The Rise of Service in China

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Abstract

This paper develops a structural change model to study the rise of service economy in China by disaggregating the service sector into distribution service and personal service. The former complements manufacturing production and the latter substitutes home production. After China transformed from the planned economy to the market economy, distribution service sector rose immediately to correct the distortion between supply and demand. Market was being built and became large. Hence manufacturing sector was released and operated at its full capacity, which increased the income. Then personal service started to grow as income grew. Meanwhile agricultural sector grew at a fast pace and release labor to non-agricultural sector.

Keywords: structural change; unbalanced growth; service economy

JEL Classification: J21; O11; O14

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1 Introduction

The Kuznets facts show that the service sector will rise eventually with high value added and large share of employment. Cross-country evidences show that service sector gradually becomes the largest sector in terms of output and employment (Kuznets (1966, 1971); Buera and Kaboski (2012a,b)). During this transformation, interesting questions would be raised: why do some countries experience a high growth rate in service sector? Why can some countries develop a wide spectrum of services while others cannot?

To answer these questions, it is important to understand how service sector rises over time and the intrinsic properties of service sector. The traditional classification of output, which categorizes all the intangible goods that do not belong to the primary and secondary industries as services, which cannot help reveal the inherent and ever-changing properties of service sector. A higher level disaggregation is required.

Services are demanded by both firms and individuals. According to the classification, service industries not only include the distribution services which are required by producers, such as sales and storage, but also include those intangible goods that can satisfy personal needs, such as catering service and entertainment. On the one hand, those service products required by manufacturing sectors can be viewed as an input factor for the final manufacturing goods. They consist of distribution services (sale and after-sale service, transportation, storage), business service (financial and insurance services, accounting, consulting), technology service (software and communication service) and so on. They are necessities for the manufacture or the complements of the manufacturing goods. On the other hand, those service products demanded by individuals are kind of luxury goods. There is an income effect on consuming this kind of service goods: when income level increases, the share of service consumption also increases. Since most service goods in this category can be substituted by home-made products, the micro foundation of the income effect comes from the comparative advantage: people who have more comparative advantage on the work would prefer to purchase the service from the market rather than making it at home.

It is important to differentiate the two kinds of services if we want to study the rise of service

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1The value added share or employment share is not linear on income level. It booms after per capita GDP reaches a certain level. In other words, there are structural breaks in the time series data of service. See Buera and Kaboski (2012a,b).
sector while existing literature fail to do so. We should observe that in early development stage, employment share in distribution service sectors rise first, then after income level increases, personal service sectors boom.

The emerging service market in after-reform China gives us a great opportunity to study the early stages of development in service sector, and its sectoral employment data confirms the intuition. China has been experienced rapid growth rate in service sector for the past 30 years. Agricultural employment share decreases from more than 70% to 40% and 2/3 of the surplus labor goes from agricultural sector to service sector. Employment share of service sector surpasses that of manufacturing sector before manufacturing sector starts to decline. By examining the data, sales (distribution services), catering service (personal services) are the main contributors of growth of service and sales services rose first.\(^2\)

This paper follows Kongsamut et al. (2001), Ngai and Pissarides (2007) and Acemoglu and Guerrieri (2008) and develops a tractable model which includes heterogeneous service sectors. I disaggregate the service sector into industrial service and household service and introduces a structural break to show the rise in service sector. We use this model to reveal the inner reasons for the rapid growth of service sector in China. After China transformed from the planned economy to the market economy, distribution service sector rose immediately to correct the distortion between supply and demand. Market was being built and became large. Hence manufacturing sector was released and operated at its full capacity, which increased the income. Then personal service started to grow as income grew. Meanwhile agricultural sector grew at a fast pace and release labor to non-agricultural sector.

The rest of this paper is organized as follows. After quickly reviewing the existing literature in the field, Section 2 provides the background and motivation by showing some empirical facts. Section 3 and 4 state the model formally. Section 5 analyzes the model quantitatively. Section 6 summarizes and concludes.

\(^2\)Cross-country studies show that the rise of service sector in the countries with relatively low GDP level is usually driven by the growth of traditional services (trade, transportation, catering and lodging, etc). See Eichengreen and Gupta (2011).
Related Literature

This paper is related to a large existing literature on structural change, unbalanced growth, and disaggregation of service.

