Impact of FDI on Relative Return to Skill*

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June 30, 2001

ABSTRACT

Since the early 1980s, China has adopted favorable economic policies to attract FDI to facilitate technology development. Since inward FDI induces either sector or factor biased technical progress, the impact of FDI on income distribution between skilled and unskilled labor is not trivial. This paper introduces vertical product differentiation to analyze the impact of FDI on the return to skill and concludes that, for a labor abundant country, this impact depends on whether the FDI induced technology transfer is skill or labor biased regardless of which sector receives FDI. The analysis shows that FDI with relatively labor biased technology will decrease the wage gap while FDI with relatively skill biased technology will increase the profit margin of the host country's exports as well as its wage gap. The findings provide policy insights for FDI recipient countries in balancing wage growth between skilled and unskilled workers by managing inward FDI with relatively labor biased and skill biased technologies. This is particularly important for China given the expected further increase of inward FDI following its imminent membership in the WTO.

JEL Classification: F23, J31, P33

Key words: foreign direct investment, product quality, wage inequality

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*I would like to thank the editors Yingyi Qian and Shang-Jin Wei, and my colleagues Patrick Conway and Al Field for their valuable comments on an earlier version of this paper.

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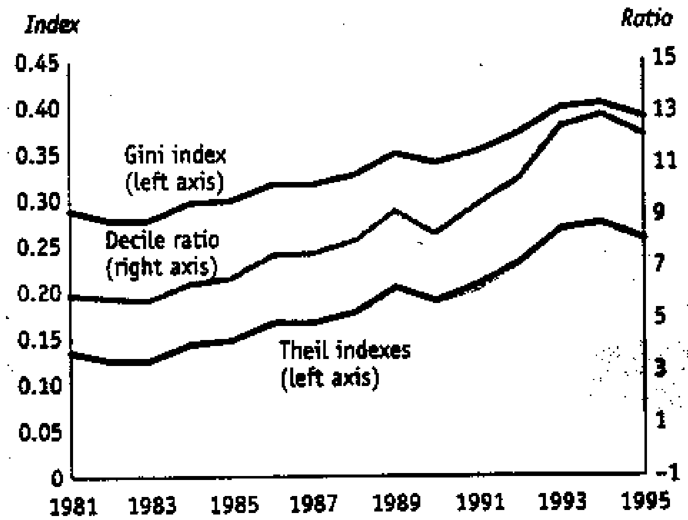
1 Introduction

China has enjoyed fast economic growth at over 9% per year on average and low inflation rates never in excess of 30% since its economic reforms unfolded in 1978. During this transition from a planned economy to a market economy, China has adopted policies to encourage foreign direct investment (FDI), which has become an integral part of China's economic growth strategy. China's share of FDI flows in gross fixed capital formation was around 4% over the period from 1987 to 1992 and rose dramatically to 14.6% in the next 5 years (UNCTAD, 1999; Zhang, 2000). By 1997, China's share of total FDI stock in GDP reached 23.5%.

Meanwhile, income inequality in China is also rising. Zhang and Zheng (1998) show that the GINI coefficient of the per capita wages in industrial sectors almost doubled between 1985 and 1995. The World Bank (1997) reports that the income inequality across all sectors has also increased dramatically since 1981 as shown in Figure 1. As rising inequality can impede growth, undermine poverty alleviation, and contribute to social tension, the impact of FDI on economic prosperity and income inequality has significant policy implications, especially for China with large volumes of inward FDI.

The impact of inward FDI on economic growth, income distribution, and technology development, especially its important role in facilitating the transfer of advanced technologies from developed countries to less developed countries are well documented (Glass and Saggi, 1999 and 2001a; Feenstra and Hanson, 1997b). This paper will contribute to this rich literature by deriving a rule-of-thumb prediction for the effect of inward FDI on a host country's relative wage of skilled versus unskilled labor. The key question is whether all FDI from newly developed or developed countries to a relatively labor abundant country, like China, will lead to an increasing return to skill. If not, will FDI's overall effect on the relative wage mainly determined by which sector receives FDI or will this effect mainly determined by whether FDI induces a relatively labor or skill biased technical progress? As China embraces the world market by joining the World Trade

Figure 1: China's Gini Index 1981–95



Note: The decile ratio is the ratio of the mean income of the top decile of the population to the mean income of the bottom decile. The Theil indexes (Theil 1 and 2, or mean log deviation) belong to the generalized entropy class of inequality measures, which are decomposable.
Source: State Statistical Bureau data and World Bank staff estimates.

Organization (WTO), this analysis can help policy makers to design accommodating policies to boost economic growth and to improve income inequality.

Feenstra and Hanson (1997b), Wu (2001a) and Zhang and Zheng (1998) show that the entrance of multinationals can lead to an increase in income inequality if such inward FDI induces a relatively skill intensive technical change. This paper will show that other types of FDI will not increase the relative return to skill, in particular, if the technology transfer induced by FDI is (unskilled) labor biased, then such FDI can actually reduce the relative wage of skilled labor and hence income inequality.

