Accounting for the Role of Land as a Source of Economic Growth in China and Japan

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

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1. INTRODUCTION

This paper has two objectives. It first measures land stock and service by land type in China and Japan in the same land capital input framework and then accounts for their roles in the growth of the two economies. China and Japan are among the world's most arable land-scarce countries, being 0.08 and 0.03 hectares per capita (data regarding circa 2010) respectively, compared to the world average of 0.21 hectare. The two countries could well represent different stages of economic development in East Asia where land played different roles. Along with the development, while land has been increasingly shifted from the agricultural to nonagricultural sectors and from production to residential use, its productivity and cost have also changed. However, the role of land has not been taken into account particularly at the industry level in the previous growth accounting exercises for China and Japan.

Studying China and Japan together provides some advantages. On the one hand, being East Asian neighbors with strong ties in culture and history, both countries are similar in many aspects. On the other hand, Japan has a better statistical system than China supported by regular surveys and censuses which have been almost uninterrupted since their establishment. Given the far insufficient information in the case of China, we have to explore both direct and indirect methods for the estimation. First, we will collect all available data on land use and land stock of all sectors of the economy. For industries where there is hardly any information at this stage, we use the case of Japan, by controlling for the stage of development, to gauge the likely land use structure and its changes over time.

This problem needs to be addressed not only with an appropriate methodology that takes into account the role of different types of land across industries but more importantly with industry productivity accounts data that are constructed coherently under the national accounts framework. This study is benefitted from the industry data constructed under the CIP (China Industrial Productivity) and JIP (Japan Industrial Productivity) Database Programs.

Our paper's contributions to previous literature are two folds. First, we estimate the stock and service of the land asset by manufacturing industry in Japan and China.[1] As far as authors know, there is no attempt for the estimation of land stock by industry in case of China, and Nomura (2004) is one of a few exceptions in the case of Japan. Second, we conduct growth accounting by employing the broader definition of capital, including tangible assets such as equipment and structures, as well as a land asset by employing the recent CIP and JIP databases. Diewert et al. (2009), and Cho et al. (2015) are limited current examples that examine the role of land as a source of economic growth in the US, Japan, and Korea, respectively.

The remainder of this paper is organized as follows. Sections 2 and 3 are devoted to land stock data construction and estimation on industry-level land services in Japan and China, respectively. Section 4 conducts growth accounting analysis with land as one of the input factors and states the results from the analysis. The last section discusses the main findings from the analysis and their implications for future research.

2. Estimation of Land Stock and Service in Japan

2.1 Estimation of Land Stock in Real Terms

Land stock value by type of area

The nominal land stock asset value estimated by Japanese System National Accounts (J-SNA) is divided into two categories: land stock value held by the private sector, and by public administration and others.[2] Table 1 shows the land stock asset estimation by the category from J-SNA. The private land stock asset value is further classified into three categories: the value of land underlying buildings and structures, the value of land under cultivation, and value of other land. We employ the nominal land stock held by the private sector, excluding other land stock in 1973-2012 as the control total for our industry level land stock estimation in this paper.[3]

[1] We will extend our estimation on land stock and service in other industries, such as agriculture sector and service sectors in the next paper.

[2] Public administration and others include general governments and non-profit institutions serving households.

[3] The share of land stock value held by public administration and others is 17 percent of total Japanese land stock value in 2014, and the share of the value of other land stock is about 12 percent of the total land stock value held by private sector in the year.

TABLE 1: THE BREAKDOWN OF LAND STOCK VALUE IN 2012

(unit: billion yen)

Land Category	Asset Value
Total Land Asset	1,132,926
Private	938,784
Building and Structure	781,713
Manufacturing use	58,945
Commercial use	110,226
Residential use	611,111
Others	1,431
Cultivated	51,264
Others	105,807
Public	194,143

(Source: J-SNA)

First, we divide land underlying buildings and structures into three types of area: (1) Manufacturing area, (2) Commercial area, and (3) Residential area. "Survey on tangible asset price and others" by Ministry of Internal Affairs and Communications[4] provides the information on the share of each three types of areas in the total area. We use the following equation for this estimation of land stock in each area type.

$$A_{it} = \alpha_{it} A_t,$$

$$\sum_i \alpha_{it} = 1$$

where

t: year (1973 to 2012)

i=m,c,r : m=industrial area, c=commercial area, and r=residential area

A_t : total value of land stock underlying buildings and structures in year t

A_{it} : value of land stock in type of area i at year t

α_{it} : share of value of land asset in type of area i at year t among total value of land stock underlying buildings and structures at year t.

