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Do Exchange Rate Changes have Symmetric Effect on the S-Curve?

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Abstract

The S-Curve hypothesis postulates that while the cross-correlation between the current exchange rate and future values of the trade balance could be positive, the same correlation between the current exchange rate and past values of the trade balance could be negative. In this paper we decompose the movement in the real effective exchange rate into partial sums of negative changes (depreciation) and positive changes (appreciation) and try to determine whether exchange rate changes have symmetric or asymmetric effects on the trade balance using the S-Curve concept. Like other areas in the literature we find that the effects are asymmetric in most countries since the S-Curve associated with depreciation does not resemble the one associated with appreciation.

Valuable comments of an ananymous referee are appreciated. However, any error is ours.
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1. Introduction

Under the current floating exchange rate system while a depreciation will improve the trade balance in the future after some adjustment lags are realized, a trade deficit will cause a depreciation, also in the future. Rather than testing these hypotheses via a simultaneous equation system, Backus *et al.* (1994) introduced a unique method known as the "S-Curve". By relying upon cross-correlation concept, they argued that while correlation coefficients between current terms of trade or the exchange rate and future values of the trade balance will be positive, the same correlations between current exchange rate and past values of the trade balance could be negative.[1] Since plotting the cross-correlation coefficients against the number of leads and lags resemble the letter S, they labeled the concept the "S-Curve".

Backus et al. (1994) tested the S-Curve for 11 OECD countries using each country's aggregate trade flows with the rest of the world and provided mixed results. Subsequent studies have tried to test the curve for different set of countries. More precisely, Senhadji (1998) tested the curve for 30 developing countries; Parikh and Shibata (2004) tested it for 14 Asian countries, 25 African countries, and 20 Latin American countries; Bahmani-Oskooee, Kutan, and Ratha (2008) for 10 emerging countries of Bulgaria, Croatia, Cyprus, Czeck Republic, Hungary, Poland, Romania, Russia, Slovak, and Turkey; and Bahmani-Oskooee, Gelan, and Ratha (2008) for 20 African nations. The S-Curve received empirical support in limited cases. For example, in the last study the S-Curve was supported only in eight out of 20 countries.

While the literature on the concept has been extended by using disaggregated trade flows either at total bilateral level between two countries or at commodity level between two countries,

[1] Note that saying that the correlation between current exchange rate and past values of the trade balance could be negative amounts to saying that correlation between current trade balance and future value of the exchange rate is negative. This implies that a trade deficit today causes a depreciation down the road. For more on adjustment lags see Bahmani-Oskooee (1985).

no matter what level of aggregation is used, the findings have been mixed. Some examples of studies which have used aggregate bilateral trade data are Bahmani-Oskooee and Ratha (2007a) who tested the curve between the U.S. and each of her 24 major trading partners and Bahmani-Oskooee and Ratha (2007b) who tested the curve between Japan and her trading partners. Examples of studies which have tested the curve using commodity level data are Bahmani-Oskooee and Ratha (2008) who tested the phenomenon for 52 industries that trade between the U.S. and U.K.; Bahmani-Oskooee and Ratha (2009) who considered the experience of 60 industries which traded between the U.S. and Canada; and Bahmani-Oskooee and Ratha (2010) who studied 100 industries which traded between the U.S. and China. Again, S-Curve was supported in some but not all industries.[2]

Our objective in this paper is to determine if currency depreciation and currency appreciation have symmetric effects on the S-pattern. To that end, we borrow the partial sum terminology from econometrics literature and separate depreciations and appreciations from the exchange rate movement and then test the S-Curve. The results which are country specific reveal that in most countries the effects are asymmetric. In Section II of the paper we introduce the methodology. Section III presents the results with a summary in Section IV.

2. The Method

As mentioned above, the S-Curve is mainly based on calculating the cross-correlation between the trade balance and the real exchange rate. The important point is to define the two variables in a manner that contemporaneous correlation is positive. Since we would like to test our hypothesis using aggregate trade flows, the real exchange rate employed here is the real effective exchange rate denoted by REER. By way of construction, a decline in the real effective

[2] For a review article see Bahmani-Oskooee and Hegerty (2010).

