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Why You Should Use High Frequency Data to Test the Impact of Exchange Rate on Trade

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Abstract

This study suggests that testing the impact of exchange rate on trade should be done using high frequency data. Using different data frequencies for identical periods and specifications between the US and Canada, we show that low frequency data might suppress and distort the evidence of the impact of exchange rate on trade in the short-run and the long-run.

Keywords:
Data frequency
Exchange rate and trade
J-Curve Theory
ARDL Cointegration
US-Canada trade

JEL Classification: F31, F14, C18

1. Introduction

Among a variety of theories attempting to explain the impact of exchange rate movements on trade balance, J-Curve Theory gained most of the attention. The theory suggests that, as a result of currency depreciation, a country's trade balance follows a J-shaped pattern as it deteriorates in the short run and recovers to a higher level in the long run. The initial deterioration is due to the presumed stickiness of the traded quantities for reasons such as previously signed contracts on the supply side, and habit formation on the demand side. Although this paper tests only the J-Curve Theory, its rationale is still applicable to other theories attempting to test the impact of exchange rate on trade.

Among the hundreds of studies which tested the J-Curve Theory, the most common empirical methodology is a combination of the Autoregressive Distributed Lag (ARDL) approach to cointegration and the Error Correction Model (ECM) (Pesaran et al., 2001). The desirability of this methodology in the literature is largely because it does not require a prior determination of which regression variables are I(0) and which are I(1), as well as the direct and easy inference of short and long run impacts of exchange rate on trade balance.

However, the literature suffers from a key problem, the assumption that data frequency has no role in empirically investigating the relationship between exchange rate and trade. In this paper, we advocate the use of high frequency data when testing the J-Curve Theory - or other theories of similar nature - for four different reasons.

First, while it is true that cointegration is a long-run notion, the short-run impact of exchange rate and error correction on trade is a vital component of the ECM. Low frequency data, such as annual or quarterly, might obscure much of the evidence needed for understanding the short-run dynamics of the relationship as high and low values might average out over the course of one period in low frequency data.

Second, regarding cointegration itself, it is thought by many researchers in the field that using low frequency data is as good as using high frequency data for testing long-run association. As stated by Bahmani-Oskooee (1996), "…using annual data over the 1960-90 period in this paper is as good as using quarterly or monthly data over the same period". However, cointegration tests with low frequency data have lower power. As shown in a Monte Carlo experiment by Zhou (2001), the loss of power applies especially for small samples of less than 50 years (as is the case in most macroeconometric applications) and for models which involve autoregressive terms. In other words, low frequency data might suppress the evidence of true cointegration.

Third, quantities and prices might change after exchange rate movements in a period as short as instantly. Using quarterly or annual data implicitly assumes that short run changes in trade values and quantities take at least three months or a year to take place. Fourth, using annual data for ARDL cointegration increases the likelihood of including I(2) variables owing to the smoothing imposed on the data by the aggregation over time. This may lead to spurious cointegration conclusions.

To address these issues, our paper tests the J-Curve Theory between the US and Canada using the ARDL-ECM approach for two identical periods using monthly, quarterly, and annual data.

The findings confirm that (a) low frequency data might suppress the evidence of cointegration, (b) higher frequency allows better understanding for the short-run dynamics of the relationship, and (c) lower frequency might cause some series to become I(2), which invalidates the ARDL cointegration approach.

