



清华大学
Tsinghua University

Skill Promotion in the Industrialization of China

An Interpretation of Human
Capital Accumulation in Developing Economies

Mengyu Ding

School of Public Policy and Management, Tsinghua University

IEA World Congress, Mexico City, 23rd June 2017

Key Questions



- Human capital measurement beyond schooling
- Is human capital exogenous or endogenous?
- How is human capital accumulated, individually or collectively?

Introduction



- Approaches in human capital studies
 - Original idea of human capital takes it as the capacity required for occupations in economic productions, including both formal schooling and skills developed in job. (Mincer, 1981)
 - Most researches reduce the human capital to schooling. This approach achieves a considerable success in explaining personal income variation.
 - Schooling is also used as the proxy of human capital to explain macro economic growth. (Barro, 1991; Barro and Lee, 2013; Gennaioli, La Porta, Lopez-de-Silanes, and Shleifer, 2013)
 - This approach does not provide direct information about skills demanded by production. A new approach emerges in recent years that is focusing on more direct and detailed information of skills and task related to occupations and jobs. (Acemoglu and Autor, 2010; Autor and Dorn, 2013; Autor and Handel, 2013)
- Understanding skills related to occupations
 - Autor and Handel (2013), skills related to task, the abstract, the routine, the manual
 - This work, skill level, comprehensive measurement of skills required by occupations, defined by International Labor Organization (ILO),
<http://www.ilo.org/public/english/bureau/stat/isco/isco88/index.htm>

Introduction



- Theoretical framework for industrialization impact on human capital accumulation
 - In neoclassical model, human capital is merely exogenous input determining long-run development.
 - Endogenous growth theory predicts that personal human capital will co-evolve with the aggregate accumulation of productive factors. (Arrow, 1962; Romer, 1986)
 - The aggregate productive factor is determined by collective input of all agents in economy. And it is embedded in the complexity of industrial structure. (Romer, 1990)
 - In developing economies, industrialization is most important structural change in economy and provides opportunities for agents to development skills serving production directly.

Introduction



- The measurement of industrialization
 - This study uses the ratio of industrial output to total output to indicate the industrialization level.
 - The ratio of output tends to remain stable for a long time and decline slightly in the later stage of industrialization. (McMillan Rodrik Verduzco-Gallo, 2014; Rodrik, 2013, 2016)
- The real experience of skill promotion in China
 - The idea that industrialization provides opportunities for on-job-training and learning by doing is consistent with observations from field studies in China. (Middleton, Ziderman and Adams, 1993; Ziderman and Horn, 1995; and Xiao and Tsang, 1999)

Introduction



- Related literature

- Endogenous but individual-based human capital accumulation: Heckman (1976); Rosen (1976); Lucas and Moll (2014)
- Learning by doing in urban areas: Glaeser and Maré (2001); La Roca and Puga (2017)
- Life-cycle human capital accumulation: Lagakos Moll Porzio Qian and Schoellman (2012, 2016, 2017)
 - The key finding is immigrant labors from less-developed countries are likely to accumulate less human capital in life-cycle. The phenomenon is ascribed to the low quality of education in less developed countries.
 - Their further research is taking human capital as exogenous.
- Low return (wage) to schooling in China
 - Li, Liu and Zhang (2012): Individual return to high school level education is quite small in China, while the return to vocational education is comparable to that in developed countries like UK and US. A large part of monetary return to education estimated in many studies using OLS model may be due to omitted ability.

Methodology



- Human Capital Measurement: Skill Level
- Source: ISCO and International Labor Organization

ISCO-08 Major Groups	Skill Level
Managers	1 or 2
Professionals	1, professional
Technicians and Associated Professionals	2, technician
Clerical Support Workers	3, skilled
Service and Sales Workers	
Skilled Agricultural and Fishery Workers	
Craft and Related Trades Workers	
Plant and Machine Operators and Assemblers	
Elementary Occupations	4, elementary

Methodology



- Ordered probit analysis
 - Wooldrige, (2002); Li and Zhou (2005)
 - Assumption: Occupations of higher skill level are preferable.

