Testing the Marshall-Lerner Condition and the J-curve Effect on U.S. –China Trade

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We estimate a VECM regressing the ratio of U.S. export to U.S. import from china on U.S. real GDP, China's real GDP, and RREX (dollar-yuan real exchange rate). The real exchange rate variable is found to be negative but insignificant, failing to satisfy the Marshall-Lerner condition and implying that the dollar's depreciation will have no effect on the U.S. trade balance with China in the long run. The variables $\Delta RREX_{t-1}$ and $\Delta RREX_{t-2}$ turn out to be negative and significant, implying that the dollar's depreciation will have a negative effect on U.S. trade balance with China in the short run.

INTRODUCTION

The U.S. has been experiencing a chronic trade deficit with China. As the data in the table below suggests, except for the year 1991, it is having a continuous trade deficit China. Even more concerning is the fact that the deficit has been widening over the years.

U.S. - China Trade (In Millions $)			
Year	**US Export to China**	**US Import from China**	**US Net Export**
1988	5,016.80	3,398.70	1,618.10
1989	5,807.37	4,413.60	1,393.77
1990	4,807.20	5,313.92	-506.72
1991	6,287.10	6,197.97	89.13
1992	7,469.60	8,598.83	-1,129.23
1993	8,767.10	16,976.49	-8,209.39
1994	9,286.90	21,421.38	-12,134.48
1995	11,748.50	24,743.89	-12,995.39
1996	11,977.90	26,730.62	-14,752.72
1997	12,805.40	32,743.93	-19,938.53
1998	12,258.00	38,000.60	-25,742.60
1999	12,943.60	42,003.09	-29,059.49
2000	15,963.70	52,199.84	-36,236.14
2001	19,234.90	54,395.06	-35,160.16
2002	22,052.70	70,063.83	-48,011.13

2003	28,418.50	92,683.72	-64,265.22
2004	34,721.00	125,180.70	-90,459.70
2005	41,836.70	163,348.33	-121,511.63
2006	55,224.00	203,897.94	-148,673.94
2007	65,238.40	233,180.64	-167,942.24
2008	71,457.00	252,786.39	-181,329.39
2009	69,576.00	221,384.35	-151,808.35
2010	91,878.30	283,678.83	-191,800.53
2011	104,121.52	324,856.47	-220,734.95
2012	110,516.62	352,539.59	-242,022.97
2013	121,721.15	369,006.71	-247,285.56
2014	123,675.67	397,099.31	-273,423.64
2015	116,186.26	410,782.82	-294,596.56
2016	115,775.12	389,714.45	-273,939.33
2017	130,369.53	433,744.89	-303,375.36

In addition, the U.S. has often been blaming China for intellectual property right violation and unfair practices in trade, such as currency manipulation and export subsidy to export-oriented industries. Citing these reasons, the Trump administration has recently announced tariffs on some of the Chinese exports to the U.S. These tariffs are in addition to a 25 percent and a 10 percent tariff imposed by the U.S. on import of steel and aluminum respectively from the top 15 steel exporters to the U.S. including China. Raising a tariff on imports or the depreciation of domestic currency has both the short-term and the long-term effect. In the short run, a tariff on imported products or a depreciation of domestic currency raises the domestic price of imported products. But, since it takes time for consumers to adjust their demand to a price rise, a rise in the price of imported products only raises the importing nation's import bill deteriorating its trade balance in the short run. In the long run, however, there are two effects: (a) first, a rise in the price of imports due to a tariff or depreciation of domestic currency forces the domestic consumers to adjust their demand for imports resulting in an improvement in importing country's trade balance and (b) second, the resulting decline in import caused by a tariff or depreciation of domestic currency also lowers the supply of importing country's currency in the exporting countries raising its price in that country. In terms of U.S.-China trade, a tariff by the U.S. on its import from China will lower the supply of U.S. dollar in China raising the dollar's price there. That in turn, will make other Chinese products cheaper to U.S. consumers and all U.S. products more expensive to Chinese consumers. Such a tariff, thus, may result in more U.S. import of other products from China and less overall Chinese import from the U.S. So, the ultimate outcome of an import tariff or a depreciation of domestic currency depends on which one of the two long-term effects dominates. The answer is provided by the Marshall-Lerner condition and the J-curve effect. If the Marshall-Lerner condition is satisfied and the J-curve effect exists on trade between the U.S. and China, then imposing the tariff may lead to a greater Chinese export to the U.S. and, thereby, deteriorating the U.S. trade balance with China due to exchange rate effect, which defeats the very purpose of import tariff. If the two of the long-term effects offset each other out, then the tariff will have no effect whatsoever on U.S. trade balance, thereby, producing a flat J-curve.

