Explaining the Chinese Success Story:

Industrial Policy, Structural Change, and Productivity Growth, 1990-2007*

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Abstract: This paper examines the success that Chinese policy efforts had on generating structural change and their impact on productivity and income. First, following McMillan and Rodrik (2011), we calculate the contribution of structural change and within-sector productivity growth to China's overall labor productivity. Second, we examine the policies that were most responsible for China's success at generating structural change. We highlight the role of China's Special Economic Zones which attracted foreign direct investment, led to marked improvements in manufacturing productivity, and spurred the creation of industrial clusters. These clusters generated a "manufacturing multiplier", in which service employment grew rapidly in the same cities. Third, we investigate in greater detail which industries within manufacturing experienced the largest growth in employment and productivity. We find that most of the productivity improvement in manufacturing was related to within sector productivity increases and shifts towards higher-end goods, such as electronics and phones. We conclude with a brief discussion of the policy implications of the Chinese experience for other developing countries.

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I. Introduction

China's economy has rapidly transformed itself from an agrarian society to an industrial powerhouse in the last two decades. Surging labor productivity and rapid increases in average incomes have lifted millions of its citizens out of poverty. Why did China succeed, when so many countries at similar income levels have failed? Furthermore, what are the lessons for other countries that find themselves in a similar predicament to China in the late 1980s?

In this paper, we examine China's transformation between 1990 and 2007 and the policies that made structural change possible. One important factor, and possibly the single most important factor, was China's ability to attract a massive influx of foreign capital during the period. Chinese Premier Deng Xiao Ping's famous "Southern Tour" in 1992 emboldened capitalist reformers throughout the country, and led to expanded privileges for the country's Special Economic Zones (Yeung et al. 2009). The selected cities attracted foreign firms and capital, and led to a massive increase in the productivity of the manufacturing industry. The entry of foreign firms provided the opportunity for technological adoption among local domestic firms as well, who were able to mimic the superior technologies employed by the multinational corporations (Du et al. 2011, Ebenstein 2012).

The arrival of these firms also generated a need for services among those employed in the factories, and the resulting increase in service-sector employment outpaced even the large growth in manufacturing employment. This "manufacturing multiplier" allowed China to move millions of workers from unproductive agricultural employment into higher productivity employment in cities. The firms were able to hire rural migrants who capitalized on more liberal policies towards internal migration that had previously forced millions of rural Chinese to stay in the countryside and on their family farms (Liu 2005). Shifts in the early 1980s away from collectivized farming led to increased agricultural output, making many of these workers unnecessary. While they were classified as employed in farming, they were no longer truly needed in the agricultural sector (Taylor and Banister 1991, Li 1996). The reallocation of this surplus labor to manufacturing yielded massive improvements in registered productivity in both the agricultural and service sectors. The rapid structural transformation in China has been hailed as an example for other countries to follow, and so a closer examination of the country's experience is of great interest.

China's structural transformation has spurred a great deal of academic research. In a recent paper, Fan et al. (2003) present a Solow-based growth framework where they consider structural change as an additional channel for economic growth. Using data from 1978 to 1995, they find that 17% of aggregate growth in China over this period is due to structural change, a factor often ignored in the standard Solow model that focuses only on growth in inputs (labor, capital) and total factor productivity. Zhang and Tan (2007) argue that China's success at changing the structure of its economy can in part be attributed to declining distortions in factor markets, which provided the impetus for labor to be reallocated to more productive sectors and regions, though they argue that capital markets still have not been integrated. Brandt et al. (2008) also examine the role of market reforms at enhancing Chinese productivity. They argue that shifts out of state-operated enterprises (SOEs) and into private enterprises led to rapid increases in productivity. In particular, they argue that TFP growth within the non-state sector is primarily responsible for China's success.

This paper's examination of China's structural transformation differs from the existing literature in several important ways. First, we quantify the contribution of structural change to productivity growth in a manner similar to McMillan and Rodrik (2011), enabling more direct comparisons with work on other countries that use this method. Second, we focus in greater detail on the role of Special Economic Zones (SEZs) and local industrial clustering. In the existing literature, multi-sector models are generally employed to characterize the Chinese economy, and these are generally estimated using national aggregate data. We argue that a major theme of Chinese policy was the SEZs, which attracted foreign capital and spurred increasing spatial concentration of firms, leading to technological spillovers and productivity growth (Porter 1998, Du et al. 2011). While the importance of clustering to China's growth has been recognized (Deichmann 2008), our geocoded firm-level data allows us to examine empirically the relationship between local Foreign Direct Investment (FDI), and expansions in manufacturing and service-sector employment. Lastly, we undertake a more detailed analysis of China's manufacturing sector, which enables us to examine more closely how structural shifts *within* manufacturing have influenced growth during the period in question. Consistent with recent work, we document that China's evolving comparative advantage has led the country to produce higher-end electronics and communication devices, which require higher-skill labor but are higher value-added products (Yu 2011).

The rest of the paper proceeds as follows. In Section II, we present a brief qualitative account of China's success at generating structural change in its economy. In Section III, we examine the role of structural change in facilitating labor productivity growth, and its impact on standards of living. In Section IV, we examine Chinese industrial policy and the roles of SEZs in spurring the development of industrial clusters, and expansions in employment in manufacturing and the services. In Section V, we exploit detailed firm-level data to examine which industries within Chinese manufacturing were most successful, and how the Chinese manufacturing industry has evolved. In Section VI, we conclude with a discussion of the policy implications of our results for other developing countries.

II. Background

In 1978, China was a very poor country that relied mainly on subsistence agriculture to feed its population. China's newly appointed leader Deng Xiaoping initiated a set of reforms that began the country's transformation. In 1981, farming was decollectivized nationally, resulting in massive increases in agricultural productivity. Millions of farmers were no longer necessary for the country to meet its agricultural needs (Liang and White 1996). This provided momentum for further reforms, including China's opening of their economy to international firms in a set of experimental Special Economic Zones (Yeung et al. 2009). These zones were envisioned as small laboratories to explore the economic potential of a further opening up of China's economy. The SEZ cities were established in 1980, but were granted further privileges following Deng Xiaoping's famous "southern tour" in 1992, which empowered reformers in these areas to experiment more extensively with regulatory changes that would attract FDI (Wang and Szirmai 2008). This included revised administrative status for these areas which allowed rural workers to work and live in these cities without local household registration, providing firms with low wage workers and attracting capital investment (Zhao 2005). The shift away from the rigid *hukou* system allowed workers to migrate fluidly to wherever they found the most attractive employment opportunity. The marketization of food and other necessities made it possible for temporary migrants to live in cities, even without urban registration (Zhao 2000). This allowed China's firms to face a highly elastic supply curve and expand rapidly without losing a competitive edge in costs (Pack and Saggi 2006).

As shown in Figure 1, China's reforms attracted a massive inflow of foreign direct investment and foreign firm entry in the manufacturing sector, especially in the Special Economic Zones. We include in this classification all SEZs, Free Trade Zones (FTZ), Export Processing Zones (EPZ), and Coastal Open Cities following Ebenstein (2012). The influx of capital enabled China to modernize its manufacturing sector, which had been a Soviet-style state industry with relatively low productivity. The marriage of cheap Chinese labor with advanced production equipment from developed countries allowed firms to produce goods at competitive prices. China's entry precipitated changes globally, as countries with higher average wages or inferior production processes, such as the United States or South Africa, were unable to compete (Autor et al. 2011, McMillan and Rodrik 2011, Ebenstein et al. 2012). The foreign firm entry was followed up by a large increase in domestic firm entry into large-scale manufacturing in both zones and other cities. As we will discuss, the expansion of manufacturing led to massive increases in Chinese productivity across all sectors.

