

# City-industry Growth in China

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## Abstract

This paper investigates the relevance of the two leading theories of city-industry growth (i.e., specialization and diversity theories) in accounting for the fast yet uneven growth of industries in China's cities. Using the data set of 29 two-digit manufacturing industries in 231 China's cities for the period 1998-2005, we find that specialization promotes city-industry growth, whereas diversity has no effect at all. In addition, we find that specialization is important for the growth of mature industries in China, but diversity is crucial for the development of China's relatively new and fast-growing industries. Our study contributes to the literature by examining the relevance of the specialization and diversity theories for a large and fast-growing developing economy.

**Keywords:** City-Industry Growth in China, Specialization, Diversity  
*JEL Codes:* R11, O12, L60

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# 1 Introduction

China has had impressive industrialization and urbanization along with its economic reform in the last thirty years (Woetzel et al., 2008; Henderson, 2009).<sup>1</sup> During this process, however, the growth of industries has been uneven across China's cities. For example, cities such as Shenzhen and Dongguan, which were unheard of thirty years ago, are now the centers of several manufacturing industries such as electronics and telecommunications, while Shanghai has seen its leading position in many manufacturing industries eroded over the past three decades.

What accounts for the city-industry growth in China? To answer this question, we focus on the relevance of the two leading theories on the growth of industries in cities. On one hand, Marshall (1890), Arrow (1962), and Romer (1986) posit that the concentration of an industry in a city helps to reduce production costs through supply of specialized inputs and knowledge exchange and, therefore, promotes the growth of that industry (in short, the specialization theory).<sup>2</sup> On the other hand, Jacobs (1969) argues that a diversified industrial environment facilitates the transmission of technology and knowledge of different industries, thereby spurring innovations and local industrial growth (in short, the diversity theory). The dramatic and uneven growth of industries in China's cities allows us to investigate the relevance of the specialization and diversity theories for city-industry growth.

This paper draws on the data set of China's 29 two-digit manufacturing industries in 231 prefecture-level cities or above for the period 1998-2005. We first regress the city-industry growth rate between 1998 and 2005 on the measures of the city-industry specialization and diversity in 1998. It is found that specialization has a negative and statistically significant coefficient, whereas diversity has a positive and statistically significant coefficient, suggesting that diversity promotes but specialization hinders the city-industry growth in China. However, these results could be biased due to the lack of control for various industry and city characteristics that may correlate with the measures of the city-industry specialization and diversity. To deal with this concern, we include industry and city dummies, and re-estimate the impacts of city-industry specialization and diversity on city-industry growth. To our

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<sup>1</sup>The number of cities including both prefecture-level cities (*Di Ji Shi* in Chinese) and county-level cities (*Xian Ji Shi* in Chinese) has increased from 191 in 1978 to 652 in 2006 (China Statistical Yearbook, 1994, 2007). The urban population increased from 172 million in 1978 to 577 million in 2006, with its share in the total population rising from 18 percent to 44 percent correspondingly (China Statistical Yearbook, 2007).

<sup>2</sup>For a recent review of the literature on the agglomeration externalities, see Rosenthal and Strange (2004).

surprise, we find that specialization turns out to have a positive and statistically significant coefficient whereas diversity has a negative and statistically insignificant coefficient, supporting the specialization theory but not the diversity theory. These results remain robust to the alternative measures of key explanatory variables and the use of the panel estimation method.

Our results imply that in China, it is industrial specialization, not diversity, that contributes to the growth of industries in cities. This is in contrast to the findings in the literature using data sets from developed countries. For example, using the data set of the six-largest manufacturing industries in 170 cities of the United States between 1956 and 1987, Glaeser et al. (1992) find support for the diversity theory but not for the specialization theory. A recent theoretical paper by Duranton and Puga (2001) provides a possible explanation for these divergent findings. They argue that new and fast-growing industries can benefit from innovations by being located in diversified cities, but mature industries can lower down their production costs by being located in specialized cities. Indeed, most of China's manufacturing industries are concentrated in mature industries, whereas the driving force for the economic growth in the United States comes from the new and fast-growing industries. To lend further support to this explanation, we follow Henderson et al. (1995) by dividing our sample into two groups of industries: mature industries and fast-growing industries. Consistent with the above explanation and findings by Henderson et al. (1995), we find support for the specialization theory in the mature industries, but support for both the specialization theory and the diversity theory in the fast-growing industries.

This paper is built on a large literature on the growth of industries in cities. In an influential paper, Glaeser et al. (1992) find support for the diversity theory, but not for the specialization theory, in the case of the United States. In a further study on city-industry growth in the United States, Henderson et al. (1995) report evidence for the specialization theory in mature industries, but support for both the diversity and specialization theories in new and fast-growing industries.<sup>3</sup> Our study contributes to the literature by examining the relevance of the specialization and diversity theories for a large and fast-growing developing economy. Our findings suggest that different determinants of the city-industry growth may be at work for economies at different development stages.

This paper is also related to an emerging literature on China's urbanization, covering the determinants of China's urbanization (e.g., Young and Deng, 1998; Au and Henderson, 2006a; Deng et al., 2008), China's city size

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<sup>3</sup>Other studies include Henderson (1997, 2003), Quigley (1998), Maurel and Sedillot (1999), and Combes (2000).

distribution (Song and Zhang, 2002), and urbanization and labor productivity (Prud'homme, 2000; Au and Henderson, 2006b). The focus of this paper is on the relevance of the specialization and diversity theories for city-industry growth, the findings of which have important policy implications.

The paper proceeds as follows. Data and variables are discussed in Section 2, and the main empirical findings are reported in Section 3. The paper concludes in Section 4.

## 2 Data and Variables

Our data is from the annual surveys of industrial firms (ASIF) conducted by the *National Bureau of Statistics of China* for the period of 1998 to 2005. These annual surveys cover all state-owned enterprises, and those non-state-owned enterprises with annual sales of five million RMB (Chinese currency) or more. The number of firms covered in the surveys varies from over 146,000 to approximately 250,000.

