The Effects of the Shift to the Service Economy on Inter-industry Linkages in China[1]

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1. Introduction

The service industries of China have grown continuously with the development of the Chinese economy as a whole since the adoption of the reform and opening up policies of 1978. The share of service industries of the GDP increased by more than double, from 24.6 percent in 1978 to 52.2 percent in 2018, and exceeded the share of manufacturing industries in 2012. The share of the service industries of total employment also increased from 12.2 percent to 46.3 percent during the same period. However, despite the rise of service industries' share of the GDP and total employment, the comparison with advanced countries or the other BRICS countries shows that the service orientation of the Chinese economy still remains at a low level.

The shift to the service economy brings out various qualitative and structural changes within industries via changes in the interrelationship between services and other sectors — especially manufacturing — in addition to increasing the service industries' share of value-added or total employment.

The industrial structure of a country usually shifts its weight first from the primary industries to manufacturing, and then from manufacturing to service industries. Thus, the inter-industry linkages for industry as a whole tend to strengthen, up to a certain level, but thereafter begin to weaken. It is known that, in general, the production inducement effect of manufacturing is stronger than that of the primary or service industries. Therefore, there is a possibility that the production inducement effect of the whole industry will strengthen as industrialization proceeds but then weaken gradually as income levels rise and the role of services as intermediate goods expands with the shift to the service economy.

1 This article draws heavily on Lee, Geonwoo (2020), *The Effects of the Shift to the Service Economy on the Linkage Structure of Chinese Industries* (in Korean), KIET Issue Paper 2020-11.

In this study, I analyze how the shift to the service economy in China, accelerated in the 2000s, has brought structural changes to Chinese industries via the change of inter-industry linkages. I calculate the aggregate linkage measure which shows the effects of shifting to the service economy on the strength of the production inducement effect of the whole industry, and examine the role of imported intermediate inputs in enhancing the level of aggregate linkages. I also analyze the relationship between the degree of the shift to the service economy and the level of aggregate linkages by carrying out a cross-country comparison.

The data for the analysis are the *Input-Output Database (2018 edition)* by OECD, which consists of 64 countries (36 OECD countries plus 28 other countries) and is based on current prices.

2. Service Orientation in the Production Process

Firstly, to examine to what extent the production process in China has become oriented toward services, I analyzed the change of the service input coefficient by each industry sector.

The service input coefficient, defined as the proportion of the service industries' intermediate inputs to the gross output of each industry, reflects the extent to which each industry's output depends on intermediate inputs from service industries, and describes the technical interrelationship between service industries and other industries from a production perspective.

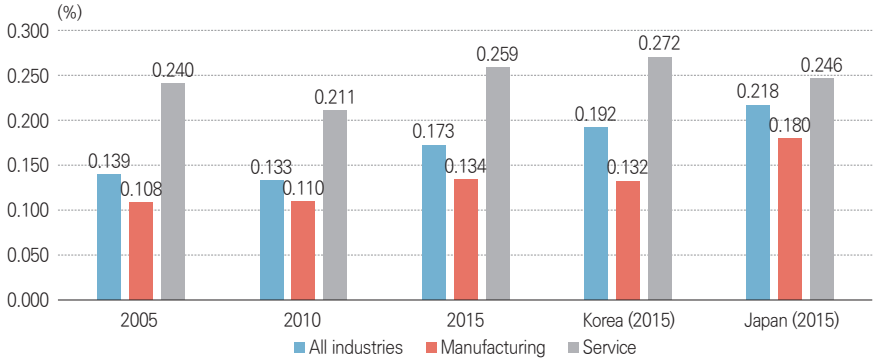
Table 1 shows the service input coefficient of each sector: all industries, manufacturing and services for the years 2005 to 2015. The result shows that the production process of Chinese

Table 1. Intermediate Input Coefficients among Industrial Sectors of China (2005 to 2015)

