Research on CMS decomposition of South Korea’s manufacturing exports to China

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Abstract. This paper analyzes the export performance of South Korea’s manufacturing products to China from 2000 to 2020 by using Constant Market Share (CMS) model. The manufacturing products are mainly electrical machinery, equipment, vehicles, optical photographic, iron and steel, organic chemicals, and related products. According to the analysis, South Korea’s manufacturing products to China had continued to increase in demand of the China market from 2000 to 2014, but it has stagnated or declined since 2015, owing to the development of manufacture-related technology of China and its lower dependence on South Korea’s products. Through CMS decomposition, it is found that: the structure effects in stages of 2000-2015, 2006-2010 and 2011-2015 contributed the most to the change of exports in China market. However, during the period of 2016-2020, it was a high negative level due to the increased self-sustaining power of China. Moreover, the structure effects are mainly from the growth effects, except for the period of 2016-2020, which was from the commodity effect. In all the four stages, the competitive effect has a positive value. Especially, in the period of 2016-2020, it reached a highest level of 620.20%, because of its high technology and high quality. Through second order decomposition, it is found that the competitive effects are mainly from the overall competitive effects, except for the period of 2006-2010, which is mainly from commodity competitive effect. In the case of residual effect, compared with the structure effect and the competitive effect, its contribution to the change of exports is very low. And the residual effects are mainly from the pure residual effects rather than dynamic effects.

1. Introduction
Rapid environmental changes in Northeast Asia's economy since 2008 have caused a serious crisis for the South Korea’s manufacturing industry. South Korea’s manufacturing industry has been falling because of price competition from the world’s quantitative easing and technology competitiveness from China’s technology growth. In particular, China had an unrivaled advantage in the cost competitiveness of manufactures. For this reason, China’s exports of manufacturing products increased greatly in recent years. Ahn (2017)¹ pointed out that South Korea’s manufactures of electronics, car and medical industries have comparative strengths over China, even if the development of manufactures of China is strong and fast around the period of the Korea-China FTA.

South Korea and China are geographically close, so they have had many exchanges for a long time (Wang, 2018)². In particular, South Korea, China and Japan, adjacent to ASEAN, are making national efforts to achieve close economic cooperation with ASEAN (Nam, 2019)³. The trade volume between the two countries increased year by year, and since mid-2000, China has grown to be South Korea's
largest trade partner. The two countries are at the top of each other in terms of trade size, exports, imports, etc, making them important to each other in trade and economy as a whole. Specifically, South Korea’s major export countries are China, the United States, Vietnam, Hong Kong, and Japan. China’s major export countries are the United States, Hong Kong, Japan, South Korea and Vietnam (La, Song, 2019)[4].

In recent decade, there had many changes in China’s external and internal economy. China's development of manufacture-related technology and growth on domestic demand-oriented (Bagaria, Ismail, 2019)[5], intensifying trade pressure between the United Stated and China had a negative impact on countries that are highly dependent on export to China. In particular, South Korea, which has the highest proportion of export to China, is affected most directly or indirectly by changes in the internal and external environment of China. Therefore, it can be a very meaningful study to analyze South Korea’s export performance to China in the last 20 years with using the Constant Market Share (CMS) model.

In this study, export data of South Korea’s manufacturing products based on HS 2 Units from 2000 to 2020 to China are extracted at UN Comtrade to examine the South Korea product’s performance with CMS model. South Korea’s manufacturing products to China are electrical machinery and equipment and parts there of (HS85), nuclear reactors, boilers, machinery and mechanical appliances parts there of (HS84), vehicles, railway or tramway rolling-stock and parts there of (HS87), plastics and articles there of (HS39), mineral fuels, mineral oils, bituminous substances, mineral waxes (HS27), optical photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus, parts and accessories there of (HS90), iron and steel (HS72), organic chemicals (HS29), articles of iron or steel (HS37).

