

Employment Growth and Innovation in China: A Firm Level Comparison across Provinces and City Districts*

by

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Abstract: This paper studies the impact of product innovations on employment growth at the firm level in China for four major industries: Textile, Wearing Apparel, Transport Equipment and Electronic Equipment. Using a very simple regression model proposed by Harrison, Jaumandreu, Mairesse and Peters (2008), we are able to estimate such impacts and decompose overall employment growth in four components respectively associated with: the output growth of innovating firms in new products and in “old” (unchanged) products, the output growth of non-innovating firms, and the average productivity growth in the production of old products.

The results are not too different from those found for manufacturing as a whole in France, Germany, Spain and the United Kingdom in the first of these studies, and for Italy in the second. They show that displacement effects induced by productivity growth in the production of old products are large, but that the effects related to product innovations are strong enough in general to overcompensate these displacement effects. Nonetheless they are interesting differences in the results for the four industries and across the four city districts and the various provinces.

JEL Classification: D2, J23, L1, O31, O33.

Key Words: Employment, Productivity, Product innovation, China

* **Preliminary Results. Comments welcome.**

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1. Introduction

Innovation is widely considered to be a primary source of macro-economic growth and is of paramount importance for firm competitiveness and productivity. In China, like in most developed as well as developing countries, policies to encourage firm-level innovation are very high on the economic agenda. The consequences of innovation for employment are also of great concern and interest. They remain, however, difficult to assess, since the relationship between innovation and employment is a complex one and is not particularly well known. On the one hand, the long-run economic impact of innovation on employment is clearly not negative; many decades, and even centuries, of innovation in advanced economies have been accompanied by employment growth instead of the ever-decreasing levels of jobs that many predicted. On the other hand, although the evidence suggests that innovative firms are more likely to survive and grow than firms that do not innovate, our understanding of the impacts of innovation on employment at the firm level remains rather fuzzy. Innovations contribute to productivity growth and thus often destroy jobs, but they also stimulate demand, both domestic and foreign, for firms' products. Overall it is unclear to what extent and through what mechanisms total employment is affected. A better assessment of such effects and mechanisms is particularly important for a well-informed implementation of innovation policy in China which has "a large pool of underemployed workers or workers in the informal sector" (Nannan Lundin and al. 2006, 2007; He Ping and al. 2008) and which faces the formidable challenge of a fast and sustainable development in the present and coming years.

Our paper focuses precisely on the comparative assessment of the effects of product innovation on labor growth across the Chinese provinces and city districts for four major but *a priori* contrasted manufacturing industries: Textile (code 17), Wearing Apparel (code 18), Transport Equipment (code 37) and Electronic Equipment (code 40). The first two industries are more labor intensive and low-tech, while the two other

industries are more capital intensive and high-tech. All four are not only important on the Chinese domestic market but also on the world market. They have grown extremely fast and have been quite innovative in recent years for China as a whole, with nonetheless wide differences across provinces.¹ Our analysis thus rely on four firm samples for the three recent years 2004-2006, which have been constructed for these four industries from the yearly survey of industrial firms organized by China National Bureau of Statistics.²

We mainly base our analysis on a regression model proposed by Harrison-Jaumandreu-Mairesse-Peters (HJMP, 2008) and estimated by them separately for the Manufacturing and the Service sectors in France, Germany, Spain and the United Kingdom (over the period 1998-2000). The same model has also been estimated by Hall-Lotti-Mairesse (HLM, 2008) for the Manufacturing sector in Italy (over the period 1995-2003).³ This model relates the overall growth of employment at the firm level to the growth of firm output separately due to new (i.e., innovative) products and to old (i.e., unchanged) products. The possibility of separate measures of output growth for new and old products follows directly from the firms' answers to the question on the new product output in a given year corresponds to new or substantially improved products introduced in this year and the two preceding years. This model can be also rewritten and viewed as a productivity regression assessing the impact of innovation on overall productivity growth. Although the two interpretations in terms of growth of labor and growth of productivity are exactly equivalent, we shall give preference here to the first one in the presentation and comments of our results.⁴

¹ The differences across sub-industries and across type of firm ownerships are also important; we control for them in the econometric analysis, but we will not focus on them here.

² We have also conducted the same analysis on smaller firm panel data samples for these same four industries for the years 2001-2003. The overall results are similar, and we will not report on them here.

³ It has also been estimated by Benavente and Lauterbach for Manufacturing in Chili (over the years 1998-2001). The results in this analysis are, however, very different from those found here and in the other two studies.

⁴ See HLM, 2008, for a presentation of the two sides of the results.

In the version of the regression model we consider here, the growth rate of labor is the dependent variable and the growth rate of new products is the basic explanatory variable.⁵ Clearly, these two variables are jointly determined by firms, implying that both are “endogenous” and that the latter must be instrumented in order to obtain consistent estimates of its impact. In addition to the OLS (“Ordinary Least Squares Estimates”, we report on two such IV (“Instrumental Variables”) estimates using both lagged long-term investment per employee and lagged R&D investment per employee, or only the latter.

On the basis of this model we can decompose the overall employment growth in four components: respectively associated with the output growth of product innovating firms in old products and in new products separately; with the output growth of non-product innovating firms (i.e., only old products); and with the average productivity growth in the production of old products. The results are not too different from those found for manufacturing as a whole in France, Germany, Spain and the United Kingdom in the first of these studies, and for Italy in the second. They show that displacement effects induced by productivity growth in the production of old products are large, but that the effects related to product innovations are strong enough in general to overcompensate these displacement effects. Nonetheless they are interesting differences in the results for the four industries and across the four city districts and the various provinces.

The paper organized as follows. After the introduction, in Section 2, we shall present our data and comment in some detail on the main descriptive statistics on employment, output and productivity growth and the percentage share of innovative output NPPO. In section 3, we shall briefly explain the regression model we consider and discuss its specification and estimation, and we shall present the estimates we obtained for the

⁵ In HJMP, 2008, and HLM, 2008, the authors also include in the model as a possibly important explanatory variable a binary indicator for process innovation. Such a variable was not available in our data.

impact parameter of product innovation on employment growth. In section 4, we shall comment on the resulting decomposition of overall employment growth associated with output growth in new and old products and productivity trend. We shall compare this decomposition for our four Chinese industries and three years 2004-2006 to that found for the manufacturing sectors of the five European countries and period and three years 1998-2000 in HLMP, 2008 and HLM, 2008. We briefly conclude in Section 5 in summarizing the main results and in sketching different perspectives and the data requirements for possibly extending and improving the analysis, and overcoming some of its main limitations. We have recorded in the Appendix additional descriptive statistics tables, regression estimates and corresponding decomposition of employment growth, which can be viewed as forms of robustness checks for different variants of the model or for different sub-samples: separately for six different categories of firm ownership and for Beijing and the largest provinces in terms of employment in the four industries.

