ICCS Journal of Modern Chinese Studies Vol.10 (1) 2017

論文

Final demand and Industrial Structural Changes in China

Fu Tingting[1]

Abstract

Industrial structural change is a fundamental characteristic of social and economic development. The final demand is one of the most important factors that shape the industrial structure. The final demand interacts with technical progress, and has profound impact on the output and industrial structure. This paper analyzes final demand and industrial structural restructuring over last two decades in China. I study the structural feature and changing trend of the final demand from 1995 to 2015. Then I explore the influence of each final demand item on 17 industrial sectors separately, with the contribution shares of each factor to the aggregate output change and the production inducement coefficient by final demand item. It sheds a light on the interaction of final demand and industrial sectors and the possible influence of the demand policies on the industrial structure optimization.

Keywords: Final demand; Industrial Structure; Input-Output Method; China

I. Introduction

Industrial structural change is a fundamental characteristic of social and economic development (Montobbio, 2002) [1] and plays a vital role in the economic growth (Carree and Thurik, 1999 [2]; Silva, Ester and Teixeira, 2011 [3]), especially prominent in the long run (Saviotti and Pyka, 2013) [4]. It's a widespread phenomenon in many countries (Maddison, 1980 [5]; Pasinetti, 1983 [6]; Laitner, 2000 [7]; Berthélemy and Söderling, 2001 [8]), and verifiable in China (Fan, Zhang and Robinson, 2003 [9]; Liu and Zhang, 2008 [10]). Wang and Szirmai (2008) [11] found the evidence of a structural change bonus in China. They proved the contribution of changes in the sectoral structure of production to aggregate manufacturing and industrial productivity. The sectoral shifts contributed 24% to overall productivity increase in 1980s, while the contribution dropped to 3.3% in the 1990s when the productivity growth already accelerated, according to their estimates. There are numerous factors that shape the industrial structure, such as the factor cost, technology progress, productivity growth, the level of economic development, and especially the final demand (Fagerberg, 2000 [12]; Krüger, 2008 [13]). The final demand interacts with technical progress (Araujo, 2013) [14], and has significant impact on the productivity growth (Cornwall and Cornwall, 2002) [15] and output (Ciaschini and Socci, 2007) [16]. Not only that, the implication of demand fluctuation on industrial structure is profound (Mills and Schumann, 1985) [17]. There is empirical evidence that the changes in final demand influence the in the sectoral structural changes in advanced economies, based

on the input-output tables from the end of 1960s to the end of 1990s (Savona and Lorentz, 2005) [18].

This paper analyzes final demand and industrial structural restructuring over last two decades. First, I present the overall picture of the final demand by answering what items constitute the final demand and how the final demand changed as the social development. Then I will explore the influence of each final demand item on every industrial sector. With 8 input-output tables from 1995 to 2012 and Leontief input-output analysis, I am able to explore the detailed effect on every sector and the corresponding changing trend, with some index: the contribution shares of each factor to the aggregate output change, the production inducement coefficient by final demand item. It sheds a light on the interaction of final demand and industrial sectors and the possible influence of the demand policies, with realistic significance.

The remainder of this paper is organized as following. Section 2 studies the final demand in China from 1995 to 2015. Section 3 explores the influence of each final demand item[2] on every industrial sector[3] from 1995 to 2012. Section 4 gives the conclusion and policy suggestion.

II. The constitute of final demand

The gross domestic product has experienced a rapid growth, from 6154 billion in 1995 to 69659 billion in 20154, up to 11 times. The three components of GDP by expenditure approach are final consumption expenditure, gross capital formation and net exports of goods

