The Journal of Business Inquiry 2016, 15, Issue 1, 1-16
http:www.uvu.edu/woodbury/jbi/articles
ISSN 2155-4072

Monetary Policy Transparency as an Exchange Rate Determinant: Evidence from the United States

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The lack in the literature regarding monetary policy transparency and its impact on exchange rates may be justified since no objective transparency indices existed until recently. This paper examines the impact of monetary policy transparency on the real effective exchange rate for the United States and finds that transparency decreases the real effective exchange rate. This study also finds that the impact of oil price on the real effective exchange rate is negative. Finally, it was found that, while domestic deficits and debt have a negative impact on the real effective exchange rate, foreign deficits and debt have the opposite effect.

Keywords: Real Effective Exchange Rate, Monetary Policy, Transparency, Oil

JEL Classification: E52, E58, F31, F40, F4

I. Introduction

Due to the steadily rising attention to transparency in the last 20 years, the literature has been well-furnished with theory, practice, and empirical studies of transparency. Alongside transparency, the behavior of foreign exchange rates has gained much attention. Globalization has undeniably made the world a smaller place, that is, international trade and foreign investment are ever increasing, bringing countries closer together. The international integration of today's world makes the exchange rate an attractive area of study; consequently, the foreign exchange literature is also quite comprehensive. However, the literature lacks an important area of focus: monetary policy transparency and its impact on foreign exchange rates, which is the topic of this paper.

The deficiency in the literature may be justified, however, given the limitations[1] of monetary transparency models. Until recently, there were no objective measures of monetary policy transparency (Kia, 2011). Kia's study determined that models of transparency originating mainly from subjective measurements of transparency were problematic, and therefore proposed an objective transparency index. Using the first market-based, objective monetary policy transparency index (hereafter known as the "Kia Index"), this paper aims to fill the gap in the literature between monetary policy transparency and the seemingly apparent impact it has on exchange rates. This is accomplished by measuring the impact of monetary policy transparency on the real effective exchange rate for the United States—and it is the first study of its kind in the literature. The remainder of this paper is outlined as follows: survey of the literature, theoretical justification and methodology, data and model, and conclusion.

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This paper was presented at the Finance and Economics Seminar at Utah Valley University on January 22, 2016. The author would like to thank the seminar attendees for their comments and suggestions for this paper. The author also would like to thank Professor Amir Kia for his guidance and useful comments.

[1] See Kia (2011) for the limitations of "pre-Kia Index" measures of transparency.

II. Survey of the Literature

While the literature is well-equipped with studies of both monetary policy transparency and the behavior of foreign exchange rates, there is relatively little in the literature that attempts to combine the two. Kuttner and Posen (2000), measuring inflation, monetary transparency, and G3 (United States, Japan, and European Union) exchange rate volatility, hypothesized about the extent to which domestic inflation and interest rate surprises contribute to short-run volatility in G3 exchange rates. They concluded that shocks from surprises should diminish in frequency and effect as monetary transparency increases, thus reducing exchange rate volatility. Kuttner and Posen measured monetary transparency by combining elements of transparency proposed by King (1997) and Posen (1999), which were, respectively, inflation targeting as the practice of monetary transparency, and characterizing elements of monetary transparency.

However, using this criterion, Kuttner and Posen (2000) did not produce an index to measure monetary policy transparency; according to Kia (2011) such an approach to determining transparency is problematic. Kuttner and Posen acknowledged this at least somewhat when they concluded the following:

> "The magnitude of the impact of increased monetary transparency on G3 exchange rate volatility, however, remains open to question. There is no quantitative, cardinal, metric for transparency, and so no way of knowing how much stability is bought for a given increase…If these ballpark but consistent estimates of the benefits of transparency were correct, there would still [be] more than two-thirds of the present monthly volatility." (p. 26)

If Kuttner and Posen had a monetary policy transparency index such as the one developed by Kia, it is possible that the study would have yielded more results that could explain the unexplained "two-thirds of the present monthly volatility."