We assume the land under cultivation is used in the agriculture sector and the other land is not used in any economic sector. In addition we assume the residential area is used for the housing purpose.

[4] Land stock estimations in J-SNA uses information on price and area of land held by private sector from the survey, but they make some adjustments on price information.

Land stock price by type of area

The information on the area by type is available from "Survey on tangible asset price and others" Then we can obtain the land price by type through dividing the value of land stock estimated in the above by the corresponding land area as the following equation

$$P_{it} = \frac{A_{it}}{Q_{it}}$$

where

P_{it}: land price of type area i in year t

Qit: land area of type area i in year t

Land Stock by Industry

When we divide the land stock into detailed manufacturing industry classification, we assume the share of capital stock in each manufacturing industry is closely correlated to the share of land stock used in each manufacturing industry. We obtain the share of capital stock information in each manufacturing industry from JIP database and apply the share for the estimation of land stock in each manufacturing industry.

$$A_{ht} = \beta_{ht} A_{mt},$$
$$\sum_h \beta_{ht} = 1,$$

where

h=1,……, 24: manufacturing industry classifications from 1 to 24.

A_{ht}: value of land stock of industry h in year t

β_{ht}: share of capital in manufacturing industry h in year t

Land stock by industry in commercial area

The commercial area is used by both manufacturing and service industry. Hence, we divide the commercial area between manufacturing industry use and service industry use. "Real Estate owned by Corporations" by Ministry of Land, Infrastructure, and Transportation provides the information on the land stock used for office buildings, shops and others by industry. By utilizing this information, we can estimate the share of a land asset used by manufacturing and service industry.

The share information available in the years of 1998, 2003 and 2008. The share of manufacturing industry use in the total is 16 percent in 1998, 11 percent in 2003, and 19 percent in 2008, respectively. In our estimation, we put the same share of 16 percent in each year before 1998 and put the same share of 19 percent in each year after 2008. In the period between 1998 and 2003, and 2003 and 2008, we interpolate the share number and put the interpolated number in each year during the period.

The equations used for this estimation as follows.

$$A_{ct} = a_{mt} + a_{st},$$
$$a_{mt} = \gamma_{mt} A_{ct},$$
$$a_{st} = \gamma_{st} A_{ct},$$
$$\gamma_{mt} + \gamma_{st} = 1$$

where

α_{mt}: land stock used for the manufacturing industry in the commercial area at year t

α_{st}: land stock used for service industry in the commercial area at year t

γ_{mt}: share of land stock used for the manufacturing industry in the commercial area at year t

γ_{st}: share of land stock used for service industry in the commercial area at year t

We further estimate land stock used for the manufacturing industry in the commercial area by more detailed manufacturing industry classification. For this purpose, we again use information on the share of land stock of each manufacturing industry from "Real Estate owned by Corporations". The size of land stock used for each manufacturing industry is estimated by the following equations.

$$a_{ht} = \eta_{ht} a_{mt},$$
$$q_{ht} = \frac{a_{ht}}{P_{ct}},$$

where

α_{ht}: land stock of the manufacturing industry h in the commercial area at year t

η_{ht}: share of land stock of the manufacturing industry h in the commercial area at year t

q_{ht}: land size of the manufacturing industry h in the commercial area at year t

Land stock price by industry

We estimate the land stock price of each manufacturing industry by the following equation. We use information of land area by more detailed manufacturing industry classification from "Census of Manufactures" by Ministry of Economy, Trade, and Industry.

$$P_{ht} = \frac{A_{ht} + \alpha_{ht}}{Q_{ht} + q_{ht}},$$

where

P_{ht}: land price of industry h in year t

Q_{ht}: land area of manufacturing industry h in year t

The land under cultivation is further classified by (1) rice field, (2) other crops field and (3) forest. The price of the land by the following equation.

$$P_{kt} = \frac{\sum_j A_{jt}}{\sum_j Q_{jt}}$$

where

$P_{kt:}$ land price under the cultivation in year t

j=r, o, f: r=rice field, o=other crops field, and f=forest

A_{jt}: value of land stock of type j in year t

Q_{jt}: land area of type j in year t

We estimate land service cost in each industry by the following equation. In order to avoid to negative land service cost problem, we use increasing rate of residential housing asset price rather than that of land price itself as in the equation, because the residential housing asset price is correlated the land price, but more stable than the land price variation in each year.

