ACCOUNTING FOR THE ROLE OF LAND AS A SOURCE OF ECONOMIC GROWTH IN CHINA

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SUMMARY

Using China Industry Productivity (CIP) data set, this study builds up by industry land stock in China over the period 1980-2010 under the national accounts framework. And by integrating land input constructed in this study and other input factors from CIP database, the Jorgensonian aggregate production possibility frontier (APPF) framework is employed to account for the industry origin of China's aggregate growth for the period 1981-2010. With the inclusion of land as one of the input factor, we show that in manufacturing and service sector, the role of land has been underestimated and the growth contribution from capital and labor has been overstated. However, in agricultural sector, where most of China's land is used, the contribution of land is not magnificent.

CHAPTER 1. INTRODUCTION

There has been much literature on productivity measurement, and China is not an exception. However, few of these literatures have taken land into consideration when measuring factor input. Traditionally, China was a unified feudal agricultural society where economic growth largely came from more efficient and intensive use of land. Into the more recent history, though input of labor and capital increased, land is still significant in economic growth in a sense that hardly any economic activities could ever happen without land. Also, like most developing countries, with economic development, usually land is shifted from agricultural sector to manufacturing and service sector. And along with this shift, the productivity and cost for economic growth will definitely change. Therefore, accounting the role of land is important if we don't want to miss a significant factor of economic growth and the impact of shift of land in the urbanization process.

There have been some attempts to include land into the productivity measurement in China. For example, Justin Yifu Lin (1989) tries to evaluate the relative importance of components of rural reform in agricultural productivity growth covering 1965 to 1987. It is found that neither did the changes of crop patterns nor the decline in cropping intensity have magnificent effects on agricultural productivity. What really matters is the institutional change during which the production team system was changed to the household responsibility system. This institutional change motivated increasing input of capital and chemical fertilizer, which consequently increased agricultural productivity. Guangzhong James Wen (1993) examines the performance of successive rural institutions in China in terms of changes in the TFPI over the period 1952-1989. It is found that the commune system succeeded in raising land productivity but worsened labor production. In contrast, the Household Responsibility System raised both land and labor productivity. Though these two studies have different opinions on the role of land during the commune system period, they both find out that since 1985 the agricultural growth has went down and suggest that the effect of institutional change on agricultural growth is becoming weaker as time goes by.

Also, there have been attempts to include land in growth accounting in other countries. For example, Taehyoung Cho, Junghoon Kim, and Paul Schreyer (2014) measure the multi-factor productivity growth on Korea from 1980 to 2012. Though land and inventory are included in the measurement, they find out that capital and labor input explain the most of Korean real income growth. However, by comparing the measurement result with and without land, they conclude that role of capital and labor may be overstated if land and inventory assets are excluded.

This paper contributes to previous literature in the following three aspects. First, and the most fundamental part, as far as the author knows this study is the first attempt to build up by industry land stock in China. Due to far insufficient information how land is used in China, discussion on land in the growth accounting context has been purposefully avoided. However, with land stock estimations from this study, we are able to have a look at how use of land has been changing over the 30 years and furthermore, growth accounting from different perspective now become possible. Second, despite the significance of land, this is the first literature to account for the role of land in China's economic development. Though there has been literature like Justin Yifu Lin (1989) and Guangzhong James Wen (1993) mentioned above, these literatures are mainly focused on the institutional change perspective. The result of their study suggest there should be reasons to explain agricultural growth other than institutional change after 1985 and this study, in some extent, can be seen as a continue of their study since this paper seeks for the growth logics over the year 1980-2010. Third, most of the literature that include land as a input factor so far in China or in the world is focused on the agricultural sector. However, it is obvious that land is not only important for agriculture. This is especially the case in China where significant change on land use has been going on. Adding manufacturing and service sector into the study enables us a more comprehensive view of what is happening and may provide us some thoughts on how resources like land, capital, and labor should be allocated to achieve more efficient economic growth. At the same time, since there has already been literature to include land in growth accounting in Japan, the U.S. and Korea, the complete of this paper also provides the opportunity for international comparison.

The following part of this paper contains three chapters. Chapter 2 focuses on the construction of land stock by type. Chapter 3 is the effort to divide land stock by type into 31 industries, which is indispensable for the growth accounting conducted in chapter 4. In chapter 4, not only will the growth accounting with the inclusion of land be done, the growth accounting result without land will also be provided for a better understanding of the role of land in economic growth.

Industrial data used in this paper are mostly from the CIP and JIP database in REITI. By type land area data is constructed based on official publication of the Chinese government.

CHAPTER 2. LAND STOCK BY TYPE

This chapter is devoted to the construction of land stock by type. With the land price by type from the Ministry of Land and Resources (MLR) of the People's Republic of China, the nominal land stock is estimated.

In China, land is divided into two major categories. Agricultural land, which is owned by the rural collectives, is the biggest part of all land type in China in terms of size. Construction land, which is owned by the state, covers almost all the other land types excluding agricultural land. The user right of both agricultural land and construction land can be transacted with a duration of 30 years and 40~70 years depending on the use of land.

2.1 Classification of land by type

Since the official classification (Table 1) is very vague and the classification commonly used in land study (Table 2) includes land that is not productive. We made our own classification as shown in table 3, which picked up land types that interest us (marked in blue) from table 2. In this study, when we refer to agricultural land, we mean the aggregation of cultivated land and orchards. And construction land consists of four parts: urban residential land, rural residential land, land used for service sector, and land used for manufacturing sector.

Table 1 – Official classification of land by type.

Category	Subcategory	Corresponding code
i. Agricultural land	Cultivated land	g1
	Orchards	g2
	Forestland	e2
	Pasture	e3
ii. Construction land	Transportation	d1~d4
	Settlements & ind/mining site	a1~a2, b1~b6, c1~c2, e1, e4~e5
	Water area	f1~f4
	Unused land	-

Table 2 – Land composition reference.

Land type	Code	Description
a. Residential	a1	Urban and town residential
	a2	Rural residential
b. Public facilities	b1	Municipal administration
	b2	Commercial and financial services
	b3	Cultural and sports services
	b4	Hospital and sanitary
	b5	Education and research institutes
	b6	Civic utilities
c. Industrial	c1	Light pollution industry
	c2	Heavy pollution industry
d. Transportation	d1	Railroad
	d2	Road and plaza
	d3	Harbor and port
	d4	Airport
e. Green land	e1	Urban park
	e2	Forest
	e3	Pasture
	e4	Natural reserves
	e5	Greens in rural and country
f. Water	f1	Streams and canals
	f2	Lakes and reservoirs
	f3	Ponds and aqua farms
	f4	Beaches and wetland
g. Agriculture	g1	Cultivated land
	g2	Orchards

Table 3– Land classification used in this study.