exchange rate implies a depreciation of domestic currency and if a depreciation is to improve the trade balance so that contemporaneous correlation is positive, we define the trade balance as TB = (M – X)/GDP where M is the total imports, X is the total exports, and GDP is Gross Domestic Product, all in nominal terms. Next, we define cross-correlation coefficients between the past and future values of TB and current REER by:

$$\rho_k = \frac{\sum (REER_t - \bar{\bar{REER}})(TB_{t+k} - \bar{TB})}{\sqrt{\sum (REER_t - \bar{\bar{REER}})^2 (TB_{t+k} - \bar{TB})^2}} \qquad (1)$$

where $\bar{REER}$ *and* $\bar{TB}$ are the mean values of the two variables over the sample period. By allowing k to take negative values such as -5, -4, -3, -2, -1 we calculate cross-correlation coefficients between past trade balances and the current real exchange rate and by allowing k to take positive values such as 1, 2, 3, 4, 5, we calculate cross-correlation coefficients between current exchange rate and future trade balances. The S-Curve is produced by plotting ρ_k against k.[3]

Next we decompose the REER into its negative (depreciation) and positive (appreciation) partial sum as: $REER = REER_0 + REER_t^+ + REER_t^-$ where $REER^+_t$ and $REER^-_t$ are partial sum process of positive and negative changes in REER. More precisely:

$$REER_t^+ = \sum_{j=1}^{t} \Delta REER_j^+ = \sum_{j=1}^{t} \max(\Delta REER_j, 0), \quad REER_t^- = \sum_{j=1}^{t} \Delta REER_j^- = \sum_{j=1}^{t} \min(\Delta REER_j, 0) \qquad (2)$$

Given the above definitions, for each country we produce three S-Curves using three definitions

[3] Note that following previous research, all data are de-trended using Hodrich-Prescott (HP) filter.

of the exchange rate, i.e., REER itself, $REER^{+}_{t}$ and $REER^{-}_{t}$. If the two curves associated with partial sums follow the same pattern, effects of appreciation and depreciation are symmetric.[4]

3. The Results

We consider the experiences of the same 11 OECD countries which were studied by Backus et al. (1994) who originally introduced the concept. Quarterly data over the period 1973I-2013II are used to carry out the empirical analysis. As mentioned above, for each country we produce three S-curves. When REER itself is used in (1) to calculate correlation coefficients, the vertical axis of the curve is identified as Corr (tb_t, REER). When $REER^{-}_{t}$ is used in (1), the vertical axis is identified as Corr (tb_t, depreciation)). Finally, when $REER^{+}_{t}$ is used in (1), the vertical axis is identified as Corr (tb_t, appreciation).[5] Figure 1 reports the results.

Figure 1 goes about here

From Figure 1 we gather that the two curves associated with depreciation and appreciation do not look similar in any country, implying that effects of currency depreciation on the trade balance are different than those of appreciation or exchange rate changes have asymmetric effect on the trade balance. Such asymmetric effects are also found by Apergis and Miller (2006) on the effects of U.S. stock market on consumption and by Verheyen (2013) on interest rate pass-through mechanism to deposit rates.

[4] For some other application of partial sum decomposition see also Shin et al (2013).

[5] All data for all countries come from the Federal Reserve Bank of St. Louis: http://research.stlouisfed.org/fred2/ except Japan for which data come from International Financial Statistics of the IMF. Note that the study period for Canada is short by two observations compared to all other countries.

4. Summary and Conclusion

Due to such lags as recognition, production, and delivery, currency depreciation is said to affect the trade balance in the future. Thus, we expect the correlation between current exchange rate and future values of the trade balance to be positive. However, the same correlation between current exchange rate and past values of the trade balance is said to be negative, implying that a current trade deficit causes currency depreciation, also in the future. Since plot of these cross-correlation coefficients against the lags and leads of the trade balance resemble the letter S, the concept is known as the S-Curve due to Backus et al. (1984). Previous authors have tested the S-Curve hypothesis by using aggregate trade data between one country and rest of the world, aggregate trade flows between two countries at bilateral level, and commodity trade data between two trading partners. They have provided mixed results.

In this paper we ask whether exchange rate changes have symmetric or asymmetric effects on the trade balance, hence the S-Curve pattern. By relying on the concept of partial sum, we decompose the movement in the real effective exchange rate into partial sums of negative changes (depreciation) and positive changes (appreciation). We then produce three S-Curves using the trade balance and each of the partial sums as well as the real effective exchange rate itself. We do this for the same 11 OECD countries that were included in Backus et al. (1994). Comparing the patterns we learn that they do not look the same, implying that exchange rate changes have asymmetric effect on the trade balance. We conjecture that these asymmetric effects could originate from different expectations and reactions that traders could have to currency depreciations as compared to appreciations.