Eichengreen and Hausmann (1999) studied the relationship between exchange rates and financial fragility and concluded that adequate disclosure and transparency favored a more financially stable economy. Their evidence came from case studies of Argentina, Panama, and Australia, looking at capital flows as well as hedged and unhedged exposure to exchange risk. They found that financial fragility could be lessened if countries would adopt securities-market regulations that discourage insider trading, market cornering, and market manipulation. Eichengreen and Hausmann concluded that in order for this to ultimately work, monetary and fiscal institutions would need reformation in a way that enhances the independence, transparency, and credibility of policy-making authorities. While this study did not attempt to measure monetary transparency's impact, it certainly acknowledged transparency's importance in the relationship between exchange rates and financial fragility. It may have been, then, useful to have applied some measure of monetary transparency, had an objective measure been available, in more precisely determining their financial fragility model.

More recently, Protopapadakis and Flannery (2012) studied the effects of macroeconomic announcements on the exchange rate between the German and US currencies. Their study found a strong relationship between foreign exchange rates and both real and nominal sector developments for both countries. They also found that real sector announcements influence the exchange rate more strongly than money or inflation announcements do. And finally, they found that real growth appreciates the exchange rate and raises yields.

The paper of Protopapadakis and Flannery (2012) is particularly interesting due to the fact that such announcements have to come from at least one party who is willing and able to disclose macroeconomic data. Could not this party be a central bank, or government entity, such as the Federal Reserve or Bureau of Economic Analysis, respectively? Certainly. When the central bank announces, for example, its projections for growth, inflation, interest, etc., is this not an act of transparency? Certainly it is. Thus, it may be worthwhile in this particular study to add a transparency index as a variable in determining the effects of announcements on the exchange rate to see if more variation can be explained.

Caporale and Cipollini (2002) studied the drastic decline in the value of the euro relative to the US dollar that happened after the initial launch of the euro. By an unconventional method, they explored the transparency of the European Central Bank in order to explain the decline. Their method of determining monetary transparency was similar to that of Kia (2011) in that it focused on the deviations of spot interest rates from policy-determined rates. It differs from Kia in that Caporale and Cipollini used these deviations as a measure of monetary policy "uncertainty," which was estimated using a stochastic volatility model. Nevertheless, Caporale and Cipollini found that by analyzing directly the impact of monetary transparency uncertainty on the euro-dollar exchange rate (meaning no other variables were used other than the mentioned rates for each country), the European Central Bank's action and motivations were not well understood by market participants, and that the misunderstanding was perceived as a lack of transparency. As a result, market participants supposed more risk to be associated with the European Union and consequently moved their capital elsewhere, thus the depreciation in the euro relative to the US dollar.

To the best of the author's knowledge, this is the extent of the literature regarding the impact of monetary policy transparency on the exchange rate. Thus we see a major lack of attention to the topic in the literature. While there are ample papers covering topics such as exchange rate determinants[1], exchange rate policy[2], and implications of monetary policy transparency[3], none estimate an exchange rate as a function of some transparency index. Admittedly, some forms of transparency measurements have been used in some papers, such as the ones mentioned by Kuttner and Posen (2000). But as stated above, Kuttner and Posen did not create an index, and as a measure of monetary policy transparency, Kuttner and Posen observed characteristics of a central bank's policy. As noted by Kia (2011), descriptive accounts of transparency concentrate on strategies that central bankers follow in order to communicate with the public. These transparency measures mostly include "do's and don'ts" of central bankers' actions, and the main problem with this measure is that no index can be derived/constructed from these "do's and don'ts." Therefore, the approach is problematic. While some papers include measures of transparency, certainly no papers use the transparency index developed by Kia to measure the impact of monetary transparency on exchange rates, especially since the Kia Index is relatively new. According to the scatter-plot (see Graph 1), there is a relationship between the real effective exchange rate and monetary policy transparency. The relationship indicated by the scatter-plot is negative. This relationship is what this paper examines by using the Kia Index to measure transparency's impact on the real effective exchange rate.