2. Data

The data comes from the yearly industrial survey organized by China National Bureau of Statistics. In fact, it is a yearly census of all state-owned firms, and non-state-owned firms with sales higher than 5 million RMB Yuan. Since the sample is large enough, we select four sectors of firm data in year 2004-2006. Two of the sectors, Textile and Wearing Apparel, are labour intensity and low-tech sectors and they play an important role in the employment and export in China. The other two sectors, Transport Equipment and Electrical Equipment, are technology intensity and high-tech sectors. They input more on innovation and have more ratio of new products output.

For the original firm data, we deleted those firms with employees less than 10, sales of products less than RMB 500 million⁶, fixed assets less than 10 thousand, or output

⁶ The delete of small sales firms can help us to get the same standard of state-owned and

less than 0 by year. Then, the growth rate of sales, labour and fix assets of each firm in each year are calculated. Firms with all the 3 growth rates between each 2.5 and 97.5 percentile are kept. After that, we calculated the growth rate of labour and new products, and deleted those firms with too fast changes of employee or new products⁷, which means we get a sets of balanced sample in each sector and we will focus on the 2-year growth rate in 2006. Then we only kept provinces with at least 20 firms in each sector, for one of the most important aims of this paper is to compare the difference by region. Finally, we got the observations of each sector and listed them in the first line of table 1.

For the variables in the model, growth rate of labour, new products and productivity are the basic variables. Another three groups of dummy variables are added to measure the difference from their characters: region dummies specified by provinces and city districts (Beijing for reference), sub-sectors dummies specified by the 4-digit industry classification (the sub-sector with the largest number of firms for reference), and ownership dummies specified by state-owned, Limited Liability, Share-holding, Private (for reference), Hong Kong Macao and Taiwan (HMT) Funded, Foreign Funded. A set of variables are considered as instrumental variables, and at last, we selected 1-year lag of R&D expenses per employee (in log.), 1-year and 2-year lags of Long-term Investments (in log.), and the binaries to identify firms with/without R&D or Long-term Investments in corresponding year. All growth rates means the growth from 2004 to 2006.

Table 1 gives the brief description of basic variables in 2006. It shows that the proportions of firms with product innovation various among different sectors. The proportion is 8.3% in textile and it is 6.1% in wearing apparel. It is much higher in high-tech sectors, reaches 18% in transport equipment and 19.5% in electronic equipment. The average firm size of product innovators is larger than non-product

non-state-owned firms, since non-state-owned firms with sales less than 5 million are not included in the census scheme.

⁷ Only those firms are kept if their log labour growth rate between -0.7 and 1 , and their new product growth rate between -0.7 and 4 .

innovators, and the former is almost two times higher in textile and transport equipment than the later. The labour growth rates of product innovators are higher than total average and non-product innovators in those two low-tech sectors, but lower in the high-tech sectors. For the productivity growth, the product innovators are higher than non-product innovators in three sectors except electronic equipment. In product innovators, high productivity growth rates always appear in firms with middle or low proportion of new products, and those product innovators with more than 75% of new products in total output has much lower growth rate of productivity, especially in low-tech sectors. Table 2 gives the descriptive statistics of output of new and old products in product innovating firms. With NPPO goes higher, the growth rate of new products goes higher and larger than 100%, and the growth rate of old products goes down to negative.

[Table 1 & table 2 about here]

3. Impact of Product Innovation on Employment

3.1 Theoretical framework

The output of a firm in a certain year can be divided into 2 kinds of goods: the old (unchanged) products, and the new products, which can be denoted with $i=1$ and $i=2$, respectively. If observing firms in two different years, which can be denoted with $t=1$ and $t=2$, outputs of old and new products in year t are denoted by Y_{1t} and Y_{2t} , respectively. We suppose year $t=1$ is the basic year and all products are old products which means Y_{21} is always equal to zero.⁸ In year $t=2$, Y_{22} may also equals to zero if the firm does not introduce any new products between the two years.

We can write the firm's production function for a product of type i in year t as equation (1) if we assume that: firstly, the production functions for old and new products are separable with both having constant returns to scale in capital, labor and

⁸ Comparing with former year(s), firms may have already introduce new products in year $t=1$. It has no effect in our model, but should be kept in mind in our estimation.

intermediate inputs.

$$Y_{it} = \theta_{it} F(K_{it}, L_{it}, M_{it}), \quad i=1,2; t=1,2 \quad (1)$$

where θ represents efficiency, K, L and M stand for capital, labor and materials, respectively. In order to get a simple relation between the employment growth and output, we pay much attention to Y and L in the following equations. Assuming cost minimization, we can write the firm's cost function as the following:

$$C(w_{1t}, w_{2t}, Y_{1t}, Y_{2t}, \theta_{1t}, \theta_{2t}) = c(w_{1t}) \frac{Y_{1t}}{\theta_{1t}} + c(w_{2t}) \frac{Y_{2t}}{\theta_{2t}} + F \quad (2)$$

where the marginal cost $c(w)$ is a function of the factors price vector w , and F represents fixed costs. According to Shephard's Lemma, we also have:

$$L_{it} = c_L(w_{it}) \frac{Y_{it}}{\theta_{it}} \quad (3)$$

where $c_L(w_{it})$ represents the derivative of the marginal cost with respect to the wage.

Then, the employment growth can be divided into two terms in equation (4): the

first part, $\frac{L_{12} - L_{11}}{L_{11}}$, is the employment growth for old products producer and the last

part, $\frac{L_{22}}{L_{11}}$, is the growth from new products producer.

$$\frac{\Delta L}{L} = \frac{L_{12} + L_{22} - L_{11}}{L_{11}} = \frac{L_{12} - L_{11}}{L_{11}} + \frac{L_{22}}{L_{11}} \quad (4)$$

or, introduce equation (3),

$$\frac{\Delta L}{L} = \frac{c_L(w_{12})Y_{12}/\theta_{12} - c_L(w_{11})Y_{11}/\theta_{11}}{c_L(w_{11})Y_{11}/\theta_{11}} + \frac{c_L(w_{22})Y_{22}/\theta_{22}}{c_L(w_{11})Y_{11}/\theta_{11}} \quad (5)$$

Assuming that the relative prices of inputs remain roughly constant in the two years and equal for old and new products, which means $c_L(w_{11}) = c_L(w_{12}) = c_L(w_{21}) = c_L(w_{22})$, we can understand the employment growth as the following approximate equation:

$$\frac{\Delta L}{L} \cong -\left(\frac{\theta_{12} - \theta_{11}}{\theta_{11}}\right) + \left(\frac{Y_{12} - Y_{11}}{Y_{11}}\right) + \frac{\theta_{11}}{\theta_{22}} \cdot \frac{Y_{22}}{Y_{11}} \quad (6)$$

Till now, the employment growth is divided into three components: the first is the change in efficiency in the production process for the old products, the second is the growth of old products output, and the third is the labor increase from expansion in production due to the introduction of new products or the effect of product innovation on employment growth. This effect depends on the relative efficiency θ_{11}/θ_{22} of old and new products. If new products are more efficient than old ones, the ratio is less than unity, and employment does not grow at the same pace as the output growth accounted for by new products.