To	From	2005	2010	2015	Korea (2015)	Japan (2015)
All industries	Primary industry	0.091	0.089	0.084	0.044	0.025
	Manufacturing	0.337	0.331	0.331	0.316	0.201
	SOC/Construction	0.037	0.027	0.026	0.026	0.029
	Service	0.139	0.133	0.173	0.192	0.218
	Total intermediate input	0.604	0.580	0.614	0.578	0.473
Manufacuring	Primary industry	0.120	0.123	0.116	0.074	0.057
	Manufacturing	0.472	0.463	0.479	0.487	0.390
	SOC/Construction	0.030	0.024	0.024	0.023	0.025
	Service	0.108	0.110	0.134	0.132	0.180
	Total intermediate input	0.730	0.720	0.753	0.716	0.652
Service	Primary industry	0.016	0.010	0.011	0.007	0.004
	Manufacturing	0.146	0.119	0.119	0.128	0.082
	SOC/Construction	0.031	0.020	0.017	0.020	0.024
	Service	0.240	0.211	0.259	0.272	0.246
	Total intermediate input	0.433	0.360	0.406	0.427	0.356

Source: Based on OECD, *Input-Output Database (2018 edition)*.

Figure 1. Service Input Coefficients by Industrial Sector in China (2005 to 2015)



Source: Based on OECD, *Input-Output Database (2018 edition)*.

industries has witnessed rapid service orientation over the period.

The service input coefficient for all industries slightly decreased, from 0.139 in 2005 to 0.133 in 2010, but increased rapidly to 0.173 in 2015, a 24.5 percent jump from 2005. The service input coefficient for manufacturing increased continually over the same period from 0.108 to 0.134, with a rise of 24.1 percent. And the service input coefficient for service industries decreased in 2010, but increased to 0.259 in 2015, a 7.9 percent uptick from 0.240 in 2005.

Table 1 also shows the service input coefficients of Korea and Japan for the year 2015. Examining the coefficient for all industries, we see that Japan (0.218) exhibits the highest value, followed by Korea (0.192). The value of China's coefficient (0.173) is revealed to be the lowest. Japan (0.180) also exhibits the highest value of the service input coefficient for manufacturing, along with China (0.134), which has a slightly higher value than that of Korea (0.132). On the other hand, the service input coefficient for services is the highest in Korea (0.272), followed by China (0.259) and Japan (0.246).

3. Inter-industry Linkages of China

In this section, I calculated the aggregate linkage measure[2] for China to see how the inter-industry linkages of China have changed over time.

There are two ways to calculate the aggregate linkage measure L. On one hand, we could use the input-output matrix inclusive of imported

2 The aggregate linkage measure proposed by Kubo et al. (1986) as a measure of the inter-industry linkages for the whole industres, can be expressed by the formula

$$L = \sum_i \sum_j r_{ij} f_j - 1$$

where L is the aggregate linkage measure and r_{ij} are the elements of the Leontief inverse, and f_j are the elements of a standardized final demand vector (consisting of shares that sum to one).

intermediates and final goods, with the resulting linkage measure signifying the extent of inter-industry relations implied by the underlying intermediate-input technology. Thus, we would call this linkage index "overall linkages". On the other hand, if we use the input-output matrix exclusive of imported intermediates and final goods, the resulting measure shows the extent of linkages emanating from the domestic industrial base alone. We would call this linkage index "domestic linkages". The difference between two measures reflects the role of imported goods in production.

The results of calculating the aggregate linkage measure — overall and domestic — for Chinese industries for the years 2005 to 2015 are presented in Table 2.

First, the value of the overall linkages ($L1$), which includes both domestic and imported goods, decreased from 1.558 in 2005 to 1.384 in 2010, but increased significantly to 1.621 in 2015, showing about a four percent rise for the whole ten-year period. Hence, in the case of China, it can be said that the inter-industry linkages implied by the underlying production technology have strengthened over the period.

Second, the value of the domestic linkages ($L2$), which considers domestic goods only, decreased until 2010, but increased rapidly in 2015 similar to the case of the overall linkages.

Table 2. Aggregate Linkages of Chinese Industries (2005 to 2015)

		2005	2010	2015
Overall linkages (domestic+imported) ($L1$)		1.558	1.384	1.621
	Domestic final demand	1.439	1.289	1.526
	(Consumption)	1.137	0.983	1.182
	(Investment)	1.815	1.579	1.911
	Exports	1.903	1.749	2.058
Domestic linkages (domestic) ($L2$)		1.080	1.049	1.300
	Domestic final demand	1.038	0.997	1.241
	(Consumption)	0.861	0.797	0.984
	(Investment)	1.272	1.198	1.536
	Exports	1.193	1.235	1.554
($L1$)-($L2$)		0.478	0.335	0.321

Source: Based on OECD, *Input-Output Database (2018 edition)*.