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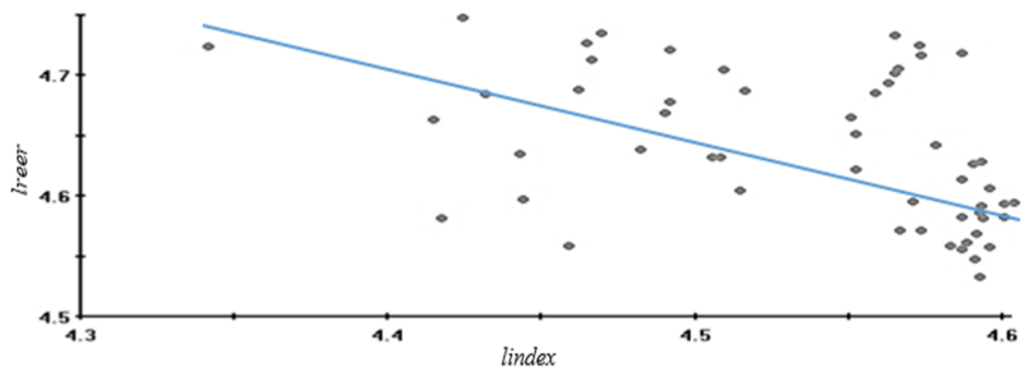
[2] For example, see Makin (1984), Chunming (2011), and Kia (2013).
[3] For example, see Bailliu *et al.* (2003), Fiess and Shankar (2009), and Ershov (2013).
[4] For example, see Issing (2005), Geraats (2006, 2009), Dai and Sidiropoulos (2011), and Sánchez (2012).

Figure 1: Real Effective Exchange Rate and Transparency Index



Notes: Sample period is 1994Q2 to 2014Q2. Variable *lreer* is the log of the real effective exchange rate, calculated as the weighted average of bilateral exchange rates adjusted by relative consumer prices, where the exchange rate is defined as the domestic price of foreign currency, and *lindex* is the log of the Transparency Index. The blue line is a trend line, which indicates a negative relationship between variables *lreer* and *lindex*.

III. Theoretical Justification and Methodology

This paper follows the methodologies of both Kia (2013) and Wilson (2009) and in effect combines the two. Kia developed a theoretical monetary model of the real exchange rate and found its long-run determinants, and Wilson used a monetary approach to exchange rate determination by examining debt, deficit, and debt management in the United States. While the Kia and Wilson models have similar monetary and fiscal variables, there are a few differences that are of particular interest in this study.

First, Wilson's paper examined the effective exchange rate. Since monetary policy and its transparency in the United States have implications worldwide, the effective exchange rate is used in this paper, as opposed to a real exchange rate in Kia's model. This seems appropriate since the effective exchange rate is calculated as the weighted average of bilateral exchange rates, and can therefore give a more representative view. Second, Wilson's model used as an explanatory variable a consumer price index for the world (world CPI). For the same reason regarding worldwide impact of US monetary policy, world price is added in this study.

I extend the Kia (2013) model by adding the monetary policy transparency index as an explanatory variable. There is one more adjustment made to Kia's model that must be noted. Kia's theoretical monetary model of the exchange rate used Canadian data, with commodity price as an explanatory variable. This is justified as Canada is a commodity-oriented country. However, this logic may be inappropriate when applying the model to the US. Consequently, commodity price is replaced with a more appropriate variable. Since the US is a net oil-importing country, oil price is used in place of commodity price. This not only seems intuitively reasonable, but the replacement is also justified by the literature. For example, Harri *et al.* (2009) found that exchange rates, commodity price, and oil price are interrelated. Amano and Norden (1998) found a co-integrated relationship between oil price and the US real exchange rate, and that causality runs from the oil price to the exchange rate. Furthermore, and relating to the euro-dollar exchange rate in particular, Clostermann and Schnatz (2000) found that oil price is a fundamental determinant of the euro-dollar exchange rate.

Since exchange rates are relative prices, foreign variables must be considered. The foreign, or international, data in this paper are represented by the European Union. The exchange rate is the Real Narrow Effective Exchange Rate for the US, calculated as the weighted average of bilateral exchange rates, comprising 26 economies. Since there is no doubt that US monetary policy has implications worldwide, it is appropriate to use a representative rate. The same logic goes for the inclusion of European variables for the foreign perspective. In the calculation of the Real Narrow Effective Exchange Rate for the US, the euro area receives the greatest weight. Of the 26 economies included, 11 are from the euro area.

It is worth noting that China is the largest trading partner with the United States, in general. However, China is not considered in the narrow definition of the real effective exchange rate. The narrow definition was selected because the euro area receives the greatest weight, and with respect to the currency market, the US dollar and euro are the two most traded currencies. These two currencies are involved in approximately 61 per cent of all currency trades (data from the Bank of International Settlements, 2013). The yuan, China's currency, is not among the major currency pairs. Therefore, since the US dollar and euro are relatively more involved in the market than are other currencies, and given that the EU receives the highest weight in the effective exchange rate calculation, the narrow definition of the real effective exchange rate is appropriate, and European variables can represent the foreign perspective needed for the model.

