Chapter 10

Globalization and Firm Demand for Skilled Labor in China's Manufacturing Sector

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CHAPTER 10

Globalization and Firm Demand for Skilled Labor in China's Manufacturing Sector

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In this paper, we use large-scale firm-level census data to examine how trade and FDI affect firm demand for skilled labor in China's manufacturing sector. Our estimation results suggest that exporters tend to employ more unskilled workers than non-exporters. This is true for both Chinese exporters in the ordinary trade regime and foreign-invested exporting firms in the processing trade regime. Although this finding is consistent with the Heckscher–Ohlin model, it contradicts the predictions of the recent international trade literature on heterogeneous firms. We also find that FDI is associated with a higher share of skilled labor in total employment, which supports the Feenstra-Hanson theory of outsourcing. Our results are robust to alternative definitions of variables and econometric methods.

1. Introduction

One of the most important questions in the study of globalization is how trade and FDI liberalization affects demand for skilled labor. This issue is related to the question of globalization and wage inequality. Conventional wisdom predicts favorable effects of trade liberalization on unskilled labor. According to the Heckscher–Ohlin model, trade liberalization will increase demand for unskilled labor in developing countries because developing countries are relatively rich in unskilled labor and will specialize in the production of goods that are unskilled-labor-intensive. The Stolper-Samuelson theorem, which is based on the Heckscher–Ohlin model, predicts that trade will increase the wages of unskilled workers and reduce wage inequality between skilled and unskilled workers. However, there is overwhelming empirical evidence in developing countries that unskilled workers are generally not better off relative to workers with higher skill levels.

Motivated by this observation, Feenstra and Hanson (1996, 1999) propose an alternative explanation. Their theory is based on outsourcing, or the international fragmentation of production, where production processes are sliced thinner and thinner into many stages and the resulting production fragments are carried out in different locations. According to Feenstra and Hanson, those production activities that are shifted to developing countries are unskill-intensive in developed countries but are in fact skill-intensive in developing countries.

In a growing body of literature on heterogeneous firms in international trade, exporters are considered to be superior to non-exporters in many respects, including the skill intensity of their workers. For example, according to the theoretical models of Yeaple (2005) and Costatini and Melitz (2007), in equilibrium, exporters are more productive and choose to employ more skilled workers than non-exporters.

China is an important laboratory for investigations of the relationship between globalization and demand for skilled labor. In the past three decades, China has been transformed from one of the most isolated countries in the world into one of its largest trading nations. China edged past Germany in 2009 to become the world's largest

exporter.[1] At the same time, there has been substantial increase in the proportion of skilled labor to total employment since reforms began to occur in the late 1970s. Table 1 shows the increase in skill level among Chinese industrial firms in the three most recent census years.

Table 1. Share in Total Employment by Education Group (%)

	1985	1995	2004
College and above	2.9	5.7	11.3
Senior high school	23.6	34.1	32.9
Junior high school and below	73.5	60.2	55.8

Source: 1985, 1995 and 2004 censuses.

To test these hypotheses, we estimate a firm-level equation using 2004 census data, which covers the universe of manufacturing firms in China. In the dataset, firms report employment by education level. We have two measures for skilled labor: the share of workers with senior high school degrees and above in total employment and the proportion of workers with college-level education and above in total employment.

In the econometric model, we use the share of skilled labor as our dependent variable. We include exports, FDI and the interaction between them as the independent variables. Capital, technology, scale and industry and provincial fixed effects are also included as control variables.

Our empirical results suggest that FDI is associated with a higher share of skilled labor. We also find that exporters tend to employ more unskilled workers than do non-exporters. This is true for both Chinese exporters in the ordinary trade regime and foreign-invested exporting firms in the processing trade regime. The empirical results are robust to alternative definitions of variables and alternative econometric models. First, we examine a more detailed classification of ownership by dividing domestic and foreign forms of ownership into five categories. Second, we experiment with alternative definitions of export and FDI variables. Instead of employing dummy variables, we use continuous variables of export intensity and foreign equity share to measure firm export orientation and foreign presence. Third, we split the sample into

[1] Associated Press: China becomes biggest exporter, edging out Germany, January 10, 2010.

data from the coastal region and from the interior region and run separate regressions with these two subsamples. Fourth, we use Tobit regression as an alternative econometric method. Our baseline regression results hold given all of these robustness checks.

The evidence that exporters employ more unskilled labor supports the Heckscher–Ohlin model. Our findings are consistent with Ma and Zhang (2008), who find that Chinese exporters are more labor intensive than non-exporters. Exporting firms are those that most effectively exploit the comparative advantages of labor cost in China. However, our findings contradict the "stylized facts' of recent theoretical and empirical literature on heterogeneous firms. The findings related to FDI support the Feenstra-Hanson theory of outsourcing. Those activities that have shifted from developed countries to China are indeed more skill-intensive than the average skill level of existing production activities in China.

Although wage inequality is related to both demand and supply factors, our empirical results have important implications for public policy. China has evolved from one of the most egalitarian countries before reform into one of the most unequal countries in the world. According to our findings, exporting can help reduce the wage gap between the skilled labor and the unskilled labor, while FDI appears to increase such inequality.

The rest of the paper is organized as follows. The next section presents the background for this study. Section 3 discusses the literature and hypotheses. Section 4 describes the data and the estimation strategy. The regression results are reported in Section 5. Finally, we discuss our conclusions and policy implications in Section 6.