$$u_{Lit} = \frac{1}{1 - c_t} P_{it}(\lambda_{it} r_t + (1 - \lambda_{it})(1 - c_t)s_t - \Delta p_{it}),$$

where

u_{Lit}: Land service cost of industry i in year t

λ_{it}: equity ratio of industry i in year t

r_t: long-term interest rate in year t

s_t: long-term prime rate in year t

Δp_{it}: increasing rate of residential housing asset price of industry i in year t

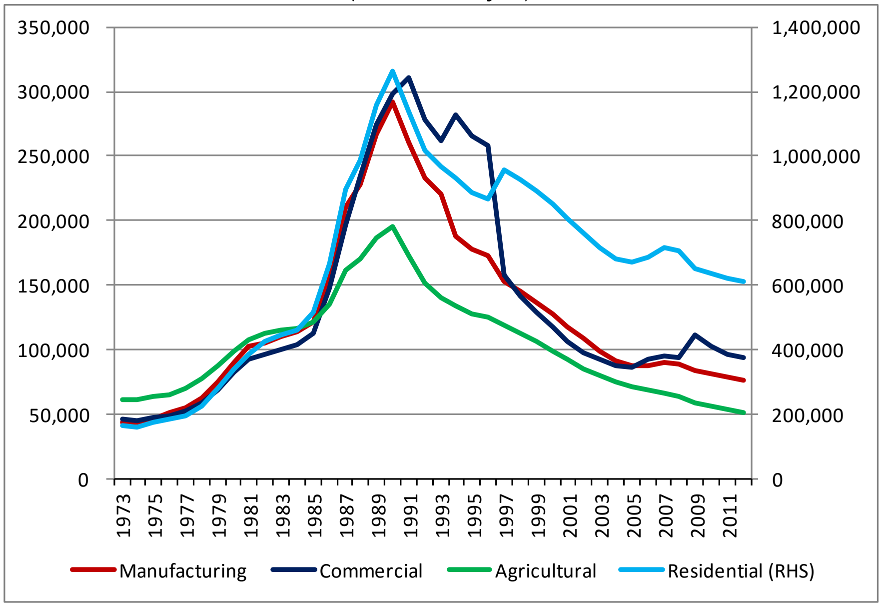
c_t: normal effective statutory tax rate in year t

2.3 An Overview of the Estimation Results

The estimation results of land stock in each Japanese sector (agriculture, manufacturing, service and resident) are shown in Figure 1. Land stock in all sectors increase substantially between 1975 and 1990. The manufacturing sector's land stock increases from 44.2 trillion yen in 1973 to 261.0 trillion yen in 1971, and the average growth rate of land value is 10.4 per cent per annum in the period. Agriculture sector's land has increased substantially in the period, but the rate of increase of land stock value is substantially lower than that in manufacturing sector. The agriculture land stock increases 61.3 trillion yen in 1973 to 173.4 trillion yen in 1991, and the annual growth rate in the period is 5.9 per cent.

All sectors experienced substantial decline in its land stock value in the period between 1973 and 2012. This variation of land stock value is mainly caused by the fluctuation of land price, rather than that of land area. As figure 2 shows, all sectors, except agriculture sector, experienced increase in land area between 1973 and 2012. Especially, the residential sector land area increased substantially in the period, from 7,951 square kilometer in 1973 to 13,862 square kilometers in 2012. On the other hand, agriculture sector's land area decreased in the latter half of the period. It decreased from 134,759 square kilometer in 1991 to 131,035 square kilometers in 2012.

FIGURE 1: LAND STOCK BY SECTOR IN JAPAN
(unit: billion yen)



(Source: The authors' estimation)

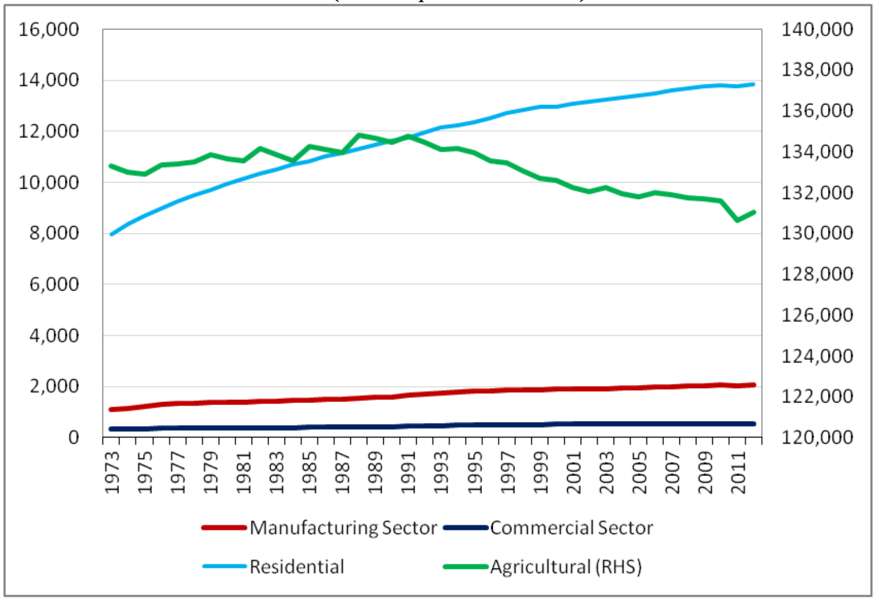
TABLE 2: LAND STOCK IN MANUFACTURING SECTOR BY INDUSTRY
(Unit: billion yen)