Of course, it is possible to include, as foreign variables, fiscal variables for *all* of the economies used in the calculation of the effective exchange rate. However, this seems excessive and unnecessary since many countries receive a trade weight of less than one per cent, while others receive a trade weight between one and three per cent. These weights are so small in the effective exchange rate calculation that it seems impossible for the fiscal variables of these economies to have any statistically significant explanatory power in the model.

Incorporating monetary and fiscal changes that influence the value of currency, my long-run real effective exchange rate model, which is an extension of Kia's (2013), can be given by the following log-linear relationship:

$$lreer_t = \beta_0 + \beta_1 lwp + \ + \beta_2 lrm_t^s + \beta_3 li_t + \beta_4 ly_t + \beta_5 lg_t + \beta_6 defgdp_t + \beta_7 debtgdp_t + \ \beta_8 fdgdp_t + \beta_9 li_t^* + \beta_{10} debtgdp_t^* + \beta_{11} fdgdp_t^* + \beta_{12} loil_t + \beta_{13} index + u_t, \quad (1)$$

where beta coefficients are constant coefficients and $\beta_1 < 0$, $\beta_2 < 0$, $\beta_3 < 0$, $\beta_4 > 0$, $\beta_5 > 0$, $\beta_6 < 0$, $\beta_7 < 0$, $\beta_8 < 0$, $\beta_9 > 0$, $\beta_{10} > 0$, $\beta_{11} > 0$, $\beta_{12} = ?$, $\beta_{13} < 0$, and *l* before any variable is the log of the variable. Variable *reer* is the real effective exchange rate for the United States (calculated as the weighted average of bilateral exchange rates, where the exchange rate is defined as the domestic price of foreign currency), *wp* is the world price index, rm^s is real money supply, *i* is gross interest rate (calculated by [r/(1 + r)], where *r* is US three-month Treasury bill rate), *y* is US real GDP, *rg* is US real government expenditure, *defgdp* is US deficit per GDP, *debtgdp* is US domestic debt per GDP, *fdgdp* is US foreign-financed debt per GDP, i^* is the foreign gross interest rate (calculated by [r^*/ (1+r^*)], where r^* is the EU three-month offer rate, LIBOR), *debtgdp** is EU domestic debt per GDP, *fdgdp** is EU foreign-financed debt per GDP, *loil* is real oil price, and *index* is the Kia Index. Further, *u* is an error term which is assumed to be white noise.

To better understand why each beta coefficient has its respective sign, it may be appropriate to review the calculation of the real effective exchange rate (reer), which, at time *t*, is calculated as:

$$reer_t = \sum_{j=1}^{n} w_j \left(\frac{E_{j,t} \times P_{j,t}}{P_t} \right) \quad (2)$$

where country j = 1,2,…,n is the domestic country's trading partner and w_j is the percentage weight of trade between the domestic country and foreign country j, where the weights sum to one. E_j is the nominal exchange rate between the domestic and foreign country j (defined as the domestic price of foreign currency, so that E_j falls with an appreciation of the domestic currency), P_j is foreign price level, and P is domestic price level. Note that in Equation (2) the expression in parenthesis is the real exchange rate between the domestic country and foreign country j. As an aside, the trade-based weighting pattern is time-varying. The respective trade weights and the time-varying pattern can be retrieved from the Bank for International Settlements.

We can now reference Equation (2) while explaining theoretically the expected sign of each beta coefficient. World price has a negative impact on the real effective exchange rate. One explanation for this is that as world price goes up, demand for US products will go up. An increase in demand leads to an increase in currency value, and thus a decrease in the exchange rate, E_i. Real money supply also has a negative impact on the real effective exchange rate. Based on the quantity theory of money, which states that there is a direct relationship between money supply and prices, an increase in money supply causes an increase in prices. This means that P increases, and the real effective exchange rate decreases. An increase in US interest rate attracts more international investors, and thus an increase in currency value. It follows that E_j decreases; therefore, the real effective exchange rate decreases.

One explanation for the positive impact of real GDP on the real effective exchange rate is that as income rises demand for imports rises. Foreign currency must be purchased to obtain imports, and thus domestic currency must be sold. It follows that E_j increases, as does the real effective exchange rate. A similar explanation can be given for the positive impact of real government expenditures. The negative impact of US deficit per GDP, US debt per GDP, and US foreign financed debt per GDP can be explained by their influence on the discount rate, in that they exert an upward pressure on the rate. The explanations for the relationships of international variables (foreign interest rate, EU debt per GDP, and EU foreign financed debt per GDP) are similar to those of US counterparts; accordingly, the beta coefficients for foreign variables have the opposite sign, which is positive. An increase in any of the foreign variables leads to an increase in the real effective exchange rate. The increase comes from either an appreciation of the exchange rate, E_j, or an appreciation of foreign price, P_j, depending on the variable.