Our study needs precise location and industry information of our sample firms. The data set provides information on the address and regional codes of each firm. During the sample period, however, China's administrative boundaries and consequently its county, city, or even provincial codes experienced some changes. For example, new counties were established, while existing counties were combined into larger ones or even elevated to cities. From 1998 to 2005, the number of counties in China increased from 2,496 to 2,862 (a total of 366), while the number of changes in the county codes was 648. From 1998 to 2005, the number of prefecture-level cities or above increased from 231 (4 municipalities, 15 vice provincial cities, and 212 prefecture-level cities) to 287 (4 municipalities, 15 vice provincial cities, and 268 prefecture-level cities). Using the 1999 National Standard (promulgated at the end of 1998 and called GB/T 2260-1999) as the benchmark codes, we convert the regional codes of all the firms to these benchmark codes to achieve consistency for the regional codes in the whole sample period.

Panel A of Table 1 shows the top five cities in terms of total manufacturing employment in 1998 and the top five manufacturing industries within each of these cities. Shanghai is the largest city with a total manufacturing employment of 2,277,312, followed by Tianjin (1,187,517), Beijing (1,128,643), Guangzhou (911,877), and Suzhou (857,509) in descending order. However, only two of these five cities - Shanghai (2,512,396; ranked #1 in 2005) and Suzhou (1,809,360; ranked #4 in 2005) - remained among the top five by 2005 (see Panel B of Table 1). The three new cities that made it to the top five were: Shenzhen (2,240,594; ranked #2), Dongguan (1,978,994; ranked

#3), and Ningbo (1,384,581; ranked #5). Note that three of the top five largest cities in 2005 are located in the Yangtze River Delta, while the other two are located in the Pearl River Delta, implying the importance of these two regions in the Chinese economy.

For each firm in the data set, there is also information on its primary two-digit, three-digit, and four-digit industry codes. However, in 2003, a new classification system for industry codes (called GB/T 4754-2002) was adopted to replace the old classification system (called GB/T 4754-1994) that had been used from 1995 to 2002. To achieve consistency in the industry codes for the whole sample period (1998-2005), we convert the industry codes in the 2003-2005 data to the old classification system by using a concordance table (in the case of a new four-digit code corresponding to an old four-digit code or several new four-digit codes corresponding to an old four-digit code) or by assigning a new code for an old code based on product information (in the case of several old four-digit codes corresponding to a new 4-digit code).

Panel A of Table 2 shows the top five manufacturing industries in terms of total manufacturing employment in 1998 and the top five cities in each of these industries. Textile is the largest manufacturing industries with a total manufacturing employment of 5,023,305, followed by nonmetal mineral products (3,902,075), raw chemical materials and chemical products (3,406,740), ordinary machinery equipment (3,165,430), and transport equipment (3,142,490) in descending order. However, only two of these five industries - textile (5,093,714; ranked #1 in 2005) and nonmetal mineral products (3,695,468; ranked #3 in 2005) - remained among the top five by 2005 (see Panel B of Table 2). The three new industries that made it to the top five were electronics and telecommunications (4,283,408; ranked #2), electric equipment and machinery (3,455,391; ranked #4), and garment and other fiber products (3,337,773; ranked #5). It is interesting to note that there were some degrees of coagglomeration among the five top industries of 2005, that is, electronics and telecommunications industry and electric equipment and machinery industry, and textile industry and garment and other fiber products industry.

The dependent variable for our study is the logarithm of growth rate of employment or output<sup>4</sup> of industry  $i$  in city  $c$  between 1998 and 2005 (denoted by  $G_{ic}$ ), where industry  $i$  is from the 29 two-digit manufacturing industries, and city  $c$  is from the 231 prefecture-level cities or above. Specifically, for the construction of  $G_{ic}$ , we aggregate the employment or output of all the firms in industry  $i$  and city  $c$  from our data set for both 1998 and 2005,<sup>5</sup> and

<sup>4</sup>Constant value of output is used.

<sup>5</sup>In 1998, the number of manufacturing firms in the 231 cities was 124,854, or about

calculate the logarithm of its growth rate accordingly. A list of the two-digit industries is provided in Appendix A, and a list of the 231 cities is shown in Appendix B.

The top five city-industry pairs in 1998, shown in Panel A of Table 3, are transportation equipment in Shanghai, electronics and telecommunications in Shenzhen, machinery and equipment in Shanghai, smelting and pressing of ferrous metals in Shanghai, and electrical equipment and machinery in Shanghai in descending order. By 2005, the top five city-industry pairs (shown in Panel B of Table 3) have become electronics and telecommunications in Shenzhen, electronics and telecommunications in Suzhou, electronics and telecommunications in Shanghai, raw chemical materials and chemical products in Guangzhou, and electronics and telecommunications in Dongguan. In terms of the growth rate between 1998 and 2005, the top five city-industry pairs are: petroleum refining in Xuchang, timer processing in Yulin, garment in Longyan, stationery, educational and sports goods in Shenyang, and chemical fibers in Lanzhou, whereas the bottom five city industry pairs are: leather and furs products in Haerbin, chemical fibers in Jinan, timber processing in Xingtai, rubber products in Nanning, and rubber products in Urumqi (see Table 4 for details). These dramatic changes (e.g., from four of the top five city-industry pairs in 1998 located in one region, Shanghai, to four of the top five city-industry pairs in 2005 located in one industry, electronics and telecommunications) illustrate the fast and uneven industry growth in China's cities, affording us an ideal setting to investigate the relevance of the city-industry growth theories.

Our key explanatory variables are *Specialization* and *Diversity*, corresponding to the two leading theories of industry growth in cities. For industry  $i$  in city  $c$ , we measure the degree of specialization by the employment (or output) share of the industry in the city over the corresponding share of the industry in the national total. Specifically, it takes the following form:

$$Specialization_{ic} = \frac{y_{ic}/y_c}{y_i/y} \quad (1)$$

where  $y_{ic}$  is the employment (or output) of industry  $i$  in city  $c$ ;  $y_c$  is the total employment (or output) in city  $c$ ;  $y_i$  is the total employment (or output) of industry  $i$ ; and  $y$  is the total employment (or output) of all those industries and cities. Hence,  $Specialization_{ic} > 1$  indicates that city  $c$  is more specialized in industry  $i$  relative to the national average. Studies using this measure of specialization include Glaeser et al. (1992) and Henderson (1997).