Category	Subcategory	Corresponding code
I. Agricultural land	Cultivated land	g1
	Orchards	g2
II. Construction land	Urban residential	a1
	Rural residential	a2
	Commercial (Service)	b1~b6, d1~d4
	Industrial	c1~c2

2.2 Land area construction by type

For agricultural land and urban residential land, we followed the official data on *Communiqué on Land and Resources of China* and *China City Statistical Yearbook* respectively. For rural residential land, since there is official annual data for rural residential land per person and rural population, it is not difficult for us to calculate rural residential area. For commercial land, there is no official record at all. Therefore, we refer to a report by Tuliu, China's biggest comprehensive service platform for land transfer. According to the report, though it is advised by the government that commercial land/residential land ratio be 4%, in most of cities in China, the ratio is between 5% to 8%. We did a rough estimation by assuming that commercial land is proportional to residential land by 6.5%. For industrial land, we referred to *Chinese City Development Report* which is a study on land use in major Chinese cities in 1991 for inner-city industrial land percentage in a national scale and add it to the out-of-city industry land from the official source. And then, based on the 1991 data, the new supply of industrial land annually from official source is aggregated to obtain industrial land area each year. The result is shown in figure 1.

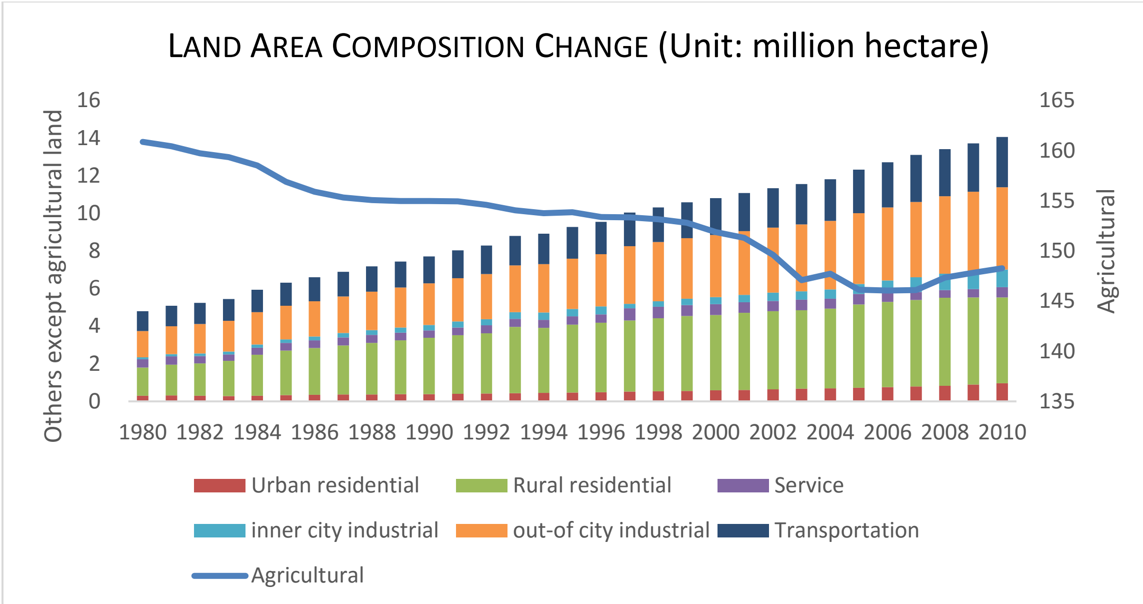


Figure 1 – Land area composition change in China from 1980 to 2010

In figure 1, because land used for transportation is a big part of land used for service sector, we single it out here to have a better understanding of change of other service land. As shown in figure 1, all land type except for agricultural land has been going through an upward trend development during the 30 years. This is not surprising at all considering the rapid urban expansion. Within residential land, rural residence is dominantly larger than urban residence despite urban residence's growth. For industrial land, both inner-city and out-of-city industrial land have been growing. However, when comparing the growth rate of the two, inner-city industrial land grows faster than out-of-city industrial land. Though city government like Beijing has been working actively to move manufacturing companies, especially heavy industries, out of the city, from a national perspective, inner-city industry land area is still growing at a fast speed as a result of urbanization. As for agricultural land, even though the overall trend has been downward, from 2007, land for agricultural use started to increase. This might be a result of the government's emphasis on agricultural land security. In 2007, a concept called "red line", which is the bottom line of arable land that is needed to feed its people, was brought up by the government. Because the increase of construction land like residential land and industrial land are obviously from agriculture, and once this shift happens, it is merely impossible to inverse, it may look strange as agricultural land increase. However, if we look deep into the *Communiqué on Land and Resources of China,* we can find that the increase of agricultural land is from renovation of land that is previously not arable, though we could not exclude the possibility of the local government exaggerating the size of renovated land to have a better-looking statistics.

2.3 Land price by type

Since we already have land size by type in 2.2, the next step is to have land price by type. For urban residential, industrial, and commercial land, based on price from official source from 2000 to 2016, we fill the missing data series by trend-deviation interpolation benchmarking on changes in gross national income. For agricultural land, based on a survey across 17 Chinese provinces, two medians for cash payment for agricultural land transfer is 245 yuan/mu (equally 0.3675 yuan/sqm) and 126 yuan/mu (equally 0.189 yuan/sqm) in 2008 and 2005 respectively. If an annual payment is capitalized at 5% (China's 10-year treasury bond yields), it would suggest a per square meter value of land of 7.35 yuan/sqm and 3.78 yuan/sqm for 2008 and 2005 respectively. Using these two years as benchmark, we construct agricultural land price using the growth trend of labor compensation in agriculture. After having agricultural land price, it would be plausible for us to assume rural residential land price to be the same as agricultural land price since farmer often build their houses on the agricultural land they own.

