Computers with Internet Access and Wage Disparities across Regions: Evidence from China

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Introduction

- Do technological developments improve people's living conditions and their welfare, or continue to lead to relative inequality and income gap? This long-standing research question encourages a detailed exploration.

	Negative Labor Relation	Positive Labor Relation
Technological Pessimistic	Zhuang Zi Jean-Jacques Rousseau	Karl Marx Ernst Friedrich Schumacher
Technological Optimistic	Adam Smith David Ricardo	John Bates Clark Johan Knut Wicksell John Maynard Keynes

FIGURE 1. CLASSIC THOUGHTS ON TECHNOLOGY DEVELOPMENT AND LABOR RELATION

- In modern era, information communication technology (ICT) has created innovative revolution. Appropriate investments toward ICT utilization have increased productivity and efficiency (Milgrom & Roberts, 1990; Brynjolfsson & Hitt, 2003; Akerman, Gaarder, & Mogstad, 2015).

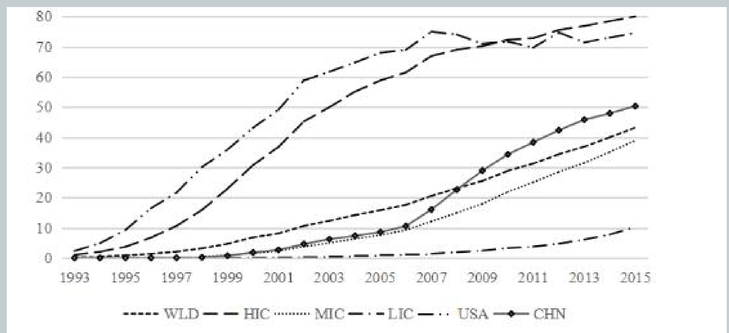

FIGURE 2. INDIVIDUALS USING INTERNET ACROSS DIFFERENT AREAS

Note: As the internet link to the world, China is the 77th admitted country access the globe in 1994. Compared to individuals using internet in High Income Countries, the gap is still large for China, but rapidly narrowing after its accelerated development.

- Computerization and digitization forming the change of technology-skill complementarity (Krueger, 1993; Goldin & Katz, 1998; Autor, Levy, & Murnane, 2003; Ben-Ner & Urtasun, 2013; Akerman, Gaarder, & Mogstad, 2015).
- Skill-biased technologies enlarged wage gap in cities with more skilled workers and created a divergence in welfare (Lindley & Machin, 2014; Berger & Frey, 2016).

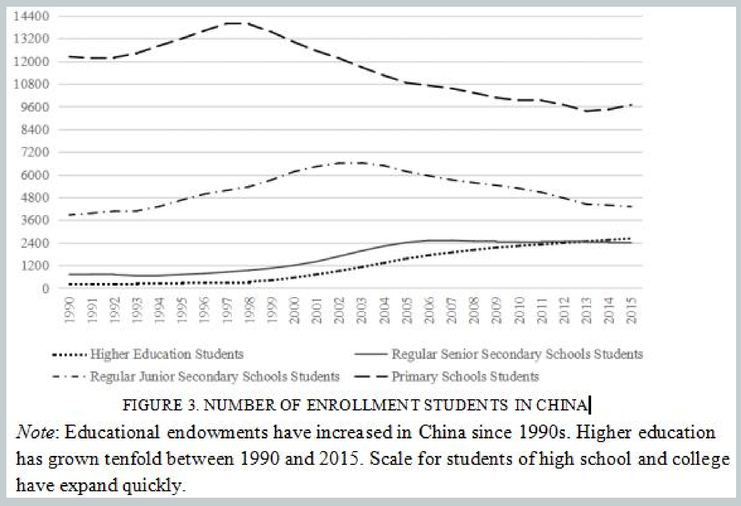

FIGURE 3. NUMBER OF ENROLLMENT STUDENTS IN CHINA

Note: Educational endowments have increased in China since 1990s. Higher education has grown tenfold between 1990 and 2015. Scale for students of high school and college have expand quickly.

- Forman, Goldfarb and Greenstein (2012) depicted a payoff puzzle: *while internet is widely adopted, wage growth is unevenly distributed across U.S. counties*.
- We resolve similar puzzle between technological advancement and the competing consequences on: *economic growth and wage inequality*.
- We analyze the developmental process of utilizing internet across regions in China with its rapid growth over the past decade, and observe the formation of human capital given its educational resources.