Table 1 shows that China's foreign direct investment has been mainly from newly developed countries/regions. Most of these FDI brings in relatively labor intensive technologies. For example, in the firm survey documented in Huang, Xie, and Chen (1994), 54.1% of FDI from newly

Table 1: China's Major FDI Source Regions

Year		1996	1997	1998	1999
Hong Kong	Total (USD million)	20,851.60	20,632.00	18,508.36	16,363.05
	% in Total FDI	49.49%	45.59%	40.71%	40.58%
Taiwan	Total (USD million)	3,482.02	3,289.39	2,915.21	2,598.70
	% in Total FDI	8.26%	7.27%	6.41%	6.45%
Singapore	Total (USD million)	2,247.16	2,606.41	3,403.97	2,642.49
	% in Total FDI	5.33%	5.76%	7.49%	6.55%
Korea	Total (USD million)	1,504.16	2,142.38	1,803.20	1,274.73
	% in Total FDI	3.57%	4.73%	3.97%	3.16%
Top 4 Newly Developed Regions					
	Total (USD million)	28,084.94	28,670.18	26,630.74	22,878.97
	% in Total FDI	66.65%	63.35%	58.58%	56.75%
Japan	Total (USD million)	3,692.14	4,326.47	3,400.36	2,973.08
	% in Total FDI	8.76%	9.56%	7.48%	7.37%
United States	Total (USD million)	3,444.17	3,239.15	3,898.44	4,215.86
	% in Total FDI	8.17%	7.16%	8.58%	10.46%
Top 2 Developed Regions					
	Total (USD million)	7,136.31	7,565.62	7,298.80	7,188.94
	% in Total FDI	16.94%	16.72%	16.05%	17.83%
Top 6 Source Regions					
	Total (USD million)	35,221.25	36,235.80	33,929.54	30,067.91
	% in Total FDI	83.59%	80.07%	74.63%	74.58%

Source: China Statistical Yearbook 1998, 1999 and 2000.

Note: The fall of FDI from Asian regions in 1998 could be partly due to the Asian Crisis.

developed countries/regions in the manufacturing sector is labor intensive. However, there is a trend that the percentage of FDI from well developed countries with relatively skill intensive technologies, such as the United States and Japan, is rising as shown in Table 1. This trend is likely to continue as China opens up sectors like telecommunication, information technology, and banking and financial services as included in it's recent WTO agreements with the US and EU. This paper demonstrates that these two types of foreign direct investment push the relative wage in opposite directions. Thus, a balanced increase in different types of FDI can have a moderate overall effect on income distribution. As studied in the World Bank (1997) China 2020 Series, China's rising income inequality can be mainly driven by the rural-urban gap and provincial disparities due to labor market immobility rather than the huge influx of foreign direct investment.

In the trade literature, Jones (1965 and 2000), Leamer (1998 and 2000) and Krugman (2000), Richardson (1995) and Xu (2001) have studied how technical progress affects the relative wage of skilled versus unskilled labor for an economy with homogeneous goods only. The effect can depend on whether technical progress occurs in a relatively skill intensive or labor intensive sector and whether it is skill or labor biased. When there is vertical product differentiation, different quality products need different skill intensity techniques to produce. Skill intensity in a sector depends on both the relative wage and the endogenous choice of quality produced. Wu (2001a) introduces both vertical and horizontal product differentiation, and focuses on the enforcement of intellectual property rights on the wage impact of FDI with skill biased technology in the differentiated sector only. This paper extends Wu (2001a) by examining how vertical product differentiation and monopolistic pricing can affect the wage impact of FDI with either labor or skill biased technology in either the homogeneous or the differentiated sector.

When consumers are willing to pay for goods with a higher quality, as reflected by the slogan, you get what you pay for, firms can charge a price above its average variable cost even under constant returns to scale. This is consistent with the empirical findings in Domowitz, Hubbard and Petersen (1988), Hall (1988), and Shapiro (1987), which reject the joint hypothesis of competition and constant returns to scale for many US industries. Meanwhile, a higher quality is often produced with a different skill intensity of production and at a higher cost.[1] If we simply think of different varieties as different goods, then we still cannot explain why prices are above firms' average variable cost and we may also have an empirical problem of how to define a product. Thus, it is important to develop a formal general equilibrium model incorporating product quality to re-examine the role of technology transfer on the relative return to skill in the presence of market power.

To model the monopolistic competition among firms, this paper adopts the Helpman-Krugman general equilibrium approach.[2] Helpman (1981) and Helpman and Krugman (1985) analyze the pattern of trade and the welfare effects of trade in a monopolistic competition market by introducing horizontal product differentiation into a Heckscher-Ohlin framework. They focus on increasing returns to scale as the driving force of intra-industry trade rather than the pursuit of higher qualities produced with a higher skill intensity production technique as later demonstrated in this paper. This paper relaxes their assumption of identical technologies and identical cost structures to emphasize the cost difference of producing different varieties.

Flam and Helpman (1987), Copeland and Kotwal (1996) and Murphy and Shleifer (1997) allow firms to have different cost structures so as to endogenize a firm's choice of quality and to relate higher quality to more labor input in production. Since their focus is the pattern of intra-industry trade as a result of population growth and technical progress, they use a Ricardian model with one factor (labor) of production. To analyze the relative factor return, as in Wu (2001a and 2001b), this paper extends the one-factor Ricardian quality model to a two-factor

[1] For example, to build a higher quality TV with a longer life tube or better picture quality requires much more research and more advanced or better production line. Hence, a higher skilled to unskilled labor ratio in the production process than to build a lower quality TV.