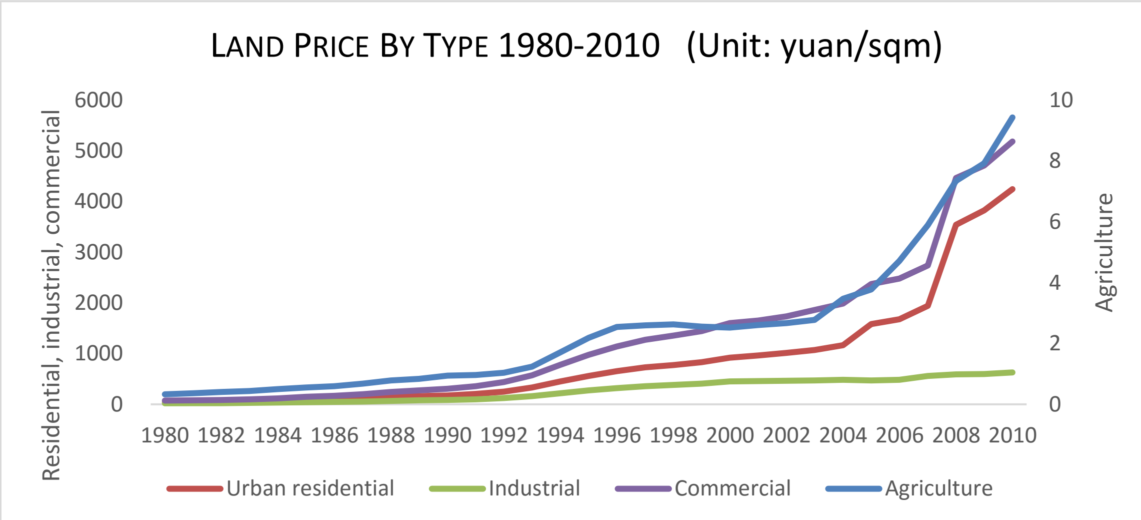


Figure 2– Land price by type in China from 1980 to 2010

In figure 2, the right axis shows the land price for agriculture while the left axis shows land price for other types of land. As shown in figure 2, all land prices have been increasing during the 30 years. In 1979, Household Responsible System was adopted, and since that time, farmers became more motivated to improve land quality. However, it was not until 1994 when land price for all types of land started to increase in a seeable scale. 1994 is the year when China started its tax reform. The tax sharing rules were changed in favor of the central government and under tighter fiscal constraints, local government had no choice but to sell agricultural land for manufacturing or service use to make their ends meet. But still, before 2004, while land price is increasing, the speed is rather stable. From 2004-2008, all land price increases very rapidly. Figure 3 shows broad money in percentage of GDP in China. And we can find that from 2004 and before the financial crisis in 2008, the broad money/GDP ratio has been in a historically high position. With limited choice of investment, it is not strange that these moneys rushed into the real estate market.

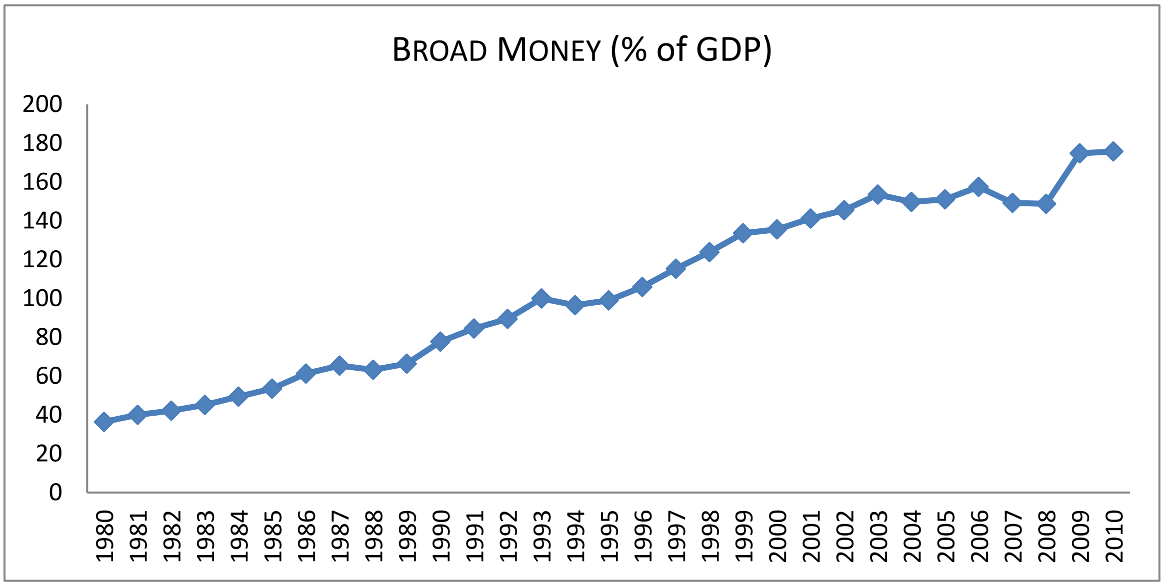


Figure 3– Broad Money in Percentage of GDP in China (Source: the World Bank)

After the financial crisis in 2008, though all land prices keep increasing, the speed of increasing become slower.

2.4 Land stock value by type

Aggregating land area and land price by type, we are able to get land stock value by type as shown in figure 4. Though agricultural land and rural residence are very large in term of area size, the extremely low price compared with other land types results in the relatively smaller land stock value. When looking at the series line for total land stock, it looks very similar to the land price figure which lead us to the conclusion that rather than quantitative effect, the price effect plays a more significant role in determination of land stock value in China's case.

