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Essays on Regional Economic Growth in China

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Dedicated to my dear father, Ren Wang, and mother, Qingyun Gao

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Abstract

This dissertation comprises of three essays that contribute to the literature on regional economic growth in China. In Chapter 2, I examine the impact of manufacturing growth on employment in the non-tradable sector for prefecture-level cities in China. I find that adding ten manufacturing jobs creates 3.4 additional jobs in the non-tradable sector during 2000-2010. The multiplier is greater for high-technology manufacturing industries, is the largest for wholesale, retail and catering, and is greater in inland regions. In Chapter 3, I explore the role of industry and services in growth. I found that increase in industry output share will lead to subsequent economic growth, but the impact of services on growth in not clear. My findings remain robust when applying alternative measure of economic growth or industrialization, and robust after accounting for spatial spillovers. Chapter 4 models the temporary rural-urban migration in China using a continuous OLG model with heterogeneous agents. An agent determines his migration duration optimally based on his ability, urban/rural wage gap, and urban/rural services price differential. The model features the role of urban/rural services price differential that generates return migration. When the service price differential increases, people tend to increase their saving during migration and reduce their migration duration.

Chapter 1. Introduction

1978 was a watershed year for the Chinese economy as it began it's road toward a market economy with the introduction of "Open up and Reform." The reforms mainly focused on the following areas: rural liberalization, privatization of State Owned Enterprises (SOEs), fiscal decentralization, and development of trade and foreign investment (Brandt, Ma, and Rawski, 2014). Since then, China has experienced rapid growth accompanied by remarkable structural transformation: its GDP per capita grew at an annual rate of 9% over the period 1978-2010, while the share of employment in agriculture declined from 70.5% to 36.7%.

The reforms first started in rural China. During the central-planning era, rural areas adopted collective farming and individual farmers did not have the right to sell products in a "market" since the "market" was totally controlled by the state. In 1978, the "Household Responsibility System" was established so that farmers could pay local government fixed rents and keep the extra production (Brandt, Ma, and Rawski, 2014).[1] It increased agricultural productivity dramatically but also generated surplus labor in rural China. Due to the Household Registration System (Hukou), rural-urban migration was strictly restricted so that the surplus labor was mainly absorbed by the township and village enterprises (Meng, 2012).[2]

In 1980, Special Economic Zones (SEZs) were first introduced in four cities: Shenzhen, Shantou, Zhuhai, and Xiamen. Local governments in these cities provided favorable policies like tax credits, cheap land, property rights protection, etc., to attract foreign investors. The SEZs then expanded gradually to other provinces based on the success of the first group. Local governments had strong incentives to promote local economic growth, especially after the 1994 fiscal decentralization that allowed local government to share tax revenues with the

[1] Refer to Cao and Birchenall (2013) for a detailed introduction about rural reform in China.

[2] Hukou, introduced to China in 1950, divided people into agricultural and non-agricultural. Refer to Song (2014) for a detailed discussion of the Hukou system.

central government.[3] Empirical studies have found that establishing SEZs increased the level of GDP, foreign direct investment, TFP, and wages (Simon, Lin, and Fabrizio, 2016; Wang, 2013). The expansion of SEZs was also associated with remarkable growth in manufacturing, especially after 2002 when China joined the World Trade Organization (WTO). In response to the increasing labor demand in urban areas, the restriction on rural-urban migration has been relaxed gradually (Meng, 2012). This allowed China to take advantage of its domestic cheap labor supply and embark on export led growth (Yao et al., 2014).

However, China's growth has been accompanied by widening regional inequality until the mid 2000s. The GDP per capita in coastal regions was about 50% higher than in inland regions in 1978, and but increased to 120% by 2006 (Lemoine et al., 2014). Since the central government launched preferential policies to develop industrial clusters in coastal regions during the earlier reform period, inland regions were left behind. In response to the rising coastal-inland gap, the central governments launched development programs in western and central China in 1999 and 2004, shifting its industrial polices towards inland regions. Also, inland local governments provided favorable investment policies to attract factories from coastal regions where both labor and land cost was more expensive (Zheng et al., 2014). The GDP per capita ratio in coastal versus inland regions started to decline around 2006, and was about 1.7 in 2011 (Lemoine et al., 2014).

While the common perception is that China has abundant cheap labor, the fact is that labor costs began to increase in the late 1990s. Li et al. (2012) show that wages have been increasing regardless of sectors, skill-intensity of labor, and regions. According to Li et al. (2012), from 1988 to 2009, the growth rates of real wage were 6.5% for workers with middle high school, 7.6% for workers with high school education, 9.0% for workers with college education and above, 7.7% in inland, and 7.8% in coastal regions. One potential reason for rising labor cost was the reform of SOEs that began in the late 1990s. The "Grasp the Large, Let go of the Small" policy allowed small SOEs to be closed or privatized and let

[3] Refer to Shen et al. (2012) for a review of fiscal decentralization in China.

large SOEs merge and form conglomerates controlled either by central or local governments. The reforms gave room to the growth of the private sector and linked workers' wages more closely to their productivity (Zhang et al., 2005). The other potential explanation is the slowdown of rural-urban migration. Surplus labor in rural China was an important source of cheap labor in labor-intensive industries. However, migration was impeded by the Hukou system that restricts rural migrants' access to social welfare in urban areas. Li et al. (2012) argue that the marginal rural migrant labourers are becoming older and the marginal cost of migration is increasing since most of young laborers who have lower migration cost have migrated already.

Given the fact that China may run out of its cheap labor, and there is still 37% of labor force working in the agricultural sector, one might wonder whether China can continue its fast growth as did in the last two decades. After all, structural transformation may slow down due to a combination of factors, such as a slowdown of manufacturing activities and institutional restrictions like Hukou. The central government is aware of the growth challenges in China. In 2011, the 12th five-year plan has been approved, focusing on upgrading current manufacturing and developing emerging industries such as IT, biotechnology, and new energy (Wang and Zheng, 2012).[4] Moreover, deregulation of the service sector is underway so that the service sector may grow faster in the near future (Rutkowski et al., 2015). How China will be affected by restructuring its industry and services remains unclear at this stage.

In this dissertation, I explore three facets of Chinese regional growth over the past couple of decades. First, I investigate the extent to which growth in manufacturing employment has led to spillover growth in the "non-tradeable" sectors of the economy. In other words, I examine whether regions in China that experience faster manufacturing employment growth also saw a faster growth in service employment. This matters because it indicates that certain regions benefitted more from China's manufacturing miracle. In the third chapter, I ask

[4]Refer to Wang and Zheng (2012) for a detailed outline of the 12th five-year plan.

whether regions that initially had larger industry shares in their local production, were better positioned to take advantage of the subsequent growth. Lastly, I explore the determinants of rural-urban migration, focusing on explaining the temporary migration pattern observed in China. As we can see from the above discussion, rural-urban migration has played, and will continue to play, an important role in structural transformation, so understanding the migration patten will be essential for policy makers.

A body of literature has documented the role of structural transformation in economic growth. Lewis (1954) provides a seminal two-sector model in which total output increases when labor flows from the low-productivity agricultural sector to the high-productivity industry sector. Kaldor (1967) empirically show that growth of middle-income countries during 1950s-1960s was mainly from the growth of manufacturing. Poirson (2001) uses a sample of 65 countries during 1960-1990 and finds that the effect of labor reallocation depends on relative productivity across sectors. As for China, Brandt, Hsieh, and Zhu (2008) utilize a three-sector (agriculture, non-state non-agriculture, and state agriculture) model to apply growth accounting and find the non-state non-agriculture sector is the main driver of growth.

China has been known as a world factory due to its dramatic growth in manufacturing. Literature has increasingly documented the impact of rising manufacturing in China on the labor market in other countries. It has been found that the rising import from China can explain the decline of the manufacturing employment in the U.S. (David, Dorn, and Hanson, 2013), Norway (Balsvik, Jensen, and Salvanes, 2015), and Latin American economies (Artuç, Lederman, and Rojas, 2015). However, researchers seem to ignore the potential impact of manufacturing growth on the labor market within China. When manufacturing grows, it can potentially generate increased demand for local services through intersectoral linkages. As a consequence, manufacturing growth not only creates jobs in the manufacturing sector but also creates additional jobs in the service sector. Moretti (2010) examines the impact of manufacturing employment growth on employment in non-tradable sectors in the U.S. during 1980-2000. He finds that for every job created in the manufacturing sector, there will be 1.6 additional jobs created in the non-tradable sector. The remarkable growth of the manufacturing sector in China raises the question of whether a similar multiplier effect exists in China. So I analyze the following research question in the second chapter: When there is one more job created in the manufacturing sector at the local level, how many additional jobs will be created in the non-tradable sector?

I find that adding ten manufacturing jobs creates 3.4 additional jobs in the non-tradable sector. The effect is heterogeneous along a number of dimensions. For example, among the 3.4% new jobs created in the non-tradable sector, about 57% goes to whole sale, retail, and catering. When one new job is created in high-technology manufacturing, it can generate more jobs in the non-tradable sector while new employment in low-technology manufacturing fails to generate spillovers. Lastly, the effect is heterogenous across regions, with a greater multiplier in inland regions. The multiplier is much smaller compared to the estimated multipliers in the U.S. or OECD countries. The result is surprising at first glance since it seems to contradict with the impressive manufacturing growth observed during the last two decades. Nevertheless, further thinking about potential channels like preferences or institutional regulations can reveal more interesting stories that could be investigated in future.

The smaller spillover of manufacturing employment found in the second chapter, however, does not necessarily invalidate the role of manufacturing in growth. Since manufacturing is the largest component in the industry sector, I examine the role of the industry sector in growth in the following chapter. Both cross-country analysis and studies at the sub-national level find that industry can significantly drive economic growth (Rodrik, 2009; Szirmai and Verspagen, 2015; Ola-David and Oyelaran-Oyeyinka, 2014). On the other hand, researchers cast doubt on the role of industry in growth and highlight the importance of services in growth (Timmer and de Vries, 2009; Dasgupta and Singh, 2005). Although Baumol (1967) points out that the service sector has less potential to achieve productivity growth, the presence of growing tradable services due to information and communication technology since the 1990s can make the service sector a potential driver of growth (Park and Shin, 2012). In the third chapter, I investigate whether an initial greater share of industry or service is associated with subsequent growth. In other words, I examine whether there was an advantage to having an early start.

I first look for the impact of industry and services on growth during the 20-year interval from 1990 to 2010 and two 10-year intervals from 1990-2000 and 2000-2010. I then investigate over a panel of cities that stack four five-year subperiods: 1990-1995, 1995-2000, 2000-2005, and 2005-2010. I find robust evidence that a higher initial industry share in GDP is associated with a higher subsequent growth rate of GDP per capita. The service sector, however, does not show a robust impact on the growth. One potential reason is that regions that initially have a greater industry sector can generate agglomeration effects that allow easy access to technology, labor, or intermediate inputs.

In fact, factor mobility is essential for seizing the benefit from structural transformation. However, the Hukou system still impedes the rural-urban migration that would have facilitated the reallocation of labor from agriculture to industry and services. Although a large scale of rural-urban migration has occurred, the fact that the share of rural population declined from 80% in 1978 to 50% in 2010, upon close investigation reveals an interesting picture. Rural people tend to migrate and work in cities when they are young and return home years later. Meng (2012) finds that rural migrants on average spend about seven years in urban areas. A strand of literature documents the inferior status for rural migrants in cities, including discrimination on the labor market (Lu and Chen, 2006; Démurger, Li, and Yang, 2012), unequal access to children's education (Chen and Yang, 2010), affordable housing (Wu, 2004), and social security programs (Zhang, 2012). To my limited knowledge, only two studies provide theoretical framework to explain temporary migration in China. Démurger and Xu (2011) attribute the return migration to left-behind children. Liu (2011) sets up a model in which rural migrants return home once they accumulate enough money to start a business. In the fourth chapter, I model a new channel - urban/rural services price differential

- to explain the migration decision of rural people. This urban/rural services price gap can reflect rural migrants' inferior status due to Hukou.

In the model, people are assumed to have different abilities and are pulled to cities because of the higher wages they can earn there. They will determine the optimal migration duration according to their abilities, urban/rural wage gap, and urban/rural service price gap. According to the model, rural people are more likely to migrate to cities if they have a higher level of ability or the urban/rural wage gap increases. However, the increasing price differential in services (mainly housing and education) either discourages migration or reduces migration duration for those who have migrated. We can tell that rural migrants return home because of the high cost of living in urban areas. Although there is no doubt that services are relatively more expensive in urban areas in almost every country, China is different in the way that its Hukou system contributes to the gap. Reforms on Hukou will be inevitable to facilitate labor mobility in China, but cautions are still needed to avoid some undesirable outcome such as urbanization without industrialization.

The Chinese economy has long been investigated in literature. Its successful growth story has stimulated interest among researchers to explore the key drivers of the existing growth as well as challenges for sustainable growth. This dissertation serves as a supplement to existing literature on regional growth in China. On one hand, it addresses three questions related to manufacturing growth and rural-urban migration. On the other hand, it proposes further research directions that arise from current findings. For example, it will be interesting to investigate potential channels that determine the manufacturing employment multiplier and the mechanism for regions benefitting from an initial larger industry sector. In addition, studying Hukou's role in rural-urban migration remains a ripe area as more data on migrants becomes available for quantifying the different channels by Hukou system.

Chapter 2. Manufacturing Growth and Local Multipliers in China

2.1 Introduction

The growth of China has been accompanied by remarkable structural transformation since 1978. Figure 2.1 demonstrates the labor reallocation from the agricultural sector to non-agricultural sectors from 1978 to 2010. During this period, the share of employment in agriculture declined from 70.5% to 36.7%. The share of employment in the tertiary sector (services) has increased steadily, but that in the secondary sector (manufacturing, mining, utility, and construction) only grew rapidly after 2000. The growth of employment in the secondary sector was primarily due to the extraordinary growth in manufacturing, which reflected in China's rise to dominance in world manufacturing. As shown in Figure 2.2, in 1991, China's share of value-added in global manufacturing was only 2.7%. It started to rise in the early 1990s but has increased radically since 2000 aided by China's accession to the WTO in 2002. In 2013, China's share of world manufacturing output reached 24.5% and ranked first globally. As Figure 2.3 shows, the number of manufacturing firms increased from 146,399 to 424,542 between 2000 and 2010; total manufacturing employment increased from 44 million to 84 million.[1] The share of manufacturing employment within secondary industries increased from 79% to 88% during 2000-2010.

The role of manufacturing in employment creation has been extensively investigated in the literature (Bivens, 2003; Moretti, 2010; Park and Chan, 1989; Valadkhani, 2005). In addition to the direct absorption of labor, the manufacturing sector can create jobs in other sectors through different channels.

[1] Data are derived from China Industrial Economy Statistical Yearbook. It covers state-owned and non-state owned firms with annual sales above 5 million RMB.

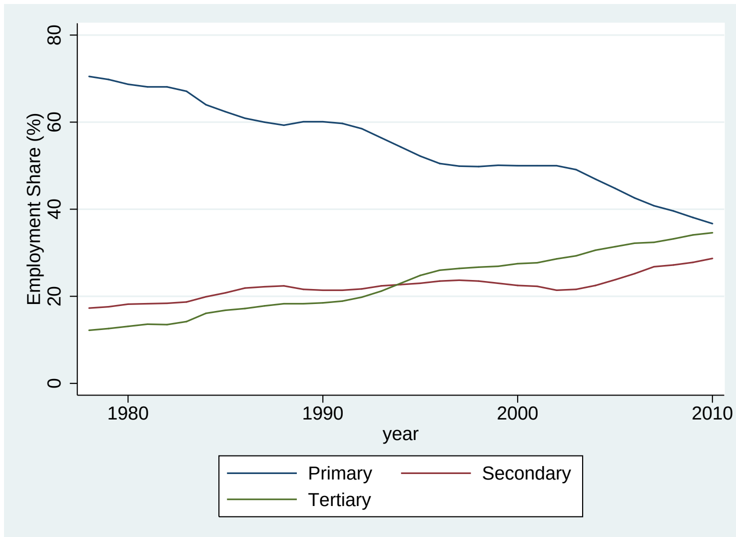

Figure 2.1: Employment Share by Sector: 1978-2010
Note: The primary sector is agricultural sector. The secondary sector includes manufacturing, utility, mining, and construction. The tertiary sector is service sector. Source: 2011 China Population and Employment Statistics Yearbook

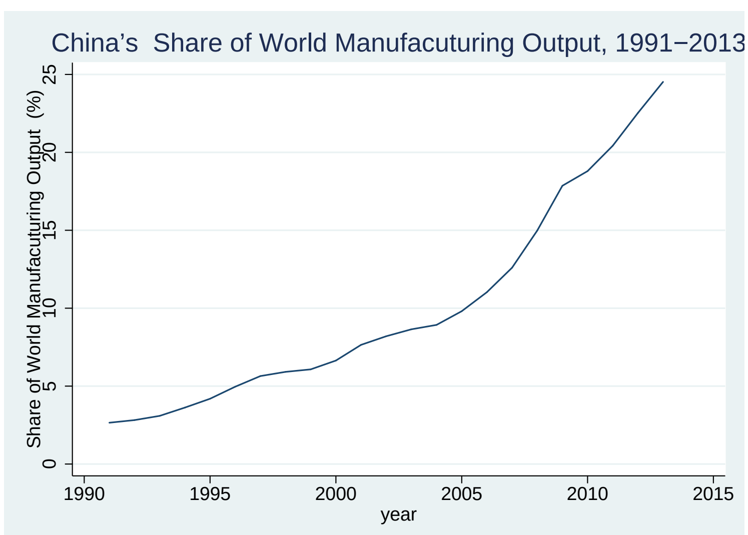

Figure 2.2: China's Share of World Manufacturing Output: 1991-2013
Source: Author's calculation based on data from World Bank World Development Indicators.

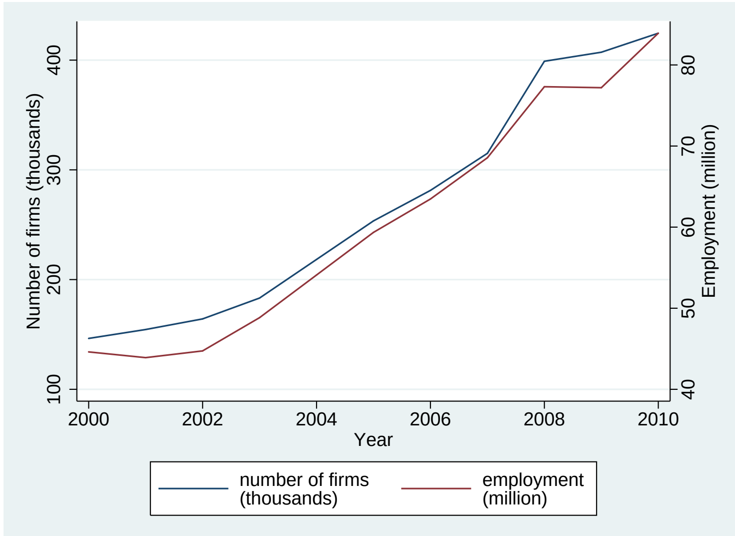

Figure 2.3: Manufacturing Growth in China: 2000-2010
Source: Author's calculation based on data from China Industrial Economy Statistical Yearbook (2001-2011).

First, services like finance, transportation, and information technology contribute to the production process as intermediate inputs in the manufacturing sector. These productive linkages lead to new jobs created in other sectors when manufacturing grows. Second, increased labor demand in manufacturing raises wages as long as labor supply is not perfectly elastic. Higher wages, therefore, increase spending on local services like haircuts, restaurants, health care, etc. The income-induced demand for local services also begets new jobs in the service sector. Given the impressive growth of manufacturing in China, it is natural to ask whether a multiplier effect of manufacturing employment growth exists in China, and if so, how large the multiplier is.

The multiplier of manufacturing employment growth can be investigated by using a reduced form introduced by Moretti (2010). He investigates the impact of employment in the tradable sector on the non-tradable sector in the U.S. during 1980-2000.[2] Ordinary least squares estimation leads to inconsistent estimates if other factors affect employment in both manufacturing and non-tradable sectors. To deal with the potential endogeneity, Moretti

[2]Moretti (2010) defines manufacturing as the tradable sector. In this paper, I will use manufacturing and tradable sector interchangeably.

employs an instrumental variable is constructed based on the shift-share approach (McGuire and Bartik, 1992) to isolate sources of exogenous variation in manufacturing employment growth. The instrumental variable is the manufacturing employment growth that would have occurred had employment grown at the national growth rate. It captures the manufacturing employment growth caused only by national shocks, purging local endogenous factors that affect employment. This approach has been applied to study the employment multiplier effect in England, Italy, Sweden, and OECD countries (Faggio and Overman, 2014; de Blasio and Menon, 2011; Moretti and Thulin, 2013; Van Dijk, 2014). As far as I am aware, there exists no such study on China. In this paper, I apply the analysis by Moretti (2010) and Moretti and Thulin (2013) of tradable and non-tradable sectors employment in the U.S. and Sweden to China, and take into account the demographic and institutional characteristics specific to China.[3]

More specifically, I use the 2000 and 2010 Censuses of Population to examine how many jobs in the non-tradable sector (utility, construction, and services) are created when one job is created in manufacturing for prefecture-level cities in China. My choices of data and research period are dictated largely by consideration of data quality. Population censuses are preferred because they provide complete employment data in China. Using employment data from other sources like City Statistical Yearbooks underestimates the size of employment by omitting many self-employed workers (Li and Gibson, 2015). I focus on the period from 2000 to 2010 because the population census in China began using the same standard to aggregate data since 2000. [4]

[3]The multiplier of manufacturing employment growth can also be examined by regional input-output models (Mathur and Rosen, 1974), which predict the impact of a change in certain economic activity. However, such models assume fixed prices, ignoring the general equilibrium effects that may arise from the multiplier effect. Regional computable equilibrium models are instead used to relax the fixed prices assumption. Nevertheless, both input-output and regional computable equilibrium models are used to predict, rather than estimate the actual effect of changes in economic activities (Faggio and Overman, 2014).

[4]The aggregate employment data at the city level in 1990 Census of Population included all workers who stayed in the city for more than one year at the time of the census. In 2000 and 2010 Censuses of Population, employment data were collected from 10% of households, and the aggregate employment data at city level included workers who stayed in the city for more than six months at the time of the census. Employment data from Population Census 1990 are not comparable to that from 2000 and 2010 Censuses of Population.

My result from IV estimation suggests that for every ten jobs created in manufacturing, 3.4 additional jobs are created in the non-tradable sector. Moreover, about 12.6% of employment growth in the non-tradable sector can be attributed to employment growth in manufacturing.[5] The average multiplier effect remains robust after considering the potential effects of development in neighboring areas, access to the world market, and physical geographical characteristics. I conduct a falsification test to show the effect is not driven by some long-run common causal factors that affect employment in both sectors. I also reconstruct the manufacturing sector by excluding tobacco, and petroleum processing and coking. These two industries are dominated by state-owned enterprises (SOEs), with shares of output exceeding 50% in 2010. I find that SOEs in manufacturing do not drive my results.

I further investigate heterogeneous effects of the multiplier along different dimensions. First, by looking at the effect of high- and low- technology manufacturing employment growth, I find that high-technology employment growth creates jobs in the non-tradable sector, and low-technology ones do not significantly generate additional jobs. Second, examining the multiplier for each non-tradable industry shows that the multiplier effect is the largest in wholesale, retail and catering. Third, I study the multiplier effect across regions. During earlier reform period, the central government designed preferential policies to develop industrial clusters at coastal cities, mainly relying on location advantages (Zheng et al., 2014). However, industrial agglomeration in coastal cities began to decline since the mid-2000s. The decline is due to rising land and labor cost in coastal cities (Li et al., 2012), and favorable investment policies provided by inland governments (Zheng et al., 2014). Indeed, my result suggests a smaller multiplier effect in coastal cities.

The average estimated multiplier effect is about 0.34, which is different from multipliers in other countries. Moretti (2010) finds that creating one new job in the manufacturing sector in the U.S. increases 1.6 additional jobs in the non-tradable sector during 1980-2000. Moretti

[5] One concern is that whether utility, construction and services can be treated as non-tradable. However, due to data limitation, I can not further classify their tradability. Instead, I examine the multipliers in different non-tradable industries to show the heterogeneity of the multipliers.

and Thulin (2013) find the multiplier is 0.48 in Sweden during 1995-2007. Van Dijk (2014) concludes the multiplier in OECD regions is about 1.12 during 1997-2006. Surprisingly, the multiplier is zero in Italy during 1991-2007 (de Blasio and Menon, 2011). Several factors can determine the magnitude of the multiplier. First, a stronger preference for non-tradable goods and services can lead to a greater multiplier. China's households have higher savings rate compared to the U.S. and OECD countries. This fact may reflect the unwillingness to spend, suppressing the multiplier. Second, local policies like restrictions on the non-tradable sector can reduce the multiplier. China regulates non-tradable sectors like utility, transportation, and finance. Also, local government's regulation of land supply restricts construction, thereby restricting labor demand. Third, vertical integration within the manufacturing sector will lead to a smaller multiplier since the manufacturing sector itself absorbs part of the spillover effect. This can also go the other way if manufacturing increasingly outsources many of its service oriented support activities. Lastly, the non-tradable sector with labor intensive technology will have a greater multiplier. Investigating these channels is left for future work.

The remainder of the paper is structured as follows. In Section 2 I provide a brief description of the dataset. Section 3 describes the empirical strategy. In Section 4, I report my main results. Section 5 concludes.