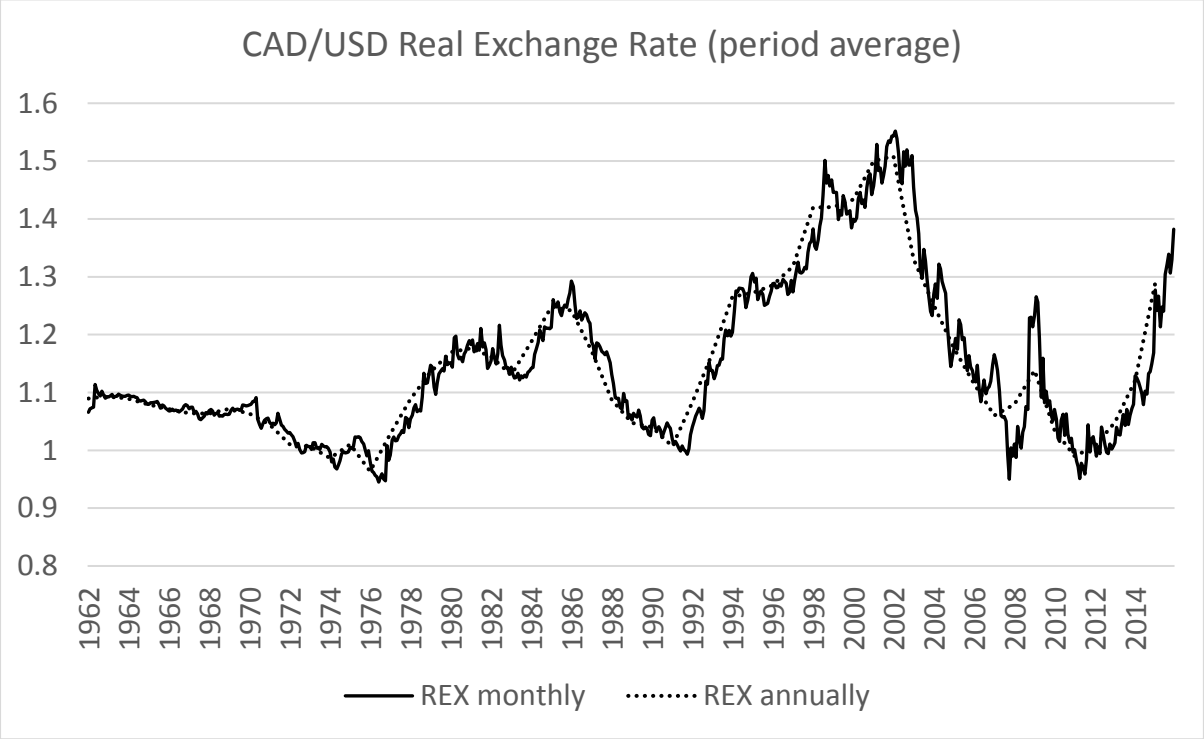
The rest of the paper is organized as follows. Section 2 explains the research methodology, section 3 presents the findings, and section 4 concludes.

2. Methodology

We choose US-Canada bilateral trade relation as an example to investigate the research questions since it continues to be the most significant global trade relation in terms of total merchandise. Additionally, the data quality is perceived to be high (low trade data discrepancy) and are available for a long period.

Since the J-Curve Theory is being tested using real exchange rate (REX), we use the whole available sample of data starting from 1962, rather than since the breakdown of the Gold Standard in early 1970s. As shown in Figure 1, especially during a financial crisis like that around 2008, annual exchange rate obscures some of the information available in monthly data. Seasonality along cannot explain the deviations of monthly data from annual averaged data. Another problem of similar nature might arise from end of period or mid-period sampling of low frequency series.

Figure 1: Annual versus monthly exchange rate (1962-2015)



The model used for investigating the J-Curve Theory is identical to that used in many studies in the field, which is a combination of ARDL cointegration as developed by Pesaran et al. (2001), and the ECM. We select two time periods for the empirical analysis. The first extends along the whole available period of 1962-2015. The second follows Bahmani-Oskooee and Wang (2008) on the same two countries and spans from 1962 to 2004. We use monthly, quarterly, and annual data for the same variables. That is, we investigate six variations of the following model. Two time periods, using three different data frequencies for each.

$$\Delta LnTB_t = \alpha + \sum_{k=1}^{n_1} \emptyset_k \Delta lnTB_{t-k} + \sum_{k=0}^{n_2} \beta_k \Delta lnUSGDP_{t-k} + \sum_{k=0}^{n_3} \gamma_k \Delta lnCGDP_{t-k} + \sum_{k=0}^{n_4} \varphi_k \Delta lnREX_{t-k} + \delta_1 lnTB_{t-1} + \delta_2 lnUSGDP_{t-1} + \delta_3 lnCGDP_{t-1} + \delta_4 lnREX_{t-1} + u_t \quad [1]$$

where TB is trade balance defined as US exports to Canada divided by US imports from Canada. REX is real exchange rate defined as the number of Canadian Dollars per USD adjusted by the price levels in each country as measured by consumer price index. CGDP and USGDP are the GDPs of Canada and US. These two variables are not available on monthly frequency, so we apply repeated quarterly data on these in the monthly regressions since these are used only as controls. All the data are retrieved from IMF-IFS Database. The data are available here.

Besides the first differences, lagged level variables appear in equation 1 to allow test for cointegration. To justify retention of these variables in the model, Pesaran et al. (2001) proposed the use of standard F-test to determine the joint significance of lagged level variables with a new set of critical values. They tabulated the critical values for lower and upper bounds depending on the order of integration of the included variables. If the computed F statistic is larger than the upper-bound tabulated value, the null hypothesis of no cointegration can be rejected. After establishing cointegration, the short-run impacts can be inferred from the coefficients of the differenced variables. Long-run impacts are retrieved using FM-OLS estimation of the cointegration.