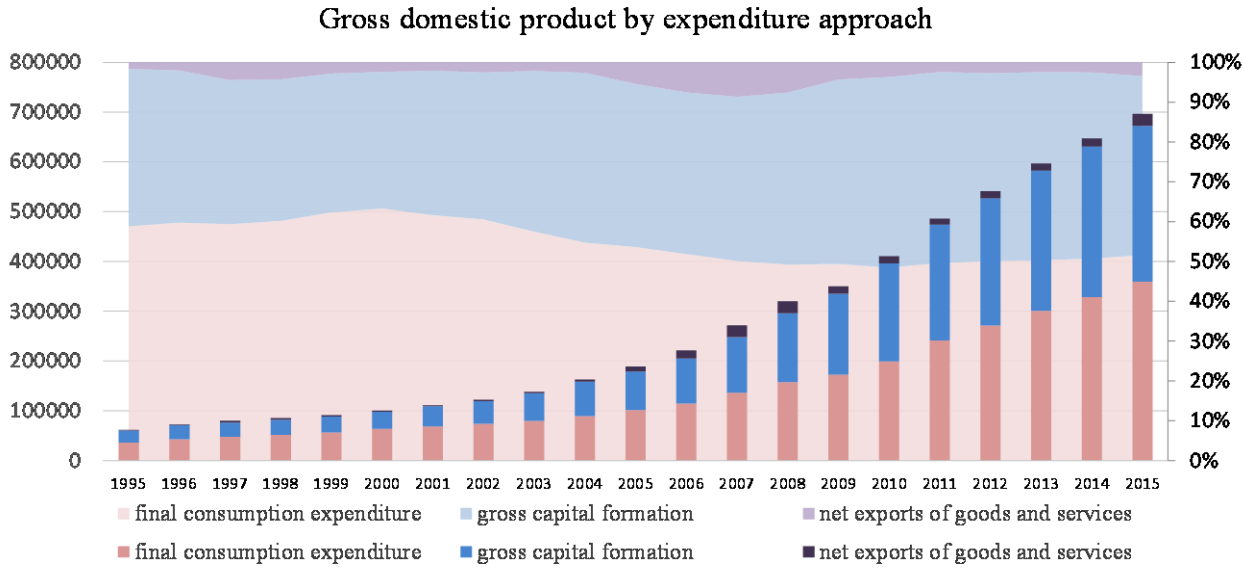

Figure 1 Constitute of GDP in China from 1995 to 2015

Notes:

[a] Data source: *China Statistical Yearbook* in 2016

[b] The bar chart shows the value of the gross domestic product by expenditure approach, shown in the primary axis, the data of which is calculated at current prices (100 million yuan).

[c] The area chart shows the structural proportion of the three components in gross domestic product, in the secondary axis.

and services. Many factors can affect demand structure, such as the improvement of living standards and technology, the level of economic development, and population aging (Katagiri, 2012) [19]. When it comes to each component of gross domestic product, the proportions and changing trend of final consumption expenditure, gross capital formation and net exports of goods services are clear in the area chart in Figure 1. The percentage of final consumption expenditure in gross domestic product fluctuated slightly, from 58.8% in 1995 increased to 63.3% in 2000, then fell to 50% approximately since 2007 to now. The proportion of gross capital formation increased marginally, from 39.6% in 1995 to 44.9% in 2015. The scale of net exports of goods services is much smaller than that of final consumption expenditure and gross capital formation, around 2% to 3%, except a sudden growth (8%) from 2006 to 2008.

Except the volume and proportion of the final demand, it also matters that how much they contribute to the increase of GDP. The proportion of the increment of each component of GDP to the increment of GDP is called the contribution shares of the three components to the increase of GDP, shown in the line chart of Figure 2. The growth rate of GDP multiplied by the contribution share of the three components is the contributions of the three components to GDP growth, listed in the bar chart of Figure 2. The proportion of the increment of final consumption expenditure reached highest value of 88.1% in 1999, fluctuated between 40% to 60% after then. The

