Granger Causality Between the Import Policy and the Comparative Advantage in China's Anti-Biotic Product

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Abstract: This study examined the Chinese "net export ratio" (NX_{ck}) that measures the trade balance as a proportion of the total trade, "revealed symmetric comparative advantage for export" (RX_{ck}) and "import restriction" (HM_{ck}) in the anti-biotic products, by using data of 1987-2019 from UN COMTRADE database. Short-run and the long-run Granger causality tests between "RX_{ck}" and "HM_{ck}" were performed with both of the directions with the specific sizes for the effects. The results revealed that in the optimal non-linear models, HM_{ck} improves RX_{ck} with positive short-run effect (p=0.033) and long-run effect (p=0.066); HM_{ck} lags have negative long-run effect (p=0.080) on the indicator of HM_{ck} itself, indicating that the Chinese import restriction intervention in the trade of the anti-biotic products has not been inertial.

1 INTRODUCTION

The 2019-ncov (COVID-19) infected pneumonia has swept China and across the world. World Heath Organization reckoned it as a pandemic and declared the disease a Public Health Emergency of International Concern (PHEIC). Many countries including China have started the R&D in the effective COVID-19 vaccine. The disease has also triggered the interest in developing the other anti-biotic pharmaceutical products to protect the public health, and has aroused the necessity of reassessing the trade policies in the anti-biotic products or the anti-biotic pharmaceutical industry.

The theories of dynamic comparative advantage argue that a developing country should support the development of the key industries by trade protectionism, in the form of either export promotion or import restriction or both (List, 2011; Grossman, 1991; Keynes, 1997), in order to improve the national comparative advantage in the export of the industries (Smith, 1998). The Chinese policy makers and a lot of researchers, however, have insisted that China is of free trade and is to be against any form of protectionism. Is there an applicable method to measure the degree of trade protectionism? If there is, how is the protectionism in the Chinese import in the anti-biotic products? Can the import restriction affect the comparative advantage in the trade of anti-biotic products? This study aims to answer the questions by empirical analyses.

This research forwarded an innovative approach to measuring a country's import restriction protectionism (HM) by the difference between her net export ability (NX) and her revealed symmetric comparative advantage in import (RM), which is the deduction of Ricardian theory of comparative advantage under the condition of perfect free trade. (Ricardo, 2015; Salvatore, 2013)

The econometric (time series) analyses based on the vector error correction (VEC) models revealed that the Chinese import restriction policy can increase the country's comparative advantage in the export of anti-biotic products, which is in accordance with the protectionist theory of "dynamic comparative advantage".

There is another protectionist policy intervention in the form of import promotion. This research also reckons the "import promotion" as trade protectionist policy intervention, because a government may adopt the trade policies in this form for various reasons. This may be true for the Chinese trade in energy products because China has been a country with booming domestic energy demand in her fast economic development during the past decades, which may have encouraged the Chinese government to promote the energy import instead of restricting it.

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2 METHODOLOGIES AND DATA

2.1 Data Curation

This research obtained the 4-digit import and export yearly data for China and the world in the anti-biotic products (code: 5413) (Chen, 2020) on March 14th, 2021, for the period of 1987-2019, under the classification of SITC Rev.1 from United Nation Comtrade database (https://comtrade.un.org/data/). Some countries' postponed data reporting to UN Statistics Division makes the data for the recent years only partially available (Balassa, 1965; Dalum, 1998). Note that the later accession to the database may generate slightly different data that may have impacts on the results.

2.2 The Indicators for The Import Patterns

- Net export ratio

The indicator of net export ratio (*NX*) measures a county's trade balance in the total trade by

$$NX_{ck} = (X_{ck} - M_{ck}) / (X_{ck} + M_{ck}) \quad (1)$$

where *X* is the export and *M* is the import. The subscript of c indicate that China, the *k* indicates the anti-biotic product. NX_{ck} ranges from -1 to 1 with a mean value of zero around which NX_{ck} is distributed symmetrically.