In the 1990s and 2000s, China's rapidly expanding manufacturing sector led the country to seek World Trade Organization accession, which made permanent many of the trade agreements it had with other member states, such as the United States (Ianchovichina and Martin 2001). China's growing importance to the global economy meant that its inclusion was critical to other countries, and provided further motivation for multinational companies to source production in China. The manufacturing surge was accompanied by growth in other sectors, such as construction, wholesale and retail trade, and public administration. The growth in these ancillary industries allowed for more agricultural workers to find employment in cities, leading to further structural change in China's economy. The impact of this reallocation of labor on productivity was enormous, leading to rapid economic growth and a rising standard of living for both rural and urban residents. This is examined in the next section.

III. Structural Change and Productivity Growth

a. "Within" and "Between" Sector Components of Productivity Growth

A country can experience increasing labor productivity through two primary channels. First, innovation and adoption of better technologies can lead to productivity improvements "within" the sector. This is the standard channel for increasing productivity in the economy. However, as highlighted by McMillan and Rodrik (2011), sectoral reallocation can affect productivity by shifting workers across sectors, either contributing or hindering growth. They decompose productivity gains into those generated from technological upgrading within a sector, and gains (or losses) from shifts in employment across sectors:

$$\Delta P_t = \sum_{i=1}^{n} \theta_{i,t-k} \Delta p_{i,t} + \sum_{i=1}^{n} p_{i,t} \Delta \theta_{i,t} \qquad (1)$$

where P_t and p_t are aggregate and sectoral labor productivity levels at year *t*, and $\theta_{i,t}$ refers to sector *i*'s share of total employment. The first term in equation (1) is the "within" term, capturing the part of aggregate growth in labor productivity due to growth within sectors. The second term in equation (1) is the "structural change" term, measuring how labor reallocation across sectors contributes to aggregate labor productivity growth.

In Table 1, we present a calculation of the relative contribution of within-sector productivity increases and between-sector shifts in explaining the massive increase in Chinese labor productivity. Agriculture employed 59% of China's workers in 1990, and this dropped to 41% by 2007, a decline of 67.7 million people. During this period, manufacturing expanded by

27.7 million workers and the service sector grew by over 84 million.[1] Since both of these sectors feature higher average productivity than agriculture, this contributed to increases in average labor productivity. This is visually represented in Figure 2, where we observe a significant positive relationship between the change in a sector's share of employment, and its relative productivity.

b. Did industrialization lead to increasing agricultural productivity?

While China was able to increase productivity growth by shifting workers out of agriculture, within agriculture, China's largest sector, the country enjoyed rapid annual productivity growth of 5.08%. How did China achieve such rapid growth in agricultural productivity? Was this the result of real technical change in farming, or simply an artifact of how productivity is measured? Productivity is calculated as the ratio of value added in the sector to total employment. Insofar as the workers who exit agriculture have lower than average productivity, or the exiting workers can be substituted for capital (e.g. tractors), structural change will lead to agricultural productivity increases as well.[2] As shown in Figure 3, the rapid increase in productivity in Chinese farming coincided with the exodus of workers from agriculture. While the data do not lend themselves to fully distinguishing between different explanations, the figure is highly suggestive that the productivity improvement in agriculture was a *byproduct* of

[1] We document very similar shifts into manufacturing and services out of agriculture in Table A1, which uses census data directly tabulated by the authors for 1990, 2000, and 2005. These data were generously provided by McMillan and Rodrik (2011), and are based on reported tabulations published by China's National Bureau of Statistics in their annual statistical yearbook series. The results using the two data sources are reassuringly similar. For example, the increase in manufacturing employment was 23 million in the census data for 1990 to 2005 using our tabulations, and 27.7 million between 1990 and 2007 using the NBS figures.

[2] In a recent paper, Alvarez-Cuadrado and Poschke (2011) present a theoretical model in which agricultural employment can decline either because of a "push" in which agricultural productivity gains reduce the need for workers, versus a "pull" in which opportunities in manufacturing and services induce workers to switch sectors. They argue using cross-country data that the "push" was a stronger force globally prior to 1960 and the "pull" in the more recent data. This is not directly related to the analysis here of China, but is consistent with our findings that the "pull" factor of employment opportunities in manufacturing due to productivity gains is a critical ingredient to China's declining share employed in agriculture.

agricultural employment decline, rather than the force driving the decline, as is often argued (Taylor 1988). The figure also illustrates that the timing of the recorded agricultural productivity gains are incompatible with the growth being entirely due to real technical change or capital upgrading in farming. Most of the adoption of new farming techniques occurred during the 1980s and 1990s, a period of relatively anemic growth in agricultural productivity compared to the explosive growth between 2000 and 2005 – precisely when China's manufacturing and service sectors expanded rapidly. One possible explanation is that since agricultural workers were constrained by China's *hukou* household registration system, even once they were no longer needed for farming, they were still recorded as employed in the sector while they were stuck on their family farms. Once the *hukou* system was relaxed, and workers were able to seek employment in cities, recorded agricultural productivity surged.

We examine this hypothesis more rigorously in Table 2. Using data collected and compiled by China's National Bureau of Statistics (NBS) by province and year, we examine the relationship between agricultural productivity and the share employed outside of agriculture, after accounting for factors that should directly affect agricultural labor productivity, such as the mechanization of farming or increased use of chemical fertilizer (Fan 1991, Fan and Pardey 1997). Our models are all estimated with province and year fixed effects, and so we exploit variation in the timing of the shift of employment out of agriculture within each province. We find that each additional percentage point of workers employed outside of agriculture (i.e. services and manufacturing) is associated with 1.6% higher agricultural labor productivity using Ordinary Least Squares (OLS), even after accounting for the role of machinery or fertilizer use, both of which also are positively associated with agricultural productivity.

Since the relationship between employment outside of agriculture and agricultural productivity is endogenous, with causal linkages operating in both directions, we estimate Two Stage Least Squares Models (2SLS) where we exploit whether a province has a Special Economic Zone. The establishment of a zone will presumably affect the share of workers who are able to find non-agricultural employment, but should not be correlated with technological shocks to agricultural productivity. Our instrument is not ideal, as it may be that zones were established partly in anticipation of changes in their ability to capitalize on China's capitalist reforms, such as Shenzhen's proximity to Hong Kong. The results are still suggestive of our posited causal link, however, as the timing of a zone will be much more correlated with expansions in manufacturing employment than with agricultural productivity shocks. As shown in column 2, our first stage estimation indicates that having a Special Economic Zone increases the share of non-agricultural employment in a province by about 2.4 percentage points. Using 2SLS (column 3), we find that having an additional percentage point of workers leave agriculture increases agricultural labor productivity by 4.1%, suggesting that China's policies aimed at expanding manufacturing employment played an important role in spurring technological improvements in agriculture.

In columns (4)-(6) of Table 2, we re-estimate our models measuring the effect of employment outside of agriculture on agricultural labor productivity by restricting our sample to the period from 1990 to 2008. Presumably, most agricultural innovations had already occurred by 1990, suggesting a diminished role for actual agricultural productivity increases in "pushing" workers out of agriculture, and a more dominant role played by our posited channel of surplus workers getting "pulled" out of the sector. The results are qualitatively similar to the results for the longer panel using both OLS and 2SLS. This confirms our earlier result that increases in the share of employment outside of agriculture contributed to agricultural productivity. Overall, these results indicate that structural change is even more critical to productivity growth in the economy than is quantified by equation 1, as they may be partly responsible for *within* sector growth, as well.

c. Implications of Structural Change on Standards of Living

As reported in Table 3, this shift in employment has led to a massive improvement in the Chinese standard of living. The data indicate that in 2005 the agricultural wage was 393 yuan per month, and manufacturing and service sector jobs paid 2.79 and 3.29 times more respectively. The time trend in these sectors also points to robust wage growth. While we have no historical data on agricultural wages, in the manufacturing and service sectors average income increased by a factor of 2.45 and 2.71 respectively between 1990 and 2005. Clearly, China's movement of workers out of agriculture and into the more lucrative manufacturing and service sectors generated rapid wage growth. How did China generate this structural change? We examine this in the next section.

