The Productivity of Unskilled Labor in Multinational Subsidiaries from Different Sources

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Version: October 13, 2008

Abstract: Currently, multinational corporations (MNCs) from both developed and emerging economies build subsidiaries in developing countries to take advantage of the resident cheap unskilled labor. Using data from the Chinese electronics industry, this paper finds that, despite the great differences between developed and emerging economies, the productivity of unskilled labor employed by MNCs of both types of economy shows no difference. This paper also finds suggestive evidence that the productivity of skilled labor is higher in the subsidiaries from developed economies.

Key Words: Unskilled labor, FDI, Skill-biased technological change
Subject Classification: (JEL) F23, O14, O33.

1. INTRODUCTION

Multinational corporations (MNCs) from both developed and emerging economies build subsidiaries in developing countries to take advantage of the resident cheap unskilled labor. Does the productivity of unskilled labor in these subsidiaries vary by location of the parent MNCs? Productivity depends on technology, and most of the world's technological innovations occur in developed economies,[1] so the productivity of unskilled labor, if different between the two types of source economies, would be expected to be higher in the subsidiaries from developed economies. Meanwhile, innovations in developed economies are found to favor skilled labor rather than unskilled labor (Berman, Bound, and Machin, 1998; Katz and Murphy, 1992). As a result, whether a productivity difference exists between subsidiaries associated with the two types of source economies is ultimately an empirical question.

China is a typical developing country with abundant unskilled labor. Using firm-level data from the Chinese electronics industry, we find that the productivity of unskilled labor in multinational subsidiaries shows no significant difference with regard to source economy. Furthermore, we document that the productivity of skilled labor is significantly higher in the subsidiaries from developed economies, suggesting that the MNCs of developed economies transmit their skill-biased homeland technologies to their subsidiaries in developing countries.

2. DATA

This study focuses on the electronics industry for two reasons. First, investigating a single industry prevents industry heterogeneity from contaminating the findings–

[1] The G-7 countries account for more than 90% of the world's R&D spending (Keller, 2001). The G-7 countries are Canada, France, Germany, Italy, Japan, United Kingdom, and United States.

different industries use different technologies, and thus have industry-specific productivity of factors; consequently, a multiple-industry study would be inevitably confounded by the technological differences among industries. Second, the electronics industry features intensive research and development (R&D), and we investigate productivity differences caused by technology. In industries in which R&D is relatively unimportant, such as garment making, productivity differences are likely to result from factors other than technology.

Two firm-level data sets from China are used in this study. The first is the Investment Climate Survey (ICS) compiled by the World Bank in 2003. Among the firm-level variables reported in this survey, we use the employment and costs of *basic production workers* and *engineering and technical personnel* for each firm to calculate wages of skilled and unskilled labor, respectively. Basic production workers are considered unskilled labor, and engineering and technical personnel are regarded as skilled labor. Next, we calculate city-level averages of firm-level wages in the electronics industry. The reason for using city-level wages will be discussed in the next section.

The second data set is the economic survey of 2004 compiled by the National Bureau of Statistics of China.[2] We extract, from the economic survey, multinational subsidiaries that are domiciled in the surveyed cities of the ICS 2003. The time lag between the two surveys strengthens the exogeneity of wage levels. Firms funded by *Hong Kong, Taiwan, and Macau (HMT)* and those by *other foreign economies* are two distinct categories in the statistical system of China, while they are regulated under the same set of laws. The economic survey reports whether a subsidiary is *foreign-funded* or *HMT-funded* without revealing the specific source country. Nevertheless, according to official statistics, nearly 90% of non-HMT subsidiaries are from developed economies.[3] Worker education levels are categorized by the economic survey as follows: (1) master's degree and above, (2) bachelor's degree, (3) junior college diploma, (4) high school diploma, and (5) some high school or less. We consider labor with education levels (4) and (5) as unskilled labor, and the rest as skilled labor. This is in line with the practice of a large literature (e.g., Autor, Katz, and Krueger, 1998; Katz and Murphy, 1992).

Notably, subsidiaries within the same industry may produce different products, which renders the comparison across subsidiaries problematic. We use several techniques to address this concern. Table 1 presents a comparison between the subsidiaries from emerging and developed economies. The first row shows that, in both types of subsidiary, 60% of sales are exported, and there is no significant difference between them. In fact, according to the *Electronics Industry Yearbook of China*, in 2003, 90% of electronics exports from China are in the form of assembling and processing. Electronics is a typically skill-intensive industry, and the activities chosen by MNCs to be located in China, a typical developing country with abundant unskilled labor, are those of lowest skill intensity; therefore, these activities are largely homogeneous.