The first term of L is a weighted sum of column sums of the Leontief inverse matrix, with the sectoral composition of final demand as weights. Because the column sum of the Leontief inverse matrix refers to the amount of goods directly and indirectly required to deliver one unit of sectoral output to final demand, the first term of L is the total value of products directly and indirectly needed to deliver one unit of final demand. Thus, the value of this term less unity, namely L, describes the value of intermediate goods needed to produce one unit of final demand with given composition.

If the composition of final demand is fixed, the value of L is proportional to the density of input-output matrix. The higher the value of L, the stronger the inter-industry linkages through intermediate goods transactions.

Kubo, Y., et al. (1986), "Interdependence and industrial structure", in *Industrialization and Growth: A Comparative Study*, edited by Chenery, H., S. Robinson, and M. Syrquin, Oxford University Press, Oxford.

Therfore, the production inducement effect of domestic industries also strengthened remarkably in the first half of the 2010s.

Third, the difference between overall linkages and domestic linkages, namely $L1$-$L2$, which describes the role of imported goods in inter-industry linkages, dropped steadily over the observation period. This means that in China the role of domestic goods in enhancing inter-industry linkages has continuously strengthened.

Table 2 also exhibits the overall and domestic linkages calculated by the categories of final demand, that is, consumption, investment and exports. In both overall and domestic linkages, exports have the highest value, followed by investment and consumption. This means that the production inducement effect of exports is much stronger than those of other categories of final demand.

4. Comparison of Inter-industry Linkages Across Countries

In last section, I examined how the aggregate linkages of Chinese industries have changed for the period of 2005 to 2015, and compared them with those of Korea and Japan for the year 2015. In this section, I tried a cross-country comparison of inter-industry linkages to evaluate the extent of inter-industry linkages of Korea more objectively.

Table 3 shows the aggregate linkages of ten OECD countries and five BRICS countries including China for the year 2015, caluculated by the same method used in Section 3. Table 3 also shows the technical linkages of fifteen sample countries, which consider the linkages in production technology alone, while excluding the influence of final demand.[3]

Examining overall linkages ($L1$), which include both domestic and imported goods, China exibits the highest value, followed by Korea. South Africa and Russia show the third and fourth highest values, respectively. In contrast, the United States reveals the lowest value of linkages, and other advanced countries also have low values around 1.0. Thus, it can be interpreted that the strength of the production spillover effect is higher in China and Korea than in advanced countries. A similar pattern is shown in case of the domestic linkages ($L2$) as well. Domestic linkages appear to be the highest in China, followed by Russia, Korea and South Africa, and remain at a relatively low level in most

3 The technical linkages can be expressed by the formula as follows, which modifies the formula of the aggregate linkage measure (L) somewhat.

$$LT = \frac{1}{n}\sum_i \sum_j r_{ij} - 1$$

This measure assumes that the sectoral composition of final demand is uniformly distributed, and is mainly used for comparing the linkages in production technology across countries with the assumption that the structures of final demand are the same among countries. Since LT considers the technical relation (r_{ij}) only and excludes the influence of final demand, we call LT as the technical linkage measure for the sake of convenience.

Table 3. Inter-industry Linkages in Fifteen Sample Countries (2015)

	USA	UK	France	Japan	Canada	Italy	Spain	Brazil
Aggregate linkages								
Overall linkages (*L*1)	0.772	0.860	0.923	0.923	0.902	1.091	1.075	0.924
Domestic linkages (*L*2)	0.627	0.604	0.603	0.717	0.563	0.713	0.678	0.723
Technical linkages								
Overall technical linkages (*LT*1)	0.881	0.989	1.017	1.089	0.975	1.229	1.222	1.122
Domestic technical linkages (*LT*2)	0.695	0.648	0.634	0.821	0.581	0.768	0.747	0.862
(*L*1)-(*LT*1)	-0.109	-0.129	-0.094	-0.166	-0.073	-0.138	-0.147	-0.198
(*L*2)-(*LT*2)	-0.068	-0.044	-0.031	-0.104	-0.018	-0.055	-0.069	-0.139
(*LT*1)-(*LT*2)	0.186	0.341	0.383	0.268	0.394	0.461	0.475	0.260