IV. Industrial Clusters and the "Manufacturing Multiplier"

a. Identifying Industrial Clusters

As described in Section III, China experienced healthy growth in manufacturing employment between 1990 and 2007, which absorbed workers who had been employed in agriculture. But it is worth noting that the employment decline in agriculture was absorbed primarily by sectors other than manufacturing. The service-sector absorbed more than 3 times as many workers as manufacturing during the period. Why, then, is manufacturing generally considered the sector responsible for China's transformation? In this section, we examine the role of China's industrial policy in generating industrial clusters, and their impact on manufacturing and service sector job growth.

Industrial clustering is a major engine for improving manufacturing productivity, as technological spillovers across firms lead each to be more competitive, and the crucible of local competition results in only firms remaining in the sector that can market its goods at globally-competitive prices. Industrial clusters generate positive externalities by providing better access to the market and suppliers, labor pooling and spillover of knowledge (Porter 1998, Deichmann et al. 2008). While clustering also may imply the presence of negative externalities due to agglomeration costs through higher prices for scarce resources (e.g. land, housing), both theory and empirical evidence from other countries suggest that agglomeration benefits outweigh the costs (Ciccone and Hall 1996, Ciccone 2002). These clusters may be particularly critical to growth in the Chinese context, where it enables the emergence of small and medium sized firms to more easily access trade credit in close proximity to other firms in their industry (Long and Zhang 2011). In the context of China's poorly-developed capital markets, this may be an important mechanism for clustering to spur growth.

Chinese policy reforms specifically encouraged the development of industrial clustering through a set of technological parks in cities where firms would concentrate on particular set of products. These are common in the US manufacturing industry, where local labor markets are associated with production of a particular good, such as in the production of automobiles (Detroit), steel (Pittsburgh), and aircraft (Seattle). In Figure 4, we examine the effectiveness of China's industrial policy at creating industrial clusters and at attracting manufacturing firms. We examine the correlation between the spatial gini coefficient of each of China's 29 sub-industries in manufacturing and the share of employment in the industry across China's Special Economic Zones (in 1995). The spatial gini coefficient of employment distribution for each sub-industry is calculated using the following formula:

$$2^*\frac{\sum_{i=1}^{N} i^*X_i}{N^*\sum_{i=1}^{N} X_i}\text{-1-1/N}$$

where counties are sorted by employment and assigned a rank i, X_i denotes employment in the ith county, and N is the number of counties. The figure indicates that industries with a higher proportion of employment in SEZs have higher spatial gini coefficients, and this relationship was strongest in 2005. In 1990, a .01 increase in the spatial gini coefficient was associated with a 0.42 percentage point increase in the share employed in special economic zones. By 2005, this relationship had grown even stronger, with each .01 increase in the spatial gini coefficient being associated with a 0.90 percentage point increase in the share employed in special economic zones. The figure also reflects that the average share employed in zones increased, with the figure indicating an increase in industries with at least 30% of workers located in special zones. The figure also suggests that some industries have reduced their spatial concentration as well, suggesting that congestion effect in the south has encouraged firms to relocate production into areas with lower cost of land and labor (He and Wang 2010). As reported in Table 3, rapid increases in manufacturing wages in China have presumably led some firms to expand into the country's interior.

b. Estimating the "Manufacturing Multiplier"

Industrial clusters also generate a need for services among the new wage earners. Many policy initiatives to support the opening of a zone and the tax privileges granted to manufacturing firms are justified by their ability to generate new jobs in other sectors, such as services. The causal link between manufacturing employment and service sector employment is difficult to estimate reliably, since contemporaneous changes that lead to manufacturing gains will often lead to gains in other sectors. For example, if a city builds an airport, this will generate employment in both the manufacturing and service sectors, as both firms and an influx of residents are attracted by the upgraded infrastructure. The Chinese experiment with trade-induced manufacturing expansion in Special Economic Zones provides at least a partial solution to this problem, as the inflow of foreign capital rose precipitously once these cities were granted special privileges. Since the firms entering these markets are primarily manufacturing firms, and the timing of their entry is observable, estimates of the relationship between manufacturing expansion and spillovers to the service sector are unlikely to suffer the same degree of bias. A "multiplier", in which each manufacturing job leads to more than 1 additional job locally, can occur because the wages generated by employment in the tradable sector spurs demand for more services, and attracts workers to provide those services. Since China's manufacturing sector provided these goods primarily for export, the increased income of the workers will presumably get captured by the service sector.

In order to examine this empirically, we created a matched sample of 309 prefectures in China where we observe the composition of employment in both 1990 and 2005 across 29 sub-industries in manufacturing.[3] For each prefecture, we examine the fraction of the population employed in each of 9 broad service sector classifications and its relationship to increases in manufacturing employment.[4] We perform three separate analyses. The first estimation strategy is

[3] The sample size varies slightly in our empirical results because the number of prefectural units that can be matched across census samples is slightly lower when matching between 1990 and 2005. For 2000 and 2005, we can identify 339 prefectural units with consistent coding. For our FDI calculations, we have 289 valid observations. See Table 4 for the relevant N for each calculation.

[4] Construction and Real Estate (1), Transportation, Storage, and Postal (2), Information, Computer, and Software Services (3), Wholesale and Retail Trade (4), Accommodation, Catering, and Residential (5), Financial and

to examine using OLS the relationship between manufacturing employment growth and service sector employment growth. The second strategy is to instrument for manufacturing employment growth with the growth in foreign trade affecting the city. Foreign trade affects the demand for manufacturing goods and thus affects the derived demand for labor force in manufacturing sector. Our instruments are weighted changes in exports and imports. We estimate the following first-stage equation:

$$\Delta Employment\_mfg_i=\beta_0+\beta_1 \sum_{j=1}^{29} share_{ij} *\Delta export_j+\beta_2 \sum_{j=1}^{29} share_{ij} *\Delta import_j+u_i \qquad (2)$$

where $\Delta Employment\_mfg_i$ denotes the manufacturing employment change between the start and end of the period. The second and third interaction terms are our excludable instruments, weighted exports and imports change, which should be exogenous to other changes in local labor markets. The weight, $share_{ij}=\frac{employment\_mfg_{ij}}{\sum employment\_mfg_{ij}}$, denotes city *i*'s employment share of the country in industry *j* in the start of period. $\Delta export_j$ and $\Delta import_j$ denote exports and imports change in industry *j* between the start and end of the period. These "Bartik" instruments are used to predict the growth in manufacturing in the city. Intuitively, this strategy exploits the fact that many Chinese cities specialize in production of a certain product, which have experienced differential growth. Inasmuch as cities switch and produce other goods in response to market demand, this strategy will not be effective.

Our alternative instrumental variables strategy is to exploit the entry of foreign direct investment in manufacturing in the city. Our data set of manufacturing firms allows us to observe the inflow of capital, and these firms are exclusively manufacturing firms. Any impact on service sector employment is presumably through the increased demands for services from the additional

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Commercial Services (6), Research and Development, Professional, and Technical (7), Public Administration (8), and Governments and other Organizations (9).

manufacturing employees. This also allows us to identify the potentially interesting reduced form relationship between FDI and service employment, which may be useful for policymakers aiming to weigh the benefits of granting foreign firms tax privileged status. The first stage is given by:

$$\Delta \text{Employment\_mfg}_i = \beta_0 + \beta_1 \Delta \text{FDI}_i + u_i \qquad (3)$$

where ΔEmployment_mfg$_i$ denotes the manufacturing employment change between the start and end of the period in city i. The excluded instrument, ΔFDI_i ,denotes the FDI change between the start and end of the period in city i.