2.2 Data

The main variable of interest is the employment change in different industries at the local level from 2000 to 2010. In this section, I briefly discuss some of the data issues surrounding the definition and construction of administrative regions and industrial classification system.

Figure 2.4: Administrative Divisions in China-Province Level
Note: This figure displays the administrative divisions at province-level in China based on data from GADM database of Global Administrative Areas. Source: http://www.gadm.org/

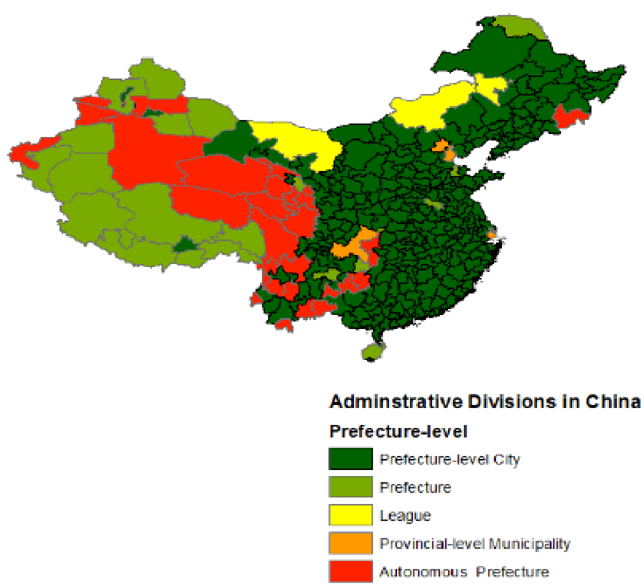

Figure 2.5: Administrative Divisions in China-Prefecture Level
Note: This figure displays the administrative divisions at prefecture-level in China based on data from GADM database of Global Administrative Areas. Source: http://www.gadm.org/

2.2.1 Administrative Regions

China's administrative divisions comprise of five levels. At the broadest level, the country is divided into 27 provinces and four province-level municipalities.[6] Second is the prefecture level. It includes prefecture-level cities (dijishi), prefectures (diqu), leagues (meng) and autonomous prefectures (zizhizhou).[7] Third is the county level, including districts (qu), county-level cities (xianjishi), and counties (xian). Fourth is the township (zhen) level. Fifth is the village (cun) level. I illustrate the administrative structures at the provincial level in Figure 2.4. Figure 2.5 provides the administrative divisions at the prefecture level.

The unit of analysis in this paper is a prefecture-level city. A prefecture-level city consists of districts (qu), counties (xian), and county-level cities (xianjishi). The districts within a prefecture-level city form an urban core area (shixiaqu), which is usually more industrialized than the rest, and is the nearest Chinese analog to a standard city like a U.S. metropolitan area (Alder et al., 2015; Baum-Snow et al., 2015). The government of a prefecture-level city is responsible for the economic development within its administrative region, leading the administrative affairs of the urban core area, and governance of counties and county-level cities. I focus on prefecture-level cities for two main reasons. First, manufacturing activities could take place either in the urban core area or outside the urban core area. The urban core area benefits firms through its better infrastructure and market access, the agglomeration advantages from technological externalities (Duranton, 2007) and labor market pooling (Breinlich, Ottaviano, and Temple, 2013). The remaining areas, instead, benefit firms via lower labor and land costs. Baum-Snow et al. (2013) find that radial railroads have decentralized industrial activities in China. Investigating the whole prefecture-level city, therefore, provides an average multiplier at the local level. Second, both one-

[6] A provincial-level municipality is a "city" with "provincial" power. The four province-level municipalities are Beijing, Tianjin, Shanghai and Chongqing.

[7] A prefecture-level city is administered by a province. Prefectures used to be the most common division at the prefecture level, but have gradually converted to prefecture-level cities since 1983. Leagues and autonomous prefectures have more ethnic minorities.

and two-digit employment data are available for prefecture-level cities, which allows me to examine narrower industries.

Due to administrative reforms between 2000 and 2010, the prefecture-level cities reported in the censuses of 2000 and 2010 are not identical.[8] In order to have a larger sample, I use prefecture-level cities in 2010 as a benchmark, track each prefecture-level city to its corresponding areas in 2000, and study the employment growth during this period. Appendix A shows details about the adjustments made to construct comparable prefecture-level cities. My final sample includes 277 prefecture-level cities, covering 91.6% of total population at the prefecture level.

It is important to reiterate that the unit of analysis in this paper is based on administrative divisions. China's National Bureau of Statistics defines urban areas in the 2010 census as areas located in or contiguous to the area where the local government is located (Chen and Song, 2014). Although the definition is a bit different from that used in the 2000 census, the difference is negligible (Chen and Song, 2014). As a result, a prefecture-level city may include both urban (chengzhen) and rural (xiangcun) areas. For simplicity, I will refer to the prefecture-level city as a city.

2.2.2 Data on Employment

Following Moretti (2010), the tradable sector is defined as manufacturing while the non-tradable sector includes utilities, construction, and services. The aggregate employment in both tradable and non-tradable sectors are comparable across two censuses. However, employment in sub-industries in the two censuses is not perfectly comparable due to the different industry classification systems. The 2000 Population Census used GB/T4754-

[8]Different administrative reforms at the prefecture level began in 1983, including converting a prefecture to a prefecture-level city, promoting a county-level city to a prefecture-level city, expanding the current prefecture-level city by absorbing nearby counties or prefectures.

1994, and the 2010 Population Census used GB/T4754-2002.[9] Take transportation as an example. Employment in transportation reported in Census 2010 included workers in public transportation like taxies and public buses. However, employment of public transportation was included in social services in Census 2000. In order to compare employment changes for sub-industries, adjustment is needed to construct comparable industries. Following Holz (2013), and documentation of GB94 and GB02, I first construct comparable 2-digit industries in manufacturing. Table A.1 illustrates the classification used in the paper. I reclassified the crafts and art production to other in the census of 2010 because this term was included in the "other" category in the census of 2000. Also, I construct comparable 1-digit industries in the non-tradable sector. Table A.2 illustrates the classification in the non-tradable sector.

2.3 Empirical Strategy

My primary focus is to investigate the causal relationship of employment growth in the tradable sector on the non-tradable sector. Following Faggio and Overman (2014), total employment growth in a city c between year $t-\tau$ and t can be written as

$$\frac{E_{c,t}-E_{c,t-\tau}}{E_{c,t-\tau}}=\frac{E_{c,t}^{NT}-E_{c,t-\tau}^{NT}}{E_{c,t-\tau}}+\frac{E_{c,t}^{T}-E_{c,t-\tau}^{T}}{E_{c,t-\tau}}+\frac{E_{c,t}^{o}-E_{c,t-\tau}^{o}}{E_{c,t-\tau}}. \tag{2.1}$$

$E_{c,t}$ is the total employment in city c at time t. It includes employment in the non-tradable sector (utilities, construction, and services) $E_{c,t}^{NT}$, employment in the tradable sector (manufacturing) $E_{c,t}^{T}$, and employment in other sectors (agriculture, mining, and governments jobs) $E_{c,t}^{o}$. $(E_{c,t}^{NT}-E_{c,t-\tau}^{NT})/(E_{c,t-\tau})$ is the contribution of non-tradable sector to total employment growth. $(E_{c,t}^{T}-E_{c,t-\tau}^{T})/(E_{c,t-\tau})$ is the contribution of tradable sector

[9] GB/T4754 is the industries classification system. The first formal classification was issued in 1984, called GB/T4754-1984 (Holz, 2013). The classification standards were later revised in 1994, 2000, and 2011, and the labels are GB/T47540-1994 (GB94), GB/T4754-2002 (GB02), and GB/T4754-2011 (GB11) respectively.

to total employment growth. To investigate to what extent the change of employment in the tradable sector affects that in the non-tradable sector, I adopt a specification similar to Faggio and Overman (2014). I regress the contribution of non-tradable sectors employment on contribution of tradable sector employment using the following specification:

$$\frac{E^{NT}_{c,t} - E^{NT}_{c,t-\tau}}{E_{c,t-\tau}} = \alpha + \beta \frac{E^{T}_{c,t} - E^{T}_{c,t-\tau}}{E_{c,t-\tau}} + \gamma X_{t-\tau} + e_{c,t}. \tag{2.2}$$

The specification is also closely related to the direct difference method used in Moretti and Thulin (2013), where the dependent and independent variables are the change of employment in the non-tradable and tradable sectors respectively. Normalizing the change by total employment level, however, does not invalidate my results. Moreover, it facilitates the interpretation of estimated coefficients for other control variables.

In Equation 3.1, the dependent variable $(E^{NT}_{c,t} - E^{NT}_{c,t-\tau})/(E_{c,t-\tau})$ is employment growth contributed by the non-tradable sector, and the independent variable $(E^{T}_{c,t} - E^{T}_{c,t-\tau})/(E_{c,t-\tau})$ is employment growth contributed by the tradable sector. $X_{t-\tau}$ includes a set of city characteristics that can potentially affect employment growth in the non-tradable sector. $e_{c,t}$ is the error term. The coefficient β is the multiplier, capturing the effect of tradable sector employment growth on non-tradable sector employment growth. In other words, β is the employment change in the non-tradable sector when there is one more additional worker in the tradable sector. If $\beta > 0$, a new job created in the tradable sector will generate β jobs in the non-tradable sector, indicating a multiplier effect of employment growth in the tradable sector on the non-tradable sector. If $\beta < 0$, one more worker in the tradable sector will reduce $-\beta$ jobs in the non-tradable sector, indicating a crowding effect of employment growth in the tradable sector on the non-tradable sector.

Estimating Equation (3.1) using ordinary least squares will bias the estimate of β if there are unobserved factors that can affect employment growth in both tradable and non-tradable sectors. On one hand, a city may attract new manufacturing firms due to its location advantages or better investment opportunities, which also attracts more people to work in the city, raising the demand for non-tradable goods and employment in the non-tradable sector. If so, the OLS estimate of β will be biased upwards. On the other hand, a city may expand its manufacturing sector in response to an overall decline in employment. This will bias the estimate of β downward.

In order to infer the causal relationship between manufacturing employment growth and non-tradable sector employment growth, I construct an instrumental variable based on the shift-share approach (McGuire and Bartik, 1992), which is widely used in regional economics literature for causal inference.[10] The idea is to isolate variation in manufacturing employment that only come from national shocks, so endogenous local factors that drive variations in employment will be purged. The Bartik instrument especially well suited in the context of China since the local economy in China is more likely to be affected by national policies. More specifically, I use the national employment growth rate in manufacturing and the initial share of manufacturing employment in the city to approximate the exogenous employment growth contributed by the manufacturing sector. The instrument is calculated as:

$$\frac{E^T_{c,t-\tau}}{E_{c,t-\tau}} \frac{E^T_{-c,t} - E^T_{-c,t-\tau}}{E^T_{-c,t-\tau}}, \tag{2.3}$$

where $(E^T_{-c,t} - E^T_{-c,t-\tau})/(E_{-c,t-\tau})$ is the national growth rate of manufacturing employment excluding city c.[11] Although the national employment growth rate constructed for each city is different, the main source of variance in the instruments is driven by the initial share of manufacturing employment (Baum-Snow and Ferreira, 2015).

[10] The shift-share approach is also used in the labor economics literature to approximate peer effects.

[11] An alternative instrument can be constructed by using 2-digit industry employment: $\sum_i \frac{E^T_{c,i,t-\tau}}{E_{c,t-\tau}} \frac{E^T_{-c,i,t} - E^T_{-c,i,t-\tau}}{E^T_{-c,i,t-\tau}}$. Here i is the 2-digit industries in the manufacturing. However, Shandong province does not report the 2-digit employment in the census of 2010. So I use the IV based on 1-digit employment when investigating the effect of total manufacturing employment on the non-tradable sector employment.

The validity of the instrument is subject to critique that the initial share may correlate with other factors which in turn affect the non-tradable sector employment. To alleviate this concern, I use a rich set of control variables capturing the starting period demographic and labor composition that may affect employment at the city level. I control for the share of urban hukou population in 2000. Hukou is the household registration system in China that classifies people to agricultural (rural) and non-agricultural (urban) hukou.[12] It has been increasingly documented in the literature as a source of labor mobility restriction, undersized cities, and unexploited gains from agglomeration (Au and Henderson, 2006; Bosker et al., 2012). The share of urban population increased from 18% to 50% from 1978 to 2010, while the share of urban hukou population increased from 16% to 34%. Controlling for the urban hukou population share captures the original residence of the city's labor force. The second control variable is share of the population with college education above age 6 in 2000. It captures human capital at the starting period, a common control variable in the urban and regional growth literature (Glaeser, Kerr, and Kerr, 2015)

I further include a region dummy variable indicating whether the city lies in coastal provinces. Policies to develop industrial clusters targeted coastal areas at the beginning of the reform period. As a result, the initial share of manufacturing employment is likely to be related to the region where the city is located. A city is assigned a region dummy taking a value of 1 if it is in the coastal provinces of Hebei, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong.

I also use a dummy variable identifying whether a city is the capital city of the province. Capital cities are usually more developed compared with other cities, which may affect employment growth differently (Chanda and Ruan, 2015). To account for the concern that employment growth may be correlated to city size, I control for the log value of initial

[12] Hukou was used to restrict rural-urban migration before 1978. Nowadays a person is free to move, but the type of hukou determines the level of welfare to which is he entitled, including education, health care, and pension (Song, 2014). In addition, rural hukou can only be converted to urban hukou after meeting requirements imposed by local governments such as holding a college degree, purchasing a local house, etc. (Chan and Buckingham, 2008).

employment. In addition, the initial unemployment rate at the city level is also used to capture labor surplus.[13]

Initial sectoral composition may affect subsequent employment growth. A city with a higher share of non-tradable employment may experience slower growth in that sector. A city with a larger government employment may demand more non-tradable goods, inducing the growth of non-tradable employment. I add both the share of non-tradable employment and share of government employment to control the potential effect of the initial sectoral composition.

I perform robustness checks via several strategies. First, I use additional controls such as a dummy taking a value of 1 if the city has a border with one of the province-level municipalities, log average night light density from 1995 to 1999 in neighboring cities, and proximity to the nearest port city to capture the effects of neighboring regions and access to world markets.[14] Second, I add geographical controls including temperature, rainfall, and altitude to show my results hold.[15] Third, I conduct a falsification test to show my result is not driven by some long-run common factors. Fourth, to address the concern that the result may be driven by employment growth in SOEs, I exclude tobacco, petroleum processing and coking from the manufacturing sector output share of SOEs in both industries were above 50% in 2010.[16]

In the second part of the paper, I examine several heterogeneous effects along a number of dimensions. I first examine the multiplier effect of high- and low-technology manufacturing industries. The details regarding the classification are introduced in Section 4. Moretti (2010) concludes that the multiplier effect from high-technology industries is greater than

[13]Feng, Hu, and Moffitt (2015) document that official statistics understate Chinese unemployment rate. It is not a concern in this paper. Official unemployment rates only account for unemployed people with local hukou, but unemployment rates calculated from population census covers all people with and without local hukou.

[14]Two cities are neighbors if they share a common border. Night lights data are from the National Geophysical Data Center. The distance to the nearest port city is the great circular distance calculated by geodist in Stata.

[15]Geographical data such as rainfall, temperature, and altitude are from Global Climate Data.

[16]I add the initial output share of SOE industries as a control variable, and the results remain robust.

lower ones. Whether similar effects exist in China requires further analysis. Following Moretti (2010), I estimate a model,

$$\frac{E^{NT}_{c,t} - E^{NT}_{c,t-\tau}}{E_{c,t-\tau}} = \alpha + \beta_1 \frac{E^{TH}_{c,t} - E^{TH}_{c,t-\tau}}{E_{c,t-\tau}} + \beta_2 \frac{E^{TL}_{c,t} - E^{TL}_{c,t-\tau}}{E_{c,t-\tau}} + \gamma X_{t-\tau} + e_{c,t}, \tag{2.4}$$

where $E^{TH}_{c,t}$ and $E^{TL}_{c,t}$ are the employment in the high- and low-technology manufacturing industries respectively. I use instruments constructed specific to each group to estimate consistent β_1 and β_2. I then investigate the multiplier effect for each non-tradable industry. Lastly, I investigate whether the multiplier effect varies with region. I interact the tradable sector employment growth contribution with indicators of whether the city lies in a coastal province.

2.4 Results

2.4.1 Summary Statistics

Table 2.1 presents the descriptive statistics for 277 prefecture-level cities. From 2000 to 2010, the contribution of manufacturing and non-tradable sector to total employment growth were 4.98% and 13.15% respectively.[17] According to Figure 2.6, there is a positive correlation between employment growth in manufacturing and non-tradable sectors.

A set of variables at initial period 2000 are also reported. The mean of share of urban hukou population was 26.67% and its standard deviation was 14.99%. The share of population with a college education had a mean of 3.56% and a standard deviation of 2.49%. The unemployment rate had a mean of 4.02% and standard deviation of 2.9%. 20.5% of people worked in non-tradable sector. Government employment made up 2.53% of total employment.[18]

[17]From 2000 to 2012, total employment grew by 6.58%. During this period, agriculture employment declined, with a negative contribution (-11.9%) to employment growth.

[18]11.86% of people worked in manufacturing in 2001.

Of the 277 cities, 35% are located in coastal provinces, 9% are capital cities, and 6.13% have a border with one of the four provincial municipalities. I calculate the proximity to the nearest port city as the reciprocal of one plus distance in thousands of kilometers.[19] A value of 1 indicates the city is one of the biggest port cities. Luminosity in neighboring cities had a mean of 0.52 and its standard deviation was 1.44.

Table 2.1: Summary Statistics

Variable	Mean	Standard deviation	Min	Max
Non-tradable sec. contri. to total employ. growth (%)	13.15	7.81	1.54	51.83
Manu. contri. to total employ. growth (%)	4.89	7.8	-6.85	43.99
Share of urban hukou pop.(%), 2000	26.67	14.99	7.42	83.17
Share of college pop. (%), 2000	3.56	2.49	.74	16.61
Region	.35	.48	0	1
Capital	.09	.29	0	1
Log employment,2000	12.05	.69	9	13.34
Unemployment rate(%), 2000	4.02	2.9	.62	21.47
Share of non-tradable employ. (%), 2000	20.5	9.69	5.6	62.5
Share of gov. employ. (%), 2000	2.52	1.1	.89	12.53
Nearby provincial municipality	6.13	24.0	0	1
Log night light density 1995-1999 in nbr. areas	.52	1.44	-5.33	2.98
Proximity to nearest port city	.69	.17	.27	1
Rainfall (meter)	.98	.47	.08	2.05
Temperature (Celsius)	13.34	5.48	-2.29	23.38
Altitude (100 meters)	5.18	6.02	.01	30.98

Note: The unit of observation is a prefecture-level city. There are in total 277 cities. Manufacturing contribution to total employment growth: change in manufacturing employment 2000-2010 normalized by total 2000 local employment. Non-tradable sector contribution to total employment growth: change in non-tradable sector employment 2000-2010 normalized by total 2000 local employment. Region: a dummy variable that equals to 1 if the prefecture-level city is in the coastal provinces of Hebei, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong. Capital: a dummy variable that equals to 1 if the prefecture-level city is the capital of the province. Nearby provincial municipality: a dummy variable that equals to 1 if the prefecture-level city has a common border with one of provincial municipalities including Beijing, Shanghai, Tianjin, and Chongqing. Log night light density 1995-1999 in nbr. areas: average night light density in neighboring regions; night light data are from National Geographical Data Center. Proximity to nearest port city: reciprocal of one plus distance to the nearest port city in thousands of kilometers. Rainfall, temperature, and altitude are from Global Climate Data.

[19] The port cities used are the 10 biggest port cities in China, including Shanghai, Shenzhen, Qingdao, Zhoushan, Xiamen, Yingkou, Guangzhou, Ningbo, Dalian, and Lianyungang.

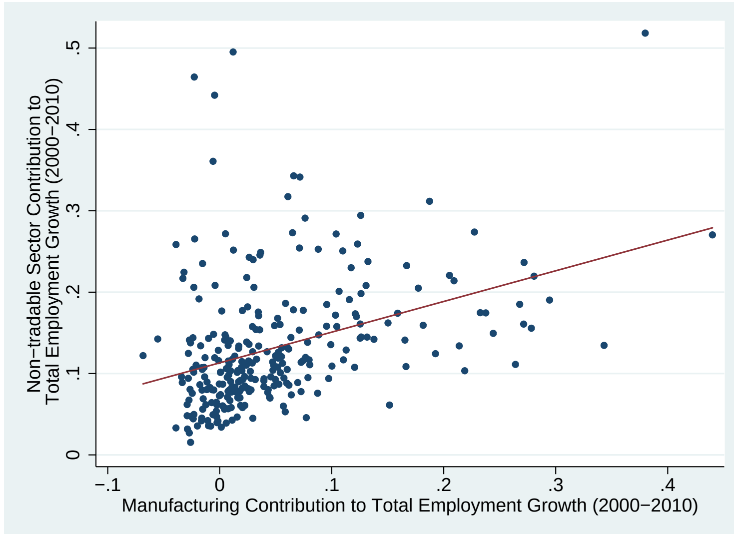

Figure 2.6: Manufacturing vs Non-tradable Sector Contribution to Total Employment Growth; Correlation: 0.3765, P-value: 0.0000.
Note: Each point represents a prefecture-level city.

2.4.2 Baseline Results

In Table 2.2, I present ordinary least sqaures estimates regressing the contribution of non-tradable sector employment on the contribution of manufacturing employment. In column (1), I control for initial demographic characteristics (urban hukou population and share of population with college education), region dummy, capital city dummy, log value of initial employment, and unemployment rate. The point estimate implies that each additional job in manufacturing creates 0.499 additional jobs in the non-tradable sector. The coefficient of urban hukou population share is significantly negative, suggesting cities with a greater share of urban hukou population experienced smaller contribution of the non-tradable sector to total employment growth. If a city has greater urban hukou population, it will have smaller share of rural labor and fewer rural migrants.[20] Combes, Démurger, and Li (2015) find that rural migrants complement rather than crowd out local urban hukou workers,

[20] Rural migrants are defined as people who stay in urban areas while holding a rural hukou.

mainly working in labor-intensive industries. Rural migrants usually take jobs urban hukou workers don't want to take (Meng, 2012; Zhao, 2000). As a result, a city with a lower share of rural labor may experience slower employment growth because less labor is available to work in low-end industries. The estimate for share of population with college education is significantly positive, suggesting cities with higher human capital stock were associated with higher contribution of the non-tradable sector to total employment growth. Although a city with more urban hukou population has a higher proportion of college educated people, the two variables are measuring different characteristics. The former captures the original residence of the local population while the latter captures the average human capital stock. Moreover, a person with urban hukou does not necessarily has college education. Finally, the coefficient of the region dummy is significantly negative, implying cities in coastal areas are associated with smaller contribution of the non-tradable sector to total employment growth.

In column (2), I add initial share of non-tradable employment as an additional control. The multiplier estimate decreases only slightly. The estimate of initial non-tradable employment share is significantly positive, suggesting that cities with more people working in the non-tradable sector experience greater contribution of the non-tradable sector to total employment growth.

In column (3), I consider the effect of initial government employment on employment growth in the non-tradable sector. The coefficient is significantly positive, indicating cities with a greater share of government employment experience greater contribution of the non-tradable sector to total employment growth. One explanation is that workers in government are usually more educated and earn more than non-government workers, so more government jobs will lead to increased demand in local non-tradable goods and services. Column (3) is the baseline model since it explains a larger variance of the outcome variable.

Table 2.2: Impact of Manufacturing on Employment Growth in the Non-tradable Sector, OLS Estimates

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010		
	(1)	(2)	(3)
Manufacturing contri. (2000-2010)	0.499***	0.445***	0.470***
	(0.052)	(0.065)	(0.064)
Share of urban hukou pop., 2000	-0.258***	-0.293***	-0.314***
	(0.070)	(0.071)	(0.072)
Share of college pop., 2000	2.255***	1.964***	2.038***
	(0.426)	(0.425)	(0.429)
Region	-0.019***	-0.023***	-0.026***
	(0.007)	(0.007)	(0.007)
Capital	0.053**	0.049*	0.044
	(0.027)	(0.027)	(0.027)
Log(employment), 2000	-0.022***	-0.016**	-0.014**
	(0.007)	(0.007)	(0.007)
Unemp. rate, 2000	0.504*	0.442	0.424
	(0.260)	(0.290)	(0.286)
Share of non-tradable employ., 2000		0.168*	0.133
		(0.098)	(0.094)
Share of gov. employ., 2000			1.008***
			(0.344)
Constant	0.340***	0.266***	0.220**
	(0.087)	(0.087)	(0.085)
N	277	277	277
Adjusted R Square	0.55	0.55	0.56

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. Descriptions of variables are in Table 2.1.
$p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Instrumental Variable Estimation

Table 2.3 presents the IV estimates for the same three specifications as Table 2.2. The instrumental variable is constructed based on Equation 2.3. The first stage estimates are reported in Appendix Table A.3. The coefficient of the instrument is positive and significant at 1 percentage level in each specification, suggesting local manufacturing employment growth closely correlates to national manufacturing employment growth. The Kleibergen-Paap rk Wald F statistic from weak identification test is reported in the last row, showing the instrument is strong in every specification.