[2] A compendium of the trade models under monopolistic competition can be found in Grossman (1992).

Heckscher-Ohlin model. The model developed in this paper further extends the analysis in Wu (2001a and 2001b) and incorporates the approach in Motta (1992) and Sutton (1991) so as to allow consumers to consumer more than one units of a particular variety.

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 derives the free trade equilibrium. Section 4 derives the trade equilibrium with foreign direct investment and analyzes the impact of FDI on the relative wage of skilled labor to unskilled labor. Comparisons are made with results in standard general equilibrium models with homogeneous goods only. Section 5 discusses the policy implications for China on accommodating foreign direct investment in its imminent accession to the WTO. Section 6 concludes and discusses limitations of the model and possible extensions.

2 The Model

Markusen and Venables (1996 and 1997) first relate multinational investment to wage inequality by developing a firm-based general equilibrium trade model. Recent studies have developed international trade models of income distribution that depart from the assumption of exogenous technical change, and link economic openness to changes in factor prices through the acceleration of endogenous technical change. Examples include Dinopoulos and Segerstrom (1999), Dinopoulos, Syropoulos and Xu (1999), Feenstra and Hanson (1996, 1997a and 1999) and Richardson (1995). This paper identifies and investigates a new trade-related mechanism of income distribution: one that relates a multinational firm's endogenous choice of product quality to factor prices as studied in Wu (2001a and 2001b).

The model focuses on a small open economy that produces two goods, X and Y. Good X is vertically differentiated with quality q. Good Y is homogeneous and is sold in a perfectly competitive market. There are two factors of production, skilled (S) and unskilled labor (L).

These two factors are perfectly mobile within the country but can not move outside the country.

Firms in the differentiated sector first choose a quality, q, and then a competitive price under free entry and exit. Each firm produces only one variety.[3] The total output of good X at a given quality q is given by the following Leontief production function:

$$X(q) = \min\{\frac{L_x}{\mu_x}, \frac{S_x}{\lambda_x q^a}\} \tag{1}$$

where L_x is the unskilled labor input and S_x is the skilled labor input in the X-sector. Following the argument in Flam and Helpman (1987), Copeland and Kotwal (1996), and Murphy and Shleifer (1997) that for a given amount of unskilled and skilled labor, the total output is smaller if a firm chooses to produce a good with a higher quality. Hence, we assume that $a \geq 1$ and $q \geq 1$ (i.e normalize the lowest quality to one).

Moreover, a higher quality can either require more skilled relative to unskilled labor in production so that average variable cost increases in quality or in product development (R&D) so that fixed cost increases in quality. Here, we focus on the former relationship so that we assume that fixed cost is zero if a firm produces the lowest quality variety and is a positive constant if otherwise. From equation (1), at constant relative factor prices (w_l for unskilled labor and w_s for skilled labor) and a given quality (q), the average variable cost, $\mu_x w_l + \lambda_x q^a w_s$, increases in quality.

μ_x and λ_x are the factor-augmenting productivity parameters for the X-sector. The relative intensity of skilled to unskilled labor in production is

$$h_x = \frac{\lambda_x q^a}{\mu_x} \tag{2}$$

and hence at constant relative factor prices, a higher h_x represents a skilled labor biased (later referred to as skill biased) technical change while a lower h_x represents a unskilled labor biased

[3] If firms can produce more than one variety, then as long as the market is not a natural or protected monopoly studied in Mussa and Rosen (1978), results on market structure with single-product firms can be extended to those with multiproduct firms as shown in Constantatos and Perrakis (1997) and Champsaur and Rochet (1989).

(latter referred to as labor biased) technical change. Unlike the case with only homogeneous goods, the Hicksian technology parameter in the X-sector, h_x, depends on the endogenous choice of quality. Hence, there are two factors that can change the skilled-unskilled labor intensity in the X-sector: one is a **technology improvement** (a fall in μ_x or λ_x) in the production of all varieties, and one is a firm's endogenous choice of quality and hence **production technique** at existing μ_x and λ_x. In the following analysis, we will use this Hicks (1932) classification to define whether a technology transfer resulting from foreign direct investment is skill biased or labor biased.[4]

The production function of the homogeneous good, Y, is assumed to be a CES function with $\alpha \neq 1$.

$$Y = ((\frac{L_y}{\mu_y})^\alpha + (\frac{S_y}{\lambda_y})^\alpha)^{1/\alpha} \tag{3}$$

where L_y is the unskilled labor input and S_y is the skilled labor input in the Y-sector. Let $\sigma = \frac{1}{1-\alpha}$ be the elasticity of substitution between skilled and unskilled labor. Similarly to the X-sector, μ_y and λ_y are the factor-augmenting productivity parameters for the Y-sector. The following analysis is based on the case where $\sigma > 1$, which is consistent with most empirical studies.[5] Unlike in the X-sector, the skill intensity of production in the Y-sector is

$$h_y = (\frac{\lambda_y}{\mu_y})^{1-\sigma}(\frac{w_s}{w_l})^{-\sigma} \tag{4}$$

which is identical for all firms with the same technology and factor prices. For $\sigma > 1$, by the Hicksian classification, a rise in λ_y/μ_y indicates a labor biased technology transfer while a fall in λ_y/μ_y indicates a skill biased technology transfer.