	1973	1983	1993	2003	2012
MANUFACTURE OF FOOD	2,476	6,368	13,041	5,743	4,811
MANUFACTURE OF BEVERAGES,TOBACCO AND FEED	1,136	3,021	6,628	3,448	2,597
MANUFACTURE OF TEXTILE PRODUCTS	3,023	5,388	8,808	3,189	2,047
MANUFACTURE OF LUMBER AND WOOD PRODUCTS, EXCEPT FURNITURE	693	1,265	2,082	755	523
MANUFACTURE OF FURNITURE AND FIXTURES	401	731	1,446	568	329
MANUFACTURE OF PULP, PAPER AND PAPER PRODUCTS	1,542	3,381	6,934	3,080	2,240
PRINTING AND ALLIED INDUSTRIES	715	1,742	4,937	2,384	1,565
MANUFACTURE OF CHEMICAL AND ALLIED PRODUCTS	5,151	11,959	21,834	10,007	8,643
MANUFACTURE OF PETROLEUM AND COAL PRODUCTS	2,360	5,000	9,208	4,196	3,666
MANUFACTURE OF PLASTIC PRODUCTS, EXCEPT OTHERWISE CLASSIFIED	1,080	3,506	7,148	3,018	2,284
MANUFACTURE OF RUBBER PRODUCTS	370	850	1,818	785	576
MANUFACTURE OF LEATHER TANNING, LEATHER PRODUCTS AND FUR SKINS	64	139	385	127	87
MANUFACTURE OF CERAMIC, STONE AND CLAY PRODUCTS	2,240	5,033	8,726	3,307	2,702
MANUFACTURE OF IRON AND STEEL	6,804	15,576	21,836	7,828	6,065
MANUFACTURE OF NON-FERROUS METALS AND PRODUCTS	1,535	3,463	6,968	3,106	2,445
MANUFACTURE OF FABRICATED METAL PRODUCTS	2,114	3,862	7,729	3,077	2,129
MANUFACTURE OF GENERAL-PURPOSE MACHINERY, PRODUCTION MACHINERY, BUSINESS ORIENTED MACHINERY	3,993	11,108	23,755	10,885	8,490
ELECTRONIC PARTS, DEVICES AND ELECTRONIC CIRCUITS	465	1,519	7,528	5,599	4,995
MANUFACTURE OF ELECTRICAL MACHINERY, EQUIPMENT AND SUPPLIES	1,893	6,137	18,941	9,037	6,262
MANUFACTURE OF INFORMATION AND COMMUNICATION ELECTRONICS EQUIPMENT	842	3,088	5,225	2,612	1,876
MANUFACTURE OF TRANSPORTATION EQUIPMENT	4,479	15,178	32,443	13,973	10,165
MISCELLANEOUS MANUFACTURING INDUSTRIES	821	1,619	3,415	1,570	1,355
Total	44,197	109,934	220,837	98,295	75,853

(Source: The authors' estimation)