Economic structural change, which has been noticed by Kuznets (1957), refers to the changes in the composition of production and occupation. In the past hundreds of years, the labor force in the major industrial countries gradually moved from the agricultural sector to the manufacturing sector, then to the service sector. Similarly, the main contribution of output was initially created by the agricultural sector, now it has been replaced by manufacturing and service.

This paper is related to the two main theoretical perspectives which are used to explain structural change. They are related to the supply side or demand side of the products and labor input. The supply-side views start with Baumol (1967). He noticed that different sectors have different technological progress which results in different sectoral growth rate. Then because of different relative costs or prices, the industrial structure will change. Although Baumol reached his result by special assumptions, his idea that technological growth pushes the supply side is general, which is extremely useful to explain the decline of manufacturing and the rise of service. Hansen and Prescott (2002) showed how the productivity growth in modern sector pulls the labor force out of traditional sector. Ngai and Pissarides (2007) showed sectoral employment changes under different TFP growth rate and the aggregate growth becomes balanced if the intertemporal utility is logarithmic. Acemoglu and Guerrieri (2008) emphasized the roles of factor proportion differences and capital deepening in the unbalanced growth.

Demand-side reasons basically assume different income elasticities of demand for different sectoral goods, hence nonhomothetic preferences are required. Stone-Geary preference and its varieties are widely used in the literature of this category. It is proven to fit the decline of agriculture and the initial rise of service very well. In the unbalanced growth literature, Kongsamut et al. (2001) use this preference to accommodate the Kuznets facts to the Kaldor facts with even technological progress.

To incorporate both effects, this paper emphasizes income effects on Agricultural and household service sectors, and features the substitution effects between manufacturing and industrial service

\(^3\text{See Matsuyama (1992), Echevarria (1997), Laitner (2000), Caselli and Coleman II (2001), Gollin et al. (2002), and Wang and Xie (2004).}\)
Nowadays more and more studies focus on the rise of service to reveal the mechanism that the service sector eventually dominates others in the structural change. Buera and Kaboski (2009) pointed out that the traditional structural change theories cannot explain the rise of service sector in the US after 1980s. They also posited some possible solutions to this issue: introducing hierarchic consumption,\(^4\) home production,\(^5\) or higher level of disaggregation. Buera and Kaboski (2012a) followed these ways to study the fact that “the growth in services has been driven by skill-intensive services”.

The idea of service heterogeneity in this paper is related to several other papers. Greenfield (1966) defined producer services as the services that are sold to the producer rather than to the consumer, and noticed that they contributes the major part of service GDP. Katouzian (1970) emphasized complementary services, such as trade and transportation, are complement goods of manufacturing goods and are not related to per capita income. In our settings, industrial services and manufacturing goods are compliments, and household services and home productions are substitutions.

Other literature disaggregate services into traditional and modern services. As technology advances, modern services show different development direction and speed. Comparing to what Baumol called stagnant service sectors, Wolff (2002) proposed a concept of progressive service sectors which consist of those service industries that are heavier information and communication technology users. Based on this idea, Kapur (2012) developed this idea to fit the post war US experience.

2 Empirical Evidence

Growth of service sector driven by the growth of traditional services (i.e. trade, transportation, catering and lodging, etc) can be supported by relatively low per capita GDP. The emerging service market in after-reform China gives us a great opportunity to study this wave of growth in service sector.

\(^4\)Hierarchic consumption means goods are consumed in a particular order. See Murphy et al. (1989), Matsuyama (2002), and Buera and Kaboski (2012a,b).

2.1 Macro Trend of Labor Reallocation

We use sectoral employment data from Chinese Statistical Yearbooks (CSY) to illustrate the labor reallocation in China from 1978 to 2007. From Figure 1 two significant facts are noticed. The first one is that agricultural employment share (red dots) declines very fast after China began its reform. It has been shrinking from more than 70% to 40% in less than 30 years, which implies a huge growth in agricultural productivity. The second one is the rapid growth of service employment share (blue triangles). It surpasses the manufacturing sector share before manufacturing sector starts to decline. Therefore more than 20% employment share goes from agricultural sector to service sector.

