World Economy Brief

October 25, 2016 | Vol. 6 No. 26 | ISSN 2233-9140

Productivity and Exports in Korea: Comparisons with China and Japan

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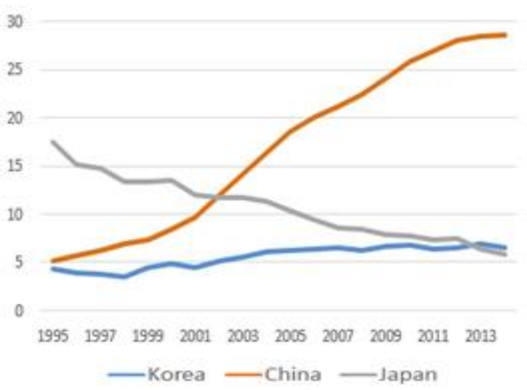
Introduction

With the rise of China's economy, competition among Korea, China, and Japan (C-J-K) in the global market has become fierce. From the Korean perspective, up until the early 2000s the three countries maintained a regime of relatively mild competition. As the global production network expanded, global trade increased remarkably, and at the same time the three countries' exports also witnessed a great surge by virtue of a clear division of labor among the three countries. However, situations have changed since the early 2000s. As China advanced technologically, China's rush into the global market became a serious threat to Japan, and even more so to Korea. For example, it is evident from China's surge and Japan's fall in the global electronics market in terms of market share since the mid-2000s (see Figure 1). More recently, the global economic recession together with trade slowdown has led to more intense competition among the three countries.

This article aims to assess Korea's competitiveness in manufacturing exports, focusing on the rivalry among the three countries. To this end, we examine the productivities of C-J-K and estimates the effect of relative productivity on exports in Korea.

Figure 1. C-J-K's share (%) in the global electronics market



Source: UN COMTRADE.

Measuring Productivity

Total factor productivity (TFP) is obtained by estimating the following logarithmic production function:

$$y_{cit} = \beta_0 + \beta_l l_{cit} + \beta_k k_{cit} + \omega_{cit} + u_{cit},$$

where y, l, and k indicate output, labor, and capital stock in year t in industry i of country c, respectively. ω is a productivity shock observed by producers, but not by econometricians, which implies a potential source of endogeneity. The Olley and Pakes (1996)' method is applied to address this issue. The data for estimating TFP are collected from OECD STATS, World KLEMS, CEIC China premium DB and the IMF. The sample period is from 1986 to 2012.

Table 1. TFP estimates of C-J-K

	KOR	CHN	JPN	USA
TFP level				
1986-89	0.165	0.065	0.409	0.449
1990-93	0.192	0.061	0.440	0.468
1994-97	0.244	0.048	0.514	0.498
1998-01	0.230	0.059	0.504	0.543
2002-05	0.276	0.103	0.539	0.623
2006-09	0.305	0.161	0.528	0.651
2008-09	0.287	0.176	0.541	0.617
2010	0.319	0.206	0.549	0.738
2011	0.333	0.244	0.589	
2012	0.376	0.255		
TFP level, USA=100				
1986-89	36.7	14.5	91.2	100
1990-93	41.0	13.1	93.9	100
1994-97	49.0	9.6	103.2	100
1998-01	42.4	10.9	92.9	100
2002-05	44.3	16.6	86.4	100
2006-09	46.8	24.7	81.0	100
2008-09	46.4	28.4	87.7	100
2010	43.3	27.9	74.4	100
TFP growth rate, %				
1986-89	7.3	0.6	5.0	1.8
1990-93	4.6	3.8	2.9	1.5
1994-97	3.6	-8.8	1.5	1.3
1998-01	-0.7	10.2	0.2	1.4
2002-05	7.0	14.5	2.0	6.2
2006-09	-2.5	10.6	-0.5	-3.0
2008-09	-9.9	6.9	1.7	-6.3
2010	17.4	15.1	3.9	
2011	4.3	18.6	7.3	
2012	12.9	4.4		

