Does the Export Promotion Improve the Chinese Comparative Advantage in the Energy Products?

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Abstract: This research employed the Chinese and the world trade data in energy products during the period of 1985-2019 to obtain of the weighted index of trade competitiveness (TC) and the indicators symmetric comparative advantage for Chinese export in the energy products (RX), and then used the differences between TC and RX to capture China's export promotion in energy products (HX). After preliminary analyses on the time paths of the indicators, this study made econometric modeling on RX and HX to empirically examine the short-run and the long-run Granger causal relationship across the two time series. We concluded that 1) China has adopted export promotion in her energy products; 2) in the short-run, there is no Granger causal relationship of any direction between the export promotion and the comparative advantage in Chinese energy export; 3) the long-run equilibrium relationship Granger cause both RX and HX, while there is no evidence that export promotion Granger causes the Chinese comparative advantage in the energy products in the long-run. This study documented that the Chinese export policy intervention has maintained continuity, and the short-run and long-run effects have been much different from the protectionist predictions of comparative advantage improving.

1 INTRODUCTION

The controversies between protectionist theories and the free trade theories have lasted for centuries. Trade protectionist theories represented by the mercantilism have argued that government should adopt import restriction or export promotion policies to ensure the trade surplus and the inflow of gold and silver, which is a nation's real wealth that can make the country stronger. Trade policy interventions have been also advocated by List (1841) (List, 2011), the dynamic comparative advantage theories (Grossman, 1991) and Keynesian economics (Keynes, 1997).

Adam Smith proposed the free trade theory of "absolute advantage" and called for rebellion against the mercantilist policy interventions (Smith, 1998). David Ricardo developed the free trade theory by elaborating the "comparative advantage" or the "comparative cost". As long as there are differences in the production costs, every country, even a country with the "absolute disadvantage" in any product, may obtain "trade benefits" in the international specialization and trade if she defers to the principles of comparative advantage (Ricardo, 2015). To the free trade theorists, government interventions in both export promotion and import restriction are protectionism (Salvatore, 2013), which the school of free trade has been fighting against.

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.

2 METHODOLOGIES AND DATA

2.1 Data Acuration

This research obtained the 3-digit import and export annual data for the world in the energy products on

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September 31st, 2020, for the period of 1985-2019, under the classification of SITC Rev.1 from United Nation Comtrade database (available from: https://comtrade.un.org/data/). There are six 3-digit energy products involved which includes "coal, coke and briquettes" (code 321), "petroleum, crude and partly refined" (code 331), "petroleum products" (code 332), "gas, natural and manufactured" (341), "electric current" (code 351) and "mineral tar" (code 521) (Chen, 2020). Some countries' delayed data reporting to UN Statistics Division makes the data for 2019 and for the recent years only partially available. As a result, later accession may generate slightly different data.

2.2 Indicators for the Trade Patterns

This study employed the indicators of "trade competitiveness" (TC) and then used the indicator of export promotion (HX) which is derived from TC and the indicators of "revealed symmetric comparative advantage for export" (RX), to examine the Chinese trade patterns in energy export.

- Trade Competitiveness. The indicator is a county's trade balance in proportion to the total import and export value in product k:

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

where X stands for export value and M is for the value of import. The subscript of c indicate that the reporting country is China and the subscript of k represents each specific 3-digit energy product. The value range of TC_{ck} is [-1, 1] with a mean of zero.

- Revealed comparative advantage. Balassa (1965) designed the indicator to measure one comparative advantage that revealed in the trade of product k (Balassa, 1965).

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

where X_c is the total trade value of country c and the subscript of w is for the world. The indicator of RCA_{ck} compares product k's share in country c to that in the world total export (X_w). RCA_{ck} ranges from 0 to X_w/X_c without a certain upper bound and a certain mean, preventing the comparing across different countries, products and other indicators of trade patterns.

- Revealed symmetric comparative advantage. Dalum, Laursen and Villumsen (1998) proposed the indicator of "revealed symmetric comparative advantage" (RSCA) to address RCA's problems of uncertain value range and definite mean (Dalum, 1998) by

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

which has the range of [-1, 1] with a mean of zero, being identical to that of TC_{ck} (Hong, 2018; Hong, 2010; Shi, 2019). This study added X to indicate the "revealed symmetric comparative advantage" is for the energy export.

- Policy intervention in export. In Ricardian comparative advantage theory, a country should specialize in and export the products in which she has comparative advantage, and import the products in which the country is dis-comparative advantaged. The higher degree of comparative advantage in product k implies country c's more export in the product and vice versa. Under perfect free trade environment where there is no any government policy intervention, the equilibrium of

$$TC_{ck}=RX_{ck} \quad (4)$$

must hold. This deduction facilitates the measuring of policy intervention in the trade by

$$HX_{ck}=TC_{ck} - RX_{ck} \quad (5)$$

where HX_{ck} is country c's policy intervention in product k's export with the value range of [-2, 2]. $HX_{ck}>0$ implies that country c promotes the export in product k, making the indicator of TC_{ck} higher than the export comparative advantage; $HX_{ck}<0$ means export restriction (Pang, 2010).