[4] Wu (2001b) finds that predictions based on the Hicksian parameters are more robust to different consumption and production functional forms than those based on factor-augmenting parameters when there is vertical production differentiation.

[5] Most studies find σ greater than one, for example, $\sigma = 1.41$ in Katz and Murphy (1992), 1.5 in Johnson (1997), and 1.67 in Krusell et. al. (2000).

On the consumption side, each individual first chooses his/her consumption between two goods, X and Y, and then chooses the quality of good X to purchase. A higher quality can be interpreted as a product with more and/or better features. Thus, a consumer's choice within a good with different qualities differs from that among different homogeneous goods, where only quantity matters.[6] This consumer's utility can be characterized by the following Cobb-Douglas function:

$$U = (Xq^{\theta})^{\alpha} Y^{1-\alpha} \tag{5}$$

where θ indexes a consumer's marginal utility of quality with a higher θ representing a consumer with a higher valuation on quality (q). X is the consumption of good X and Y is the consumption of good Y. This utility function is similar to that in Motta (1992) and Sutton (1991).

It is easy to check that a consumer always spends α percent of its income on good X and $1-\alpha$ on good Y. Let $p(q)$ be the price of good X with quality q. From production function (1), at given income, I, and factor prices, w_l and w_s, the unit variable cost of producing good X with quality q is $w_l\mu_x + w_s\lambda_x q^a$. If each quality is sold at its unit variable cost so that $p(q) = w_l\mu_x + w_s\lambda_x q^a$, then a consumer chooses q to maximize his/her utility as follows.

$$\max_{q} \quad U = \left(\frac{\alpha I}{w_l\mu_x + w_s\lambda_x q^a} q^{\theta}\right)^{\alpha} \left(\frac{(1-\alpha)I}{p_y}\right)^{1-\alpha} \tag{6}$$

where p_y is the price of good Y. The first order derivative gives

$$\frac{dU}{dq} = \frac{\alpha U}{qp(q)}(\theta w_l\mu_x + w_s\lambda_x q^a(\theta - a)) \begin{cases} > 0 & \text{if } \theta \geq a \\ < 0 & \text{if } \theta = 0 \end{cases} \tag{7}$$

From the above first order derivative, there is a group of consumers with $\theta \geq a$ who always prefer the highest quality offered at unit variable cost (the high type consumers) and another group of consumers with θ close to zero who always prefer the lowest quality offered at unit

[6] This is consistent with a consumer's behavior of replacing his/her slower PC with a faster PC rather than buying another slower PC.

variable cost (the low type consumers). To simplify the analysis, we assume that β percent of skilled and unskilled labor has $\theta = 0$ and the rest $1 - \beta$ percent has $\theta = a$.

By assumption, there is no fixed cost to produce a variety with the lowest unit quality, but to produce a higher quality variety, a firm needs to do R&D to get a blue print and hence there is a fixed cost. According to Shaked and Sutton (1983 and 1987), there will be an infinite number of firms producing a variety with unit quality sold at unit variable cost and a finite number of firms producing a higher quality variety sold at a price above unit variable cost. By the analysis in Helpman (1992), multinational firms who have developed a blue print in a foreign country and hence can utilize its advantage technology to earn a positive profit via foreign direct investment in a relatively labor abundant country.

We focus on a small open economy with S units of skilled labor and L units of unskilled labor, and hence a total population of $L+S$. Its technology parameters are μ's and λ's. If all the corresponding variables in the rest of the world have an asterisk superscript hereafter, then by the following assumption (A0), compared with the rest of the world, this small country is relatively unskilled labor abundant and uses less advanced technologies in both sectors. Moreover, in the home country, the X-sector uses a relatively labor-augmenting technology and the unskilled labor is relatively more productive in the Y-sector than in the X-sector. This analysis for a "small" country applies to China as a small country here refers to one that cannot affect the world demand and supply and hence price, though such a country may not be small in geographical size or population.

(A0) $S^*/L^* > 1 > S/L$, $\mu_x > \mu_x^* \geq 1$, $\lambda_x > \lambda_x^* \geq 1$, $\mu_y > \mu_y^* \geq 1$, $\lambda_y > \lambda_y^* \geq 1$, $\lambda_x/\mu_x \geq 1$, and $\mu_x \geq \mu_y$.

3 Free Trade Equilibrium

Since firms in the home country uses less advanced relatively labor-augmenting technology, firms in the foreign country can produce the high quality varieties of good X at a relatively lower cost and can charge a price above its unit variable cost as in Shaked and Sutton (1982 and 1984). Suppose foreign consumers are all of high type, then this small country produces domestic low quality good X for domestic low type consumers only and imports good X with a higher quality, q_h^*, at the world price p_h^*. This pattern of trade assumption is not crucial to the main findings in this paper and is consistent with most empirical results. q_h^* and p_h^* are given since a small open economy has no influences on the world market.