We can use the following regression equation to estimate the parameters:

$$l = \alpha_0 + y_1 + \beta y_2 + u \quad (7)$$

where l is the growth rate of employment⁹ between year t=1 and t=2, y_1 is the contribution of old products to output growth which equals to $\frac{Y_{12} - Y_{11}}{Y_{11}}$, y_2 is the

⁹ In the estimation, we used the log growth rate, $l = \ln(L_{t2}) - \ln(L_{t1})$, to estimate the results.

contribution of new products to output growth which equals to $\frac{Y_{22}}{Y_{11}}$, and u is a random disturbance which has a mean of zero. For the parameters, α_0 is the constant represents the negative of the average efficiency growth from old products, β is the marginal cost in efficiency units of producing new products, comparing with old products. It can help us to identify the gross effect of product innovation (output of new products) on employment.

For the measurement of the growth of output, the prices should be considered since it is related in two different years. We used the gross ex-factory index of each sector between year t=1 and t=2 to get a comparable output in year t=2 and the comparable growth rate of output. Equation (7) can be rewrite as equation (8) by using g instead of y , which means the new one includes the average change of price in industrial level. On the other hand, we use more indicators separately from α_0 to specify the difference among different regions, ownership and sub-sectors by using 3 groups of dummies: reg_j , own_k and ind_q . Then we get the equation used in the estimation.

$$l - g_1 = \hat{\alpha}_0 + \sum_j \hat{\alpha}_{0j} reg_j + \sum_k \hat{\alpha}_{0k} own_k + \sum_q \hat{\alpha}_{0q} ind_q + \hat{\beta} g_2 + \hat{v} \quad (8)$$

3.2 Estimation of Product Innovation on Employment

Table 3 presents our main estimates of Equations (8) by using 2 different series of instrumental variables to correct possible simultaneity and measurement biases, together with simple estimation by using ordinary least squares (OLS) for comparison. The left hand is the employment growth rate minus the growth rate of the deflated sales due to old products and the right hand side variables are the growth rate of deflated sales due to new products and 3 groups of dummies. The coefficient of new product growth in the OLS regression is always significant and well below unity, implying that the growth rate of employment for innovating firms is much higher. We

tried 2 groups of instrumental variables in the estimation of Equation (8): IV_1 includes one-year lag of R&D expenses per employee (in log.) and a binary indicator to identify firms without R&D, IV_2 includes one-year lag of R&D expenditures per employee (in log.), one-year and two-year lags of Long-term Investments per employee (in log.), and three corresponding binary indicators to identify firms without R&D or Investments. Comparing with OLS estimation, the coefficient of the sales growth due to new products estimated by IVs growth higher but not significantly different from unity, implying that no significant differences exist between the efficiency levels of production of old and new products. The constant term gives an estimate of the average productivity growth for old products: around 20% in the first 3 sectors and nearly 46% in electronic equipment. They are close to the average productivity growth presented in Table 1: a little bit lower in the first 3 sectors, but much higher in electronic equipment.

[Table 3 about here]

4. Employment Growth Decomposition across Region

The employment growth rate of old products from equation (8) in each firm can be written as the following 6 components except the residual \hat{v} in the right side of equation (9):

$$l = \hat{\alpha}_0 + \sum_j \hat{\alpha}_{0j} reg_j + \sum_k \hat{\alpha}_{0k} own_k + \sum_l \hat{\alpha}_{0l} ind_l + [1 - I(g_2 > 0)]g_1 + I(g_2 > 0)(g_1 + \hat{\beta}g_2) + \hat{v} \quad (9)$$

where the $\hat{\alpha}$ s and $\hat{\beta}$ are the estimated coefficients of the best preferred specification, i.e. IV_2 estimate of 2004-2006 wave in table 3. The first component ($\hat{\alpha}_0$) is the average level of productivity trend in old products. The second to the fourth components ($\sum_j \hat{\alpha}_{0j} reg_j, \sum_k \hat{\alpha}_{0k} own_k, \sum_l \hat{\alpha}_{0l} ind_l$) measure the difference of employment growth in different region, ownership and sub-sector. The fifth term ($[1 - I(g_2 > 0)]g_1$)

describes the employment change associated with output growth of old products for firms that do not introduce new products output. The last one ($I(g_2 > 0)(g_1 + \hat{\beta}g_2)$) explains the employment change caused by output growth of product innovation firms, which can be divided into two sub-components: component $I(g_2 > 0)g_1$ gives the difference of employment growth by old product output, and component $I(g_2 > 0)\hat{\beta}g_2$ gives the difference of employment growth by new product.

We can calculate each component in firm level and summarize them by firms within the same character, e.g. firms have the same kind of ownership, in the same province or in the same sub-sector, so that we can compare the difference of components by ownership, province or sub-sector in a medium-level. Table 4 gives the results of the decomposition in industrial level, and graph 1 to 4 gives the decomposition by regions of the 4 sectors. The other results of decomposition by ownership and sub-sector are omitted here.

The results of industrial level decomposition presented in table 4, together with early results of 5 European countries by HJMP (2008) and HLM (2008). Notice that for each sector the average residual component is equal to zero, and thus average specific trend in the production of old products can be obtained by subtracting the sum of the first 4 components in equation (9). We can see that the average employment growth are 5.9% in textile, 5.4% in wearing apparel, 8.8% in transport equipment, and 13.8% in electronic equipment. The productivity improvements in the production of existing products are an important source of reductions in employment requirements for a given level of output. The effects are around -30% in the 4 Chinese sectors, much higher than the 5 European countries in manufacturing level. However, growth in output of existing old products in non-innovators over this 3-year period more than compensates for the productivity effect in all Chinese sectors, like the European countries except Germany. In contrast, product innovations play an important role in stimulating firm-level employment growth. They are 3.9% in textile, 3.6% in wearing apparel, 7.1% in transport equipment and 12.0% in electronic equipment, from 66% (textile) to 87% (electronic equipment) of total employment growth rate in the period.

The employment growth due to the growth of new products in product innovators are even higher in improving employment growth and counteract the decline of employment in old product output.

[Table 4 about here]

From graph 1 to graph 4, we can see the difference of component strength in each region by sector. The employment growth due to product innovation is decomposed into 2 parts: growth of old products (Inno_Old) and growth of new products (Inno_New). In textile, the growth due to Inno_New is much higher in 5 regions, i.e. Beijing, Sichuan, Henan, Jilin and Zhejiang. The growth due to Inno_Old is highly positive in Henan, the large and traditional textile province. The rules in wearing apparel are similar with textile for the close relation of these 2 sectors, i.e. growth due to Inno_New is large in Beijing, Zhejiang, Henan and Tianjin, and growth due to Inno_Old is highly positive in Henan. For transport equipment in graph 3, growth due to Inno_New is an important large part in most regions, especially in Tianjin, Shaanxi, Beijing, Liaoning, Heilongjiang, Zhejiang and Hunan. In electronic equipment, growth due to Inno_New is quit important in not only improving employment, but also filling up the reduction of labour by average productivity growth trend, especially in Beijing, Tianjin, Liaoning, Sichuan, Guangxi and Hunan.