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91% of the total sample. By 2005, the corresponding number increased to 224,286, or about 94% of the total sample.

For industry  $i$  in city  $c$ , we measure the extent of diversity by one minus the sum of the square of employment (or output) share of all industries other than industry  $i$  in the same city  $c$ . Specifically,

$$Diversity_{ic} = 1 - \sum_{k \neq i} s_{kc}^2 \quad (2)$$

where  $s_{kc}$  is the employment (or output) share of industry  $k$  in city  $c$ . A higher value of  $Diversity_{ic}$  implies a greater extent of diversity. Studies using this measure of diversity include Henderson et al. (1995), Henderson (1997, 2003), and Gao (2004).

As in Glaeser et al. (1992), we include the following control variables in the regressions. The first control is the initial city-industry employment (or output) measured by the logarithm of employment (or output) in industry  $i$  and city  $c$  in 1998, which is used to account for the possible catching-up effects. The second one is the logarithm of average wage in industry  $i$  and city  $c$  in 1998 as a control for the possible effects caused by the relocation of firms to low-wage areas or the migration of workers to high-wage areas. The last one is the the degree of competition of industry  $i$  in city  $c$  in 1998, which is measured by the number of firms per worker of industry  $i$  in city  $c$  over the number of firms per worker of industry  $i$  in the national total (à la Glaeser et al., 1992). Alternatively, the degree of competition is measured by the negative value of the Herfindahl Index of industry  $i$  and city  $c$ .

Table 5 lists the summary statistics of all the variables, and Table 6 gives the correlations of the key variables.

## 3 Empirical Analysis

### 3.1 Main Results

To investigate the relevance of the specialization and diversity theories on the city-industry growth in China, we estimate the following equation:

$$G_{ic} = \alpha + \beta \cdot Specialization_{ic} + \gamma \cdot Diversity_{ic} + X'_{ic} \cdot \zeta + \varepsilon_{ic} \quad (3)$$

where  $X'_{ic}$  is a vector of control variables. To deal with possible heteroskedasticity issues, we use the White-robust standard errors.

The benchmark estimation results, in which  $Specialization_{ic}$  and  $Diversity_{ic}$  are measured by employment data, are reported in Table 7. Columns 1-2 use  $Specialization_{ic}$  and  $Diversity_{ic}$  separately, and Column 3 includes both of

them together. It is found that  $Specialization_{ic}$  has a negative and statistically significant coefficient, while  $Diversity_{ic}$  has a positive and statistically significant coefficient. These findings imply that industries grow faster in cities with higher city-industry diversity but lower city-industry specialization, lending support to the diversity theory but not to the specialization theory.

These results, however, could be biased due to the lack of control for various industry and city characteristics that may correlate with the measures of city-industry specialization and diversity, that is,  $E(Specialization_{ic} \cdot \varepsilon_{ic}) \neq 0$  and  $E(Diversity_{ic} \cdot \varepsilon_{ic}) \neq 0$ . To deal with this possible concern, we then include industry and city dummies, and re-estimate equation (3). As shown in Column 4 of Table 7, once the industry and city dummies are included, our early results become completely reversed.<sup>6</sup> Specifically,  $Specialization_{ic}$  turns out to be positively and statistically significantly correlated with industry growth in cities, but  $Diversity_{ic}$  does not have any significant impact on industry growth in cities. These findings imply that city-industry specialization promotes industry growth in cities, while city-industry diversity has no effect at all.

The complete reversal in our regression results when industry and city dummies are included implies the importance of accounting for industry and city characteristics. Specifically, the omitted variables are expected to be negatively correlated with the measure of specialization but positively correlated with that of diversity. One important determinant for city-industry growth in China is the industrial policies adopted by the local city officials. It is well documented that under the centrally-planned economy local bureaucrats were instructed to pursue well-diversified economies even at suboptimal scales (called *Xiao Er Quan* in Chinese), partly for the national defense strategy (e.g., Henderson, 2009). Such pursuit of small but diversified local economies has persisted during China's economic reform. This is because the promotion prospects of China's local officials depend on the local economic development, and for risk-diversification concerns, local officials tend to mimic one another in developing what is considered as strategically important industries. Indeed, virtually every Chinese city has its economic and development zones. In other words, local city officials favor industrial diversity rather than industrial specialization. The omission of such variables would naturally lead to over-estimated impacts of diversity, but under-estimated impacts of specialization.

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<sup>6</sup>As there is little evidence for multicollinearity between our key explanatory variables and other control variables (specifically, the *VIF* value for *Specialization* is 1.14 and that for *Diversity* is 1.13), henceforth we only list the estimation results when our key explanatory variables are included together to save space.



## 3.2 Robustness Checks

In this sub-section, we conduct a series of robustness checks on our aforementioned regression results.

**Output data.** Some studies in the literature have used output data to measure city-industry specialization and diversity (e.g., Gao, 2004). We therefore use output data to measure the dependent variable and all the relevant explanatory variables, and repeat the analysis. Column 1 of Table 8 summarizes the estimation results, and it is clear that our main results (i.e., shown in Column 4 of Table 7) remain robust.

**Alternative measure of competition.** Our measure of *Competition* in the benchmark estimation follows that of Glaeser et al. (1992), that is, the number of firms per worker of a given industry in a given city over the number of firms per worker of the industry in the national total. For robustness check, we use the negative value of the Herfindahl Index to measure the degree of competition. Regression results are reported in Column 2 of Table 8 when employment data are used, and in Column 3 of Table 8 when output data are used. Clearly, the results are similar to our earlier findings.