With simple time series analysis we find structural break in the growth of service employment share. Figure 2 shows the graph for Quandt-Andrews structural break test F statistics with 15% trimmed data. The test is based on the following regression:

\[ \ln(1 - \text{Service\%}) = c_1 + c_2 \times t. \]
Figure 2: Quandt-Andrews Structural Break Test: LR F-Statistic, 15% Trimmed Data

The test rejects the null hypothesis that there are no breakpoints in the sample period at a 1% significant level, and year 1994 is the break point (if assuming single break point). This result is also robust for linear regressions on service share with time $t$.

2.2 Disaggregation of Service Employment Share

By disaggregating the data we find that during the sample period the notable rapid growth components in service sector are sales, transportation, storage, catering, accommodation. Using our classification, distribution services which are complements for manufacturing production, consist of wholesale, retailing trade, transport, storage; personal services which are substitutes for home production of service, include catering, travel, accommodation, media, and other personal services. Figure 3 shows the disaggregation.

Some comments are needed here. Although China’s reform began in 1978, it started from the agricultural sector first. Around 1983 private enterprises are allowed to enter sales and trade industries. A jump of distribution service employment share also confirmed it, while personal service share grew smoothly with no jump at the same time. If ignoring the decline between 1989-1992 (which resulted from a national political movement), distribution service employment share shows the same pattern as the manufacturing employment share in Figure 1. However, personal service
employment share started to boom in 1993 which is in accord with our structural break test result. If comparing with per capita GDP data, the strong growth trend in personal service data indicates a large income elasticity.

2.2.1 Growth of Distribution Service

Distribution service and manufacturing sectors are complement goods. Manufacturing sector depends heavily on distribution services. Input-Output Tables shows that about 12% intermediate input of manufacturing sector comes from distribution services while only a negligible 0.7% comes from personal services.\(^6\)

One thing should be emphasized that the employment share of distribution service sectors rose earlier than that of personal service sectors. Cross-country evidence shows that this is also true for developed countries. I use KLEMS (1970-2004) panel data to estimate the value added share and employment share of distribution services and personal services for European Union 15 countries.

and United States based on the following regression:

$$\text{Service}_{it} = \text{Constant} + \sum \theta_i D_i + y + y^2 + y^3 + \mu_{it},$$

where $D_i$ is the country dummy and $y$ is log per capita GDP (PPP 2005 $). Figure 4 shows the results after removing the fixed effects. We can see that for both value added share and employment share, distribution service sectors rose earlier than personal service sectors.

![Distribution and Personal Services Graphs](image)

Figure 4: Estimated distribution servies and personal services in EU15+U.S.

To summarize, During China’s past 30 years, service sector has absorbed two thirds of labor allocation from agricultural sector while manufacturing sector are still growing. In this transition, distribution service employment has been harmonizing the movement of manufacturing employment and personal service employment shows a strong growth pattern which can be explained by income effects.

This is because distribution services are complement goods of manufacturing goods and are not related to per capita income (Katouzian (1970); Eichengreen and Gupta (2011)). On the contrary, personal services are related to per capita income and feature income effects (Eichengreen and Gupta (2011); Buera and Kaboski (2012a,b)). Cross-country evidence also shows that distribution
service sectors rise first, then after income level increases, personal service sectors boom.

3 Simple Model

This section presents a simple model without capital that highlights the intuition and structure. In order to fully demonstrate the reasons for structural change, the model incorporate both nonhomothetic preference and differential TFP growth rate. On the demand side, we use Stone-Geary type preference as in Kongsamut et al. (2001) and Gollin et al. (2002); on the supply side, we allow for uneven TFP grow rate across sectors as in Ngai and Pissarides (2007).