2. Methodology of Constant Market Share

In this study, Constant Market Share model is used to more comprehensively analyze South Korea’s export performance to China. The CMS model was introduced by Tyszynski (1951)[7] for international trade research as a way to analyze export fluctuation factors. The CMS model is evaluated to be useful for decomposing changes of market share in a particular country into various factors and explaining the extent to what each factor contributed to changes in export change. The model is composed of the factors of structure effect, competitive effect, residual effect in a given period, assuming that the export country has a constant global market share with export products. Tyszynski (1951)[7] suggested to use year 0 weights to measure the structural effect at constant market shares and year t weights to compute the competitiveness component:

\[
\Delta q = \sum_i s_i^0 \Delta V_i + \sum_i \Delta s_i V_i^t
\]  

(1)

Baldwin (1958)[6] employed year 0 weights to compute both the structural effect and the competitive effect, which leaves a residual effect interacting between the structural and the competitive term:

\[
\Delta q = \sum_i s_i^0 \Delta V_i + \sum_i \Delta s_i V_i^0 + \sum_i \Delta s_i \Delta V_i
\]  

(2)

Where,

\(\Delta q\) denotes the change in export value of manufacturing products of South Korea between time \(t\) and time 0 to China;
\(V\) denotes the total import volumes of manufacturing products in China;
\(s\) denotes as the market share of a South Korea in China;
\(i\) denotes a certain product;
0 denotes starting years of a period;
\(t\) denotes ending years of a period.

Both formula (1) and (2) are called first-order decomposition.

In this study, we use formula (2) to analyze the performance of South Korea’s manufacturing products to China. The meanings of first-order decomposition for CMS (Shim, 2019)[8] is as the follows.
\[ \sum_i s_i^0 \Delta V_i \] refers to the structure effect, which comes from the effect of changes in global import demand on growth of exporter’s export volume, and can be further decomposed as growth effect of \( s_i^0 \Delta V \) from import changes, and commodity effect of \( \left( \sum_i s_i^0 \Delta V_i - s_i^0 \Delta V \right) \) from change of export products.

\[ \sum_i \Delta s_i V_i^0 \] refers to the competitive effect, which comes from the effect of changes in export competitiveness on export growth, and can be further decomposed as aggregate competitive effect of \( \Delta s V^0 \) from change in overall competitiveness of export country, and commodity competitive effect of \( \left( \sum_i \Delta s_i V_i^0 - \Delta s V^0 \right) \) from change in the competitiveness of specific commodity in export country.

\[ \sum_i \Delta s_i \Delta V_i \] refers to the residual effect, which comes from the effect of interacting between the structure effect and competitive effect on export growth, and can be further decomposed as pure residual effect of \( \left( \frac{V^t}{V_0} - 1 \right) \sum_i \Delta s_i V_i^0 \) from interaction between the export competitiveness and the import demand, and dynamic residual effect of \( \left[ \sum_i \Delta s_i \Delta V_i - \left( \frac{V^t}{V_0} - 1 \right) \sum_i \Delta s_i V_i^0 \right] \) from the interaction between export competitiveness and export commodity structure.

Thus, second order decomposition can be obtained as follows:

\[
\Delta q = s_i^0 \Delta V + \left( \sum_i s_i^0 \Delta V_i - s_i^0 \Delta V \right) + \Delta s V^0 + \left( \sum_i \Delta s_i V_i^0 - \Delta s V^0 \right) + \left( \frac{V^t}{V_0} - 1 \right) \sum_i \Delta s_i V_i^0 + \left[ \sum_i \Delta s_i \Delta V_i - \left( \frac{V^t}{V_0} - 1 \right) \sum_i \Delta s_i V_i^0 \right]
\]

Analysis using CMS model is easy to understand, widely used for analysis of export fluctuation factors between countries, and is meaningful for that it provides a basic direction before in-depth research.