	Germany	South Africa	Korea	Mexico	Russia	China	India
Aggregate linkages							
Overall linkages (*L*1)	0.959	1.199	1.412	0.864	1.109	1.621	1.070
Domestic linkages (*L*2)	0.608	0.749	0.817	0.435	0.840	1.300	0.730
Technical linkages							
Overall technical linkages (*LT*1)	1.057	1.380	1.399	0.908	1.266	1.523	1.168
Domestic technical linkages (*LT*2)	0.652	0.843	0.826	0.504	0.940	1.222	0.764
(*L*1)-(*LT*1)	-0.098	-0.181	0.013	-0.044	-0.157	0.098	-0.098
(*L*2)-(*LT*2)	-0.044	-0.094	-0.009	-0.069	-0.100	0.078	-0.034
(*LT*1)-(*LT*2)	0.405	0.537	0.573	0.404	0.326	0.301	0.404

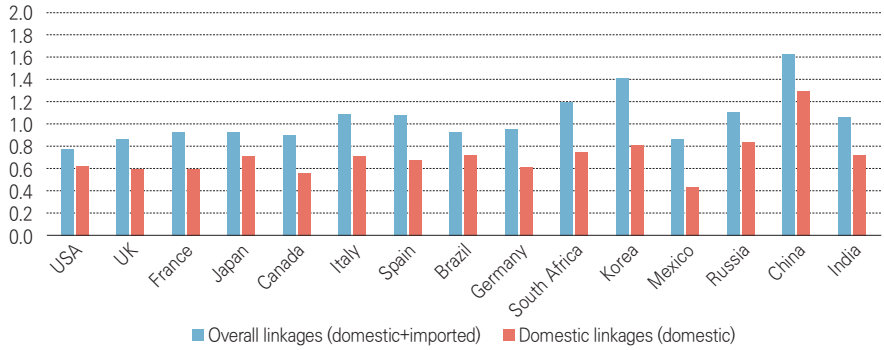
Source: Based on OECD, *Input-Output Database (2018 edition)*.

advanced countries.

The technical linkages (*LT*1, *LT*2) reveals a pattern very similar to the aggregate linkages. As explained before, the technical linkages reflect the relationships among intermediate goods, excluding the influence of final demand. Hence, the difference between *LT*1 and *LT*2 in Table 3 represents the role of imported intermediate goods in production process. The role of imported intermediate goods appears to be smallest in United States, followed by Brazil and Japan. China has the value of *LT*1-*LT*2, which is fourth-smallest among the fifteen countries. This result confirms that, in the cases of China and Japan, domestic intermediate inputs take an important role in enhancing technical linkages for production.

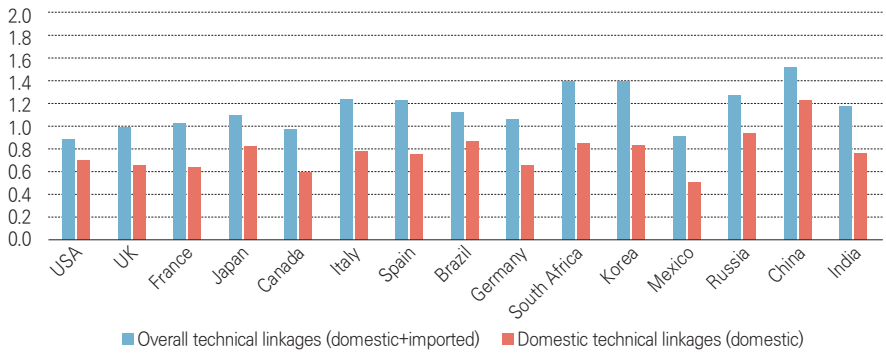
On the contrary, the role of imported intermediate goods appears to be the strongest for Korea. This means that, in Korea, due to high import dependency for intermediate goods, a large portion of induced production seeps out to foreign countries without staying in the domestic economy. Thus, it can be said that there

Figure 2. Comparison of Aggregate Linkages Across Countries (2015)



Source: Based on OECD, *Input-Output Database (2018 edition)*.