Several studies have tested the Marshall-Lerner (M-L) condition and J-curve effect on bilateral and multilateral trade. For example, Turkay (2014) investigates the M-L condition in Turkey using Johansen cointegration test and error correction model on data from 1980 to 2012 and finds the validity of the M-L condition. Similarly, Hinaunye (2013) tests the M-L condition on the data from Namibia and finds that import and export respond significantly to a change in the exchange rate and that the M-L condition does hold for Namibia. A similar study by Wang, et al (2012) that investigates the short-run and long-run effects of exchange rate change on trade balance between China and its trading partners using the panel cointegration and the panel error correction methodologies on the data over the period 2005-2009 finds a support for the M-L condition. Kyophilavong, et al (2013), on the other hand use an ARDL approach and

test the M-L condition in case of Laos on quarterly data over the period 1993-2010. They get a perverse result. A similar study by Set and Har (2014) on the trade between Malaysia and its five main trading partners fails to show the validity of M-L condition in all five pairs of bilateral trade. Similarly, Dong (2017) tests the M-L condition between the U.S. and other countries of G7 on data over 1985-2016 and finds that price elasticities of exports and imports hardly satisfy the M-L condition. Hsing (2010), on the other hand, test the M-L condition on trade between eight selected Asian countries and finds that the M-L condition only holds for India, Korea, Japan, and Pakistan. Similarly, Onafowora (2003) investigates the trade between three ASEAN countries and the U.S. and Japan using the VECM and the generalized impulse response functions approach, and concludes that M-L condition does hold in the long run but with varying degree of J-curve effects in the short run. A similar study by Pandey (2013) empirically verifies the M-L condition on trade between India and other countries.

To our knowledge, the Marshall-Lerner condition and the J-curve effect both have never been tested on the trade between the U.S. and China over the same range of data, which this study will undertake. Section 2 presents the model, section 3 outlines data sources, section 4 details the empirical analyses and findings, and section 5 summarizes the study.

THE MODEL

Let X and M be the U.S. export to and import from China respectively. U.S. net export to China, then, is defined as

$$NX = X - EM$$

Also, let E be the exchange rate of U.S. dollar defined as the number of U.S. dollar required to purchase one unit of Chinese currency (renminbi). Differentiating the above identity with respect to E yields,

$$\frac{\partial NX}{\partial E} = \frac{\partial X}{\partial E} - E\frac{\partial M}{\partial E} - M\frac{\partial E}{\partial E} \text{ or}$$

Multiplying both sides of above equation by $\frac{E}{X}$ yields,

$$\frac{\partial NX}{\partial E}\frac{E}{X} = \frac{\partial X}{\partial E}\frac{E}{X} - E\frac{\partial M}{\partial E}\frac{E}{X} - M\frac{\partial E}{\partial E}\frac{E}{X}$$

When trade between the U.S. and China is balanced, $X = EM$. Applying this condition to above equation yields,

$$\frac{\partial NX}{\partial E}\frac{E}{X} = \frac{\partial X}{\partial E}\frac{E}{X} - E\frac{\partial M}{\partial E}\frac{E}{EM} - M\frac{\partial E}{\partial E}\frac{E}{EM} \text{ or}$$
$$\frac{\partial NX}{\partial E}\frac{E}{X} = \frac{\partial X}{\partial E}\frac{E}{X} - \frac{\partial M}{\partial E}\frac{E}{M} - 1$$

For a depreciation of U.S. dollar to increase U.S. net export, the left-hand side term of the above equation must be positive, which implies the right-hand side term must also be positive, that is,

$$\frac{\partial X}{\partial E}\frac{E}{X} - \frac{\partial M}{\partial E}\frac{E}{M} - 1 > 0$$

The first two terms on the left-hand side of above inequality are exchange rate elasticity of U.S. export and import and denoted by $\eta_{X_E} and\ \eta_{M_E}$ respectively. That is,

$\eta_{X_E} - \eta_{M_E} - 1 > 0$

Since exchange rate elasticity of import is negative, the above condition implies that

$$\eta_{X_E} + |\eta_{M_E}| - 1 > 0 \text{ or}$$
$$\eta_{X_E} + |\eta_{M_E}| > 1 \quad (1)$$

That is, for an increase in renminbi's exchange rate (i.e. a depreciation of U.S. dollar) to increase a U.S. net export to China, the sum of the absolute value of the exchange rate elasticity of U.S. export and import must be greater than one.