- Weighting approaches. Because there are six 3-digit specific energy products, weighting is necessary to obtain the indicators of the trade patterns for the product category j. We used the proportion of country c in the world total export value of product k, or

$$w_1=X_{ck} / X_{wk} \quad (6)$$

to weight RX_{ck} because only export is involved here. The weight for the HX_{ck} is

$$w_2=(X_{ck} + M_{ck}) / (X_{wk} + M_{wk}) \quad (7)$$

because both the export and the import are necessary to obtain the indicator of HX_{cj}.

2.3 Econometric Analyses

Different approaches should be employed according to the generating process of the time series of RX_{ck} and HX_{ck} in order to avoid any conjecture. This research performed augmented Dicky-Fuller (ADF) unit root tests to examine the stationarity of the time series; we employed the least information criteria of the vector auto-regression (VAR) models to select between the linear or non-linear model assumptions as well as the VAR lag interval; this research made vector error correction (VEC) models select the optimal VEC specification and therefore performed Johansen co-integration test; this research finally conducted short-run and long-run Granger causality tests with specific short-run and long-run effects reported along with the directions of Granger causal relationship.

- Augmented Dicky-Fuller (ADF) unit root tests. OLS using non-stationary time series may cause the problem of spurious regression. This research conducted ADF unit root tests to determine the further econometric approaches. The test types of exogenous assumptions are as follows: 1) "constant and linear trend"; 2) "constant"; and 3) "none" according to the principle of decreasing restriction conditions. The maximum lags are automatically selected by Schwarz information criterion. The test proceeded until the ADF statistic is significant at 0.05 level. If none of the tests for the level series satisfy this condition, the study took first differences of the series and repeated the above mentioned procedures. Because the relationship across the variables may be non-linear, this study took natural logarithms on the time series plus one to avoid taking logarithms on negative values (Ma, 2020).
- Fundamental modelling. This research assumed that when the relationship across the time series is linear, the fundamental model or the co-integrating equation is

$$RX_{cj,t} = a_0 + a_1 HX_{cj,t} + a_2 T + u \quad (8)$$

where a_0 is the constant, a_1 and a_2 are the coefficients to be estimated, T is a deterministic time trend, and u is the disturbing error. When the relationship is non-linear, the model is assumed to be

$$\ln(RX_{cj,t} + 1) = b_0 + b_1 \ln(HX_{cj,t} + 1) + b_2 T + v \quad (9)$$

where b_0 is the constant, b_1 and b_2 are the coefficients to be estimated and v is the disturbing error. The specific co-integrating equation was determined by Johansen co-integration tests.

- Selection for the linear or non-linear assumptions. This research made linear and non-linear VAR models and selected the VAR lag interval 1 to "L" by the information criteria of FPE (Final prediction error), AIC (Akaike information criterion), SC (Schwarz information criterion) and HQ (Hannan-Quinn information criterion). The criteria for linear and non-linear assumptions are compared at the same time to select the optimal model assumption.
- Specification for the vector error correction (VEC) models and Johansen co-integration tests. This study made VEC models and summarized Johansen co-integration test results of all the possible five specifications with the optimal VEC lag interval of 1 to L-1, and selected the optimal VEC specification by the five information criteria of FPE, AIC, SC and HQ.
- Short-run Granger causality tests. Granger (1963) assumed that the cause precedes the effect and the future does not cause the past. This study employed block exogeneity Wald tests based on the optimal VEC models to examine the short-run Granger causal causality between RX_{cj} and HX_{cj} if the assumption is linear, and between $\ln(RX_{cj,t}+1)$ and $\ln(HX_{cj,t}+1)$ if it is non-linear. The specific values for short-run effect(s) were measured by aggregating the coefficients of the corresponding VAR lags.
- Long-run Granger causality tests. This study used Wald F tests to explore long-run Granger causality for the error correction term of VEC models as well as the individual independent variables. The specific value(s) of the long-run effect of the separate independent series upon the dependent series is (are) captured by the convergence value(s) of the corresponding generalized impulse-response functions if the Granger causality is statistically significant (Hong, 2014).

3 RESULTS

3.1 ADF Unit Root Test Results

Table 1 reports the results for ADF unit root tests. Only the time series of RX_{cj} has a unit root, while the first differences of all series are stationary. This facts imply that we can make VEC models for further econometric analyses.

Table 1: ADF unit test results.

Variable	Test type	ADF	Prob.	Variable	Test type	ADF	Prob.
$RX_{cj,t}$	NN0	-0.383	0.539	$\Delta RX_{cj,t}$	NN0	-5.562	0.000
$HX_{cj,t}$	NN3	-4.829	0.000	$\Delta HX_{cj,t}$	CN2	-6.427	0.000
$\ln(RX_{cj,t}+1)$	CN7	-3.815	0.031	$\Delta\ln(RX_{cj,t}+1)$	NN0	-5.164	0.000
$\ln(HX_{cj,t}+1)$	NN3	-4.423	0.000	$\Delta\ln(HX_{cj,t}+1)$	CN2	-6.613	0.000

a: "C, T, p" stands for "constant", "trend" and the "lag length".

b. The symbol of "N" is used when there is no a constant or a time trend.