[Graph 1 to 4 about here]

With the decomposition method, we also calculate the similar results in these 4 sectors by estimate the regression separately in sub-samples like 5 developed regions in China and 6 kinds of ownerships. The first draft results are presented in appendix table 3 to appendix table 6.

5. Conclusion

By using a simple equation developed in HJMP (2008) and HLM (2008), this paper analyses the impact of new product output in improving employment growth in firm

level, and the difference of relative components in improving it in four sectors in China. The average level of output and growth of basic data shows that proportion of product innovation is not high in either low-tech sectors or high-tech sector, but the growth of output and productivity are quit fast in recent years. The fast growth of output, low level of product innovation, and high average specific trend in decomposition proves that China is still playing a role of manufacturing factory in world market, at lest in these four important sectors. We also find that the growth of old products in non-innovators play an important role in compensating the effect of productivity growth, and the net contribution of product innovation takes a high proportion in total employment growth.

For further improvement, we want to analysis in some important regions of China, introduce wage to understand welfare, introduce export to understand markets of domestic and aboard. We also want to improve the firm level study to macro analysis like survival, strategic behavior from competitors and so on.

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Table 1: Descriptive statistics: Number of firms, Size and Growth rates

Industry	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
Number of Firms: All firms	12721	6199	5656	4184
Non-Product Innovators (%)	91.7	93.8	82.0	80.6
Product Innovators (%)	8.3	6.2	18.0	19.4
of which ¹ : 0 < NPPO ≤ 25%	52.1	44.2	47.8	29.9
25% < NPPO ≤ 50%	24.6	14.7	21.4	17.8
50% < NPPO ≤ 75%	12.1	11.3	16.2	17.3
NPPO > 75%	11.2	29.8	14.6	35.1
Size ² : All Firms	309	346	363	686
Non-Product Innovators	273	339	240	600
Product Innovators	701	460	922	1043
of which: 0 < NPPO ≤ 25%	755	376	547	844
25% < NPPO ≤ 50%	846	553	1221	943
50% < NPPO ≤ 75%	550	783	1229	1855
NPPO > 75%	293	415	1370	862
Output Growth Rate (%) ^{3,4} : All Firms	35.5	32.5	36.0	41.6
Non-Product Innovators	35.1	32.0	35.7	42.1
Product Innovators	40.3	40.0	37.2	39.5
of which: 0 < NPPO ≤ 25%	45.9	45.3	38.5	40.6
25% < NPPO ≤ 50%	34.8	51.1	35.2	41.4
50% < NPPO ≤ 75%	40.0	33.3	35.6	45.1
NPPO > 75%	27.1	29.1	37.7	34.7
Labor Growth Rate (%) ³ : All Firms	5.9	5.4	8.8	13.8
Non-Product Innovators	5.8	5.1	9.0	13.9
Product Innovators	6.9	9.6	7.8	13.4
of which: 0 < NPPO ≤ 25%	7.3	6.4	6.9	13.5
25% < NPPO ≤ 50%	5.3	17.5	8.4	13.4
50% < NPPO ≤ 75%	9.8	11.6	8.8	13.5
NPPO > 75%	5.6	9.6	8.9	13.3
Productivity (%) ³ : All Firms	29.6	27.1	27.2	27.8
Non-Product Innovators	29.3	26.9	26.8	28.2
Product Innovators	33.4	30.4	29.4	26.1
of which: 0 < NPPO ≤ 25%	38.6	38.9	31.5	27.2
25% < NPPO ≤ 50%	29.5	33.6	26.8	28.1
50% < NPPO ≤ 75%	30.2	21.7	26.8	31.6
NPPO > 75%	21.5	19.5	28.8	21.4

1. NPPO is the percentage of New Products Output in Total Output in 2006.

2. Size is the average number of employees in 2006.

3. The growth rates of labor, output, and productivity are the log growth rates for 2004-2006. The two last are adjusted for changes in the over all industry prices for 2004-2006.

Table 2: Descriptive statistics: Growth rates of output of old and new products for product innovating firms

Industry	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
All Products ¹	40.3	40.0	37.2	39.5
of which: 0<NPPO<=25%	45.9	45.3	38.5	40.6
25%<NPPO<=50%	34.8	51.1	35.2	41.4
50%<NPPO<=75%	40.0	33.3	35.6	45.1
NPPO>75%	27.1	29.1	37.7	34.7
New Products ²	51.6	71.9	57.2	90.1
of which: 0<NPPO<=25%	16.2	15.7	17.6	17.5
25%<NPPO<=50%	58.4	71.8	56.4	61.8
50%<NPPO<=75%	106.4	99.6	95.8	115.8
NPPO>75%	142.3	144.7	145.5	153.6
Old Products ³	-11.2	-31.9	-20.0	-50.6
of which: 0<NPPO<=25%	29.7	29.7	20.9	23.1
25%<NPPO<=50%	-23.6	-20.7	-21.1	-20.4
50%<NPPO<=75%	-66.4	-66.3	-60.2	-70.7
NPPO>75%	-115.2	-115.7	-107.7	-118.9

1. The log growth rates of total output for product innovating firms are adjusted for changes in the over all industry prices for 2004-2006.
2. The proportion of new products output in 2006 divided by total output in 2004 for product innovating firms are adjusted for changes in the over all industry prices for 2004-2006.
3. The log-growth rates of old products are calculated by the Growth rate of all products minus growth rate of new products for product innovating firms.