In Table 4, we examine the first-stage relationship of equations (2) and (3) empirically. We merged trade data from the UN COMTRADE database and FDI data from the large-scale manufacturing firm survey with China's census data for 1990-2005 to examine the relationship between trade/FDI and manufacturing employment expansion across Chinese prefectures. The data are described in the appendix materials. Column 1 indicates that a one unit change in exports is associated with a 0.120 unit change in manufacturing employment from 1990-2005, and this result is statistically significant at the 1 percent level. Column 1 also indicates no statistically significant relationship between imports and changes in manufacturing employment. Similar results are reported in column 2 for a smaller time frame of 2000-2005. These results suggest that exports have led to an expansion in manufacturing employment, and as you would expect, local imports have no strong relationship with expansion in production. We also find that FDI is correlated with manufacturing employment expansion. Column 3 indicates that a one unit change in foreign direct investment is associated with a 0.228 unit change in manufacturing employment from 2000-2005, and this result is statistically significant at the 1 percent level. This result suggests that foreign direct investment has also led to increased manufacturing employment.

In Table 5, we estimate the "manufacturing multiplier" by OLS and 2SLS using our two instrumental variables strategies (Columns 1-5). All three strategies produce elasticities greater than 1: each additional manufacturing job is associated with an additional 1.2 to 1.6 jobs in service sector employment, and all estimates are statistically significant at the 5% level (except for the results in the third row in column (1) and column (2), which are insignificant). It is interesting to note that our 2SLS results are slightly stronger than our OLS results. This suggests that the manufacturing multiplier effect may be underestimated by an OLS approach, or alternatively that the service sector growth spurred by trade-driven expansion is more robust than by manufacturing employment in general. This may be due to the fact that products exported command a higher price than items for domestic Chinese consumption. Alternatively, it may be that multinational firms pay higher wages, leading to more services demanded by the workers (Aitken et al. 1996). It is also interesting to note that our results for 2000-2005 are slightly stronger than our results from 1990-2005, suggesting an acceleration in this phenomenon. The table also shows that the most responsive service sectors are what you would expect: wholesale and retail trade, accommodation (catering and residential), and construction and real estate. All of these sectors would have many services demanded by entering manufacturing workers and firms, either as a byproduct of the needs of the industry to have secondary production and packaging, hospitality services for the visiting businesspeople, or from new demand for commercial and residential housing by the influx. Finally, in column 6 we estimate a log-log regression of the impact of FDI in manufacturing on service sector employment. We find that a 1% increase in FDI in manufacturing is associated with a 0.5% increase in service sector employment, suggesting that attracting FDI has a direct and quantitatively large impact on the local economy outside of manufacturing.

The results suggest that China's rapid structural transformation was spurred by manufacturing employment growth, but augmented dramatically by the expansion in employment outside of this sector. The lesson for other developing countries is clear: success at attracting capital in manufacturing sectors may lead to employment opportunities outside of this sector, as construction is needed to accommodate the new workers and firm, and the new city inhabitants demand a host of services.

V. A Closer Look at the Chinese Manufacturing Productivity Miracle

In this section, we examine in detail which manufacturing industries experienced the largest expansion in China. We break down manufacturing into 29 separate 2 digit industries which are consistently coded for 1990 and 2005. Our motivation is to better understand which industries have expanded in China. Furthermore, we wish to understand the degree of spatial clustering, as that has been pointed to as a key driver of the success of the Chinese manufacturing industry. We report the employment totals by industry, the spatial gini coefficients, and the change in the change in each of these metrics.

As shown in Table 6 and plotted in Figure 5, there is significant heterogeneity across China's 29 manufacturing sub-industries in their productivity and their trends over time. Large industries, such as textiles and non-metal mineral products, employed 20% of China's manufacturing workers in 1998, but declined in share to 15% by 2007. Smaller industries, such as electric equipment and communications, increased their relative share of manufacturing employment from 8% in 1998 to 15% in 2007. This indicates that manufacturing in China is experiencing a shift towards more complex industries, as the country capitalizes on its reputation for producing high-quality products and expands in industries that require greater skilled workers and machinery. This shift reflects a shift in China's role in the value chain of manufacturing production after China's WTO accession in 2001, where Chinese firms participate in the production of higher value products for foreign firms (Yu 2011). Brandt and Thun (2010) document that foreign firms efforts to localize production for goods aimed at the Chinese market also played a role in the shift to higher value added products in the production of construction equipment, machine tools, and automobiles. These trends have resulted in the production of cheaper goods for export in countries like Vietnam, which have lower labor costs than China (McCaig and Pavcnik 2012). This process has allowed China to continue to evolve rather than be priced out of production, as the country capitalizes on its evolving comparative advantage (Lin 2011).

We also observe rapid productivity growth in all sectors of manufacturing, with overall productivity increasing from 30 thousand to 117 thousand yuan per worker annually, at 1998 constant prices. Most of the productivity improvement in manufacturing was related to within sector productivity increases, which averaged 18.2% between 1998 and 2007. Productivity growth was actually slowed slightly by structural change within manufacturing, with shifts to lower productivity industries reducing productivity growth by China by 1.9%. One explanation is the industries in manufacturing with higher average productivity are being upgraded with even more capital intensive technology, leading to reduced share of workers in these industries. However, while structural change within manufacturing has negatively contributed to growth, shifts to electric equipment and communications contributed 1.46% to annual productivity growth. This suggests that pockets of the sector with robust growth in aggregate demand, such as the market for iPhones and other new popular devices, are growing faster than the industry average in spite of their high average productivity.

VI. Conclusion

This paper has examined structural change in China, and its relationship to the country's explosive economic growth between 1990 and 2007. China's rapid increase in manufacturing productivity was spurred by successful industrial policies that encouraged foreign direct investment into the country, leading to improved performance among domestic manufacturing firms as well. The manufacturing expansion led to the rapid growth of the service sector as well, allowing China's cities to absorb a large number of agricultural workers. Using both OLS and IV, where we exploit trade-induced expansion in manufacturing employment, we find that the service sector increases even faster than the manufacturing sector in response to the external demand. This "priming the pump" Keynesian multiplier contributed to a rapid expansion in wage employment in Chinese cities, and allowed these cities to absorb millions of rural migrants. Coupled with China's relaxed attitude towards internal migration, this shedding of surplus agricultural workers allowed firms to produce goods at competitive prices, and may have been responsible for the rapid increase in agricultural productivity. This is suggestive evidence that countries wishing to improve agricultural productivity should look to policies that generate manufacturing growth in cities, and perhaps worry less about directly encouraging farmers to adopt more capital intensive techniques.

Whether other countries can follow the Chinese model for spurring structural change is unclear. Several factors that are unique to the Chinese experience suggest that mimicking its performance will be difficult. First, China was unnaturally undeveloped from decades of anti-capitalist policy prior to Deng Xiaoping's appointment. Other countries may have more fundamental problems that are inhibiting growth, meaning that a switch to unfettered Chinese capitalism may not yield the same results. Second, China has a very stable government in which foreign capital does not fear that an outbreak of violence will result in the loss of plant and equipment, a real concern in many African countries. Third, China's massive rural population was willing and able to work for low wages. This may or may not be the case in other countries, as Chinese manufacturing workers are famously willing to absorb poor work conditions, and still perform well. However, nothing rules out a similar approach working for other countries. Prior to 1978, China was a poor country with little prospect for growth. Today, the country has been transformed. This paper suggests that this is indeed the case, and that shifts from agriculture are critical to improving productivity throughout the economy.

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Data Appendix:

A. China Census Data

We use the 1% sample for the 1990 Census, 0.1% sample for 2000, and the 20% sample of the 2005 1% Population Sample Survey (sometimes referred as mini-census). Our samples include data on industry and occupation affiliation, while our 2005 sample includes additional data such as employment status, wages, years of education, and demographic characteristics such as age, sex and ethnicity. In order to create a consistent industry scheme across samples, we aggregate several industries and occupations. We create a consistent 2-digit industry code across samples based on Chinese industrial classification codes (GB4754-84, GB/T4754-1994 and GB4754/T-2002) and a consistent 2-digit occupation code across samples based on Chinese occupation codes (GB6565-86, GB/T 6565-1999). We also use income information in 2005 data to calculate wage and wage inequality for 2005.