### 3. Analysis of CMS model results
Comparing South Korea’s manufacturing product exports to China from 2000 to 2020 and China’s import of the same products from the world during the same period, the trend is as shown in Figure 1.
Figure 1 shows that the products imported by China from the world and South Korea continued to increase for 10 years from 2000 to 2010 except for financial crisis of 2009, and have decreased or stagnated since then. Of all the manufacturing products (HS Code 2 units), the electrical machinery and equipment and parts of (HS85) represented the most for 20 years. Despite of the decline or stagnation of export since 2015, the export of the products requiring a high level of technology continued to increase. It can be inferred that South Korea's electronic product’s competitiveness is considered as good quality and technology in the China market.

Next, CMS Model is applied for the increase and decrease in export to China for the four periods 2000-2005, 2006-2010, 2011-2015 and 2016-2020 to analyze export change in the competitiveness of South Korea's manufacturing products to China. The results are as per Table 1.

| Factors                  | 2000-2005 | 2006-2010 | 2011-2015 | 2016-2020 |
|--------------------------|-----------|-----------|-----------|-----------|
| Value                    | Percentage| Value      | Percentage| Value      | Percentage| Value      | Percentage|
| Change in exports        | 51,444.10 | 100%      | 56,375.55 | 100%      | 33,926.06 | 100%      | -6,847.20 | 100%      |
| Structure effect         | 38,823.93 | 75.47%    | 56,633.73 | 100.46%   | 21,865.53 | 64.45%    | 34,486.83 | -503.66%  |
| Growth effect            | 38,946.18 | 75.71%    | 63,082.62 | 111.90%   | 16,915.04 | 49.86%    | 38,242.23 | -558.51%  |
| Commodity effect         | -122.25   | -0.24%    | -6,448.89 | -11.44%   | 4,950.49  | 14.59%    | -3,755.41 | 54.85%    |
| Competitive effect       | 9,130.26  | 17.75%    | 155.22    | 0.28%     | 12,284.78 | 36.21%    | -42,466.06| 620.20%   |
| Overall competitive effect| 9,335.39  | 18.15%    | -4,883.58 | -8.66%    | 20,695.65 | 61.00%    | -43,860.11| 640.56%   |
| Commodity competitive effect| -205.13 | -0.40%    | 5,038.80  | 8.94%     | -8,410.87 | -24.79%   | 1,394.06  | -20.36%   |
| Residual effect          | 3,489.91  | 6.78%     | -413.40   | -0.73%    | -224.25   | -0.66%    | 1,132.03  | -16.53%   |
| Pure residual effect     | 12,423.70 | 24.15%    | 120.24    | 0.21%     | 2,004.11  | 5.91%     | -10,043.59| 146.68%   |
| Dynamic residual effect  | -8,933.78 | -17.37%   | -533.65   | -0.95%    | -2,228.36 | -6.57%    | 11,175.62 | -163.21%  |

In order to more intuitively reflect the performance of Korea’s exports to China, the components of CMS decomposition during the four periods with first CMS decomposition and the contribution of every effect are as the Figure 2.
Figure 2 Components of CMS decomposition during the four periods

From Table 1 and Figure 2, it is found that, structure effects from 2000 to 2015 were 75.47%, which contributed the most to the change of exports. However, the 2016–2020 period, it was -503.66%, a high level of (-), which means that although the demand for South Korea's manufacturing products in the China market continued to increase, it has fallen sharply since 2016. It was caused that China has invested in manufacture-related technology since mid-2000, which has lowered its dependence on foreign countries and increased its self-sustaining power. In 2006-2010 and 2011-2015, the structure effects were 100.46% and 64.45% respectively, which also contributed the most in the two periods to the change of exports. Through second order decomposition, it is found that, in three stages, it is the growth effects which contributed the most to the structure effect, rather than the commodity effects, except for the period of 2016-2020, which had 54.85% of the commodity effect.