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Figure 1: S-Curves

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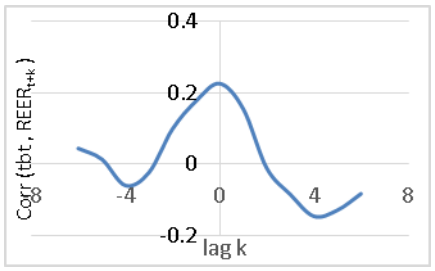

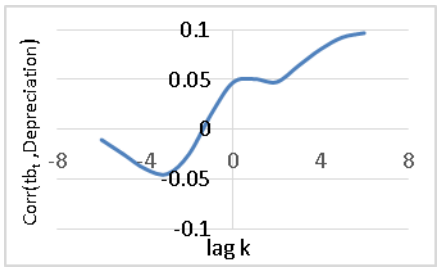

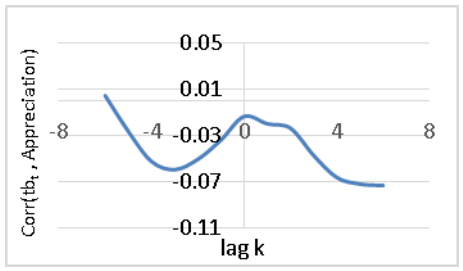

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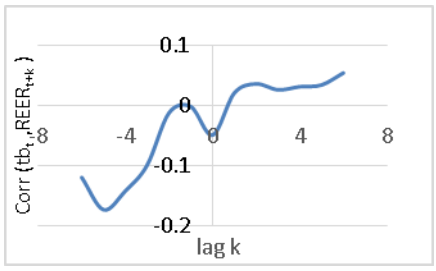

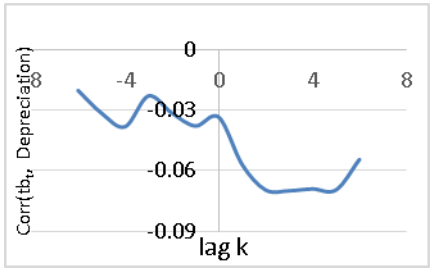

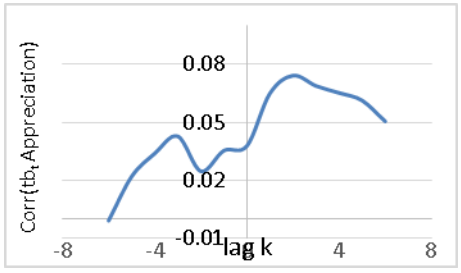

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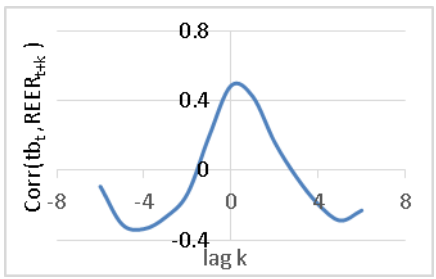

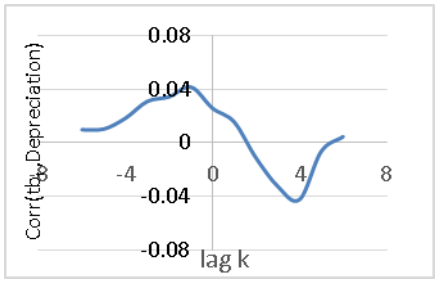

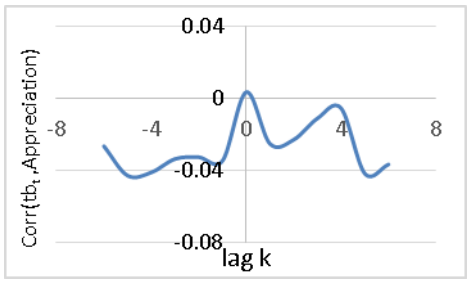

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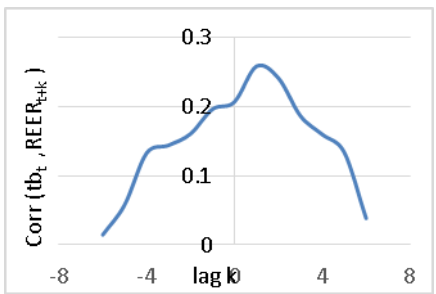