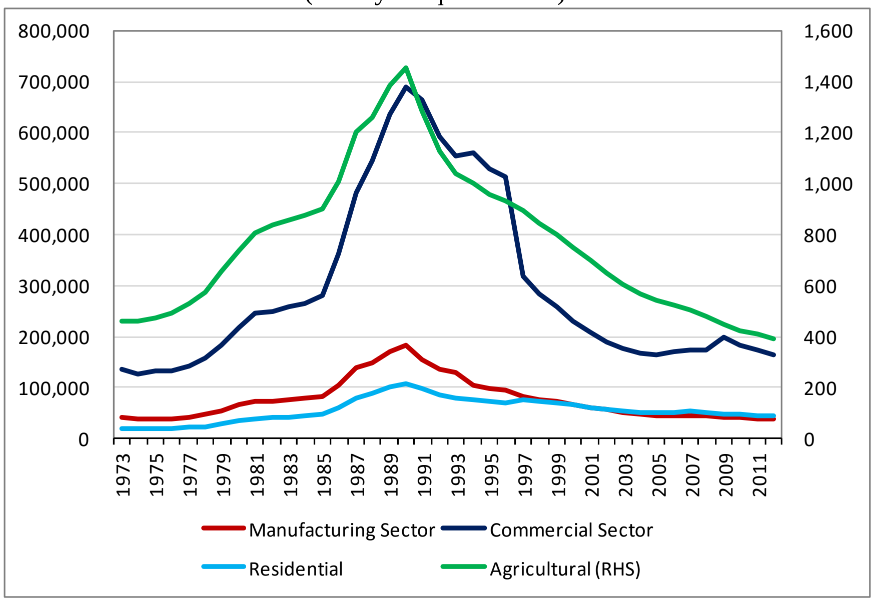
Table 2 shows the estimation results of land stock in the manufacturing sector by industry. The Iron and Steel Industry holds the highest share among the manufacturing sector in 1973, followed by Chemical Industry and Transport Equipment Industry. Both Transport Equipment Industry and Chemical Industry increased their land stock in the period between 1973 and 2012, and on their shares of land stock in 2012 surpass that of Iron and Steel Industry.

FIGURE 2: LAND AREA BY SECTOR IN JAPAN
(Unit: square kilometer)



(Source: The authors' estimation)

FIGURE 3: AVERAGE LAND STOCK PRICE BY SECTOR
(Unit: yen/square meter)



(Source: The authors' estimation)

Figure 3 shows the price development of each sector in the period. All sectors' average land stock prices increased substantially in the former half of the period, and then they declined in the latter half of period. The land price in commercial area increased very rapidly from 135,996 yen per square meters in 1973 to 664,674 yen per square meters in 1991.

3. Estimation of Land Stock and Service in China

From macroeconomic point of view, Chinese official land related statistics are very limited and in rather poor quality, thus insufficient for constructing any meaningful volume, value and price measures, not to mention satisfying the requirement of sophisticated growth accounting exercise. In this study, we present very preliminary estimation for China's land stock, value and price in broad sectors, namely agriculture, industry and services. In many areas, we have to make heroic assumptions in order to keep our explorative adventure going. What reported below are simple list of the approaches we use in the estimation and its summary results to invite constructive comment and suggestion.

Constructing land areas by use

Residential land

For residential land, official statistics provided newly developed land area for residential use in rural and urban areas, respectively, from 1981 to 1995 on an annual basis. The series stopped for a decade and restarted in 2006. Between the two segmented periods there were only data for 2003. We fill the missing data series by trend-deviation interpolation benchmarking on changes in rural and urban population, respectively (Wu 2014). To construct residential land areas for China with very limited information our estimation, we take mainly two steps.

First, we explore the relationship between per capital living area, construction area and land plot in rural and urban China. The first two indicators are occasionally released from rural and urban household surveys as two types of floor area (*China Rural Household Survey Yearbook*; *China Household Survey Yearbook*). Taking into account that residential density in cities is generally higher than that in countryside, we assume that the floor area ratio, or FAR used to measure residential density, is 0.5 in rural areas in 1978 as most rural residents then lived in a one-story house that presumably occupied half of the land plot. For urban we assume the FAR is 0.8 or two thirds higher than that of rural.

Second, assuming that these FARs are held for the whole planning period 1949-1978, its implied land area per person for 1949 is 22.6 and 8.6 square meters for rural and urban respectively. With the population data for 1949, we can establish the initial residential land stock in a perpetual inventory method (PIM) model. Assuming that the new population each year would be automatically granted with the same plot area, 22.6 and 8.6 square meters in rural and urban areas, we obtain the estimate of China's rural and urban residential land areas.

Agricultural land

The only available agricultural land statistics are cultivated land and arable land areas with the former beginning in 1950 and the latter commencing in 1962. The two series are very close if not identical till 1983 when the arable land suddenly jumps by 5.1 percent while the cultivated land shows a 0.4-percent decline. However, in 1997 the cultivated land illogically exceeded that of arable land and has ever since maintained that situation. While searching for more information, we now tentatively merge the two series to make the cultivated land equal to the arable land from 1983 onwards.