Significance

We focus on whether the access to internet augments the wage inequality across regions, as indicated with statistical data from provinces, cities, and counties in China. We find that internet access is associated with regional GDP growth and wage inequality in general, observed both in linear and inverted U-shaped forms. The region's technological endowment alleviates the linear relationship that decrease the marginal effect of internet access and flattens the inverted-U curve. We further test whether college educational endowment offers a solution to the inequality problem, or acts as a catalyst to enlarge the income gap for workers. We find that educational endowment can potentially alleviate the inducing effect of skill-biased technology on wage inequality.

Theoretical Background

ICT Adoption and Wage Inequality

- We consider an economy with one sector that produces consumer goods using three production factors (Autor & Dorn, 2013; Beaudry, Doms, & Lewis, 2010): ICT capital and both low- and highly skilled labor inputs for routine and non-routine tasks.
- Internet access increases information demand and lowered the costs of engaging in economic activities (Malecki, 2002; Forman, Goldfarb, & Greenstein, 2005; Bekkerman & Gilpin, 2013).
- With changing welfare, the ICT capital complement skilled workers and act as a substitute for unskilled workers (Akerman, Gaarder, & Mogstad, 2015).
- As technology use increases with time, it increases the substitution for labor performing non-routine tasks.
- The wage gap increases with increased technology input, but tends to decrease as an inverted U-shape.

Human Capital and Educational Endowment

- The greater the quantity of human capital, the greater the supply of skilled labor in the local market. This will narrow wage inequality through a supply of talent to decrease the wage premiums caused by ICT.
- Educational endowments have a similar impact with increased ICT adoption and the increased demand for skilled labor (Caselli & Coleman, 2001; Glaeser & Saiz, 2004). This increase in demand for skilled labor creates further wage premiums and increases the wage gap.
- We test our model and determine whether the supply of or demand for skilled labor dominates the relationship.

Hypotheses

H1: With greater ICT adoption and skilled labor supply, the area's economic wealth can increase.

H2: The region with higher level of ICT usage will have more pronounced wage inequality.

H3: An inverted U-shaped relationship exists between internet access and economic growth and wage gap.

H4: Technological endowment enhances a region's productivity and increases its economic growth. Technological endowment reshapes skill-biased technology on economic growth and wage inequality.

H5: Education endowment ensures a region's economic growth. Meantime, educational endowment reshapes skill-biased technology on economic growth and wage inequality.

Methods

Data: The study employs the data from mainland Chinese provinces and cities at the prefectural and county levels (county-level administrative division municipalities).

We construct the variables and compose 3 sampled panels from the Annual Statistical Yearbook of China, Educational Statistical Yearbook of China, China Labor Statics Yearbook, provincial statistical yearbooks, local statistical bureau reports, government bulletins, and other formal media documents from 2001 to 2015.

Estimation: We construct the statistical model of the impacts of internet access on economic growth and wage inequality across provinces, prefecture-cities, and county-cities.

H1: $LnGDP_{i,j,t} = \alpha + \beta_1 Internet_{i,j,t} + wControl_{i,j,t} + u_{i,j,t}$

H2: $LnGap_{i,j,t} = \alpha + \beta_1 Internet_{i,j,t} + wControl_{i,j,t} + u_{i,j,t}$

H3: $LnGDP_{i,j,t} = \alpha + \beta_1 Internet_{i,j,t} + \beta_2 (Internet_{i,j,t})^2 + wControl_{i,j,t} + u_{i,j,t}$

$LnGap_{i,j,t} = \alpha + \beta_1 Internet_{i,j,t} + \beta_2 (Internet_{i,j,t})^2 + wControl_{i,j,t} + u_{i,j,t}$

We interact internet access with computer usage and educational endowment, respectively, to examine how the prior endowment of skill and human capital can further moderate the focused relationship.

H4: $LnGDP_{i,j,t} = \alpha + \beta_1 Internet_{i,j,t} + \beta_2 (Internet_{i,j,t})^2 + \lambda_1 Computer_{i,j,t} + \lambda_2 Internet_{i,j,t} \times Computer_{i,j,t} + \lambda_3 (Internet_{i,j,t})^2 \times Computer_{i,j,t} + wControl_{i,j,t} + u_{i,j,t}$

$LnGap_{i,j,t} = \alpha + \beta_1 Internet_{i,j,t} + \beta_2 (Internet_{i,j,t})^2 + \lambda_1 Computer_{i,j,t} + \lambda_2 Internet_{i,j,t} \times Computer_{i,j,t} + \lambda_3 (Internet_{i,j,t})^2 \times Computer_{i,j,t} + wControl_{i,j,t} + u_{i,j,t}$