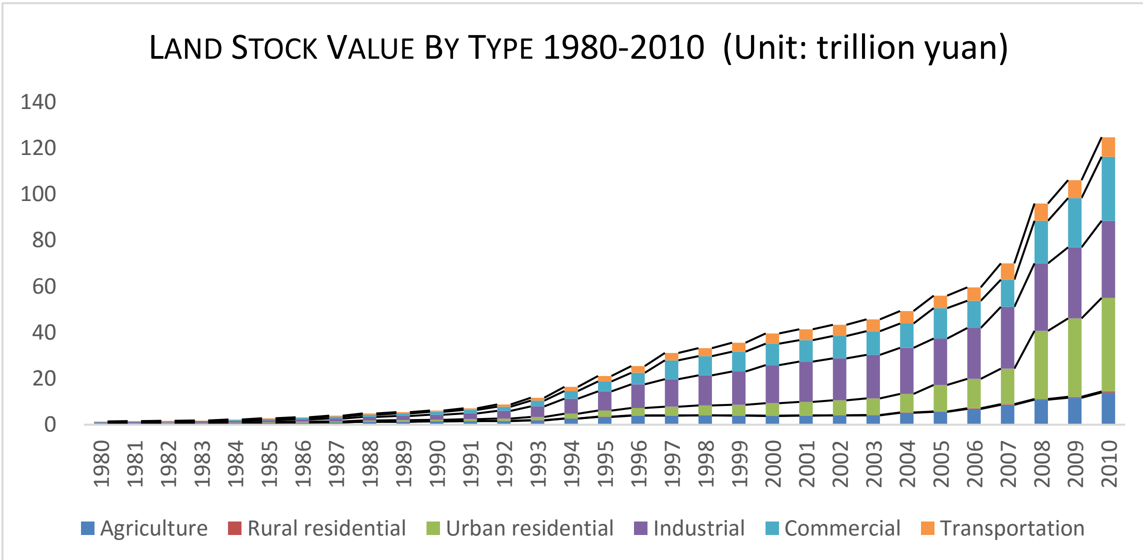


Figure 4– Land stock value by type in China from 1980 to 2010

CHAPTER 3. LAND STOCK BY INDUSTRY

3.1 Land stock by industry

To investigate the TFP performance by industry, we categorize the 37 industries in the CIP database into 31 industries to make sure it is comparable to the JIP database (see APPENDIX A). Assuming that the share of capital stock in each industry is closely related to the land stock used in each industry, we can divide land stock by type into land stock by industry using the formulas below:

$$A_{i,t} = \beta_{i,t} A_{h,t} \tag{1}$$

Where, $\beta_{i,t}$ is the share of capital stock in industry i in year t. $A_{i,t}$ is the value of land stock in industry i in year t. $A_{h,t}$ is the value of land stock in land type h in year t. And here we have $\sum \beta_{i,t} = 1$.

By employing this approach, we are able to get land stock by industry for manufacturing (17 industries) and service (13 industries) respectively. Table 4 and table 5 shows land stock in 17 manufacturing industries and 13 service industries. In manufacturing, industries like primary & fabricated metal industry, chemicals and allied products industry have higher land stock than other industries. This is pretty intuitive since production in these industries often requires large machinery and occupies large land area. In service industries, real estate industry standouts with land stock of 11,798 billion yuan in 2010, a clear reflection of the real estate developing boom in China over the past decades.

Table 4– Land stock by industry in manufacturing sector (Unit: billion yuan)

Year	1980	1985	1990	1995	2000	2005	2010
FDB	13	50	154	651	1,239	1,332	2,434
TBC	1	3	16	104	290	249	249
TEX	18	71	218	795	1,238	1,419	1,784
LEA	1	5	15	74	116	158	210
WDF	3	9	22	85	177	261	478
PAP	8	23	64	260	635	901	1,093
PET	7	17	61	297	788	792	1,397
CHE	38	100	254	974	2,085	2,346	3,760
RBP	5	19	55	227	472	648	884
BUI	20	63	166	697	1,194	1,342	2,207
MET	50	110	280	1,235	2,384	2,997	5,584
MCH	54	114	236	685	1,047	1,205	2,429
ELE	7	19	61	284	598	745	1,484
ICT	6	17	48	245	756	1,547	2,551
INS	3	8	16	66	105	157	257
TRS	20	42	93	419	920	1,144	2,103
OTH	5	8	27	182	266	206	348

Table 5– Land stock by industry in service sector (Unit: billion yuan)

Year	1980	1985	1990	1995	2000	2005	2010
UTL	104	175	361	1,415	2,750	3,254	5,375
CON	18	35	59	170	338	415	652
SAL	80	106	183	459	914	904	1,667
HOT	6	14	27	86	199	244	692
T&S	112	259	625	2,321	4,434	5,457	8,492
P&T	11	10	16	35	121	105	130
FIN	14	19	31	87	161	117	134
REA	21	59	180	1,110	2,829	5,076	11,798
BUS	12	30	57	126	236	292	708
ADM	34	59	111	313	758	1,413	4,223
EDU	22	53	120	277	584	855	1,311
HEA	5	13	31	73	149	220	485
SER	6	16	36	92	181	234	604

3.2 Land area by industry

Though there is no information regarding how land area is allocated among industries, we try to use the indirect way building the Chinese by industry land area by analyzing the Japanese data where by industry land area is available. Even though China and Japan are in different developing status and have different economic structure, it is plausible to think that the land used by certain industry in both countries is closely related to some shared factors because the property of industry hardly varies across countries. Based on this consideration, we try to firstly grasp the relationship between land area used by industry and several possible factors in Japan by doing a fixed effect regression. Below table 6 shows the independent and dependent variables in the regression. All variables are in growth rate terms, and industry is used as dummy variable. Because in the CIP data, there are only two types capital: structure, and equipment, we include both into the regression. However, to avoid multicollinearity problems equipment per labor change instead of just equipment. Also, because land price is different by industry, while the macro economy going through ups and downs, land will shift from industry where land price is low to industries where land price is higher. Therefore we include macroeconomic indicators like GDP and employment in manufacturing and service sector.

Table 6– Definition of variables used in the empirical analysis

Variable	Definition
ARECHG	Annual area change in industry i
STRCHG	Annual change of structure used in industry i

EQUPERCHG	Annual change of equipment per labor used in industry i
GDPGRO	GDP growth
MEMCHG	Change of manufacturing employment
SEMCHG	Change of service employment

The regression is done for manufacturing sector and service sector respectively and the results can be found in table 7.

Table 7– Regression results on Japanese industrial data

Manufacturing sector

Independent variables	Coefficients	Pr(>|t|)	
STRCHG	0.2434158	9.12E-07	***
EQUPERCHG	-0.0126498	0.6393	
GDPGRO	0.0238314	0.785607	
MEMCHG	0.1294392	0.194188	
SEMCHG	-0.0491011	0.827586	
INDBUI	0.0043252	0.527086	
INDCHE	0.0129144	0.057296	.
INDELE	0.0140391	0.043067	*
INDFDB	0.0197565	0.003572	**
INDICT	0.0281046	4.23E-05	***
INDINS	0.0114916	0.093148	.
INDLEA	-0.0072102	0.319855	
INDMCH	0.0234729	0.000736	***
INDMET	0.0116977	0.084697	.
INDOTH	0.0145036	0.03529	*
INDPAP	0.0118797	0.079153	.
INDPET	-0.0001596	0.981202	
INDRBP	0.0318092	4.44E-06	***
INDTBC	0.0220281	0.002136	**
INDTEX	-0.0167949	0.015207	*
INDTRS	0.0188752	0.005244	**
INDWDF	-0.0163533	0.016809	*