Table 2.3: Impact of Manufacturing on Employment Growth in the Non-tradable Sector, IV Estimates

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010		
	(1)	(2)	(3)
Manufacturing contri. (2000-2010)	0.451***	0.287**	0.339**
	(0.078)	(0.132)	(0.136)
Share of urban hk pop., 2000	-0.263***	-0.334***	-0.344***
	(0.070)	(0.078)	(0.075)
Share of college pop., 2000	2.279***	1.799***	1.894***
	(0.440)	(0.445)	(0.444)
Region	-0.016**	-0.019**	-0.022***
	(0.008)	(0.008)	(0.008)
Capital	0.051*	0.043	0.039
	(0.027)	(0.031)	(0.030)
Log(employment), 2000	-0.022***	-0.011	-0.010
	(0.007)	(0.008)	(0.007)
Unemp. rate, 2000	0.498*	0.380	0.377
	(0.259)	(0.320)	(0.312)
Share of non-tradable employ., 2000		0.296**	0.242*
		(0.143)	(0.145)
Share of gov. employ., 2000			0.849**
			(0.336)
Constant	0.339***	0.208**	0.180**
	(0.086)	(0.096)	(0.091)
N	277	277	277
First Stage F-statistic	43.77	23.88	21.84

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. Descriptions of variables are in Table 2.1. The instrumental variable is equal to the 2000 share of manufacturing employment for a given city multiplied by the 2000-2010 growth rate in national manufacturing employment (exclude own city). Corresponding first-stage estimates are reported in Appendix Table A.3.
* $p < 0.1$ ** $p < 0.05$, *** $p < 0.01$.

Column (3) in Table 2.3 is my baseline result. The coefficient of manufacturing employment contribution is 0.339, suggesting that for every ten jobs created in manufacturing, about 3.4 additional jobs are generated in the non-tradable sector. In addition, the result indicates that about 12.6% of employment growth in the non-tradable sector can be attributed to employment growth in manufacturing.[21] For the average multiplier estimated in this section, the OLS and IV estimates are not significantly different. However, there are significant differences when investigating the heterogeneous effects in the next section.

[21] 12.6% is calculated by 4.89*0.339/13.15, where 4.89 is the mean of manufacturing contribution to total employment growth, and 13.15 is the mean of non-tradable sector contribution to total employment growth.

Based on the estimated coefficients in the baseline model, a 1 percentage point increase in urban hukou population share decreases the non-tradable employment contribution by 0.3 percentage points, and a 1 percentage point increase in share of population with college education increases the non-tradable employment contribution by 1.8 percentage points. Employment growth contributed by the non-tradable sector in coastal cities is on average 2 percentage points lower than that in non-coastal cities. When the initial share of government employment increases 1 percentage point, the employment growth contribution by the tradable sector increases 0.85 percentage points.

2.4.3 Neighboring Cities and Geographical Characteristics

Employment growth in a city may not only be affected by characteristics like demographic composition, city size, and labor market conditions, but also influenced by other factors like development in its neighboring areas, access to world markets, and physical geographical advantages. I investigate these factors in Table 2.4. I first use controls including a dummy variable identifying whether a city has a border with one of the four provincial municipalities - Beijing, Shanghai, Chongqing and Tianjin, log level of night light density in neighboring cities, and inverse distance to the nearest port city. The two former variables intend to control for the effect from neighboring regions, while the last variable captures access to world markets. I further control for geographical variables including rainfall, temperature and altitude. The total number of observations drop to 276 since the city of Zhoushan does not have neighboring cities, so the light data for neighboring areas are missing.

Columns (1) and (2) in Table 2.4 are OLS estimates, and corresponding IV estimates are in columns (3) and (4). Appendix Table A.4 shows the first stage estimates. The estimated coefficients of the instrument variable are significant at 1 percent. The F statistics from the weak identification test indicate the instrument remains strong after controlling for additional variables. In column (1) of Appendix Table A.4, being located near a port city increases employment growth in manufacturing. However, the effect disappears when further controlling for geographical characteristics. The estimated coefficient of altitude is negative and significant at 1 percent level, showing that cities with lower altitudes experience greater contribution by manufacturing to employment growth. Sharing a border with one of the four provincial municipalities does not affect manufacturing employment growth.

In columns (3) and (4) of Table 2.4, my estimates suggest that one additional job in manufacturing increases non-tradable employment by between 0.38 to 0.39. The coefficients of urban hukou population share, share of population with college education share, region dummy, and government share dummy remain significant and have the same signs as the baseline model. One exception is the unemployment rate, which becomes significant at the 10 percent level after controlling for geographical characteristics, suggesting that cities with a higher unemployment rate have greater employment growth in the non-tradable sector. Adjacency to one of the four provincial municipalities increases contribution by the non-tradable sector to employment growth - the estimate is significant at 10 percent. The estimates of development in neighboring cities, proximity to the nearest port city, and other geographical characteristics, are insignificant.

One may be concerned that each province may have province-specific features that affect the cities within its jurisdiction, which may affect employment in both tradable and non-tradable sectors. In Appendix Table A.5, I address this concern by controlling for province fixed effects. Columns (1) to (3) are fixed effects estimates, and columns (4) to (5) are corresponding IV estimates. The observations in IV regressions drop by 1 because Xining city, the only prefecture-level city in Qinghai province, is dropped. The F-statistics in the first stage suggest the instrument is strong. The multiplier effect is 0.36 and significant at 5 percent.

Table 2.4: Impact of Manufacturing on Employment Growth in the Non-tradable Sector, Additional Controls

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010			
	OLS		IV	
	(1)	(2)	(3)	(4)
Manufacturing contri. (2000-2010)	0.481***	0.524***	0.383***	0.390***
	(0.066)	(0.072)	(0.142)	(0.151)
Share of urban hukou pop., 2000	-0.316***	-0.326***	-0.334***	-0.331***
	(0.072)	(0.082)	(0.073)	(0.082)
Share of college pop., 2000	2.180***	2.058***	2.056***	1.897***
	(0.428)	(0.431)	(0.436)	(0.457)
Region	-0.023***	-0.029***	-0.023***	-0.029***
	(0.009)	(0.010)	(0.009)	(0.010)
Capital	0.038	0.040	0.036	0.037
	(0.027)	(0.026)	(0.028)	(0.028)
Log(employment), 2000	-0.012*	-0.010	-0.010	-0.007
	(0.007)	(0.008)	(0.007)	(0.008)
Unemp. rate, 2000	0.480*	0.648**	0.420	0.561*
	(0.277)	(0.268)	(0.309)	(0.298)
Share of non-tradable employ., 2000	0.097	0.117	0.178	0.206
	(0.098)	(0.106)	(0.152)	(0.142)
Share of gov. employ., 2000	1.100***	0.988***	0.976***	0.904***
	(0.371)	(0.334)	(0.369)	(0.303)
Nearby provincial municipality	0.023*	0.020	0.024**	0.022*
	(0.012)	(0.012)	(0.012)	(0.012)
Ln(light density) 1995-99 in nbr. areas	-0.007*	-0.008	-0.007*	-0.008
	(0.004)	(0.006)	(0.004)	(0.006)
Proximity to port city	0.018	0.053	0.031	0.062
	(0.038)	(0.046)	(0.039)	(0.046)
Rainfall (meter)		-0.030*		-0.027
		(0.017)		(0.017)
Temperature (celsius)		0.001		0.002
		(0.001)		(0.001)
Altitude(meter)		0.001		0.001
		(0.001)		(0.001)
Constant	0.186**	0.145	0.158*	0.097
	(0.088)	(0.110)	(0.093)	(0.120)
N	276	276	276	276
First Stage F-statistic			19.60	18.99

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. The instrumental variable is equal to the 2000 share of manufacturing employment for a given city multiplied by the 2000-2010 growth rate in national manufacturing employment (exclude own city). Corresponding first-stage estimates for columns (3) and (4) are reported in Appendix Table A.4. Descriptions of variables are in Table 2.1.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The evidence above suggests that my results are robust after considering potential effects from neighboring areas, access to the world market, physical geographical characteristics, and province fixed effects.

2.4.4 Falsification Test

During the period that I study, both tradable and non-tradable sectors experienced a secular rise. Despite including a large set of control variables, one concern for my analysis is that some other unknown long-run common causal factors, such as trade or population growth, may drive the increase in employment in both sectors. To verify that my result captures the causal effect of manufacturing employment growth on employment in the non-tradable sector, I conduct a falsification test by regressing past employment growth in the non-tradable sector on future employment growth in manufacturing.

I report my result in Table 2.5. The variable of interest is contribution of manufacturing to employment growth from 2010 to 2013.[22] Column (1) reports OLS estimates for the baseline model. The coefficient of future manufacturing employment growth contribution is insignificant. The IV estimates of the baseline model are presented in column (4) of Table 2.5. However, the instrument is weak; the F statistics from first stage is 3.5. Although the IV estimates are not informative, the OLS estimates suggest little correlation between future manufacturing employment growth and past employment growth in the non-tradable sector. This finding can alleviate the concern that some long-run factors driving employment in both sectors may overestimate the multiplier effect.[23]

[22] Employment data are from China City Statistical Yearbook 2011 and 2014.

[23] I also conduct a falsification test using the contribution of other sectors to total employment growth as dependent variable and find that there is no multiplier effect.

Table 2.5: Impact of Future Manufacturing on Past Employment Growth in the Non-tradable Sector, Falsification Tests

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Manufacturing contri. (2010-2013)	-0.000	0.000	-0.001	0.032	0.034	0.032
	(0.005)	(0.005)	(0.005)	(0.031)	(0.032)	(0.031)
Share of urban hukou pop., 2000	-0.415***	-0.394***	-0.339***	-0.416***	-0.403***	-0.369***
	(0.101)	(0.096)	(0.105)	(0.099)	(0.095)	(0.103)
Share of college pop., 2000	1.487***	1.525***	1.400***	1.606***	1.699***	1.566***
	(0.563)	(0.551)	(0.539)	(0.559)	(0.548)	(0.536)
Region	-0.012	-0.025**	-0.027**	-0.014*	-0.023**	-0.024**
	(0.009)	(0.010)	(0.011)	(0.008)	(0.010)	(0.011)
Capital	0.029	0.032	0.029	0.030	0.029	0.028
	(0.035)	(0.034)	(0.034)	(0.034)	(0.033)	(0.032)
Log(employment), 2000	-0.001	-0.003	0.001	-0.005	-0.005	-0.002
	(0.007)	(0.008)	(0.008)	(0.007)	(0.007)	(0.008)
Unemp. rate, 2000	0.209	0.123	0.265	0.259	0.217	0.367
	(0.414)	(0.383)	(0.394)	(0.412)	(0.390)	(0.401)
Share of non-tradable employ., 2000	0.530***	0.503***	0.471***	0.478***	0.445***	0.434***
	(0.086)	(0.091)	(0.108)	(0.091)	(0.096)	(0.109)
Share of gov. employ., 2000	0.445	0.501	0.661**	0.639**	0.737**	0.859***
	(0.362)	(0.377)	(0.307)	(0.323)	(0.332)	(0.292)
Nearby provincial municipality		0.028*	0.029*		0.031**	0.031**
		(0.016)	(0.015)		(0.015)	(0.015)
Ln(light density) 95-99 in nbr. areas		-0.006	-0.006		-0.009*	-0.010
		(0.005)	(0.007)		(0.005)	(0.006)
Proximity to port city		0.085*	0.088		0.078*	0.081
		(0.044)	(0.055)		(0.042)	(0.052)
Rainfall (meter)			-0.017			-0.021
			(0.019)			(0.018)
Temperature (celsius)			0.003**			0.003**
			(0.001)			(0.001)
Altitude(meter)			0.001			0.000
			(0.001)			(0.001)
Constant	0.076	0.047	-0.044	0.113	0.071	0.002
	(0.092)	(0.093)	(0.119)	(0.090)	(0.090)	(0.115)
N	276	275	275	276	275	275
First Stage F-statistic				3.50	3.27	3.32

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. Descriptions of variables are in Table 2.1.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

2.4.5 Role of State Owned Enterprises (SOEs)

The growth of the Chinese economy has been accompanied by a dramatic transformation of SOEs. In the late 1990s, a policy named "Grasp the Large, Let go of the Small" was adopted for reforms in SOEs. Small SOEs were closed or privatized, large SOEs in strategic sectors (such as infrastructure construction, oil, and utilities) were merged and formed large conglomerates controlled either by central or local governments (Li, Liu, and Wang, 2014; Hsieh and Song, 2015). The reforms gave room to the growth of the private sector and linked workers' wage more closely to their productivity. On one hand, overall rising wages may potentially increase the demand for non-tradable goods and services. On the other hand, large SOEs still earn more profits because of their monopoly power and dominance in the market. In 2010, output share of SOEs in both tobacco and petroleum processing and coking exceeded 50%. One may be concerned that the multiplier effect might be driven by employment growth in SOEs since their employees earn higher wages than non-SOE employees, creating higher demand for non-tradable goods and services.

I investigate this concern in Table 2.6. I reconstruct the manufacturing sector by excluding tobacco and petroleum processing and coking. The OLS and IV estimates for the baseline model are in columns (1) and (4) respectively. The F statistics in the first stage demonstrate the strength of the instrument. The estimated multiplier is 0.346, with a standard deviation of 0.137. The multiplier effect is not significantly different from the baseline model, suggesting the results in the baseline model are not driven by the presence of SOEs. Other controls like share of urban hukou population, college population share, region dummy, and government employment share also have an effect similar to the baseline model in Table 2.3. When I add further controls for effects of neighboring areas, access to the world market, and geographical characteristics, the results remain robust.

Table 2.6: Impact of Manufacturing on Employment Growth in the Non-tradable Sector, Excluding Industries Dominated by State Owned Enterprises

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Manufacturing contri. (2000-2010)	0.463***	0.475***	0.517***	0.346**	0.391***	0.403***
	(0.064)	(0.066)	(0.072)	(0.137)	(0.143)	(0.153)
Share of urban hukou pop., 2000	-0.317***	-0.319***	-0.329***	-0.343***	-0.334***	-0.332***
	(0.072)	(0.072)	(0.083)	(0.074)	(0.072)	(0.082)
Share of college pop., 2000	2.035***	2.178***	2.051***	1.905***	2.071***	1.913***
	(0.431)	(0.430)	(0.433)	(0.444)	(0.437)	(0.458)
Region	-0.026***	-0.023***	-0.029***	-0.022***	-0.023***	-0.028***
	(0.007)	(0.009)	(0.010)	(0.008)	(0.009)	(0.010)
Capital	0.043	0.037	0.040	0.039	0.036	0.037
	(0.028)	(0.027)	(0.026)	(0.030)	(0.028)	(0.027)
Log(employment), 2000	-0.014**	-0.012*	-0.010	-0.011	-0.010	-0.007
	(0.007)	(0.007)	(0.008)	(0.007)	(0.007)	(0.008)
Unemp. rate, 2000	0.427	0.484*	0.659**	0.384	0.432	0.581*
	(0.284)	(0.276)	(0.268)	(0.310)	(0.310)	(0.300)
Share of non-tradable employ., 2000	0.141	0.105	0.126	0.237	0.174	0.201
	(0.094)	(0.099)	(0.107)	(0.145)	(0.152)	(0.142)
Share of gov. employ., 2000	0.999***	1.095***	0.987***	0.857**	0.988***	0.915***
	(0.340)	(0.368)	(0.333)	(0.339)	(0.375)	(0.308)
Nearby provincial municipality		0.024**	0.021		0.024**	0.022*
		(0.012)	(0.012)		(0.012)	(0.012)
Ln(light density) 95-99 in nbr. areas		-0.007*	-0.008		-0.007*	-0.008
		(0.004)	(0.006)		(0.004)	(0.006)
Proximity to port city		0.018	0.053		0.030	0.061
		(0.038)	(0.046)		(0.039)	(0.045)
Rainfall (meter)			-0.031*			-0.028
			(0.018)			(0.017)
Temperature (celsius)			0.002			0.002
			(0.001)			(0.001)
Altitude(meter)			0.001			0.001
			(0.001)			(0.001)
Constant	0.220**	0.185**	0.142	0.184**	0.161*	0.101
	(0.086)	(0.088)	(0.110)	(0.092)	(0.094)	(0.121)
N	277	276	276	277	276	276
First Stage F-statistic				22.44	20.06	19.38

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. The manufacturing sector is reconstructed by excluding tobacco; petroleum processing and coking. Descriptions of variables are in Table 2.1.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

2.4.6 Heterogeneous Effects

In this section, I study several heterogeneous effects of the multiplier. I first investigate the multiplier effect by high and low-technology manufacturing employment growth. I then look at the multiplier effect in different industries in the non-tradable sector. Lastly, I analyze whether the multiplier effect is different across regions.

Multipliers by High- and Low-technology Manufacturing Employment Growth

Moretti (2010) and Moretti and Thulin (2013) find the multiplier effect is heterogeneous in terms of types of new jobs created in manufacturing. New jobs in high-technology manufacturing generate more jobs in the non-tradable sector than do low-technology jobs. I estimate Equation 2.4 to allow the effect of adding a job in high-technology manufacturing industries to be different from adding a job in low-technology ones. Based on High-Technology Industry (Manufacturing Industry) Classifications (2013), I define high-technology manufacturing industries as manufacturing of medicines; machinery industry; transport equipment; manufacture of communication equipment, computers and other; manufacture of measuring instruments and machinery for cultural activity and office work.[24]

I present my results in Table 2.7. Columns (1) to (3) are OLS estimates, showing that adding a job in high-technology manufacturing generates more jobs in the non-tradable sector. The specification in Equation 2.4 has two endogenous variables: employment growth contributed by high- and low- technology manufacturing. I construct group-specific instruments to infer causal analysis, and report results in columns (4) to (6). To save space, I only report the first stage in Appendix Table A.6 for IV regressions in columns (4) and (6) of Table 2.7.

[24] High-Technology Industry (Manufacturing Industry) Classification (2013) is available in 2013 China Statistics Yearbook on High-Technology Industry. It provides 4-digit high-technology industries. Due to data limitation, I define high-technology industries based on 2-digit industries.

Table 2.7: Impact of High- and Low-Technology Manufacturing on Employment Growth in the Non-tradable Sector

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
High tech manu. contri. (2000-2010)	0.596***	0.606***	0.641***	0.526**	0.572**	0.621**
	(0.137)	(0.148)	(0.158)	(0.239)	(0.244)	(0.265)
Low tech manu. contri. (2000-2010)	0.438***	0.466***	0.492***	-0.016	-0.029	-0.061
	(0.078)	(0.083)	(0.088)	(0.135)	(0.157)	(0.164)
Share of urban hukou pop., 2000	-0.318***	-0.335***	-0.345***	-0.372***	-0.379***	-0.359***
	(0.073)	(0.076)	(0.084)	(0.087)	(0.085)	(0.093)
Share of college pop., 2000	2.015***	2.182***	2.041***	1.373**	1.387**	1.174**
	(0.458)	(0.452)	(0.449)	(0.541)	(0.549)	(0.572)
Region	-0.026***	-0.022**	-0.027**	-0.018*	-0.025**	-0.026**
	(0.009)	(0.010)	(0.011)	(0.010)	(0.011)	(0.013)
Capital	0.052*	0.042	0.044	0.057	0.056	0.057
	(0.031)	(0.030)	(0.028)	(0.037)	(0.035)	(0.035)
Log(employment), 2000	-0.015**	-0.011	-0.009	-0.009	-0.009	-0.005
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
Unemp. rate, 2000	0.411	0.525*	0.696**	0.344	0.358	0.494
	(0.302)	(0.301)	(0.298)	(0.326)	(0.328)	(0.333)
Share of non-tradable employ., 2000	0.092	0.064	0.091	0.396**	0.403**	0.407**
	(0.105)	(0.109)	(0.111)	(0.157)	(0.170)	(0.159)
Share of gov. employ., 2000	1.497**	1.709**	1.632**	0.376	0.478	0.825
	(0.742)	(0.773)	(0.760)	(0.910)	(1.004)	(0.905)
Nearby provincial municipality		0.025*	0.021		0.027*	0.025*
		(0.013)	(0.013)		(0.014)	(0.014)
Ln(light density) 95-99 in nbr. areas		-0.009**	-0.011*		-0.009*	-0.012*
		(0.005)	(0.006)		(0.005)	(0.007)
Proximity to port city		0.015	0.042		0.063	0.068
		(0.038)	(0.046)		(0.046)	(0.053)
Rainfall (meter)			-0.031*			-0.026
			(0.018)			(0.018)
Temperature (celsius)			0.002			0.003**
			(0.001)			(0.001)
Altitude(meter)			0.001			0.000
			(0.001)			(0.001)
Constant	0.229**	0.173*	0.132	0.180*	0.137	0.063
	(0.093)	(0.099)	(0.122)	(0.099)	(0.104)	(0.133)
N	260	259	259	260	259	259
First Stage F-statistic				25.37	22.25	18.46

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. The high- and low-technology manufacturing industries are classified based on NBS High-Technology Industry (Manufacturing Industry) Classifications (2013). Details of the classification are in Appendix Table A.10. Instruments are group specific. Corresponding first-stage estimates for columns (4) and (6) are reported in Appendix Table A.6. Descriptions of variables are in Table 2.1.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In columns (1) and (2) of Appendix Table A.6, the two endogenous variables are regressed on two group-specific instruments and other baseline controls respectively. Employment growth in high-technology manufacturing is positively correlated to the high-technology group instrument, but is insignificantly affected by the low-technology group instrument. Employment growth in low-technology manufacturing is negatively correlated to the high-technology group instrument, and is positively correlated to low-technology group instrument. The results indicate that high-technology manufacturing employment may crowd out low-technology manufacturing employment. The first stage F-statistics are reported in last row, indicating the instruments are strong. Columns (3) and (4) give similar results when adding more controls. The estimated coefficients from IV regressions in column (4) of Table 2.7 suggests that adding a job in high-technology manufacturing increases 0.53 jobs in the non-tradable sector, but each new job created in low-technology manufacturing does not have significant multiplier effects. The results hold when using additional controls in columns (5) and (6).

To supplement my analysis, I also define high- and low- technology manufacturing using education level as a threshold. In Appendix Table A.10, I list the percentage of employment with high school (college) education and above for 2-digit manufacturing industries.[25] Alternative definition of high- and low-technology manufacturing industries are listed in Appendix Table A.10. I first define manufacturing industries as high-technology if the share of workers with high school education exceeded 45% in 2010.[26] I further use 40% and 35% as cutoff. If I choose 30% as a cutoff, rubber products will instead be classified as high-technology. It does not alter my results. Since the average percentage of workers with high school education and above in manufacturing is 30%, so I do not use cutoffs below 30%.

I present my results for baseline model in Table 2.8. Columns (1) to (3) are the OLS estimates when using 45%, 40%, and 35% as cutoff respectively. Columns (4) to (6) display

[25] I mainly use high school education level to define high- and low-technology manufacturing, but using college education gives similar classifications.

[26] When using 50% as cutoff, high-technology manufacturing include tobacco; petroleum processing and coking; manufacture of medicines. The instruments are weak in first stage, and the F statistics of it is 1.06.

the IV estimates. In column (4), the magnitude of multiplier for high-technology manufacturing industries is higher than that for low-technology manufacturing industries, but both multiplier effects are insignificant. This may because the first stage is not strong. The F statistics from the weak identification test is 6.6, and weak instruments increase standard errors of estimates. Another potential explanation is that the 45% cutoff may be too strong to define the high tech manufacturing industries. Columns (5) and (6) present IV estimates for 40% and 35% cutoff respectively. Both show a significant multiplier effect for high-technology manufacturing, but not so for low-technology manufacturing. Under the 40% cutoff, one new job created in high-technology manufacturing creates 0.575 additional jobs in the non-tradable sector.

Table 2.8: Impact of High- and Low-Tech Manu. on Employment Growth in the Non-tradable Sector, Alternative Definition of High- and Low-Tech Manu. Industries

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
High tech manu.contri.	0.625***			0.823		
(45% cutoff)	(0.170)			(0.609)		
Low tech manu. contri.	0.463***			0.181		
(45% cutoff)	(0.074)			(0.182)		
High tech manu. contri.		0.652***			0.575**	
(40% cutoff)		(0.121)			(0.270)	
Low tech manu. contri.		0.396***			-0.087	
(40% cutoff)		(0.082)			(0.136)	
High tech manu. contri.			0.558***			0.395**
(35% cutoff)			(0.111)			(0.197)
Low tech manu. contri.			0.422***			-0.167
(35% cutoff)			(0.089)			(0.190)
N	260	260	260	260	260	260
First Stage F-statistic				6.64	26.31	21.15

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. All baseline controls are included. The high- and low-technology manufacturing industries are classified based on education level. Details of the classification are in Appendix Table A.10.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In Appendix Tables A.7 and A.8, I add the initial share of high school population as an additional control. It is to address the concern that the results above might be driven by the initial human capital with high school education. However, controlling for the initial share of high school population does not significantly affect my results. One policy implication is that local governments should attract more high-technology manufacturing industries because they can generate greater multiplier effect. The estimated coefficient for high-technology manufacturing in China (about 0.53), however, is far below the multipliers estimated in the US (2.5) and Sweden (1.1). One possible explanation is that workers in the high-technology manufacturing industries in China have an average lower level of education compared to workers in the US or Sweden. So high-technology manufacturing jobs in China have smaller income-induced effect, creating a smaller multiplier.

Multipliers in Different Non-tradable Industries

The baseline model result indicates that one additional job in the manufacturing sector creates 0.339 additional jobs in the non-tradable sector. The non-tradable sector is defined to include utilities, construction, and all service sectors. In order to have a better understanding of manufacturing employment growth effect on the non-tradable employment growth, I estimate the multiplier effect for each non-tradable industry. Since the sectoral classification system in the censuses of 2000 and 2010 are different, I construct 11 comparable non-tradable industries as listed in Appendix Table A.2.