- Revealed symmetric comparative advantage

Balassa (1965) originated the indicator of

$$RCA_{ck} = (X_{ck} / X_{wk}) / (X_c / X_w) \quad (2)$$

to capture the comparative advantage that revealed in the trade. X_c is the total export of country c and X_w is for that of the world (Hong, 2018). $RCA_{ck}>1$ implies that country c has comparative advantage in product k, or she is more specialized in product k than the world as a total (Hong, 2010). Dalum, Laursen and Villumsen (1998) noted that RCA_{ck} ranges from zero to X_w/X_c without a definite mean, and designed the indicator of

$$RX_{ck}=RSCA_{ck} = (RCA_{ck} - 1) / (RCA_{ck} + 1) \quad (3)$$

to address the problem of the asymmetric distribution of RCA_{ck} (Shi, 2019). The value range of $RSCA_{ck}$ or "revealed symmetric comparative advantage" is [-1, 1] with a definite mean of zero.

This study used RX_{ck} to emphasize that it is applicable to export, and therefore employed

$$RCAM_{ck} = (M_{ck} / M_{wk}) / (M_c / M_w) \quad (4)$$

$$RM_{ck}=-RSCAM_{ck} = -(RCAM_{ck} - 1) / (RCAM_{ck} + 1) \quad (5)$$

to capture the "revealed symmetric comparative advantage" in country c's import. Because the larger RM_{ck} reflects that country c imports more product k than the world average, country c is comparative disadvantaged. Noting this fact, this research added a negative sign at the right side of the equals sign in order to ensure that RM_{ck} means the same with RX_{ck}.

- The degree of import policy intervention

Under the ideally perfect free trade condition, there is

$$NX_{ck} = RM_{ck} \quad (6)$$

A transposition of this equilibrium generates

$$HM_{ck} = NX_{ck} - RM_{ck} \quad (7)$$

where HM_{ck} is the indicator of country c's degree of protectionist import policy intervention which can be understood as the Chinese import restriction (Pang, 2010).

3 RESULTS AND DISCUSSION

3.1 The Import Patterns of the Anti-Biotic Product

Figure 1 depicts the Chinese indicators of NX_{ck}, RX_{ck} and HM_{ck} during the sample period of 1987 to 2019.

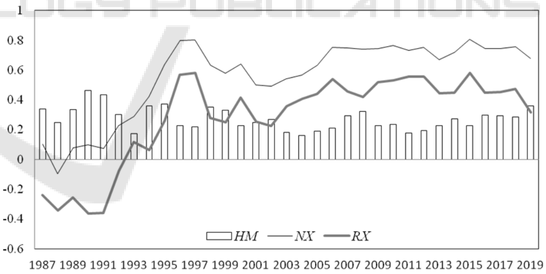

Figure 1: NX_{ck}, RX_{ck} and HM_{ck} in the Chinese trade in anti-biotic product (1987-2019).

NX_{ck} has been positive but for 1988 when the it was -0.096. It hit 0.807 in 2015 and the mean is 0.557; RX_{ck} was -0.365 in 1990 and reached the high of 0.583 in 1997 with the mean of 0.283; HM_{ck} has been always positive, implying that China have adopted the import restriction policies in the anti-biotic product in order to support the Chinese anti-biotic industry.

Table 1: ADF unit root test results for RXck,t and HMck (ln(RXck +1) and ln(HMck +1)).

Variable	Test type	ADF	p-value	Variable	Test type	ADF	p-value
RX_{ck}	C, N, 3	-3.98	0.00	ΔRX_{ck}	C, N, 1	-5.41	0.00
HM_{ck}	C, N, 0	-3.36	0.02	ΔHM_{ck}	N, N, 1	-8.14	0.00
$\ln(RX_{ck}+1)$	C, N, 1	-5.94	0.00	$\Delta\ln(RX_{ck}+1)$	N, N, 1	-4.80	0.00
$\ln(HM_{ck}+1)$	C, N, 0	-3.38	0.02	$\Delta\ln(HM_{ck}+1)$	N, N, 1	-7.93	0.00

Table 2: Number of co-integration.