Service sector

Independent variables	Coefficients	Pr(>|t|)	
SSTRCHG	0.10435	0.00129	**
SEQUPERCHG	0.587202	< 2e-16	***
SGDPGRO	-0.279752	0.01855	*
SMEMCHG	0.388554	0.00342	**
SSEMCHG	-0.504518	0.101921	
SINDADM	0.021905	0.008442	**
SINDBUS	0.027181	0.001234	**
SINDCON	-0.008622	0.291603	
SINDEDU	0.012405	0.136679	
SINDFIN	-0.033773	6.84E-05	***
SINDHEA	0.029433	0.000454	***
SINDHOT	0.004531	0.58439	
SINDP & T	0.020993	0.010314	*
SINDREA	0.030345	0.000225	***
SINDSAL	-0.002719	0.739463	
SINDSER	0.006494	0.425694	
SINDT & S	-0.007224	0.375123	
SINDUTL	-0.008666	0.30415	

The results are very intuitive. Change of structure is significant for land area change for both land type. Even though higher buildings can contribute to higher structure without changing land area, generally the increase of structure is often accompanied with increased land areas. For other factors like equipment per labor, GDP growth, and employment change, they are significant in service sector, but not in manufacturing sector. This may be explained by the sensitivity to macroeconomic environment because land used in service sector is more expensive and the need for more service land is closed affected by macroeconomic environment. While in manufacturing sector, where the influence of local government is very strong, (In order to increase employment and tax revenue, most of local government is more than welcome to introduce manufacturing companies. And this behavior of the local government is not so sensitive to economic situations.) may detach from the change of these macroeconomic factor.

Applying the coefficients in the Japanese case by industry to structure change, equipment per labor change, and these macroeconomic indicators, we are able to have annual area change by industry in China thanks to the CIP database. For 1980, we refer to the portion of land by industry in the Japanese data and build up land area level data by industry in China since we already build up by type land area in chapter 2. Though some people might think using the Japanese land area by industry proportion is inappropriate due to different developing stage of the two countries, this practice could be justified if we look closer at the Japanese industrial land proportion. The fact that over 30 years, the land proportion for each industry has rarely changed makes us believe the rare relativity of land area proportion and economic development stage. Considering that 1980 is the year when the Chinese government has just started the opening-up policy and most of the land use is planned by the government, we adjusted the portion of real estate to reflect the circumstance in China.

Figure 5 and figure 6 shows the results by two different approaches. The blue line is the aggregate result we get by doing regression on the Japanese data, using coefficients to build up by industry land area in China, and aggregating the year total land area by type. The orange line is the by type land area data we build in chapter 2. Though in service sector from year 2000, the gap between the two approaches has a tendency to be enlarged, overall, these two approaches seem consistent.