B. China Urban Household Survey

We use China's Urban Household Survey to calculate wage and wage inequality for 1990 and 2000. Since the Urban Household Survey covers only urban areas, we also restrict our 2005 mini-census sample to urban areas to make our wage data comparable across years. Wages for each year are adjusted by CPI reported in China's statistic yearbook using 2005 as the base year.

C. China Manufacturing Census

China's Annual Survey of Manufacturers contains information on all firms with over 5 million RMB of revenue. The survey contains over 150,000 individual manufacturing firms. We calculate firm productivity in the manufacturing sector from 1998 to 2007 using these data. These data are also our source for foreign direct investment for 2000 and 2005.

D. Trade Data

The trade data are taken from UN Comtrade Database. It contains information on exports and imports of commodities at the 6-digit Harmonize System (HS) product code level. We first make a concordance between the HS code and 4-digit SIC industry code, and then use a concordance between the SIC code and the 4-digit Chinese industry codes (GB4754/T-2002). Finally, we aggregate exports and imports into 2-digit Chinese industry code to match our employment share data, which are tabulated at the 2-digit census industry code level.

Table 1

Within and Between Sector Changes in Labor Productivity, 1990-2007

Sectors	Share of Emp. in 1990(%)	Share of Emp. in 2007(%)	Change in Share of Emp.	Labor Prod. in 1990	Labor Prod. in 2007	Sectoral Annual Growth Rate	"Within" Contribution to Total Annual Growth Rate	"Structural" Contribution to Total Annual Growth Rate
Agricultural	59.01	40.99	-18.02	1,311	3,047	5.08%	1.02%	-0.55%
Mining	1.53	1.08	-0.45	4,576	57,798	16.09%	0.81%	-0.26%
Manufacturing	14.92	16.07	1.15	4,395	25,227	10.83%	3.09%	0.29%
Public Utility	0.50	0.66	0.15	7,660	67,915	13.70%	0.30%	0.10%
Construction	4.19	7.53	3.34	3,467	8,823	5.65%	0.22%	0.29%
Retail & Wholesale	4.91	8.69	3.78	6,040	13,397	4.80%	0.36%	0.50%
Transportation and Comm.	2.71	3.64	0.93	5,733	19,085	7.33%	0.36%	0.18%
Finance and Business Services	0.62	0.89	0.26	44,536	141,984	7.06%	0.61%	0.37%
Other Service	2.71	5.16	2.45	2,565	13,253	10.14%	0.29%	0.32%
Government Service	8.91	15.31	6.40	2,367	6,451	6.08%	0.36%	0.41%
Total	-	-	-	2,693	11,823	9.09%	7.42%	1.67%

Source : China National Bureau of Statistics (1990-2007)

Notes: Value Added is measured in constant 2000 ppp dollars. Data on employment and productivity were tabulated by McMillan and Rodrik (2011) from data originally provided by China's National Bureau of Statistics.

Table 2

Agricultural Productivity and Non-agricultural Employment in China, 1949-2008

Dependent Variable: Log of Agricultural Productivity per Capita	Full Sample (1949-2008)			Restricted Sample (1990-2008)		
	OLS	First Stage	2SLS	OLS	First Stage	2SLS
	(1)	(2)	(3)	(4)	(5)	(6)
Share of employment that is non-agricultural (%)	0.016***		0.041***	0.016***		0.015*
	(0.001)		(0.004)	(0.001)		(0.008)
Machinery input/farming area (kw/hectare)	0.024***	0.621***	0.042***	-0.004	0.586**	0.029***
	(0.006)	(0.193)	(0.010)	(0.006)	(0.241)	(0.009)
Fertilizers input/farming area (ton/hectare)	0.215***	-1.361	0.281***	0.033	3.056*	0.155***
	(0.048)	(1.375)	(0.064)	(0.045)	(1.705)	(0.058)
Special Economic Zone (1=yes)		2.418***			1.228***	
		(0.212)			(0.317)	
Observations	1105	988	988	578	460	460
R-squared	0.981	0.852	0.9709	0.968	0.578	0.964

Source: China National Bureau of Statistics (1949-2008)

Notes: The data are organized by province and year. All models include province and year fixed effects. The OLS and 2SLS regressions estimate the relationship between the log of agricultural productivity per capita and the listed independent variable. The first stage presented in columns (2) and (5) predict the share of non-agricultural workers in the province with a dummy for whether the province had a Special Economic Zone of any type. Special Economic Zones includes all Special Economic Zones (SEZ), Free Trade Zones (FTZ), Export Processing Zones (EPZ), and Coastal Open Cities (COC). Note the full sample first stage and 2SLS results are for 1950 to 2004, the years in which SEZ status are available, and resticted to 1990-2004 in the restricted sample.

Table 3

Monthly Salary (*yuan*) by Sector in China, 1990-2005

	1990	2000	2005
Agriculture			393
Manufacturing	447	909	1,095
Services	478	1,110	1,295

Source: Data for 1990 and 2000 are taken from the China Urban Household Survey. Data for 2005 are taken from the 1% Population Sample Survey (.2% sample).
Notes: Sample excludes individuals out of the labor force. Income reported adjusted for the Chinese CPI using 2005 as the base year.

Table 4

Trade Shocks and Manufacturing Employment, 1990-2005

	LHS: Change in Manufacturing Employment (000s)		
	1990-2005	2000-2005	2000-2005
Change in Exports: 1990-2005	0.120*** (0.015)		
Change in Imports: 1990-2005	-0.008 (0.007)		
Change in Exports: 2000-2005		0.039*** (0.015)	
Change in Imports: 2000-2005		0.032 (0.021)	
Change in FDI: 2000-2005			0.228*** (0.025)
Observations	309	339	289
R-squared	0.761	0.729	0.226

Source: Employment data are taken from Population Census 1990 (1% sample), Population Census 2000 (0.095% sample) and 2005 1% Population Sample Survey (0.2% sample); Trade data are taken from UN Comtrade Database (1992, 2000 and 2005); FDI data are taken from Annual Survey of Manufacturing Firms (2000 and 2005).

Notes: The regressions reported are the first stages in the 2SLS models estimated in Table 5, column (2), column (4) and column (5) respectively. Both exports and imports change are weighted by employment share, see equation in text for detail. Exports, imports are measured in quantity, FDI is measured in million dollar. Exports and imports in 1990 are proxied by their values in 1992, the first year of available data in the UN Comtrade Database.

Table 5

Impact of Manufacturing Employment on Service Sector Employment across Chinese Cities, OLS and 2SLS

	1990-2005		2000-2005			
	OLS	2SLS (IV=Trade)	OLS	2SLS (IV=Trade)	2SLS (IV=FDI)	OLS (RHS=FDI)
	(1)	(2)	(3)	(4)	(5)	(6)
All Services	1.218	1.429	1.501	1.672	1.631	0.512
Construction & Real Estate	0.171	0.188	0.242	0.261	0.242	0.341
Transportation, Storage & Postal	0.025	0.032	0.189	0.208	0.204	0.278
Information, Computer & Software	0.051	0.055	0.055	0.066	0.074	0.327
Wholesale & Retail	0.355	0.381	0.360	0.399	0.394	0.404
Accommodation, Catering & Residential	0.215	0.240	0.214	0.231	0.239	0.350
Financial and Commercial	0.113	0.125	0.142	0.168	0.175	0.318
R&D & Professional Technical	0.029	0.031	0.037	0.041	0.042	0.479
Public Admistration & Public Goods Related	0.165	0.168	0.160	0.159	0.143	0.355
Governments & Other Organizations	0.080	0.079	0.094	0.098	0.086	0.217
Number of Cities Included	309	309	339	339	289	289

Source : Employment data are taken from Population Census 1990 (1% sample), Population Census 2000 (0.095% sample) and 2005 1% Population Sample Survey (0.2% sample); Trade data are taken from UN Comtrade Database (1992, 2000 and 2005), FDI data are taken from Annual Survey of Manufacturing Firms (2000 and 2005).