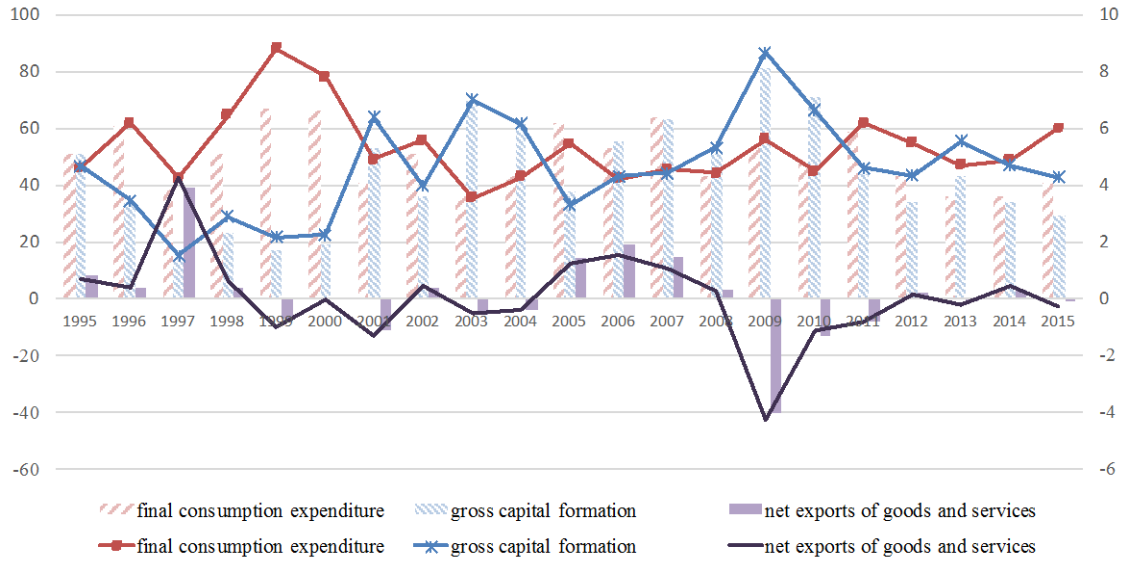

Figure 2 The contributions and contribution shares of the three components to GDP growth

Notes:

[a] data source: *China Statistical Yearbook* in 2016

[b] Data in this figure are calculated at constant prices.

[c] The line chart in the primary axis shows the contribution shares of the three components to the increase of GDP (the proportion of the increment of each component of GDP to the increment of GDP).

[d] The bar chart in the secondary axis shows the contributions of the three components to GDP growth (the growth rate of GDP multiplied by the contribution share of the three components).

contributions of the final consumption expenditure to GDP growth also got the peak of 6.7 in 1999. The change ranges of gross capital formation and net exports of goods services are relative larger that of final consumption expenditure. In the long run, the contributions and contribution shares of gross capital formation show a general upward trend, from the lowest (the contribution shares of gross capital formation to the increase of GDP is 15.1%; the contributions of gross capital formation to GDP growth is 1.4) in 1997 to the peak (the contribution shares of gross capital formation to the increase of GDP is 86.5%; the contributions of gross capital formation to GDP growth is 8.1) in 2009. The contribution shares of gross capital formation to the increase of GDP is around 40%-60% in recent 5 years, roughly the same as that of final consumption expenditure. As for the net exports of goods services, the indicators overall show a downward trend. It reached highest level at 1997 (42.6% in the contribution shares of net exports of goods services to the increase of GDP; 3.9 in the contributions of net exports of goods services to GDP growth), decreased to the bottom of -42.6% in the contribution shares of net exports of goods services to the increase of GDP and -4 in the contributions of net exports of goods services to GDP growth, then maintained low level around 0.

III. The influence of final demand on industries

1. Leontief input-output method

The growth rate of domestic production product in China maintains in a high level. It is necessary to figure out which sector and which component in the final demand contributed most in the rapid growth, and to give emphasis on these sectors and components in the following economic structural restructuring.

With the detailed input-output tables of 17 sectors in 1995, 1997, 2000, 2002, 2005, 2007, 2010, 2012 from *China Statistical Yearbook* by Department of National Accounts of the National Bureau of Statistics, I'm able to pick up the influence of final demand on each industry in China and decompose the find demand into consumption, investment, export, import and other. The input-output table, a chess-board shaped matrix format, can display the mutually dependent economic and technological relationships among 17 industries.

I use the input-output method (Leontief, 1986) [20] to implement the above analysis. In the input-output table, the basic equality is $\boldsymbol{X}_{n\times 1} = \boldsymbol{Z}_{n\times n} + \boldsymbol{Y}_{n\times 1}$, in which $\boldsymbol{X}_{n\times 1}$ is the aggregate output vector, $\boldsymbol{Y}_{n\times 1}$ is the final demand vector. $\boldsymbol{Z}_{n\times n}$ is the intermediate input matrix of n industrial sectors, the elements in which is Z_{ij}, on behalf of product i used as an intermediate input in the production process of sector j. Let $\boldsymbol{Z}_{n\times n} = \boldsymbol{AX}$ and $\boldsymbol{B} = (\boldsymbol{I} - \boldsymbol{A})^{-1}$, we can get $\boldsymbol{X} = \boldsymbol{AX} + \boldsymbol{Y}$ and $\boldsymbol{X} = (\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{Y} = \boldsymbol{B}\,\boldsymbol{Y}$, in which $\boldsymbol{I}$ is identity matrix and $\boldsymbol{B}$ is Leontief inverse matrix. The elements of Leontief inverse matrix bij is the product i required in total in the production of one extra unit of sector j, in monetary unit rather than amount unit. The above equation can be translated into