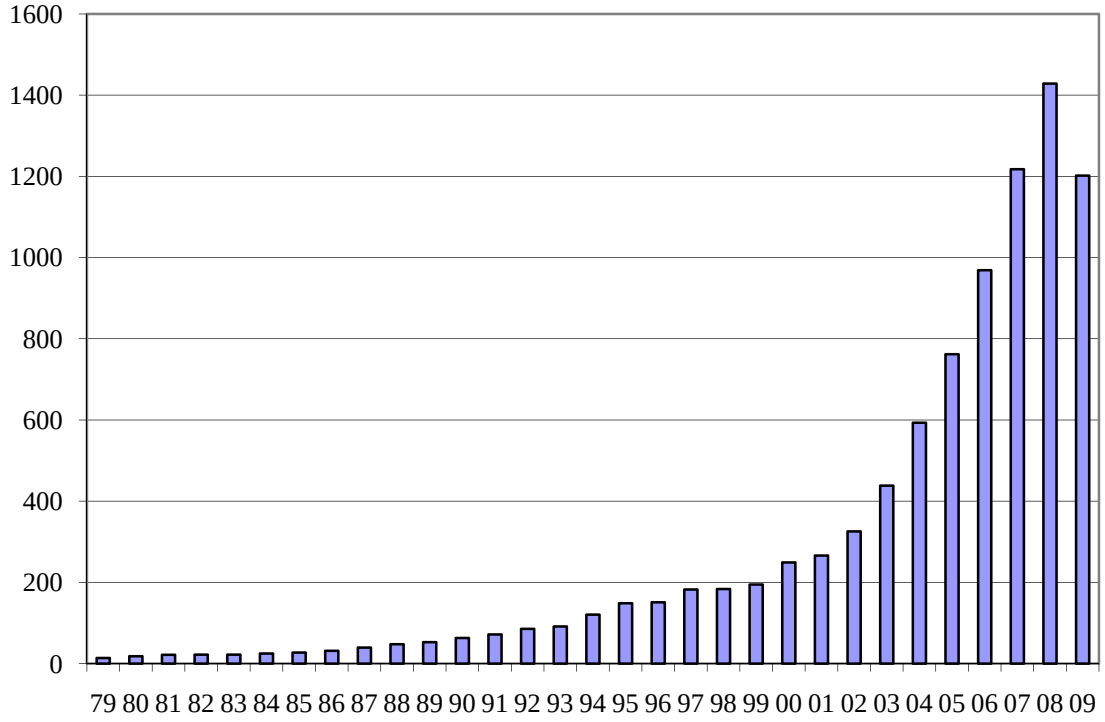
2. Background: Trade and FDI in China

In the 1970s, China was one of the most isolated countries in the world. Since the early 1980s, the Chinese government has been actively promoting foreign trade. The reforms had several key features, including granting trading rights to manufacturing firms, the reduction and eventual elimination of the mandatory plan, and the reform of

the foreign exchange regime (Lardy, 2001, p. 46). These trade reforms, combined with other export promotion policies such as rebates on value-added taxes on exports and the duty drawback system, have helped to transform China into a major trading power. Stimulated by China's entry into the WTO, the annual growth rate for Chinese exports between 2001 and 2009 was as high as 20 percent. In the reform era, China's exports grew from $14 billion in 1979 to $1202 billion in 2009 (Figure 1), while over the same period, the ratio of exports to GDP rose from 0.06 to 0.31.

Figure 1. China's Exports (1979-2009)

(Unit: Billions of U.S. Dollars)



Sources: 1979-2008: China Statistical Yearbook, 1988, 1995, 2009;
2009: Statistical Communiqué of the People's Republic of China on 2009 National Economic and Social Development.

China's exports structure has changed dramatically over the past three decades. In the 1980s, China's leading exports were crude oil, refined petroleum products and apparel. In the early and mid-1990s, labor-intensive goods dominated Chinese exports. Since the late 1990s, China has emerged as a major producer and exporter of electronic

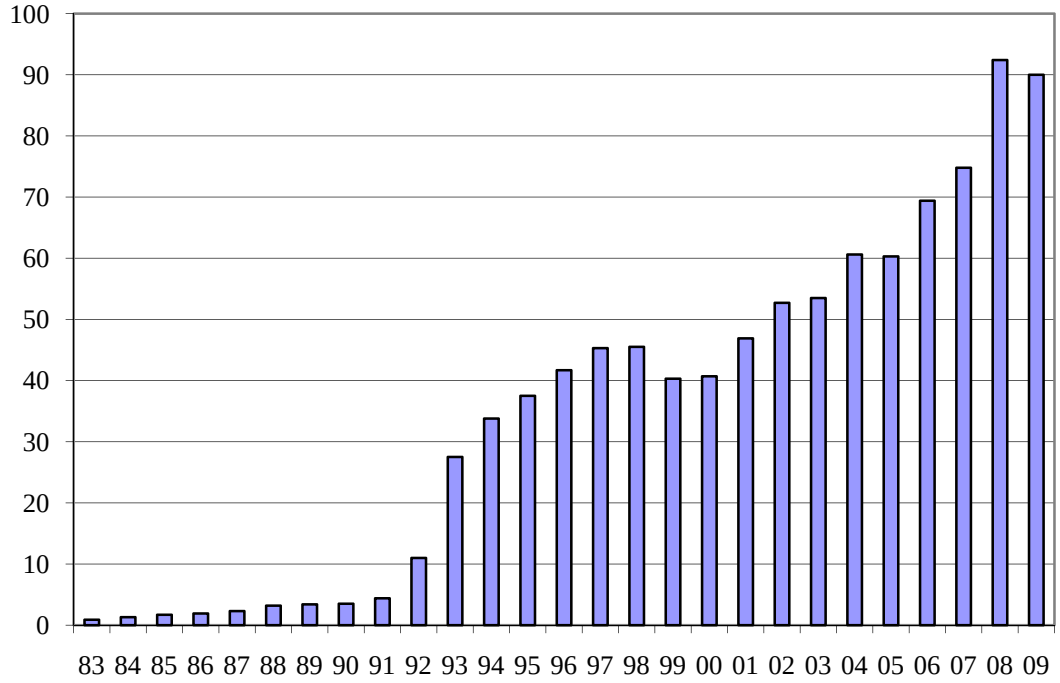
and information technology products such as consumer electronics, office equipment and computers, and communications equipment. China has become the world's new manufacturing workshop for technology-oriented products.

Similarly, in the reform era, China has aggressively pursued policies that encourage FDI inflow. It is not surprising that China developed its first law governing foreign investment in 1979, while the first law relevant to domestic firms was not enacted until 1988.[2] Figure 2 shows that the amount of China's FDI inflow has increased dramatically, shifting from less than $1 billion in 1983 to $90 billion in 2009. China's accumulative FDI reached $900 billion by the end of 2009.[3] Foreign-invested firms accounted for about 10 percent of total investment in fixed assets and 31 percent of total industrial output in 2008.[4] Nearly 70 percent of FDI in China was poured into the manufacturing sector. This is mainly due to the competitive edge that China's relatively low production cost for manufacturing affords. One of the main goals of China's FDI policies is to promote technology transfer to China, especially from multinational companies. Since the mid-1990s, China has been encouraging FDI to flow into technology-oriented industries such as electronic information, bioengineering, new materials, and aviation and aerospace. Local R&D centers have also been established.[5]

[2] Source: Table 11.1, Clarke *et al.* (2008).
[3] Source: Author's calculation based on information from the *China Statistical Yearbook*.
[4] Source: *China Statistical Yearbook* 2009.
[5] See Long (2005) for a recent review of China's FDI policy.