As the total revenue from sales to a consumer is always αI, but it is costly to produce a higher quality, under perfect monopolistic competition with zero fixed cost (Lancaster, 1979), the domestic producers in the X-sector produce good X with the lowest quality ($q = 1$) at price $p(1) = w_l\mu_x + w_s\lambda_x$. The equilibrium Hicksian productivity parameter in the X-sector becomes the following ratio of factor-augmenting parameters and is independent of factor prices

$$h_x = \frac{\lambda_x}{\mu_x} \tag{2'}$$

From (2$'$), a fall in λ_x/μ_x represents a labor biased and a rise in λ_x/μ_x represents a skill biased technology transfer in the X-sector.[7]

Given the above price and quality of domestic variety of good X and the foreign variety with q_h^* at the world price p_h^*, consumer with $\theta = 0$ will choose the lowest quality domestic product while consumers with $\theta = a$ will choose the foreign variety if $\frac{\alpha I}{p_h^*}(q_h^*)^\theta \geq \frac{\alpha I}{w_l\mu_x + w_s\lambda_x}$. This condition holds for all high type consumers if $w_l\mu_x + w_s\lambda_x \geq 1$ and

(A1) $\theta = a \geq \frac{\ln p_h^*}{\ln q_h^*}$.

[7]This illustrates that a biased technology transfer by the Hicksian classification can be exactly the opposite as that by the factor-augmenting classification. This relationship is analyzed in detail in Xu (2001).

We normalize the price of good Y to one, i.e. $p_y = 1$. Under perfect competition, p_y is equal to its marginal cost of production, which can be derived from the CES production function as follows (Varian, 1984).

$$p_y = ((\mu_y w_l)^{1-\sigma} + (\lambda_y w_s)^{1-\sigma})^{\frac{1}{1-\sigma}} = \mu_y w_l (1 + \frac{w_s}{w_l} h_y)^{\frac{1}{1-\sigma}} = 1 \tag{8}$$

Suppose I is a consumer's total income. If each consumer contributes one unit of labor, then a consumer's total income, I, is w_l for an unskilled labor or w_s for a skilled labor. The full employment conditions give the equilibrium relative wage of unskilled to skilled labor and the total output of good Y.

$$\mu_x \beta \frac{w_l L + w_s S}{w_l \mu_x + w_s \lambda_x} + \mu_y (1 + \frac{w_s}{w_l} h_y)^{\frac{\sigma}{1-\sigma}} Y = L \tag{9}$$

$$\lambda_x \beta \frac{w_l L + w_s S}{w_l \mu_x + w_s \lambda_x} + h_y \mu_y (1 + \frac{w_s}{w_l} h_y)^{\frac{\sigma}{1-\sigma}} Y = S \tag{10}$$

Let $l = \frac{L}{L+S}$, $s = \frac{S}{L+S}$, and $y = \frac{Y}{L+S}$. The full employment conditions yield:

$$y = \frac{l(1 - \beta + \frac{w_s}{w_l}(\frac{\lambda_x}{\mu_x} - \beta \frac{s}{l}))}{\mu_y (1 + \frac{w_s}{w_l}\frac{\lambda_x}{\mu_x})} (1 + \frac{w_s}{w_l} h_y)^{\frac{\sigma}{\sigma-1}} \tag{11}$$

$$\frac{s}{l} = \beta \frac{\lambda_x}{\mu_x} \frac{1 + \frac{w_s}{w_l}\frac{s}{l}}{1 + \frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}} + h_y \frac{1 - \beta + \frac{w_s}{w_l}(\frac{\lambda_x}{\mu_x} - \beta \frac{s}{l})}{1 + \frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}} \tag{12}$$

$$= \frac{\beta \frac{\lambda_x}{\mu_x} + \beta \frac{\lambda_x}{\mu_x}\frac{s}{l}\frac{w_s}{w_l} + (\frac{\lambda_y}{\mu_y})^{1-\sigma} (\frac{w_s}{w_l})^{1-\sigma} ((1-\beta)\frac{w_s}{w_l} + \frac{\lambda_x}{\mu_x} - \beta \frac{s}{l})}{1 + \frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}} \tag{13}$$

From equation (8),

$$\frac{1}{w_l} = \mu_y (1 + \frac{w_s}{w_l} h_y)^{\frac{1}{1-\sigma}} \tag{14}$$

Hence, we can solve for w_l, w_s and y from the above three equations and then all the other remaining variables. From (14), $w_l \mu_x + w_s \lambda_x = w_l \mu_x (1 + \frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}) = \frac{\mu_x}{\mu_y}(1 + \frac{w_s}{w_l} h_y)^{\frac{1}{\sigma-1}} (1 + \frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}) \geq 1$ so that the prices of good X are all higher than that of good Y. As discussed at the beginning of this section, under assumption (A1), consumers with $\theta = 0$ spend α percent of their income (w_l or w_s) on the domestic variety of good X with the lowest quality while consumers with $\theta = a$

spend α percent of their income (w_l or w_s) on the imported variety of good X at price p_h^*. Given assumption (A0), $\frac{\lambda_x}{\mu_x} \geq 1 \geq \beta \frac{s}{l}$ so that $y \geq 0$ from equation (11). Hence, the country produces both goods, X and Y. All consumers spend $1 - \alpha$ percent of their incomes on good Y, either from domestic production or imports.