$$\begin{aligned} \boldsymbol{X} &= \boldsymbol{AX} + \boldsymbol{Y} \\ &= [\,\boldsymbol{I} - \boldsymbol{A}\,]^{-1}[\boldsymbol{Y}^{C} + \boldsymbol{Y}^{I} + \boldsymbol{E} + \boldsymbol{M} + \boldsymbol{R}] \\ &= \boldsymbol{BG} \end{aligned} \qquad \text{Eq. (1)}$$

in which Y^C, Y^I, E, M and R respectively represent consumption, investment, export, import and

other in the final demand, and $\boldsymbol{B} = [\boldsymbol{I} - \boldsymbol{A}]^{-1}$, $\boldsymbol{G} = \boldsymbol{Y}^{C} + \boldsymbol{Y}^{I} + \boldsymbol{E} + \boldsymbol{M} + \boldsymbol{R}$. The models on two time points (0, 1) are B_0G_0 and B_1G_1, so the output change between these two time points can be factor decomposed as followed:

$$\begin{aligned}\Delta X &= X_1 - X_0 = B_1G_1 - B_0G_0 \\ &= B_1(G_1 - G_0) + (B_1 - B_0)G_0\end{aligned} \qquad \text{Eq. (2)}$$

$B_1(G_1 - G_0)$ represents the part of output change in each sector caused by the fluctuated final demand (more detailed, consumption, investment, export, import and other). $(B_1 - B_0)G_0$ represents the part of output change in every sector induced by fluctuated Leontief inverse matrix, which implies the interindustry input-output relations. In this model, the result is different if we chose different time point as the reference items G_0 and B_0. As a compromise, I take the average value as the reference, which is also a common treatment:

$$\Delta X = (B_1 + B_0)/2 \cdot (G_1 - G_0) + (B_1 - B_0) \cdot (G_1 + G_0)/2 \qquad \text{Eq. (3)}$$

2. The contribution shares of each factor to the aggregate output change

To help us understand which factor contributed most in the output growth from 2010 to 2012, make the output change caused by each factor divided by the aggregate output change, we get the contribution shares of each factor to the output change from 2010 to 2012, as shown in Table 1.

On the whole, the consumption and investment are the major driving forces to the economic development in China. The contribution shares of consumption and investment on the output growth are more than 50%. However, when we explore the results in sector level, it's clear that the influence of consumption expenditure on Agriculture, Forestry, Animal Husbandry & Fishery (104.65%), Mining (145.57%), Manufacture of Foods, Beverage & Tobacco (91.03%), Other Services (77.13%) and Manufacture of Textile, Wearing Apparel & Leather Products (20.26%) was big, while on Other Manufacture (-76.96%) was just the opposite. The investment pushed the midstream and upstream sectors, such as Mining (168.31%), Construction (92.40%) and Transport, Storage, Post, Information Transmission, Computer Services & Software (78.63%). Compared with the import, the export contributed more to domestic economic growth. The export mainly influenced Other Manufacture (71.09%) and Mining (69.01%), while had hardly no influence on the localization sectors, such as Construction (-0.35%). In the sectors of Mining and Manufacture of Machinery and Equipment in China, the contribution shares of export (69.01%, 37.76%) are much bigger than those of the import (-205.15%, -32.43%), which is consistent with the actual situation. The change in the interindustry input-output relations is the primary influencing factor in Other Manufacture and Manufacture and Processing of Metals and Metal Products, caused by the technological progress and industrial structural change.