Table 2: Linear/non-linear model selection.

lag	FPE	AIC	SC	HQ
	Linear Model Assumption			
1	NA	0.000	-3.088	-2.993
2	56.215	0.000	-5.051	-4.766*
……				
5	22.750*	1.49e-05*	-5.484*	-4.628
	Non-linear Model Assumption			
1	NA	0.000	-2.317	-2.222
2	59.624	0.000	-4.417	-4.131*
……				
5	22.602*	2.89e-05*	-4.824*	-3.968

a. The maximum VAR lag is 7 that is about one fifth of the sample period.

b. * indicates lag order selected by the criterion.

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	82.685*	82.730	82.760	83.128	84.181
Akaike information criterion	-4.179*	-4.115	-4.051	-4.009	-4.012
Schwarz criterion	-3.245*	-3.135	-3.023	-2.934	-2.891
Number of coefficients	20	21	22	23	24

Model 1 assumes "no intercept or deterministic trend in CE (co-integrating equation)"; model 2 assumes "intercept (no deterministic trend) 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"; * indicates the model assumption selected by each individual information criterion

Table 4: Summary of The Johansen Co-Integration Test Results.

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

3.2 Linear or Non-Linear Model Selection Results

Table 2 provides the results of the VAR lag intervals for linear/non-linear model assumptions.

Both assumptions have the VAR lag interval of 1-5, and the optimal linear VEC lag interval is 1-4.

3.3 VEC Model Specification Results

Table 3 reports the statistics for the information criteria for all the five possible linear VEC models.

Both SC and AIC criterion selected "model 1". Only "determinant resid covariance" selected "model 5" but the "determinant resid covariance (dof adj.)" also selected "model 5". This research determined that "model 1" is the optimal VEC model specification, which has no exogenous variable.

3.4 Johansen Co-Integration Test Results

Table 4 summarizes all 5 sets of assumptions a 0.05 level.

3.5 Short-Run Granger Causality Test Results

Table 5 reports the short-run Granger causality test or block exogeneity Wald test results. No statistically significant Granger causal relationship of any direction was found.

Table 5: Short-Run Granger Causality Test Results

Variable	ΔHX_{cj}			$\Delta RXcj$		
	Chi-sq	Prob.	SE	Chi-sq	Prob.	SE
$\Delta HX_{cj,t}$	——	——	——	3.243	0.519	——
$\Delta RX_{cj,t}$	3.609	0.462	——	——	——	——

Note: In the brackets are the probabilities of Chi-sq statistics of short-run Granger causality tests; SE refers to short-run effect which is (are) provided only when the Chi-sq statistics are statistically significant at 0.1 level.

Table 6: Long-Run Granger Causality Test Results.

Variable	$\Delta HX_{cj,t}$				$\Delta RX_{cj,t}$			
	F-stat	df	Prob.	LE	F-stat	df	Prob.	LE
ECT_{t-1}	6.142	(1, 21)	0.022	——	6.142	(1, 21)	0.022	——
ECT_{t-1}, $\Delta HX_{cj,t-1}$, $\Delta HX_{cj,t-2}$, $\Delta HX_{cj,t-3}$, $\Delta HX_{cj,t-4}$	7.541	(5, 21)	0.000	0.011	1.036	(5, 21)	0.422	——
ECT_{t-1}, $\Delta RX_{cj,t-1}$, $\Delta RX_{cj,t-2}$, $\Delta RX_{cj,t-3}$, $\Delta RX_{cj,t-4}$	2.037	(5, 21)	0.115	——	1.765	(5, 21)	0.164	——

Note: LE refers to long-run effect which is (are) provided only when the F-statistics are statistically significant at 0.1 level.

3.6 Long-Run Granger Causality Test Results

Long-run Granger causality results are reported in Table 6.

The error correction term (ECT_{t-1}) Granger causes ΔHX_{cj} and ΔRX_{cj} significantly (p=0.022). This result, however, can not satisfy the curiosity of how the change in an independent variable has the impact on the dependent variables. Only the lags of $\Delta HX_{cj,t}$ Granger cause ΔHX_{cj} itself significantly (p=0.000) with positive long-run effect (LE=0.011) jointly with the long-run equilibrium relationship (ETC_{t-1}), implying that the Chinese energy export promotion has maintained continuity. This research found no evidence that $\Delta HX_{cj,t}$ or $\Delta RX_{cj,t}$ Granger causes each other in any direction in the long-run.

4 CONCLUSIONS

1) China has had dis-comparative disadvantage in the energy products since the year of 1990.

2) China has deliberately promoted the export in the energy products, which is a form of trade protectionism;

3) The Chinese export promotion effort, however, has not significantly improved the comparative advantage in the energy products in either short-run or long-run;

4) Neither in short-run nor long-run, we found evidence that the Chinese export policy intervention has been Granger caused by her comparative advantage in the energy exports. The trade protectionist predictions do not hold for the Chinese trade in energy products;

5) The Chinese energy export promotion has maintained continuity. An increase in the degree of the export promotion will cause more future policy intervention in the form of export promotion.

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