Figure 2. FDI Inflow into China (1983-2009)

(Unit: Billions of U.S. Dollars)

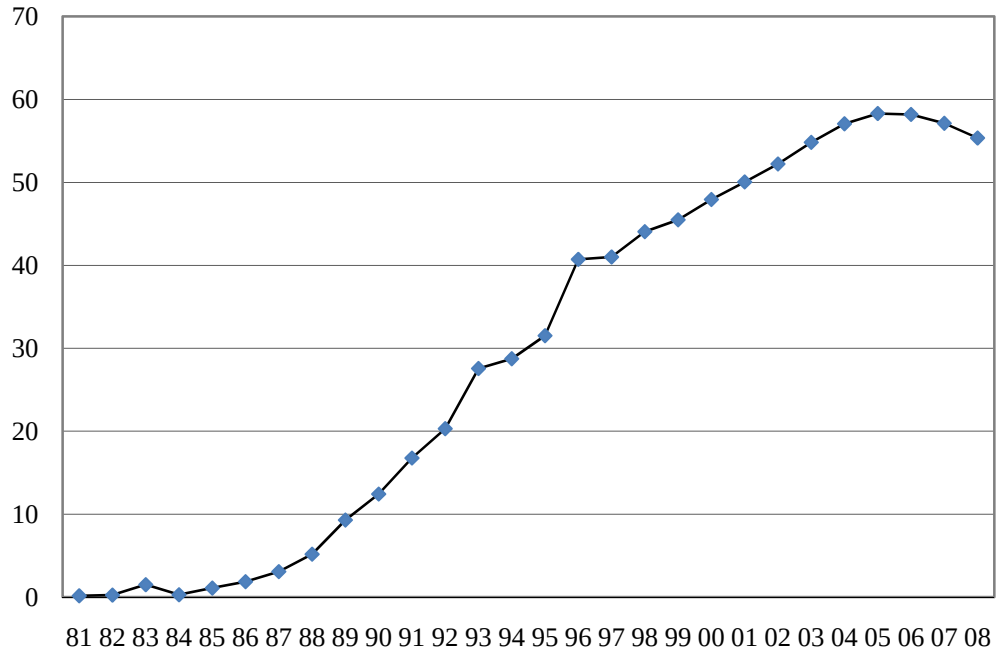


Sources: 1983-2008: China Statistical Yearbook, 1988, 1995, 2009;
2009: Statistical Communiqué of the People's Republic of China on 2009 National Economic and Social Development.

China's exports and FDI are closely related. With the increasing fragmentation of production, multinationals have used China as a major assembly center. A large part of China's overall success in foreign trade can be attributed to the strong export orientation of foreign-invested firms. Foreign parts and components are brought in, assembled or processed using relatively low-cost Chinese labor, and then exported to international markets. The contribution of foreign-invested firms to total exports jumped from only 0.2 percent in 1981 to 55 percent in 2008 (Figure 3). In the electronics and telecommunications industry, for example, foreign-invested firms accounted for 95 percent of Chinese exports. China is able to export huge quantities of high-tech products only because it imports most of the high value-added and technology-intensive parts and components. China only specializes in the assembly of these goods, which constitutes the labor-intensive stage of the vertical value chain. Moreover, most exports

of electronic and information products are produced not by Chinese-owned firms but instead by foreign firms that are using China as an export platform.

Figure 3. Percentage of Foreign-Invested Firms in China's Exports (1981-2008)



Source: Author's calculations based on China Statistical Yearbook, 1988, 1995, 2009.

As a result of FDI, China's foreign trade is often described as dual regimes. The ordinary trade regime, which is characterized by Chinese-owned firms, purchases intermediate inputs from domestic suppliers and exports labor-intensive goods such as garments and shoes. On the other hand, the processing trade regime, which is characterized by foreign-invested firms, purchases intermediate inputs from overseas and exports capital-intensive or technology-intensive goods such as machinery and electronics. In this paper, we utilize this unique dual regimes feature of Chinese foreign trade to test our hypotheses regarding trade and FDI.

3. Related Literature and Hypotheses

The Heckscher–Ohlin model of international trade probably provides the most direct link between trade openness and the demand for skilled labor. Although the theoretical and empirical drawbacks of the model are widely acknowledged at this time, this model has dominated the thinking about the distributional effects of globalization for a long time. (Goldberg and Pavcnik, 2007). The Heckscher–Ohlin model predicts that countries that are relatively rich in unskilled labor will specialize in the production of goods that are unskilled-labor intensive, leading to increased demand for unskilled labor.

The Stolper–Samuelson theorem, a companion theorem of Heckscher–Ohlin model, deals with distributional effects by linking changes in product prices to changes in factor returns. An increase in the price of unskilled-labor-intensive products that is induced by trade liberalization should increase the return to unskilled labor, the factor that is most intensively used in the production of these products. In contrast, the expected decrease in the price of skilled-labor-intensive imported products should lead to a decline in wages for skilled labor. Based on the Stolper–Samuelson theorem, one would expect trade liberalization in developing countries to favor unskilled workers.

There has been abundant evidence in developing countries that contradicts the theorized Stolper–Samuelson effects. Empirical studies on developing countries such as Argentina, Brazil, Mexico, Chile, Colombia and India have consistently found increasing inequality for those countries with greater exposure to globalization.

The Heckscher–Ohlin model mainly deals with industry-level variables. At the firm level, it is possible that in developing countries, exporters are less skill-intensive than non-exporters to fully exploit their comparative advantage. However, this is not always true in a theoretical sense. As Bernard and Jensen (1997) point out, large variation in factor intensity exists among firms even within narrowly defined industries. Bernard *et al.* (2007) study the firm dynamics within comparative advantage industries and comparative disadvantage industries under trade liberalization. They find that the improvements in aggregate productivity following trade liberalization can even reverse the real-wage losses of scarce factors.