Table 3: Estimates of the impact of product innovation on growth of employment

Dependent: Growth of Employment (l_g1)		Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
	Output Growth for New Products (g2)	0.832 *** (0.018)	0.872 *** (0.024)	0.850 *** (0.018)	0.873 *** (0.014)
OLS	Constant	-0.195 (0.050)	-0.198 (0.040)	-0.195 (0.036)	-0.205 (0.042)
	Root MSE	0.466	0.476	0.438	0.463
	Output Growth for New Products (g2)	0.938 *** (0.133)	0.924 *** (0.299)	0.973 *** (0.067)	1.231 *** (0.069)
IV_1 ¹	Constant	-0.210 (0.054)	-0.201 (0.044)	-0.204 (0.036)	-0.446 (0.064)
	Root MSE	0.466	0.476	0.439	0.497
	Output Growth for New Products (g2)	1.126 *** (0.123)	1.263 *** (0.266)	1.036 *** (0.064)	1.250 *** (0.067)
IV_2 ²	Constant	-0.237 (0.054)	-0.221 (0.044)	-0.208 (0.036)	-0.459 (0.063)
	Root MSE	0.470	0.486	0.442	0.501
Number of Firms		12721	6199	5656	4184

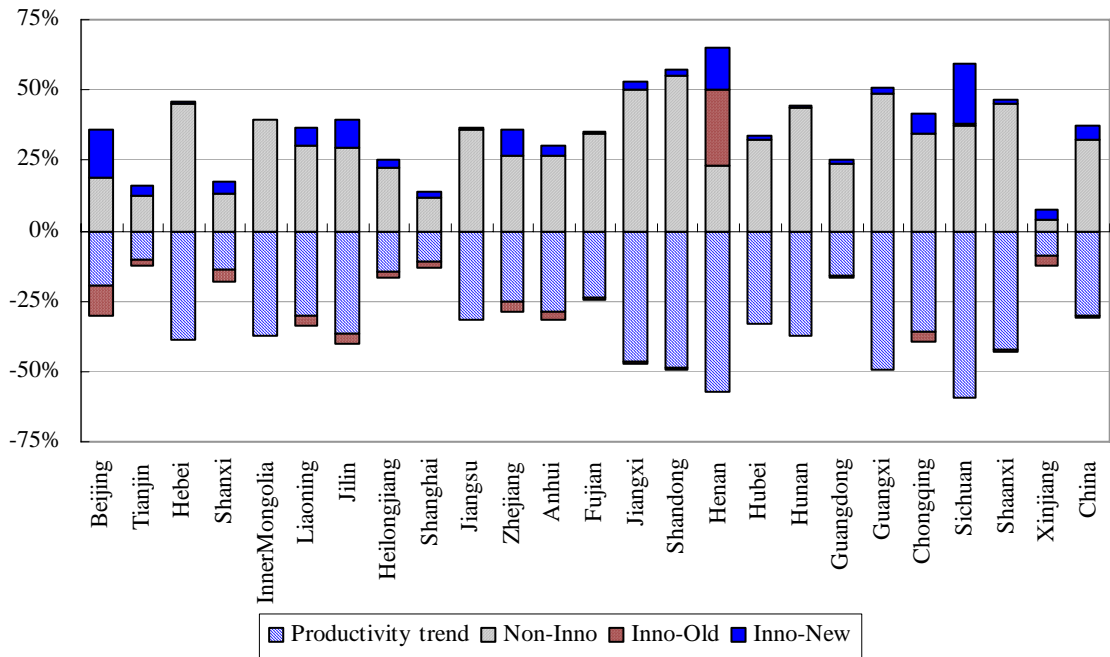
1. The instrumental variables include one-year lag of R&D expenses per employee (in log.) and a binary indicator to identify firms without R&D.

2. The instrumental variables include one-year lag of R&D expenditures per employee (in log.), one-year and two-year lags of Long-term Investments per employee (in log.), and three corresponding binary indicators to identify firms without R&D or Investments.

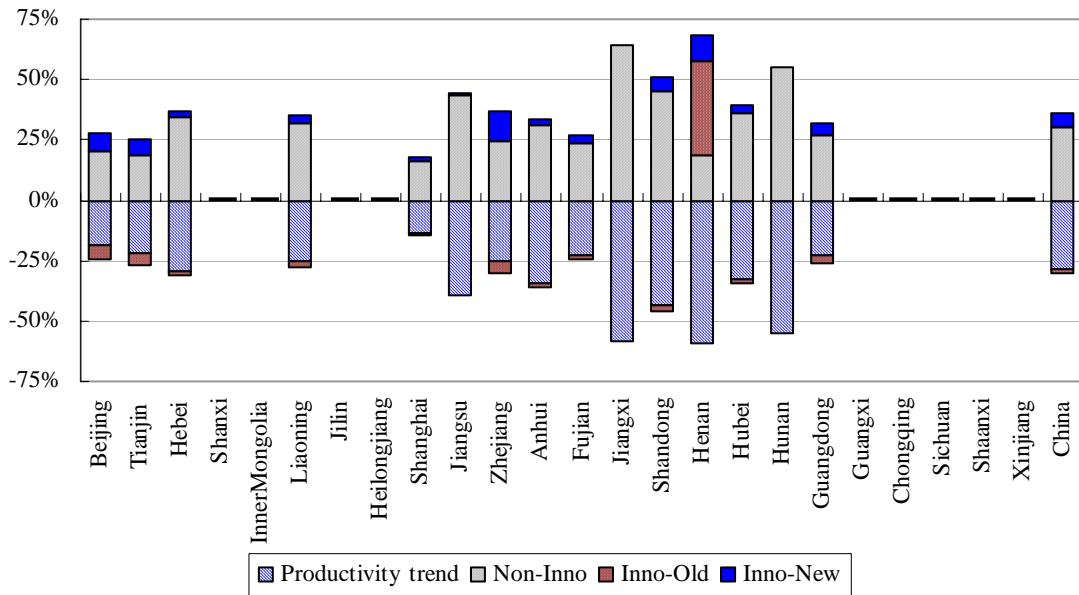
Table 4: Employment growth decomposition for four industries and comparison with five European countries

Industry / Country	China (2004-2006)				European Manufacturing (1998-2000)				
	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment	France	Germany	Spain	UK	Italy
Employment growth	5.9	5.4	8.8	13.8	8.3	5.9	14.2	6.7	2.5
Average specific trend	-30.2	-28.3	-27.6	-32.1	-1.9	-7.5	-5.7	-5	-5.6
Growth due to non-innovators	32.2	30.0	29.3	33.9	4.7	5.4	12.5	7.9	5.8
Growth due to product innovation	3.9	3.6	7.1	12.0	5.5	8.0	7.4	3.9	2.4
of which: old product	-0.9	-2.0	-3.6	-9.8	-	-	-	-	-
new product	4.8	5.6	10.7	21.8	-	-	-	-	-
Number of Observations	12721	6199	5656	4184	4631	1319	4548	2493	4618