I present my results in Table 2.9. Each row is a separate regression and the dependent variable is the employment growth contributed by each non-tradable industry. All controls in the baseline model are included. OLS estimates suggest a significant multiplier effect for every non-tradable industry except utility. The multiplier is the largest for wholesale,retail and catering. The IV estimate of the multiplier in wholesale, retail, and catering is also the largest- the coefficient of it is 0.192, with a standard deviation 0.059. The estimate shows that when one additional job created in the manufacturing sector, about 57% (0.192 divided by 0.339) of the new jobs go to wholesale, retail, and catering. There is no multiplier effect for utilities. The utility industry, including electric power, steam and hot water, gas production and supply, and tap water production and supply is still highly regulated by the government.[27] In addition, the utility industry is more capital-intensive. These two factors are the possible causes for the insignificant multiplier. As for construction, land use in China is strictly controlled by the government. The employment growth therefore may not be significantly driven by market force.

Table 2.9: Impact of Manufacturing on Employment Growth in Specific Non-Tradable Industries

Non-tradable Industry	OLS	IV
Utility	0.003	0.007
	(0.004)	(0.010)
Construction	0.101***	-0.071
	(0.022)	(0.063)
Transport, post and telecom services; adminstration of water, environment, and public facilities	0.035**	0.046
	(0.014)	(0.030)
Whole sale,retail, catering	0.209***	0.192***
	(0.024)	(0.059)
Finance	0.009***	0.022***
	(0.003)	(0.007)
Real estate	0.019**	0.022***
	(0.004)	(0.006)
Health care,sports and welfare	0.011***	0.014***
	(0.002)	(0.004)
Education, culture and entertainment	0.023***	0.039***
	(0.004)	(0.008)
Scientific research, polytechnic services, and geological prospecting	0.010***	0.018**
	(0.002)	(0.007)
Resident and other services	0.023***	0.001
	(0.008)	(0.014)
Others	0.045***	0.068***
	(0.007)	(0.015)

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. Each row is a separate regression, and the independent variable is contribution of the specific industry to total employment growth . Each regression includes the baseline controls.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

[27] According to the 2011 industry statistical yearbook, the SOEs share of output was 92% in electric power and steam and hot water, 44.14% in gas production and supply, and 68.71% in tap water production and supply in 2010.

Multipliers by Region

The estimated coefficient of the region dummy in the baseline model shows that cities located in coastal provinces have, on average, less employment growth in the non-tradable sector. Whether the multiplier is heterogeneous across regions requires further investigation. Consider coastal and inland cities: the average wage in coastal cities is higher, which can generate more spending on local service goods, increasing the multiplier effect. However, the higher living cost in coastal areas could offset the labor supply, reducing the multiplier effect. I therefore interact my variable of interest and region dummy to examine the coefficient of the interaction term. If the estimate is significantly negative, the multiplier effect is smaller in coastal cities.

There are two endogenous variables in the regressions, so at least two instruments are needed. I follow Wooldridge (2010) to construct an instrument for the interaction term.[28] I present my results in Table 2.10. Columns (1) to (3) are OLS estimates, and columns (4) to (6) are IV estimates. To save space, I report the first stage in Table A.9 for IV regressions in columns (4) and (6) of Table 2.10. The F-statistic in the first stage demonstrates the instruments are strong.

Column (4) of Table 2.10 present the IV regression including baseline controls. The coefficient of manufacturing employment contribution 0.842 measures the multiplier effect for non-coastal cities, suggesting that one additional manufacturing job in inland cities generates 0.842 new jobs in the non-tradable sector. The estimate for interaction term is -0.5, with significance at 10 percent. The significant negative estimate for the interaction term indicates a smaller multiplier effect in coastal cities. When adding more controls in columns (5) and (6), the results still show a smaller multiplier effect in coastal regions.

[28] Wooldridge (2010, p.145-146) suggests following steps to construct instrument for the interaction term. First, obtain the fitted value by regressing the endogenous variable on all the other control variables. Second, construct the instrument for the interaction term by interacting the fitted value with the dummy variable. Third, take the fitted value and the newly constructed IV for interaction term as instruments.

Table 2.10: Impact of Manufacturing on Employment Growth in the Non-tradable Sector, Coastal vs Inland Effects

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Manufacturing contri.	0.557***	0.551***	0.667***	0.842***	0.913***	0.886***
	(0.087)	(0.093)	(0.109)	(0.287)	(0.310)	(0.277)
Manu. employ. contri.x region	-0.137	-0.110	-0.207*	-0.500**	-0.520**	-0.489**
	(0.112)	(0.117)	(0.125)	(0.232)	(0.238)	(0.200)
Share of urban hukou pop., 2000	-0.308***	-0.312***	-0.311***	-0.278***	-0.280***	-0.288***
	(0.075)	(0.075)	(0.087)	(0.087)	(0.085)	(0.089)
Share of college pop., 2000	1.985***	2.131***	1.954***	1.904***	2.079***	1.844***
	(0.458)	(0.456)	(0.468)	(0.449)	(0.448)	(0.479)
Region	-0.020**	-0.018*	-0.022**	-0.007	-0.000	-0.013
	(0.009)	(0.011)	(0.011)	(0.011)	(0.013)	(0.011)
Capital	0.043	0.038	0.040	0.044	0.040	0.041
	(0.028)	(0.028)	(0.026)	(0.030)	(0.029)	(0.027)
Log(employment), 2000	-0.013*	-0.011	-0.008	-0.012	-0.012	-0.007
	(0.007)	(0.007)	(0.008)	(0.007)	(0.008)	(0.008)
Unemp. rate , 2000	0.386	0.454	0.612**	0.303	0.420	0.580**
	(0.299)	(0.287)	(0.273)	(0.305)	(0.319)	(0.288)
Share of non-tradable employ., 2000	0.160	0.121	0.155	0.185	0.127	0.190
	(0.097)	(0.102)	(0.106)	(0.150)	(0.160)	(0.139)
Share of gov. employ., 2000	0.979***	1.068***	0.894***	0.971**	1.078**	0.783***
	(0.338)	(0.367)	(0.308)	(0.388)	(0.442)	(0.294)
Nearby provincial municipality		0.023**	0.020*		0.023**	0.020*
		(0.012)	(0.012)		(0.010)	(0.012)
Ln(light density) 95-99 in nbr. areas		-0.006	-0.005		-0.002	-0.001
		(0.004)	(0.006)		(0.004)	(0.006)
Proximity to port city		0.012	0.052		-0.024	0.049
		(0.039)	(0.045)		(0.045)	(0.043)
Rainfall (meter)			-0.031*			-0.034*
			(0.017)			(0.017)
Temperature			0.001			0.001
			(0.001)			(0.001)
Altitude(meter)			0.001			0.002*
			(0.001)			(0.001)
Constant	0.205**	0.181**	0.115	0.180*	0.190*	0.084
	(0.088)	(0.088)	(0.114)	(0.092)	(0.097)	(0.122)
N	277	276	276	277	276	276
First Stage F-statistic				12.74	11.96	12.49

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. A prefecture-level city is assigned a region dummy taking a value of 1 if it is in the coastal provinces of Hebei, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong, and Guangdong. Corresponding first-stage estimates for columns (4) and (6) are reported in Appendix Table A.9. Descriptions of variables are in Table 2.1.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

2.5 Conclusion

In this paper, I examined the impact of employment growth in manufacturing on employment in the non-tradable sector during 2000-2010 at prefecture-level cities in China. While, the average multiplier of 0.34, I also found substantial heterogeneity along skill intensity of manufactures, specific service industries, and geography. The multiplier is robust to a large variety of initial conditions, geographic controls and other characteristics.

Given the current trend of a slowdown in Chinese manufacturing, an obvious question that arises is whether the point estimate is useful for future analysis. While the slowdown itself need not reduce the size of the multiplier, the overall economic impact would be certainly lower due to slower job creation in manufacturing. In terms of thinking more long term, assuming that average incomes in China will continue to increase, even if it happens at a slower rate, Engel's law implies that the demand for services will increase. Hence, so should the size of the multiplier. Moreover, this effect might be reinforced as China continues to develop and is more and more likely to focus on high technology industries which, as we have seen already, has a higher spillover. On the other hand, while inland regions have clearly benefitted from rapid manufacturing growth over the decade of my analysis, this advantage is likely to diminish over time. In other words, given that all these factors are at play, one should be cautious in extrapolating for the future. At the same time this also indicates that further investigating the various channels of the spillovers remains a ripe area for future research.

Chapter 3. Structural Transformation and Local Economic Growth in China

3.1 Introduction

A voluminous amount of literature has investigated the determinants of economic growth. On one hand, researchers emphasize the importance of fundamentals, such as geographical advantages (Hibbs and Olsson, 2004) and institutions (Acemoglu, Johnson, and Robinson, 2001). On the other hand, economic growth can happen via structural transformation that entails the reallocation of economic resources away from agriculture to industry and services.[1] A high level of fundamentals, such as good institutions is not a necessary condition for getting factor reallocation started, so it can potentially lead to growth, especially in poor countries (Rodrik, 2013). Indeed, growth of countries in East Asian, such as China and Vietnam, is mainly driven by structural transformation. During this process, resources flow from the agricultural sector to the industry and service sectors. As for the roles of the industry and service sectors in growth, empirical literature has provided mixed results.[2]

One strand of literature emphasizes the role of industry in economic growth.[3] Rodrik (2009) finds that initial industry output share has a significant positive impact on subsequent growth by using a large sample of countries during 1960-2004. Szirmai and Verspagen (2015) further investigate the manufacturing sector and find that manufacturing has a positive impact on growth. Similar evidence has also been found at the sub-national level. For

[1]However, in the absence of strong fundamentals, even this process might come to a premature end.

[2]There is also theoretical literature that models structural transformation and generalized balanced growth simultaneously by incorporating multiple sectors. They emphasize different sources of the technological progress that drive the structural transformation. For example, Kongsamut, Rebelo, and Xie (2001) attribute structural transformation to income changes, while Ngai and Pissarides (2007) model structural transformation caused by relative prices changes. Refer to Herrendorf, Rogerson, and Valentinyi (2014) for a review of the theoretical papers.

[3]Industry sector include mining, manufacturing, utility, and construction. Some literature studies manufacturing since it is the largest component in the industry sector.

example, Kathuria and Natarajan (2013) conclude that regions that are more industrialized in India grow faster. Hansen and Zhang (1996) use provincial level data from 1985 to 1991 and find that manufacturing is an engine of economic growth in China. Another strand of the literature has focused on the role of the service sector in growth. Timmer and de Vries (2009) document the importance of the service sector in growth for a sample of countries from Asia and Latin America. Thomas (2009) finds that the service sector has been the driver of growth in India since the 1990s. China, as one of the largest developing countries, has witnessed rapid structural transformation since 1978. During 1990-2010, the share of industry's output had a modest increase of only 5 percentage points, while the services output share had an increase of 12 percentage points. Given the fact that the service's output share grows faster than the industry sector, it is interesting to explore whether the two sectors have different impacts on growth. In this paper, I investigate the role of both industry and services in growth for prefecture-level cities in China during 1990-2010.

Specifically, I first explore whether larger industry and service shares are associated with economic growth during the twenty-year interval from 1990 to 2010 and two ten-year intervals from 1990-2000 and 2000-2010. Cross-sectional analysis can provide a picture of long-term economic growth. I further use a panel of prefecture-level cities over the years 1990, 1995, 2000, 2005, and 2010 such that there are four five-year intervals. During the first five-year interval, 1990-1995, China began the transition from planned economy to market economy initiated by Deng Xiaoping's "Southern Tour." During the tour, Deng gave several speeches that first officially acknowledged the role of the private sector and encouraged market competition. In the next five-year interval, 1995-2000, China started State-Owned Enterprise (SOEs) reforms that allowed small and median SOEs to be privatized or shut down. The SOE reforms aimed to improve efficiency, but it broke workers' "iron rice bowl" and raised unemployment (Liu et al., 2014).[4] The uncertainty due to the restructures of SOEs, combined with the Asian Financial Crisis, slowed down the economic growth. The

[4] "Iron rice bowl" refers to the employment in SOE before the reform, where workers are secured by permanent employment.

third 5-year interval, 2000-2005, witnessed China's rapid growth in manufacturing since its accession to WTO in 2002. The relaxation of rural-urban migration further contributed to China' export-led growth. During the last five-year interval, 2005-2010, China shifted its industrial policies from coastal regions to inland regions with the purpose of reducing regional disparity. Given the different stages of China's development during the four five-year intervals, I apply pooled OLS and control for period fixed effects to examine the role of industry and services in growth. Furthermore, I show the heterogeneity of the impacts across the four five-year intervals.

Following the empirical approach used in Rodrik (2009) and Szirmai and Verspagen (2015), the average growth rate is regressed on a set of control variables that reflect the starting period characteristics to alleviate endogeneity. The variables of interest are initial share of industry output in GDP and initial share of services output in GDP. I have included a set of control variables that may potentially affect local growth, including initial value of GDP per capita, initial demographic characteristics, such as share of urban hukou population and share of college population, initial investment to GDP ratio, initial foreign direct investment (FDI) to GDP ratio, and a dummy variable that equals to one if a city is the capital of a province. I also study the impact of the initial share of industry and services on labor productivity growth. Due to data limitations, I restrict my sample period to 2000-2010 when examining labor productivity growth. Moreover, the availability of sectoral employment data in 2000 and 2010 at the city level allows me to measure the growth of GDP per worker in both industry and service sectors. Thus I can also examine sectoral growth and convergence rates for this period.

I find that initial industry output share is significantly associated with subsequent economic growth. I also find that this is true when we look at productivity growth instead of per capita growth. As for services, the results indicate the impact on growth is not significant. Using employment share in industry to measure industrialization further confirms the role of industry in economic growth. Also, I find evidence of convergence at prefecture-level cities.

The findings in this paper contribute to the existing literature on economic growth in China. Many studies use data at the province-level to investigate certain determinants of growth, such as financial development (Chen, 2006), FDI (Yao, 2006), infrastructure (Demurger, 2001), physical and human capital (Ding and Knight, 2011). Jones, Cheng et al. (2003) employ city-level data to examine the impact of special economic zone (SEZ) and FDI on growth. I complement the current literature by exploring the impact of sectoral composition on growth at the city level, intending to shed light on the current debate on the role of industry and services in growth. For example, if the industry sector is associated with growth, it indicates regions with higher initial industry share were better poised to capitalize on China's manufacturing miracle that allowed them to have a sustained growth advantage over the next two decades. It will further lead to a question regarding the sources of different initial shares of industry across cities, which could be done in future research.

There are several reasons that industry is considered as an engine of growth. First, endogenous growth models emphasize the impact of technological change on economic growth. Research and development, which mainly happens in the industry sector, is one of the main factors that drive technological change. In developing countries like China, where research and development is limited, especially at the starting period of the Open Up reform, international technology spillovers via trade or foreign direct investment can contribute to its productivity growth. Second, productivity can more readily increase in the industry sector by upgrading equipment or technology. According to "Cost Disease of Services" (Baumol, 1967), the service sector is considered to have less potential to achieve productivity growth. However, the presence of growing tradable services due to information and communication technology since 1990s can also make the service sector a potential driver of growth (Park and Shin, 2012).

The remainder of the paper is structured as follows. In Section 2 I provide a brief description of the dataset and the empirical strategy. Section 3 presents the results. Section 4 concludes.

3.2 Data and Empirical Strategy

The unit of analysis in this paper is a prefecture-level city. Data is collected from China City Statistical Yearbooks for 1991-2011 and Population Censuses in 2000 and 2010. China City Statistical Yearbooks provide rich information for prefecture-level cities, such as GDP, population, sectoral composition, investment, FDI, etc. Population Censuses provide data on education and sector employment. The growth rate of real GDP per capita is calculated based on 1990 constant prices. Price indices are drawn from World Development Indicators.[5] FDI is converted to RMB by using the exchange rate released by the People's Bank of China.

To investigate the impact of industry and services on economic growth, I apply the following econometric specification:

$$g_{c;t,t+\tau} = \beta_1 \text{Industry's Share}_{c,t} + \beta_2 \text{Services' Share}_{c,t} + \alpha \ln y_{c,t} + \gamma X_{c,t} + \mu Z_p + \epsilon_{c,t}. \quad (3.1)$$

The dependent variable $g_{c;t,t+\tau}$ is the annual growth rate of real GDP per capita from the year t to the year $t+\tau$ at the prefecture-level city c. The variables of interest are the initial shares of industry and services in GDP respectively in the year t at the prefecture-level city c. If both β_1 and β_2 are positive and significant, both industry and service sectors are associated with subsequent growth. Furthermore, I can examine which sector is relatively important to growth by comparing β_1 and β_2. Z_p is the province-specific fixed effect. $\epsilon_{c,t}$ is the error term.

In the main specification, I also control for a set of variables that can potentially affect local economic growth. I control for log value of initial GDP per capita $\ln y_{c,t}$ to capture the convergence effect. Existence of convergence has been documented in a large body of literature both at country-level and sub-national level (Solow, 1956; Gennaioli et al., 2014).

[5] Price indices are not available for prefecture-level cities. Price indices at the province level can also be used. In this paper, I use national deflators, and the impact from province-level prices will be absorbed by the province fixed effect.

In the case of China, Cai, Wang, and Du (2002) validate the convergence effect by using province-level data between 1978 and 1998. Chen and Sun (2013) find convergence at the provincial level during 1990-2010. When examining the impact of industry on growth rate of GDP per worker, GDP per worker in industry, and GDP per worker in services, I use the log value of GDP per worker, log value of GDP per worker in industry, and log value of GDP per worker in services respectively to capture the convergence effect.

Human capital is considered as an essential factor in growth in the neoclassical growth framework, so I control for the initial share of college population to capture human capital stock. China's household registration system (Hukou) divides people into rural and urban. Hukou has been documented in the literature as a source of labor mobility restriction, undersized cities, and unexploited gains from agglomeration (Au and Henderson, 2006; Bosker et al., 2012). Controlling for the initial share of urban hukou population can pick up the impact of this friction on economic growth.

I further include fixed capital formation to GDP ratio and FDI to GDP ratio. The former variable measures the investment efficiency since as market is more liberalized, more investment will be directed to fixed capital investment (Cai, Wang, and Du, 2002). The latter variable captures the openness of the local economy.[6]

Lastly, I control for a dummy variable that equals to one if a city is the capital of the province. One may be concerned that growth of a region may also be affected by its surrounding areas. To control for spatial correlation, I define two cities as neighbors if they share a common border. I then include the average of log GDP per capita in neighboring cities to investigate the impact of overall development from nearby cities.

[6] Alternative measures for openness of an economy such as exports to GDP ratio, imports to GDP ratio, growth rate of exports, and growth rates of imports are not available at prefecture-level cities. Proximate to port city can also be used to capture the openness, and controlling for it will not change the results significantly.

Table 3.1: Summary Statistics: Mean and Standard Deviation

Panel A: Dependent Variables:				
	1990-2010	1990-2000	2000-2010	
Average growth rate of real gdp per capita (%)	8.80	8.32	10.04	
	(4.23)	(3.72)	(3.33)	
Average growth rate of real gdp per worker (%)			10.14	
			(3.14)	
Average growth rate of real gdp per worker in industry (%)			8.03	
			(4.91)	
Average growth rate of real gdp per worker in services (%)			6.19	
			(3.11)	
	1990-1995	1995-2000	2000-2005	2005-2010
Average growth rate of real gdp per capita (%)	9.69	6.89	9.27	10.83
	(6.44)	(3.89)	(4.47)	(5.20)
Panel B: Initial controls:				
	1990-1995	1995-2000	2000-2005	2005-2010
Share of industry output(%)	45.49	45.07	44.22	46.22
	(14.48)	(11.70)	(11.11)	(12.49)
Share of services output(%)	27.49	32.12	35.19	36.34
	(8.84)	(7.78)	(7.33)	(8.37)
GDP per capita (RMB)*	2062.92	3480.63	4630.81	7322.96
	(1831.56)	(3846.40)	(5463.53)	(9303.44)
Share of college pop. (%)	1.51	2.65	3.72	5.99
	(1.69)	(2.06)	(2.55)	(3.52)
Share of urban hukou pop. (%)	32.56	32.85	29.87	33.68
	(20.44)	(17.96)	(16.12)	(18.19)
FDI/GDP (%)	0.74	3.84	2.51	2.30
	(2.25)	(7.09)	(4.55)	(3.06)
Fixed investment/GDP (%)	17.87	20.46	22.68	45.81
	(12.68)	(11.61)	(10.51)	(14.68)
Capital	0.09	0.10	0.09	0.08
	(0.29)	(0.30)	(0.29)	(0.28)
GDP per capita in nbr.(RMB)*	1740.88	2793.43	3626.95	5715.33
	(670.24)	(1493.79)	(2313.43)	(3702.15)
Panel C: Other initial controls at 2000				
	All	Industry	Services	
GDP per worker (RMB)*	7784.58	21813.01	15238.67	
	(5128.27)	(14030.67)	(5698.26)	
GDP per worker in nbr.(RMB)*	6601.12	19142.09	14245.29	
	(3168.96)	(6454.84)	(4695.69)	

Note: The unit of observation is a prefecture-level city. Standard Deviations are included in parentheses. Log values are used for variables denoted with *.

Table 3.1 reports the summary statistics of the variables used in this paper. Panel A includes dependent variables that measure economic growth in different sample periods.

From 1990 to 2010, the average annual growth rate of real GDP per capita was 8.80%, with a standard deviation of 4.23%. When splitting the sample period into two 10-year intervals, the average annual growth rate of real GDP per capita was 8.32% during 1990-2000, smaller than the one during 2000-2010, which was 10.04%. From 2000 to 2010, the average annual growth rate of real GDP per worker was 10.14%. The labor productivity in the industry sector grew at a rate of 8.03% annually, while the service sector has a slower growth, with an annual growth rate of 6.19%. One may be concerned that the overall labor productivity growth is greater than that in the industry and service sector. It could be because although on average labor productivity grows, some cities experienced a slow down in the industry sector.

I further report economic growth during the following four five-year intervals: 1990-1995, 1995-2000, 2000-2005, 2005-2010. The average annual growth rate of real GDP per capita during 1990-1995 was 9.69%, with a standard deviation of 6.44%. The growth rate declined to 6.89% during 1995-2000 when China experienced SOEs reform and the Asian financial crisis. Since 2000, the economy entered a period of rapid growth. The growth rates of real GDP per capita were 9.27% and 10.83%, respectively, during the next two five-year intervals.

In Panel B of Table 3.1, I report a set of variables that reflect the initial conditions at the city level. The average share of industry in GDP was 45.49% in 1990 and had minor ups and downs in the next 20 years. The average share of services, however, had a steady increase during 1990-2010. Real GDP per capita increased from RMB 2062.92 in 1990 to RMB 7322.96 in 2005, indicating that living standards have improved over the years.[7] The human capital stock, measured by share of the population with a college education and above, increased from 1.51% in 1990 to 5.99% in 2005. The share of urban hukou population had a slight increase. The share of fixed investment in GDP increased from 17.87% in 1990 to 45.81% in 2005. The share of FDI in GDP was 0.74% in 1990, increased to 3.84% in 1995, but dropped to 2.51% and 2.30% in 2000 and 2005. Real GDP per capita in neighboring

[7] In 1990, the purchasing power of RMB 1.4 is equivalent to $1.

cities follows a similar trend as GDP per capita in the local city. In Panel C, I include other initial controls at 2000. Real GDP per worker had a mean of RMB 7784.58. Real GDP per worker in industry was RMB 21813.01, higher than RMB 15238.67, the Real GDP per worker in services. The neighboring real GDP per worker was RMB 6601.12, and labor productivity in industry and services was higher, RMB 19142.09 and RMB 14245.29 respectively.

3.3 Results

3.3.1 Cross-sectional Evidence

I examine the impact of industry and services on growth based on cross-sectional data during different periods in Table 3.2. The dependent variable is the average annual growth rate of real GDP per capita. Column (1) of Table 3.2 presents the results by using 20-year interval data during 1990-2010. The estimated coefficients of share of industry output and share of services output are to evaluate the role of industry and services in growth. The results show that one standard deviation increase in the share of industry in GDP is associated with a 1.4 percentage point increase in the subsequent average annual growth rate of GDP per capita.

Conditional on other variables, the increase of the industry share in GDP is equivalent to the decrease of the agricultural share in GDP, which could result from factor reallocation from the agriculture sector to the industry sector. Since the industry sector is more productive than the agricultural sector, this reallocation facilitates subsequent growth. However, the share of services is not significantly associated with the subsequent growth. It indicates that when factors flow from the agricultural sector to the service sector, local growth is not significantly affected. One explanation is that the service sector itself is less likely to achieve productivity growth. Also, the service sector tends to absorb more unskilled labor that have low productivity.

The coefficient of the share of the urban hukou population is negative and significant at the 1% level, implying that a city with a greater initial share of urban hukou population has a slower subsequent growth. One possible reason is that a city with more urban hukou population tends to impose more restrictions on labor mobility, so the local growth therefore slows down due to the labor market distortion. Other control variables, such as share of college population, fixed investment to GDP ratio, FDI to GDP ratio, and capital city dummy, are not significantly associated with subsequent growth.