In fact, recent literature on heterogeneous firms in international trade (e.g., Melitz, 2003) can be extended to link exporter status with higher skill share because exporters need to overcome the fixed costs of accessing international markets. Theoretical and empirical studies at the firm level have always found that exporting firms are larger, use more advanced technologies, employ more skilled workers, pay higher wages, and appear to be more productive than firms that do not export. In fact, exporters are more skill-intensive is considered one of the most robust findings in Tybout's (2003) survey article. Recent work on innovation and exports provides theoretical guidance to understand this issue. For example, in Yeaple's (2005) model, firms endogenously choose technology and workers' skill. In equilibrium, exporters choose higher skilled workers than do non-exporters. Costantini and Melitz (2007) construct a theoretical model in which decisions regarding export market participation and innovation are modeled jointly. In their theory, innovation by exporters generates extra demand for skilled labor. In an empirical study, Bustos (2005) finds that exporters in Argentina use more skilled labor than non-exporters.

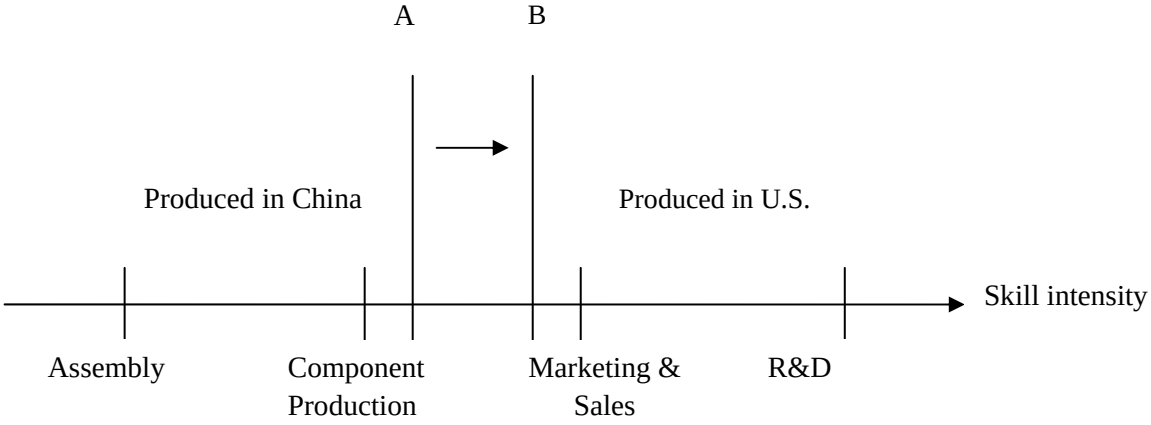
In another strand of literature, Feenstra and Hanson (1996, 1997, 1999) propose a theory of trade in intermediate goods and outsourcing. In their model, the final good is assembled from a continuum of intermediate inputs indexed by $z \in [0,1]$, which includes all activities from design and production to final delivery to the consumer. Inputs vary in terms of the relative amounts of skilled and unskilled labor used in production. These activities are listed based on skilled/unskilled ratios in increasing order. For example, the least skill-intensive activity is assembly, and the most skill-intensive activity is R&D. Feenstra and Hanson show that the south will produce the range of goods $[0, z^*)$ and that the north will produce $(z^*,1]$. When capital flows from the north to the south, the equilibrium value of z^* increases. As a result, outsourcing increases the demand for skilled labor in both the north and the south.

To understand the Feenstra-Hanson effects, let us consider the "value chain" of a multinational firm from the Unites States, which includes all of the activities involved in the production of a good, from R&D to assembly to marketing and after-sales service. In Figure 4, we arrange these activities in increasing order based on the ratio of skilled to unskilled labor used in each activity. In this example, assembly uses the least amount

of skilled labor relative to unskilled labor, followed by component production. We assume the marketing and sales and R&D require a higher level of skilled labor. Under globalization, a firm would outsource to China those activities that used the most unskilled labor. Therefore, activities to the left of line A would be relocated to China, while activities to the right of line A would be performed in the United States. Suppose that this multinational firm wishes to outsource more activities to China due to reduced trade costs or increasing production costs at home. The firm will choose those activities that are just to the right line A. The new borderline between the activities performed in China and the U.S. is now line B.

The activities between A and B are less skill-intensive than the activities still conducted in the U.S. This means that on average, the range of activities now done in the U.S. is more skill-intensive than before the shift. As a result, the relative demand for skilled labor in U.S. should increase. The activities that are newly outsourced to China (those between A and B) are more skill-intensive than the activities that already took place in China (those to the left of A). Therefore, the relative demand for skilled labor in China should also increase.

Figure 4. Outsourcing on the Value-Chain



Note: This figure is modified from figure 4 of Feenstra (2007).

The effects of outsourcing have been examined empirically for a number of developed economies, including, for example, Feenstra and Hanson (1999) for the U.S., Falk and Koebel (2001) for Germany; Strauss-Kahn (2003) for France, Hijzen *et al.* (2005) for the UK, and Hsieh and Woo (2005) for Hong Kong. Most of these studies

find that outsourcing is an important source of increasing demand for skilled labor in developed countries.

There have been very few similar studies of developing countries. Feenstra and Hanson (1997) test their theory using Mexican data. They linked the increase in relative wages for skilled labor to the FDI inflow in Mexico and find that FDI can explain a large portion of the increase in the skilled labor share in total wages. Much of the FDI was the results of outsourcing by U.S. multinationals. To the best of our knowledge, there has been virtually no empirical work on the relationship between globalization and firm skill structure in China.

It is worth mentioning that in the literature, in addition to the Feenstra-Hanson theory, there are other theories of the relation between trade and skill structure. These studies include "defensive innovations" (Wood, 1995), product life cycle (Zhu, 2005), and quality upgrades to products for export (Verhoogen, 2008).

In this paper, we take advantage of the dual regime of Chinese exports to empirically test these major theories in international trade. The ordinary trade exports produced by Chinese firms are directly related to the Heckscher–Ohlin model, while processing trade exports produced by foreign-invested firms will allow us to test the Feenstra-Hanson theory.