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	1	0	0	0
Max-Eig	0	0	0	0	0

a. Critical values based on MacKinnon-Haug-Michelis

Table 3: VEC model specification results.

Information Criteria	Model 1	Model 2	Model 3	Model 4	Model 5
Determinant resid covariance (dof adj.)	0.000	0.000*	0.000	0.000	0.000
Determinant resid covariance	0.000	0.000	0.000	0.000	0.000*
Log likelihood	91.372*	93.926	94.023	94.680	96.072
Akaike information criterion	-5.291	-5.395*	-5.335	-5.312	-5.338
Schwarz criterion	-4.731	-4.788*	-4.681	-4.611	-4.591

b. * indicates the model assumption selected by each individual information criterion.

3.2 ADF Unit Root Test Results

Table 1 presents the Augmented Dicky-Fuller (ADF) test results for RX_{ck} and HM_{ck}. Because the relationship of the variables can also be non-linear and the level series of RX_{ck} and HM_{ck} recorded have negative values, the results of $\ln(RX_{ck}+1)$ and $\ln(HM_{ck}+1)$ are also reported. (Shi, 2019; Hong, 2020).

All series are stationary under both linear and non-linear model assumptions. The first differences, however, are also stationary (p=0.001), making the time series are applicable for the econometric analyses based on the VEC models.

3.3 Selection of The Linea/Non-Linear Model Assumptions

This research compared the lag interval of unrestricted vector auto regression (VAR) models with the maximum lag of 6, which is approximately one fifth of the total sample period (32 years), between the linear and the non-linear VAR model assumptions. For both linear and non-linear model assumptions, all of the information criteria of FPE, AIC, SC and HQ selected lag order of 3 as the optimal. The non-linear models have smaller information criteria, making us select the non-linear models with the lag interval of 1-3, which implies that the optimal VEC models are non-linear with the lag interval of 1-2.

3.4 Summary of Johansen Co-Integration

Table 2 summarizes the five sets of co-integration test types with the critical value set to be 0.05 level.

Trace statistic identified one co-integrating relation, while Max-eigenvalue identified none. This may be because the omission of some key variable(s) in the model, which can be expected to be improved by extending the model to include the indicator of the "export policy intervention". This research, however, reckoned that $\ln(RX_{ck,t}+1)$ and $\ln(HM_{ck,t}+1)$ are co-integrated and then proceeded to further analyses.

3.5 VEC Model Specification Results

Model 1 in Table 3 assumes "no intercept or deterministic trend in CE (co-integrating equation)"; model 2 assumes "intercept (no deterministic trend)

Table 4: Short-run Granger causality test results for ln(RXck,t +1) and ln(HMck,t +1).

Independent \ Dependent	$\Delta\ln(RX_{ck,t}+1)$			$\Delta\ln(HM_{ck,t}+1)$		
	Chi-sq	p	SE	Chi-sq	p	SE
$\Delta\ln(RX_{ck,t-1}+1)$, $\Delta\ln(RX_{ck,t-2}+1)$	——	——	——	2.646	0.266	——
$\Delta\ln(HM_{ck,t-1}+1)$, $\Delta\ln(HM_{ck,t-2}+1)$	6.850	0.033	1.900	——	——	——

Table 5: Long-run Granger causality test results for ln(RXck,t +1) and ln(HMck,t +1).