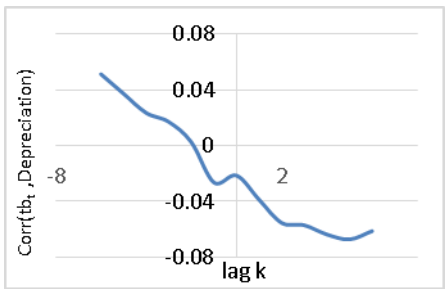

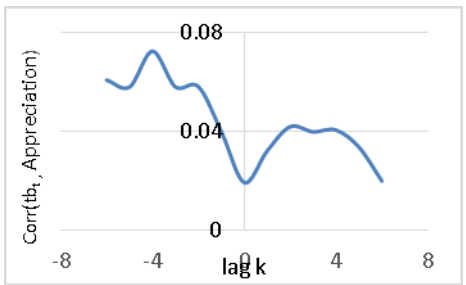

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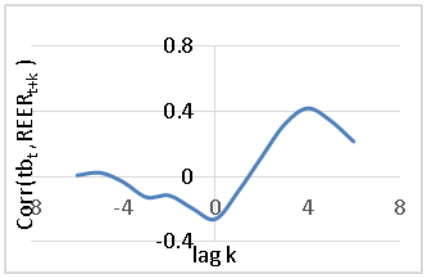

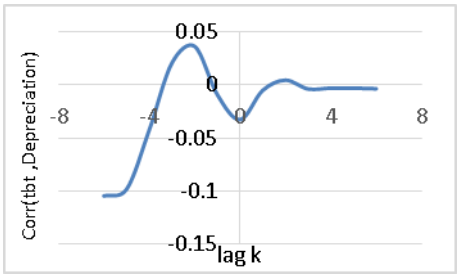

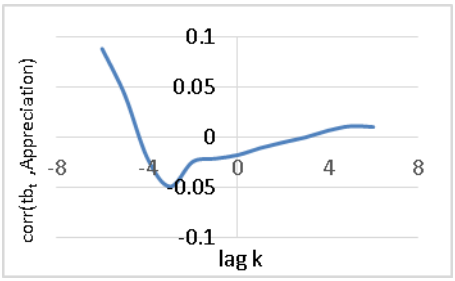

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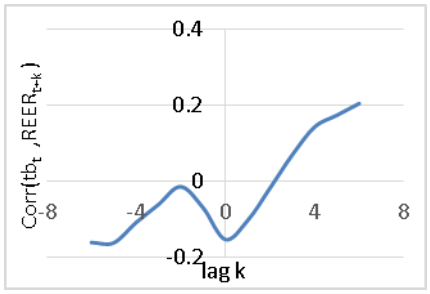

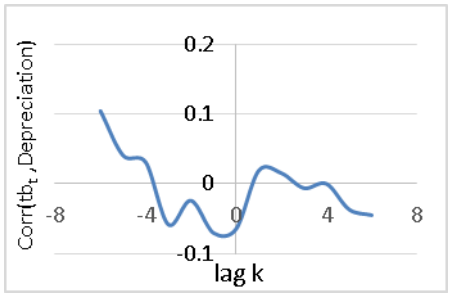

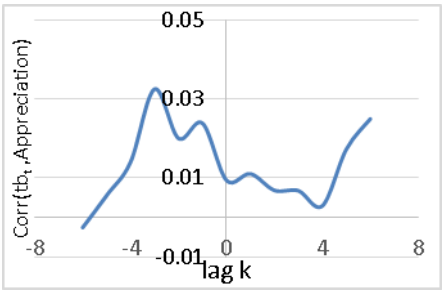

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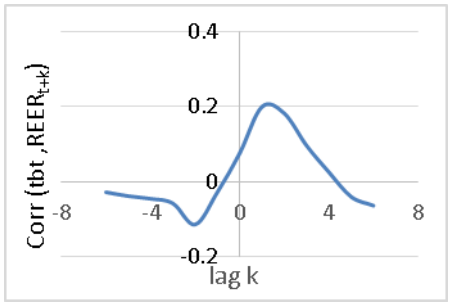