H5: $LnGDP_{i,j,t} = \alpha + \beta_1 Internet_{i,j,t} + \beta_2 (Internet_{i,j,t})^2 + \gamma_1 College_{i,j,t} + \gamma_2 Internet_{i,j,t} \times College_{i,j,t} + \gamma_3 (Internet_{i,j,t})^2 \times College_{i,j,t} + wControl_{i,j,t} + u_{i,j,t}$

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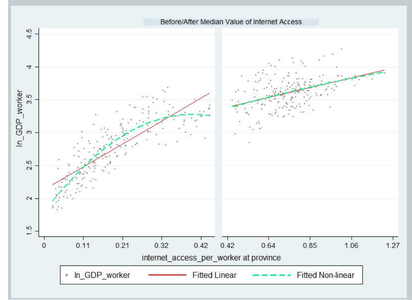
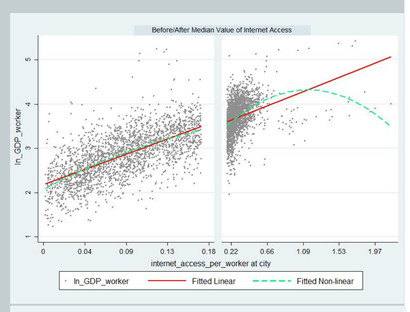
Results





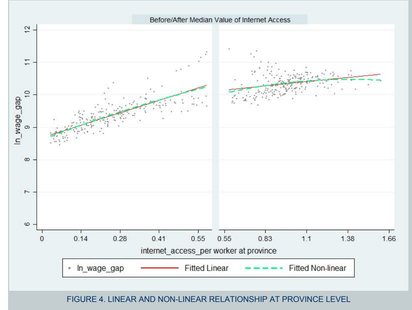


FIGURE 4. LINEAR AND NON-LINEAR RELATIONSHIP AT PROVINCE LEVEL

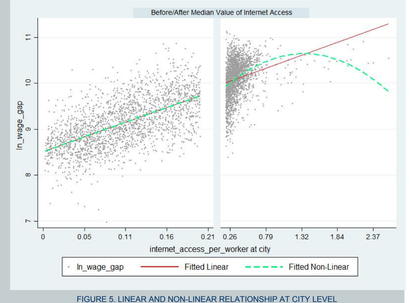


FIGURE 5. LINEAR AND NON-LINEAR RELATIONSHIP AT CITY LEVEL

Table 1 Effect of Internet Access on Regional Economic Growth

H1	(1)	(2)	(3)	(4)	(5)	(6) H3
	ln_GDP_prov	*ln_GDP_prov*	*ln_GDP_city*	*ln_GDP_city*	*ln_GDP_coun*	*ln_GDP_coun*
internet_access	0.00101***	0.00368***	0.000352***	0.00115***	0.0705***	0.179***
	(0.000336)	(0.00110)	(0.000112)	(0.000268)	(0.0170)	(0.0296)
internet_access^2		-0.00000391***		-0.00000126***		-0.0207***
		(0.00000108)		(0.000000255)		(0.00405)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Regional Fix Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fix Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	450	450	4187	4187	1299	1299
R^2	0.9574	0.9614	0.9392	0.9402	0.9743	0.9751

Note: Driscoll-Kraay standard errors in parentheses; $^*p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.

Table 2 Effect of Internet Access on Regional Wage Gap

H2	(1)	(2)	(3)	(4)	(5)	(6) H3
	ln_gap_prov	*ln_gap_prov*	*ln_gap_city*	*ln_gap_city*	*ln_gap_coun*	*ln_gap_coun*
internet_access	0.0000448	0.000789*	0.000143**	0.000871***	0.0177*	0.0397***
	(0.000157)	(0.000441)	(0.0000690)	(0.000247)	(0.00973)	(0.0140)
internet_access^2		-0.00000109*		-0.00000115***		-0.00421***
		(0.000000545)		(0.000000287)		(0.00118)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Regional Fix Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fix Effect	Yes	Yes	Yes	Yes	1299	1299
Observations	450	450	4187	4187	0.5225	0.5231
R^2	0.9840	0.9847	0.9515	0.9522	*ln_gap_coun*	*ln_gap_coun*

Note: Driscoll-Kraay standard errors in parentheses; $^*p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.