Independent \ Dependent	$\Delta\ln(RX_{ck,t}+1)$			$\Delta\ln(HM_{ck,t}+1)$		
	F-stat	p	LE	F-stat	p	LE
ECT_{t-1}	1.604	0.217	——	0.548	0.466	——
ECT_{t-1},$\Delta\ln(RX_{ck,t-1}+1)$, $\Delta\ln(RX_{ck,t-2}+1)$	1.251	0.313	——	0.967	0.111	——
ECT_{t-1},$\Delta\ln(HM_{ck,t-1}+1)$, $\Delta\ln(HM_{ck,t-2}+1)$	2.719	0.066	0.020	2.531	0.080	-0.105

in CE"; model 3 assumes "intercept (no deterministic trend) in CE"; model 4 assumes "intercept and trend in CE"; model 5 assumes "quadralic deterministic trend", compares the information criteria for the non-linear VEC models with the lag interval of 1-2.

The statistics of both "Akaike information criterion" (AIC) and "Schwarz criterion" (SC) selected "model 2" as the optimal, and the statistics of "determinant residual covariance (dof adj.)" also confirmed this selection. This research thus determine "model 2" or "intercept in CE, no deterministic time trend in the VAR" to be the optimal.

3.6 Short-Run Granger Causality Test Results

Table 4 reports the results of short-run Granger causality tests or the block exogeneity Wald tests. Along with the direction, this research also reports the specific value(s) for the short-run effect(s) (SE) by aggregating the coefficients of all lags of the independent variable(s).

There is a unidirectional Granger causality running from $\ln(HM_{ck,t}+1)$ to $\ln(RX_{ck,t}+1)$ significantly (p=0.033) with positive short-run effect (SE=1.900), implying that the import restriction can improve the Chinese comparative advantage. At least in the short-run, the prediction of the theories of dynamic comparative advantage holds for the trade in anti-biot product.

3.7 Long-Run Granger Causality Test Results

Table 5 shows the long-run Granger causality test results.

The long-run effect(s) (LE) are measured by the converge values (at the 25th period) of the generalized impulse-response functions after the shock. The long-run equilibrium error correction term (ECT_{t-1}) of the VEC models does not Granger cause either $\Delta\ln(RX_{ck,t}+1)$ or $\Delta\ln(HM_{ck,t}+1)$. The lags of $\Delta\ln(HM_{ck,t}+1)$ jointly with ECT_{t-1}, however, Granger cause $\Delta\ln(RX_{ck,t}+1)$ with positive long-run effect (LE=0.020, p=0.066) and Granger cause $\Delta\ln(HM_{ck,t}+1)$ with negative long-run effect (LE=-0.105, p=0.080).

The evidence show that in the long-run, the Chinese trade in the anti-biot products has also complied to the predictions of the dynamic comparative advantage theories. The Chinese import policy intervention policy has been effective in improving the export comparative advantage in the anti-biot product, although marginally significant. Not surprisingly, the evidence from China differ to the results for the Indian protectionism policies in the anti-biotic industry (Hong, 2019). This implies that even the same industry (product) of the two comparable developing countries can be different.

4 CONCLUSION

This study obtained the trade patterns of NX_{ck}, RX_{ck} and HM_{ck} for the Chinese trade in the anti-biotic pharmaceutical products using UN Comtrade annual data. We conducted time series analyses of "revealed symmetric comparative advantage for export" (RX_{ck}) and "import restriction" (HM_{ck}), including both short-run and long-run Granger causality tests.

- During the sample period of 1987-2019, China has restricted the import of the anti-biot product significantly and has had comparative advantage in the product export;

• The Chinese import restriction (HM_{ck}) improves the comparative advantage in the anti-biotic product (RX_{ck}) with positive short-run and long-run effect.

• The lags of HM_{ck} have negative long-run effect on of HM_{ck}, implying that the Chinese trade policy intervention has not been inertial.

The empirical evidence is in accordance with the predictions of the dynamic comparative advantage theories. (Ma, 2019; Yang, 2020; Hong, 2021) The short-run and long-run effects of the import interventions have improved the comparative advantage of the anti-biotic industry.

Every country has right to choose its own path to the development. A developing country's protectionist policy intervention should not be criticized so much, as long as it can improve the country's comparative advantage in a certain specific industry that is crucial for its development.

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