The second row of Table 1 shows that there is no significant difference in the employment of skilled labor relative to unskilled labor, illustrating the similarity of subsidiaries in labor composition. The electronics industry, as a general classification, consists of a large number of four-digit industries, and thus we examine the distributions of four-digit industry codes of subsidiaries across sources. The distributions are shown in Figure 1, and a Kolmogorov-Smirnov test further confirms their similarity (Row 3, Table 1). Furthermore, producing more sophisticated products necessarily involves related intermediate inputs, most of which are unavailable in an unskill-abundant economy such as China, and thus must be imported. By the same token, the value of sales is presumably

[2] To our knowledge, the papers that use this data set include Wang (2008), Wang and Shi (2008), and Zhang and Zheng (2007).

[3] Data source and calculation details on this statistic are available on request.

higher for more sophisticated products. In order to purify the heterogeneity embedded in intermediate inputs and sales, we use their difference, or the value-added, in our analysis.

3. SPECIFICATION

Our specification is a micro-level variant of Caselli and Coleman (2006). We assume that the production functions of multinational subsidiaries from developed and emerging economies have the same functional form. For flexibility, consider a function with constant elasticity of substitution

$$Y = K^{\alpha}[(A_u L_u)^{\sigma} + (A_s L_s)^{\sigma}]^{(1-\alpha)/\sigma}, \quad (1)$$

where Y is value-added, K is capital proxied by fixed assets, L_u (L_s) is the employment of unskilled (skilled) labor, and A_u (A_s) is its productivity. The elasticity of substitution between skilled and unskilled labor is $\frac{1}{1-\sigma}$. First-order condition implies that

$$\frac{W_s}{W_u} = (\frac{A_s}{A_u})^{\sigma}(\frac{L_s}{L_u})^{\sigma-1}. \quad (2)$$

In this paper, we focus on A_u and report A_s as a comparison. The simultaneous system of equations (1) and (2) generate analytical solutions for A_u and A_s:

$$A_u = \frac{Y^{1/(1-\alpha)}K^{-\alpha/(1-\alpha)}}{L_u}(\frac{W_u L_u}{W_u L_u + W_s L_s})^{1/\sigma}, \quad (3)$$

and

$$A_s = \frac{Y^{1/(1-\alpha)}K^{-\alpha/(1-\alpha)}}{L_s}(\frac{W_s L_s}{W_u L_u + W_s L_s})^{1/\sigma}. \quad (4)$$

We assume that A_u and A_s vary between developed and emerging economies, while α and σ are shared by them. Following the standard practice, we specify $\alpha = 1/3$.[4] Since σ is crucial in determining A_u and A_s and has no empirical values, we use the following technique to estimate it. Equation (2) can be rewritten as

$$\ln\frac{L_s}{L_u} = \frac{\sigma}{1-\sigma}\ln\frac{A_s}{A_u} - \frac{1}{1-\sigma}\ln\frac{W_s}{W_u}. \quad (5)$$

Construct a dummy variable, DE, which equals 1 if a given subsidiary is from developed economies, and 0 if from emerging economies. Running a regression of $\ln L_s/L_u$ on DE and $\ln(w_s/w_u)$

$$\ln\frac{L_s}{L_u} = \phi + \beta\cdot DE - \gamma\ln\frac{w_s}{w_u} + \epsilon \quad (6)$$

would estimate $\frac{\sigma}{1-\sigma}[\ln(A_s/A_u)|_{DE=1} - \ln(A_s/A_u)|_{DE=0}]$ by $\widehat{\beta}$ and $\frac{1}{1-\sigma}$ by $\widehat{\gamma}$. Then, $\widehat{\sigma}$ can be calculated based on $\widehat{\gamma}$. A possible concern is the endogeneity of $\ln\frac{w_s}{w_u}$. We use city-level wages rather than firm-level wages to address this. There are 15,566 electronics manufacturing firms in total, with only 1,538 of them being multinational subsidiaries. The total share of multinational subsidiaries is less than 10%, and thus it is difficult to imagine that multinational subsidiaries drive the equilibrium wages in the local labor

[4] Given that observations are from the same industry, α does not vary significantly across firms. Also, since the terms involving α in equations (3) and (4) are the same, it is unlikely that the value of α drives our results. Moreover, as discussed later, we have experimented with different values of α as a robustness check.

market.

