — Ed=12 — Ed=16
Actual Profiles: —+— Ed=10 —□— Ed=12 —▲— Ed=16
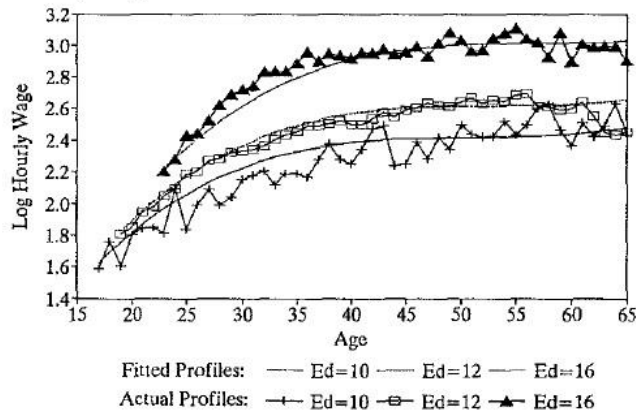
b. Hourly Wage Profiles for Women

Fitted Profiles: — Ed=10 — Ed=12 — Ed=16
Actual Profiles: —+— Ed=10 —□— Ed=12 —▲— Ed=16

- Actual age-earnings profiles for men and women using pooled samples from the 1994, 1995, 1996 March Current Population Surveys
- log hourly earnings by single year of age for individuals with 10, 12 and 16 years of education.
- The actual means and the fitted values obtained from Mincer equation including a cubic term in potential experience.
- Age-earnings profiles for US men and women are well-approximated
- Mincer's model has some trouble fitting the precise curvature of the age profiles for different education groups in US data: Underestimation

Source: Card, 1999

4.1 Age-Wages Profile: The Mincer Function is Alive and Well

Monthly Wages Profiles
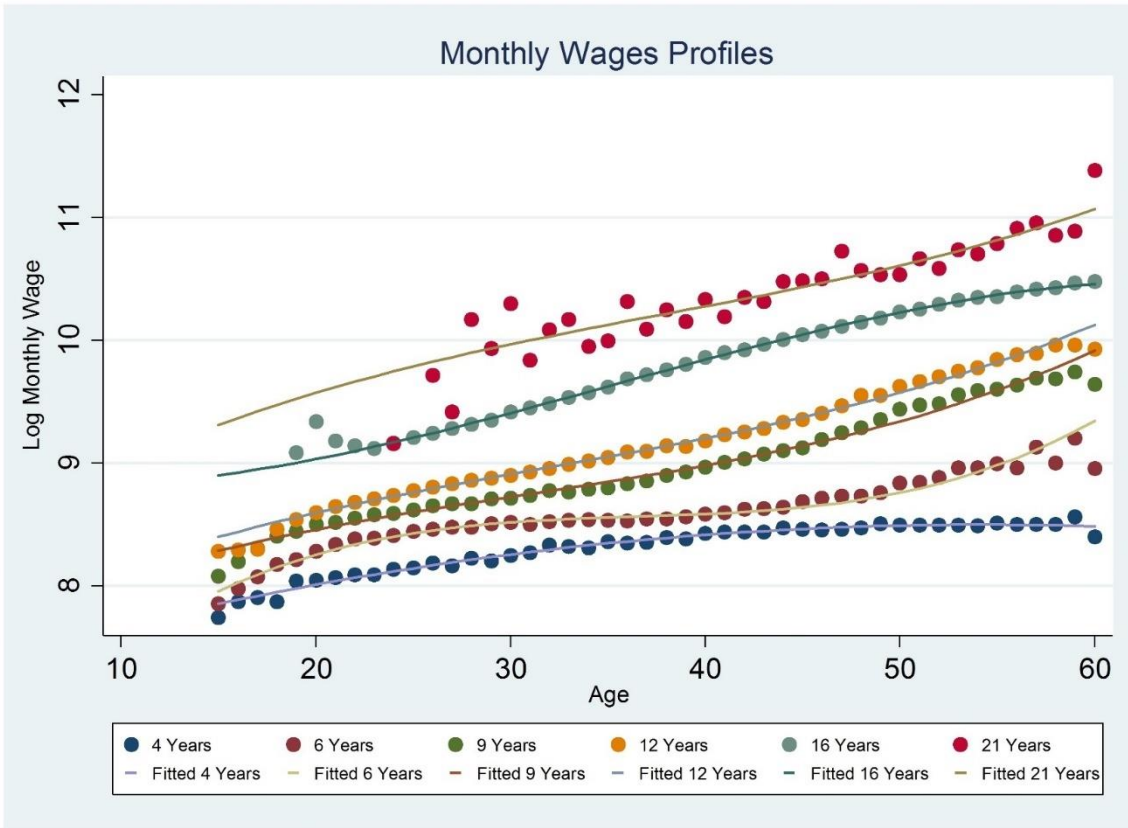
- The actual means and the fitted values obtained from Mincer equation including a quadratic term in potential experience.
- Age-wages profiles are well-approximated
- In contrast to US data, the problem in fitting the precise curvature is less pronounced in Thai data.