Notes: Each cell represents the coefficient from a separate regression. In columns (1)-(5), the outcome variable is the total service sector employment in the listed industry, and the right-hand side variable is total manufacturing employment. The instrument in column (2) and (4) is the city's concentration of employment in each industry at the beginning of the period interacted with changes in the volume of trade during the period. The instrument in column (5) is the change in the amount of foreign direct investment in manufacturing between 2000 and 2005, taken from the annual survey of manufacturing firms. In column (6), we calculate the reduced form relationship between foreign direct investment in manufacturing and service sector employment, both measured in logs. All estimates are statistically significant at the 5% level, except for the third row in column (1) and column (2), which are insignificant.

Table 6

Within and Between Sector Increases in Labor Productivity in Manufacturing, 1998-2007

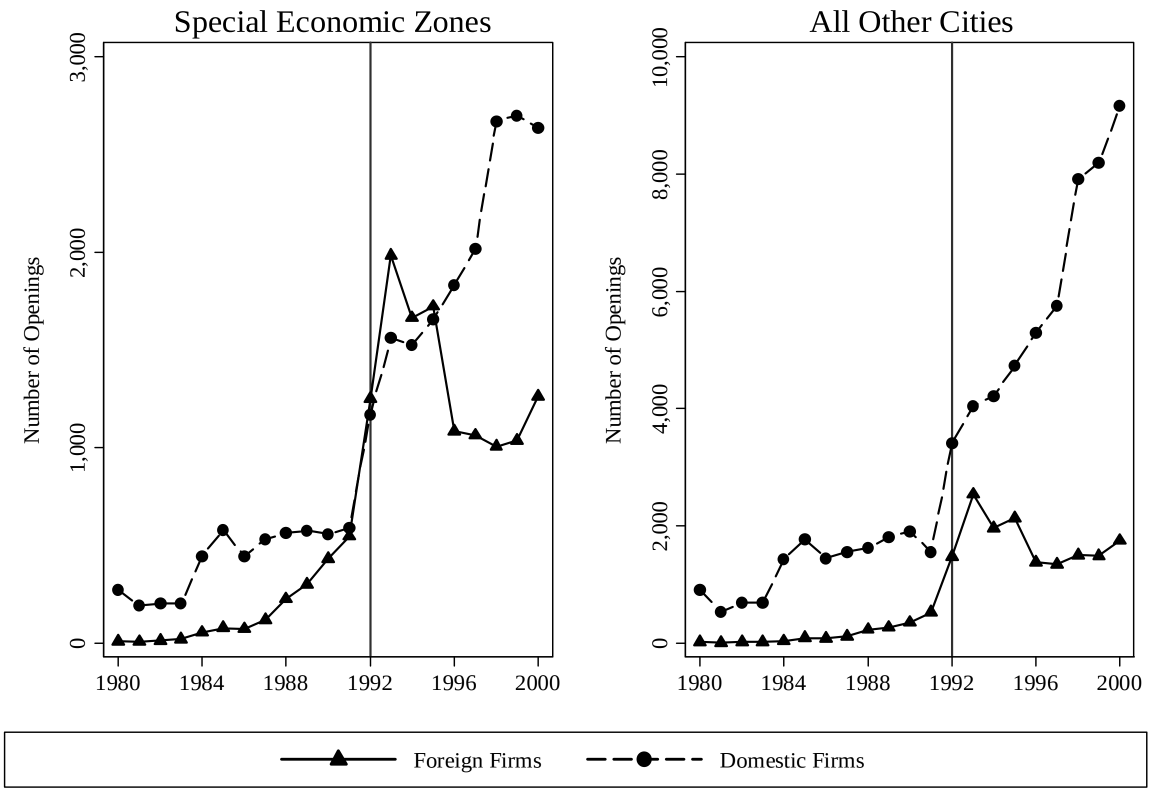
2-digit Industry	Share of Emp. in 1998(%)	Share of Emp. in 2007(%)	Change in Share of Emp.	Prod. in 1998	Prod. in 2007	Change in Prod.	"Within" Growth	"Structural Change" Growth	"Within" Annual Growth Rate	"Structural" Annual Growth Rate	Spatial Gini in 1990	Spatial Gini in 2005
Agricultural food processing	4.10	3.85	-0.25	34	151	117	4.78	-0.38	0.89%	-0.07%	0.75	0.66
Food manufacturing	1.96	1.96	0.00	31	119	87	1.71	0.00	0.32%	0.00%		
Beverage manufacturing	2.27	1.47	-0.80	47	160	113	2.57	-1.28	0.48%	-0.24%	0.86	0.84
Tobacco processing	0.58	0.28	-0.30	303	1,262	959	5.55	-3.73	1.04%	-0.70%	0.98	0.96
Textile industry	11.63	9.42	-2.21	18	65	48	5.53	-1.45	1.03%	-0.27%	0.86	0.87
Textile clothing, shoes and hat manufacturing	4.08	6.05	1.97	23	47	24	0.99	0.92	0.18%	0.17%	0.79	0.87
Leather, fur, feathers (fine hair) and its products industry	2.20	3.74	1.53	25	50	25	0.55	0.76	0.10%	0.14%	0.88	0.95
Wood processing and related products	1.07	1.55	0.48	23	83	61	0.65	0.40	0.12%	0.07%	0.89	0.79
Furniture manufacturing	0.50	1.33	0.83	31	61	30	0.15	0.51	0.03%	0.10%	0.76	0.87
Paper and paper products industry	2.57	2.02	-0.55	25	108	84	2.14	-0.60	0.40%	-0.11%	0.89	0.89
Printing and copying of media records	1.36	1.05	-0.32	27	83	55	0.76	-0.26	0.14%	-0.05%	0.85	0.89
Cultural, educational and sports goods manufacturing	1.21	1.74	0.53	23	40	17	0.20	0.21	0.04%	0.04%	0.94	0.96
Petroleum refining, processing and nuclear fuel processing	1.55	1.15	-0.40	68	337	269	4.16	-1.34	0.78%	-0.25%	0.98	0.95
Chemical materials and products manufacturing	7.62	5.58	-2.04	28	165	136	10.39	-3.36	1.94%	-0.63%	0.87	0.84
Pharmaceutical and medicine manufacturing	2.16	1.99	-0.17	41	144	102	2.21	-0.24	0.41%	-0.04%	0.93	0.89
Chemical fiber manufacturing	0.90	0.64	-0.26	39	158	119	1.07	-0.41	0.20%	-0.08%	0.97	0.96
Ruber products industry	1.53	1.29	-0.24	26	93	67	1.02	-0.22	0.19%	-0.04%	0.90	0.94
Plastic products industry	2.19	3.28	1.10	32	81	49	1.08	0.89	0.20%	0.17%	0.88	0.92
Non-metal mineral product industry	9.03	6.54	-2.50	20	93	73	6.58	-2.32	1.23%	-0.43%	0.79	0.76
Ferrous metal forgings and stampings	6.04	4.43	-1.62	33	255	222	13.41	-4.12	2.50%	-0.77%	0.93	0.90
Non-ferrous metal forgings and stampings	2.23	2.27	0.04	30	247	218	4.85	0.09	0.90%	0.02%	0.96	0.92
Metal products industry	3.12	3.94	0.82	29	96	67	2.10	0.78	0.39%	0.15%	0.83	0.87
General purpose machinery manufacturing	6.95	6.11	-0.83	21	105	84	5.84	-0.87	1.09%	-0.16%	0.88	0.87
Special purpose machinery manufacturing	4.90	3.74	-1.16	19	103	84	4.09	-1.19	0.76%	-0.22%	0.86	0.88
Transportation equipment manufacturing	6.84	5.96	-0.88	32	147	115	7.84	-1.29	1.46%	-0.24%	0.90	0.87
Electric equipment and machinery manufacturing	4.76	6.49	1.73	37	117	80	3.79	2.02	0.71%	0.38%	0.90	0.92
Communication and other electronic equipment	3.58	8.57	4.99	61	116	54	1.95	5.78	0.36%	1.08%	0.98	0.95
Instruments and meters, culture and office machines	1.41	1.54	0.13	27	94	67	0.95	0.12	0.18%	0.02%	0.94	0.93
Arts and crafts products and other manufacturing	1.65	2.01	0.36	23	57	34	0.56	0.21	0.10%	0.04%	0.88	0.92
Manufacturing Sector Overall	-	-	-	30	117	87	97.46	-10.35	18.18%	-1.93%	0.73	0.72