The Olley-Pakes estimates on TFP are listed in Table 1. The U.S. recorded the highest level of TFP over all the years except the mid-1990s, expanding the production frontiers. Japan showed a remarkable increase in TFP until the mid-1990s, although figures remained sluggish in the late 1990s. Korea's TFP steadily rose to 46% of the U.S TFP in the mid-2000s, from 37% in the 1980s. After 2000, China picked up drastic growth in TFP. It even recorded an increase of 6.9% during the global financial crisis (2008-09), when most countries witnessed a TFP decline. Meanwhile the productivity gap between Korea and Japan reduced by 20% in the mid-2000s, compared to 1986. Nonetheless, Korea's TFP stays only at 55-60% of Japan's, which implies that the gap is still huge. In contrast, there has been a significant decrease in the TFP gap between Korea and China in the 2000s. China's TFP reached approximately 70% of Korea's during 2010-12. This means that the productivity gap between the two countries reduced by 52%, compared to 1995.

Measuring Technical Efficiency

Traditional studies on productivity mainly pay attention to the expansion of potential production capabilities through technological progress, such as product and process innovations. However, productivity also depends on how efficiently production occurs: in other words, technical efficiency. Technical efficiency refers to the difference between the observed output and the maximum output, given a bundle of inputs and a technology. It holds importance in that productivity can be raised by improving the production environment, in the form of regulations and institutions related to business activities and market mechanisms. Technical efficiency is measured by estimating the stochastic frontier model based on the estimate of the following frontier production function:

$$y_{cit} = f(L_{cit}, K_{cit}) - u_{cit} + v_{cit},$$

where y and f represent the observed output and the maximum output level, respectively. u captures the possibility of inefficiency. If *u*=0, there is no inefficiency, implying that the actual production optimally occurs at the maximum level of output. In general, however, *u*>0 is likely. *u* is commonly assumed to be distributed as Half-Normal, Exponential or Gamma (Belotti et al., 2012). The stochastic frontier model is estimated using the data employed for the TFP estimations.

Figure 2. Technical efficiency of C-J-K

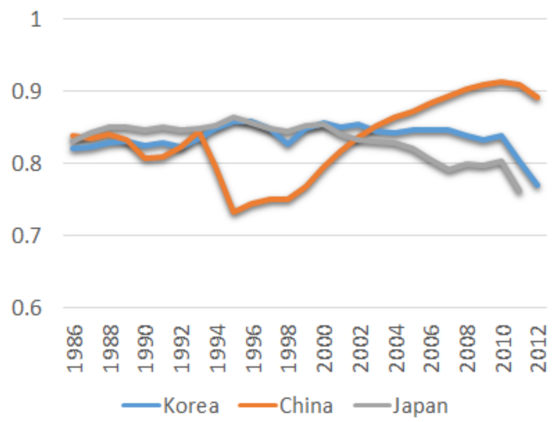


Figure 2 illustrates the estimates of the technical efficiency of Korea, China, and Japan. The production frontier of a country is determined by the level of its technology. Figure 2 implies that the closer the efficiency measure of the country is to 1, the less its actual output deviates from its optimal (or maximum) output. The most noticeable change occurs in the 2000s. During this period, technical efficiency dramatically rose in China, while it dropped gradually in Korea and Japan. After the global financial crisis of 2008-09, in particular, the collapse in technical efficiency is more clearly apparent in Korea and Japan than in China. China's efficiency already overtook the other two countries' in the mid-2000s. This suggests that the productivity surge in China resulted from increased technical efficiency as well as technical progress. China has reformed economic systems including tax, investment, exchange rates, etc. and has introduced various international standards (or practices) since its WTO entry in 2001. These institutional reforms seem to have contributed to the rise in productivity through efficiency improvements.

Relationship between Productivity and Exports in Korea

A standard gravity model (Anderson and van Wincoop, 2003) is augmented with productivity measures to empirically identify the relationship between productivity and exports in this section. The logarithmic value of bilateral exports, deflated to 2005 prices, and Korea's share in the partner's import market are taken as the dependent variables, respectively. The sample includes Korea's six major partners (China, Japan, France, Germany, U.K., U.S.) and 11 manufacturing sectors (ISIC Rev 4. 10-12, 13-15, 16-18, 19, 20-21, 22-23, 24-25, 26-27, 28, 29-30, 31-33). The productivity variables as focus regressors are defined in relative terms and lagged by one year. The supplementary data for estimation are gathered from UN Comtrade and the World Bank DB. The productivity measures, TFP and technical efficiency, are obtained from the previous sections. Table 2 describes the variables employed in regression.