Our main regressions are specified as

$$A_u = \mu_u + \delta_u \cdot DE + \lambda_u' X + \epsilon \tag{7}$$

and

$$A_s = \mu_s + \delta_s \cdot DE + \lambda_s' X + \epsilon, \tag{8}$$

where μ's are constant terms, X represents firm-level control variables, and δ's are of interest to us.

4. RESULTS

Table 2 reports the results of regression (6). In order to prevent city-level heterogeneity from contaminating the results, we control for *GDP per capita* and *share of population with college education* for regions encompassing cities of interest. Four-digit industry fixed effects are also controlled for. The estimated elasticity of substitution between skilled and unskilled labor is 1.38, almost equal to the empirical value of 1.4 in the literature (e.g., Katz and Murphy, 1992; Caselli and Coleman, 2006). The coefficient of DE is positive and significant, indicating that the relative employment of skilled labor is higher by 1.2% ($\exp(0.16) \approx 1.2$) in the subsidiaries from developed economies than in those from emerging economies.

We then use the $\widehat{\sigma}$ calculated based on $\widehat{\gamma}$ to calculate A_s and A_u and then run regressions (7) and (8). These results are reported in Table 3. Notably, fixed assets and value added, two firm-level characteristics, have already been controlled for on the left-hand side of the regression. In other words, our measures of A_s and A_u have taken these two factors into account. The rationale behind controlling for them is to prevent the aforementioned firm-level heterogeneity from contaminating the results. Another two firm-level characteristics, age and size, are included on the right-hand side.

Columns (1) and (2) show that A_u has no significant difference between two types of subsidiaries, while Columns (3) and (4) suggest that A_s is higher in the subsidiaries from developed economies. In Column (2), the coefficient of age is positive, a possible interpretation of which is that subsidiaries make efforts to raise A_u over time. This is potentially in line with the theory of directed technological change (Acemoglu, 1998, 2002), which argues that technologies are endogenous in the long run, and firms choose technologies according to factor supplies. We also experiment with A_s/A_u, the relative productivity of skilled labor, as the dependent variable. As expected, Columns (5) and (6) illustrate a relative skill bias in the technologies used by the subsidiaries from developed economies. This bias attenuates over time, for the same reason as does the rise in A_u over time. In fact, this skill bias holds in the absolute sense as well, because A_u is no higher in the subsidiaries from developed economies.

We argue that these findings show that the productivity of unskilled labor in the subsidiaries from developed economies is no different than that in the subsidiaries of emerging economies, because innovations in developed economies favor skilled labor only. Our results also suggest that the MNCs from developed economies transmit skill-biased technologies to their subsidiaries located in developing countries. A possible explanation is that the overall trend of innovation is to bias toward skilled labor, and thus it is too costly for the MNCs of developed economies to innovate another set of technologies that are unskill-biased specifically for their subsidiaries located in developing countries.

There may be a concern that the coefficient of DE is driven by the self-selection of skilled labor; namely, skilled labor of higher quality self-selects into subsidiaries from developed economies. However, if this is true, self-selection is expected to happen in the unskilled labor market as well, such that the measured A_u would be accordingly higher in subsidiaries of developed economies. Another possible concern is that the MNCs from developed economies, compared to those from emerging economies, pay higher wages to skilled labor, but the same wage to unskilled labor. Nevertheless, this is the other side of the same coin–the demand for skilled labor is higher in the subsidiaries from developed economies, whereas that for unskilled labor does not differ significantly between the two types of subsidiaries–an inference of the skill bias in the technology used by the subsidiaries from developed economies.

We have performed three sets of robustness checks: (1) the $\widehat{\sigma}$ calculated based on $\widehat{\gamma}$ might be biased because $1/(1-\sigma)$ is nonlinear in σ, so we experiment with other neighboring values of σ;[5] (2) adoption of values of α other than $1/3$; (3) use of production function that takes the complementarity between skilled labor and capital into account.[6] They all lead to the same conclusion as our benchmark specification.