**4-digit industry level analysis.** Thus far, our analysis is at the 2-digit industry level to be comparable to the literature (e.g., Glaeser et al., 1992). However, for a fast-growing economy like China, industrial dynamic could be different from those relatively mature economies like the U.S., especially at a more disaggregate level. Meanwhile, there is a concern whether our contrasting findings are driven by the definition of the industry, i.e., 2-digit level. To address these concerns, we carry out an estimation at a more disaggregate level, that is, 4-digit industry level. Regression results are reported in Column 1 of Table 9. Evidently, we find a much similar results.

**Panel estimation.** Our main results show the importance of controlling for industry and city characteristics that may correlate with the measures of city-industry specialization and diversity. While the inclusion of industry and city dummies is one way to deal with this problem in the literature (e.g., region dummies are used in Henderson et al., 1995 for each industry estimation; whereas industry dummies are used in Gao, 2004), an alternative way is to use the panel estimation in which industry-city dummies are included to account for all possible time-invariant omitted variables (e.g., Henderson, 1997, 2003). Thus, for robustness check, we use the panel estimation (with six-year city-industry growth, the longest possible panel setting in our data set) and report the regression results in Column 2 of Table 9. It is found that specialization has a positive and statistically significant impact on six-year city-industry growth, consistent with our earlier results.

**Sample attrition.** The ASIF data set that we have used does not

include small private firms (those non-state-owned firms with annual sales less than five million RMB). This may raise a concern of sample attrition, that is, the computed city-industry growth rate may not well capture the real growth rate. To address this concern, we use the two industry censuses conducted in 1995 and 2004, respectively, which contains all manufacturing firms in China at these two years. We then regress the ten-year city-industry growth rate on the level of specialization, diversity and competition in 1995 along with other initial controls. Regression results are reported in Column 3 of Table 9. Clearly, we find consistent findings, that is, specialization has a positive and statistically significant impact whereas diversity does not have a significant impact. These results reassure us that our baseline results are not affected by the truncation nature of the ASIF data set.

### 3.3 Discussion

Our study shows that in China, industries grow faster in cities with greater industrial specialization. This is in contrast to the findings using data from developed countries, for example, the support for the diversity theory but not for the specialization theory found by Glaeser et al. (1992) in the case of the United States. One possible explanation for the divergent findings is based on the theoretical argument put forward by Duranton and Puga (2001). They propose that new and fast-growing industries can benefit from more innovations by being located in diversified cities, but mature industries can lower their production costs by being located in specialized cities. Along with globalization, developed countries become specialized in new and fast-growing industries, while developing countries focus on mature industries. Hence, industrial diversity in cities is important for city-industry growth in developed countries, while specialization is crucial for city-industry growth in developing countries.

Following the logic of the above explanation, we would expect that specialization is important for mature industries in China, but diversity is crucial for its relatively new and fast-growing industries. As in Henderson et al. (1995), we focus on two sub-samples of industries: mature and fast-growing industries. Specifically, following Henderson et al. (1995), mature industries are defined as those three-digit industries that experienced employment drop during the sample period (1998-2005), whereas fast-growing industries are defined as those three-digit industries that had employment more than doubled during the sample period. For the list of those mature and fast-growing industries, see Appendix C. The regression results are shown in Table 10, with column 1 for the mature industries and column 2 for the fast-growing industries. Indeed, we find strong support for the specialization theory in the

mature industries, but for both the specialization and the diversity theory in the fast-growing industries. These results are similar to those found by Henderson et al. (1995).

### 3.4 Uncovering Industry and City Characteristics

Recall that once industry and city dummies are included in the regressions, we find support for the specialization theory but not for the diversity theory, which is in sharp contrast to the findings without the dummies (i.e., support for the diversity theory but not for the specialization theory). This highlights the importance of accounting for industry and city characteristics in estimating the relevance of different theories for city-industry growth.

To uncover those industry and city characteristics, we carry out two series of exercises. First, we keep the city dummies, but replace the industry dummies by the stepwise inclusion of industry-level variables such as industry capital intensity, average age, concentration, average productivity, debt to asset ratio, import tariff rates, priority industry, SOE ratio, and privatization ratio. Regression results are reported in Table 11. It is found that along with the stepwise inclusion of industry characteristics, the coefficient of specialization changes from negative and statistically significant to positive and significant. The coefficient of diversity remains positive but becomes statistically insignificant. The regression results when all general industry-level variables are included are close to what we have with the industry dummies, suggesting that these four industrial characteristics capture most of the industry characteristics that may correlate with the measures of city-industry specialization and diversity.

Second, we keep the industry dummies but replace the city dummies by the stepwise inclusion of city-level variables such as per capita GDP, population density, realized FDI, road density, the ratio of students in higher education over total population, financial development, and coastal area. The regression results are reported in Table 12. It is found that along with the stepwise inclusion of city characteristics, the coefficient of specialization changes from negative to positive but remains statistically insignificant. The coefficient of diversity remains positive and statistically significant. The regression results suggest that these general city-level characteristics only capture part of the city characteristics that may correlate with the measure of city-industry specialization but not that of city-industry diversity. As discussed in Section 3.1, the policies adopted by local city officials are expected to have significant impacts on city-industry growth. Future studies should be directed at understanding the motives of local city officials and classifying and incorporating city-industry policies into the analysis.

## 4 Conclusion

China has had fast yet uneven growth of industries in cities in the last thirty years. This prompts us to investigate what accounts for the city-industry growth in China. In this paper, using a data set of 29 two-digit manufacturing industries in 231 China's cities for the period 1998-2005, we examine the relevance of the two leading theories for industry growth in cities (i.e., the specialization theory by Marshall, Arrow, and Romer, and the diversity theory by Jacobs). We find that city-industry specialization promotes industry growth in cities, while city-industry diversity has no effect at all. These results lend support to the specialization theory but not for the diversity theory. They have direct policy suggestions for fostering industrial agglomeration and regional specialization in China, given that there is evidence suggesting that the partial reform approach adopted by the Chinese government in the last thirty years has led to local protectionism and insufficient specialization of industrial activities (Young, 2000; Bai et al. 2004; Lu and Tao, 2009).