Table 3.2: Impact of Industry and Services on Growth: Cross-section

	Dependent Variable: Average Annual Growth Rate of Real GDP per Capita		
	(1990-2010)	(1990-2000)	(2000-2010)
	(1)	(2)	(3)
Share of industry output	0.100**	0.122***	0.114***
	(0.044)	(0.028)	(0.033)
Share of service output	0.026	0.079*	-0.009
	(0.034)	(0.043)	(0.035)
Log GDP per capita	-0.022***	-0.011	-0.051***
	(0.007)	(0.008)	(0.008)
Share of college pop.	0.188	-0.085	0.269
	(0.268)	(0.179)	(0.236)
Share of urban hukou pop.	-0.050***	-0.130***	0.004
	(0.019)	(0.022)	(0.024)
Fixed investment/GDP	-0.006	0.026	0.080***
	(0.016)	(0.018)	(0.029)
FDI/GDP	0.007	0.382	0.189**
	(0.095)	(0.241)	(0.089)
Capital	0.006	0.027***	-0.001
	(0.009)	(0.007)	(0.011)
N	257	241	241
Adjusted R^2	0.086	0.474	0.591

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. All regressions control for province fixed effects.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Columns (2) and (3) display regression results based on two 10-year intervals: 1990-2000 and 2000-2010. The estimated coefficients of the share of industry output are 0.122 and 0.114, respectively, both with a 1% significance level. The results confirm the role of the industry sector in economic growth. The services sector is associated with a higher subsequent growth rate only during 1990-2000, but the significance level is only 10%. One potential explanation is that the reallocation of resources from the agriculture sector to the service sector during 1990 was more likely to be controlled by the government and involved more reallocation of high-skilled labor than that in 2000, which could contribute to subsequent economic growth.

Table 3.2 also presents a picture of regional convergence in China since 1990. From column (1), the convergence rate was about 2.2% per year during 1990-2010. Columns (2) and (3) show that the convergence rate varies during different sample periods. Regional convergence mainly happened during 2000-2010, with a convergence rate of 5.1%; there was no convergence during 1990-2000. The findings match some of the existing literature on convergence. Studies based on the country-level or sub-national level find that the β convergence rate is around 2% (Magrini, 2004). Gundlach (1997) examines the provincial-level data from 1979 to 1989 and finds the convergence rate was 2.2%. Wei, Yao, and Liu (2009) document that the convergence rate was about 1.36% during 1979 to 2003. Chen and Sun (2013) use provincial-level data and find the convergence rate was 1.07% during 1990-2010 and 2.4% during 2000-2010. In addition, Chen and Sun (2013) find divergence during 1990-2000. My convergence rate at the city level is greater during 1990-2010 and 2000-2010. One explanation is that borders tend to be less important when investigating cities since the movements of resources are easier across cities than across provinces. This can explain the faster convergence rate found at the city level.

3.3.2 Evidence from Panel Data

In this part, I split the sample period to four five-year intervals, that is, 1990-1995, 1995-2000, 2000-2005, and 2005-2010. I stack the four five-year subperiods and investigate the impact of industry and services on short-term growth.

Table 3.3: Impact of Industry and Services on Growth: Pooled OLS on 5-year Intervals

	Dependent Variable: Average Annual Growth Rate of Real GDP per Capita		
	(1990-2010)	(1990-2000)	(2000-2010)
	(1)	(2)	(3)
Share of industry output	0.117***	0.077**	0.212***
	(0.024)	(0.034)	(0.034)
Share of service output	0.001	0.082	0.030
	(0.042)	(0.053)	(0.059)
Log GDP per capita	-0.039***	-0.014	-0.062***
	(0.008)	(0.009)	(0.011)
Share of college pop.	0.358**	0.487**	0.017
	(0.157)	(0.226)	(0.229)
Share of urban hukou pop.	-0.071***	-0.127***	0.027
	(0.020)	(0.025)	(0.024)
Fixed investment/GDP	0.006	0.034	-0.005
	(0.017)	(0.022)	(0.023)
FDI/GDP	0.062	-0.060	0.127
	(0.062)	(0.058)	(0.100)
Capital	0.011*	0.009	0.020*
	(0.006)	(0.009)	(0.011)
Period (1990-1995)	-0.036***	0.030***	0.000
	(0.009)	(0.007)	(.)
Period (1995-2000)	-0.052***	0.000	0.000
	(0.006)	(.)	(.)
Period (2000-2005)	-0.023***	0.000	-0.037***
	(0.005)	(.)	(0.006)
N	1015	506	509
Adjusted R^2	0.203	0.262	0.339

Note: The unit of observation is a prefecture-level city. Standard errors are clustered at the city-level and reported in parentheses. All regressions control for province fixed effects. Columns (1) and (3) take the last five-year interval during 2005-2010 as the baseline period. Column (2) takes the second five-year interval during 1995-2000 as the baseline period.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Column (1) of Table 3.3 displays the regression based on the whole sample period. The dependent variable is the five-year average annual growth rate of real GDP per capita. In addition to the control variables included in column (1) of Table 3.2, I control for period fixed effects to capture the unobservable time-invariant characteristics during each subperiod. Standard errors are clustered at the city level. The estimated coefficient of share of industry is 0.117, with a significance level of 1%. This coefficient does not significantly differ from the estimated coefficient in the cross-sectional analysis. The estimated coefficient of the share of service is insignificant, suggesting no significant impact on growth. Initial human capital stock is associated with higher subsequent growth, while the initial urban hukou population share is associated with lower subsequent growth. The average growth rate is 1 percentage point higher in a capital city than a non-capital city. The coefficient of each period dummy reflects the period-specific growth relative to the baseline period 2005-2010. The estimated coefficient of log GDP per capita is negative and significant at the 1% level, confirming the convergence effect found in the long-term growth analysis.

In columns (2) and (3) of Table 3.3, I restrict my sample period to 1990-2000 and 2000-2010, respectively. These two regressions can be considered as unrestricted models that allow heterogeneity across different periods. The industry output share is associated with a greater subsequent growth rate during 2000-2010. It implies that the factor reallocation from the agriculture sector to the industry sector during 2000-2010 contributes more on subsequent growth than that during 1990-2000. One potential reason is that the industry sector was more productive during 2000-2010, so it can take advantage of the factors reallocated from the agriculture sector. Although the service sector is associated with subsequent growth during 1990-2010 from cross-sectional analysis in Table 3.2, the results from pooled data analysis here suggest no positive impact of services on growth. One possible explanation is that the estimated coefficient of the service output share in column (2) of Table 3.2 captures a certain period effect. So controlling for the period fixed effect may absorb this impact. I will show the analysis in next table. As for convergence, I found no convergence during 1990-2000, and the convergence rate was 6.2% during 2000-2005.

To better understand the structural transformation and economic growth in China, I further present regression results based on each five-year interval in Table 3.4. The impact of the industry output share is increasing since 1995, which may capture the industry sector's capability to absorb and use resources reallocated from the agriculture sector. The estimated coefficient of the industry output share during 1990-1995 is not significantly different from the one estimated during 2005-2010. However, the sectoral composition in 1990 was more likely to be controlled by the central government, so the positive relationship between 1990-1995 is more likely to reveal growth under government control while the one between 2005-2010 is more likely to reflect growth under market force. The estimated coefficient of the service share output is only positive and significant during 1990-1995. The potential reason could be attributable to the government control on the sectoral composition during that period. Lastly, convergence only existed in the last two five-year intervals, and was faster during 2005-2010. This shows that cities tend to have a different convergence pattern during short term.

Table 3.4: Impact of Industry and Services on Growth: OLS on each Five-year Interval

	Dependent Variable: Average Annual Growth Rate of Real GDP per Capita			
	(1990-1995)	(1995-2000)	(2000-2005)	(2005-2010)
	(1)	(2)	(3)	(4)
Share of industry output	0.180***	0.062*	0.081*	0.186***
	(0.048)	(0.037)	(0.044)	(0.053)
Share of service output	0.131*	0.057	-0.051	-0.044
	(0.078)	(0.056)	(0.054)	(0.077)
Log GDP per capita	-0.026	-0.001	-0.030***	-0.082***
	(0.017)	(0.011)	(0.011)	(0.014)
Share of college pop.	0.102	-0.008	0.392	0.644**
	(0.360)	(0.271)	(0.293)	(0.301)
Share of urban hukou pop.	-0.198***	-0.063**	0.058*	-0.032
	(0.044)	(0.025)	(0.035)	(0.022)
Fixed investment/GDP	0.032	0.033	0.129***	0.008
	(0.034)	(0.029)	(0.031)	(0.026)
FDI/GDP	0.719***	0.072	0.378***	-0.147
	(0.259)	(0.059)	(0.123)	(0.138)
Capital	0.025**	0.021*	-0.012	-0.011
	(0.012)	(0.012)	(0.014)	(0.018)
N	259	247	241	268
Adjusted R^2	0.431	0.186	0.519	0.586

Note: The unit of observation is a prefecture-level city. Robust standard errors are reported in parentheses. All regressions control for province fixed effects.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.3.3 Growth in Labor Productivity

In the last two sections, economic growth was measured by GDP per capita. In this section, I use GDP per worker, namely, labor productivity to measure economic growth and investigate the impact of sectoral composition on labor productivity. I divide GDP by total employment to obtain GDP per worker. The sample period is restricted to 2000-2010 due to data limitations. Employment data at the city-level are from Population Censuses of 2000 and 2010.

Table 3.5: Impact of Industry and Services on Labor Productivity Growth during 2000-2010

	Dependent Variable: Average Annual Growth Rate of Real GDP per Worker				
	(All)	(Industry)	(Industry)	(Services)	(Services)
	(1)	(2)	(3)	(4)	(5)
Share of industry output	0.096***	0.116***	0.122***	0.055**	0.055**
	(0.028)	(0.038)	(0.040)	(0.024)	(0.023)
Share of service output	0.004	-0.033	-0.002	-0.030	-0.045
	(0.033)	(0.057)	(0.077)	(0.034)	(0.047)
Log GDP per worker	-0.044***				
	(0.006)				
Log GDP per worker in industry		-0.057***	-0.053***		-0.003
		(0.007)	(0.010)		(0.007)
Log GDP per worker in services			-0.008	-0.052***	-0.050***
			(0.013)	(0.006)	(0.008)
Share of college pop.	0.269	0.702**	0.677**	0.612***	0.644***
	(0.217)	(0.318)	(0.324)	(0.184)	(0.197)
Share of urban hukou pop.	0.032	-0.027	-0.026	-0.046**	-0.049**
	(0.022)	(0.034)	(0.034)	(0.021)	(0.022)
Fixed investment/GDP	0.102***	0.094**	0.088**	0.054**	0.055**
	(0.029)	(0.037)	(0.037)	(0.023)	(0.023)
FDI/GDP	0.102	-0.009	0.003	0.212***	0.205***
	(0.063)	(0.094)	(0.097)	(0.069)	(0.070)
Capital	-0.005	-0.017	-0.018	-0.010	-0.010
	(0.010)	(0.015)	(0.015)	(0.009)	(0.009)
N	241	241	241	241	241
Adjusted R^2	0.550	0.552	0.550	0.582	0.580

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. All regressions control for province fixed effects.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In column (1) of Table 3.5, the dependent variable is the annual average growth rate of real GDP per worker. The control variables are the same as in column (1) of Table 3.2 with the exception that real log GDP per worker now substitutes log GDP per capita. Robust standard errors are displayed in the parentheses. Based on the results, one standard deviation increase in the share of industry output was associated with a 1.06 percentage point increase in subsequent labor productivity growth. The coefficient is not significantly different from the one in column (3) of Table 3.2. The estimated coefficient of the share of service output is not significant at the 10 percentage level, suggesting that services do not significantly drive economic growth during 2000-2010. The estimated coefficient of log GDP per worker is -0.044, with a significance level of 10%, reflecting the convergence effect. The convergence rate is not significantly different from the one estimated in column (3) of Table 3.2.

With the availability of sectoral employment data, I further investigate the impact of sectoral composition on labor productivity in both industries and services. I construct labor productivity in each sector by dividing the sectoral GDP by its total employment. Column (2) of Table 3.5 displays the regression that examines the impact of sectoral composition on labor productivity growth in the industry sector. It shows that a one standard deviation increase in the share of industry output was associated with 1.28 percentage points increase in subsequent labor productivity growth in the industry sector. Services do not contribute to the growth of labor productivity in the industry sector. The estimated coefficient of log value of GDP per worker in industry is -0.057 and significant at the 1% level. This finding suggests the existence of convergence in the industry sector. In column (3), I further add the log value of GDP per worker in services to test if the initial labor productivity in the service sector is associated with subsequent growth of labor productivity in the industry sector. The results do not change significantly from column (2). The estimated coefficient of log GDP per worker in services is insignificant at the 10% level, indicating that higher labor productivity in services does not affect the growth of labor productivity in the industry.

Column (4) presents the regression that investigates the impact of sectoral composition on labor productivity growth in services. Industry is found to have a positive impact on the growth of labor productivity in services. When there is a one standard deviation increase in the share of industry output, the growth rate of GDP per worker in services will increase by 0.6 percentage points. One explanation is that the growth of the industry sector may potentially increase the demand for local services or generate technology spillovers, which may lead to growth of the service sector. Combined with column (2), we can tell that the industry output share contributes more to the labor productivity growth in the industry sector than in the service sector. This may be because a larger industry sector is more likely to benefit from agglomeration and economic scale, which can raise the labor productivity in the industry sector, and this impact is greater than the spillovers on the service sector. The estimated coefficient of log GDP per worker in services is -0.052, with a significance level of 1%. So convergence also exists in the services sector. In column (5), I include log GDP per worker in industry to control for the potential inter-sectoral spillovers effects. However, the higher labor productivity in the industry sector seems to not contribute to the labor productivity growth in the services sector.

3.3.4 Measuring Industrialization using Employment Shares

In this section, I replace the measurement of industrialization - share of industry output - in Table 3.5 by share of industry employment. The industry output share captures production by various factors like capital, technology, and labor. The industry ndustry employment share, however, focuses more on the labor market. When employment share increases, it does not necessarily lead to an increase in labor input. I will investigate whether the findings will be affected when measuring industrialization by employment share. The results are displayed in Table 3.6.

Table 3.6: Impact of Industry Employment on Labor Productivity Growth during 2000-2010

	Dependent Variable: Average Annual Growth Rate of Real GDP per Worker				
	(All)	(Industry)	(Industry)	(Services)	(Services)
	(1)	(2)	(3)	(4)	(5)
Share of industry employment	0.059**	0.034	0.054*	0.071***	0.103***
	(0.023)	(0.029)	(0.029)	(0.018)	(0.021)
Log GDP per worker	-0.030***				
	(0.005)				
Log GDP per worker in industry		-0.039***	-0.035***		0.016***
		(0.006)	(0.006)		(0.004)
Log GDP per worker in services			-0.016*	-0.057***	-0.067***
			(0.010)	(0.005)	(0.006)
Share of college pop.	0.212	0.562*	0.675**	0.694***	0.589***
	(0.215)	(0.321)	(0.315)	(0.185)	(0.171)
Share of urban hukou pop.	0.018	0.017	0.002	-0.068***	-0.074***
	(0.024)	(0.035)	(0.035)	(0.023)	(0.022)
Fixed investment/GDP	0.123***	0.109***	0.095**	0.063***	0.057***
	(0.028)	(0.037)	(0.038)	(0.022)	(0.021)
FDI/GDP	0.046	0.015	0.010	0.150*	0.143**
	(0.073)	(0.112)	(0.106)	(0.077)	(0.072)
Capital	-0.011	-0.026	-0.026	-0.018*	-0.011
	(0.011)	(0.016)	(0.016)	(0.009)	(0.008)
N	241	241	241	241	241
Adjusted R^2	0.532	0.523	0.526	0.572	0.603

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. All regressions control for province fixed effects.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Column (1) examines to what extent the share of industry employment affects the growth rate of labor productivity during 2000-2010. When there is a one standard deviation increase in the share of industry employment, the growth rate of labor productivity will be increased by 0.75 percentage points. The share of service employment is not included because of multicollinearity.[8] From column (1) of Table 3.5, one standard deviation increase in the share of industry output was associated with a 1.06 percentage point increase in subsequent labor productivity growth. One may ask why the industry output share and the industry employment share have such different impacts on the subsequent labor productivity growth. When the industry output share increases, it may reflect the adoption of advanced technology

[8]When adding share of service employment as an additional control, its VIF is above 10 based on the regression.

and other factors, like capital or labor. When the industry employment share increases, it could be because labor is needed to operate new equipments or master new technology, or it may result from the expansion of some labor-intensive industries. As a result, increase in the industry employment share may be associated with slower labor productivity growth than the industry output share. Interestingly, a one standard deviation increase in the industry employment share is associated with a 0.68 percentage point increase in the industry labor productivity growth and a 1.3 percentage point increase in the service labor productivity growth. It indicates that increasing labor in the industry sector can generate a greater impact on the service sector. Because workers in the industry sector on average earn more than workers in other sectors, growing industry employment can lead to growth of the service sector. The increasing industry employment contributes less to the industry labor productivity growth, which may be because a higher industry employment share does not necessarily go hand in hand with better technology, which is essential to productivity growth.

Table 3.6 also presents the existence of convergence in both industry and service sectors. The convergence rates are 3.5% and 6.7% per year in the industry and service sectors respectively. The convergence rates are different from those in Table 3.5, but one should be cautious when interpreting convergence rates that rely on different conditional variables. Nevertheless, the results do show the existence of convergence in both sectors.

3.3.5 Robustness to Spatial Effects

The economic growth of a city may be affected by the development in neighboring regions due to spillovers of technology as well as movements of people and capital. Ignoring the potential spatial impact will lead to biased estimates. To address this concern, I further include variables that reflect the development in neighboring cities. I define two cities as neighbors if they share a common border.

Table 3.7: Impact of Industry and Services on Growth, with Spatial Controls

	Dependent Variable: Average Annual Growth Rate of Real GDP per Capita					
	Cross Section			Pooled OLS		
	(90-10)	(90-00)	(00-10)	(90-10)	(90-00)	(00-10)
	(1)	(2)	(3)	(4)	(5)	(6)
Share of industry output	0.100**	0.121***	0.118***	0.117***	0.076**	0.212***
	(0.044)	(0.028)	(0.033)	(0.024)	(0.034)	(0.034)
Share of service output	0.026	0.079*	0.003	0.007	0.080	0.042
	(0.034)	(0.043)	(0.034)	(0.042)	(0.053)	(0.062)
Log GDP per capita	-0.022***	-0.011	-0.049***	-0.037***	-0.014	-0.059***
	(0.007)	(0.008)	(0.007)	(0.008)	(0.010)	(0.011)
Share of college pop.	0.194	-0.076	0.238	0.334**	0.500**	-0.034
	(0.272)	(0.181)	(0.236)	(0.158)	(0.228)	(0.238)
Share of urban hukou pop.	-0.049**	-0.129***	-0.003	-0.074***	-0.126***	0.019
	(0.019)	(0.022)	(0.022)	(0.020)	(0.026)	(0.023)
Fixed investment/GDP	-0.005	0.027	0.080***	0.004	0.036	-0.004
	(0.016)	(0.018)	(0.029)	(0.017)	(0.023)	(0.023)
FDI/GDP	0.005	0.380	0.201**	0.070	-0.062	0.151
	(0.095)	(0.241)	(0.088)	(0.063)	(0.058)	(0.102)
Capital	0.006	0.027***	0.000	0.012*	0.009	0.021*
	(0.009)	(0.007)	(0.011)	(0.006)	(0.009)	(0.011)
Log GDP per capita in nbr.	0.001	0.001	-0.003	-0.004*	0.001	-0.007*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
N	257	241	241	1015	506	509
Adjusted R^2	0.082	0.472	0.594	0.205	0.260	0.349

Note: The unit of observation is a prefecture-level city. All regressions control for province fixed effects. Columns (1) to (3) report robust standard errors in parentheses. Columns (4) to (6) report standard errors clustered at the city level in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Columns (1)-(3) in Table 3.7 display regressions based on cross-sectional data - 1990-2010, 1990-2000, 2000-2010. They investigate the impact of sectoral composition on the growth rate of real GDP per capita with spatial controls. For each regression, I control for average of log GDP per capita in neighboring cities. The estimated coefficient of spatial control is insignificant during every sample period. The estimated coefficients of the share of industry output are not significantly different from the ones estimated in Table 3.2.

In columns (4) - (5) of Table 3.7, I examine the same question by using pooled data in the following periods: 1990-2010, 1990-2000, and 2000-2010. The estimated coefficients of the log value of GDP per capita in the neighboring regions is -0.004 and significant at the 10% . during 1990-2010, suggesting negative spillovers from neighboring regions during 1990-2010.

When restricting the sample period to 1990-2000 and 2000-2010, the negative spillovers exist only during 2000-2010. As for the estimated coefficients of share of industry output, there are no significant changes from the regressions without spatial controls.

Table 3.8 reports the results based on regressions over the period 2000-2010 that use growth rate of labor productivity to measure economic growth. In column (1), I include log GDP per worker in the neighboring regions. There are no significant spillovers from the neighboring development. In column (2), I investigate the impact of industry on the growth of labor productivity in the industry sector after controlling for spatial variables. I include the average share of industry and average log GDP per worker in industry in the neighboring regions to approximate the neighboring regions' development. The insignificant estimated coefficients of both spatial controls indicate no inter-regional spillover effect. The estimated coefficient of share of industry output is not significantly different from the one estimated in column (2) of Table 3.5. Results are robust when including labor productivity in services as an additional control in column (3).

In column (4) of Table 3.8, I examine the impact of industry on labor productivity growth in the service sector, using average share of service output and average log GDP per worker in services in neighboring regions as spatial controls. Again, I find no inter-regional spillover effects. When I include labor GDP per worker in industry in column (5), the results remain robust.

In Table 3.9, I take share of industry employment as an alternative measure of industrialization and study its impact on growth during 2000-2010 after considering the potential effect from neighboring regions. Other control variables are the same as those in Table 3.6. Table 3.9 also shows the robust impact of the industry sector on economic growth after controlling for spatial effects.

Table 3.8: Impact of Industry and Services on Growth during 2000-2010, with Spatial Controls

	Dependent Variable: Average Annual Growth Rate of Real GDP per Worker				
	(All)	(Industry)	(Industry)	(Services)	(Services)
	(1)	(2)	(3)	(4)	(5)
Share of industry output	0.100***	0.121***	0.125***	0.053**	0.053**
	(0.028)	(0.038)	(0.039)	(0.024)	(0.024)
Share of service output	0.014	-0.018	0.006	-0.032	-0.042
	(0.033)	(0.059)	(0.078)	(0.035)	(0.048)
Log GDP per worker	-0.043***				
	(0.006)				
Log GDP per worker in industry		-0.056***	-0.053***		-0.002
		(0.008)	(0.011)		(0.007)
Log GDP per worker in services			-0.006	-0.050***	-0.049***
			(0.013)	(0.007)	(0.008)
Share of college pop.	0.249	0.673**	0.654**	0.597***	0.619***
	(0.216)	(0.319)	(0.324)	(0.185)	(0.200)
Share of urban hukou pop.	0.025	-0.033	-0.032	-0.050**	-0.052**
	(0.021)	(0.033)	(0.034)	(0.021)	(0.022)
Fixed investment/GDP	0.101***	0.094**	0.089**	0.057**	0.058**
	(0.029)	(0.037)	(0.038)	(0.023)	(0.023)
FDI/GDP	0.111*	0.002	0.009	0.213***	0.208***
	(0.062)	(0.099)	(0.101)	(0.069)	(0.070)
Capital	-0.004	-0.016	-0.016	-0.008	-0.008
	(0.010)	(0.015)	(0.015)	(0.009)	(0.009)
Log GDP per worker in nbr.	-0.002				
	(0.002)				
Log GDP per worker in nbr. industry		-0.002	-0.002		
		(0.003)	(0.003)		
Share of industry in nbr.		-0.007	-0.004		
		(0.051)	(0.053)		
Log GDP per worker in nbr. services				-0.003	-0.003
				(0.002)	(0.002)
Share of service in nbr.				0.038	0.035
				(0.054)	(0.054)
N	241	241	241	241	241
Adjusted R^2	0.553	0.550	0.549	0.581	0.579

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. All regressions control for province fixed effects.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.9: Impact of Industry Employment on Labor Productivity Growth during 2000-2010, with Spatial Controls

	Dependent Variable: Average Annual Growth Rate of Real GDP per Worker				
	(All)	(Industry)	(Industry)	(Services)	(Services)
	(1)	(2)	(3)	(4)	(5)
Share of industry employment	0.062***	0.056*	0.068**	0.055***	0.086***
	(0.023)	(0.030)	(0.030)	(0.018)	(0.020)
Log GDP per worker	-0.030***				
	(0.005)				
Log GDP per worker in industry		-0.039***	-0.036***		0.017***
		(0.005)	(0.006)		(0.003)
Log GDP per worker in services			-0.013	-0.055***	-0.066***
			(0.010)	(0.006)	(0.006)
Share of college pop.	0.216	0.579*	0.663**	0.683***	0.577***
	(0.210)	(0.323)	(0.318)	(0.182)	(0.163)
Share of urban hukou pop.	0.010	0.007	-0.002	-0.069***	-0.074***
	(0.023)	(0.036)	(0.036)	(0.022)	(0.021)
Fixed investment/GDP	0.123***	0.106***	0.096**	0.069***	0.063***
	(0.029)	(0.037)	(0.039)	(0.021)	(0.020)
FDI/GDP	0.053	0.056	0.046	0.137*	0.129*
	(0.072)	(0.114)	(0.111)	(0.079)	(0.074)
Capital	-0.010	-0.026	-0.026	-0.014	-0.007
	(0.011)	(0.017)	(0.016)	(0.009)	(0.008)
Log GDP per worker in nbr.	-0.002				
	(0.002)				
Share of nbr. industry employment		-0.062	-0.054		
		(0.043)	(0.044)		
Log GDP per worker in nbr. industry		-0.002	-0.001		
		(0.002)	(0.002)		
Share of nbr. services employment				0.122**	0.128**
				(0.053)	(0.051)
Log GDP per worker in nbr. services				-0.004**	-0.004***
				(0.001)	(0.001)
N	241	241	241	241	241
Adjusted R^2	0.536	0.525	0.526	0.584	0.616

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. All regressions control for province fixed effects.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

As for spatial effects, the results indicate no spillovers on overall or industry labor productivity from neighboring regions. Interestingly, I find that a city will have lower labor productivity growth in service if its neighboring regions have higher labor productivity in services sector. However, if the neighboring regions have a higher share of service employment, the labor productivity in services in the local city will grow faster. Compared to the insignificant spatial effects estimated in columns (4) and (5) of Table 3.8, one may wonder why such differences exists. One possible reason is that a city may have more interactions with cities within their provinces, so controlling the provinces fixed effects may potentially absorb the spatial effects. However, the mechanism of the interaction between neighboring regions can be investigated in future research, and attention to different controls is needed, since they may lead to different patterns of the spatial effects.