- Econometric specification
 - $SL_{i(k)} = \beta_0 + \beta_1 * ratio_{k,t(i)} + \beta_2 * ratio_{k,t(i)}^2 + \beta_3 * E_i + \beta_4 * X_i + \varepsilon_i$
 - Dependent variable:
 - $SL_{i(k)}$: skill level of final or current job for person i in province k
 - Independent variable:
 - $ratio_{k,t}$: the ratio of industrial output in province k and year t , the year person i beginning first job;
 - E_i : dummies of various levels of education for person i ;
 - X_i : other variables of personal or family background for person i

Methodology



- IV strategy

- Problems of endogeneity comes from industrialization may be correlated with the error term, especially in free economy which depends on individual decision. (animal spirit, entrepreneur spirit)
- Use the special institutional context in China to solve the problem of identification
 - Before market-oriented reform, governments of different levels decide the fixed capital investment of all firms; after the reform, governments still possess significant influence on local investment.
 - Governments make investment decision according to ideological or political reasons, such as national defense, regional equality, and economic independence; rather than individual performance.
 - China's industrialization in recent decades is mainly led by fixed investment input.
 - Fiscal federalism, or so-called M-shape inter-government structure, makes available the comparison between provinces. (Qian and Xu, 1993; Qian and Roland, 2006)
- Instrumental variable: fixed capital stock by provinces and years

Data



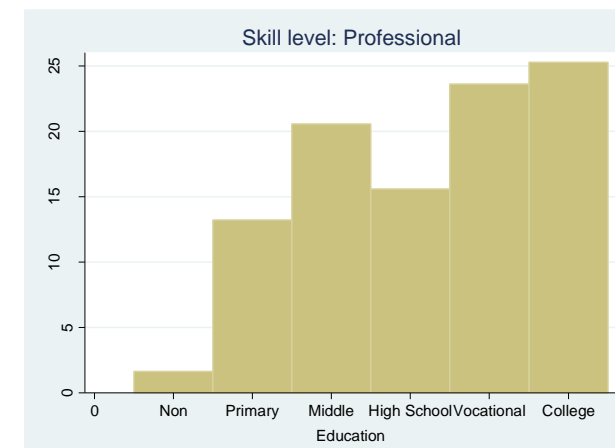
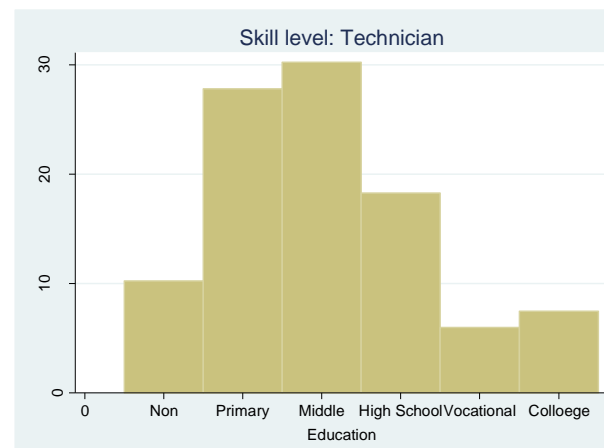
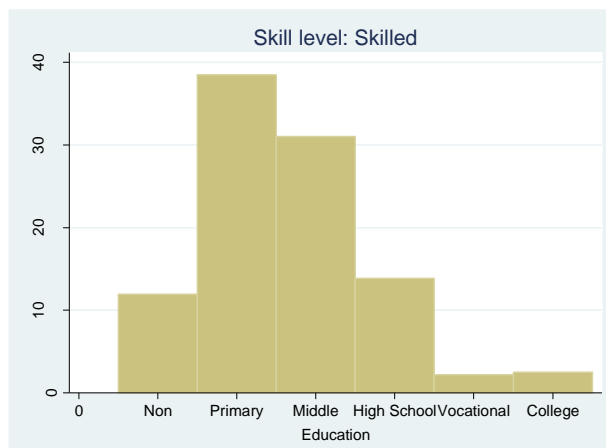
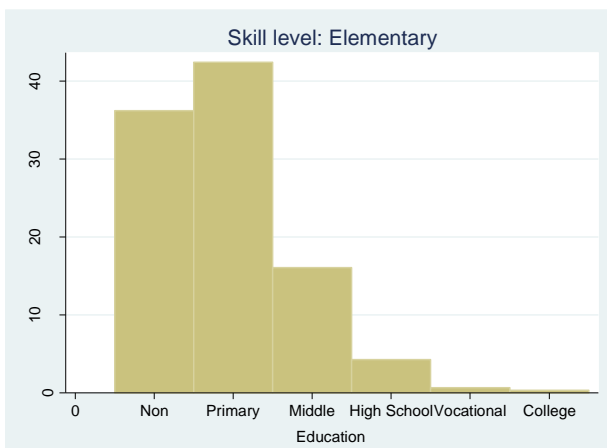
- Micro level: China Health and Retirement Longitudinal Study (Charls)
 - Representative sample
 - Including observations over 45 years old, reflecting personal human capital change in life-cycle
 - Rich information of personal and household background
 - The variable “skill level” indicating the status of final or current job
 - Including variables of personal education, current age, age at the beginning first job and so on
- Macro level: official data from National Bureau of Statistics
 - Provincial ratio of industrial output in the year when first job beginning
 - Capital stock per capita in the year when first job beginning (thousand yuan)
 - Source: official investment statistics
 - Perpetual inventory method, calculating by province, borrowing from Shan (2008)