4. Data and Empirical Strategy

4.1. The Data

The main dataset used in this study is the 2004 Economic Census Database. China conducted its first economic census in 2004; it covers the universe of Chinese industrial firms and service firms in that year. Our firm-level dataset includes all manufacturing industries. In the data, firms report detailed information including firm IDs, ownership, output, value added, exports, four-digit industry codes, six-digit geographic codes, employment, and capital stock. After deleting those observations with missing variables, we have a total sample of about 1.18 million manufacturing firms.

Most important for this study are the variables related to human capital: the number of employees by education level. Unfortunately, the database does not provide a wage information breakdown by education level. Because of this data limitation, we can only study skill structure based on employment share, not based on wage share. In the data, we have two measures of skilled labor: (1) senior high school and above, which accounts for about 39 percent of total manufacturing employment; and (2) college and above, with about 9 percent of total employment.

Table 2 reports summary statistics for the key variables in the 2004 census. Appendix Tables 1 and 2 present the share of skilled labor by province and two-digit industry in 2004. To our surprise, the skill share of the coastal region on average is actually lower than that of the interior region. We believe that this is strong indication of the Heckscher–Ohlin effect.

Table 2. Summary Statistics of 2004 Census

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment (person)	1,187,267	68.99	355.03	1.0	113781
Capital Stock	1,187,264	7357.72	178216.00	0.0	103000000
Output	1,187,267	16308.55	270184.00	1.0	73000000
Export	1,187,267	3456.23	123592.60	0.0	69400000
Number of Computers	1,187,267	9.32	1687.99	0.0	874206
Share of Senior High School and above in Total Employment	1,187,267	0.39	0.31	0.0	1
Share of College and above in Total Employment	1,187,267	0.09	0.17	0.0	1
ln(K/Y)	1,167,218	-1.18	1.44	-11.6	15
ln(Y)	1,187,267	7.60	1.77	0.0	18
ln(wage rate)	1.186,045	2.08	0.64	-6.0	10
FDI Dummy	1,187,267	0.08	0.27	0.0	1
Exporter Dummy	1,187,267	0.11	0.31	0.0	1
ln(computer intensity)	1,187,267	-6.48	0.70	-6.9	12
Export intensity	1,187,267	0.07	0.24	0.0	1
Foreign Equity Share	1,179,206	0.06	0.24	0.0	1

Note: The unit of all values is 1,000 Yuan.

4.2. Econometric Model

Following Berman *et al.* (1994), we estimate the following firm-level equation:

$$S_i = \alpha + \beta_1 \ln\left(\frac{K_i}{Y_i}\right) + \beta_2 \ln(Y_i) + \beta_3 \ln(\text{computer intensity})_i + \beta_4 Exporter_i + \beta_5 FDI_i + \beta_6 Exporter * FDI + \sum_j \theta_j Industry_j + \sum_k \gamma_k Province_k + \varepsilon_i, \quad (1)$$

where

- S_i : the share of skilled labor in total employment for firm *i*.
- $\ln\left(\frac{K_i}{Y_i}\right)$: the logarithm of capital intensity, which captures the capital-skill complementarity.
- $\ln(Y_i)$: the logarithm of output, included to control for scale effects.
- *FDI*: a dummy for foreign-invested firms.
- ln(computer intensity): defined as $\ln\left(\frac{\text{number of computers}}{Y_i}+0.001\right)$. We include computer intensity as a proxy for firm technology.
- $Exporter*FDI$: an interaction term for the FDI dummy and exporter dummy.
- $Industry_j$: a full set of three-digit industry dummies.
- $Province_k$: a full set of provincial dummies.

5. Regression Results

5.1. Baseline Regression

Table 3 reports the estimation results for Equation (1) with 2004 firm-level data. The dependent variable in the first three columns is the share of workers with senior high school-level education and above in total employment. Because we include the exporter dummy, FDI dummy and the interaction term between them in the regression, the benchmark category is domestic non-exporters. The first column shows that the average skill share of domestic non-exporters is 0.378, while the share of skilled labor of domestic exporters is on average 0.016 lower than that of domestic non-exporters. Foreign-invested non-exporters tend to have a much higher skill share, 0.556, but the average skill share of foreign-invested exporters is only 0.455. All of the variables are statistically significant at the 1 percent level. Throughout the paper, we report the standard errors corrected for 2-digit industry/province clustering. In the second column,

we add the capital intensity (ln(K/Y)), scale effect (ln$Y$) and technology proxy (ln(computer intensity)). Compared with that in the first column, the coefficient of the FDI dummy in the second column is decreased by nearly half. To the extent that the capital and technology introduced by FDI are skill-biased, including these controls in the regression may underestimate the effect of FDI. The regression results indicate that capital intensity, the scale factor and computer intensity are all associated with a higher skill share. Given that both trade and FDI vary enormously across industries and regions, we include in column 3 a full set of industry and provincial dummies. Now the R-squared increases substantially from that of the second column, but the estimates are similar.

Table 3. Skill Share Regression (Baseline)

	Dependent Variable: Share of Senior High School and above			Dependent Variable: Share of College and above		
	1	2	3	4	5	6
Exporter Dummy	-0.016**	-0.059***	-0.013***	0.001	-0.023***	-0.002**
	(0.007)	(0.001)	(0.003)	(0.003)	(0.003)	(0.001)
FDI Dummy	0.178***	0.091***	0.097***	0.125***	0.074***	0.073***
	(0.008)	(0.002)	(0.005)	(0.006)	(0.005)	(0.004)
Exporter*FDI	-0.101***	-0.063***	-0.079***	-0.086***	-0.064***	-0.065***
	(0.009)	(0.002)	(0.006)	(0.001)	(0.005)	(0.004)
ln(K/Y)		0.011***	0.007***		0.0013*	-0.001*
		(0.001)	(0.001)		(0.001)	(0.001)
lnY		0.029***	0.023***		0.015***	0.012***
		(0.001)	(0.001)		(0.001)	(0.000)
ln(Computer Intensity)		0.118***	0.086***		0.081***	0.062***
		(0.004)	(0.002)		(0.003)	(0.002)
Constant	0.378***	0.946***	0.797***	0.082***	0.497***	0.445***
	(0.007)	(0.024)	(0.019)	(0.003)	(0.021)	(0.019)
Industry Dummies	No	No	Yes	No	No	Yes
Provincial Dummies	No	No	Yes	No	No	Yes
No. of observations	1187267	1187267	1167218	1187267	1187267	1167218
R-squared	0.0124	0.0812	0.1792	0.0205	0.1229	0.2320

Notes: The benchmark category is domestic non-exporters. Numbers in parentheses are standard errors corrected for 2-digit industry/province clustering. *, **, and *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

In the last three columns, we use college education rather than senior high school-level education as a measure of skilled labor. The estimated coefficients of the exporter dummy, the FDI dummy and the interaction term are generally lower than in the first three columns. For example, the estimate of the FDI dummy decreases from 0.101 in

column 3 to 0.076 in column 6. This is expected because the overall share of workers with college-level education is much smaller than the share of workers with senior high school-level education.