3.1 Technology

For this benchmark model we assume linear technologies without capital in the production of agricultural goods \( Y_a \) and manufacturing goods \( Y_m \):

\[
Y_a (t) = A_a(t)L_a(t), \\
Y_m (t) = A_m(t)L_m(t).
\]

We disaggregate the service sector into 2 parts: distribution services and personal services. The distribution service sector provides complement services for the manufacturing goods, and the personal service sector provides services which substitute the home production. Again we assume linear technologies with only labor input in the production of distribution services \( Y_{ds} \) and personal services \( Y_{ps} \):

\[
Y_{ds} (t) = A_{ds}(t)L_{ds}(t), \\
Y_{ps} (t) = A_{ps}(t)L_{ps}(t).
\]

Households consume a final good \( Y_f \) which are produced from two intermediates, i.e., distribution services \( Y_{ds} \) and manufacturing goods \( Y_m \):

\[
Y_f (t) = \left[ \eta Y_{ds} (t)^{\frac{1}{\theta}} + (1 - \eta) Y_m (t)^{\frac{1}{\theta}} \right]^{\frac{\theta}{\theta - 1}},
\]
with $\epsilon < 1$, $\eta \in (0, 1)$.

We also assume $A_j(t)$ grows at a constant rate:

$$A_j(t) = A_j(1 + \gamma_j)^t, \quad j \in \{a, m, ds, ps\},$$

where $A_j$ is the initial labor productivity in sector $j$, $\gamma_j$ is the constant exogenous productivity growth rate in sector $j$.

We assume the good and factor markets are competitive and factors are perfectly mobile. Therefore the factor prices are equal across sectors. At each date $t$, given the price of good $Y_j$, $j \in \{a, m, is, hs\}$, and wage rate $w(t)$, the profit maximization problem for a representative firm in sector $j$ is

$$\max_{L_j(t) \geq 0} p_j(t) Y_j(t) - w(t) L_j(t).$$

(1)

We also assume there is a hidden sector which produces home goods with a traditional technology that one unit of labor produces one unit of goods:

$$Y_h(t) = L_h(t).$$

3.2 Preferences

The economy has an infinitely lived representative household endowed with one unit of labor. Labor is supplied inelastically. The household's utility is based on the consumption of agricultural goods $C_a(t)$, personal services $C_{ps}(t)$, home products $C_h(t)$ and final goods $C_f(t)$.

The period utility function is given by

$$U \{C_a(t), C_f(t), C_{ps}(t)\} = \begin{cases} C_a(t) & \text{if } C_a(t) < \bar{a} \\ \bar{a} + (1 - \phi) \ln C_f(t) & \\ + \phi \ln \left[ \nu C_{ps}(t) \frac{\xi - 1}{\zeta} + (1 - \nu) C_h(t) \frac{\xi - 1}{\zeta} \right] \frac{\xi}{\zeta} & \text{if } C_a(t) \geq \bar{a} \end{cases},$$

where $\bar{a} > 0$ is the subsistence parameter of agricultural consumption, and $\phi \in (0, 1)$. This representative household considers personal services $C_{ps}$ and home products as substitutes, i.e., $\zeta > 1$. 
The lifetime utility maximization problem for the representative household is as follows:

$$\max_{C_a, C_f, C_{ps}, C_h} \sum_{t=0}^{\infty} \beta^t U \{C_a(t), C_f(t), C_{ps}(t), C_h(t)\}, \quad (2)$$

subject to

$$p_a(t) C_a(t) + p_f(t) C_f(t) + p_{ps}(t) C_{ps}(t) = w(t) (1 - L_h(t)),$$

where $p_f$ is the price of the final good $Y_f$.

### 3.3 Equilibrium

The following market clearing conditions hold in each period $t$.

- **Goods market**

  $$C_a(t) = Y_a(t), \quad C_f(t) = Y_f(t), \quad (3)$$

  $$C_{ps}(t) = Y_{ps}(t), \quad C_h(t) = Y_h(t).$$

- **Labor market**

  $$L_a(t) + L_m(t) + L_{ds}(t) + L_{ps}(t) = 1 - L_h(t). \quad (4)$$

We define a competitive equilibrium of this economy based on TFP parameters $\{A_j, \gamma_j\}$ and structural parameters $\{\eta, \epsilon, \beta, \bar{a}\}$ as follows.