Figure 3. Comparison of Technical Linkages Across Countries (2015)



Source: Based on OECD, *Input-Output Database (2018 edition)*.

is much room for enhancing domestic industrial linkages in Korea, by substituting imported intermediate goods with domestic ones.

In advanced countries, the earlier shift to the service economy caused an expansion of the production share of service industries, whose production inducement effect is smaller than that of manufacturing, and this in turn has weakened the strength of linkages across the whole industry. As a result, the inter-industry linkages of advanced countries appear to be lower than those of China or Korea.[4]

In order to reaffirm the relationship between the shift to the service economy and inter-in-

4 Among BRICS countries, which are not counted among advanced countries, Mexico, Brazil and India reveal relatively low levels of inter-industry linkages. Especially in case of Mexico, where both the value of overall linkages ($L1$) and domestic linkages ($L2$) show exceptionally low levels. In particular, the latter is the lowest among the countries under consideration. There are some reasons for the low level of linkages in these countries, but it is supposed that an industrial structure with a relatively high share of primary and service industries whose production inducement coefficients are relatively small might be a cause of weak inter-industry linkages.

dustry linkages, I examined the interrelation between the service sector's share of gross output and the level of the overall aggregate linkages in the above fifteen countries.

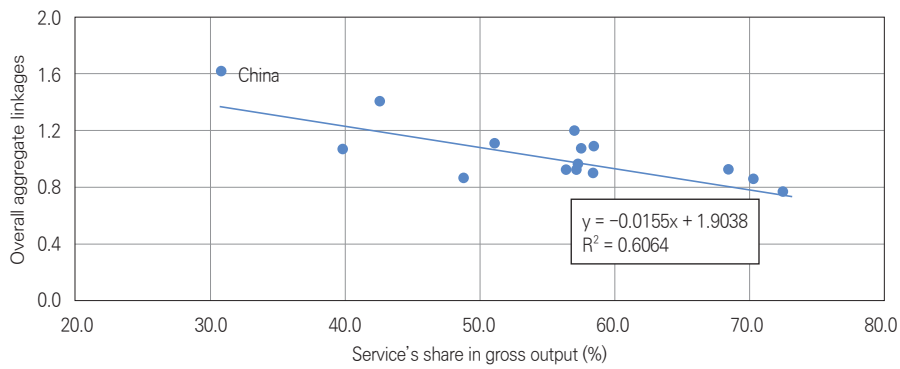
As expected, Figure 4 illustrates an inverse relationship within our sample between the service industry's share in gross output and the inter-industry linkages, and also shows a relatively strong correlation between the two.

In Table 3, the difference between overall aggregate linkages and overall technical linkages, *L*1-*LT*1 or the difference between domestic aggregate linkages and domestic technical linkages, *L*2-*LT*2, represent the impacts of the composition of total and domestic final demand on the inter-industry linkages, respectively. The former is a negative number in all countries except China and Korea; the latter is negative in all countries except China. This means that the composition of final demand has a negative effect on the value of inter-industry linkages in most of the countries in the comparison except for China and Korea. In other words, it can be interpreted that inter-industry linkages in advanced countries (and some BRICS countries) remain at a low level since the share of services in final demand is high and the share of manufactures in final demand is low.

Comparing service's share of total (domestic and imported) final demand among the fifteen countries for the year 2015 in Figure 5 reveals that most advanced countries, including the United States (71.1 percent), the United Kingdom (69.1 percent), France (63.4 percent) and Japan (61.6 percent) belong to the highest group. On the contrary, China (33.0 percent) shows the lowest value of service's share and Korea (47.0 percent) exhibits the fourth-lowest value, following India (42.3 percent) and Mexico (45.9 percent).