Our estimates are not only statistically significant but also quantitatively significant. For example, a one-standard-deviation increases in the FDI dummy increases college skill share by 0.31×0.076 = 2.4%.

5.2. Examining the Different Categories of Ownership

The dichotomy between domestic firms and foreign-invested firms may be overly simplistic because there is a large degree of variation within each category. Chinese statistics identify two types of foreign-invested firms: those with investments from Hong Kong, Macao and Taiwan (HMT) and those with investments from countries in other regions (mostly the OECD countries). HMT investment in China accounted for about 40 percent of China's overall FDI in 2004. The investors from these regions have cultural, linguistic and geographic advantages over OECD firms. The advantages of OECD firms over HMT firms lie in their more advanced technology, global production chains and internationally recognized brand names.

Within domestic ownership categories, state-owned enterprises (SOEs) used to be the "commanding heights" before reform. After several rounds of privatization, large state enterprises still play an important role in today's Chinese economy. According to a study by Jefferson *et al.* (2008), SOEs are the least efficient firms in China in terms of productivity. However, government policy has continued to favor the SOEs by providing bank credits and subsidized resources. Before the higher education reform of the late 1990s, each college graduate in China was guaranteed a government-assigned job through a centralized placement system. Under such a system, the SOEs usually absorb a majority of college graduates.

To examine how ownership and export status affect demand for skilled labor, we classify all firms into one of the following 5×2 categories: state exporters and non-exporters, collective exporters and non-exporters, private exporters and non-exporters, HMT FDI exporters and non-exporters, and OECD FDI exporters and non-exporters. Table 4 shows the regression results with private non-exporters as the missing category (benchmark). Columns 3 and 6 are our preferred specifications. Consistent with the

baseline regression results, for every ownership category, exporters have a lower skill share than non-exporters. For both exporters and non-exporters, OECD-invested firms appear to have the highest skill share, followed by SOEs, HMT invested firms, and finally, collective and private firms.

Table 4. Skill Share Regression (Ownership)

	Dependent Variable: Share of Senior High School and above			Dependent Variable: Share of College and above		
	1	2	3	4	5	6
HMT FDI Exporter	0.042***	-0.039***	-0.012	0.022***	-0.024***	-0.005
	(0.012)	(0.010)	(0.009)	(0.006)	(0.006)	(0.005)
HMT FDI Non-Exporter	0.166***	0.092***	0.095***	0.098***	0.056***	0.056***
	(0.009)	(0.008)	(0.006)	(0.006)	(0.005)	(0.004)
OECD FDI Exporter	0.134***	0.058***	0.070***	0.083***	0.042***	0.041***
	(0.012)	(0.010)	(0.008)	(0.006)	(0.006)	(0.005)
OECD FDI Non-Exporter FDI	0.241***	0.160***	0.142***	0.177***	0.129***	0.111***
	(0.009)	(0.007)	(0.006)	(0.008)	(0.006)	(0.005)
State-Owned Exporter	0.135***	0.067***	0.061***	0.074***	0.041***	0.032***
	(0.009)	(0.007)	(0.004)	(0.005)	(0.004)	(0.002)
State-Owned Non-Exporter	0.189***	0.145***	0.098***	0.102***	0.077***	0.051***
	(0.006)	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)
Collective-Owned Exporter	-0.020***	-0.056***	-0.028***	-0.011***	-0.031***	-0.017***
	(0.007)	(0.006)	(0.005)	(0.003)	(0.003)	(0.003)
Collective-Owned Non-Exporter	0.028***	0.028***	0.010***	0.006***	0.008***	-0.006***
	(0.005)	(0.004)	(0.003)	(0.002)	(0.002)	(0.001)
Private Exporter	-0.023***	-0.052***	-0.006**	-0.001	-0.018***	0.002
	(0.007)	(0.006)	(0.003)	(0.003)	(0.003)	(0.001)
ln(K/Y)		0.006***	0.004***		-0.001	-0.002***
		(0.001)	(0.001)		(0.001)	(0.001)
lnY		0.021***	0.018***		0.010***	0.010***
		(0.001)	(0.001)		(0.000)	(0.000)
ln(Computer Intensity)		0.111***	0.081***		0.076***	0.064***
		(0.004)	(0.002)		(0.003)	(0.002)
Constant	0.357***	0.928***	0.782***	0.070***	0.487***	0.438***
	(0.007)	(0.022)	(0.020)	(0.003)	(0.021)	(0.019)
Industry Dummies	No	No	Yes	No	No	Yes
Provincial Dummies	No	No	Yes	No	No	Yes
No. of observations	1187267	1187267	1167218	1187267	1187267	1167218
R-squared	0.0452	0.0998	0.1877	0.0559	0.1437	0.2177

Notes: The benchmark category is private non-exporters. Numbers in parentheses are standard errors corrected for 2-digit industry/province clustering. *, **, and *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

5.3. Using Alternative Definitions of Export and FDI Variable

In this subsection, to conduct a robustness check, we use alternative definitions of export and FDI variables. Rather than using an exporter dummy variable, we create an export intensity variable defined as the export to sales ratio. As a continuous variable, export intensity allows us to exploit richer information on the export orientation of firms. Similarly, we create a new variable of foreign equity share to replace the FDI dummy. Wholly foreign-owned firms may have stronger incentives to bring the latest technology to China than will joint ventures. Foreign equity share can be a better measure of foreign presence than the FDI dummy.

Table 5 reports the regression results with alternative definitions of export and FDI variables. The results are qualitatively the same. Compared with the baseline results in Table 3, the negative effects of the export variable are stronger for both measures of skilled labor in Table 5.