It is also important to point out that our findings on the importance of city-industry specialization are in contrast to the findings using data from developed countries, for example, the support for the diversity theory but not for the specialization theory found by Glaeser et al. (1992) in the case of the United States. One possible explanation for the divergent findings is that different determinants of the city-industry growth may be at work for economies at different development stages. Specifically, industrial diversity in cities is important for the new and fast-growing industries, which are the drivers of economic growth in developed countries, while specialization is crucial for the growth of mature industries in cities, which constitute most of the economic activities in the developing countries.

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**Table 1. Five largest cities****Panel A. Five largest cities in 1998**

City	Employment	Five largest industries
Shanghai	2,277,312	Transportation equipment, Ordinary machinery equipment, Smelting and pressing of ferrous metals, Electric equipment and machinery, Electronics and telecommunications
Tianjin	1,187,517	Transportation equipment, Electronics and telecommunications, Raw chemical materials and chemical products, Smelting and pressing of ferrous metals, Textile
Beijing	1,128,643	Smelting and pressing of ferrous metals, Electronics and telecommunications, Transportation equipment, Nonmetal mineral products, Special equipment manufacturing
Guangzhou	911,877	Garment and other fiber products, Leather and furs and related products, Electric equipment and machinery, Transportation equipment, Raw chemical materials and chemical products
Suzhou	857,509	Textile, Raw chemical materials and chemical products, Garment and other fiber products, Ordinary machinery equipment, Electronics and telecommunications

**Panel B. Five largest cities in 2005**

City	Employment	Five largest industries
Shanghai	2,512,396	Electronics and telecommunications, Transportation equipment, Ordinary machinery equipment, Electric equipment and machinery, Raw chemical materials and chemical products
Shenzhen	2,240,594	Electronics and telecommunications, Electric equipment and machinery, Plastic products, Metal products, Garment and other fiber products
Dongguan	1,978,994	Electronics and telecommunications, Electric equipment and machinery, Education and sports goods, Leather and furs and related products, Garment and other fiber products
Suzhou	1,809,360	Electronics and telecommunications, Textile, Electric equipment and machinery, Garment and other fiber products, Metal products
Ningbo	1,384,581	Textile, Electric equipment and machinery, Ordinary machinery equipment, Garment and other fiber products, Metal products

**Table 2. Five largest industries****Panel A. Five largest industries in 1998**

Industry	Employment	Five largest cities
Textile	5,023,305	Shanghai, Suzhou, Shaoxing, Wuxi, Nantong
Nonmetal mineral products	3,902,075	Foshan, Beijing, Chongqing, Zibo, Tangshan
Raw chemical materials and chemical products	3,406,740	Shanghai, Nanjing, Jilin, Tianjin, Chongqing
Ordinary machinery equipment	3,165,430	Shanghai, Dalian, Wuxi, Beijing, Chongqing
Transportation equipment	3,142,490	Shanghai, Changchun, Shenyang, Shiyuan, Tianjin

**Panel B. Five largest industries in 2005**

Industry	Employment	Five largest cities
Textile	5,093,714	Suzhou, Shaoxing, Ningbo, Hangzhou, Jiaxing
Electronics and telecommunications	4,283,408	Shenzhen, Suzhou, Dongguan, Shanghai, Huizhou
Nonmetal mineral products	3,695,468	Zibo, Foshan, Quanzhou, Zhengzhou, Shanghai
Electric equipment and machinery	3,455,391	Shenzhen, Dongguan, Foshan, Shanghai, Ningbo
Garment and other fiber products	3,337,773	Shanghai, Quanzhou, Jiaxing, Guangzhou, Suzhou



**Table 3. Five largest city-industry pairs**

**Panel A. Five largest city-industry pairs in 1998**

City	Industry
Shanghai	Transportation equipment
Shenzhen	Electronics and telecommunications
Shanghai	Machinery and equipment
Shanghai	Smelting and pressing of ferrous metals
Shanghai	Electrical equipment and machinery

**Panel B. Five largest city-industry pairs in 2005**

City	Industry
Shenzhen	Electronics and telecommunications
Suzhou	Electronics and telecommunications
Shanghai	Electronics and telecommunications
Guangzhou	Raw chemical materials and chemical products
Dongguan	Electronics and telecommunications

**Table 4. Growth of City-Industry pairs**

**Panel A. Five Fastest-Growing City-Industry pairs**

Rank	City	Industry	Log(employment growth)
1	Xuchang	Petroleum refining	5.54
2	Yulin	Timber processing	5.02
3	Longyan	Garment	4.95
4	Shenyang	Stationery, educational and sports goods	4.85
5	Lanzhou	Chemical fibers	4.75

**Panel B. Five Slowest-Growing City-Industry pairs**

Rank	City	Industry	Log(employment growth)
1	Harbin	Leather and furs products	-4.92
2	Jinan	Chemical fibers	-4.27
3	Xingtai	Timber processing	-4.23
4	Nanning	Rubber products	-4.19
5	Urumqi	Rubber products	-4.17