The impact of oil price on the real effective exchange rate is an empirical issue. Since the United States is a net oil-importing country, an increase in the price of oil results in an increase in the cost of imports of oil. Buying the oil requires a sale of domestic currency and a purchase of foreign currency. Consequently, E_j will go up. This increase yields an increase in the real effective exchange rate. Simultaneously, however, a higher oil price results in a higher cost schedule for each industry, and therefore higher US prices. This means that P will go up. The resulting increase in the denominator yields a decrease in the real effective exchange rate. The impact of oil price on the real effective exchange rate depends on these two opposite effects. This means that the overall impact cannot be explained theoretically and is thus an empirical issue. Finally, monetary policy transparency, as measured by the Kia Index, negatively impacts the real effective exchange rate. One explanation, the most intuitive, is that more transparency in monetary policy reduces risk and uncertainty, which results in more investment and attracts more international investors.

Consequently, demand for the US dollar will go up, which results in a higher value of US dollar. In other words, E_j gets smaller, and so does the real effective exchange rate.

IV. Data and Estimation

A. Data

The majority of data were retrieved from the Federal Reserve Economic Database (FRED). Data for the European Union (EU debt per GDP and EU foreign-financed debt per GDP) were retrieved from the European Central Bank Statistical Data Warehouse. Quarterly data is used for the period 1994Q4:2014Q4. The author is aware of the seemingly limited time period, which is due to the formation of the European Union, whose fiscal variables should be included in this paper. The importance of the inclusion of EU data in this model has already been addressed.

It should also be noted that the two data taken from the European Central Bank Statistical Data Warehouse were only available as annual data for the entire period. Only more recent data were available at higher frequency. The annual data were interpolated from low-frequency to high-frequency using the RATS (Regression Analysis of Time Series) version 9 software package. All estimations were completed in this software, except for the long-run estimations using the ARDL approach to cointegration, as advanced by Pesaran and Shin (1999). These estimations were completed in the Microfit 5.0 software package.

Table 1*: Stationary Tests: 1994Q2 – 2014Q2 Absolute Values

Variables	Augmented Dickey-Fuller τ-Stat	Phillips-Perron τ-Stat	Zivot-Andrews τ-Stat
lreer	1.21	1.21	3.13 at 1997Q4
lwp	2.42	2.51	4.02 at 2005Q1
lrm^s	1.26	1.99	2.50 at 2008Q4
li	0.44	0.03	4.85[b] at 2008Q4
ly	2.29	2.72	3.91 at 2008Q1
lrg	1.37	1.43	2.97 at 2011Q1
defgdp	1.39	1.52	3.30 at 2008Q1
debtgdp	0.63	1.23	6.25[a] at 2008Q3
fdgdp	0.63	1.08	3.78 at 2008Q3
*li**	0.10	0.36	4.31 at 2009Q1
*debtgdp**	0.72	0.70	5.84[a] at 2009Q1
*fdgdp**	0.53	0.53	6.11[a] at 2010Q1
loil	1.72	1.53	4.43[a] at 2004Q3
index	5.27[a]	5.50[a]	3.78 at 2004Q4

Notes: *l(X)* = log(*X)*. Variable *reer* is the real effective exchange rate for the United States (calculated as the weighted average of bilateral exchange rates, where the exchange rate is defined as the domestic price of foreign currency), *wp* is the world price index, rm^s is real money supply, *i* is gross interest rate (calculated by [r/(1 + r)], where r is US three-month Treasury bill rate), *y* is US real GDP, *rg* is US real government expenditure, *defgdp* is US deficit per GDP, *debtgdp* is US domestic debt per GDP, *fdgdp* is US foreign-financed debt per GDP, *i** is the foreign gross interest rate (calculated by [r^*/ (1+r^*)], where r^* is the EU three-month offer rate, LIBOR), *debtgdp** is EU domestic debt per GDP, *fdgdp** is EU foreign-financed debt per GDP, *loil* is real oil price, and *index* is the Kia Index.