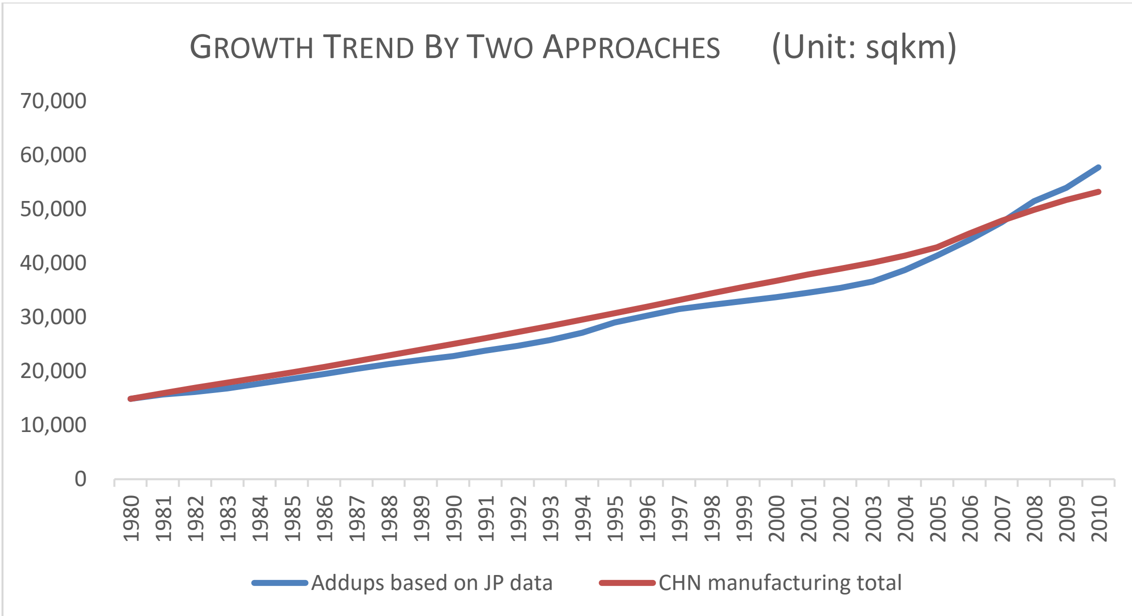


Figure 5– Land area by type by two approaches in manufacturing sector

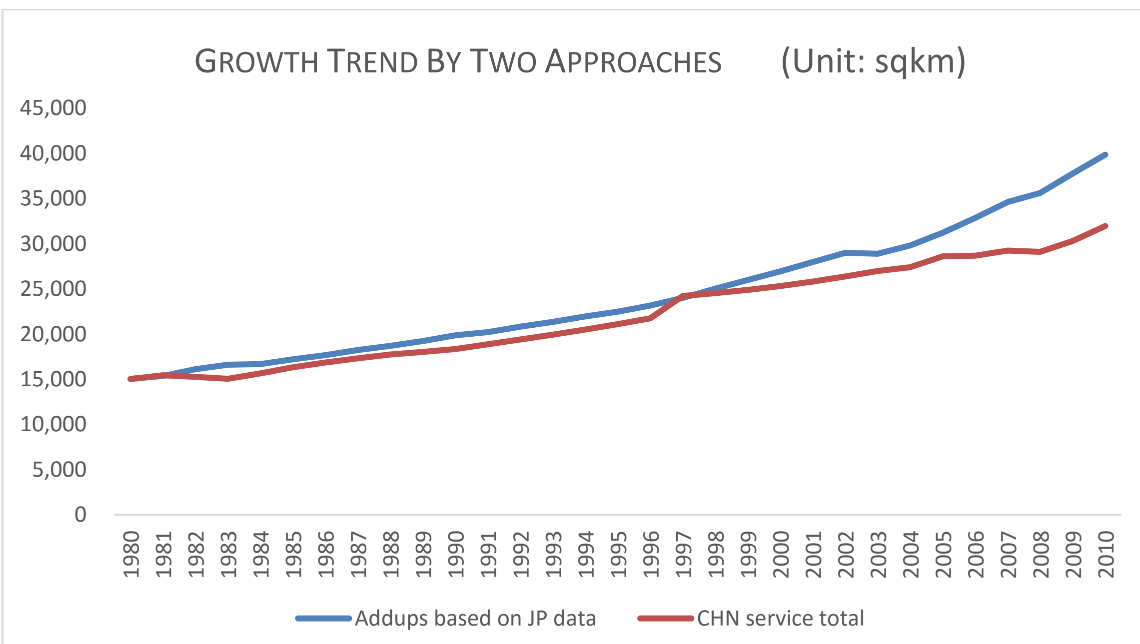


Figure 6– Land area by type by two approaches in service sector

CHAPTER 4. GROWTH ACCOUNTING

4.1 User cost of land

"User cost of capital", also called the "rental price", is the corresponding price of capital services. This approach, developed by Jorgenson (1963), is derived from the neoclassical theory of investment. In equilibrium, investors are indifferent between earning a nominal rate of return on an investment or buying a unit of capital, collecting a rental price and the selling the depreciated asset in the next period as shown in formula (2).

$$U_{m,i,t} = (i_{i,t} - \pi_{m,i,t})P_{m,i,t-1} + \delta_{m,i,t}P_{m,i,t} \tag{2}$$

Where $U_{m,i,t}$ is user cost of asset m (e: equipment, s: structure, d: land) of industry i in year t. $i_{i,t}$ is nominal interest rate. $\pi_{m,i,t}$ is the inflation rate of asset m (e: equipment, s: structure, d: land) of industry i in year t. $\delta_{m,i,t}$ is the depreciation rate of asset m (e: equipment, s: structure, d: land) of industry i in year t. $P_{m,i,t}$ is price of asset m (e: equipment, s: structure, d: land) of industry i in year t. And $\pi_{m,i,t}$ satisfies the following equation (3).

$$\pi_{m,i,t} = (P_{m,i,t} - P_{m,i,t-1})/P_{m,i,t-1} \tag{3}$$

Nominal interest rate:

$$i_{i,t} = \frac{KC_{i,t} - \sum_{m=e,s,d}\left[\left(\delta_{m,i,t} - \pi_{m,i,t}\right)A_{m,i,t}\right]}{\sum_{m=E,S,D} A_{m,i,t}} \tag{4}$$

Where $KC_{i,t}$ is capital compensation which is the aggregation of services coming from structure, equipment, and land. Since we have value-added $VA_{i,t}$ and labor compensation $LC_{i,t}$ data in CIP, we can easily derive $KC_{i,t}$ by the following equation (5)

$$KC_{i,t} = VA_{i,t} - LC_{i,t} \tag{5}$$

In 3.1, we already had nominal capital stock $A_{i,t}$ in equation (1). Here we convert $A_{i,t}$ in nominal price into $A_{m,i,t}$ in 1990 price for comparison purpose.

So far, with all the data we have and equation (1) ~ (5), the only thing we need to know is land price. However, with equation (6) below, we can easily have land price by industry.

$$P_{d,i,t} = \frac{A_{d,i,t}}{Q_{d,i,t}} \tag{6}$$

Where $Q_{d,i,t}$ is the by industry land area we derive in 3.2

4.2 Input factors and TFP calculation

For capital input, since we have two types of capital: equipment and structure, the increase of capital input can be calculated as:

$$\Delta lnK_{i,t} = \frac{E_{i,t}}{E_{i,t} + S_{i,t}} \Delta lnA_{e,i,t} + \frac{S_{i,t}}{E_{i,t} + S_{i,t}} \Delta lnA_{s,i,t} \tag{7}$$

For labor input, we employ the data from CIP database, where labor input has been adjusted to homogenous hours. For increase of land input we have:

$$\Delta lnD_{i,t} = \Delta lnA_{d,i,t} \tag{8}$$

Aggregating what we have together using the following equation (8), we will be able to have TFP by industry.

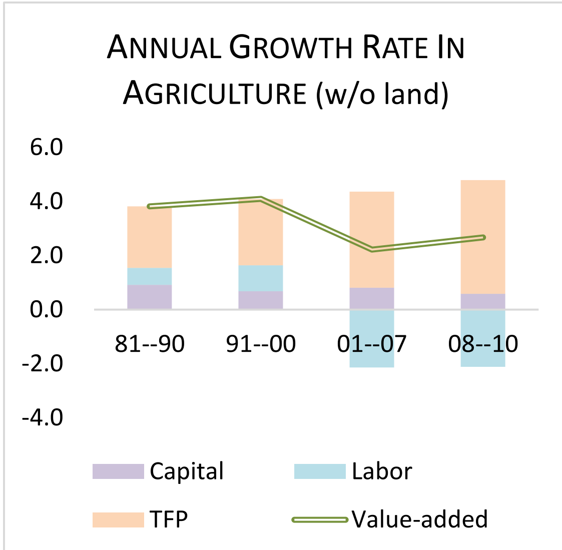
$$v_i = \Delta lnY_i - (\overline{w}_{K,i}\Delta lnK_i + \overline{w}_{L,i}\Delta lnL_i + \overline{w}_{D,i}\Delta lnD_i + \overline{w}_{X,i}\Delta lnX_i) \tag{9}$$

Where $\overline{w}_{j,i}$ is the cost share of factor J (K: capital, L: labor and D: land) in industry i at time t as shown in equation (10). And v_i is total factor productivity by industry.

$$\overline{w}_{J,i} = P_{J,i}J_i / P_{Y,i}Y_i \tag{10}$$

4.3 Empirically results

We conducted the growth accounting in manufacturing sector, agriculture sector and service sector for every 10 years in the period between 1981 and 2010 (1981-1990, 1991-2000, 2000-2007, 2008-2010) by applying the method described in the above. The estimated results for each industry are presented in Figure 7, 8 and 9, respectively.