Preliminary Results



- Statistics

- Personal education distribution at different skill levels



- Skill level distribution

Skill Level	Elementary	Skilled	Technician	Professional
Percentage	66.40%	23.39%	5.18%	5.03%

Preliminary Results



- Statistics
 - Explanatory variables

Obs. 16785	Mean	Std. Dev.
Age	59.56	9.93
Age at the Beginning of First Job	17.07	5.11
Male (Dummy)	0.49	0.50
Education (Dummies)		
Non	0.27	0.45
Primary	0.39	0.48
Middle	0.21	0.40
High	0.08	0.27
Vocational	0.02	0.15
College and Above	0.02	0.16
Attending Adult Education	0.04	0.19
Provincial Ratio of Industrial Output in the Year When First Job Beginning	0.30	0.12
Capital Stock Per Capita in the Year When First Job Beginning (thousand Yuan)	3.56	9.80
Government Occupation (Dummy)	0.02	0.15
Institution Occupation (Dummy)	0.05	0.21

Preliminary Results



- Baseline estimates

	Probit	Probit	Ordered-Probit	Ordered-Probit
Ratio		2.594*** (0.427)	2.487*** (0.396)	2.977*** (0.581)
Ratio²		-1.564*** (0.556)	-1.805*** (0.497)	-3.192*** (0.758)
Education				
Primary	0.438*** (0.031)	0.402*** (0.031)	0.442*** (0.030)	0.425*** (0.032)
Middle	0.868*** (0.036)	0.790*** (0.037)	0.857*** (0.036)	0.813*** (0.037)
High	1.202*** (0.047)	1.103*** (0.047)	1.171*** (0.043)	1.086*** (0.046)
Vocational	1.737*** (0.080)	1.640*** (0.081)	2.071*** (0.075)	2.012*** (0.077)
College	1.993*** (0.095)	1.899*** (0.096)	2.159*** (0.073)	2.025*** (0.076)
Adult Education	0.345*** (0.061)	0.350*** (0.061)	0.380*** (0.055)	0.386*** (0.056)
Personal and Family Features	Y	Y	Y	Y
Provincial Dummies				Y
Period Dummies				Y
Observations	16,785	16,785	16,785	16,785

Preliminary Results



- Average marginal effects

	Elementary		Skilled		Technician		Professional	
	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.	dy/dx	Std. Err.
Ratio of Industrial Output	-0.875	0.170	0.477	0.093	0.173	0.034	0.226	0.044
Ratio ²	0.938	0.222	-0.511	0.121	-0.185	0.044	-0.242	0.058
Education								
Primary	-0.125	0.009	0.068	0.005	0.025	0.002	0.032	0.003
Middle	-0.238	0.010	0.130	0.006	0.047	0.003	0.062	0.003
High	-0.319	0.013	0.174	0.007	0.063	0.003	0.082	0.004
Vocational	-0.591	0.022	0.322	0.013	0.117	0.005	0.153	0.007
College	-0.595	0.022	0.324	0.013	0.118	0.005	0.153	0.006

Preliminary Results



- Interactions of industrialization and education

	(1)	(2)	(1)	(2)	(2)
Ratio	2.899*** (0.584)	5.065*** (0.990)			
Ratio²	-2.174*** (0.796)	-5.523*** (1.523)			
Education			*Ratio	*Ratio	*Ratio²
Primary	0.527*** (0.077)	0.644*** (0.157)	-0.413 (0.251)	-1.489 (1.019)	1.995 (1.543)
Middle	1.081*** (0.100)	1.785*** (0.214)	-0.921*** (0.296)	-5.469*** (1.240)	6.564*** (1.749)
High	1.497*** (0.141)	2.584*** (0.343)	-1.300*** (0.384)	-7.718*** (1.794)	8.697*** (2.314)
Vocational	2.474*** (0.221)	2.643*** (0.484)	-1.554** (0.615)	-3.012 (2.708)	2.576 (3.597)
College	2.936*** (0.212)	3.494*** (0.460)	-2.803*** (0.569)	-6.582*** (2.463)	5.632* (3.181)

Preliminary Results



- Interactions of industrialization and education

	(1)	(1)
Ratio	2.899*** (0.584)	
Ratio²	-2.174*** (0.796)	
Education		*Ratio
Primary	0.527*** (0.077)	-0.413 (0.251)
Middle	1.081*** (0.100)	-0.921*** (0.296)
High	1.497*** (0.141)	-1.300*** (0.384)
Vocational	2.474*** (0.221)	-1.554** (0.615)
College	2.936*** (0.212)	-2.803*** (0.569)