Source: Author's compilation based on LFS data, 1986-2012

4.3 Empirical Results

- ## Empirical results: First stage

First Stage Effects of Compulsory Education Law on Education Attainment

	First Stage Dependent Variable: Number of Years of Schooling	Observations
United States	0.110 ***	
	(0.0070)	2,814,203
Canada	0.130 ***	
	(0.0154)	854,243
	Dependent Variable: Age Left Full-Time Education	**Observations**
United Kingdom	0.489 ***	
	(0.049)	82,908
Britain	0.436 ***	
	(0.064)	73,954
Fixed Effects:		
Regional Controls	Yes	
Birth Cohort	Yes	
Additional Controls:	Age Quartic	
	Survey Year	
	Gender	

Notes: Data are first aggregated into cell means and weighted by cell size. Regressions are clustered by birth cohort. Robust standard errors in parentheses. ***, **, and * indicate $p<0.01$, $p<0.05$, and $p<0.1$, respectively.

Source: Author`s compilation based on the information from Oreopoulos (2008)

Interpretation:
- The compulsory education variable is statistically significant across different countries.
- The effects of compulsory education on the years of schooling are quite small in the US and Canada.
- This may imply that compulsory education does not affect a majority of sample. Individuals do not really comply to the law.
- In the UK, the effects of compulsory education on the age left full-time education is approximately 0.5 year.
- It is not exactly corresponding to the law which forces students to stay in the school one year longer.

4.3 Empirical Results

- ## Empirical results: Reduced form

Reduced Form Effects of Compulsory Education Law on Education Attainment

	Reduced Form	
	Dependent Variable: Log Weekly Wage	Observations
United States	0.016 ***	
	(0.0015)	2,814,203
	Dependent Variable: Log Annual Wage	Observations
Canada	0.012 ***	
	(0.0037)	854,243
United Kingdom	0.053 ***	
	(0.017)	82,908
Britain	0.047 **	
	(0.018)	73,954
Fixed Effects:		
Regional Controls	Yes	
Birth Cohort	Yes	
Additional Controls:	Age Quartic	
	Survey Year	
	Gender	

Notes: Data are first aggregated into cell means and weighted by cell size. Regressions are clustered by birth cohort. Robust standard errors in parentheses. ***, **, and * indicate $p<0.01$, $p<0.05$, and $p<0.1$, respectively.

Source: Author`s compilation based on the information from Oreopoulos (2008)

Interpretation:
- The compulsory education variable is statistically significant for all studies.
- The fit predicts that average wages increased for the cohorts that come after the change of the law.
- The magnitude is smaller than those of Thailand.
- A possible explanation is that the compulsory school-leaving age is corresponding to 8th or 9th grade; therefore, graduating from either 8th or 9th grade may not result in a big difference in wages.

4.3 Empirical Results

- ## Empirical results: OLS

OLS, IV-RD, and FE Panel Estimates of the Returns to (Compulsory) Schooling

	OLS	IV-RD	FE Panel
	Dependent Variable:		
	Log Weekly Wage		
United States [a]	0.078 ***	0.142 ***	-
	(0.0005)	(0.0119)	-
	Dependent Variable:		
	Log Annual Wage		
Canada [a]	0.099 ***	0.096 ***	-
	(0.0007)	(0.0254)	-
United Kingdom [a]	0.085 ***	0.108 ***	-
	(0.002)	(0.0328)	-
Britain [a]	0.083 ***	0.101 ***	-
	(0.003)	(0.0421)	-
	Dependent Variable:		
	Log Hourly Wage		
Thailand [b]	0.115 **	0.148 **	0.151 **
	(0.000250)	(0.0194)	(0.0100)

Notes: a Region, birth cohort, age quartic, survey year, and gender are controlled in the regressions. Data are first aggregated into cell means and weighted by cell size. Regressions are clustered by birth cohort. Robust standard errors in parentheses. ***, **, and * indicate $p<0.01$, $p<0.05$, and $p<0.1$, respectively.

b Age quadratic, and cohort dummies are included in the regressions. The instrument variable is a dummy variable identifying the provinces in which universities or teacher training colleges are located. Standard errors in parentheses. ** indicates that coefficients are significant at or below the 0.05 level.