3. Findings

Before running our six regressions, we first ensured that all our variables are either I(1) or I(0) using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The variables are all found to be I(1), regardless of the data frequency, using either test. The optimal lag structure for each regression is chosen through Schwarz Information Criterion. The following table summarizes the estimates provided by each regression. For brevity, we report only the short-run estimates of the variable of interest, LnREX.

Table 1: Regression outputs of dependent variable $\Delta LnTB_t$

Period	1962-2015			1962-2004		
Frequency	Monthly	Quarterly	Annually	Monthly	Quarterly	Annually
ARDL (F)	3.95	4.61	4.19	4.2	2.07	3.58
Cointegrated?	Yes	Yes	Yes	Yes	No	No
$\Delta LnRex_t$			0.31(1.49)		-0.19(-1.03)	
$\Delta LnRex_{t-1}$		0.29 (2.37) **				0.24(0.96)
$\Delta LnRex_{t-2}$	0.29 (2.31)**			0.36(1.86)*		
$\Delta Ln\ REX_{t-3}$		0.28(2.22)**				
LnREXt	-0.44 (-6.12)***	-0.27(-2.72)***	-0.42(-3.07)***	-0.55 (-4.78)***	-0.54(-3.44)***	-0.27(-1.14)
LnUSGDP	0.99 (3.84)***	0.18(0.42)	1.17(4.70)***	0.43(0.99)***	0.59(0.91)	-1.27(-4.6)***
LnCGDP	-1.03(-3.9)***	-0.98(-3)***	-1.19(-4.68)***	-1.26(-5.25)***	-1.3(-3.79)***	1.19(4.11)***
Intercept	-0.01(-0.31)	1.06(3.54)***	-0.01(-0.17)	1.07(2.54)***	0.98(1.75)*	0.08(0.66)
Adj. R^2	41%	33%	21%	41%	34%	35%
LM Test	1.8	0.69	1.49	2.79*	1.85	2.32

*,**,*** indicate significance at 10%, 5%, and 1% respectively. Numbers inside parenthesis are t-ratios. Critical ARDL F values are 3.77 and 4.35 at 10% and 5% levels of significance, respectively. LM serial correlation test reported values are F stats of Breusch-Godfrey Test. HAC robust standard errors are applied for hypothesis testing when autocorrelation is present.

The results indicate the presence of the J-Curve phenomenon for all four cointegrated regressions as REX appears to have positive effect in the short run and negative effect in the long run. That is, a depreciation of USD is expected to worsen the US trade balance with Canada in the short-run and improve it in the long-run.

The findings confirm that aggregation over time suppresses the evidence of the long-run effect of exchange rate on trade. This is because no cointegration could be established only using annual or quarterly data for the period 1962-2004. In line with Zhou (2001), the results suggest that lower frequency data might capture the long-run impact of exchange rate on trade only when the period is long enough. The annual sample of 1962-2004 was also used by Bahmani-Oskooee and Wang (2008) for the same trade relation but using sectoral trade data. Thus, it is also likely for them to have not found enough support for cointegration due to aggregation over time. They found support of cointegration for 80 sectors out of 152.

Additionally, for the regressions of 1962-2015, we see that monthly data can better explain the dynamicity of the relationship. It shows that the impact of REX on TB appears after two months, while quarterly and annual results are less accurate and show that the impact kicks in any time within the first quarter, or year, respectively. As reflected in adjusted R^2, we also note that monthly data – by using more information – provides a better fit of the same variables over the same period.

Finally, using low frequency data might also cause a rarely discussed problem, which impacts the application of ARDL cointegration. That is the inclusion of I(2) series. This is particularly problematic for studies in this field as there has been a tendency not to test for unit root at all since ARDL allows for the inclusion of I(0) and I(1) series without prespecifying the order for the test. For instance, Bahmani-Oskooee and Ratha (2004) state that: "The new critical values tabulated by Pesaran et al. (2001) do take into consideration the stationarity properties of the series. For this reason, there is no need for pre-testing of unit roots".

Table 2 selects a particular sample from our study as an example of how aggregation over time might make some series I(2).

Table 2: Unit root test for the variables from 1984-2009 (26 years)

	Order of integration		
Series\frequency	Monthly	Quarterly	Annually
LnRex	I(1)	I(1)	I(2)
LnTB	I(1)	I(1)	I(1)
LnUSGDP	NA	I(1)	I(2)
LnCGDP	NA	I(1)	I(2)

The results are confirmed by ADF as well as PP

It should be noted that many studies tested the impact of exchange rate on trade using annual data for 26 years or shorter.

4. Conclusion

This paper argued that the impact of exchange rate on trade should be investigated using monthly data and showed that using low frequency data might suppress the evidence of a true relationship. It was further shown that using high frequency data allows better understanding of the dynamics of the relationship and reduces the likelihood of using I(2) series.

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