**Table 5. Summary statistics of all variables**

Variable	Mean	Standard deviation	Number of observations
Log of city-industry employment growth for all industries	-.049	1.015	5,406
Log of city-industry output growth for all industries	1.021	1.274	5,345
Log of city-industry employment growth for mature industries	-.415	1.167	6,231
Log of city-industry employment growth for new high-tech industries	.553	1.401	1,744
Specialization using employment data for all industries	1.208	1.934	5,406
Specialization using output data for all industries	1.310	2.385	5,345
Specialization using employment data for mature industries	2.069	5.056	6,231
Specialization using employment for new high-tech industries	1.930	5.609	1,744
Diversity using employment data for all industries	.884	.080	5,406
Diversity using output data for all industries	.858	.111	5,345
Diversity using employment data for mature industries	0.939	0.061	6,231
Diversity using employment data for new high-tech industries	0.930	0.072	1,744
Competition a la Glaeser et al. (1992) using employment data for all industries	1.876	3.377	5,406
Competition a la Glaeser et al. (1992) using output data for all industries	6.361	35.015	5,345
Competition as the negative value of Herfindahl Index using employment data for all industries	.332	.289	5,406
Competition as the negative value of Herfindahl Index using output data for all industries	.384	.301	5,345
Competition as the negative value of Herfindahl Index using employment data for mature industries	.287	.363	6,231
Competition as the negative value of Herfindahl Index using employment data for new high-tech industries	.592	.421	1,744
City-industry initial average wage for all industries	1.700	.512	5,406
City-industry initial average wage for mature industries	1.668	.599	6,231
City-industry initial average wage for new high-tech industries	1.491	.808	1,744
City-industry initial employment for all industries	7.899	1.626	5,406
City-industry initial output for all industries	12.095	1.995	5,345
City-industry initial employment for mature industries	7.083	1.550	6,231
City-industry initial employment for new high-tech industries	5.597	1.517	1,744
<i>Industrial characteristics</i>			
Average age	13.210	2.826	29
Concentration	.004	.005	29
Average productivity (*000RMB/worker)	38.750	28.375	29
Debts to asset ratio (%)	64.300	3.949	29
Capital intensity (fixed assets/employment)	68.602	175.099	29
Average import tariff rate (%)	13.436	7.283	29
Supported industries	0.471	0.499	29
SOEs employment ratio (%)	41.815	20.295	29
Privatization share (%)	9.365	3.198	29
<i>Regional characteristics</i>			

Students in higher education per 10000person	97.168	101.587	226
Real amount of foreign capital absorbed (\$100 million)	2.025	4.734	228
Area of paved roads / area of territory (%)	30.399	45.396	228
Population density (1000 person/sq.km)	1.256	1.060	228
Per capita income ('000RMB/person)	8.857	9.839	225
Ratio of loans in GDP (%)	96.755	224.527	226
Coastal city	0.184	0.388	231

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**Table 6. Correlations of key variables**

	Log of city-industry employment growth for all industries	Specialization using employment data for all industries	Diversity using employment data for all industries	Competition a la Glaeser et al. (1992) using employment data for all industries
Log of city-industry employment growth for all industries	1.000			
Specialization using employment data for all industries	-.104	1.000		
Diversity using employment data for all industries	.017	.146	1.000	
Competition a la Glaeser et al. (1992) using employment data for all industries	.311	-.164	-.079	1.000

**Table 7. Main results**

Dependent variable: Log of city-industry employment growth				
	Without dummies			With dummies
	(1)	(2)	(3)	(4)
Specialization	-.024 (-3.21)		-.025 (-3.36)	.050 (3.57)
Diversity		.820 (4.09)	.843 (4.20)	-.445 (-0.72)
City-industry initial employment	-.085 (-7.19)	-.109 (-8.82)	-.099 (-8.02)	-.230 (10.00)
Competition	.073 (7.37)	.071 (7.25)	.071 (7.29)	.058 (5.80)
City-industry initial average wage	.459 (14.91)	.452 (14.74)	.456 (14.84)	.388 (10.21)
Constant	-.265 (-2.55)	.004 (0.03)	-.044 (-0.37)	1.284 (4.86)
City dummies	No	No	No	Yes
Industry dummies	No	No	No	Yes
Adjusted R <sup>2</sup>	.151	.153	.155	.376
Number of observations	5,406	5,406	5,406	5,406

Note: Robust t statistics are in parentheses beneath estimated coefficients.

**Table 8. Robustness checks using output data and an alternative measure of competition**

Dependent variable	Log of city-industry output growth	Log of city-industry employment growth	Log of city-industry output growth
	Competition a la Glaeser et al. (1992)	Competition as negative Herfindahl Index	Competition as negative Herfindahl Index
	(1)	(2)	(3)
Specialization	.061 (5.08)	.076 (4.75)	.083 (5.93)
Diversity	.654 (1.22)	-.467 (-0.72)	.897 (1.57)
City-industry initial employment (or output)	-.356 (-16.95)	-.369 (-16.77)	-.463 (-21.05)
Competition	.006 (6.00)	.260 (3.42)	.443 (5.34)
City-industry initial average wage	.111 (2.31)	.397 (9.93)	.165 (3.37)
Constant	6.414 (19.38)	2.750 (10.70)	7.941 (22.69)
City dummies	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes
Adjusted R <sup>2</sup>	.400	.376	.387
Number of observations	5,345	5,406	5,345

Note: Robust t statistics are in parentheses beneath estimated coefficients.

**Table 9. Robustness checks using 4-digit industry, panel estimation, and industry census data**

	Dependent variable: Log of city-industry employment growth		
	4-digit industry	Panel estimation	Industry census data
	(1)	(2)	(3)
Specialization	.008 (7.17)	.108 (3.72)	.042 (2.39)
Diversity	0.326 (-0.20)	-.544 (-0.78)	-.715 (-1.11)
City-industry initial employment	-0.401 (-39.21)	-1.178 (-31.00)	-0.275 (-11.20)
Competition as negative value of Herfindahl Index	.024 (6.32)	.161 (1.65)	.001 (1.90)
City-industry initial average wage	.289 (19.22)	.191 (5.79)	-0.011 (-0.44)
Constant	1.389 (0.84)	8.770 (26.18)	6.052 (8.05)
City dummies	Yes	Yes	
Industry dummies	Yes	Yes	
Industry-city dummies			Yes
Number of observations	23,838	10,276	5,526

Note: Robust t statistics are in parentheses beneath estimated coefficients.



**Table 10. Subsamples**

Dependent variable: Log of city-industry employment growth		
	Mature industries	Fast-growing industries
	(1)	(2)
Specialization	.020 (4.22)	.026 (3.21)
Diversity	-2.779 (-1.53)	10.918 (2.23)
City-industry initial employment	-.303 (-18.66)	-.425 (-12.52)
Competition as negative value of Herfindahl Index	.025 (6.16)	.045 (4.19)
City-industry initial average wage	.366 (11.64)	.296 (4.54)
Constant	3.944 (2.19)	-9.328 (-1.96)
City dummies	Yes	Yes
Industry dummies	Yes	Yes
Adjusted R <sup>2</sup>	.319	.486
Number of observations	6,231	1,744

Note: Robust t statistics are in parentheses beneath estimated coefficients.