The Marshall-Lerner condition shown in inequality (1) can be tested using the following model.

$$\mathrm{XTM_t} = \beta_0 + \beta_1 \mathrm{URGDP_t} + \beta_2 \mathrm{CRGDP_t} + \beta_3 \mathrm{REX_t} + \mathrm{u_t} \quad (2)$$

Where, XTM is the ratio of U.S. export to China to U.S. import from China, URGDP is U.S. real GDP, CRGDP is China's real GDP, and REX is renminbi's exchange rate defined as the number of U.S. dollar needed to purchase one renminbi. Thus, β_3 in equation (2) is the Marshall-Lerner condition specified in inequality (1). That is,

$$|\beta_3| = \eta_{X_E} + |\eta_{M_E}| > 1$$
$$If |\beta_3| > 1, the\ Marshall - Lerner\ condition\ is\ satisfied.$$

This implies that an increase in renminbi's exchange rate (i.e. depreciation of U.S. dollar) will raise U.S. export to China and lower U.S. import from China improving the U.S. trade balance (i.e. X/M) with China.. So, the sign of β_3 is expected to be positive. The sign of β_1 is expected to be negative, because increase in U.S. real GDP is likely to increase U.S. import including that from China lowering thereby the U.S. trade balance with China. On the other hand, the sign of β_2 is generally expected to be positive, because increase in China's real GDP is likely to increase China's imports including that from the U.S., thereby, raising U.S. export to China improving, in turn, U.S. trade balance with China.

DATA

We obtained data on U.S. export to and import from China from International Monetary Fund website (http://data.imf.org/regular.aspx?key=61726508), on U.S. and China's real GDP from World Development Indicators, 2017, and on average annual exchange rate between U.S. dollar and Chinese renminbi from OANDA website (https://www.oanda.com/currency/average). Our data on the variables range from 1992 to 2016.

METHODOLOGY AND EMPIRICAL FINDINGS

Since all model variables are found to be nonstationary at their levels but stationary at their first-differenced values, we conducted the Johansen cointegration test to see if these variables are tied with each other in a long-run relationship. The results of the test are shown below:

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		**Trace**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.786978	6.37E+01	47.85613	0.0008
At most 1	0.527192	28.15987	29.79707	0.0763
At most 2	3.50E-01	1.09E+01	1.55E+01	0.2157
At most 3	**0.044029**	**1.035639**	**3.841466**	**0.3088**
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				

As shown in the above table the trace statistics (63.7) for no existence of any cointegrating vector is greater than the 5% critical value (47.85613) rejecting the null hypothesis of no cointegration.

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		**Max-Eigen**	**0.05**	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	**0.786978**	**35.5663**	**27.58434**	**0.0038**
At most 1	0.527192	17.22851	21.13162	0.1615
At most 2	0.349653	9.895721	14.2646	0.2189
At most 3	0.044029	1.035639	3.841466	0.3088
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				

The existence of at least one cointegrating vector is also supported by the Maximum Eigenvalue test shown above, as the Max-Eigen statistic of 35.5663, against the hypothesis of no cointegration, is higher than its 5% critical value of 27.58434. This finding implies that there does exist at least one cointegrating vector among the model variables and allows us to run a vector error correction model (VECM). Based on the VECM estimation our long-run and short-run equations can be written as:

Long-Run Equation:

$$\begin{array}{l} XTM_t = \mathit{1.143407} - \mathit{5.36E^{-14}}URGDP_t - \mathit{1.64E^{-14}}CRGDP_t - 0.1135RREX_t \\ \text{t-value} = \qquad\qquad (-4.37501) \qquad\quad (-0.41895) \qquad\quad (-0.3651) \end{array} \tag{2}$$