4 Foreign Direct Investment

Because firms in the developed country use more advanced technologies than firms in the developing country, the wages of both skilled and unskilled labor are higher in the developed country than in the developing country due to higher productivity as shown in most of the empirical studies. As a result, a foreign firm in a developed country will find it profitable to take advantage of their more advanced technologies to produce in a developing country (Brainard, 1997; Helpman, 1992). By reallocating their production via foreign direct investment to a developing country, they can produce goods at a lower marginal cost by using less labor inputs than local firms. These multinational firms can charge a price above its average variable cost. However, a foreign firm's gain from foreign direct investment will be offset by its fixed cost of going multinational so that all multinational firms and local firms in both countries earn zero profits.

Through foreign direct investment either in the form of whole ownership or joint venture, firms in a small economy will be exposed to the more advanced technology used in small economies. This process of technology diffusion gives most developing countries the big incentive to promote foreign direct investment or even implement favorable FDI policies to compete with each other as studied in Glass and Saggi (2001b). The aim of this section is to examine whether foreign direct investment in different sectors can cause different types of technology transfer with different impacts on the relative return to skill.

If the foreign direct investment is in the differentiated sector, then there is an incentive for the multinational firm to take over the whole market for consumers with a zero θ. The multinational firm can produce a variety with the lowest or close to the lowest quality and charge a price just below $p(1)$ but above its average variable cost due to its technology advantage. The new production by multinationals will change the demand for skilled and unskilled labor. As discussed in Glass and Saggi (2001b) and Wu (20001a), the speed of this technology diffusion and hence the short-run and long-run effects on the relative wages depend on the intellectual property right enforcement in a small economy. In this paper, we focus on the long-run effect and assume that technology transfer is inevitable so that all firms producing in the developing country will eventually use the new technology to produce the zero quality variety as consumers put no value on quality. To derive the new factor prices, we replace λ_y by λ_y^* and μ_y by μ_y^* in the full employment conditions (9) and (10).

The standard Heckscher-Ohlin theorem suggests that, since the small open economy is endowed with less skilled labor, it does not have a comparative advantage in producing the high quality good even with the same technology. Empirical results also show that usually multinational firms in the developing country will target lower quality brands rather than higher quality ones. Thus, we assume that the developing country still perfectly specializes in the lowest quality variety and produces no high quality varieties even with foreign direct investment.

If the foreign direct investment is in the Y-sector, then initially, the factor prices will stay the same as those determined by equations (13) and (14). Gradually, as the new technology indexed by λ_y^* and μ_y^* are adopted by more multinational and local firms, the factor prices will change as a result of this technology transfer. Again, eventually, all firms producing in the developing country will use the new technology and the full employment conditions will be changed accordingly. The new factor prices will still be different from those in the developed country because the developed country has different skilled and unskilled labor endowments and may have already developed more advanced technologies than those indexed by λ_y^* and μ_y^*.[8]

By totally differentiating equation (13), the appendix derives the effect of a technology transfer induced by FDI in different sectors on the relative wage of skilled labor as summarized in Proposition 1.

Proposition 1. *Under assumptions (A0) and (A1), and if the existing equilibrium wages satisfy* $\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}(\sigma-1) > 1$*, then foreign direct investment in both the differentiated sector and the homogeneous sector will decrease the relative wage of skilled labor in the host economy, if the technology introduced by foreign direct investment is labor biased by Hicksian classification (*$\frac{\lambda_x}{\mu_x}$ decreases, $\frac{\lambda_y}{\mu_y}$ increases*). If the technology is skill biased (*$\frac{\lambda_x}{\mu_x}$ increases, $\frac{\lambda_y}{\mu_y}$ decreases)*, then the relative wage of skilled labor increases regardless of whether foreign direct investment occurs in the homogeneous sector or the differentiated sector.*

From equations ($2'$) and (12), the relative skill intensity in sectors X and Y is

$$h_x - h_y = \frac{\lambda_x}{\mu_x} - \frac{\frac{s}{l}(1+\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}) - \beta\frac{\lambda_x}{\mu_x}(1+\frac{w_s}{w_l}\frac{s}{l})}{1-\beta+\frac{w_s}{w_l}(\frac{\lambda_x}{\mu_x}-\beta\frac{s}{l})} = (\frac{\lambda_x}{\mu_x}-\frac{s}{l})\frac{1+\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}}{(1-\beta)+\frac{w_s}{w_l}(\frac{\lambda_x}{\mu_x}-\beta\frac{s}{l})} > 0 \qquad (15)$$

Hence, under assumption (A0), the X-sector is the relatively more skill intensive than the Y-sector at the **equilibrium** factor prices. However, the results in Proposition 1 are independent of the relative factor intensities and do not require the X-sector be the relatively skill intensive sector under **all** factor prices.

Proposition 1 also shows that unlike in the case of homogeneous goods studied in Jones (1965) and Xu (2001), the effect of a technical transfer on the relative wage of skilled labor for a small country depends only on whether it is skill or labor biased when there is product differentiation. It no longer depends on whether foreign direct investment occurs in a relatively skill or labor

[8] Such a product or technology development cycle is studied in detail in Glass and Saggi (1999 and 2001b).

intensive sector, which can actually change depending on the endogenous choice of quality. There are several forces at work.