3.4 Conclusion

In this paper, I investigate the impact of industry and service on economic growth at the prefecture-level cities in China during 1990-2000. It shows that a city with a greater initial share of industry in GDP was associated with subsequent growth in GDP per capita. There is no clear impact of service on growth. This is also true when examining the labor productivity growth in both industry and service sectors. The findings suggest that if a city initially has a greater industry sector, it can be benefited in certain ways that lead to a sustained growth. One potential channel is that agglomeration of industries is more likely to occur in regions that already have large industry sectors, so more businesses will be attracted to these regions due to the availability of technology, intermediate inputs, labor, etc. In addition to the agglomeration effects, the industry sector can generate stronger intersector linkages. When the industry sector grows, it will lead to increased demand for local services, driving the growth of the service sector. Lastly, examining the sources of the industry share may provide some insights on structural transformation. For example, it is possible that some regions have location advantages, better access to immediate goods, or favorable policies from the central government that trigger the growth of the industry sector. Investigating these factors can be an interesting area in further research.

Chapter 4. Temporary Rural-Urban Migration in China

4.1 Introduction

According to the Migrant Report by National Bureau of Statistics, there were about 145 million rural-urban migrants in 2009 in China, accounting for 34% of the total rural labor force. The large wage gap between rural and urban areas is assumed to be the most important incentive for rural-urban migration (Wu and Zhu, 2004; Knight and Song, 1995). In spite of the existing wage gap, not everyone migrates to cities; and for those who do migrate, they only migrate temporarily. The Rural-Urban Migration in China (RUMiC), a national representative data set for rural-urban migrants, shows that rural laborers on average spend about 7 years in urban areas (Meng, 2012). This pattern of temporary rural-urban migration in China raises several questions. Why do some rural people migrate to urban areas while others stay? For those migrating to urban areas, why do they stay in the city temporarily? What determines an individual's migration duration and the aggregate migrant stocks?

In this paper, I build a model that features the role of price differential in services, which mainly consist of education and housing, in determining the migration pattern. In the model, people with higher abilities migrate to cities as they earn higher wages there; yet, they do not necessarily stay in the city permanently because of the higher services costs. Instead, they work in the city for a period of time to accumulate wealth, with which they spend later in rural areas where the services price is lower. Higher services price differential will increase individual's savings rate during migration, decrease the migration duration, but increase the aggregate temporary migrant stock both in absolute term and relative to the permanent migrant stock.

Rural people in China value education and housing. In 2009, 8% of the rural household's consumption expenditure is devoted to education and 21% to housing. Following food consumption, which accounts for 35% of total consumption expenditure, these two categories are the second largest contributor to the rural consumption (National Bureau of Statistics, 2010b). To make a contrast, an average household only spends about 5% on clothing (National Bureau of Statistics, 2010b). For households with rural-urban migrants, they spend even more on education and housing, respectively 10.6% and 35.4% out of total expenditure in 2009 (National Bureau of Statistics, 2012). Combined together, they take even a larger share than the expenditure on food, clothing and transportation, which is 27.4% in total (National Bureau of Statistics, 2012).

Rural-urban migrants need to pay higher services price in host cities than they do at hometown. As for children's education, the cost in cities (2205 RMB/year) is about 3.3 times the cost (677 RMB/year) in rural areas in 2007 (Liu, 2013). Extra fee, in the name of sponsorship fee, is charged because rural-urban migrants do not have host city hukou[1] and thus are effectively excluded from associated schooling subsidy by the local government (Chen and Feng, 2013). The amount of extra fee charged varies city by city. In the most severe case, Shen Zhen, one of the cities where migrants flowed to, the extra fee is as high as 3407 RMB/year in 2007, more than twice the monthly wage income of an migrant[2] (Liu, 2013). In some cases, migrants are required to provide certificates about residence, employment, social insurance enrollment, birth planning policy compliance, and health conditions to enroll their children into local public school (Li and Chui, 2011). As a result of the barriers to access to local public school, 24% of migrant children who live with their parents are enrolled in the so called "migrant schools", which are often unlicensed, and provide poor facilities and human resources (Liu, 2013). More revealing about the high education cost in host city, in 2012, 14.15 million school age children (6-14 years old) are left behind by parents

[1] Hukou works like an internal passport, it entitles people the local social benefit where the hukou is issued.

[2] The average monthly wage income for a migrant worker is 1650 RMB/year.

at hometown, accounting for about 49% out of the total school age children belonging to migrants households (All China Women's Federation, 2013).

The housing price in cities is also higher than that in rural areas. The residential land price in 36 major cities was 5117 RMB/sqm in 2009 (Ministry of Land and Resources, 2010). It is equivalent to 3.6 times monthly wage for a rural-urban migrant. The housing price is even higher as it also includes other cost. This explains the facts that only 0.8% of rural-urban migrants purchased house where they were working, 50% of rural-urban migrants lived in dormitory, and those who were renting only spent on average of 245 yuan per month (National Bureau of Statistics, 2010a), far away from affording a good living condition. While not directly comparable, evidence shows that the rural housing is cheaper. The present housing value of one squared meter in rural areas is about 991 RMB in 2011 [3] (CFPS, 2012).

This paper is closely related to the work by Djajić and Milbourne (1988), Stark, Helmenstein, and Yegorov (1997),Dustmann (2003), and Brücker and Schröder (2006) on international temporary migration. They all assume preference for consumption in home country, so that people want to return home after working abroad for a while. The home preference is either generated by exogenous preference assumption or by a higher general price level in host country. Similar to these research, my paper also builds on the intuition that utility difference out of consumption between the host and home areas keeps people from migrating permanently. Different from them, I model a more specific channel, higher services price in urban areas, to generate people's preference for rural areas. I argue that such a model setup is appealing for studying internal temporary migration. Different from international migration, agents are unlikely to have strong exogenous home preferences when they move within a country to live and work in a city of similar culture and lifestyle. Also, one cannot assume a general price difference, as the low transaction cost will arbitrage away such a difference in traded goods like clothing, motorcycle, and so on. Instead, the price difference in the non-traded service is an appropriate way to generate the location specific preference.

[3] The present housing value of one squared meter in urban areas is about 6500 RMB (CFPS, 2012).

Djajić and Vinogradova (2015) study the effect of housing price on an agent's international migration duration by solving his utility maximization problem. They assume that the agent chooses an optimal migration duration with a savings target for a "luxury" home purchase upon return. In their environment, the housing services for host country and home country are fixed. My model differs in that I model a composite service good for internal migration, and agents are allowed to choose service quantities. Moreover, I study an equilibrium heterogeneous agent model. The model setup enables me to analyze permanent, temporary, returned and non-migrants stocks.

The paper is also related to literature on rural-urban migration in China. Démurger and Xu (2011) use a two period overlapping generation model to study how left behind children affect whether an agent will return in the second period. Liu (2011) models an economy where rural people migrate to cities temporarily to earn money for starting business after return. Empirical evidence, however, shows no clear impact of temporary migration on productive investment in rural areas (De Brauw and Rozelle, 2008; Zhu et al., 2014, 2012). To my limited knowledge, this is the first paper to model temporary rural-urban migration in China through urban/rural services price differential. This is also the first paper to endogenously model migration duration for internal temporary migrants. While the high education cost for rural-urban migrants might be unique to China, high urban housing prices are pandemic. Therefore, the model may potentially be applied to explain the temporary migration phenomenon in other developing countries as well.

4.2 Related Background on China

Rural-urban migration in China was strictly restricted under the Household Registration System (hukou) established since 1958. Hukou system divides people into two groups: rural hukou holders and urban hukou holders. Because hukou was closely related to food ration, access to amenities and social services at that time, rural-urban migration without changing hukou status was impossible (Wu, 2009). The requirement for changing hukou status was strict. As a result, the rural-urban migration was strictly controlled.

The hukou policy was gradually relaxed with the economic reform beginning in 1978. In response to increased labor demand from special economic zones during the 1980s, migrants were allowed to work in cities after they applied for temporary registration in the city where they worked. Fast growth of cities in late 1990s and China's entry of WTO further increased demand for unskilled labor substantially and migration restriction then relaxed considerably (Meng, 2012). Nowadays, everyone is allowed to work freely in cities. Hukou status today is mainly related to local social benefits like medical care, housing assistance and education (Li and Chui, 2011). Except for education, however, other policies are not likely to have large impact on rural people's migration pattern. For medical care, they can work in cities without giving up their rural hukou related benefit (Liu and Tsegai, 2011). As for housing assistance benefit, they do not have it in rural areas either.

Although rural-urban migration is no longer strictly restricted today, changing rural hukou to urban hukou remains difficult. Urban hukou are mostly issued to those who are highly educated, or rich enough to make large investment (e.g. on housing), or immediately family of existing urban residents (Chan and Buckingham, 2008). However, 77% of rural-urban migrants, the target of my model, have at most 9 years of education (National Bureau of Statistics, 2010a). Their meager income cannot afford the expensive investment in cities. Thus they are unlikely to acquire an urban hukou, although they can stay in urban areas permanently.

4.3 The Model

4.3.1 The Environment

Demographic Structure: There are only rural hukou holders in the model. The total population is of mass T. There is no population growth. At each instant, one cohort is born. Each individual lives T periods and supplies labor inelastically from age 0 to T. Individual i from the cohort is endowed with random ability a_i, and when he works in the urban sector, his effective labor supply is a_i, but when he works in the rural sector his effective labor supply is one. Ability a_i is drawn from the uniform distribution $a \sim U[a_{min}, a_{max}]$.

Consumption Good Production: There are two sectors, rural and urban, to produce the homogeneous consumption good whose price is normalized to 1. The labor markets in both sectors are competitive. In the urban sector, the production function is

$$Y_U = \tilde{B} L_{e,U}^{\gamma_1}. \tag{4.1}$$

Here $L_{e,U}$ is the effective labor employed in urban sector. $\tilde{B}$ is a constant representing all other factors that affect urban consumption good production including technology, urban hukou holders' labor supply, capital and so on. $0 < \gamma_1 < 1$, so that $\frac{\partial Y_U}{\partial L_{e,U}} > 0, \frac{\partial^2 Y_U}{\partial^2 L_{e,U}} < 0$, that is, urban consumption good production increases with effective labor supply but the marginal product of labor decreases with it. Rural-urban migrants earn wages and profits go to urban hukou holders who are outside the model and assumed to consume all of the profits.

In the rural sector, the production function is

$$Y_R = \tilde{A} L_{e,R}. \tag{4.2}$$

$\tilde{A}$ is a constant representing productivity of rural production and $L_{e,R}$ is the effective labor employed in the rural sector.

Service Supply: The composite service mainly consists of housing and education services. Rural-urban migrants pay P_U for one unit of service in cities, and pay P_R after they return home. Prices are exogenous, and $P_U > P_R$. This assumption is consistent with the facts that housing prices are higher in cities, that rural-urban migrants have a negligible impact on urban housing prices (Chen et al. 2011), and that they need to pay an expensive fee for city education because of hukou restrictions.

Preference: At each instant, individual i's utility is $U(c_{i,s}, s_{i,s}) = \frac{(c_{i,s}^{\alpha} s_{i,s}^{1-\alpha})^{1-\theta}}{1-\theta}$. Individuals live either in urban(s=U) or rural(s=R) areas. $c_{i,s}$ is goods consumption in area s, and $s_{i,s}$ is services consumption in area s. $0 < \alpha < 1$ is the share of total expenditure on the consumption good.

$\theta > 0$ is the constant relative risk aversion governing agent's consumption smoothing motive, and in this Cobb-Douglas utility function, it also determines whether goods and services are Edgeworth substitutes ($\theta > 1$) or Edgeworth complements ($\theta < 1$). For the sake of simplicity, I assume the discount factor to be 1 and that there is no interest rate. These assumptions do not affect the qualitative results of the model.

Lifetime utility for individual i is

$$\int_0^{\tau_i} U(c_{i,U}, s_{i,U})dt + \int_{\tau_i}^{T} U(c_{i,R}, s_{i,R})dt, \tag{4.3}$$

where τ_i is migration duration. If $\tau_i = 0$, the individual will stay in the rural sector for the duration of his life; if $\tau_i = T$, the agent will stay in the urban sector for the duration of his life. For simplicity, I assume that people always migrate first and later return.

Agent i chooses the migration duration $\tau(i)$, consumption good $c_{i,s}(t)$ and service $s_{i,s}(t)$ in rural (s=R) and urban areas (s=U)to maximize his lifetime utility (4.3) subject to

$$\int_0^{\tau_i} (c_{i,U}(t) + P_U s_{i,U}(t))dt + \int_{\tau_i}^{T} (c_{i,R}(t) + P_R s_{i,R}(t))dt = a_i w_U \tau_i + w_R(T - \tau_i). \quad (4.4)$$

w_U is rural-urban migrants' wage per effective labor in the urban sector, w_R is the wage in the rural sector. These are assumed to be constant over the worker's lifetime as this paper focuses on steady-state equilibrium instead of the transition process.

4.3.2 Agent's Problem

At each instant, given total expenditure e,, agent i will consume $c_{i,s} = \alpha e, s_{i,s} = \frac{(1-\alpha)e}{P_s}$ ($s = U$ or R). The indirect utility function can be written as

$$u_s(e) = \frac{(c_{i,s}^{\alpha} s_{i,s}^{1-\alpha})^{1-\theta}}{1-\theta} = \frac{(\alpha^{\alpha}(1-\alpha)^{1-\alpha})^{1-\theta}}{1-\theta} \frac{e^{1-\theta}}{P_s^{(1-\alpha)(1-\theta)}}. \quad (4.5)$$

From the above equation, it is plain to see since $P_U > P_R$ by assumption, $u_U(e) < u_R(e)$. Given the same expenditure, the agent enjoys higher utility in the rural sector, no matter whether $\theta > 1$ or $\theta < 1$. This reason that some people return to rural areas even though they can earn higher wages in cities. From the above equation, it is possible to represent the agent's problems in expenditure form.

$$max_{e_{i,U}, e_{i,R}, \tau_i} \int_0^{\tau_i} u_U(e_{i,U}(t))dt + \int_{\tau_i}^{T} u_R(e_{i,R}(t))dt \quad (4.6)$$

$$\text{subject to } \int_0^{\tau_i} e_{i,U}(t)dt + \int_{\tau_i}^{T} e_{i,R}(t)dt = a_i w_U \tau_i + w_R(T - \tau_i), \quad (4.7)$$

where $e_{i,U}(t) = c_{i,U}(t) + P_U s_{i,U}(t), e_{i,R}(t) = c_{i,R}(t) + P_R s_{i,R}(t)$.

Solving the problem by the method of Lagrange, the first order conditions for expenditure are

$$u'_U(e_{i,U}(t)) = \lambda \tag{4.8}$$

$$u'_R(e_{i,R}(t)) = \lambda, \tag{4.9}$$

and the first order conditions for migration duration is

$$u_U(e_{i,U}(\tau_i)) - u_R(e_{i,R}(\tau)) + \lambda(a_i w_U - w_R - e_{i,U}(\tau_i) + e_{i,R}(\tau_i)) = 0, \tag{4.10}$$

where λ is Lagrangian multiplier.

From equations (4.8) and (4.9), it is obvious that expenditure in each sector is constant: $e_{i,U}(t) = e^*_{i,U}, e_{i,R}(t) = e^*_{i,R}$, and the agent equalizes marginal utility from expenditure in urban and rural areas, i.e. $u'_U(e^*_U) = u'_R(e^*_R)$. From equation (4.5),

$$\frac{e_{i,U}^{-\theta}}{P_U^{(1-\alpha)(1-\theta)}} = \frac{e_{i,R}^{-\theta}}{P_R^{(1-\alpha)(1-\theta)}}. \tag{4.11}$$

From equation(4.10),

$$u_R(e^*_{i,R}) - u_U(e^*_{i,U}) = u'_R(e^*_R)(a_i w_U - w_R - e^*_{i,U} + e^*_{i,R}). \tag{4.12}$$

This implies that agents optimize their migration duration when the utility loss from staying in the city for an extra unit of time equals the utility gain from saving in that period.

Combining the first order conditions with the budget constraint yields

$$e^*_{i,U} = \frac{1-\theta}{\theta}(a_i w_U - w_R)\frac{1}{\phi - 1} \tag{4.13}$$

$$e^*_{i,R} = \frac{1-\theta}{\theta}(a_i w_U - w_R)\frac{\phi}{\phi - 1} \tag{4.14}$$

$$\tau_i = [(1-\theta)\frac{\phi}{\phi-1} - \theta\frac{1}{a_i\frac{w_U}{w_R} - 1}]T, \tag{4.15}$$

where $\phi = (\frac{P_U}{P_R})^{\frac{(1-\alpha)(1-\theta)}{\theta}}$, $\phi < 1$ if $\theta > 1$, and $\phi > 1$ if $\theta < 1$. The role of θ is analyzed in the subsequent section.

The optimal flows of consumption on goods and services in both areas follow:

$$c_{i,U}(t) = c^*_{i,U} = \frac{\alpha(1-\theta)}{\theta}(a_i w_U - w_R)\frac{1}{\phi - 1} \tag{4.16}$$

$$c_{i,R}(t) = c^*_{i,R} = \frac{\alpha(1-\theta)}{\theta}(a_i w_U - w_R)\frac{\phi}{\phi - 1} \tag{4.17}$$

$$s_{i,U}(t) = s^*_{i,U} = \frac{(1-\alpha)(1-\theta)}{\theta}(a_i w_U - w_R)\frac{1}{P_U}\frac{1}{\phi - 1} \tag{4.18}$$

$$s_{i,R}(t) = s^*_{i,R} = \frac{(1-\alpha)(1-\theta)}{\theta}(a_i w_U - w_R)\frac{1}{P_R}\frac{\phi}{\phi - 1}. \tag{4.19}$$

4.3.3 Partial Equilibrium Analysis

In this section I take wages and prices as given in order to analyze expenditure, consumption of goods and services, saving, migration duration, and migrant stocks.

Migration Duration

From (4.15), agents whose optimal migration duration satisfies $0 < \tau_i < 1$ are temporary migrants. They tend to stay longer in a city if the urban wage increases, i.e. $\frac{\partial\tau(i)}{\partial w_U} > 0$. Among all the temporary migrants, when urban wage rises, lower-ability workers delay their return more than higher-ability workers, i.e. $\frac{\partial(\partial\tau_i/\partial w_U)}{\partial a_i} < 0$.

As for the rural wage, agents spend less time in cities when the rural wage increases, i.e. $\frac{\partial\tau(i)}{\partial w_R} < 0$. The implication is that people from poorer areas stay longer in city. When rural wage rises, lower ability workers accelerate their return more than higher ability workers, i.e. $\frac{\partial(\partial\tau_i/\partial w_R)}{\partial a_i} > 0$. The analysis above shows that the marginal effect of wage (urban or rural) on migration duration is always larger for workers of lower ability.

If the services price differential increases, agents stay a shorter period in the city, i.e. $\frac{\partial\tau(i)}{\partial P(_U/P_R)} < 0$. Intuitively, the higher the service price in urban areas, the higher the utility cost of an individual consuming in urban areas, so he wishes to return home sooner rather than later. The marginal effect of services price differential on migration duration, however, is same for all the workers.

Expenditure and Consumption

For non-migrants ($\tau_i = 0$) and permanent migrants ($\tau_i = T$), the results are trivial. They consume the whole of their income (wage) at each period, spending α share of their income on goods consumption and $1 - \alpha$ share of their income on services consumption. Non-migrants and permanent migrants do not save-this is a result of the simplified assumptions of zero discount rate, zero interest rates, no liquidity constraint, and a constant wage over an agent's lifetime.

For temporary migrants, the optimal flows of consumption of goods and services are given by equations (4.16),(4.17), (4.18), and (4.19). Combining these equations yields the following results

$$\phi = \frac{e^*_{i,R}}{e^*_{i,U}} = \frac{c^*_{i,R}}{c^*_{i,U}} = (\frac{P_U}{P_R})^{\frac{(1-\alpha)(1-\theta)}{\theta}} \tag{4.20}$$

$$\frac{s^*_{i,R}}{s^*_{i,U}} = (\frac{P_U}{P_R})^{\frac{1-\alpha(1-\theta)}{\theta}}. \tag{4.21}$$

From equation (4.21), $\frac{s^*_{i,R}}{s^*_{i,U}}$ is unambiguously greater than 1; that is, migrants consume more services in their hometowns, where there service price is lower. The pattern is not clear for expenditure ratio $\frac{e^*_{i,R}}{e^*_{i,U}}$, or goods consumption ratio $\frac{c^*_{i,R}}{c^*_{i,U}}$ from equation (4.20). Specifically, migrants spend more (less) and consume more (less) goods in rural areas relative to what they do in urban areas if $\theta < 1 (\theta > 1)$. This result follows because aside from governing risk aversion and consumption smoothing, θ also determines whether goods and services consumption are Edgeworth complements ($\theta < 1$) or Edgeworth substitutes ($\theta > 1$). The marginal utility of one category increases in the level of the other one if goods and services are Edgeworth complements ($\theta < 1$) in consumption. Thus, people consume more goods in rural areas where service consumption is higher because of the lower price. To the contrary, the marginal utility of one category decreases in the level of the other one if goods and services are Edgeworth substitutes ($\theta > 1$) in consumption. Thus, agents consume more goods to substitute for the reduction in service consumption when they work in urban areas. Empirical research shows the constant relative risk aversion θ is above 1 (Whalley and Yue, 2009), so I assume $\theta > 1$ in the following sections.

The ratios from (4.20) and (4.21) also depend on $\frac{P_U}{P_R}$ and α. Intuitively, $\frac{P_U}{P_R}$ is the very reason why rural and urban goods consumption and expenditure differ, and $1-\alpha$ determines the importance of service consumption in utility, and thus the extent to which $\frac{P_U}{P_R}$ can cause these differences. The greater $\frac{P_U}{P_R}$ and $1-\alpha$, the greater of the expenditure and goods consumption gap between urban and rural areas. Note that the expenditure, goods consumption and services consumption ratios are independent of wages and ability.

When the urban wage increases, goods and services consumption in both sectors increase because an increased urban wage increases both lifetime income given migration duration and the migration duration itself. Interestingly, when the rural wage increases, goods and services consumption in both sectors decreases. This is because an increased rural wage increases lifetime income given migration duration, but it decreases migration duration and the latter effect dominates.

Saving

An agent's savings rate in the urban sector is given by

$$S_{i,U} = \frac{a_i w_U - e^*_{i,U}}{a_i w_U} = 1 - \frac{1-\theta}{\theta}(1 - \frac{w_R}{a_i w_U})\frac{1}{\phi - 1}, \tag{4.22}$$

where $\phi = (\frac{P_U}{P_R})^{\frac{(1-\alpha)(1-\theta)}{\theta}}$.

If the price of urban services increases, the agent will shorten his stay in the urban sector to cut the losses from lower services consumption. In order to save for future consumption in the rural sector, the agent tends to spend less in the city. As a result, migrants in a city with a higher services price tend to have a higher savings rate.

If the urban wage increases, the agent will stay longer in the urban sector. The agent will then spend fewer periods in the rural sector, so he will require less savings to support his future consumption in the rural sector. As a result, the agent increases his spending in the urban sector. One implication is that migrants in a city with a higher wage tend have a lower savings rate. If the rural wage increases, income when the agent returns to the rural sector is relatively higher, and he will stay for less time in the urban sector. The agent will reduce spending in the urban sector in order to save more during the shorter period. A testable implication is that the migrants from poorer rural areas tend to have a lower savings rate.

Migration Decision and Migrant Stocks

Beginning at age 0, individuals solve their own utility maximization problem to determine the optimal migration duration as well as goods and services consumption flows. If the optimal duration is negative, the individual is a non-migrant; if the optimal duration exceeds T, the individual is a permanent migrant; otherwise the individual is a temporary migrant. If services price in the urban sector is much higher than that in the rural sector ($\phi < \frac{1}{\theta}$), the economy has only non-migrants and temporary migrants ($\tau_i < T,$). Otherwise, the economy has non-migrants, temporary migrants and permanent migrants. Empirically, for $\alpha = 70\%$, and $\theta = 2$, as long as $\frac{P_U}{P_R} < 101$, it's possible for $\phi > \frac{1}{\theta}$. Therefore, a moderate services price differential $\phi > \frac{1}{\theta}$ is a reasonable assumption. Hereafter, I will assume that there are three groups of people in the economy.