**Definition 1.** A competitive equilibrium is a sequence of goods prices $\{p_a(t), p_m(t), p_{ds}(t), p_f(t), p_{ps}(t)\}_{t=0}^{+\infty}$, factor prices $\{w(t)\}_{t=0}^{+\infty}$, and labor and goods allocations $\{L_a(t), L_m(t), L_{ds}(t), L_{ps}(t), L_h(t), C_a(t), C_f(t), C_{ps}(t), C_h(t), Y_a(t), Y_m(t), Y_{ds}(t), Y_f(t), Y_{ps}(t), Y_h(t)\}_{t=0}^{+\infty}$, such that given prices, the allocations solve the representative firm’s maximization problem (1), the representative household’s maximization problem (2), and satisfy the market clearing conditions (3), and (4).
3.3.1 Relative prices and consumption

Without capital there are no intertemporal decisions thus we only have to solve static problems in each period. At every $t$, the profit maximization and competitive market implies that

$$ p_j(t) = \frac{w(t)}{A_j(t)}, \quad j \in \{a, m, ds, ps\}, $$

$$ p_f(t) = \left[ \eta p_{ds}(t)^{1-\epsilon} + (1 - \eta)p_m(t)^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}}, $$

$$ p_m(t) = (1 - \eta)p_f(t) \left[ \frac{Y_m(t)}{Y_f(t)} \right]^{-\frac{1}{\epsilon}}, $$

$$ p_{ds}(t) = \eta p_f(t) \left[ \frac{Y_{ds}(t)}{Y_f(t)} \right]^{-\frac{1}{\epsilon}}. $$

Assuming the agricultural production has already passed the subsistence level, then agricultural consumption are constant:

$$ C_a(t) = \bar{a}. $$

3.3.2 Labor allocation

For simplicity we normalize price level by the wage, that is, $w(t) = 1$ for all $t$. Same as in the consumption of household services, there is also a structural break in the labor market.

Goods Market clearing conditions give the labor allocation result:

$$ L_a(t) = \bar{a} \frac{A_a(t)}{A_a(t)}, $$

$$ \frac{L_m(t)}{L_{ds}(t)} = \left( \frac{1 - \eta}{\eta} \right)^{\epsilon} \left[ \frac{A_{ds}(t)}{A_{m}(t)} \right]^{1-\epsilon}, $$

$$ \frac{L_{ps}(t)}{L_h(t)} = \left( \frac{\nu}{1 - \nu} \right)^{\epsilon} \left[ \frac{1}{A_{ps}(t)} \right]^{1-\epsilon}. $$
With labor market clearing condition (4) $L_m$, $L_{ds}$, $L_{ps}$ and $L_h$ can be solved:

$$L_{ds}(t) = \frac{(1 - \phi) \left[ 1 - \frac{\bar{a}}{A_d(t)} \right]}{1 + \left( \frac{1 - \eta}{\eta} \right)^{\epsilon} \left[ \frac{A_{ds}(t)}{A_m(t)} \right]^{1-\epsilon}},$$

$$L_m(t) = \frac{(1 - \phi) \left[ 1 - \frac{\bar{a}}{A_a(t)} \right]}{1 + \left( \frac{\eta}{1 - \eta} \right)^{\epsilon} \left[ \frac{A_a(t)}{A_{ds}(t)} \right]^{1-\epsilon}},$$

$$L_{ps}(t) = \frac{\phi \left[ 1 - \frac{\bar{a}}{A_p(t)} \right]}{1 + \left( \frac{1 - \nu}{\nu} \right)^{\epsilon} \left[ \frac{1}{A_{ps}(t)} \right]^{1-\epsilon}},$$

$$L_h(t) = \frac{\phi \left[ 1 - \frac{\bar{a}}{A_h(t)} \right]}{1 + \left( \frac{\nu}{1 - \nu} \right)^{\epsilon} \left[ \frac{1}{A_{ps}(t)} \right]^{1-\epsilon}}.$$

Therefore in this system TFP changes in one sector will have an impact on the labor allocation of another sector. Proposition (1) states the results.