Industrial and service land

The only data available for the land used in industrial production and services are newly purchased (allocated) land for broad industry and service use since 2006 in physical measure (square meters). To solve the problem of initial land stocks, we propose to use the Japanese data-implied shares of different land areas as broadly defined in this study, that is, residential, agricultural, industrial and service land areas.

Our starting point is to control for the similar stage of development in China and Japan. We use per capita PPP GDP (in 1990 prices) as a yardstick to pin point a proper period in each country for the comparison with available data. According to Maddison (2001 and 2007) and Maddison and Wu (2008), updated to 2012 (Wu 2014), Japan achieved the level of per capita PPP$8000 in 1969 and China arrived at the same level by 2013. In our exercise Japanese data for 1973 and Chinese data for 2012 are available. In 1973, Japanese agricultural land accounted for 93.4 percent, residential 5.6, manufacturing 0.8 and commercial 0.2 percent, respectively. Considering China's rapidly emergence as the world manufacturing power in the 2000s, we argue that it is reasonable to slightly reduce the agriculture share in China's total land stock to 90 percent for 2012. Therefore, holding the estimated residential land area, which accounts for 3.7 percent of the total land area, the rest can be allocated using the manufacturing-to-commercial land ratio in Japan.

Table 3 reports our estimates for selected years. Figure 4 demonstrates the dynamics of structural changes over the past 35 years along with China's economic reforms. It suggests that China's agricultural land only began to decline after 1990. However, along with this decline the most rapid increase appears to be the residential land by almost three folds. China's industrial land use declined continuously along with the reform for about two decades from 68 to 54 thousand square kilometers, and reversed along with China's accession to WTO. China's service land use remained almost no change.

TABLE 3: CONSTRUCTED CHINA'S LAND AREA BY USE

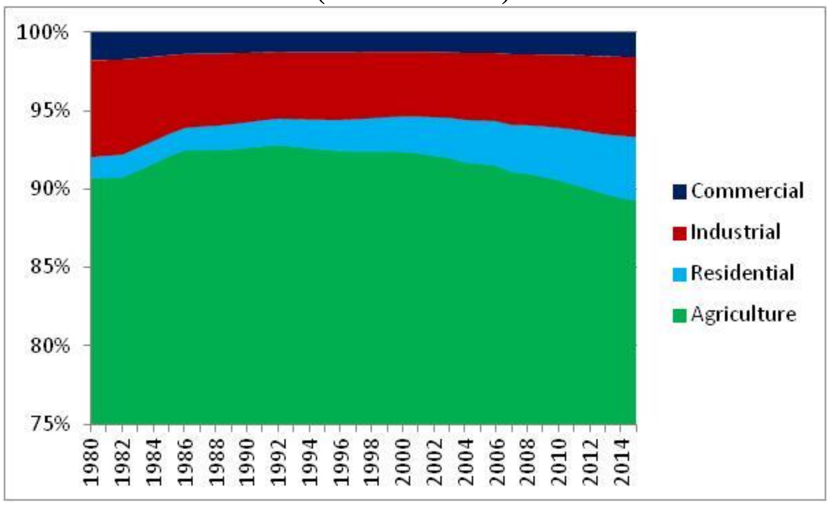
(1000 square kilometers)

	Total	Agriculture	Residential	Industrial	Services
1980	1,097	995	15	68	20
1985	1,266	1,166	18	63	19
1990	1,349	1,250	22	60	18
1995	1,334	1,234	26	57	17
2000	1,321	1,220	30	54	16
2005	1,246	1,141	35	53	17
2010	1,216	1,102	41	56	18
2015	1,200	1,071	49	61	19

Source: Authors' estimate.

FIGURE 4: SHARE OF CHINA'S LAND AREA BY USE

(Total area = 100)



Land price indices and land stocks in nominal and constant values

In the valuation of the estimated residential land areas, we reconstruct residential land price index in yuan per square meter using limited official price statistics and monthly housing price index, mainly for the period since the 1990s. For the 1980s, when housing was still controlled by the planning system, we use changes of non-agricultural employment (Wu 2014) to approximate the changes of prices. For the rural residential land price, we assume, though rather arbitrarily, that rural residential land price on average is about ten times that of agricultural land and it moves along with the average agricultural labor compensation as obtained from China's input-output accounts (Wu and Ito 2015).

In the valuation of agricultural land, we rely on a rental-imputed farm land price estimate for 2008 based on a comprehensive land use rights survey across 17 Chinese provinces, jointly conducted by the Rural Development Institute, Renmin University of Beijing, and Michigan State University (Prosterman et al., 2009). We then assume that the farm land price changes with rural residential land price as constructed above.