Short-Run Equation:

$$\begin{array}{l} \Delta XTM_t = -\mathit{0.220561} + 0.720806\Delta XTM_{t-1} + \mathit{0.261538}\Delta XTM_{t-2} + \mathit{4.22E^{-14}}\Delta URGDP_{t-1} \\ \qquad\qquad\qquad\qquad\quad (2.25622) \qquad\quad (1.09897) \qquad\quad (1.10056) \\ \quad + \mathit{1.27E^{-14}}\Delta URGDP_{t-2} + \mathit{1.87E^{-13}}\Delta CRGDP_{t-1} + 4.57\mathit{E^{-13}}\Delta CRGDP_{t-2} - 5.384354\Delta RREX_{t-1} \\ \qquad\quad (0.39802) \qquad\quad (1.31425) \qquad\quad (2.53645) \qquad\quad (-2.20071) \\ \quad -3.231418\Delta RREX_{t-2} \\ \qquad (-1.88559) \end{array} \tag{3}$$

The corresponding t-values are given in parentheses. In the long run equation, the coefficient associated with the variable $RREX_t$ is negative but insignificant, implying that any depreciation of the U.S. dollar will not affect the U.S. trade balance with China in the long run, which is not as expected. This finding also indicates that the Marshall-Lerner condition is not satisfied in trade between the U.S. and China. In the short-run equation, on the other hand, the coefficients associated with the variables $\Delta RREX_{t-1}$ and $\Delta RREX_{t-2}$ are negative and significant at 5% and 10% level respectively, which implies that a depreciation (appreciation) of the U.S. dollar will have negative (positive) effect on U.S. trade balance with China in the short run. This finding indicates that a depreciation (appreciation) of the U.S. dollar will deteriorate (improve) U.S. trade balance with China in the short run but will have no effect in the long run producing a flat J-curve effect. In order to verify the above result through impulse responses, we plotted impulse response functions between pairs of model variables. The output is shown in the appendix. The curve representing the response of XTM to RREX slops downward until period 4 and becomes flat thereafter supporting our result from the VECM estimation. This result also implies that a possible appreciation of U.S. dollar against renminbi resulting from U.S. tariff on import from China will improve U.S. trade balance with China in the short run, but will have no effect on the U.S. trade balance in the long run.

SUMMARY AND CONCLUSTIONS

As the data presented in this paper shows the U.S. has been experiencing a chronic trade deficit with China since 1992, which has been widening up until 2017. In addition, the U.S. has often been blaming China for intellectual property right violation and unfair practices in trade. Citing these reasons, the Trump administration has recently announced tariffs on some of the Chinese exports to the U.S. in addition to a 25 percent and a 10 percent tariff imposed by the U.S. on import of steel and aluminum respectively from several countries including that from China. Raising a tariff on imports or the depreciation of domestic currency has both the short-term and the long-term effect. In the short run, it raises the domestic price of imported products. But, since it takes time for consumers to adjust their demand to a price rise, a rise in the price of imported products only raises the importing nation's import bill deteriorating its trade balance in the short run. In the long run, however, there are two effects: (a) first, a rise in the price of imports due to a tariff forces the domestic consumers to adjust their demand for imports resulting in an improvement in importing country's trade balance and (b) secondly, resulting decline in import caused by a tariff also lowers the supply of importing country's currency in the exporting country raising its price in that country. Thus, a tariff by the U.S. on its import from China will lower the supply of U.S. dollar in China raising the dollar's price in China. That in turn, will make other Chinese products cheaper to U.S. consumers and all U.S. products more expensive to Chinese consumers. Such a tariff, thus, may result in more U.S. import of products other than steel and aluminum from China and less overall Chinese import from the U.S. So, the ultimate outcome of an import tariff depends on which of the two long-term effects dominates. The answer is provided by the Marshall-Lerner condition and the J-curve effect. If the Marshall-Lerner condition is satisfied and the J-curve effect exists on trade between the U.S. and China, then imposing the tariff may lead to a greater Chinese export to the U.S. and, thereby, deteriorating the U.S. trade balance with China due to exchange rate effect, which defeats the very purpose of import tariff. If the two of the long-term effects offset each other out, then the tariff will have no effect whatsoever on U.S. trade balance, thereby, producing a flat J-curve.

In this study, we test both the Marshall-Lerner condition and the J-curve effect on U.S.-China trade data over the years 1992-2017. We estimate a vector error correction model with XTM (ratio of U.S. export to China to U.S. import from china) as the dependent variable and URGDP (U.S. real GDP), CRGDP (China's real GDP), and REX (real exchange rate of renminbi defined as the number of U.S. dollar needed to purchase one renminbi) as independent variables. In the long run equation, the coefficient associated with the variable $RREX_t$ is negative but insignificant, implying that any depreciation of the U.S. dollar will have no effect on the U.S. trade balance with China in the long run. This finding also indicates that the Marshall-Lerner condition is not satisfied on the trade between the U.S. and China. In the short-run equation, on the other hand, the coefficients associated with the variables $\Delta RREX_{t-1}$ and $\Delta RREX_{t-2}$ are

negative and significant at 5% and 10% level respectively, which implies that the depreciation (appreciation) of the U.S. dollar will have negative (positive) effect on U.S. trade balance with China in the short run. This finding indicates that a depreciation (appreciation) of the U.S. dollar will deteriorate (improve) U.S. trade balance with China in the short run but will have no effect in the long run producing a flat J-curve effect.