Table 3 Interactive Effect of Internet Access and Computer Use

H4	(1)	(2)	(3)	(4)	(5)	(6)
	ln_GDP_city	*ln_GDP_city*	*ln_GDP_city*	*ln_gap_city*	*ln_gap_city*	*ln_gap_city*
internet_access_city		0.000625***	0.00176***		0.000416***	0.00172***
		(0.0000963)	(0.000301)		(0.000151)	(0.000323)
internet_access_city^2			-0.0000214***			-0.00000259***
			(0.000000443)			(0.000000482)
pc_use	0.00648***	0.00888***	0.0111***	0.000792*	0.00348***	0.00744***
	(0.000465)	(0.00116)	(0.00201)	(0.000456)	(0.00119)	(0.00140)
pc*internet_access_city		-0.0000143**	-0.0000404**		-0.0000182**	-0.0000636***
		(0.00000704)	(0.0000176)		(0.00000901)	(0.0000156)
pc*internet_access_city^2			6.43e-08**			0.00000010***
			(3.02e-08)			(2.66e-08)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
City Fix Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fix Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4187	4187	4187	4187	4187	4187
R^2	0.9410	0.9424	0.9437	0.9514	0.9518	0.9530

Note: Driscoll-Kraay standard errors in parentheses; $^*p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.

Table 4 Interactive Effect of Internet Access and Educational Endowment

H5	(1)	(2)	(3)	(4)	(5)	(6)
	ln_GDP_city	*ln_GDP_city*	*ln_GDP_city*	*ln_gap_city*	*ln_gap_city*	*ln_gap_city*
internet_access_city		0.000830***	0.00137***		0.00101**	0.00179***
		(0.000212)	(0.000388)		(0.000403)	(0.000494)
internet_access_city^2			-0.00000123			-0.00000204***
			(0.000000878)			(0.000000780)
ln_col_edu_city	0.0179***	0.0201***	0.0185***	-0.00174	0.00213	0.00171
	(0.00433)	(0.00484)	(0.00399)	(0.00432)	(0.00544)	(0.00528)
ln_col*internet_access_city		-0.0000674**	-0.0000326		-0.0000122**	-0.0000134***
		(0.0000319)	(0.0000459)		(0.0000485)	(0.0000424)
ln_col*internet_access_city^2			-7.01e-10			0.00000134
			(0.00000104)			(9.84e-08)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
City Fix Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fix Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4187	4187	4187	4187	4187	4187
R^2	0.9384	0.9393	0.9403	0.9514	0.9517	0.9523

Note: Driscoll-Kraay standard errors in parentheses; $^*p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.

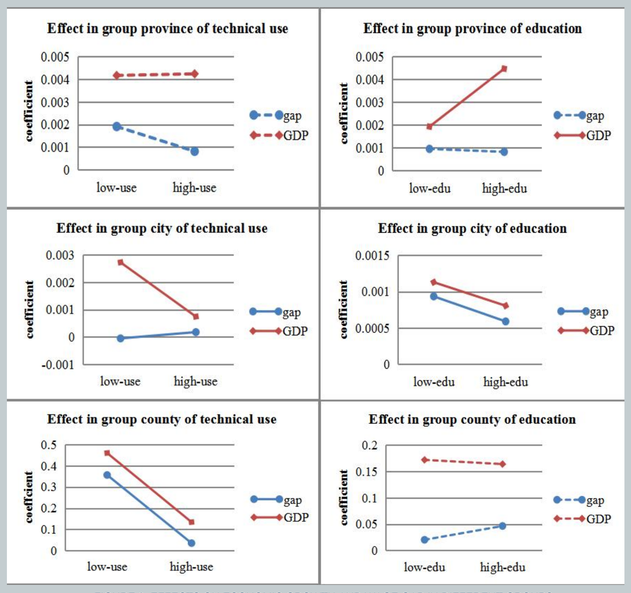


FIGURE 8. EFFECTS ON ECONOMIC GROWTH AND WAGE GAP IN DIFFERENT GROUPS

Note: The dashed line indicate the insignificant effect. The solid line indicate the significant effect.

Conclusion

Undertaking this examination, we calibrate the puzzle raised by Forman, Goldfarb and Greenstein (2012) that widely-used advanced internet technology generate unequal distribution of wage growth across regions, depending on how the region is equipped with proper endowments.

As these effects can be observed at economies' different developmental stages, this helps in the search for a solution to the problematic combination of growth and inequality.

Our findings help resolve the puzzle in the way that the adverse impact of new technology adoption can be alleviated by increasing supply of skilled labor and accumulating educational endowment.

By grouping our results, we attempt to explain the former puzzle of technological optimistic and pessimism in the literature. Our study explains why the wage of workers has risen at information-based skilled cities in China.