Next, I will focus on the dynamic variation of the contribution shares of each factor to the output change from 1995 to 2012. To save space, I only list the contribution shares of each factor to the output change *in sector level* from 2010 to 2012 in Table 1, only the contribution shares of

Table 1. The contribution shares of each factor to the output change in sector level from 2010 to 2012

(%)

	Leontief inverse matrix	Consumption (C)	Investment (I)	Export (E)	Import (M)	Other (R)
Agriculture, Forestry, Animal Husbandry & Fishery	-26.08	104.65	37.71	14.20	-17.04	-13.43
Mining	-144.87	145.57	168.31	69.01	-205.15	67.14
Manufacture of Foods, Beverage & Tobacco	-0.10	91.03	20.41	14.58	-13.36	-12.56
Manufacture of Textile, Wearing Apparel & Leather Products	-12.92	70.26	18.81	34.61	-16.09	5.33
Other Manufacture	151.16	-76.96	-24.48	71.09	-14.38	-6.43
Production and Supply of Electric Power, Heat Power and Water	54.66	18.14	24.85	35.31	-37.31	4.36
Coking, Gas and Processing of Petroleum	-11.99	13.19	62.37	33.49	-6.75	9.69
Chemical Industry	1.57	17.50	66.80	27.75	-16.94	3.32
Manufacture of Nonmetallic Mineral Products	26.14	11.63	53.26	36.88	-29.18	1.28
Manufacture and Processing of Metals and Metal Products	138.76	-16.39	-4.94	0.53	-11.42	-6.54
Manufacture of Machinery and Equipment	39.70	1.36	50.69	37.76	-32.43	2.92
Construction	10.20	-1.69	92.40	-0.35	0.15	-0.70
Transport, Storage, Post, Information Transmission, Computer Services & Software	-54.84	62.59	78.63	31.12	-25.36	7.86
Wholesale and Retail Trades, Hotels and Catering Services	11.14	46.54	29.67	26.78	-9.52	-4.62
Real Estate, Leasing and Business Services	44.53	40.06	22.87	7.73	-6.97	-8.22
Financial Intermediation	52.78	34.99	15.38	7.48	-6.26	-4.37
Other Services	12.18	77.13	9.75	4.18	-3.92	0.69
Total	**-13.06**	**54.38**	**52.36**	**24.04**	**-18.62**	**0.91**

each factor to the *aggregate* output growth for other years in Table 2. Based on the data in Table 2, it's obvious that the export (106.75%) contributed most to the aggregate output increase from 1995 to 1997, which is consistent with the actual situation of China in the late 20th century. With the pressure of laggard production technology at that time, the economic development was driven by the exports. Since then, the contribution share of export had fallen, lowest to 12.77% from 2007 to 2010. The contribution share of consumption to economic development is around 40% to 50% over last two decades, with peak of 62.97% in the period of 2000-2002 and nadir of 28.68% in 2002-2005. The contribution share of investment is similar to that of consumption, but with wider fluctuation range, up to 71.3% during 2000 to 2002, as low as 23.03% during 1997 to 2000. The contribution of the investment was smaller than that of consumption before 2000, while became bigger than that of consumption after 2000, which is related to the technological progress. The variations of Leontief inverse matrix imply the interindustry input-output relations experienced drastically change as industry reforms carried out in China, then stabilized gradually in recent years.

3. The production inducement coefficient by final demand item

The ultimate purpose of all the production in every industrial sector is to meet the final demand of the society. The demand for intermediate product is derived demand. The final demand is the basic reason that impacts sectors' production decision. The driving effects of consumption, investment and export on economic growth is unequal. We use production inducement coefficient by each final demand item to show the relations between the sectors production and each final demand item. The final demand consists of consumption expenditure demand, the investment demand, the exports demand, the imports demand, others. The products induced by each final demand items are the aggregate output (directly and intermediate) required to meet the final demand item of consumption, investment and export. The production inducement coefficient by final demand item equals to the products induced by each final demand items divided by the total of corresponding final demand items, which represents the growth of industrial production

Table 2. The contribution shares of each factor to the aggregate output change

（%）

Year	aggregate output growth (10000yuan)	Leontief inverse matrix	Consumption (C)	Investment (I)	Export (E)	Import (M)	Other (R)
2012-2010	3489822113	-13.06	54.38	52.36	24.04	-18.62	0.91
2010-2007	4337859101	-0.42	40.40	66.87	12.77	-20.66	1.06
2005-2007	2720942543	8.93	33.17	38.67	34.43	-16.91	1.70
2002-2005	2333342060	18.28	28.68	46.99	51.27	-42.70	-2.51
2000-2002	558777185	-33.98	62.97	71.30	39.33	-40.96	1.34
1997-2000	577085511	18.95	51.70	23.03	36.16	-36.20	6.36
1995-1997	432993080	3.24	49.54	34.27	106.75	-87.25	-6.56