5. CONCLUSION

Technological innovations in developed economies favor skilled labor, and thus the productivity of unskilled labor in the subsidiaries from developed economies is no different from that in the subsidiaries from emerging economies. Our results verify this hypothesis, and also provide suggestive evidence that the MNCs from developed economies transmit skill bias in their homeland technologies to their subsidiaries in developing countries.

REFERENCES

[1] Acemoglu, Daron. 1998. Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality. *Quarterly Journal of Economics*, 113(4):1055-1089.

[2] Acemoglu, Daron. 2002. Directed Technical Change. *Review of Economic Studies*, 69(4):781-809.

[3] Autor, David H.; Katz, Lawrence F. and Krueger, Alan B. 1998. Computing inequality: Have computers changed the labor market? *Quarterly Journal of Economics*, 113(4):1169–1213.

[4] Berman, Eli; Bound, John and Machin, Stephen. 1998. Implications Of Skill-Biased Technological Change: International Evidence. *Quarterly Journal of Economics*, 113(4):1245-1279.

[5] Caselli, Francesco and Coleman, Wilbur John. 2006. The World Technology Frontier. *American Economic Review*, 96(3): 499-522.

[6] Katz, Lawrence F. and Murphy, Kevin M. 1992. Changes in relative wages, 1963-1987: Supply and demand factors. *Quarterly Journal of Economics*, 107(1):35–78.

[7] Keller, Wolfgang. 2001. Knowledge Spillovers at the World's Technology Frontier. CEPR Discussion Papers 2815.

[5] Autor, Katz, and Krueger (1998) conclude that $1/(1-\sigma)$ is very unlikely to fall outside [1,2]. Also see Caselli and Coleman (2006).

[6] The complementarity between skilled labor and capital is considered as a reason for SBTC. See Voilante (2007).

[8] Violante, Giovanni. 2007. Skilled-biased Technical Change.

[9] Wang, Zheng and Shi, Jinchuan Shi. 2008. Productivity Performance and Investment Efficiency of China's Private Enterprises. *Economic Research Journal (in Chinese)*, 43(1):114-126.

[10] Wang, Zheng; Sun, Liumei and Shi, Jinchuan. Forthcoming. FDI Spillover, Absorptive Capacity and the Productivity Of China's Private Firms: Evidence from the First National Economic Census Data. *China Economics Quarterly (in Chinese).*

[11] Zhang, Hua and Zheng, Wei. 2007. Geographical Agglomeration of Chinese Manufacturing Industries. *Chinese Journal of Population, Resources and Environment*, 5(2): 3–11.

Table 1: Comparison between Subsidiaries from Emerging and Developed Economies

	Emerging Economies (Standard error)	Developed Economies (Standard error)	Difference (Standard error)
Share of export in Sales	0.60	0.60	-0.0005
	(0.01)	(0.02)	(0.02)
Skilled worker / unskilled worker	0.64	0.68	-0.04
	(0.15)	(0.10)	(0.22)
Kolmogorov-Smirnov statistic of 4-digit industry distribution	0.05	-0.05	0.05
(p-value)	(0.23)	(0.18)	(0.36)
Number of Observations	1016	522	

Table 2: Estimation of the Elasticity of Substitution

Dependent variable:	ln (Ls/Lu)
OECD dummy	0.16**
	(0.08)
ln Ws/Wu	-1.38***
	(0.43)
ln GDP per capita	-0.54
	(0.37)
Share of population with college education	0.006
	(0.08)
Constant	4.63
	(3.12)
Number of observations	1456
F-statistic	21.96
(p-value)	(0.00)
R-square	0.21

Note: Fixed effects at the 4-digit industry level have been controlled for. * <0.1, ** <0.05, *** <0.01

Table 3: Main Results

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent Variable:	lnAu	lnAu	lnAs	lnAs	lnAs-lnAu	lnAs-lnAu
DE dummy	0.028	0.016	0.665***	0.667***	0.631***	0.646***
	(0.150)	(0.150)	(0.206)	(0.207)	(0.202)	(0.202)
Size		0.00003		-1.90e-06		-0.00003
		(0.00002)		(0.00002)		(0.00004)
Age		0.029*		-0.028		-0.053**
		(0.016)		(0.023)		(0.021)
Number of observations	889	889	879	879	876	876
F-statistic	0.03	1.57	10.39	3.95	9.77	5.70
(p-value)	(0.85)	(0.21)	(0.00)	(0.01)	(0.00)	(0.00)
R-square	0.14	0.05	0.14	0.14	0.18	0.19

Notes: City-level fixed effects are controlled for. Robust standard errors are clustered at the four-digit industry level. Constant term is not reported. * <0.1, ** <0.05, *** <0.01.