**Table 11. Industrial characteristics**

Dependent variable: Log of city-industry employment growth								
	Without industrial characteristics		With industrial characteristics					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Specialization	-.006 (-0.58)	-.001 (-0.10)	-.006 (-0.61)	.001 (0.09)	.008 (0.73)	.009 (0.88)	.022 (2.02)	.022 (2.01)
Diversity	1.161 (1.75)	1.122 (1.71)	.744 (1.16)	.633 (0.99)	.465 (0.73)	.431 (0.68)	.200 (0.32)	.247 (0.39)
<b><i>Common control variables</i></b>								
City-industry initial employment	-.145 (-10.54)	-.149 (-11.06)	-.128 (-9.51)	-.142 (-10.29)	-.151 (-10.65)	-.155 (-10.54)	-.181 (-10.61)	-.177 (-10.16)
Competition	.061 (7.27)	.063 (8.14)	.063 (8.07)	.061 (7.85)	.061 (7.78)	.060 (7.69)	.059 (7.43)	.062 (7.23)
City-industry initial average wage	.280 (7.59)	.333 (8.35)	.357 (8.98)	.364 (9.15)	.381 (9.45)	.383 (9.48)	.387 (9.63)	.395 (9.72)
<b><i>Industrial characteristics</i></b>								
Capital intensity		-.001 (-3.74)	-.001 (-3.66)	-.001 (-3.29)	-.001 (-2.85)	-.001 (-2.92)	-.001 (-2.74)	-.001 (-2.49)
Average age			-.038 (-10.92)	-.036 (-10.46)	-.033 (-8.95)	-.034 (-8.66)	-.032 (-8.28)	-.028 (-6.04)
Concentration				-35.44 (-4.60)	-34.45 (-4.48)	-35.21 (-4.63)	-37.11 (-4.91)	-34.23 (-4.32)
Avg productivity					-.001 (-2.26)	-.001 (-2.25)	-.002 (-3.41)	-.001 (-2.35)
Debts to asset ratio						.347 (1.13)	-.627 (-1.69)	.217 (0.39)
Avg tariff rate							.011 (4.35)	.007 (2.56)
Priority Industry							.154 (4.35)	.168 (4.32)
SOE ratio								-.309 (-2.35)

Privatization share								-0.438 (-0.77)
Constant	.635 (3.14)	.651 (3.25)	.903 (4.43)	1.045 (5.15)	1.046 (5.17)	.882 (3.58)	1.536 (5.40)	1.037 (2.87)
City dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	No	No	No	No	No	No	No
Adjusted R2	.315	.319	.337	.341	.342	.342	.345	.346
Observations	5,406	5,402	5,402	5,402	5,402	5,402	5,402	5,402

Note: Robust t statistics are in parentheses beneath estimated coefficients.

**Table 12. Regional characteristics**

Dependent variable: Log of city-industry employment growth								
	Without regional characteristics		With regional characteristics					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Specialization	-.013 (-1.99)	-.006 (-0.88)	-.003 (-0.45)	.001 (0.01)	.004 (0.62)	.004 (0.50)	.001 (0.19)	.001 (0.16)
Diversity	.783 (3.78)	.792 (3.86)	.754 (3.67)	.727 (3.54)	.823 (4.03)	.984 (4.23)	.866 (4.09)	.778 (3.65)
<b>Common control variables</b>								
City-industry initial employment	-.103 (-6.69)	-.127 (-7.84)	-.133 (-8.07)	-.142 (-8.38)	-.159 (-9.45)	-.160 (-8.52)	-.133 (-7.37)	-.132 (-7.34)
Competition	.079 (6.84)	.073 (6.43)	.072 (6.35)	.071 (6.26)	.068 (6.24)	.064 (5.63)	.069 (6.21)	.069 (6.12)
City-industry initial average wage	.533 (16.25)	.458 (12.60)	.458 (12.63)	.444 (12.11)	.455 (12.51)	.433 (11.51)	.400 (10.35)	.394 (10.19)
<b>Regional characteristics</b>								
Per capita income		.127 (5.17)	.124 (5.03)	.100 (3.77)	.189 (6.53)	.291 (9.75)	.283 (6.23)	.278 (5.46)
Population density			.250 (2.17)	.218 (1.90)	.702 (5.47)	.765 (5.52)	.629 (3.95)	.608 (3.14)
Real FDI absorbed				.088 (3.43)	.185 (6.54)	.155 (5.35)	.133 (4.06)	.132 (4.69)
Road area/territory area					-.000 (-7.78)	-.000 (-8.15)	-.000 (-1.86)	-.000 (-1.71)
Students in higher education						-.045 (-2.49)	-.030 (-2.82)	-.032 (-2.06)
Financial development							.174 (7.50)	.164 (6.98)
Coastal								.131 (3.92)
Constant	-.084 (-5.83)	-.874 (-4.33)	-.834 (-4.10)	-.535 (-2.23)	-1.16 (-4.65)	-1.77 (-6.81)	-1.37 (-6.26)	-1.28 (-5.83)

City dummies	No	No	No	No	No	No	No	No
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R2	.218	.219	.220	.233	.234	.242	.252	.254
Observations	5,406	5,270	5,270	5270	5270	4,637	4,637	4,637

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Note: Robust t statistics are in parentheses beneath estimated coefficients.