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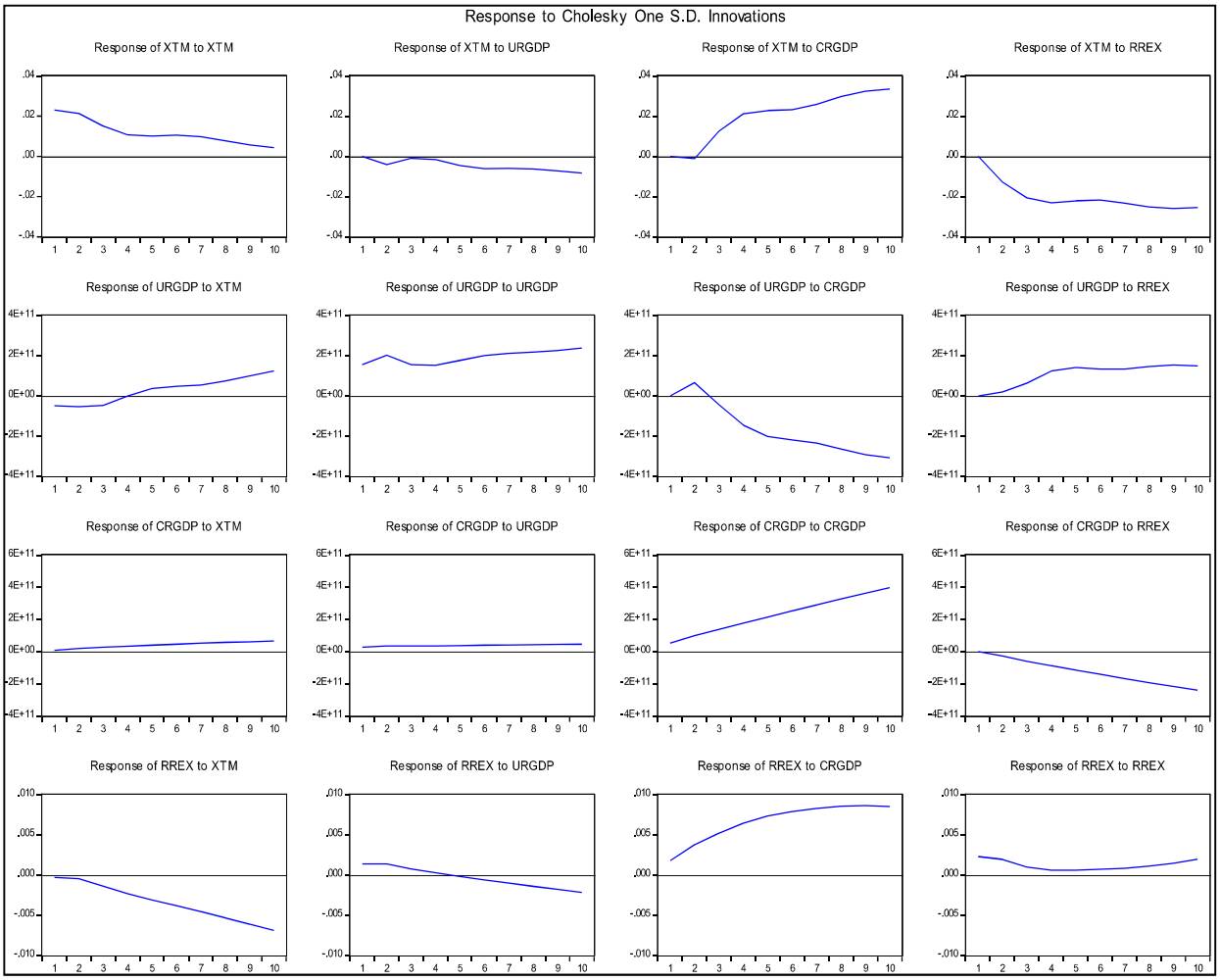
APPENDIX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