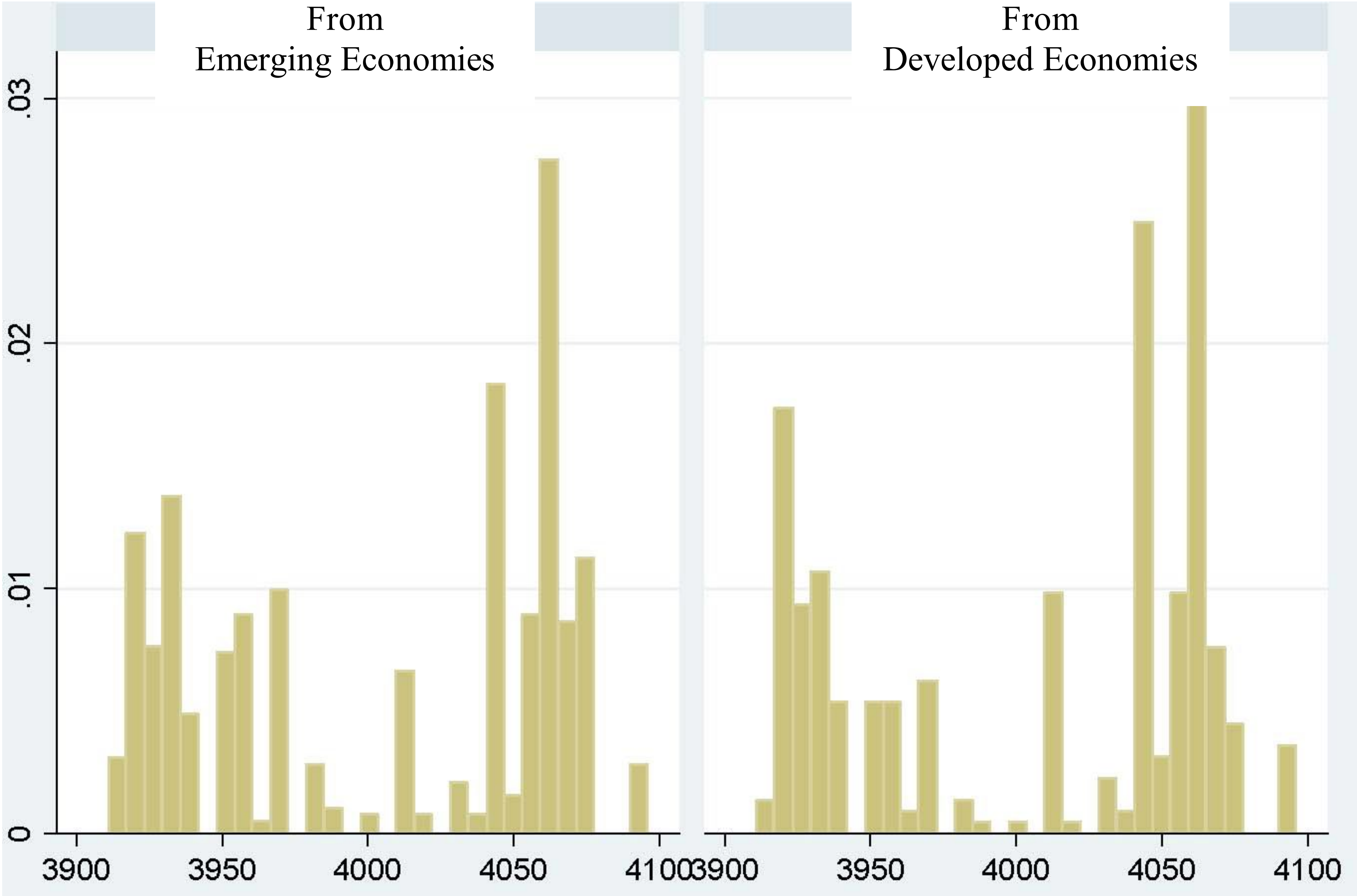

Figure 1: Distribution of Four-digit Classification Codes in the Electronics Industry