Preliminary Results



- Interactions of industrialization and education

	(2)	(2)	(2)
Ratio	5.065*** (0.990)		
Ratio²	-5.523*** (1.523)		
Education		*Ratio	*Ratio²
Primary	0.644*** (0.157)	-1.489 (1.019)	1.995 (1.543)
Middle	1.785*** (0.214)	-5.469*** (1.240)	6.564*** (1.749)
High	2.584*** (0.343)	-7.718*** (1.794)	8.697*** (2.314)
Vocational	2.643*** (0.484)	-3.012 (2.708)	2.576 (3.597)
College	3.494*** (0.460)	-6.582*** (2.463)	5.632* (3.181)

Preliminary Results



- IV probit regression

- Column 1: Wald test of exogeneity: $\chi^2(1) = 36.58$ Prob > $\chi^2 = 0.0000$
- Column 2: Wald test of exogeneity: $\chi^2(2) = 30.77$ Prob > $\chi^2 = 0.0000$
- Variable Ratio is endogenous, but its positive effect on skill promotion is confirmed.

	(1)	(2)
Instrumented Variables	Ratio	Ratio Ratio ²
Ratio	4.868*** (0.554)	3.480** (1.389)
Ratio ²		3.175 (2.948)
Education		
Primary	0.364*** (0.032)	0.365*** (0.033)
Middle	0.715*** (0.039)	0.706*** (0.041)
High	0.978*** (0.051)	0.959*** (0.055)
Vocational	1.570*** (0.083)	1.569*** (0.083)
College	1.759*** (0.097)	1.756*** (0.097)

Preliminary Results



- Dropping sample from big cities (Beijing, Tianjin, and Shanghai) and governmental sector
 - Results keep robust.

	No governmental sample	No big city sample
Ratio	4.221*** (0.565)	3.758*** (0.571)
Ratio ²	-4.380*** (0.775)	-3.701*** (0.834)
Education		
Primary	0.357*** (0.032)	0.429*** (0.032)
Middle	0.696*** (0.038)	0.851*** (0.037)
High	0.926*** (0.048)	1.148*** (0.045)
Vocational	1.579*** (0.101)	2.077*** (0.078)
College	1.683*** (0.109)	2.132*** (0.077)

Preliminary Results



- The industrialization at 35 and 45 years old
 - The effect of industrialization on skill promotion becomes insignificant at 35 and 45 years old. Some studies, such as Heckman (1976) and Rosen (1976), argue that ability and motivation of learning is weakened as people aging.

	35-year old	45-year old
Ratio	-0.633 (0.993)	0.758 (1.391)
Ratio ²	1.745 (1.197)	0.617 (1.634)
Education		
Primary	0.423*** (0.032)	0.425*** (0.032)
Middle	0.809*** (0.037)	0.818*** (0.037)
High	1.081*** (0.046)	1.092*** (0.046)
Vocational	2.011*** (0.078)	2.017*** (0.078)
College	2.023*** (0.076)	2.027*** (0.076)

Preliminary Results



- Skill promotion is not caused by political mismatch between education and occupation.
 - Introduce dummies of year 1978 and culture revolution (CR) and their interaction terms with education.
 - If political factors works, the interaction terms will show significance. Education's effect will be lowered during the culture revolution, then be improved after market-oriented reform in 1978.
 - The result refuses significant effect of political factors.

	whole	1968-1988		1956-1986
D1978	0.186** (0.089)	0.114 (0.104)	D_CR	0.069 (0.058)
Primary*D1978	0.120 (0.096)	0.133 (0.111)	Primary*D_CR	0.016 (0.068)
Middle*D1978	-0.100 (0.095)	0.064 (0.110)	Middle*D_CR	-0.141* (0.072)
High School*D1978	-0.182* (0.106)	-0.034 (0.121)	High School*D_CR	-0.068 (0.089)
Vocational*D1978	-0.036 (0.171)	0.201 (0.206)	Vocational*D_CR	-0.213 (0.160)
College*D1978	-0.200 (0.156)	0.133 (0.187)	College*D_CR	-0.266* (0.158)

Concluding Remarks



- Industrialization, as the collective factor, has significantly positive effect on personal skill promotion. Human capital is endogenously accumulated.
- The effect decreases when industrialization enters its later stage.
- Education also positively promote personal human capital accumulation. But the advantage shared by educated people is not so large if industrialization is booming.
- Vocational education plays a more important role.