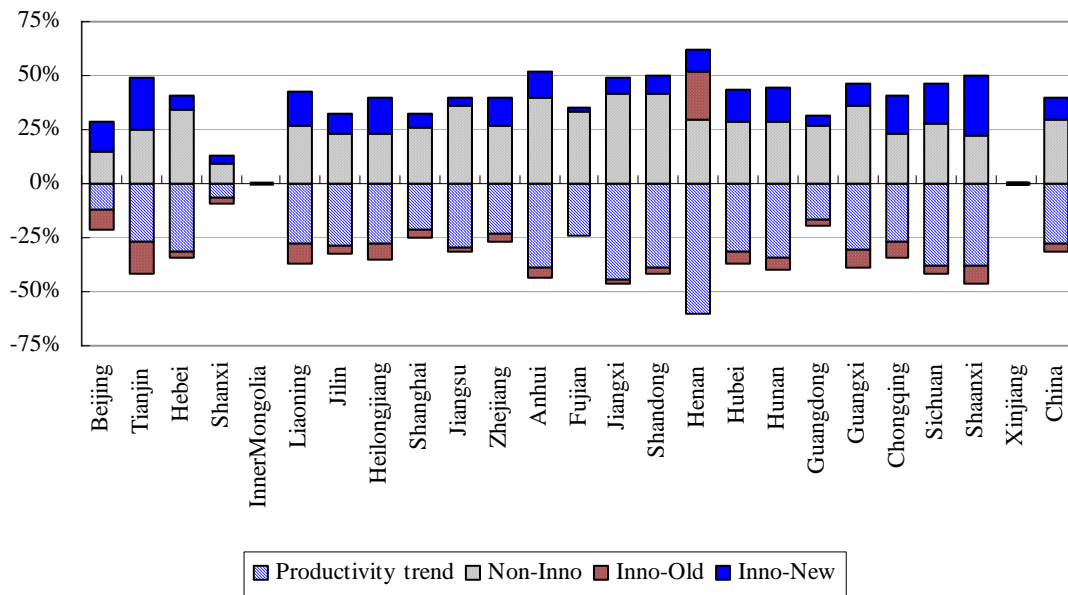
The last 5 columns are from HJMP, 2008 and HLM, 2008, with "Growth due to process innovation in old products " added to "Growth due to non-innovators".



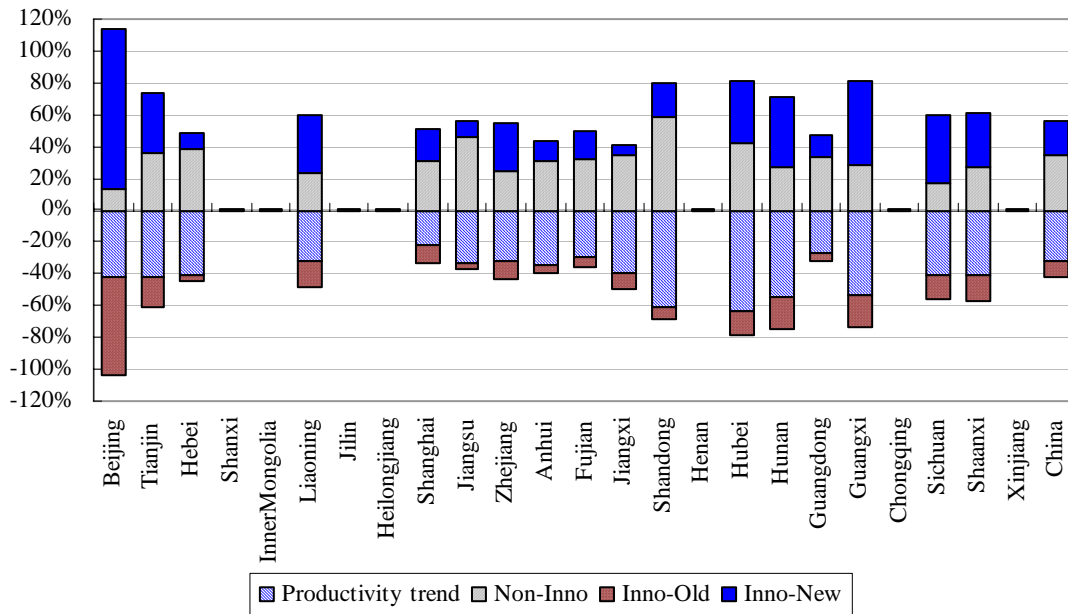
Graph 1: Employment growth decomposition by provinces: Textile



Graph 2: Employment growth decomposition by provinces: Wearing Apparel



Graph 3: Employment growth decomposition by provinces: Transport Equipment



Graph 4: Employment growth decomposition by provinces: Electronic Equipment

Appendix Tables:

**Appendix Table 1: Employment growth decomposition
with elasticity of new product output growth equal to 1**

China (2004-2006)				
Industry	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
Employment growth	5.9	5.4	8.8	13.8
Average specific trend	-29.6	-27.1	-27.2	-27.8
Growth due to non-innovators	32.2	30.0	29.3	33.9
Growth due to product innovation	3.4	2.5	6.7	7.6
of which: old product	-0.9	-2.0	-3.6	-9.8
new product	4.3	4.4	10.3	17.4
Number of Observations	12721	6199	5656	4184

**Appendix Table 2: Employment growth decomposition
with usual growth rates**

China (2004-2006)				
Industry	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
Employment growth (normal growth)	11.4	11.2	14.5	21.4
Average specific trend	-50.7	-48.2	-49.6	-60.3
Growth due to non-innovators	55.9	52.6	50.2	60.7
Growth due to product innovation	6.1	6.8	13.8	21.0
of which: old product	1.8	-0.1	0.5	-4.3
new product	4.3	6.9	13.3	25.3
Number of Observations	12721	6199	5656	4184

Appendix Table 3: Estimated impact of new product output growth on growth of employment for Beijing and four other regions

		China		Beijing		Tianjin		Zhejiang		Shandong		Guangdong	
		coef.	t	coef.	t	coef.	t	coef.	t	coef.	t	coef.	T
Textile													
OLS	Output Growth for New Products (g2)	0.832 *** (0.018)		0.743 *** (0.099)		0.628 * (0.343)		0.827 *** (0.021)		1.033 *** (0.121)		0.981 *** (0.122)	
IV_2	Output Growth for New Products (g2)	1.126 *** (0.123)		0.951 *** (0.212)		1.280 * (0.721)		1.193 *** (0.124)		1.367 *** (0.447)		1.994 * (1.067)	
	Number of Firms	12721		91		67		4063		1222		1072	
Wearing Apparel													
OLS	g2ac	0.872 *** (0.024)		0.942 *** (0.179)		0.884 *** (0.213)		0.849 *** (0.028)		0.738 *** (0.108)		0.917 *** (0.051)	
IV_2	g2ac	1.263 *** (0.266)		1.459 *** (0.493)		1.229 (0.798)		1.264 *** (0.238)		1.573 (1.100)		1.324 *** (0.364)	
	Number of Firms	6199		151		92		1400		348		1284	
Transport Equipment													
OLS	g2ac	0.850 *** (0.018)		0.916 *** (0.082)		0.823 *** (0.060)		0.819 *** (0.031)		0.989 *** (0.115)		0.923 *** (0.095)	
IV_2	g2ac	1.036 *** (0.064)		0.991 *** (0.167)		0.362 (0.273)		1.125 *** (0.122)		1.311 *** (0.443)		1.510 *** (0.353)	
	Number of Firms	5656		175		122		1247		338		392	
Electronic Equipment													
OLS	g2ac	0.873 *** (0.014)		0.815 *** (0.041)		0.913 *** (0.090)		0.883 *** (0.031)		0.935 *** (0.065)		0.875 *** (0.027)	
IV_2	g2ac	1.250 *** (0.067)		0.976 *** (0.132)		0.984 *** (0.242)		1.198 *** (0.105)		0.875 ** (0.355)		1.161 *** (0.099)	
	Number of Firms	4184		173		108		617		166		1555	

1. The instrumental variables include 1-year lag of R&D expenditures per employee (in log.), one-year and two-year lags of Long-term Investments per employee (in log.), and three corresponding binary indicators to identify firms without R&D or Investments.