* All tests include constant and trend. The critical value for the Augmented Dickey-Fuller τ test is 2.89 at 5% and 3.51 at 1%. The critical value for the Phillips-Perron non-parametric Z test is 2.89 at 5% and 3.51 at 1%. The number of observations is 81. The critical value for Zivot-Andrews Unit Root Test is 4.80 at 5% and 5.34 at 1%. The number of usable observations is 80.

a = Significant at 1%.

b = Significant at 5%.

Table 1 shows the results of stationary tests. For robustness, Augmented Dickey-Fuller (1979), Phillips-Perron (1988), and Zivot-Andrews (1992) tests were used. From the table, the stationary tests indicate that the model includes both stationary and non-stationary variables, with most being non-stationary. Data were transformed to meet the same criteria as the Kia (2013) exchange rate determinant model. Table 2 provides summary statistics on the transformed data.

Table 2: Summary Statistics of Variables for Real Effective Exchange Rate Model
Sample Period: 1994Q2–2014Q2

Variable	Mean	Std. Error	Minimum	Maximum
lreer	4.680	0.088	4.535	4.858
lwp	1.473	0.399	0.887	2.384
lrm^s	6.609	0.162	6.440	7.072
Li	-0.947	1.118	-3.932	-0.154
Ly	9.484	0.144	9.185	9.681
lrg	4.142	0.355	3.554	4.679
defgdp	0.007	0.007	-0.006	0.023
debtgdp	69.660	15.559	53.832	103.269
fdgdp	17.578	8.397	8.925	34.910
*li**	-0.519	0.472	-1.609	-0.141
*debtgdp**	73.795	8.279	64.992	92.053
*fdgdp**	9.914	6.529	3.709	23.475
loil	-1.527	0.551	-2.577	-0.468
Index	90.666	8.679	63.988	99.807

Notes: *l(X)* = log(*X*).Variable *reer* is the real effective exchange rate for the United States (calculated as the weighted average of bilateral exchange rates, where the exchange rate is defined as the domestic price of foreign currency), *wp* is the world price index, rm^s is real money supply, *i* is gross interest rate (calculated by [r/(1 + r)], where r is US three-month Treasury bill rate), *y* is US real GDP, *rg* is US real government expenditure, *defgdp* is US deficit per GDP, *debtgdp* is US domestic debt per GDP, *fdgdp* is US foreign-financed debt per GDP, *i** is the foreign gross interest rate (calculated by [*r**/ (1+*r**)], where *r** is the EU three-month offer rate, LIBOR), *debtgdp** is EU domestic debt per GDP, *fdgdp** is EU foreign-financed debt per GDP, *loil* is real oil price, and *index* is the Kia Index.

B. Long-Run Estimation

As an extension to the Kia (2013) model, which is a theoretical monetary model of the real exchange rate, this model incorporates the Kia Index, which is stationary. For this reason, I used the Fully Modified-Ordinary Least Squares (FM-OLS) estimation, originally developed by Phillips and Hansen (1990). Further, I used Akaike Information Criterion (AIC) and Schwartz Bayesian Information Criterion (SBIC) to determine lag length. Based on these tests, 7 lags of quarterly observations were used in the FM-OLS regression.

Table 3 gives the output of the Fully Modified–Ordinary Least Squares regression. The explanatory variables are statistically significant with the exception of US real government expenditure, US budget deficit per GDP, and US government debt per GDP. As theoretically predicted, the coefficients have the correct signs. The impact of oil price on the real effective exchange rate is negative. This relationship means that the impact of a higher US price (denominator) is greater than the impact of a higher exchange rate (numerator), and so the net effect is negative, or the net effect results in a decrease in the real effective exchange rate.

Table 3: Fully Modified-Ordinary Least Squares Regression Output

Dependent Variable: *lreer* — Lag Length: 7

Variable	*lwp*	*lrm*^{s}	*li*	*ly*	*lrg*	*defgdp*	*debtgdp*	*fdgdp*	*li**	*debtgdp**	*fdgdp**	*loil*	*index*	*Con*
β Coeff.	-0.0585	-0.1990	-0.0278	0.6177	0.0051	-0.2661	-0.0017	-0.0181	0.0481	0.0087	0.0058	-0.1326	-0.0797	0.1644
(τ-stat)	(-7.62)	(-3.88)	(-5.16)	(6.12)	(0.95)	(-0.732)	(-3.65)	(-6.36)	(2.57)	(5.71)	(5.55)	(-15.6)	(-2.96)	(0.11)