If a multinational firm uses a more skill intensive technology in a small open economy, then first, this more advanced skill biased technology will increase the productive of and the relative demand for skilled labor and hence its relative wage regardless of whether this multinational firm produces in the differentiated or the homogeneous sector. Second, as the relative wage of skilled labor increases, firms in both sectors will want to use less skilled and more unskilled labor. However, in the differentiated sector, this shift from skilled to unskilled labor will be limited as it will cause a decrease in quality and hence profit margin. Finally, there is a price effect by the Stolper-Samuelson theorem. If the multinational firm operates in the X-sector, then the price of good X will fall and so does the relative wage of skilled labor at equilibrium. The opposite will happen if the multinational firm operates in the Y-sector. Proposition 1 proves that all the opposing effects against the first effect are dominated.

The results in Proposition 1 are consistent with those in Wu (2001b), where each consumer buys only one variety and each firm charges a price equals to its marginal cost. Although Wu (2001a) allows for both horizontal and vertical product differentiation, the result in Wu (2001a) that FDI increases the relative return to skilled labor is actually a special case of Proposition 1 as Wu (2001a) only considers FDI with relatively skill intensive technology and in the differentiated sector only.

5 Implications on China's FDI Policy

In China, attracting foreign direct investment has been a strategic economic policy adopted to upgrade technology and boost economic growth. The development of special economic zoom and the tax break for joint ventures and wholly foreign owned subsidiaries have made a significant contribution to the rapidly increase of FDI inflows into China in the past three decades, especially into the 1990s. Since 1993, China has become the second largest FDI recipient after the United States (United Nations, 1999). Firms with FDI have contributed to over 40% of China's total trade since the mid-1990s.

Meanwhile, income inequality is becoming a more and more important issue for social stability as China is also experiencing large layoffs of workers from the formally state owned enterprises during their reforms toward a market economy. Indeed, multinational firms with relatively skill intensive technologies can be responsible for China's rising income inequality as studied in Wu (2001a). These FDIs have pushed up the relative wage of skilled labor and hence the wage in those relatively skill intensive sectors, which is consistent with the sectorial wage data presented in Wu (2001a). However, as shown in Table 1, although FDI from well developed countries is increasing, a higher percentage of China's FDI is still from newly developed countries/regions with mostly relatively labor biased technologies, which can reduce the wage gap. Hence, FDI can have a neutral effect on the relative return to skilled labor in all sectors across the country. Based on the previous analysis, we can draw the following implications on China's FDI policy to promote economic growth and to minimize social inequality.

First, one type of foreign direct investment in China aims at taking advantage of China's cheap unskilled labor and is mostly in China's export oriented sectors. This type of FDI usually brings about relatively (unskilled) labor biased technology transfers in either the homogeneous or the differentiated sector. As a result, the relative wage of unskilled labor will increase and the wage inequality between skilled and unskilled labor will decrease. Hence, it is beneficial, not only in terms of promoting economic growth but also in terms of minimizing income inequality, to use favorable policies, such as tax breaks, to attract foreign direct investment with labor biased technology.

Indeed, Table 1 shows that almost 50% of China's inward foreign direct investment is from

Hongkong and Taiwan. Many multinational firms originated in Hongkong and Taiwan have setup factories in China that employ many unskilled labor displaced from farming. These foreign direct investments have definitely contributed to China's rapid income growth in the past two decades. Income per capita has doubled in China from 1978 to 1994 (World Bank, 1997). China has been very successful in utilizing its close social and cultural ties with Hongkong and Taiwan to boost export and growth in order to smooth the transition from a planned economy to a market economy.

Second, another type of foreign direct investment aims at profiting from China's huge domestic market as well as exporting. This type of FDI usually involves developing a new product to compete with the existing domestic products and hence inducing a skill biased technical progress mostly in the differentiated sector. This will certainly increase the relative return to skill. In China, most college graduates nowadays can earn a much higher wage than average if they work for a foreign funded enterprises (either wholly foreign owned or joint venture), which usually use a more skill intensive technology than those local firms in China. This is the case studied in Wu (2001a), where the wage gap between skilled and unskilled labor increases with inward FDI and the size of this increase depends on the enforcement of intellectual property rights in China. Hence, we can have the following trade-off between economic prosperity and social inequality.

On the one hand, such foreign direct investment introduces more advanced technology, increases China's competitiveness in the high-end product markets, especially in the high-tech sector, and facilitates China's gradual movement from exporting low value added products to high value added products and hence its potential economic growth. On the other hand, such a technology transfer will intensify the social tension between skilled and unskilled labor in moving toward freer trade and foreign direct investment. This trade-off is also present if foreign direct investment is in the homogeneous sector as long as the induced technology transfer is skill biased.

Being aware of this trade-off, China can encourage small scale foreign direct investment with relatively skill biased technologies. For example, computer software industry is skill intensive, but can operate on a relative small scale with only several employees. This can maximize gains from FDI in upgrading China's technology and the profit margin of its exports while minimizing the potential risk of rising income inequality between skilled and unskilled labor across the country.