Table 3. The production inducement coefficient by final demand item in China

Year	Consumption (C)	Investment (I)	Export (E)	Import (M)	Other (R)
2012	2.564	3.358	3.367	3.240	2.931
2010	2.645	3.525	3.526	3.440	1.490
2007	2.649	3.518	3.483	3.423	0.146
2005	2.626	3.282	3.297	3.306	3.258
2002	2.319	2.998	2.850	2.941	2.647
2000	2.544	3.186	3.099	3.119	3.408
1997	2.438	2.976	2.846	2.942	2.770

derived by the increase of one unit of certain final demand item.

The production inducement coefficients by final demand item in China are listed in Table 3, shows the relative effect degree of each final demand item on industrial sectors' production. We can learn the inducement of each final demand item on the production, and figure out which demand item induce the economic growth. It has important political imply on the choice of policy aimed to stimulate economy. Which area the policy should focus on, consumption, investment, or export? The bigger the production inducement coefficient is, the greater inducement of certain final demand item on aggregate production is.

The production inducement coefficients of export and investment in China are highest, next is the imports. The production inducement coefficients of export and investment have gone up rapidly these years, shows powerful inducement on industrial sectors production. The increase on the production inducement coefficient of import and export prove that the international trade commercial intercourse promoted the industrial production and economic growth since the reform and opening up in China. The production inducement coefficient of final consumption expenditure fluctuated little, and notable lower than those of investment and export. The final consumption expenditure is closely related to residents' life, can't be ignored.

IV. Conclusions and Discussion

In recent years, the industrial structure optimization is emphasized by the government and firms in China frequently. It is wildly acknowledged that the change of final demand is the external reason of industrial structural change, while the technological progress serves as the major internal reason. Correct understanding on the interaction of the final demand and industrial production can help to promote the industrial structural optimization to high-grade development process, and adapted relation among the industrial structure, resources supply, technical level and demand structure. According to the analysis in this paper, the consumption and investment are the main compositions of the gross domestic product, and contributed most to the economic growth. The influence of consumption expenditure on Agriculture, Forestry, Animal Husbandry & Fishery, Mining, Manufacture of Foods, Beverage & Tobacco, Other Services and Manufacture of Textile, Wearing Apparel & Leather Products was big, which are closing related to our life. The investment mainly pushed the midstream and upstream sectors, such as

Mining, Construction and Transport, Storage, Post, Information Transmission, Computer Services & Software. While when it comes to the production inducement coefficient by final demand item, the export and investment induced more industrial productions. The export mainly influenced Other Manufacture and Mining, while had hardly no influence on the localization sectors, such as Construction, which should be taken into account in the progress of industrial structure updating and economic development.

Note*

[1] Graduate Department of Chinese Studies, Aichi University, Japan.

[2] In section 2, I analyze the final demand in macroscopic level, according to the three components of GDP by expenditure approach, which includes final consumption expenditure, gross capital formation and net exports of goods and services. In section 3, I try to figure out the detailed effect of final demand on every sector, in a microscopic level. So I decompose the find demand to consumption, investment, export, import and other. The major change is to decompose the net export to export and import.

[3] The 17 sectors include: Agriculture, Forestry, Animal Husbandry & Fishery; Mining; Manufacture of Foods, Beverage & Tobacco; Manuf. of Textile, Wearing Apparel & Leather Products; Other Manufacture; Production and Supply of Electric Power, Heat Power and Water; Coking, Gas and Processing of Petroleum; Chemical Industry; Manufacture of Nonmetallic Mineral Products; Manufacture and Processing of Metals and Metal Products; Manufacture of Machinery and Equipment; Construction; Transport, Storage, Post, Information Transmission, Computer Services & Software; Wholesale and Retail Trades, Hotels and Catering Services; Real Estate, Leasing and Business Services; Financial Intermediation; Other Services.

[4] The data is calculated at current prices, from China Statistical Yearbook in 2016

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