Ability threshold for being a temporary migrant is

$$\underline{a} = (\frac{\theta}{(1-\theta)^{\frac{\phi}{\phi-1}}} + 1)\frac{w_R}{w_U}. \tag{4.23}$$

Ability threshold for being a permanent migrant is

$$\bar{a} = (\frac{\theta}{(1-\theta)^{\frac{\phi}{\phi-1}} - 1} + 1)\frac{w_R}{w_U}. \tag{4.24}$$

An individual is a temporary migrant if $\underline{a} < a_i < \bar{a}$. Combining with the savings rate from equation (4.22), temporary migrants have positive savings rate, so they save more than permanent migrants and non-migrants, both of whom have zero savings.

Individuals are compelled to migrate temporarily or permanently to the urban sector if the urban/rural wage gap increases, i.e. $\frac{\partial \underline{a}}{\partial w_U/w_R} < 0, \frac{\partial \bar{a}}{\partial w_U/w_R} < 0$. Intuitively, when the urban wage is high enough to cover the high services cost in the urban sector, workers of lower ability would like to stay in cities permanently due to higher earnings. Conversely, increased services price differential discourages individuals from temporary or permanent migration due to the increased services cost in cities, i.e. $\frac{\partial \underline{a}}{\partial P_U/P_R} > 0, \frac{\partial \bar{a}}{\partial P_U/P_R} > 0$.

In the following part, I denote those migrants currently staying in the urban sector as "temporary migrants," and those who have already returned to the rural sector as "returned migrants." At each instant the labor force in the urban sector consists of temporary and permanent migrants whereas the labor force in the rural sector consists of non-migrants and returned migrants. The total labor force remains unchanged since there is no population growth. In the steady-state, the labor force in each sector is constant and the allocation of the labor force between the two sectors could be shown in Figure 1. From the figure, higher ability people will migrate and stay longer in the urban sector. The average ability of temporary migrants is higher than that of returned migrants as a result of lower-ability migrants returning sooner than higher-ability migrants.

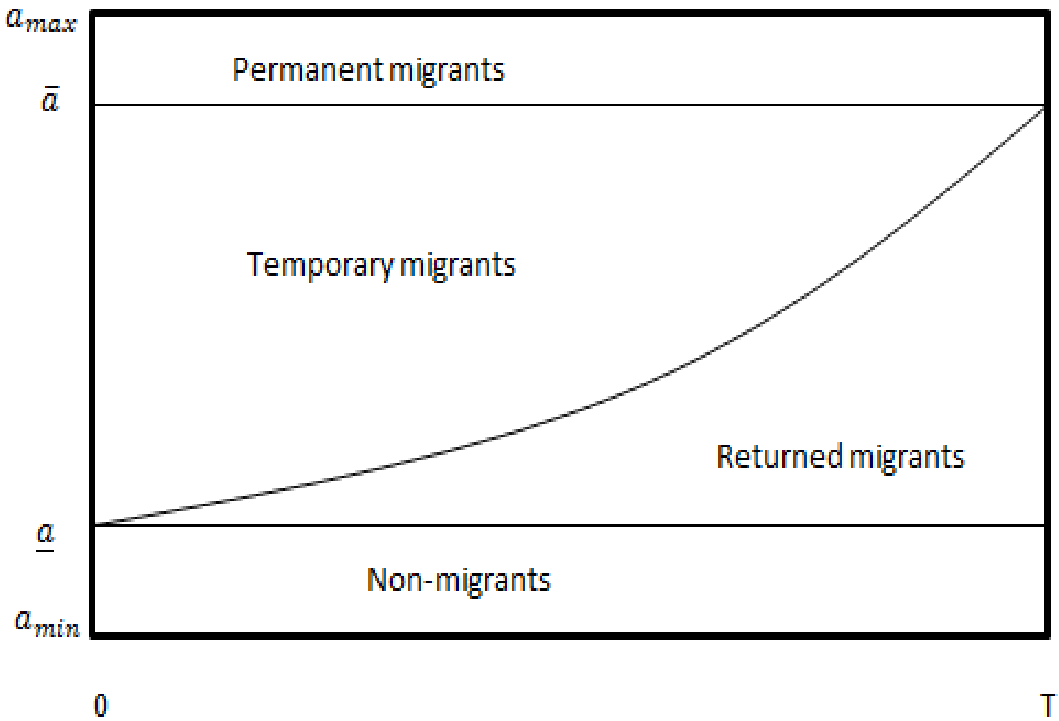

Figure 4.1: Allocation of Labor Force in an Economy with a Moderate Urban/rural Services Price Differential: $\phi > \frac{1}{\theta}$

At each instant, stock of permanent migrants is

$$L_U^P = \int_{\bar{a}}^{a_{max}} \tau(a) f(a) da = \frac{T}{a_d}(a_{max} - (\frac{\theta}{A-1} + 1)\frac{w_R}{w_U}) \tag{4.25}$$

stock of temporary migrants is

$$L_U^T = \int_{\underline{a}}^{\bar{a}} \tau(a) f(a) da = \frac{T\theta}{a_d}\frac{w_R}{w_U}(\frac{1}{A-1} - \ln(\frac{A}{A-1})) \tag{4.26}$$

stock of returned migrants is

$$L_R^R = \int_{\underline{a}}^{\bar{a}} (T - \tau(a)) f(a) da = \frac{T\theta}{a_d}\frac{w_R}{w_U}[ln\frac{A}{A-1} - \frac{1}{A}] \tag{4.27}$$

stock of non-migrants is

$$L_R^N = \int_{a_{min}}^{\underline{a}} \tau(a)f(a)da = \frac{T}{a_d}((\frac{\theta}{A}+1)\frac{w_R}{w_U} - a_{min}), \tag{4.28}$$

where

$$A = (1-\theta)\frac{\phi}{\phi-1}, a_d = a_{max} - a_{min}.$$

If the urban wage increases, the optimal migration duration for each ability level increases. Thus, more people will settle down in cities ($\frac{\partial L_U^P}{\partial w_U} > 0$) and there will be fewer temporary migrants ($\frac{\partial L_U^T}{\partial w_U} < 0$). This is because the higher urban wage encourages people to change from temporary to permanent migration. While the higher urban wage may also encourage returned and non-migrants to become temporary migrants, the former effect dominates. Overall, there are fewer temporary migrants when the urban wage increases. Similarly, some returned migrants become temporary migrants as they return to cities, whereas some non-migrants become returned migrants at the same time, the former effect dominates so there are fewer returned migrants at the end ($\frac{\partial L_R^R}{\partial w_U} < 0$). For non-migrants, an increased urban wage reduces the non-migrant stock as more people are compelled to migrate temporarily ($\frac{\partial L_R^N}{\partial w_U} < 0$).

Conversely, increases in the rural wage or services price differential have exactly the opposite effect as an increase in the urban wage on stocks of the four groups of people. Again, these results can be obtained from a partial analysis of equations (4.25), (4.26), (4.27), (4.28). Since the intuition is similar to that of an urban wage increase, I will not repeat it here. However, I do want to emphasize the effect of an increase in the services price differential. Specifically, an increase in the services price differential will discourage migration, thus keeping the labor force from being allocated to the more efficient production sector and reducing aggregate productivity. More interestingly, an increase in the services price differential will increase the stock of temporary migrants and decrease the stock of permanent migrants. Therefore, more individuals will choose to migrate temporarily rather than permanently. This result helps explain why Chine has such a large share of temporary migrants when compared to other developing countries.

The labor force in urban sector L_U consists of permanent migrants and temporary migrants:

$$L_U = L_U^P + L_U^T = \frac{T}{a_d} a_{max} - \frac{T}{a_d} \frac{w_R}{w_U} (1 + \theta \ln \frac{A}{A-1}). \tag{4.29}$$

More individuals choose to work temporarily or permanently in the urban sector when urban/rural wage gap increases, i.e. $\frac{\partial L_U}{\partial w_U / w_R} > 0$. As shown above, increased wage gap increases permanent migrants and decreases temporary migrants. The the former effect dominates, so the labor force in the urban sector increases.

As for increased urban/rural services price differential, it reduces the labor force in urban $\frac{\partial L_U}{\partial (P_U / P_R)} < 0$. It leads to reduced permanent migrants and increased temporary migrants, and the former effect dominates.

To summarize, the labor force in urban sector increases in wage gap, and decreases in services price differential, but effects on its components (temporary migrants and permanent migrants) are different. However, the labor force in rural sector L_R decreases in wage gap and increases in services price differentia, but the effects on its components (returned migrants and non-migrants) are the same.

4.3.4 Equilibrium and Comparative Statics

In the previous sections, I take the services prices and wages as given to analyze individual decisions on consumption, saving, and migration duration. I also analyze migrant stocks. In this section, I make wages endogenously determined, then analyze the effects of exogenous changes on migrant stocks.

In equilibrium the urban and rural labor markets must clear, and resource constraints must also be satisfied. The latter are satisfied automatically as I assume that agents who receive profits in urban goods production and receive urban and rural service incomes will consume their entire income on goods, and that all rural workers, regardless of migrant status, will consume all of their lifetime income. As a result, at each instant all goods produced are consumed and there is no net saving flow in the economy.

As for the rural labor market, since I assume competitive markets for rural goods production, the demand for labor is perfectly elastic. For the market to clear, the wage equals the rural sector goods production TFP in equilibrium, i.e. $w_R = \tilde{A}$.

As for the urban labor market, the supply of effective labor from migrants

$$L^s_{e,U} = \int_{\underline{a}}^{a_{max}} a\tau(a)f(a)da = \frac{Ta^2_{max}}{2a_d} - \frac{T}{a_d}\frac{w^2_R}{w^2_U}(\frac{\theta^2}{2A(A-1)} + \theta \ln \frac{A}{(A-1} + \frac{1}{2}). \tag{4.30}$$

The demand for effective labor from migrants is derived from urban firms' profit maximization condition. Given the production function given in equation (4.1),

$$L^d_{e,U} = (\frac{w_U}{\gamma_1 \tilde{B}})^{\frac{1}{\gamma_1 - 1}} \tag{4.31}$$

In the urban sector, labor market clears when equation (4.31) equals to equation (4.30),

$$(\frac{w_U}{\gamma_1 \tilde{B}})^{\frac{1}{\gamma_1 - 1}} = \frac{Ta^2_{max}}{2a_d} - \frac{T}{a_d}\frac{w^2_R}{w^2_U}(\frac{\theta^2}{2A(A-1)} + \theta \ln \frac{A}{(A-1} + \frac{1}{2}). \tag{4.32}$$

The supply of effective labor from equation (4.32) increases in w_U the demand of effective labor from migrants increases in w_U, so there exists a unique w_U that solves the equation.

Totally differentiate the equilibrium condition in the urban labor market, it's simple to show the following results. When TFP in the urban sector increases, demand for migrants' labor increases, raising the urban wage. That is, $\frac{\partial w_U}{\partial \tilde{B}} > 0$. When TFP in the rural sector increases, rural wage increases, reducing rural-urban migration. Thus, the effective supply of labor in urban areas declines, so the urban wage rises. That is, $\frac{\partial w_U}{\partial \tilde{A}} > 0$. When services price differential increases, rural-urban migration declines, and the resulting reduced labor supply in urban areas leads to increased urban wage. That is, $\frac{\partial w_U}{\partial (P_U/P_R)} > 0$. An implication is reducing urban/rural services price differential can decrease urban/rural wage gap, thereby reducing misallocation and increasing aggregate productivity.

Change in Urban TFP

In this section, I investigate the effect of increased urban TFP on migrant stocks. Since such an increase affects neither the rural wage or services prices, it affects migrant stocks only by increasing the urban wage; it has the same qualitative implication as an increase in the urban wage. The results can be summarized in the following proposition.

Proposition 1. When TFP in the urban sector increases, the stock of permanent migrants increases, and those of temporary, returned, and non-migrants decrease. The labor force in urban sector increases.

Change in Rural TFP

In this section I investigate the effect of an increase in rural TFP on migrant stocks. Different from an increase in urban TFP, an increase in rural TFP affects the rural as well as the urban wage. The effect on migrant stocks depends on the elasticity of the urban wage with respect to rural TFP (or equivalently, the rural wage). The proof is shown in Appendix D.1. The intuition is that when TFP in the rural sector increases, if the urban wage is more responsive relative to the rural wage, the effect from an increase in the urban wage dominates. Otherwise, the effect from an increase in the rural wage dominates.

Proposition 2. When TFP in the rural sector increases, the stock of permanent migrants increases, and those of temporary, returned, and non-migrants decrease if elasticity of urban wage with respect to rural TFP is greater than 1. Otherwise, the stock of permanent migrants decreases, and those of temporary, returned, and non-migrants increase. The labor force in the urban sector increases if elasticity of urban wage with respect to rural TFP is greater than 1. Otherwise, it decreases.

Change in Urban/Rural Services Price Differential

In this section I investigate the effect of an increase in the services price differential on the migrant stock. Similar to an increase in rural TFP, an increase in services price increase the urban wage and they work in opposite directions on an agent's migration duration, which is obvious from equation (4.15). As a result, the effect of the services price differential depends on the elasticity of the urban wage with respect to the services price differential. If the elasticity is sufficiently small, the result will be the same as if the urban wage were given. Yet, different from an increase in rural TFP, an increase in the urban/rural services price differential will have different effects for individuals of differing abilities. Therefore, the elasticity threshold cannot be 1. The details for elasticity thresholds are provided in Appendix D.2.

In Appendix D.2, Table A.11 summarizes the effects of an increase in urban/rural services price differential on stocks of migrants. The intuition is that if the urban wage is less responsive with respect to urban/rural services price differential, the effect from an change of services price differential dominates.

4.4 Conclusion

In this paper, I build a model to explain how urban/rural services price differential together with urban/rural wage gap can generate temporary migration behaviors. I also analyze how changes in the services price differential, wage gap, and urban and rural productivity can affect an agent's migration duration and savings rate, and the economy's aggregate migrant stocks. The set of partial and general equilibrium results can be used as testable hypothesis for future empirical work.

I take a shortcut by modeling a composite service good in this paper. It can be extended to model housing and education separately. As for housing, allowing endogenous housing supply may enable the interaction of migration and housing price. As for education, one can endogenize family decision on migration as well as children's education location. In addition, since high education can help rural people obtain urban hukou, it is interesting to analyze rural people's education choice .

Chapter 5. Conclusion

This dissertation studies three questions related to the growth of China. In the first essay, I primarily explore the multiplier of employment growth in the manufacturing sector. It provides a picture of the spillover effect on employment generated by the growth in the manufacturing sector. It is found that for every ten jobs created in manufacturing, 3.4 additional jobs will be generated in the non-tradable sector. The multiplier is also heterogeneous along skill intensity of manufactures, specific service industries, and geography. In the second essay, I investigate the impact of industry and services on economic growth at the local level in China. The essay answers the question that whether cities can take advantages of their early start in subsequent growth. The analysis also sheds light on the current debate that whether the industry is still important to economic growth and whether the service sector has become a primary driver of growth. I find robust evidence that increase in the industry output share leads to a significant increase in the growth rate of GDP per capita. Services, however, do not show a robust impact on growth. In the last essay, I provide a theoretical model to illustrate the temporary rural-urban migration in China. The model features the role of urban/rural service price differential that generates the pattern of return migration.

The current slowdown of the Chinese economy has revealed the challenges faced by both central and local governments. China has been taking the advantages of the cheap labor over years to promote the labor-intensive industries. However, with the continuous rising labor cost, China is less likely to rely on cheap labor to foster its further growth. Based on the findings from the first two essays, regions that have a higher initial industry share will continue to grow faster. Local governments may launch policies that facilitate agglomeration to foster subsequent growth. Also, local government should develop the high-technology industries since they can generate greater spillovers. Given the fact that China still has 50% population living in rural areas, as the economy grows, more and more rural people are expected to migrate to cities in the near future. However, the hukou system imposes higher cost for migrants that potentially reduce the migration duration as well as the labor force in cities. Further reform, therefore, is required to facilitate the reallocation of labor from the rural to the urban China.

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Appendix

A Harmonizing Administrative Regions across Censuses

Here I illustrate four main types of administrative changes and methods employed to adjust the unit of analysis. First, a city in the census of 2010 that was a county or a county-level city in the census of 2000. For example, Zhongwei city was a prefecture-level city in Ningxia province in 2010, but it was a county administrated under Wuzhong city in 2000. The census of 2000 reports the employment data for Wuzhong city, which includes Zhongwei county. The census of 2010 reports the employment for Wuzhong and Zhongwei cities. I combine Wuzhong city and Zhongwei city in 2010 to compare to Wuzhong city in 2000. Secondly, a city in 2010 was expanded from a prefecture-level city and its surrounding prefecture in 2000. For example, Nanning city in Guangxi province in 2010 consists of the Nanning city and part of Nanning diqu in 2000. The rest part of Nanning diqu in 2000 becomes Chongzuo city in 2010. I combine Nanning city and Nanning diqu in 2000 to compare to the combination of Nanning City and Chongzuo City in 2010. Thirdly, a city in the census of 2010 was a prefecture in 2000. For example, Baoshan city in Yunnan province in 2010 was Baoshan prefecture in 2000. This type of change usually doesn't occur in expanding or declining areas, so they are comparable. Fourth, a city in the census of 2010 administered more or fewer counties. This change is mainly because some counties were administered by different upper prefecture-level cities in the two censuses. In fact, most types of changes between 2000 and 2010 are of the third variety, which is not a concern to compare the data between the two censuses. I adjust the unit of analysis for the first two types. I exclude Hainan province since the government restricts manufacturing industries to protect the local environment for tourism development. I drop Tibet due to data limitations.

B Industry Category

Table A.1: Comparable 2-digit Manufacturing Industries

	Census 2000	Census 2010
1	13. food processing 14. food manufacturing	12. processing of food from agric. products 13. manufacture of foods
2	15.manufacture of beverages	14. manufacture of beverages
3	16.manufacture of tobacco	15. manufacture of tobacco
4	17.textile industry	16. manufacture of textiles
5	18. garments and other fiber products	17. manufacture of textiles, apparel, footwear and caps
6	19. leathers, furs, down and related products	18. manufacture of leather, fur, feather and related products
7	20. Timber processing, bamboo, canes, palm, fiber and straw products	19. Timber processing, bamboo, canes, palm, fiber and straw products
8	21.furniture manufacturing	20. furniture manufacturing
9	22. papermaking and paper products	21. manufacture of paper and paper prod.
10	23. printing industry	22. printing and recorded media
11	24. cultural, education and sports good	23. cultural, education and sports good
12	25. petroleum processing and coking	24. processing of petroleum, coking, nuclear fuel
13	26. raw chemical materials and chemical products chemical products	25.manufacture of chemical raw materials and
14	27. medical and pharmaceutical products	26. manufacture of medicines
15	28. chemical fiber	27. manufacture of chemical fiber
16	29.rubber products	28. rubber products
17	20. plastic products	29. plastic products
18	31. nonmetal mineral products	30. nonmetal mineral products
19	32. smelting and pressing of ferrous metals	31. smelting and pressing of ferrous metals
20	33. smelting and pressing of nonferrous metals	32. smelting and pressing of nonferrous metals
21	34. metal products	33. metal products
22	35. ordinary machinery 36. special purpose equipment 38. weapons and ammunition manufacturing	34. manufacture of general purpose machinery 35. manufacture of special purpose machinery
23	37. transport equipment	36. transport equipment
24	39. electric equipment and machinery	37. electric equipment and machinery
25	40. electronic and telecommunications equipment	38. manufacture of communication equipment, computers and other
26	41. instruments, meters, cultural and office equipment	39. manufacture of measuring instruments and machinery for cultural activity and office work
27	42. other manufacturing	40. manufacturing of artwork and other manufacturing 41. recycling and disposal of waste

Note: The No. listed in the first column indicate a category constructed by the author. The No. listed in the second and third columns are from population census 2000 and 2010 by each province, representing two-digit industry. The english titles are from Holz (2013).

Table A.2: Comparable 1-digit Non-tradable Sector

industry	Census 2000	Census 2010
1	IV.utilities	IV.utilities
2	V. construction	V. construction
3	VII. transport, storage, post and telecommunication services VI50.water management XI71. public services	VI.transport, storage, and postal services XIV. adminstration of water, environment, and public facilities
4	VIII. wholesale and retail trades, and catering services	VIII. wholesale and retail trades IX. accommodation and catering - IX63. accommodation
5	IX. finance and insurance	X. finance
6	X. real estate	XI. real estate
7	XII. health care, sports, and social welfare	XVII. health care, social insurance/welfare XVIII88. sports
8	XIII. education, culture and arts, radio, film, and television	XVI. education XVIII. culture, sports and entertainment -XVIII89.entertainment-XVIII88.sports
9	XIV. scientific research and polytechnic services VI46.geological prospecting	XIII. scientific research, polytechnic services, and geological prospecting
10	XI72. residence Services	XV. resident and other services
11	XI.social service - XI71. public services - XI72. residence services	VII. information transfer, computer services, and software XII. leasing and commercial services IX63. accommodation XVIII89.entertainment

Note: The No. listed in the first column indicate a category constructed by the author. The roman number listed in the second and third columns are from population census 2000 and 2010, which represents 1-digit industry. The numeric number listed in the second and third columns represents 2-digit industry. The english titles are from Holz (2013).

C Appendix Tables

Table A.3: First Stage Regressions

	Dependent Variable: Manufacturing's Contribution to Total Employment Growth, 2000-2010		
	(1)	(2)	(3)
Instrument	1.118***	0.916***	0.891***
	(0.169)	(0.188)	(0.191)
Share of urban hukou pop., 2000	-0.133	-0.187**	-0.176**
	(0.082)	(0.083)	(0.081)
Share of college pop., 2000	-0.640	-1.051**	-1.072**
	(0.539)	(0.492)	(0.483)
Region	0.012	0.007	0.008
	(0.009)	(0.008)	(0.008)
Capital	0.008	-0.003	-0.001
	(0.025)	(0.025)	(0.024)
Log(employment), 2000	0.001	0.012*	0.011
	(0.006)	(0.007)	(0.007)
Unemp. rate, 2000	-0.109	-0.218	-0.211
	(0.215)	(0.189)	(0.190)
Share of non-tradable employ., 2000		0.325***	0.345***
		(0.105)	(0.110)
Share of gov. employ., 2000			-0.448
			(0.506)
Constant	0.035	-0.116	-0.098
	(0.078)	(0.083)	(0.086)
N	277	277	277
First stage statistics	43.77	23.88	21.84

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. The instrumental variable is equal to the 2000 share of manufacturing employment for a given city multiplied by the 2000-2010 growth rate in national manufacturing employment (exclude own city). Descriptions of variables are in Table 2.1.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: First Stage Regressions, with Additional Controls

	Dependent Variable: Manufacturing's Contribution to Total Employment Growth, 2000-2010	
	(1)	(2)
Instrument	0.851***	0.831***
	(0.192)	(0.191)
Share of urban hukou pop.,2000	-0.151*	-0.095
	(0.078)	(0.081)
Share of college pop.,2000	-1.122**	-1.065**
	(0.472)	(0.447)
Region	-0.009	0.003
	(0.010)	(0.009)
Capital	0.004	0.001
	(0.023)	(0.024)
Log(employment),2000	0.008	0.007
	(0.007)	(0.007)
Unemp. rate,2000	-0.369**	-0.346*
	(0.187)	(0.203)
Share of non-tradable employ.,2000	0.357***	0.284***
	(0.113)	(0.105)
Share of gov. employ.,2000	-0.444	0.090
	(0.538)	(0.267)
Nearby provincial municipality	0.012	0.014
	(0.017)	(0.017)
Ln(light density) 1995-99 in nbr. areas	-0.005	-0.010**
	(0.004)	(0.004)
Proximity to port city	0.106***	0.028
	(0.034)	(0.033)
Rainfall (meter)		0.004
		(0.013)
Temperature (celsius)		0.003***
		(0.001)
Altitude(meter)		-0.002***
		(0.001)
Constant	-0.134	-0.113
	(0.089)	(0.098)
N	276	276
First Stage F-statistic	19.60	18.99

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. The instrumental variable is equal to the 2000 share of manufacturing employment for a given city multiplied by the 2000-2010 growth rate in national manufacturing employment (exclude own city). Descriptions of variables are in Table 2.1.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Impact of Manufacturing on Employment Growth in the Non-tradable Sector, Province Fixed Effects Estimates