Source: Annual Survey of Manufacturing firms (1998, 2007); Population Census 1990 (1% sample), Population Census 2000 (0.095% sample) and 2005 1% Population Sample Survey (0.2% sample).

Notes: Value added is measure in constant prices using 2000 as the base year. The total employment in manufacturing sector is 50.38 million in 1998 and 68.43 million in 2007. The spatial gini of employment distribution in the last two columns are calculated using data from Population Census 2000 (0.095% sample) and 2005 1% Population Sample Survey (0.2% sample). To calculate the spatial gini coefficient, we calculate the number of employment of each county for each 2-digit industry within manufacturing, and then calculate the gini coefficient of employment distribution across counties. "Agricultural food processing" and "Food manufacturing" are aggregated in calculating spatial gini in order to make a consistent coding scheme between 1990 and 2005 since they are coded as the same industry in 1990.

Figure 1

Manufacturing Firm Openings in Chinese Cities, 1980-2000

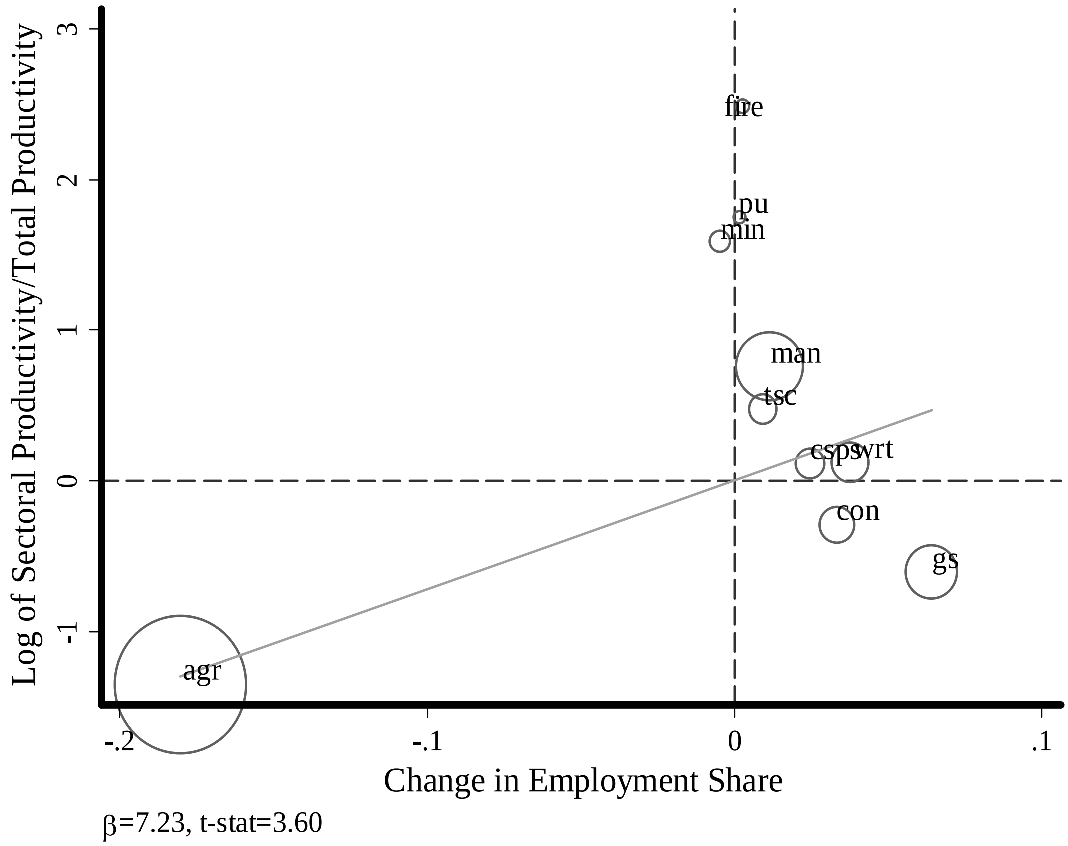


Source: Chinese Annual Survey of Manufacturing Firms (2003)

Notes: A vertical line is placed at 1992, the year in which Deng Xiao Ping visited China's special trade areas and initiated additional autonomy and tax exemptions for foreign firms. Special Economic Zones includes all Special Economic Zones, Free Trade Zones, Export Processing Zones, and Coastal Open Cities.

Figure 2

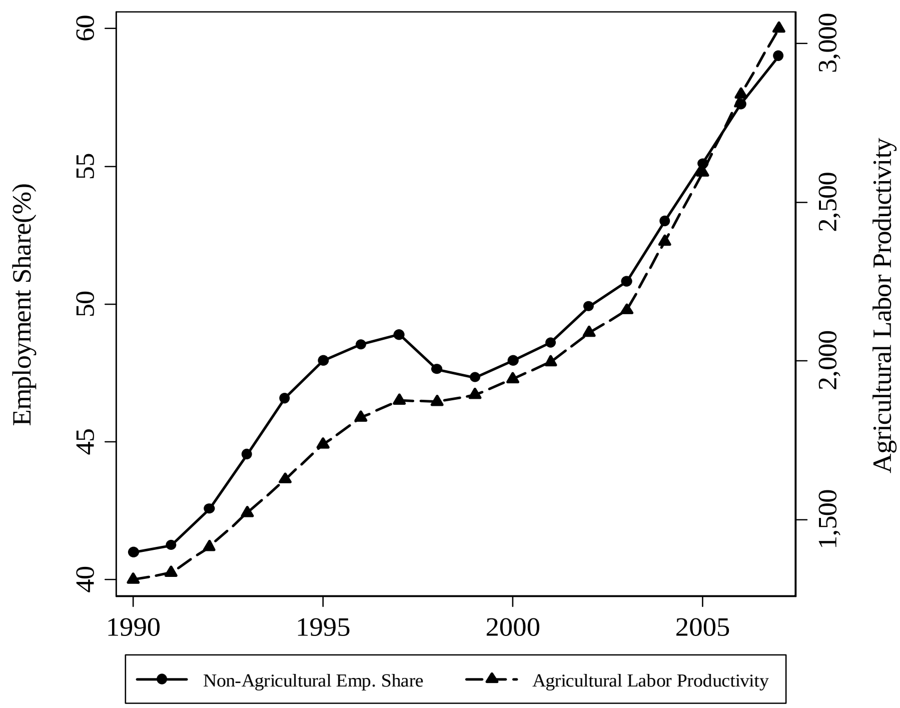
Correlation Between Sectoral Productivity and Change in Sectoral Employment Share, 1990-2007



Notes: Data on employment and productivity were tabulated by McMillan and Rodrik (2011) from data originally provided by China's National Bureau of Statistics. Size of circle is proportional to the industry's employment share in 1990. Abbreviations are as follows: (agr) Agricultural; (min) Mining; (mfg) Manufacturing; (pu) Public Utilities; (con) Construction; (wrt) Wholesale and Retail Trade; (tsc) Transport and Communication; (fire) Finance and Business Services; (csps) Community, Social, Personal Services; (gs) Government Services.