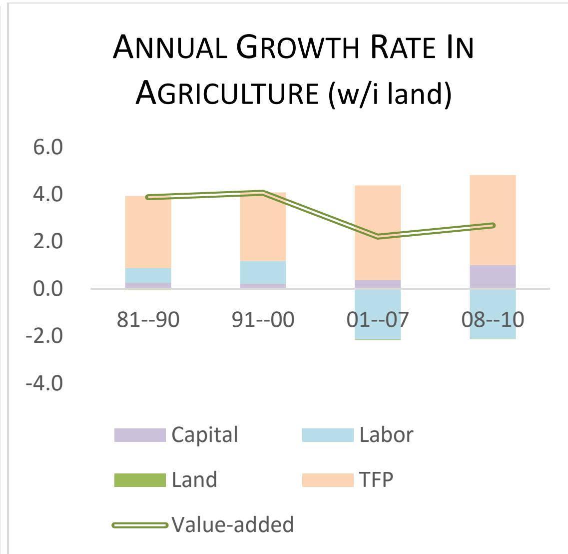
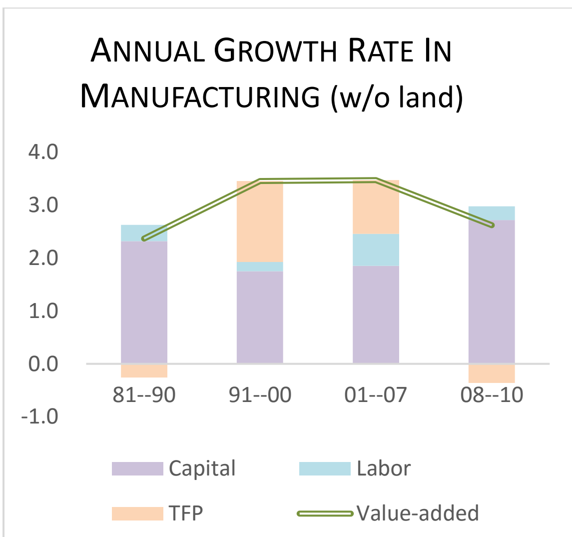


Figure 7– Annual growth rate in agriculture



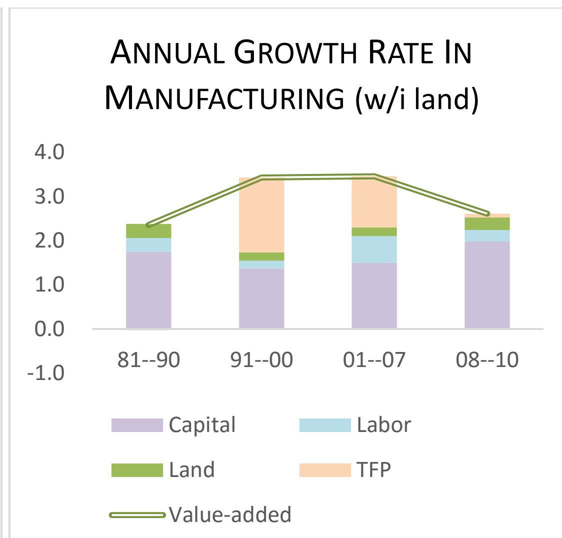


Figure 8– Annual growth rate in manufacturing sector

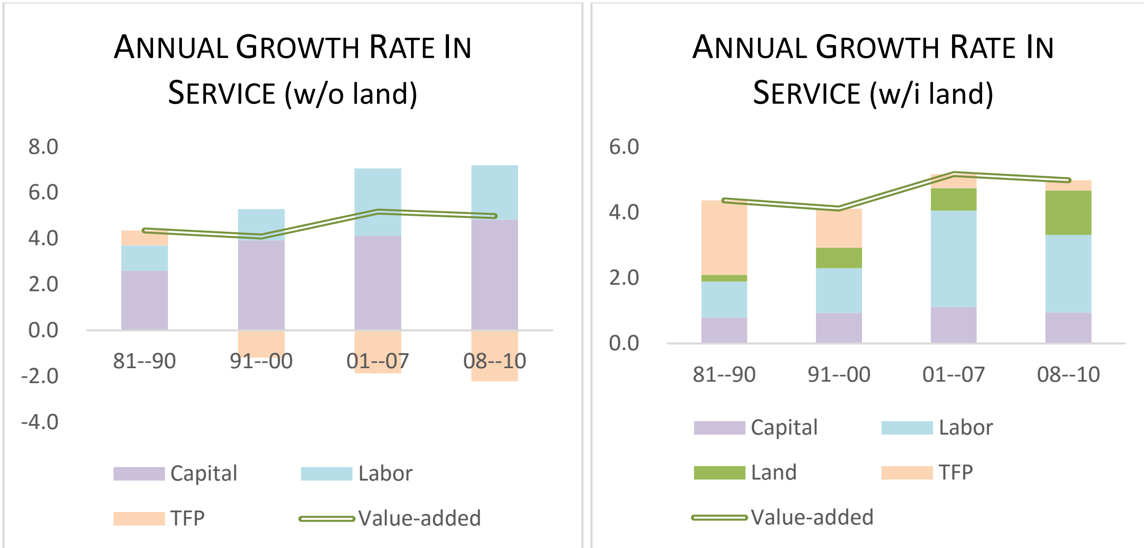


Figure 9– Annual growth rate in service sector

As the figures imply, overall, without land as an input factor, capital contribution is exaggerated and TFP is underestimated.

China's agriculture achieved the best TFP performance with or without the calculation of land input. It maintained a strong positive productivity growth throughout the calculated period. However, this is accompanied by a continuous decline in land input throughout the 30 years in discussion and decline in labor input since the 21 century. Growth of land over the 30 years shows a negative tendency which is a result of more and more land being taken from agriculture for other type of use. On the other hand, impact of land input in agriculture is very small because land price is extremely cheap and has a very limited increase during the 30 years in study. Here we come to the same conclusion as Justin Yifu Lin (1989). Though land is massively used in agriculture, what really drive the growth of agriculture is mainly improvement of irrigation, and use of fertilizer, which in other words, the increase of structure and equipment within capital input. As for the decline in labor input since 2000, it makes sense when taking into consideration of the urbanization where farmers move to cities in seek of better paid jobs.