Table 2. Definition of variables

Variable	Definition
Dependent	
lnrex	Log of Korea's bilateral real exports with 2005 as the base year
share	Korea's share in a partner's market
Independent	
lnrgdp_p	Log of real GDP of partners with 2005 as the base year
tfp_kp	Korea's TFP/Partner's TFP
tfp_kc	Korea's TFP/China's TFP
tfp_jk	Japan's TFP/Korea's TFP
u_k	Korea's technical efficiency

The modified gravity equation is estimated sweeping out partner- and industry-specific fixed effects with the within transformation. It also includes year dummies to control for unobserved year characteristics. Table 3 shows the results of estimations for the gravity model. The first four columns and the last four columns present the impact of productivity on exports in value and share, respectively. In all regressions the estimate of real GDP is significantly positive, as expected, implying that Korea's bilateral exports increase in line with the economic size of partner countries. Looking at the productivity variables, which are of main interest, in column 1 the ratio of Korea's TFP to partner's is estimated to be significantly positive. An enhancement of productivity in Korea relative to partners increases its bilateral exports on average. Similarly, columns 2 and 3 suggest that a relative increase of Korea's TFP to China and Japan is linked positively to Korea's exports. In column 4, relative TFP is replaced by the measure of Korea's technical efficiency, and its estimate shows that an improvement in production efficiency is likely to increase exports. When taking Korea's share in partner's market as a dependent variable, the coefficients of the productivity variables remain unchanged in terms of their sign and significance. As a consequence, an increase in Korea's productivity relative to its partners, especially China and Japan, may be important for its greater global market share.

Table 3. Relationship between productivity and exports in Korea

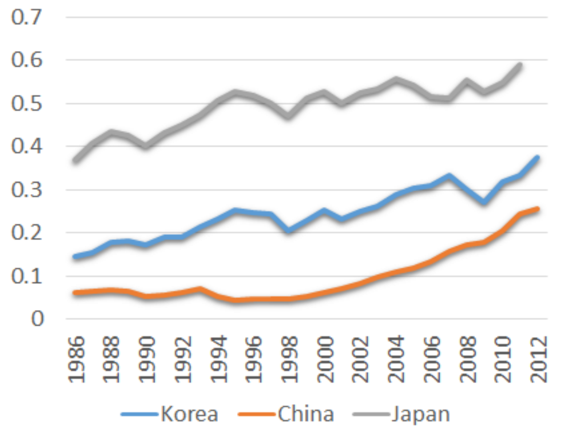
Variables	Korea's bilateral real exports				Korea's share in a partner's market			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lnrgdp_p	2.148** (.0951)	1.656** (.0755)	1.708** (.0714)	1.708** (.0653)	.0649** (.0042)	.0263** (.0032)	.0221** (.0030)	.0221** (.0030)
tfp_kp(-1)	.2551** (.0369)				.0177** (.0014)			
tfp_kc(-1)		.0465+ (.0275)				.0030** (.0011)		
tfp_jk(-1)			-.4399** (.0508)				-.0102** (.0020)	
u_k(-1)				.0916** (.0049)				.0019** (.0002)
Adj. R2	.9217	.9242	.9216	.9342	.8383	.8170	.8140	.8220
Observations	1,357	1,287	1,430	1,430	1,229	1,170	1,300	1,300

Note: 1) Standard errors are in parentheses.
2) **, *, + indicate significance at 1, 5, 10% respectively.
3) (-1) represents the variable lagged one year.

Conclusion

This article sheds lights on the relationship between productivity and exports in Korea, especially focusing on comparisons with China and Japan. It finds that first, China has drastically caught up with Korea since 2000, while there still exists a relatively large productivity gap between Japan and Korea. This is reminiscent of the sandwich theory, meaning that Korea is literally sandwiched between a fast-growing China and a technologically advanced Japan, as seen in Figure 3.

Figure 3. "Sandwiched" Korea, in terms of TFP



Second, technical efficiency, an important determinant of productivity, has improved rapidly and steadily in China during the 2000s, while it has declined in Korea and Japan since the global financial crisis. Third, there seems to be a positive link between productivity and exports in Korea. In particular, a relative increase in productivity to China and Japan is highly related to its export performance. Not only technological progress, but also the enhancement of production efficiency is important for boosting export volumes and global market share.

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