As China joins the WTO, both types of FDI are expected to increase. Hence, as long as China keeps a balanced inward FDI with both skill and labor biased technologies in either relatively skill or labor intensity sectors, inward FDI will facilitate China's technology development, increase its competitiveness in the world market of both low- and high-end products, and induce a balanced wage increase for both skilled and unskilled workers in China.

6 Conclusions and Extensions

This paper develops a general equilibrium trade model and shows that the wage gap between skilled and unskilled labor in a small labor abundant economy will decrease as it opens up more market and attracts more FDI with advanced labor biased technology either into high-tech sectors or into low-tech sectors . On the other hand, FDI with advanced skill biased technology will increase the wage gap as well as the host country's competitiveness in the high-end product markets.

The analysis also shows that product differentiation does introduce a new prospect to the existing Heckscher-Ohlin models with only homogeneous products. Although the above results depend on the assumptions on consumption and production, there are several lessons that we can learn from the analysis in this paper. These results can apply to a broad range of trade issues that involve either both homogeneous and differentiated markets or both perfect competitive and monopolistic competition markets.

First, we can still consider an industry, such as electronics and autos, as a relatively skill intensive industry even if it uses a large proportion of relatively labor intensive inputs as long as quality upgrade requires more skilled labor relative to unskilled labor.

Second, under normal conditions, vertical product differentiation provides firms in each country more authority in setting prices and hence makes the impact of technology transfer on factor prices not so much dependent on the size of the economy. As a result, even in a small economy, factor bias is all that matters, i.e. a skill-using technology transfer increases the relative wage of skilled labor while a labor biased technology transfer decreases it no matter whether the technology transfer occurs in the differentiated or homogeneous sector.

To extend the analysis in this paper to derive more general results on the effects of technology transfer via foreign direct investment on factor prices in a small economy, we need to use more general utility and production functions. Although this generalization would not change the basic intuitions and the main implications of this study, the generalization can provide more precise predictions for empirical studies. Meanwhile, we should be aware of that different functional forms can also induce other factors that might change factor prices, for an example, increasing economies of scale discussed in Dinopoulos, Syropoulos and Xu (1999).

Appendix

Proof of Proposition 2.

Totally differentiating equation (13) gives:

$$\frac{d(\frac{w_s}{w_l})}{d(\frac{s}{l})} = -\frac{1}{\Delta}\frac{\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}(1-\beta)+(\frac{\lambda_y}{\mu_y})^{1-\sigma}(\frac{w_s}{w_l})^{1-\sigma}\beta+1}{1+\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}} < 0 \tag{A.1}$$

$$\frac{d(\frac{w_s}{w_l})}{d(\frac{\lambda_x}{\mu_x})} = \frac{1}{\Delta}\frac{\beta(1+\frac{\lambda_x}{\mu_x}(\frac{w_s}{w_l}-1))(1+\frac{s}{l}\frac{w_s}{w_l})+(\frac{\lambda_y}{\mu_y})^{1-\sigma}(\frac{w_s}{w_l})^{1-\sigma}((\frac{w_s}{w_l}-1)(\frac{\lambda_x}{\mu_x}-1)+\beta(\frac{s}{l}+\frac{w_s}{w_l}))}{(1+\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x})^2} > 0 \tag{A.2}$$

$$\frac{d(\frac{w_s}{w_l})}{d(\frac{\lambda_y}{\mu_y})} = -\frac{1}{\Delta}(\sigma-1)(\frac{\lambda_y}{\mu_y})^{-\sigma}(\frac{w_s}{w_l})^{1-\sigma}\frac{(1-\beta)\frac{w_s}{w_l}+\frac{\lambda_x}{\mu_x}-\beta\frac{s}{l}}{1+\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}} < 0 \tag{A.3}$$

$$\Delta = (\frac{\lambda_y}{\mu_y})^{1-\sigma}(\frac{w_s}{w_l})^{1-\sigma}\frac{(\sigma-1)(1-\beta)+\sigma\frac{\lambda_x}{\mu_x}(\frac{\lambda_x}{\mu_x}-\beta\frac{s}{l})+(\frac{w_s}{w_l})^{-1}(\frac{\lambda_x}{\mu_x}-\beta\frac{s}{l})(\sigma-1)}{(1+\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x})^2}$$
$$+\frac{(\frac{\lambda_y}{\mu_y})^{1-\sigma}(\frac{w_s}{w_l})^{1-\sigma}(1-\beta)(\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}(\sigma-1)-1)+\beta\frac{\lambda_x}{\mu_x}(\frac{\lambda_x}{\mu_x}-\frac{s}{l})}{(1+\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x})^2} > 0 \tag{A.4}$$

By assumption, $1+\beta\frac{s}{l} \geq \frac{\lambda_x}{\mu_x} \geq 1 > \frac{s}{l} > \beta\frac{s}{l}$ and $\frac{w_s}{w_l} > 1$. Hence, the above signs hold if $\frac{w_s}{w_l}\frac{\lambda_x}{\mu_x}(\sigma-1) > 1$, i.e. the elasticity of substitution between skilled and unskilled labor (σ) in the Y-sector and the technology advantage of unskilled labor in the X-sector ($\frac{\lambda_x}{\mu_x}$), the unskilled over skilled labor endowment ratio and hence the relative wage of skilled labor ($\frac{w_s}{w_l}$) are not too small.

Q.E.D.

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