**Proposition 1.** *Structural change in labor allocation*

1. $\frac{\partial L_m}{\partial A_a} < 0$;

2. $\frac{\partial L_j}{\partial A_a} > 0$, $j \in \{m, ds, ps, h\}$;

3. Given $\epsilon < 1$,

$$\frac{\partial L_m}{\partial A_m} / L_{ds} < 0;$$

4. Given $\zeta > 1$,

$$\frac{\partial L_{ps}}{\partial L_h} / \partial A_{ps} > 0.$$

### 4 Quantitative Model

This section builds a model with capital and wage gap across sectors which is better suited to assessing the quantitative implications.
4.1 Technologies

Agricultural goods $Y_a$ and manufacturing goods $Y_m$:

\begin{align*}
Y_a (t) &= A_a(t) K_a (t)^{\theta_a} L_a (t)^{1-\theta_a}, \\
Y_m (t) &= A_m(t) K_m (t)^{\theta_m} L_m (t)^{1-\theta_m}.
\end{align*}

Service sector consists of distribution services and personal services. The distribution service sector provides complement goods of manufacturing goods. The personal service sector provides services which substitute the home production.

Industrial services $Y_{ds}$ and household services $Y_{ps}$:

\begin{align*}
Y_{ds} (t) &= A_{ds}(t) K_{ds} (t)^{\theta_{ds}} L_{ds} (t)^{1-\theta_{ds}}, \\
Y_{ps} (t) &= A_{ps}(t) K_{ps} (t)^{\theta_{ps}} L_{ps} (t)^{1-\theta_{ps}}.
\end{align*}

Households consume the final goods $Y_f$ which are produced from two intermediates: distribution services $Y_{ds}$ and manufacturing goods $Y_m$

\begin{align*}
Y_f (t) &= \left[ \eta Y_{ds} (t)^{\frac{\epsilon-1}{\epsilon}} + (1 - \eta) Y_m (t)^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}},
\end{align*}

with $\epsilon < 1, \eta \in (0, 1)$.

$Y_f$ can also be used as capital:

\begin{align*}
K_a (t) + K_m (t) + K_{ds} (t) + K_{ps} (t) &= K (t), \\
K (t + 1) - (1 - \delta) K (t) + C_f (t) &\leq Y_f (t),
\end{align*}

where $K(0) > 0$ is given, and $\delta > 0$ is the capital depreciation rate.

We also assume $A_j(t)$ grows at a constant rate:

\begin{align*}
A_j(t) = A_j(1 + \gamma_j)^t, \ j \in \{a, m, ds, ps\},
\end{align*}

where $A_j$ is the initial labor productivity in sector $j$, $\gamma_j$ is the constant exogenous productivity growth.
growth rate in sector \( j \).

We assume the good and factor markets are competitive and factors but not perfectly mobile. There are many institutional and policy constraints that restrict movement of labor between sectors. We use wage gap \( \mu \) to measure this labor market frictions:

\[
\begin{align*}
    w_a (t) &= \mu_a w_m (t), \\
    w_{ds} (t) &= \mu_{ds} w_m (t), \\
    w_{ps} (t) &= \mu_{ps} w_m (t),
\end{align*}
\]

where \( \mu_j \) is the wage ratio between sector \( j \) and manufacturing sector.

At each date \( t \), given the price \( p_j \), \( j \in \{ a, m, ds, ps \} \), wage rate \( w_j (t) \) and capital rental price \( r(t) \), the profit maximization problem for a representative firm in sector \( j \) is

\[
\max_{L_j(t),K_j(t) \geq 0} \{ p_j (t) Y_j (t) - w_j (t) L_j (t) - r (t) K_j (t) \}. \tag{11}
\]

The profit maximization problem for final good sector is

\[
\max_{Y_m(t),Y_{ds}(t) \geq 0} \{ Y_f (t) - p_m (t) Y_m (t) - p_{ds} (t) Y_{ds} (t) \} \tag{12}
\]

### 4.2 Preferences

The economy has an infinitely lived representative household endowed with one unit of labor. Labor is supplied inelastically. The period utility function is given by

\[
U \{ C_a (t) , C_f (t) , C_{ps} (t) \} = \begin{cases} 
    C_a (t) & \text{if } C_a (t) < \bar{a} , \\
    \bar{a} + (1 - \phi) \ln C_f (t) + \phi \ln (C_{ps} (t) + \bar{s}) & \text{if } C_a (t) \geq \bar{a} 
\end{cases}
\]

where \( \bar{a} > 0, \bar{s} > 0 \), and \( \phi \in (0, 1) \).