**Appendix Table 4: Employment growth decomposition for Beijing and four other regions
based on separate regressions**

Region	China	Beijing	Tianjin	Zhejiang	Shandong	Guangdong
Textile						
Employment growth	5.9	5.4	3.6	6.9	7.7	8.4
Average specific trend	-30.2	-16.8	-11.0	-24.4	-49.5	-16.3
Growth due to non-innovators	32.2	19.0	13.0	25.5	55.3	22.6
Growth due to product innovation	3.9	3.3	1.6	5.9	2.0	2.1
of which: old product	-0.9	-10.9	-2.4	-3.7	-0.7	-0.9
New product	4.8	14.2	4.0	9.5	2.7	3.0
Number of Observations	12721	91	67	4063	1222	1072
Wearing Apparel						
Employment growth	5.4	3.3	-1.8	7.2	5.4	6.5
Average specific trend	-28.3	-19.3	-30.4	-24.3	-44.4	-23.8
Growth due to non-innovators	30.0	19.5	26.1	23.7	44.9	27.0
Growth due to product innovation	3.6	3.1	2.5	7.8	4.9	3.3
of which: old product	-2.0	-5.3	-4.3	-4.7	-2.3	-2.6
New product	5.6	8.3	6.7	12.5	7.2	5.8
Number of Observations	6199	151	92	1400	348	1284
Transport Equipment						
Employment growth	8.8	7.3	7.4	13.6	8.2	12.1
Average specific trend	-27.6	-10.1	-17.2	-23.3	-37.2	-22.5
Growth due to non-innovators	29.3	13.6	29.7	25.9	38.7	29.7
Growth due to product innovation	7.1	3.8	-5.2	11.0	6.8	4.8
of which: old product	-3.6	-9.3	-14.1	-3.7	-3.2	-2.3
New product	10.7	13.1	8.9	14.7	10.0	7.1
Number of Observations	5656	175	122	1247	338	392
Electronic Equipment						
Employment growth	13.8	10.0	12.4	11.8	10.5	14.5
Average specific trend	-32.1	-26.7	-49.0	-34.6	-60.0	-24.8
Growth due to non-innovators	33.9	15.8	45.9	27.1	63.4	32.7
Growth due to product innovation	12.0	20.9	15.4	19.3	7.2	6.6
of which: old product	-9.8	-63.6	-19.1	-10.8	-8.8	-5.4
New product	21.8	84.5	34.5	30.1	16.0	11.9
Number of Observations	4184	173	108	617	166	1555

Appendix Table 5: Estimated impact of new product output growth on growth of employment by separate categories of ownership

		China		State owned		Limited Liability		Share Holding		Private		HMT		Foreign	
		coef.	t	coef.	t	Coef.	t	coef.	t	coef.	T	coef.	t	Coef.	t
Textile															
OLS	Output Growth for New Products (g2)	0.832 ***		1.152 ***		0.814 ***		1.125 ***		0.828 ***		0.848 ***		0.862 ***	
		(0.018)		(0.260)		(0.057)		(0.130)		(0.024)		(0.048)		(0.060)	
IV_2	Output Growth for New Products (g2)	1.126 ***		1.221 ***		1.282 ***		1.727 ***		1.032 ***		0.952 ***		1.155 ***	
		(0.123)		(0.630)		(0.219)		(0.388)		(0.237)		(0.227)		(0.278)	
	Number of firms	12721		108		1392		171		7481		1713		1252	
Wearing Apparel															
OLS	Output Growth for New Products (g2)	0.872 ***		-		0.841 ***		1.223 ***		0.890 ***		0.868 ***		0.825 ***	
		(0.024)		-		(0.106)		(0.225)		(0.036)		(0.050)		(0.050)	
IV_2	Output Growth for New Products (g2)	1.263 ***		-		0.991 *		1.108 **		1.228 ***		0.636 *		0.924 *	
		(0.266)		-		(0.596)		(0.405)		(0.350)		(0.356)		(0.474)	
	Number of firms	6199		26		477		54		2622		1493		1314	
Transport Equipment															
OLS	Output Growth for New Products (g2)	0.850 ***		0.760 ***		0.807 ***		0.720 ***		0.890 ***		0.880 ***		0.863 ***	
		(0.018)		(0.057)		(0.041)		(0.084)		(0.036)		(0.080)		(0.036)	
IV_2	Output Growth for New Products (g2)	1.036 ***		0.214		0.923 ***		1.272 ***		1.201 ***		0.993 ***		1.079 ***	
		(0.064)		(0.317)		(0.111)		(0.323)		(0.111)		(0.228)		(0.193)	
	Number of firms	5656		271		1084		135		2437		446		735	
Electronic Equipment															
OLS	Output Growth for New Products (g2)	0.873 ***		1.374 ***		0.874 ***		0.746 ***		0.858 ***		0.899 ***		0.888 ***	
		(0.014)		(0.311)		(0.029)		(0.068)		(0.030)		(0.034)		(0.026)	
IV_2	Output Growth for New Products (g2)	1.250 ***		1.303 **		1.181 ***		0.628 ***		0.988 ***		1.227 ***		1.497 ***	
		(0.067)		(0.600)		(0.107)		(0.168)		(0.111)		(0.164)		(0.157)	
	Number of firms	4184		65		527		93		1071		1103		1196	

1. The instrumental variables include 1-year lag of R&D expenditures per employee (in log.), one-year and two-year lags of Long-term Investments per employee (in log.), and three corresponding binary indicators to identify firms without R&D or Investments.
2. State-owned firms in the wearing apparel industry have no new product output in 2006.