## **Appendix A. A list of 29 two-digit manufacturing industries**

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Food processing  
Food production  
Beverage production  
Tobacco processing  
Textile industry  
Garments & other fiber products  
Leather, furs, down & related products  
Timber processing, bamboo, cane, palm fiber & straw products  
Furniture manufacturing  
Papermaking & paper products  
Printing & record pressing  
Stationery, educational & sports goods  
Petroleum processing, cooking products, gas production & supply  
Raw chemical materials & chemical products  
Medical & pharmaceutical products  
Chemical fibers  
Rubber products  
Plastic products  
Nonmetal mineral products  
Smelting & pressing of ferrous metals  
Smelting & pressing of nonferrous metals  
Metal products  
Machinery & equipment manufacturing  
Special equipment manufacturing  
Transportation equipment manufacturing  
Electrical equipment & machinery  
Electronic & telecommunication equipment  
Instruments, meters, cultural and office machinery  
Other manufacturing

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**Appendix B. A list of 231 prefecture-level cities or above**

<b>Beijing (1)</b> Beijing	Dalian Anshan Fushun	Heihe <b>Shanghai (1)</b> Shanghai	Bengbu Huainan Maanshan Huabei Tongling Anqing Huangshan Fuyang Chuzhou Suzhou <b>Fujian (8)</b> Fuzhou Xiamen Putian Sanming Quanzhou Zhangzhou Nanping Longyan	Dongying Yantai Weifang Jining Taian Dezhou Weihai Liaocheng Linyi Laiwu Rizhao <b>Henan (15)</b> Zhengzhou Kaifeng Luoyang Pingdingshan Anyang Hebi Xinxiang Jiaozuo	Xiangfan Ezhou Jingmen Xiaogan Huanggang Xianning <b>Hunan (12)</b> Changsha Zhuzhou Xiangtan Hengyang Shaoyang Yueyang Yiyang Changde Chenzhou Yongzhou Huaihua Zhangjiajie	Zhongshan Dongguan Shanwei Heyuan Yangjiang Qingyuan Jieyang Yunfu <b>Guangxi (9)</b> Nanning Liuzhou Guilin Wuzhou Beihai Fangchenggang Qinzhou Yulin Guigang <b>Hainan (2)</b> Haikou Sanya	Suining Neijiang Guangan Leshan Yibin Nanchong <b>Guizhou (3)</b> Guiyang Liupanshui Zunyi <b>Yunnan (3)</b> Kunming Yuxi Qujing <b>Tibet (1)</b> Lhasa <b>Shaanxi (7)</b> Xian Tongchuan Baoji Xianyang	<b>Qinghai (1)</b> Xining <b>Ningxia (3)</b> Yinchuan Shizuishan Wuzhong <b>Xinjiang (2)</b> Urumqi Karamay
<b>Tianjin (1)</b> Tianjin	Benxi Dandong Jinzhou							
<b>Hebei (11)</b> Shijiazhuang Tangshan Qinhuangdao Handan Xingtai Baoding Zhangjiakou Chengde Cangzhou Langfang Hengshui	Yingkou Fuxin Liaoyang Panjin Tieling Chaoyang Huludao <b>Jilin (8)</b> Changchun Jilin Siping Liaoyuan	Nanjing Wuxi Xuzhou Changzhou Suzhou Nantong Lianyungang Huaiyin Yancheng Yangzhou Zhenjiang Taizhou Suqian						
<b>Shanxi (6)</b> Taiyuan Datong Yangquan Changzhi Jincheng	Tonghua Baishan Baicheng Songyuan <b>Heilongjiang (11)</b> Harbin Qiqihar Jixi	<b>Zhejiang (10)</b> Hangzhou Ningbo Wenzhou Jiaxing	<b>Jiangxi (7)</b> Nanchang Jingdezhen Pingxiang					
Shuozhou <b>Inner Mongolia (4)</b> Hohhot Baotou Wuhai Chifeng		Huzhou Shaoxing Jinhua Quzhou Zhoushan Taizhou <b>Anhui (12)</b>	Jiujiang Xinyu Yingtian Ganzhou <b>Shandong (15)</b> Jinan Qingdao	Shangqiu Nanyang Xinyang <b>Hubei (11)</b> Wuhan Huangshi Shiyan	Zhuhai Shantou Foshan Jiangmen Zhanjiang Maoming Huizhou Zhaoqing	Chongqing <b>Sichuan (13)</b> Chengdu Zigong Panzhihua Luzhou Deyang	Yanan Hanzhong Weinan <b>Gansu (5)</b> Lanzhou Jiayuguan Jinchang	

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<b>Liaoning (14)</b>	Qitaihe	Hefei	Zibo	Jingzhou	Chaozhou	Mianyang	Baiyin
Shenyang	Mudanjiang	Wuhu	Zaozhuang	Yichang	Meizhou	Guangyuan	Tianshui

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## Appendix C. Mature and new high-tech industries

	<b>Industry</b>	<b>SIC (GB/T 4754-1994)</b>
<b>Mature</b>	Food processing	131, 132, 133
	Food production	143, 144, 145, 149
	Beverage production	151, 155, 159
	Tobacco processing	162, 169
	Textile industry	171, 172, 174, 176, 177
	Papermaking & paper products	222
	Printing & record pressing	231
	Raw chemical materials & chemical products	261, 262, 263, 265
	Medical & pharmaceutical products	271
	Chemical fibers	281, 185
	Rubber products	291, 292, 293, 295, 298, 299
	Nonmetal mineral products	311,313
	Smelting & pressing of ferrous metals	321, 322
	Smelting & pressing of nonferrous metals	331, 332
	Metal products	345
	Machinery & equipment manufacturing	351, 352, 358, 359
	Special equipment manufacturing	361, 362, 363, 364, 367
Transportation equipment manufacturing	371, 376, 377, 378	
Instrument, meters, cultural and office machinery	422, 423, 426	
<b>Fast-growing</b>	Electronic & telecommunication equipment	413, 414, 415, 416, 418
	Metal fabric manufacturing	341
	Plastic products	302,305, 307, 308
	Stationery, educational & sports goods	242, 245
	Furniture manufacturing	211, 212, 213, 214, 219
	Bamboo, vine, palm and grass products	202, 204
	Leather, furs, down & related products	191, 192
	Garments & other fiber products	181, 182
	Knitwear products	178