The lifetime utility maximization problem for the representative household is as follows:

\[
\max_{C_a(t),C_f(t),C_{ps(t)},X(t)} \beta^t U \{ C_a (t) , C_f (t) , C_{ps} (t) \}, \tag{13}
\]

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subject to

\[ p_a(t) C_a(t) + C_f(t) + X(t) + p_{ps}(t) C_{ps}(t) = \sum_{j=a,m,ds,ps} (w_j(t) L_j(t) + r(t) K_j(t)), \]

where \( X(t) = K(t+1) - (1 - \delta) K(t) \) is the capital investment, the price of the final good \( Y_f \) is normalized to be 1.

### 4.3 Equilibrium

The following market clearing conditions hold in each period \( t \):

- **Goods market**
  \[ C_a(t) = Y_a(t),\ C_f(t) + X(t) = Y_f(t),\ C_{ps}(t) = Y_{ps}(t) ; \]
  \( \tag{14} \)

- **Capital market**
  \[ K_a(t) + K_m(t) + K_{ds}(t) + K_{ps}(t) = K(t), \]
  \[ K(t+1) - (1 - \delta) K(t) = X(t) ; \]
  \( \tag{15} \)

- **Labor market**
  \[ L_a(t) + L_m(t) + L_{ds}(t) + L_{ps}(t) = 1. \]
  \( \tag{16} \)

### 4.3.1 The static equilibrium

The equilibrium problem can be broken into a static part and a dynamic part. Given the state variables \( K(t), A_j(t), j \in \{a, m, ds, ps\} \), we can solve the allocation of factors as well as consumption
across sectors. The profit maximization and competitive market imply that

\[ w_j(t) = (1 - \theta_j) p_j(t) A_j(t) \left[ \frac{K_j(t)}{L_j(t)} \right]^{\theta_j}, \quad j \in \{a, m, ds, ps\} \]  

\[ r_j(t) = \theta_j p_j(t) A_j(t) \left[ \frac{K_j(t)}{L_j(t)} \right]^{\theta_j-1}, \quad j \in \{a, m, ds, ps\} \]  

\[ 1 = \left[ \eta^\epsilon p_{ds}(t)^{1-\epsilon} + (1 - \eta)^\epsilon p_m(t)^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}}, \]  

\[ p_m(t) = (1 - \eta) \left[ \frac{Y_m(t)}{Y_f(t)} \right]^{-\frac{1}{\epsilon}}, \]  

\[ p_{ds}(t) = \eta \left[ \frac{Y_{ds}(t)}{Y_f(t)} \right]^{-\frac{1}{\epsilon}}. \]  

Therefore the marginal rate of technical substitution should satisfy:

\[ \frac{1}{\mu_a} \frac{1 - \theta_a}{L_a} K_a = \frac{1 - \theta_m}{L_m} K_m = \frac{1 - \theta_ds}{L_ds} K_{ds} = \frac{1 - \theta_ps}{L_ps} K_{ps}. \]  

Given different capital intensities in manufacturing and distribution service sectors, this model features a capital deepening effect. Employment share between these two sectors follows

\[ \frac{L_m(t)}{L_{ds}(t)} = \left( \frac{\mu_{ds}}{\eta} \frac{1 - \theta_m}{1 - \theta_ds} \right)^{\epsilon} \left( \frac{A_{ds}(t)}{A_m(t)} \right)^{1-\epsilon} \left[ \frac{(K_{ds}(t)/L_{ds}(t))^{\theta_{ds}}}{(K_m(t)/L_m(t))^{\theta_m}} \right]^{1-\epsilon}. \]  

Assuming the agricultural production has already passed the subsistence level, then agricultural consumption is constant:

\[ C_a(t) = \bar{a}. \]  

Because of the positive endowment parameter \( \bar{s} \), personal service consumption features a structural break. If \( \bar{s} > \frac{\phi}{1 - \phi} \frac{C_f(t)}{p_{ps}(t)} \), \( C_{ps}(t) = 0 \). Otherwise we have

\[ \frac{C_{ps}(t) + \bar{s}}{C_f(t)} = \frac{\phi}{1 - \phi} \frac{1}{p_{ps}(t)}. \]  