Appendix Table 6: Employment growth decomposition for China and six ownerships

Region	China	State owned	Limited Liability	Share Holding	Private	HMT	Foreign
Textile							
Employment growth	5.9	-4.7	3.6	1.5	6.8	6.0	7.0
Average specific trend	-30.2	-16.5	-29.0	-34.9	-33.4	-21.8	-23.8
Growth due to non-innovators	32.2	6.7	27.0	23.0	36.4	25.7	28.1
Growth due to product innovation	3.9	5.1	5.6	13.4	3.8	2.1	2.7
of which: old product	-0.9	-3.5	-1.2	-5.7	-0.4	-2.0	-1.9
new product	4.8	8.6	6.8	19.1	4.2	4.1	4.6
Number of Observations	12721	108	1392	171	7481	1713	1252
Wearing Apparel							
Employment growth	5.4	-2.8	3.6	15.6	6.2	3.9	6.7
Average specific trend	-28.3	-14.8	-23.8	-26.7	-30.5	-23.6	-22.4
Growth due to non-innovators	30.0	12.0	26.4	35.8	34.4	26.4	27.6
Growth due to product innovation	3.6	0.0	1.1	6.4	2.4	1.1	1.5
of which: old product	-2.0	0.0	-1.9	-2.9	-2.0	-2.3	-2.1
new product	5.6	0.0	3.0	9.4	4.3	3.4	3.6
Number of Observations	6199	26	477	54	2622	1493	1314
Transport Equipment							
Employment growth	8.8	-4.5	5.6	4.2	9.7	10.1	18.8
Average specific trend	-27.6	-13.6	-25.0	-39.8	-33.2	-15.5	-22.7
Growth due to non-innovators	29.3	15.5	22.8	21.6	35.4	22.5	32.3
Growth due to product innovation	7.1	-6.4	7.9	22.4	7.4	3.2	9.2
of which: old product	-3.6	-10.5	-4.9	-14.9	-0.9	-3.1	-7.6
new product	10.7	4.1	12.8	37.3	8.3	6.3	16.8
Number of Observations	5656	271	1084	135	2437	446	735
Electronic Equipment							
Employment growth	13.8	-4.7	12.7	7.5	12.4	14.7	17.0
Average specific trend	-32.1	-42.8	-33.4	-9.9	-29.4	-28.2	-35.5
Growth due to non-innovators	33.9	22.4	25.8	16.6	35.0	35.2	37.7
Growth due to product innovation	12.0	15.7	20.4	0.9	6.8	7.7	14.9
of which: old product	-9.8	-6.2	-22.1	-31.7	-7.8	-5.5	-9.2
new product	21.8	21.9	42.4	32.6	14.7	13.2	24.1
Number of Observations	4184	65	527	93	1071	1103	1196

**Appendix Table 7: Number of employees in Census and sample coverage
by industry and provinces in 2006**

Code	Region	Number of employees in Census (1,000 people)				Percentage of employees in the sample (%)			
		Textile	Wearing Apparel	Transport Equipment	Electronic Equipment	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
11	Beijing	31.4	77.8	91.9	116.9	59.6	76.2	67.0	54.3
12	Tianjin	50.8	74.2	101.0	132.1	53.9	47.0	53.0	58.9
13	Hebei	242.2	78.5	106.1	22.4	59.7	62.8	63.5	71.1
14	Shanxi	42.6	6.4	36.6	29.6	63.3	-	76.5	-
15	InnerMongolia	56.4	8.4	10.5	6.6	61.2	-	-	-
21	Liaoning	92.6	128.7	174.0	73.1	62.9	43.9	60.1	45.7
22	Jilin	25.6	11.2	195.5	6.7	40.6	-	32.8	-
23	Heilongjiang	38.0	2.4	43.7	4.3	58.8	-	46.9	-
31	Shanghai	158.6	218.3	191.2	294.9	69.6	67.0	72.7	58.3
32	Jiangsu	1149.8	641.4	346.7	961.1	70.1	62.8	67.7	59.5
33	Zhejiang	1117.3	643.5	417.9	290.9	65.7	63.8	62.0	60.0
34	Anhui	127.0	47.0	89.8	23.6	59.8	43.5	59.7	72.0
35	Fujian	234.6	333.8	80.4	197.1	63.2	51.8	66.1	71.7
36	Jiangxi	93.0	53.2	50.1	35.1	58.6	30.2	21.1	28.2
37	Shandong	1028.1	346.4	281.9	197.4	67.1	46.3	56.0	41.7
41	Henan	283.8	41.6	94.9	23.4	64.5	54.6	63.2	-
42	Hubei	243.8	79.9	234.1	40.4	58.5	47.1	65.9	24.0
43	Hunan	105.7	18.2	77.1	22.7	50.9	53.8	65.3	51.5
44	Guangdong	634.5	923.3	279.4	2197.0	57.1	59.4	58.4	65.3
45	Guangxi	43.9	6.3	60.2	11.0	46.0	-	62.2	38.1
50	Chongqing	41.4	4.7	267.5	10.4	61.2	-	75.4	-
51	Sichuan	126.1	13.6	102.6	83.1	65.5	-	59.9	30.4
61	Shaanxi	84.9	5.1	58.0	48.1	68.8	-	32.9	63.3
65	Xinjiang	52.3	1.0	4.0	2.2	49.1	-	-	-
Total 24 regions		6104.7	3765.1	3395.1	4830.2	64.4	57.0	60.5	59.4
Total other 7 regions		49.6	10.6	52.9	20.1	-	-	-	-
Total China		6154.3	3775.7	3448.0	4850.3	63.9	56.8	59.6	59.2

Appendix Table 8: Comparing the 2003-2006 growth rates of labor, output and productivity in the study samples, in the Census, and in the Statistical year book

	Textile	Wearing Apparel	Transport Equipment	Electronic Equipment
Labor growth rates				
Average of firm log-growth rates in sample: Mean ($\ln(L_{2i}/L_{1i})$)	5.9	5.4	8.8	13.8
Average of firm usual growth rates in sample: Mean ($(L_{2i}-L_{1i})/L_{1i}$)	11.4	11.2	14.5	21.4
Usual aggregate growth rate for sample: $(\text{sum}(L_{2i})-\text{sum}(L_{1i}))/\text{sum}(L_{1i})$	6.9	7.9	6.8	24.2
Usual aggregate growth rate for Census	4.7	13.8	1.0	29.2
Usual aggregate growth rate recorded in yearbook	18.5	17.9	14.4	51.5
Output growth rates				
Average of firm log-growth rates in sample: Mean ($\ln(O_{2i}/O_{1i})$)	32.0	28.8	33.0	36.8
Average of firm usual growth rates in sample: Mean ($(O_{2i}-O_{1i})/O_{1i}$)	64.6	57.6	59.3	65.2
Usual aggregate growth rate for sample: $(\text{sum}(O_{2i})-\text{sum}(O_{1i}))/\text{sum}(O_{1i})$	43.3	46.5	41.0	52.3
Usual aggregate growth rate for Census	44.1	53.0	44.1	58.7
Usual aggregate growth rate recorded in yearbook	56.0	51.2	78.5	67.4
Productivity growth rates				
Average of firm log-growth rates in samples	26.6	24.0	24.8	23.8
Average of firm usual growth rates in sample:	47.8	41.8	39.2	36.1
Usual aggregate growth rate for sample:	34.1	35.8	32.0	22.7
Usual aggregate growth rate for Census	37.7	34.5	42.7	22.8
Usual aggregate growth rate recorded in yearbook	31.6	28.3	56.0	10.5

1. Prices changes are included in the growth of output;
2. Productivity growth rates are calculated as the ratio of the corresponding output and labor growth rates.