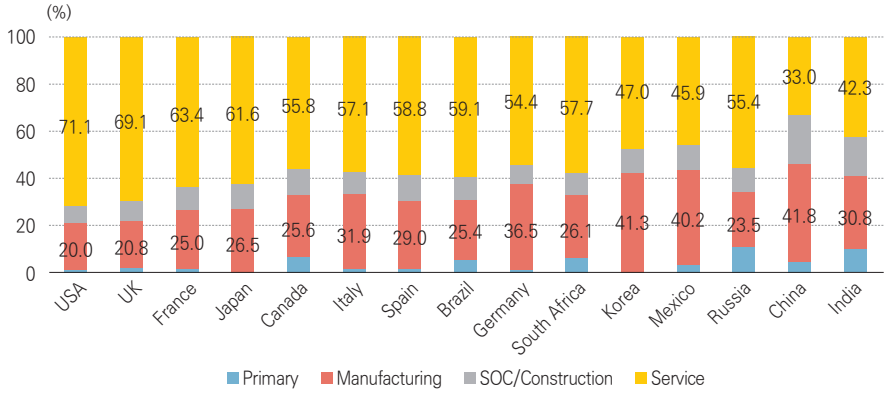
Therefore, we can say that the fact that inter-industry linkages in advanced countries are lower than those of China or Korea is closely related to the extent of service orientation in

Figure 4. Relationship between the Service Sector's Share of Gross Output and Inter-industry Linkages



Source: Based on OECD, *Input-Output Database (2018 edition)*.

Figure 5. Comparison of Sectoral Composition of Final Demand Across Countries (2015)



Source: Based on OECD, *Input-Output Database (2018 edition)*.

both the supply side (production) and the demand side (consumption) of these advanced economies. That is, the inter-industry linkages in advanced countries appear to be weak because the shares of services, of which the production inducement effect on other industries is not strong, in both production and final demand increases as the shift to the service economy continues. Hence, there is some possibility that inter-industry linkages or the strength of the production spillover effect in China will progressively weaken during the shift to the service economy, following the example set by advanced countries.

5. Implications for Korean Industry

In this study, I have shown how inter-industry linkages in China have changed from 2005 to 2015, using the concept of service input coefficients and the aggregate linkage measure, and examined the role of imported intermediate goods in enhancing overall linkages in China. In addition, I compared the levels of inter-industry linkages and the role of imported intermediates among fifteen countries, including China.

The analysis of service input coefficients revealed that in China, the production process is rapidly orienting toward services, but as a whole still remains at a lower level than in Japan or Korea. But If we focus on manufacturing industries only, the level of service orientation in the production process is found to be slightly higher in China than in Korea. This result shows that Korea's service industries have developed so far mainly owing to increased consumption that has accompanied income growth; the proportion of development in the service sector related to production activities in the manufacturing sector is comparatively small.

The fact that Korea's service industries have not developed hand-in-hand with manufacturing is basically due to insufficient growth in manufacturing-related services, such as dis-

tribution, financial services and professional business services including legal, accounting, market research, management consulting and advertising services. To promote manufacturing-related services, it is necessary to strengthen the demand-side policy support to facilitate service outsourcing of manufacturing firms as well as enhance supply-side capacity and service quality by means of deregulation, the encouragement of competition, standardization, specialization and enlargement, professional workforce training and so on.

In order to prevent domestic production in Korea being wed to excessive import inducement and strengthen inter-industry linkages, policy should focus on measures that substitute imported intermediates with domestic ones by enhancing the competitiveness of intermediate industries, such as parts and basic materials, which are highly dependent on imports.

Next, the analysis of the aggregate linkage measure showed that inter-industry linkages in China have rapidly strengthened in recent years despite a continuous shift to the service economy. A cross-country comparison revealed that the levels of overall and domestic linkages in China remained the highest among the fifteen countries of the comparison. In addition, we could see that there was a relatively strong negative correlation between the service sector's share of gross output and the level of inter-industry linkages. Therefore, we can infer that, as the shift to the service economy continues hereafter in China, the inter-industry linkages or the strength of production spillover effect in China will eventually weaken.

There is some possibility that the weakening of inter-industry linkages will lead to negative effects on the growth rate of Chinese economy. The reason is that the weakening of the inter-industry linkages brings about a decrease of intermediate inputs and gross output, and this, ceteris paribus, tends to be connected to reduction in income and employment being created in the process of production. Hence the weakening of inter-industry linkages can be interpreted as a shifting of the industrial structure to an undesirable direction from the perspective of income and employment creation.

A decreasing growth rate in China due to the shift to the service economy may have negative impacts on Korean exports to China in the near future. Therefore, it is necessary to diversify the export markets of some industries, such as electronic parts, petrochemicals and precision apparatus, which are highly reliant on exports to China. In addition, from a long-term perspective, the economic structure needs to be improved in the direction of expanding the share of domestic demand.

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