In all the four stages, the competitive effects had a (+) value. Especially, in the period of 2016-2020, the competitive effect reached 620.20%. It means that although the demand of China for South Korea’s products has decreased, it is competitive when it comes to technology and quality of the South Korea products. Given that most of South Korea's manufacturing products require a high level of technology such as HS85 (electrical machinery and equipment and parts there of), HS90 (optical photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus, parts and accessories there of), it can be expected that South Korea's high-tech technology level is considered as high in China market. Through second order decomposition, it is found that, the competitive effects are mainly from the overall competitive effects except for the period of 2006-2010, which is mainly from commodity competitive effect.

In the case of residual effect, it has all (-) values except for the period 2000 to 2005. Compared to the structure effect and the competitive effect, its contribution to the change in exports was very low. And the residual effects are mainly from the pure residual effects rather than dynamic effects.

4. Conclusion

In this study, the implications are obtained by analyzing the performance of South Korea's manufacturing product exports in China from 2000 to 2020 with UN Comtrade statistics data and CMS model. Through analysis of the market share of South Korea's manufacturing exports in China over the past 20 years, it continued to increase from 2000 to 2014, but it has declined or stagnated since then. The manufacturing products for 20 years are electrical machinery and equipment and parts of (HS85), nuclear factors, boilers, machinery and mechanical applications parts of (HS84), vehicles, railway or tramway rolling-stocks and parts of (HS85). In other words, it can be confirmed that China's manufacture-related technology has developed a lot since 2015, lowering its dependence on foreign countries and increasing its self-sustaining power.
Through CMS decomposition, it is found that:

First, the structure effects in three stages of 2000-2015, 2006-2010 and 2011-2015 contributed the most to the change of South Korea's manufacturing products in China market. However, the 2016-2020 period, it was a high level of (-), owing to the lower dependence of China on foreign countries and the increased self-sustaining power of China. Moreover, the structure effects are mainly from the growth effects, except for the period of 2016-2020, which was from the commodity effect.

Second, in all the four stages, the competitive effect has a (+) value. Especially, in the period of 2016-2020, the competitive effect reached a highest level of 620.20%, owing to its high technology and high quality. Through second order decomposition, it is found that the competitive effects are mainly from the overall competitive effects except for the period of 2006-2010, which is mainly from commodity competitive effect.

Third, in the case of residual effect, compared with the structure effect and the competitive effect, its contribution to the change in exports is very low. And the residual effects are mainly from the pure residual effects rather than dynamic effects.

In a word, according to the analysis of performance of South Korea’s manufacturing products in the China market, the competitiveness of the manufacturing products seems to be good so far. However, China's manufacture-related technology has continued to develop, and the Chinese government is still investing a lot to strengthen its technology. South Korea government should take positive actions in restructuring of industries, high value-added export products, and rationalization of management.

Future research will be conducted for in-depth on the performance of South Korea products against export competitors such as Japan or Singapore.

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Reference
[1] Ahn, Y. (2017) The analysis on the effect of Korea-China FTA on the manufacturing industry. E-business., 18(5): 203–222.
[2] Wang, S. (2018) Developing value added service of cold chain logistics between China and Korea. Journal of Korea Trade., 22(3): 247-264.
[3] Nam, D. (2019) Comparison analysis of the export structure and competitiveness of three Northeast Asia countries to ASEAN. Korean-Chinese Social Science Studies., 53(0): 353–376.
[4] La, K., Song, J. (2019) A Study of competitiveness through analysis of export similarity index and constant market share of Korea's major export products in China. International Commerce and Information Review., 21(4): 51–69.
[5] Bagaria, N., Ismail, S. (2019) Export performance of China: A constant market share analysis. Frontiers of Economics in China., 14(1): 110–130.
[6] Shim, J. (2019) A study on Korea’s export competitiveness and its determinants to India. The Journal of Humanities and Social science., 10(4): 211–222.
[7] Tyszynski, H. (1951) World trade in manufactured commodities, 1899-1950. The Manchester School., 19(3): 272–304.
[8] Baldwin, R.E. (1958) The commodity composition of trade: Selected industrialized countries, 1900-1954. Review of Economics and Statistics., (40): 50–71.