(14), (15), (16), (17), (18), (19), (20), (21), (22), (23), (24), (25) determine the static allocation.
4.3.2 Equilibrium dynamics

The optimal consumption rule of $C_f$ is determined by

$$\frac{C_f(t + 1)}{C_f(t)} = \beta \left[ r(t + 1) + (1 - \delta) \right].$$  \hspace{1cm} (26)

5 Quantitative Analysis

I calibrate the model parameters to minimize the sum of squared errors between model simulated employment share (agriculture, manufacturing, distribution service) and the real data. And I test the model using value added share data. See Figure 5 and 6. Lines are simulated data and points are real data.

Figure 5: Employment Share

The structural break parameter $\bar{s}$ has not been calibrated yet so personal service does not fit well. In the next step I will use Chinese Household Income Project (CHIP) survey data to calibrate
the change of consumer preferences.

6 Conclusion

Structural change phenomena are proven to have a strong relationship with aggregate productivity, which is the essence in development economics. As stated in Duarte and Restuccia (2010), since productivity in manufacturing sector is higher than agriculture and service, moving labor out of agricultural sector to would raise aggregate productivity, while moving labor to service sector would decrease aggregate productivity. This paper shows that a relative low productivity in industrial service or a high productivity in household service would result in an early quick rise in service employment share. This may be good or bad for aggregate productivity. On the one hand, low productivity in industrial service prevents the growth of the final good sector, since industrial service and manufacture are compliment goods; on the other hand, high productivity in household service
can absorb the surplus labor from agricultural sector which promotes the aggregate productivity.

References


### A Data Description

#### A.1 China

The aggregate economic time series, which include employment, value added, and capital by sector, are mainly collected from the official yearbooks published by National Bureau of Statistics of China (NBS). The data ranges from 1978 (the year China started to reform) to 2007 (before the global financial crisis).

Disaggregate level data of 4 sectors are needed. They are agriculture, manufacturing, distribution service and personal service. Agricultural sector consists of farming, animal husbandry, forest and fishing. Manufacturing sector consists of mining, manufacturing, construction and public utility. Distribution service consists of wholesale, retailing, transportation and storage. Personal service consists of restaurant, hotel and other personal and community services.

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\(^7\)The data contains agricultural service after 2002.
The official employment data has a structural break in 1990 after NBS modified its estimation based on 1990 Population Census. Therefore this break is quite artificial and it has been discussed by a few papers.\(^8\) To fix this jump, I followed the way used by Wu (2011) to adjust the data prior to 1990. To break down employment of service sector, I use the data of sectoral employment share from China Industrial Productivity Database (CIP).\(^9\) The CIP database contains detailed sectoral level data as far back as 1987. For the detailed service employment data before 1987, I construct my own data from the official yearbook.

Nominal sectoral value added data and implicit sectoral deflators are collected from official yearbooks.\(^10\) Then the constant-price value added data are calculated based on the price of the year 1990. Value added data for personal and community services comes from CIP (1987-2007). From this data we can see the relative shares among nominal value added data of public administration, health, education, and personal and community services are very stable before 2002. So the data before 1987 are estimated with the assumption that the relative shares keep stable.

Nominal aggregate gross fixed capital formation data and implicit deflators are collected from official yearbooks. The more detailed fixed investment expenditure data are used to estimated sectoral gross fixed capital formation and they are scaled to be consistent with aggregate gross fixed capital formation. Then capital stock data for the 4 sectors are estimated using perpetual inventory method with the assumption that all sectors share the same capital depreciation rate \(\delta = 0.5\):

\[
K_j (t + 1) = (1 - \delta)K_j (t) + I_j (t),
\]

where \(I_j\) is gross fixed capital formation. The capital stock data of the first year for each sector are estimated:

\[
K_j (1978) = \frac{I_j (1978)}{g_j}, \quad j \in \{a, m, ds, ps\},
\]

where \(g_j\) is the average growth rate around 1978.

\(^9\)See RIETI CIP2011.
\(^10\)Historical data have been adjusted and updated by NBS after several national economic census.
A.2 Korea

A.3 Japan