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
Manufacturing contri. (2000-2010)	0.480***	0.487***	0.476***	0.363***	0.366**	0.361**
	(0.094)	(0.098)	(0.104)	(0.124)	(0.164)	(0.151)
Share of urban hukou pop., 2000	-0.373***	-0.352***	-0.340***	-0.393***	-0.367***	-0.358***
	(0.089)	(0.100)	(0.092)	(0.093)	(0.092)	(0.094)
Share of college pop., 2000	2.480***	2.451***	2.360***	2.470***	2.423***	2.326***
	(0.550)	(0.560)	(0.512)	(0.556)	(0.544)	(0.526)
Capital	0.026	0.034	0.035	0.018	0.027	0.028
	(0.031)	(0.033)	(0.031)	(0.027)	(0.027)	(0.027)
Log(employment), 2000	-0.017**	-0.018**	-0.017**	-0.014*	-0.016**	-0.015**
	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.007)
Unemp. rate, 2000	0.946***	0.954***	0.984***	0.922***	0.925***	0.974***
	(0.282)	(0.276)	(0.270)	(0.282)	(0.283)	(0.272)
Share of non-tradable employ., 2000	0.045	0.002	0.004	0.110	0.064	0.065
	(0.093)	(0.110)	(0.113)	(0.122)	(0.133)	(0.137)
Share of gov. employ., 2000	1.051**	0.972**	0.991**	1.008***	0.949***	0.980***
	(0.418)	(0.382)	(0.412)	(0.363)	(0.342)	(0.363)
Nearby provincial municipality		0.013*	0.016*		0.016	0.019
		(0.007)	(0.008)		(0.015)	(0.015)
Ln(light density)95-99 in nbr. areas		-0.008	-0.008		-0.005	-0.007
		(0.006)	(0.007)		(0.007)	(0.007)
Proximity to port city		0.088	0.101		0.100*	0.114**
		(0.070)	(0.063)		(0.058)	(0.055)
Rainfall (meter)			-0.003			-0.007
			(0.025)			(0.021)
Temperature (celsius)			0.004			0.004
			(0.006)			(0.004)
Altitude(meter)			0.002			0.002
			(0.004)			(0.003)
Constant	0.253***	0.212**	0.130			
	(0.087)	(0.091)	(0.136)			
N	277	276	276	276	275	275
First Stage F-statistic				14.67	11.15	13.46

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. All estimates include province fixed effects. Descriptions of variables are in Table 2.1. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6: First Stage Regressions, High- and Low-technology Manufacturing Industries Analysis

	Model 1		Model 2	
	High skill manu. contri.	Low skill manu. contri.	High skill manu. contri.	Low skill manu. contri.
Instrument (high-tech. manu.)	0.718***	-1.048***	0.663***	-1.013***
	(0.169)	(0.239)	(0.160)	(0.227)
Instrument (low-tech. manu.)	0.025	0.912***	0.048	0.827***
	(0.097)	(0.124)	(0.081)	(0.118)
Share of urban hukou pop., 2000	-0.065	-0.078	-0.022	-0.028
	(0.041)	(0.055)	(0.041)	(0.059)
Share of college pop., 2000	-0.201	-0.644*	-0.139	-0.699**
	(0.219)	(0.347)	(0.181)	(0.321)
Region	0.002	0.006	-0.007	0.001
	(0.003)	(0.007)	(0.004)	(0.008)
Capital	-0.022*	0.007	-0.019*	0.008
	(0.011)	(0.016)	(0.010)	(0.016)
Log(employment), 2000	0.006*	0.007	0.004	0.005
	(0.003)	(0.005)	(0.003)	(0.006)
Unemp. rate, 2000	-0.069	-0.171	-0.105	-0.374**
	(0.114)	(0.142)	(0.106)	(0.168)
Share of non-tradable employ.,2000	0.187***	0.256***	0.120**	0.232***
	(0.068)	(0.092)	(0.048)	(0.076)
Share of gov. employ., 2000	-0.292	-1.055**	-0.200	-0.253
	(0.279)	(0.467)	(0.293)	(0.532)
Nearby provincial municipality			0.012	0.003
			(0.011)	(0.008)
Ln(light density) 1995-99 in nbr. areas			0.002	-0.006
			(0.002)	(0.004)
Proximity to port city			0.022	0.026
			(0.014)	(0.029)
Rainfall (meter)			0.001	0.011
			(0.005)	(0.010)
Temperature (celsius)			0.001	0.002*
			(0.000)	(0.001)
Altitude(meter)			-0.000	-0.001**
			(0.000)	(0.001)
Constant	-0.070	-0.047	-0.075	-0.075
	(0.046)	(0.069)	(0.050)	(0.083)
N	260	260	259	259
First Stage F-statistic	25.37		18.46	

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. Descriptions of variables are in Table 2.1.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.7: Impact of High- and Low-Technology Manufacturing on Employment Growth in the Non-tradable Sector, with Control of Share of High School Pop.

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
High tech manu. contri.	0.663***	0.668***	0.707***	0.675***	0.703***	0.785***
	(0.147)	(0.160)	(0.173)	(0.211)	(0.223)	(0.244)
Low tech manu. contri.	0.440***	0.461***	0.486***	0.018	0.000	-0.026
	(0.075)	(0.082)	(0.087)	(0.132)	(0.154)	(0.161)
Share of urban hk pop.,2000	-0.252***	-0.278***	-0.285***	-0.302***	-0.318***	-0.298***
	(0.078)	(0.079)	(0.085)	(0.086)	(0.084)	(0.089)
Share of college pop.,2000	2.432***	2.495***	2.364***	1.759***	1.721***	1.533**
	(0.506)	(0.499)	(0.490)	(0.572)	(0.584)	(0.610)
Share of high school pop.,2000	-0.451**	-0.369**	-0.390**	-0.388**	-0.346*	-0.387**
	(0.181)	(0.178)	(0.181)	(0.186)	(0.186)	(0.194)
Region (coastal=1)	-0.026***	-0.022**	-0.027**	-0.019*	-0.024**	-0.025**
	(0.009)	(0.010)	(0.011)	(0.010)	(0.011)	(0.012)
Capital	0.041	0.034	0.036	0.051	0.050	0.052
	(0.032)	(0.031)	(0.030)	(0.036)	(0.035)	(0.034)
Log(employment),2000	-0.014*	-0.010	-0.008	-0.010	-0.008	-0.005
	(0.007)	(0.008)	(0.009)	(0.008)	(0.008)	(0.009)
Unemp. rate,2000	0.264	0.383	0.554*	0.227	0.247	0.388
	(0.321)	(0.315)	(0.311)	(0.330)	(0.332)	(0.335)
Share of non-tradable employ.,2000	0.094	0.069	0.097	0.349**	0.365**	0.371**
	(0.106)	(0.111)	(0.113)	(0.149)	(0.163)	(0.150)
Share of gov. employ.,2000	1.793**	1.953**	1.895**	0.783	0.866	1.222
	(0.737)	(0.780)	(0.770)	(0.893)	(0.998)	(0.919)
Nearby provincial municipality		0.019	0.015		0.021	0.018
		(0.013)	(0.013)		(0.013)	(0.013)
Ln(light density) 1995-99 in nbr. areas		-0.009**	-0.011*		-0.009*	-0.013*
		(0.005)	(0.006)		(0.005)	(0.007)
Proximate to port city		0.017	0.045		0.059	0.065
		(0.037)	(0.045)		(0.045)	(0.051)
Rainfall (meter)			-0.032*			-0.030
			(0.018)			(0.018)
Temperature (celsius)			0.002			0.003**
			(0.001)			(0.001)
Altitude(meter)			0.001			0.000
			(0.001)			(0.001)
Constant	0.238**	0.179*	0.136	0.202**	0.152	0.087
	(0.094)	(0.100)	(0.123)	(0.099)	(0.103)	(0.134)
N	260	259	259	260	259	259
First Stage Statistics				21.11	19.88	15.37

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. The high- and low-technology manufacturing industries are classified based on NBS High-Technology Industry (Manufacturing Industry) Classifications (2013). Details of the classification are in Appendix Table A.10. Instruments are group specific.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.8: Impact of High- and Low-Tech Manu. on Employment Growth in the Non-tradable Sector, Alternative Definition of High- and Low-Tech Manu. Industries, with Control of Share of High School Pop.

	Dependent Variable: Non-tradable Sector's Contribution to Total Employment Growth, 2000-2010					
	OLS			IV		
	(1)	(2)	(3)	(4)	(5)	(6)
High tech manu.contri.	0.690***			0.916		
(45% cutoff)	(0.167)			(0.579)		
Low tech manu. contri.	0.476***			0.288		
(45% cutoff)	(0.073)			(0.176)		
High tech manu. contri.		0.733***			0.772***	
(40% cutoff)		(0.135)			(0.246)	
Low tech manu. contri.		0.389***			-0.066	
(40% cutoff)		(0.078)			(0.135)	
High tech manu. contri.			0.633***			0.545***
(35% cutoff)			(0.115)			(0.182)
Low tech manu. contri.			0.402***			-0.174
(35% cutoff)			(0.086)			(0.193)
N	260	260	260	260	260	260
First Stage Statistics				7.21	8.25	21.88

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. All baseline controls are included. The high- and low-technology manufacturing industries are classified based on education level. Details of the classification are in Appendix Table A.10.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.9: First Stage Regressions, Regional Effects

	Model 1		Model 2	
	manu. contri.	manu. contri. × region	manu. contri. manu. contri.	manu. contri. × region
Fitted values	0.895***	-0.098	0.641**	-0.339
	(0.291)	(0.212)	(0.305)	(0.252)
Fitted values × region	0.101	1.061***	0.327*	1.232***
	(0.212)	(0.103)	(0.190)	(0.132)
Share of urban hukou pop., 2000	-0.016	-0.033	-0.024	-0.003
	(0.106)	(0.095)	(0.089)	(0.072)
Share of college pop., 2000	0.002	0.045	-0.013	-0.157
	(0.532)	(0.485)	(0.509)	(0.435)
Region	-0.003	-0.004	-0.014	-0.022**
	(0.010)	(0.009)	(0.012)	(0.010)
Capital	-0.002	-0.015	-0.007	-0.018
	(0.025)	(0.023)	(0.025)	(0.021)
Log(employment), 2000	0.001	0.003	0.001	0.004
	(0.007)	(0.005)	(0.007)	(0.005)
Unemp. rate, 2000	0.008	-0.068	-0.018	-0.030
	(0.199)	(0.158)	(0.229)	(0.180)
Share of non-tradable employ., 2000	0.018	0.074	0.046	0.139
	(0.171)	(0.160)	(0.165)	(0.149)
Share of gov. employ., 2000	-0.007	0.168	0.019	-0.176
	(0.548)	(0.415)	(0.262)	(0.306)
Nearby provincial municipality			0.006	0.018
			(0.017)	(0.015)
Ln(light den.) 1995-99 in nbr. areas			-0.003	0.001
			(0.005)	(0.003)
Proximity to port city			0.016	0.037
			(0.037)	(0.027)
Rainfall (meter)			-0.001	-0.020**
			(0.013)	(0.010)
Temperature (celsius)			0.001	0.003**
			(0.002)	(0.001)
Altitude(meter)			-0.001	-0.000
			(0.001)	(0.001)
Constant	-0.003	-0.037	-0.018	-0.095
	(0.091)	(0.064)	(0.109)	(0.080)
N	277	277	276	276
First Stage F-statistic	12.74		12.49	

Note: The unit of observation is a prefecture-level city. Robust standard errors reported in parentheses. Descriptions of variables are in Table 2.1.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.10: Classification of High- and Low- Technology Manufacturing Industries

Cat.	Industries	Employ. above high school (%)	Employ. above college (%)	High-Technology Manu.			
				NBS	above high school		
					45%	40%	35%
14	26. manufacture of medicines	64	33.5	H	H	H	H
12	24. processing of petroleum, coking nuclear fuel	63	30.4	L	H	H	H
3	15. manufacture of tobacco	61.2	29.9	L	H	H	H
22	34. general purpose machinery	36.4	12.5	H	H	H	H
	35. special purpose machinery	46.6	18.7	H	H	H	H
13	25.manufacture of chemical raw materials and chemical products	45.9	18.4	L	H	H	H
23	36. transport equipment	45.6	18.3	H	H	H	H
25	38. manufacture of communication equipment, computers and other	44.6	16.2	H		H	H
19	31. smelting and pressing of ferrous metals	44.2	16.7	L	L	H	H
20	32. smelting and pressing of nonferrous metals	42.3	15.7	L	L	H	H
26	39. manufacture of measuring instruments and machinery for cultural activity and office work	41.5	17.0	H	L	H	H
2	14. manufacture of beverages	40.5	14.7	L	L	H	H
10	22. printing and recorded media	39.5	12.3	L	L	L	H
24	37. electric equipment and machinery	39.2	14.5	L	L	L	H
15	27. manufacture of chemical fiber	38.9	12.6	L	L	L	H
16	28. rubber products	30.8	9.2	L	L	L	L
21	33. metal products	26.1	7.1	L	L	L	L
9	21. manufacture of paper and paper prod.	29.1	8.0	L	L	L	L
1	12. processing of food from agri. products	22.5	6.0	L	L	L	L
	13. manufacture of foods	29.4	9.7	L	L	L	L
17	29. plastic products	24.2	6.2	L	L	L	L
18	30. nonmetal mineral products	23.1	6.1	L	L	L	L
11	23. cultural, education and sports good	21.1	6.1	L	L	L	L
4	16. manufacture of textiles	19.8	4.0	L	L	L	L
8	20. furniture manufacturing	17.6	4.0	L	L	L	L
5	17. manufacture of textiles 17. apparel, footwear and caps	15.6	3.1	L	L	L	L
6	18. manufacture of leather 18. fur, feather, etc.	14.6	2.6	L	L	L	L
7	19. Timber processing, bamboo, canes, palm, fiber and straw products	14.2	2.6	L	L	L	L
27	40. manufacture of artwork and other manufacturing	18.5	4.7	L	L	L	L
	41. recycling and disposal of waste	12.6	2.6	L	L	L	L

Note: NBS classification is based on High-Technology Industry Classifications (2013). Education data are from National Population Census 2010. H (L) denotes high (low)-technology manufacturing industry.

D Appendix Proofs

D.1 Comparative Statics-Change in Rural TFP

I investigate the effect of an change in rural TFP on stock of permanent, temporary, returned and non-migrants.

Ability Threshold for Migration

Combining equations (4.23) and (4.32), then taking the derivative yields

$$\frac{\partial \underline{a}}{\partial \tilde{A}} = (\frac{\theta}{(1-\theta)\frac{\phi}{\phi-1}} + 1)\frac{1 - \frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}}}{w_U}. \tag{D.1}$$

The *threshold for temporary migrants* increases (decreases) with $\tilde{A}$ when $\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} < 1$ ($\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} > 1$).

Combining equations (4.24) and (4.32), then taking the derivative yields

$$\frac{\partial \bar{a}}{\partial \tilde{A}} = (\frac{\theta}{A-1} + 1)\frac{1 - \frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}}}{w_U}. \tag{D.2}$$

The *threshold for permanent migrants* increases (decreases) with $\tilde{A}$ when $\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} < 1$ ($\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} > 1$).

Stocks of Migrants

For *permanent migrants*, combining equations (4.25), (4.32), then taking the derivative yields

$$\frac{\partial L_U^P}{\partial \tilde{A}} = -\frac{T}{a_d}(\frac{\theta}{A-1} + 1)\frac{1 - \frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}}}{w_U}. \tag{D.3}$$

The stock of permanent migrants decreases (increases) with $\tilde{A}$ when $\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} < 1$ ($\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} > 1$).

For *temporary migrants*, combining equations (4.26), (4.32), then taking the derivative yields

$$\frac{\partial L_U^T}{\partial \tilde{A}} = \frac{T\theta}{a_d}(\frac{1}{A-1} - \ln\frac{A}{A-1})\frac{1-\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}}}{w_U}. \tag{D.4}$$

The stock of temporary migrants increases (decreases) with $\tilde{A}$ when $\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} < 1$ ($\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} > 1$).

For *returned migrants*, combining equations (4.27), (4.32), then taking the derivative yields

$$\frac{\partial L_R^R}{\partial \tilde{A}} = \frac{T\theta}{a_d}(\ln\frac{A}{A-1} - \frac{1}{A})\frac{1-\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}}}{w_U} \tag{D.5}$$

The stock of returned migrants increases (decreases) with $\tilde{A}$ when $\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} < 1$ ($\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} > 1$).

For *non-migrants*, combining equations (4.28), (4.32),then taking the derivative yields

$$\frac{\partial L_R^N}{\partial \tilde{A}} = \frac{T}{a_d}(\frac{\theta}{A} + 1)\frac{1-\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}}}{w_U} \tag{D.6}$$

The stock of returned migrants increases (decreases) with $\tilde{A}$ when $\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} < 1$ ($\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} > 1$).

For *urban labor force*, combine equations (4.29), (4.32),and take derivative

$$\frac{\partial L_U}{\partial \tilde{A}} = -\frac{T}{a_d}(1+\theta\ln\frac{A}{A-1})\frac{1-\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}}}{w_U} \tag{D.7}$$

The urban labor force decreases (increases) with $\tilde{A}$ when $\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} < 1$ ($\frac{\partial w_U/w_U}{\partial \tilde{A}/\tilde{A}} > 1$).

D.2 Comparative Statics-Change in Urban/Rural Services Price Differential

I investigate the effect of an change in urban/rural services price differential on stocks of permanent, temporary, returned and non-migrants.

Ability Threshold for Migration

Combining equations (4.23) and (4.32), then taking derivatives yields

$$\frac{\partial \underline{a}}{\partial \frac{P_U}{P_R}} = \frac{\tilde{A}}{\frac{P_U}{P_R} w_U}[-(\frac{\theta}{A}+1)\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} + \frac{1-\alpha}{\phi}]. \tag{D.8}$$

Denote $f_1 = \frac{(1-\alpha)/\phi}{\theta/A+1}$. If $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_1$, $\frac{\partial \underline{a}}{\partial \frac{P_U}{P_R}} > 0$, otherwise, $\frac{\partial \underline{a}}{\partial \frac{P_U}{P_R}} < 0$. That is, *temporary migration thershold* increases (decreases) with services price differential when $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_1$ ($\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} > f_1$).

Combining equations (4.24) and (4.32), then taking derivatives yields

$$\frac{\partial \bar{a}}{\partial \frac{P_U}{P_R}} = \frac{\tilde{A}}{\frac{P_U}{P_R} w_U}[-(\frac{\theta}{A-1}+1)\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} + \frac{A^2}{(A-1)^2}\frac{1-\alpha}{\phi}]. \tag{D.9}$$

Denote $f_2 = \frac{A^2}{(A-1)^2}\frac{(1-\alpha)/\phi}{\theta/(A-1)+1}$. If $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_2$, $\frac{\partial \bar{a}}{\partial \frac{P_U}{P_R}} > 0$; otherwise, $\frac{\partial \bar{a}}{\partial \frac{P_U}{P_R}} < 0$. That is, *permanent migration threshold* increases (decreases) with services price differential when $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_2$ ($\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} > f_2$).

Stocks of Migrants

For *permanent migrants*, Combining equations (4.25), (4.32), then taking derivatives yields

$$\frac{\partial L_U^P}{\partial \frac{P_U}{P_R}} = -\frac{T}{a_{max}-a_{min}}\frac{\tilde{A}}{\frac{P_U}{P_R} w_U}[-(\frac{\theta}{A-1}+1)\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} + \frac{A^2}{(A-1)^2}\frac{1-\alpha}{\phi}]. \tag{D.10}$$

If $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_2$, $\frac{\partial L_U^P}{\partial \frac{P_U}{P_R}} < 0$, otherwise, $\frac{\partial L_U^P}{\partial \frac{P_U}{P_R}} > 0$. That is, the stock of permanent migrants increases (decreases) with services price differential when $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_2$ ($\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} > f_2$).

For *temporary migrants*, combining equations (4.26), (4.32), then taking derivatives yields

$$\frac{\partial L_U^T}{\partial \frac{P_U}{P_R}} = \frac{1}{\frac{P_U}{P_R}}\frac{T\theta}{a_{max}-a_{min}}\frac{\tilde{A}}{w_U}[-(\frac{1}{A}-\ln\frac{A}{A-1})\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} - \frac{1}{(A-1)^2}\frac{(1-\alpha)(1-\theta)}{\theta(1-\phi)}]. \tag{D.11}$$

Denote $f_3 = -\frac{1}{(A-1)^2}\frac{1-\alpha}{\theta}\frac{1-\theta}{1-\phi}/(\frac{1}{A-1} - \ln\frac{A}{A-1})$. If $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_3$, $\frac{\partial L_U^T}{\partial \frac{P_U}{P_R}} > 0$; otherwise, $\frac{\partial L_U^T}{\partial \frac{P_U}{P_R}} < 0$. That is, the stock of temporary migrants increases (decreases) with services price differential when $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_3$ ($\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} > f_3$).

For *returned migrants*, combining equations (4.27), (4.32), then taking derivatives yields

$$\frac{\partial L_R^R}{\partial \frac{P_U}{P_R}} = \frac{1}{\frac{P_U}{P_R}}\frac{T\theta}{a_{max} - a_{min}}\frac{\tilde{A}}{w_U}[-(\ln\frac{A}{A-1} - \frac{1}{A})\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} + \frac{1-\alpha}{A-1}\frac{1}{\theta\phi}]. \tag{D.12}$$

Denote$f_4 = \frac{1-\alpha}{A-1}\frac{1}{\theta\phi}/(\ln\frac{A}{A-1} - \frac{1}{A})$. If $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_4$, $\frac{\partial L_R^R}{\partial \frac{P_U}{P_R}} > 0$; otherwise, $\frac{\partial L_R^R}{\partial \frac{P_U}{P_R}} < 0$. That is, the stock of returned migrants increases (decreases) with services price differential when $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_4$ ($\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} > f_4$).

For *non-migrants*, combining equations (4.28), (4.32), then taking derivatives yields

$$\frac{\partial L_R^N}{\partial \frac{P_U}{P_R}} = \frac{T}{a_{max} - a_{min}}\frac{\tilde{A}}{\frac{P_U}{P_R}w_U}[-(\frac{\theta}{A} + 1)\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} + \frac{1-\alpha}{\phi}]. \tag{D.13}$$

If $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_1$, $\frac{\partial L_R^N}{\partial \frac{P_U}{P_R}} > 0$, otherwise, $\frac{\partial L_R^N}{\partial \frac{P_U}{P_R}} < 0$. That is, the stock of non-migrants increases (decreases) with services price differential when $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_1$ ($\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} > f_1$).

For *urban labor force*, combining equations (4.29), (4.32), then taking derivatives yields

$$\frac{\partial L_U}{\partial \frac{P_U}{P_R}} = -\frac{1}{\frac{P_U}{P_R}}\frac{T\theta}{a_{max} - a_{min}}\frac{\tilde{A}}{w_U}[-(\frac{1}{A(A-1)} + \frac{1}{\theta} + \ln\frac{A}{A-1})\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} + \frac{1-\alpha}{\theta\phi}\frac{A}{A-1}]. \tag{D.14}$$

Denote $f_5 = \frac{1-\alpha}{\phi\theta}\frac{A}{A-1}/(\frac{1}{A(A-1)} + \frac{1}{\theta} + \ln\frac{A}{A-1})$. When $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_5$, $\frac{\partial L_U}{\partial \frac{P_U}{P_R}} < 0$; otherwise, $\frac{\partial L_U}{\partial \frac{P_U}{P_R}} > 0$. That is, urban labor force increases(decreases) with services price differential when $\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} < f_5$ ($\frac{\partial w_U/w_U}{\partial \frac{P_U}{P_R}/\frac{P_U}{P_R}} > f_5$)

It can be proved that $f_1 < f_5 < f_2 < f_3 < f_4$. The effects of rising urban/rural services price differential are summarized in the following table.

Table A.11: Effects of an Increase in Urban/Rural Price Differential on Stocks of Migrants

case	Condition	$\underline{a}$	$\bar{a}$	L_U^P	L_U^T	L_R^R	L_R^N	L_U
1	$\frac{\partial w_U/w_U}{\partial(P_U/P_R)/(P_U/P_R)} < f_1$	$\uparrow$	$\uparrow$	$\downarrow$	$\uparrow$	$\uparrow$	$\uparrow$	$\downarrow$
2	$f_1 < \frac{\partial w_U/w_U}{\partial(P_U/P_R)/(P_U/P_R)} < f_5$	$\uparrow$	$\uparrow$	$\downarrow$	$\uparrow$	$\uparrow$	$\uparrow$	$\downarrow$
3	$f_5 < \frac{\partial w_U/w_U}{\partial(P_U/P_R)/(P_U/P_R)} < f_2$	$\downarrow$	$\uparrow$	$\downarrow$	$\uparrow$	$\uparrow$	$\downarrow$	$\uparrow$
4	$f_2 < \frac{\partial w_U/w_U}{\partial(P_U/P_R)/(P_U/P_R)} < f_3$	$\downarrow$	$\downarrow$	$\uparrow$	$\uparrow$	$\uparrow$	$\downarrow$	$\uparrow$
5	$f_3 < \frac{\partial w_U/w_U}{\partial(P_U/P_R)/(P_U/P_R)} < f_4$	$\downarrow$	$\downarrow$	$\uparrow$	$\downarrow$	$\uparrow$	$\downarrow$	$\uparrow$
6	$\frac{\partial w_U/w_U}{\partial(P_U/P_R)/(P_U/P_R)} > f_4$	$\downarrow$	$\downarrow$	$\uparrow$	$\downarrow$	$\downarrow$	$\downarrow$	$\uparrow$

Vita

Ting Wang was born in Weinan, Shaanxi, China in 1987. She attended Jilin University, Changchun, China, where she earned a Bachelor of Science with a major in Information and Computational Science in 2009. In 2011, she completed her Master of Science in Finance at Shanghai University of Finance and Economics. After that, she entered graduate school in the Department of Economics at Louisiana State University (LSU) and received her Master of Science in Economics in 2013. During graduate school at LSU, she worked as a research assistant as well as an instructor in the Department of Economics teaching Principles of Microeconomics, Principles of Macroeconomics, and Money, Banking and Financial Market. She will join Citizens Bank as a Quantitative Analyst, VP at Boston, Massachusetts, following her anticipated graduation in the Summer of 2016.