Source: Author's compilation based on the information from Oreopoulos (2008) and Warunsiri and Mcnown (2010).

Interpretation:
- The OLS results are similar in developed countries.
- Having said that, the OLS estimate from Thailand is higher but still comparable.
- My OLS estimate is consistent with that of previous studies from Thailand.

4.3 Empirical Results and Discussions

- ## Empirical results: IV

OLS, IV-RD, and FE Panel Estimates of the Returns to (Compulsory) Schooling

	OLS	IV-RD	FE Panel
	Dependent Variable: Log Weekly Wage		
United States [a]	0.078 ***	0.142 ***	-
	(0.0005)	(0.0119)	-
	Dependent Variable: Log Annual Wage		
Canada [a]	0.099 ***	0.096 ***	-
	(0.0007)	(0.0254)	-
United Kingdom [a]	0.085 ***	0.108 ***	-
	(0.002)	(0.0328)	-
Britain [a]	0.083 ***	0.101 ***	-
	(0.003)	(0.0421)	-
	Dependent Variable: Log Hourly Wage		
Thailand [b]	0.115 **	0.148 **	0.151 **
	(0.000250)	(0.0194)	(0.0100)

Notes: a Region, birth cohort, age quartic, survey year, and gender are controlled in the regressions. Data are first aggregated into cell means and weighted by cell size. Regressions are clustered by birth cohort. Robust standard errors in parentheses. ***, **, and * indicate $p<0.01$, $p<0.05$, and $p<0.1$, respectively.

b Age quadratic, and cohort dummies are included in the regressions. The instrument variable is a dummy variable identifying the provinces in which universities or teacher training colleges are located. Standard errors in parentheses. ** indicates that coefficients are significant at or below the 0.05 level.

Source: Author's compilation based on the information from Oreopoulos (2008) and Warunsiri and Mcnown (2010).

Interpretation:
- In previous studies, the OLS results are lower than those of IV. It indicates that the return to schooling is underestimated in the OLS regression.
- In the US, the IV estimate is double than that of the OLS.
- The differences between OLS and IV are moderate in the UK and Thailand.
- In Canada, the OLS estimate is larger than that of IV.
- In Thailand, the estimates from IV and FE panel are similar in magnitude.
- The magnitude of my IV estimate is consistent with previous studies from Canada and the UK. In contrast to previous literatures, IV estimate is smaller than that of OLS in my study.

4.3 Empirical Results

- Disaggregated Analysis

Dependent Variables	OLS	IV	Bias Gap	Sample Size	Comparison	
					Returns to Schooling	Bias Gap
Log monthly wages, all workers	0.112*** (0.00186)	0.0832*** (0.00767)	0.0288	1,308,519		
Log monthly wages, male	0.108*** (0.00185)	0.0790*** (0.00932)	0.029	663,501	Female > Male	Female > Male
Log monthly wages, female	0.116*** (0.00190)	0.0831*** (0.00718)	0.0329	645,018		
Log monthly wages, cohort 1955-1970	0.125*** (0.00205)	0.0860*** (0.00549)	0.039	813,981	Old > Young	Old > Young
Log monthly wages, cohort 1961-1985	0.101*** (0.00183)	0.0816*** (0.00623)	0.0194	1,017,586		
Log monthly wages, urban	0.108*** (0.00159)	0.0834*** (0.00546)	0.0246	857,828	Urban > Rural	Rural > Urban
Log monthly wages, rural	0.104*** (0.00225)	0.0680*** (0.00907)	0.036	450,691		
Log monthly wages, BKK	0.0953*** (0.00145)	0.0737*** (0.00391)	0.0216	162,399		
Log monthly wages, North	0.124*** (0.00309)	0.0965*** (0.0114)	0.0275	256,447	Northeast, North > Others	Northeast, North > Others
Log monthly wages, Northeast	0.140*** (0.00379)	0.0925*** (0.0293)	0.0475	298,457		
Log monthly wages, South	0.0926*** (0.00309)	0.0709*** (0.00959)	0.0217	222,181		
Log monthly wages, Centre	0.0972*** (0.00295)	0.0748*** (0.00708)	0.0224	369,035		
Log monthly wages, Agricultural sector	0.100*** (0.00299)	0.0583*** (0.00536)	0.0417	428,987	Service > Manufacture > Agriculture	Agriculture > Manufacture > Service
Log monthly wages, Manufacturing sector	0.0936*** (0.00252)	0.0682*** (0.00307)	0.0254	238,514		
Log monthly wages, Service sector	0.102*** (0.00184)	0.0812*** (0.00225)	0.0208	638,080		