The price data for industrial and service land are only available since 2000. To gauge price changes before 2000, we assume that the industrial land prices in general moved along with investment prices of structures and commercial (service) land price moved along with urban residential prices.

The real land stock for each type of use is constructed by the perpetual inventory method (PIM) model assuming residential and commercial land depreciate by one percent per annum and industrial or manufacturing land by 1.5 percent per annum and agricultural land, arguably, does not depreciate.

(Tables and figures for price changes and land stock changes are presented here later…)

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4. INDUSTRY-LEVEL GROWTH ACCOUNTING ANALYSIS

4.1 Growth Accounting Framework

The section conducts the standard growth accounting exercise using the both output and input information by industry from CIP and JIP database, and the estimated land service cost by industry in the previous section.

We employ the following framework for value added growth accounting.

$$\Delta \mathrm{Ln}VA_{it} = \widetilde{w_t^K}\Delta lnK_{it} + \widetilde{w_t^l}\Delta lnL_{it} + \widetilde{w_t^{LA}}\Delta lnLA_{it} + \Delta lnA_{it}$$

where

$\Delta \mathrm{ln}VA_{it}$: the growth rate of real value added in industry i at time t

$\Delta \mathrm{ln}K_{it}$: the growth rate of capital service in industry i at time t

$\Delta \mathrm{ln}L_{it}$: the growth rate of labor service in industry i at time t

$\Delta \mathrm{ln}LA_{it}$: the growth rate of land stock service in industry i at time t

ΔlnA_{it}: the growth rate of total factor productivity in industry I at time t

$\widetilde{w_{it}^{J}}$: the cost share of factor j (K: capital, L:labor and LA: Land) in industry i at time t

Real land stock service is estimated by deflating nominal land stock service (user cost of land × land area) by GDP deflator.

4.1.1 Japan

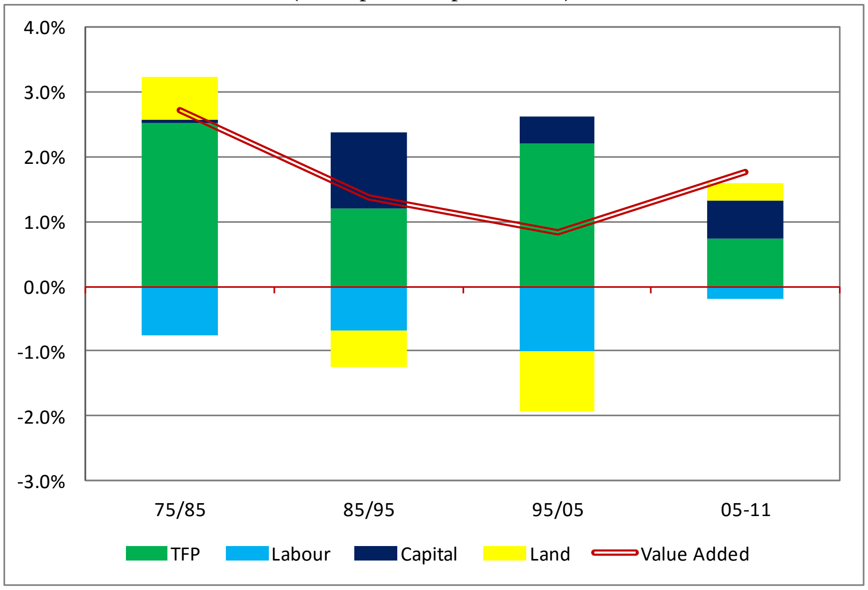
We conducted the growth accounting in manufacturing sector, agriculture sector and service sector for every 10 years in the period between 1975 and 2011(1975-1985, 1985-1995, 1995-2005, 2005-2011) by applying the method described in the above. The estimated results for each industry are presented in Figure 4, 5 and 6, respectively. As can be seen in the figures, the land stock contributes to sectoral output growth significant, especially in the agriculture sector.

Land stock services contribute positively in the period between 1975 and 1985 both in the manufacturing sector and service sector, and they contribute negatively in 1985-2005 period in the sectors. The service plays much more important role on the value added growth in the manufacturing, but it plays only limited role in the service sector. In the period 1975-1985, the service contributes more to the value added growth in the manufacturing sector than the capital service in the sector.

Land stock service contribution to value added growth is very important, and absolute value of contribution to output growth is larger than that of capital service and labor service. The results show that land stock service contributes negatively both in 1985-1995 and 1995-2005 period. These large negative contributions to value added growths in two periods are mitigated by the TFP growths in the sector.