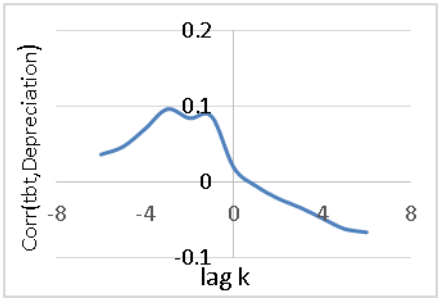

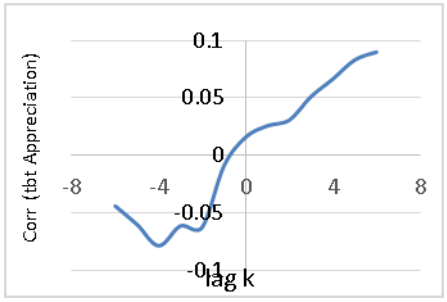

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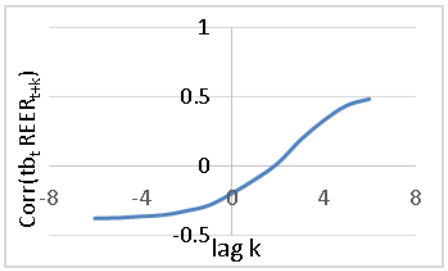

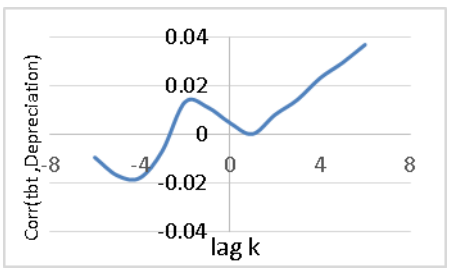

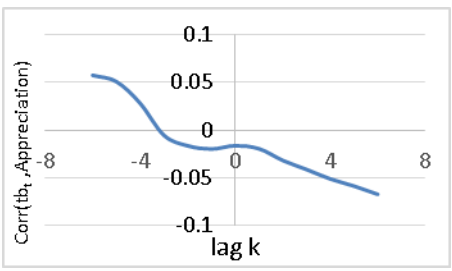

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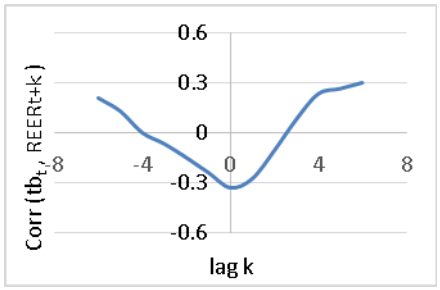

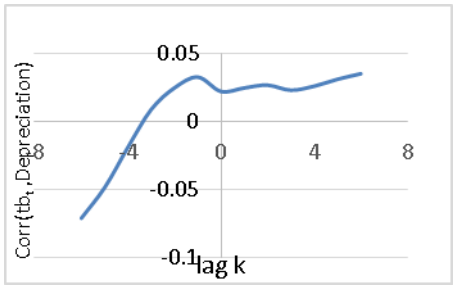

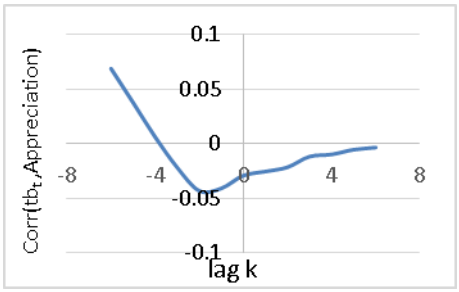

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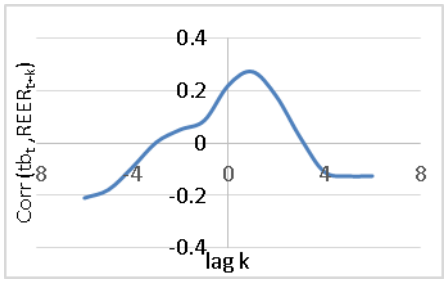

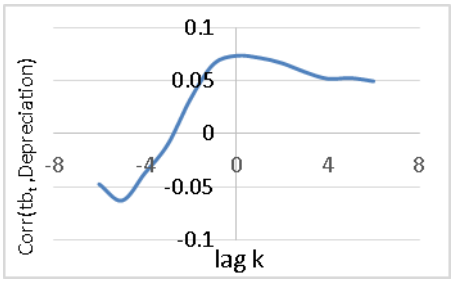

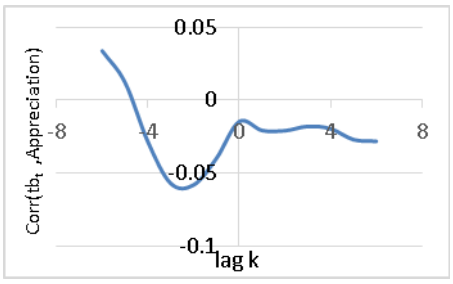

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