Table 5. Skill Share Regression (Export Intensity and Foreign Equity Share)

	Dependent Variable: Share of Senior High School and above			Dependent Variable: Share of College and above		
	1	2	3	4	5	6
Export Intensity	-0.057***	-0.097***	-0.029***	-0.019***	-0.044***	-0.010***
	(0.009)	(0.007)	(0.005)	(0.004)	(0.003)	(0.002)
Foreign Equity Share	0.203***	0.101***	0.109***	0.139***	0.076***	0.080***
	(0.012)	(0.009)	(0.005)	(0.009)	(0.005)	(0.006)
Export Intensity*Foreign Equity Share	-0.135***	-0.091***	-0.130***	-0.116***	-0.079***	-0.099***
	(0.011)	(0.009)	(0.006)	(0.008)	(0.005)	(0.006)
ln(K/Y)		0.010***	0.008***		0.0013*	-0.001
		(0.001)	(0.001)		(0.001)	(0.001)
lnY		0.028***	0.023***		0.015***	0.013***
		(0.001)	(0.001)		(0.001)	(0.000)
ln(Computer Intensity)		0.119***	0.086***		0.081***	0.063***
		(0.004)	(0.002)		(0.003)	(0.002)
Constant	0.380***	0.953***	0.798***	0.084***	0.502***	0.447***
	(0.003)	(0.024)	(0.018)	(0.003)	(0.022)	(0.019)
Industry Dummies	No	No	Yes	No	No	Yes
Provincial Dummies	No	No	Yes	No	No	Yes
No. of observations	1179206	1160713	1160713	1179206	1160713	1160713
R-squared	0.0131	0.0838	0.1811	0.0201	0.1257	0.2334

Notes: Export intensity is defined as ratio of export to sales. Foreign equity share is defined as the share of total equity held by foreign firms or foreign investors. Numbers in parentheses are standard errors corrected for 2-digit industry/province clustering. *, **, and *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

5.4. Examining the Coastal Region and the Interior Region

The geographic distribution of trade and FDI in China has been highly uneven. Due to their convenient location, better infrastructure and superior business environment, the coastal regions have been the main source of exports and main recipients of FDI. In 2004, our sample year, the coastal provinces accounted for 89 percent of total exports and received 88 percent of the total FDI in China. Because both trade and FDI are highly concentrated in the coastal region, it will be useful to examine if our earlier results hold for the interior region.

To compare the interior region with the coastal region, we split the sample and run the same regression separately for interior firms only and coastal firms only.[6] We report the estimation results in Table 6. The firms in coastal and interior regions show a similar pattern. The only exception is Column 4, where the negative coefficient of the exporter dummy is no longer statistically significant.

Table 6. Skill Share Regression (Coastal vs. Interior Region)

	Dependent Variable: Share of Senior High School and above		Dependent Variable: Share of College and above	
	Coastal Region Only	Interior Region Only	Coastal Region Only	Interior Region Only
Exporter Dummy	-0.011***	-0.016***	-0.002	-0.001
	(0.003)	(0.006)	(0.001)	(0.003)
FDI Dummy	0.101***	0.979***	0.074***	0.082***
	(0.006)	(0.005)	(0.004)	(0.004)
Exporter*FDI	-0.079***	-0.043***	-0.064***	-0.046***
	(0.005)	(0.008)	(0.004)	(0.006)
ln(K/Y)	0.003**	0.016***	-0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
lnY	0.021***	0.025***	0.012***	0.011***
	(0.001)	(0.001)	(0.000)	(0.000)
ln(Computer Intensity)	0.082***	0.094***	0.058***	0.076***
	(0.002)	(0.002)	(0.002)	(0.002)
Constant	0.801***	0.777***	0.434***	0.474***
	(0.022)	(0.020)	(0.022)	(0.016)
Industry Dummies	Yes0.2260	Yes	Yes	Yes
Provincial Dummies	Yes	Yes	Yes	Yes
No. of observations	816826	350392	816826	350392
R-squared	0.1589	0.2339	0.2012	0.2659

Notes: We run the regression with two subsamples: coastal region and interior region. The benchmark category is domestic non-exporters. Numbers in parentheses are standard errors

[6] The coastal region includes Beijing, Fujian, Guangdong, Hainan, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin and Zhejiang; the interior region includes all other provinces.

corrected for 2-digit industry/province clustering. *, **, and *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

5.5. Alternative Econometric Model: Tobit Regression

Given that the skill share is defined as bounded between 0 and 1, it may not be appropriate to use this censored variable as a dependent variable. We re-estimate Equation (1) using Tobit regression. The estimation results are presented in Table 7. Again, the export variable and FDI variable exhibit opposite signs and are statistically significant at the 1 percent level. The coefficient of the interaction term is also negative.

Table 7. Skill Share Tobit Regression

	Dependent Variable: Share of Senior High School and above			Dependent Variable: Share of College and above		
	1	2	3	4	5	6
Exporter Dummy	-0.004***	-0.064***	-0.014***	-0.003***	-0.052***	-0.015***
	(0.002)	(0.002)	0.000	(0.001)	(0.001)	(0.001)
FDI Dummy	0.222***	0.107***	0.118***	0.239***	0.107***	0.111***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Exporter*FDI	-0.131***	-0.082***	-0.106***	-0.155***	-0.092***	-0.989***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
ln(K/Y)		0.014***	0.009***		0.012***	0.008***
		0.000	0.000		0.000	0.000
lnY		0.039***	0.032***		0.055***	0.048***
		0.000	0.000		(0.000)	(0.000)
ln(Computer Intensity)		0.154***	0.112***		0.160***	0.123***
		(0.001)	(0.001)		(0.000)	(0.000)
Constant	0.364***	1.087***	0.895***	0.296***	0.591***	0.425***
	(0.000)	(0.002)	(0.004)	0.000	(0.002)	(0.004)
Industry Dummies	No	No	Yes	No	No	Yes
Provincial Dummies	No	No	Yes	No	No	Yes
No. of observations	1187267	1187267	1167218	1187267	1187267	1167218
Pseudo R-squared	0.0101	0.0729	0.1593	0.0423	0.2321	0.3751

Notes: The benchmark category is domestic non-exporters. Numbers in parentheses are standard errors. *, **, and *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Alternatively, we have also used the logistic transformation of skill share as the dependent variable:

$$\text{LOGIT Skill Share} = \ln\left(\frac{\text{Skill Share}}{1-\text{Skill Share}}\right).$$

The results are similar and are available upon request. Our baseline regression results are quite robust to the use of these alternative econometric methods.