FIGURE 4: GROWTH ACCOUNTING FOR THE MANUFACTURING SECTOR

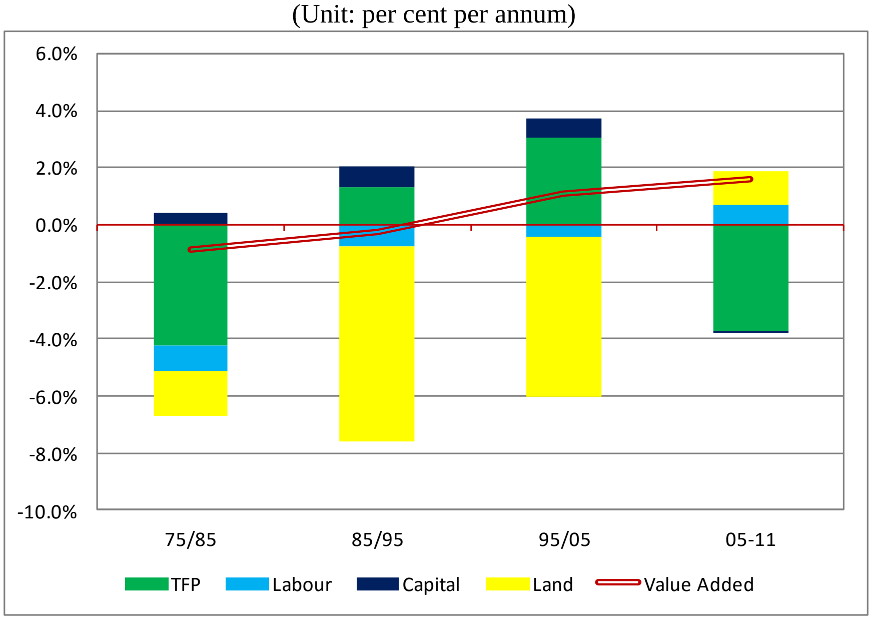
(Unit: per cent per annum)



(Source: the authors' estimation)

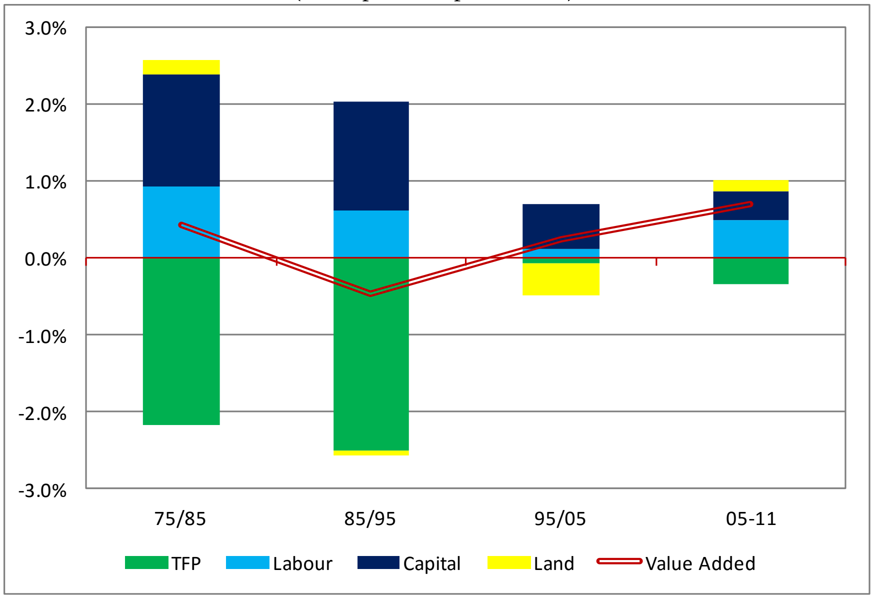
FIGURE 5: GROWTH ACCOUNTING FOR THE AGRICULTURAL SECTOR

(Unit: per cent per annum)



(Source: the authors' estimation)

FIGURE 6: GROWTH ACCOUNTING FOR THE SERVICE SECTOR
(Unit: per cent per annum)



(Source: the authors' estimation)

4.2 China

(To be followed at the poster presentation…)

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5. Conclusion

We estimate the land stock and its service by industry in China and Japan, and conduct the growth accounting in each industry. Our estimation results implicate that the land stock service plays very important role to economic growth in the agriculture sector, and ignoring the land stock service contribution, it leads to misunderstanding of the source of sector output growth and the role of TFP.

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