When looking at the manufacturing and service sector, we can see that land stock contributes positively in the period from 1981 to 2010. In manufacturing sector, land does not contribute as much as in service sector, but still, the role of land cannot be neglected. Manufacturing sector, usually seen as the growth engine of China, has a positive TFP growth since the 1990s as we expected. After the financial crisis in 2008, TFP growth become negative. However, when accounting for the role of land the TFP growth become slower but still positive. After the financial crisis, the central government is financing 4 trillion-yuan package and local governments proposed their own stimulus packages of 18 trillion yuan. The central government knows that the economy has been suffering from overcapacity. Therefore, the stimulus package from the central government was concentrated in infrastructure, instead new factories and that is why we see more capital growth in the period 2008-2010 than in period 2001-2007. However, for local government, though knowing factories are going through overcapacities, due to limited investment channels, they accelerate the speed of selling land to manufacturing companies by cooperating with banks that provide manufacturing companies with low interest rate loans. And this may be why we see the highest ever land growth rate since the 1990s.

In service sector, figure 9 shows a significant difference between the two scenarios. First and most obvious is the TFP growth, with the inclusion of land, the result implies that service sector is not as inefficient as we previously thought. Another observation is on capital input. With the inclusion of land, capital input growth is only about half of what we observe without land.

With the inclusion of land, one of the biases that often occur in growth accounting is eliminated. However, as far as the calculation in this paper concerns, there are still several factors that might lead to a biased result and are subject to improvement of approaches of future study. Firstly, agricultural land is not estimated detailed enough. For example, the productivity of land that can be ploughed twice a year is higher than land that can only be used once a year. Despite this fact, all land are treated equal in this study due to data availability issues. Secondly, most of the data employed in this study comes from official sources. However, there is possibility that the data is not fully reliable due to the incentive to have better looking statistics and this may also lead to biased results.

APPENDIX A. INDUSTRY CLASSIFICATION

#	Manufacturing industries in this study	Code	JIP Classification
1	Agriculture, forestry, animal husbandry & fishery	AGR	1. Rice, wheat production
			2. Miscellaneous crop farming
			3. Livestock and sericulture farming
			4. Agricultural services
			5. Forestry
			6. Fisheries
2	Food and kindred products	FDB	8. Livestock products
			9. Seafood products
			10. Flour and grain mill products
			11. Miscellaneous foods and related products
			12. Prepared animal foods and organic fertilizers
			13. Beverages
3	Tobacco products	TBC	14. Tobacco
4	Textile mill products & apparel and other textile products	TEX	15. Textile products
5	Saw mill products, furniture, fixtures	WDF	16. Lumber and wood products
			17. Furniture and fixtures
6	Paper products, printing & publishing	PAP	18. Pulp, paper, and coated and glazed paper
			19. Paper products
			20. Printing, plate making for printing and bookbinding
7	Leather and leather products	LEA	21. Leather and leather products
8	Rubber and plastics products	RBP	22. Rubber products
9	Chemicals and allied products	CHE	23. Chemical fertilizers
			24. Basic inorganic chemicals
			25. Basic organic chemicals
			26. Organic chemicals
			27. Chemical fibers
			28. Miscellaneous chemical products
			29. Pharmaceutical products
10	Petroleum and coal products	PET	30. Petroleum products
			31. Coal products
11	Stone, clay, and glass products	BUI	32. Glass and its products
			33. Cement and its products
			34. Pottery
			35. Miscellaneous ceramic, stone and clay products

12	Primary & fabricated metal industries & metal products (excluding rolling products)	MET	36. Pig iron and crude steel
			37. Miscellaneous iron and steel
			38. Smelting and refining of non-ferrous metals
			39. Non-ferrous metal products
			40. Fabricated constructional and architectural metal products
			41. Miscellaneous fabricated metal products
13	Industrial machinery and equipment	MCH	42. General industry machinery
			43. Special industry machinery
			44. Miscellaneous machinery
14	Instruments and office equipment	INS	45. Office and service industry machines
15	Electric equipment	ELE	46. Electrical generating, transmission, distribution and industrial apparatus
			47. Household electric appliances
16	Electronic and telecommunication equipment	ICT	48. Electronic data processing machines, digital and analog computer equipment and accessories
			49. Communication equipment
			50. Electronic equipment and electric measuring instruments
			51. Semiconductor devices and integrated circuits
			52. Electronic parts
15	Electric equipment	ELE	53. Miscellaneous electrical machinery equipment
17	Motor vehicles & other transportation equipment	TRS	54. Motor vehicles
			55. Motor vehicle parts and accessories
			56. Other transportation equipment
13	Industrial machinery and equipment	MCH	57. Precision machinery & equipment
8	Rubber and plastics products	RBP	58. Plastic products
18	Miscellaneous manufacturing industries	OTH	59. Miscellaneous manufacturing industries

#	Service industries in this study	Code	JIP Classification
20	Construction	CON	60. Construction
19	Power, steam, gas and tap water supply	UTL	61. Civil engineering
			62. Electricity
			63. Gas, heat supply
			64. Waterworks
			65. Water supply for industrial use
			66. Waste disposal

21	Wholesale and retail trades	SAL	67. Wholesale
			68. Retail
25	Financial Intermediations	FIN	69. Finance
			70. Insurance
26	Real estate services	REA	71. Real estate
			72. Housing
23	Transport, storage & post services	T & S	73. Railway
			74. Road transportation
			75. Water transportation
			76. Air transportation
			77. Other transportation and packing
			78. Telegraph and telephone
			79. Mail
29	Education	EDU	80. Education (private and non-profit)
27	Leasing, technical, science & business services	BUS	81. Research (private)
30	Healthcare and social security services	HEA	82. Medical (private)
			83. Hygiene (private and non-profit)
28	Government, public administration, and political and social organizations, etc.	ADM	84. Other public services
27	Leasing, technical, science & business services	BUS	85. Advertising
			86. Rental of office equipment and goods
			87. Automobile maintenance services
			88. Other services for businesses
31	Cultural, sports, entertainment services; residential and other services	SER	89. Entertainment
24	Information & computer services	P & T	90. Broadcasting
			91. Information services and internet-based services
			92. Publishing
			93. Video picture, sound information, character information production and distribution
21	Hotels and restaurants	HOT	94. Eating and drinking places
			95. Accommodation
31	Cultural, sports, entertainment services; residential and other services	SER	96. Laundry, beauty and bath services
			97. Other services for individuals
29	Education	EDU	98. Education (public)
27	Leasing, technical, science & business services	BUS	99. Research (public)
30	Healthcare and social security services	HEA	100. Medical (public)
			101. Hygiene (public)
			102. Social insurance and social welfare

			(public)
28	Government, public administration, and political and social organizations, etc.	ADM	103. Public administration
30	Healthcare and social security services	HEA	104. Medical (non-profit)
			105. Social insurance and social welfare (non-profit)
28	Leasing, technical, science & business services	BUS	106. Research (non-profit)

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