Figure 3

Trends in Agricultural Labor Productivity and Non-Agricultural Employment: 1990-2007

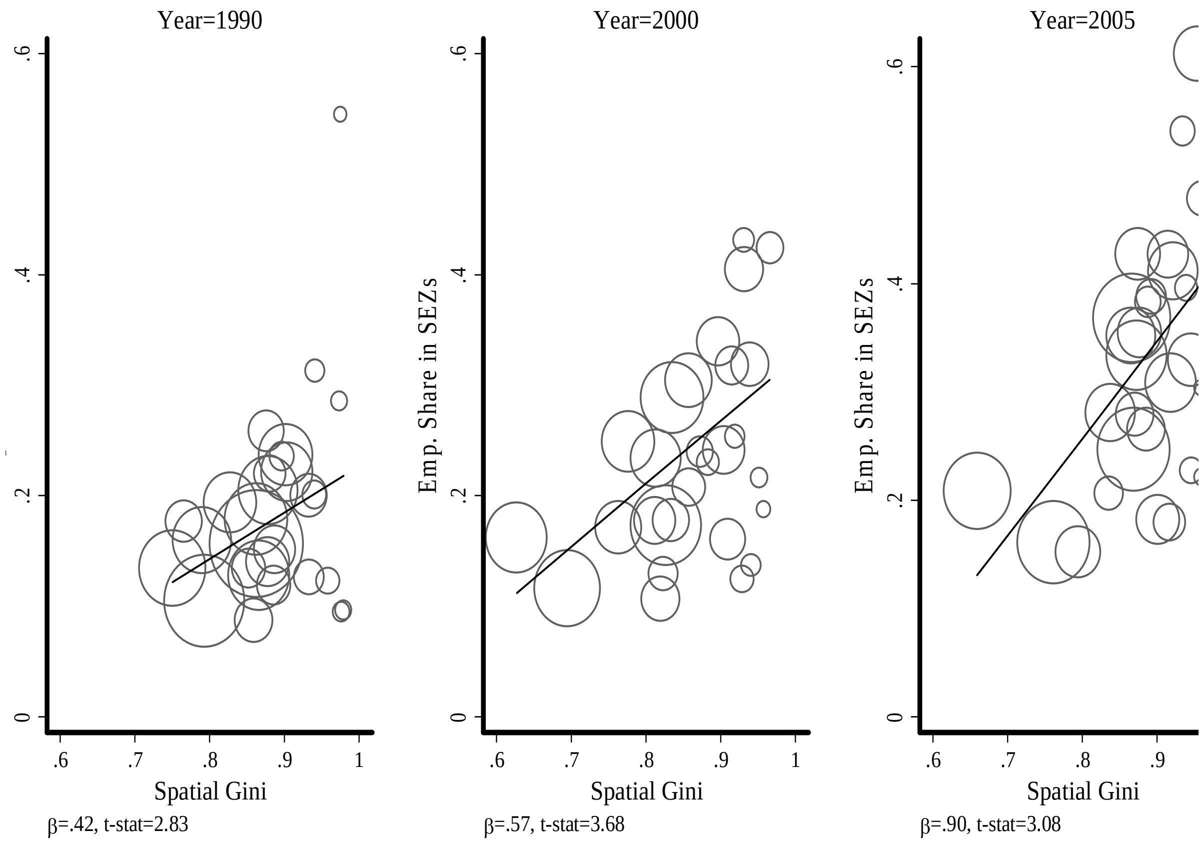


Source: China National Bureau of Statistics (1990-2007)

Notes: Value Added is measured in constant 2000 ppp dollars.

Figure 4

Spatial Geni Coefficients and Employment Share in Special Economic Zones, 1990-2005

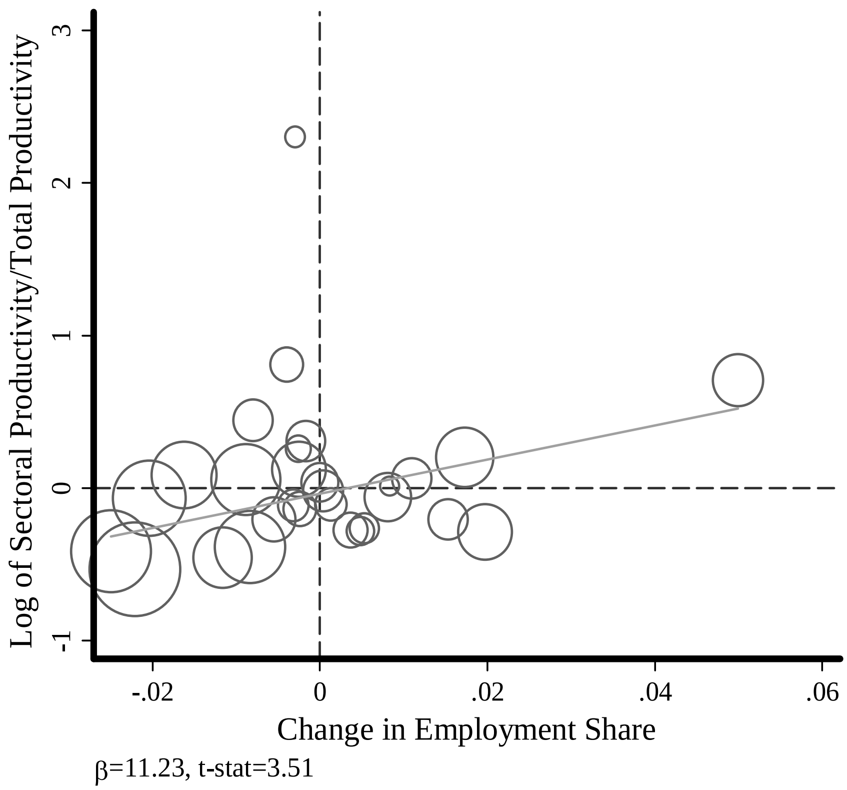


Source : Population Census 1990 (1% sample), Population Census 2000 (0.095% sample), 2005 1% Population Sample Survey (0.2% sample).

Notes : Size of circle is proportional to the industry's share of manufacturing employment in corresponding years. The spatial gini coefficient is a measure of the industry's employment concentration across counties. To calculate the spatial gini coefficient, we calculate the number of employment of each county for each 2-digit industry within manufacturing, and then calculate the gini coefficient of employment distribution across counties. Special Economic Zones includes all Special Economic Zones, Free Trade Zones, Export Processing Zones, and Coastal Open Cities.

Figure 5

Correlation Between Productivity in 2-digit Manufacturing Industries and Change in Employment Share, 1998-2007



Source: Manufacturing firm survey (1998, 2007).

Notes: N=29. Size of circle represents the industry's share of employment share in 1998.

Table A1

Employment Structure of the Chinese Economy using Census Data, 1990-2005

	1990	2000	2005
Total Labor Force (000's)	636,941	642,977	671,956
Agriculture (000's)	455,305	407,116	373,157
	71.20%	*63.32%*	*55.49%*
Manufacturing (000's)	85,350	90,193	108,050
	13.35%	*14.03%*	*16.14%*
Construction (000's)	12,964	18,206	24,264
	2.03%	*2.83%*	*3.61%*
Services (000's)	83,322	127,462	166,485
	13.03%	*19.82%*	*24.76%*

Source: Population Census 1990 (1% sample), Population Census 2000 (0.095% sample) and 2005 1% Population Sample Survey (0.2% sample)

Note : Sample excludes individuals out of the labor force. Each sector's share of the workforce is listed in italics.