6. Conclusions and Policy Implications

This study uses large-scale firm-level census data to examine how trade and FDI affect the demand for skilled labor in China's manufacturing firms. We use two measures of skilled labor: senior high school-level education and college-level education. For both measures, we find that exporters tend to employ more unskilled workers than do non-exporters. The results hold for both Chinese exporters in the ordinary trade regime and foreign-invested exporting firms in the processing trade regime. Although these findings are consistent with the Heckscher–Ohlin model, they are somewhat surprising given the predictions of a large body of literature on trade and heterogeneous firms. We also find that FDI is associated with a higher share of skilled labor in total employment. We interpret this finding as evidence in support of Feenstra and Hanson's outsourcing theory. Our results are qualitatively the same for several robustness checks.

The estimation results revealed in this paper do not provide a direct answer to the inequality question because the equilibrium return to skill is determined by both demand and supply factors. However, the demand factors have strong effects on wages. In Table 8, we run a firm-level wage regression in which we regress the logarithms of wage rates on the share of college education and the share of senior high school education. Table 8 reports the estimation results with the full sample and the subsamples for the coastal region and interior region. We find that those firms with a higher share of skilled labor do pay higher wages.[7] Such effects are stronger for the coastal sample than for the interior sample.

[7] Column 2 of Table 8 implies about 12.7 percent and 3.3 percent returns to an additional year of schooling for college education and senior high school education, respectively. Recent studies find about 10 percent returns to a year of schooling in China's urban area (for example, Zhang and Zhao, 2007).

Table 8. Wage Regression

Dependent Variable: ln(wage rate)

	Full Sample		Coastal Region Only		Interior Region Only	
	1	2	3	4	5	6
Share of College Education	0.650***	0.506***	0.665***	0.523***	0.648***	0.458***
	(0.003)	(0.018)	(0.004)	(0.025)	(0.006)	(0.015)
Share of Senior High School	0.109***	0.097***	0.104***	0.091***	0.179***	0.100***
	(0.002)	(0.007)	(0.003)	(0.007)	(0.004)	(0.013)
Constant	2.008***	2.363***	2.087***	2.255***	1.802***	2.074***
	(0.001)	(0.003)	(0.004)	(0.055)	(0.002)	(0.031)
Industry Dummies	No	Yes	No	Yes	No	Yes
Provincial Dummies	No	Yes	No	Yes	No	Yes
No. of observations	1187267	1187267	1187267	1187267	1187267	1187267
R-squared	0.0336	0.1572	0.0361	0.1406	0.0388	0.1008

Notes: Numbers in parentheses are standard errors corrected for 2-digit industry/province clustering. *, **, and *** represent statistical significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Our empirical results should be very useful for policy-makers. If a more equal distribution of income between skilled labor and unskilled labor is desired, then according to our findings, government policies that promote exports (and particularly ordinary trade exports) can be strongly justified. Policy-makers should also be aware of the opposite effects of foreign direct investment.

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Appendix Table 1. Percentage of Skilled Labor in Total Employment by Province (2004)

Province	2004 (Senior High School and above)	2004 (College and above)
National Average	47.5	13.0
Beijing	58.6	22.0
Tianjin	52.2	13.4
Hebei	40.7	8.9
Shanxi	46.5	11.7
Inner Mongolia	57.1	14.5
Liaoning	45.0	16.1
Jilin	59.5	16.8
Heilongjiang	57.7	17.0
Shanghai	41.0	12.8
Jiangsu	43.0	9.4
Zhejiang	31.7	6.7
Anhui	41.4	10.5
Fujian	35.7	7.8
Jiangxi	43.1	9.6
Shandong	44.8	10.3
Henan	44.9	10.0
Hubei	54.4	15.3
Hunan	48.5	12.3
Guangdong	41.5	8.9
Guangxi	45.0	10.4
Hainan	56.0	16.5
Chongqing	51.8	14.2
Sichuan	48.2	14.4
Guizhou	47.6	15.3
Yunnan	40.3	11.1
Tibet	30.1	9.4
Shaanxi	59.0	17.3
Gansu	52.6	14.4
Qinghai	51.2	13.1
Ningxia	46.9	12.7
Xinjiang	57.1	19.2

Source: 2004 Census Database.

Appendix Table 2. Percentage of Skilled Labor in Total Employment by Industry (2004)

Industry	2004 (Senior High School and above)	2004 (College and above)
Processing of Food from Agricultural Products	42.5	9.7
Mfg. of Foods	46.3	12.5
Mfg. of Beverages	52.4	14.4
Mfg. of Tobacco	62.6	23.0
Mfg. of Apparel, Footwear, and Caps	34.1	5.3
Mfg. of Textile Wearing Apparel, Footwear and Caps	30.3	4.9
Mfg. of Leather, Fur, Feather and Related Products	27.8	4.1
Processing of Timber, Mfg. of Wood, etc. Products	32.5	5.6
Mfg. of Furniture	35.1	6.8
Mfg. of Paper and Paper Products	41.0	8.2
Printing, Reproduction of Recording Media	49.1	10.9
Mfg. of Articles for Culture, Education and Sport	29.6	5.4
Processing of Petroleum and Nuclear Fuel and Coking	59.3	18.6
Mfg. of Raw Chemical Mat'ls and Chem. Products	51.8	15.0
Mfg. of Medicines	69.4	27.2
Mfg. of Chemical Fibers	51.6	12.7
Mfg. of Rubber	41.5	8.3
Mfg. of Plastics	39.3	8.2
Mfg. of Non-metallic Mineral Products	32.7	5.8
Smelting and Pressing of Ferrous Metals	54.0	15.3
Smelting and Pressing of Non-ferrous Metals	50.1	14.6
Mfg. of Metal Products	40.2	9.1
Mfg. of General Purpose Machinery	47.5	12.7
Mfg. of Special Purpose Machinery	56.3	17.5
Mfg. of Transport Equipment	57.2	17.2
Mfg. of Electrical Machinery and Equipment	49.9	14.0
Mfg. of Comm. Equip., Computers, and Electronic Equip.	59.8	18.1
Mfg. of Instruments and Mach. for Culture and Office Work	56.7	20.0
Mfg. of Artwork and Other Manufacturing	33.1	6.1

Source: 2004 Census Database.