The sample period is 1994Q2– 014Q2. *l(X)* = log(*X*).Variable *reer* is the real effective exchange rate for the United States (calculated as the weighted average of bilateral exchange rates, where the exchange rate is defined as the domestic price of foreign currency), *wp* is the world price index, rm^s is real money supply, *i* is gross interest rate (calculated by [r/(1 + r)], where r is US three-month Treasury bill rate), *y* is US real GDP, *rg* is US real government expenditure, *defgdp* is US deficit per GDP, *debtgdp* is US domestic debt per GDP, *fdgdp* is US foreign financed debt per GDP, *i** is the foreign gross interest rate (calculated by [*r**/ (1+*r**)], where *r** is the EU three-month offer rate, LIBOR), *debtgdp** is EU domestic debt per GDP, *fdgdp** is EU foreign-financed debt per GDP, *loil* is real oil price, and *index* is the Kia Index.

Dummy variables were created to represent potential policy regime shifts and exogenous shocks. The following dummies were constructed: *sep11* (=1 for 2001Q4 and zero otherwise), *afwar* (=1 since 2001Q4 and zero otherwise), *bern* (=1 from 2006Q1 to 2014Q1 and zero otherwise), and *crisis* (=1 from 2007Q3 to 2009Q2 and zero otherwise); where *sep11*, the terror attack on September 11; *afwar,* the War in Afghanistan; *bern*, the tenure of Federal Reserve Chairman Ben Bernanke, and *crisis,* the financial crisis. All of the dummy variables are statistically insignificant. It is worth mentioning that the dummies were expected to be statistically insignificant given that Kia (2011) developed the transparency index in such a way to account for all policy regime changes and shocks.

For robustness, I used the ARDL approach to cointegration, as advanced by Pesaran and Shin (1999) to measure the long-run relationship as it was explained before. This was completed using the Microfit 5.0 software package. The main advantage to this testing and estimation strategy is that the method can be applied irrespective of whether the explanatory variables are *I*(0) or *I*(1). There are a few restrictions worth noting when using the ARDL approach, namely there is a limit to the number of variables one can use, and critical values are given based on the assumption of variables being *I*(0) or *I*(1). That is to say, if a variable is *I*(2), it is not appropriate for the estimation. To meet these requirements, statistically insignificant variables must be removed. Thus, a parsimonious result is reported. These tests are not reported here, but are available upon request. Table 4 reports the ARDL estimates.

It may be useful to give a brief and simple explanation to the ARDL approach to cointegration, which explanation is borrowed from Pesaran and Pesaran (2009). The existence of a long-run relationship between the variables is tested by computing the *F*-statistic for testing the significance of the lagged levels of the variables in the error correction form of the underlying ARDL model. It must be noted that the distribution of this *F*-statistic are non-standard, irrespective of explanatory variables being either *I*(0) or *I*(1), and Pesaran *et al.* (1996) have formulated the appropriate critical values for different numbers of variables. Two sets of critical values are given: one assuming that all of the variables in the ARDL are *I*(0), and the other assuming all the variables are *I*(1). This process provides a band covering all the possible classifications of the variables into *I*(0) or *I*(1). If the *F*-statistic falls outside the band, then a conclusive decision can be made. An *F*-statistic above the upper bound means that the null hypothesis of no level relationship is rejected. An *F*-statistic below the lower bound means that the null hypothesis of no level relationship cannot be rejected. And finally, an *F*-statistic between the bounds means that the test is inconclusive.

Table 4: Autoregressive Distributed Lag Estimates[a]
ARDL(1,0,2,1,2,1,2) Selected Based on Akaike Information Criterion

Dependent Variable: *lreer*
Sample Period: 1994Q2-2014Q2

Variable	Coefficient	Standard Error
$lreer_{t-1}$	0.5089	0.10
lwp	-0.0344	0.02
li_{t-1}	-0.0321	0.01
ly	-1.9954	0.52
ly_{t-2}	1.4056	0.60
fdgdp	-0.0169	0.01
$fdgdp_{t-1}$	0.0131	0.01
$fdgdp^*_{t-1}$	0.0061	0.00
loil	-0.0854	0.02
$loil_{t-1}$	-0.0091	0.02
$loil_{t-2}$	0.0617	0.02
lindex	-0.0872	0.04

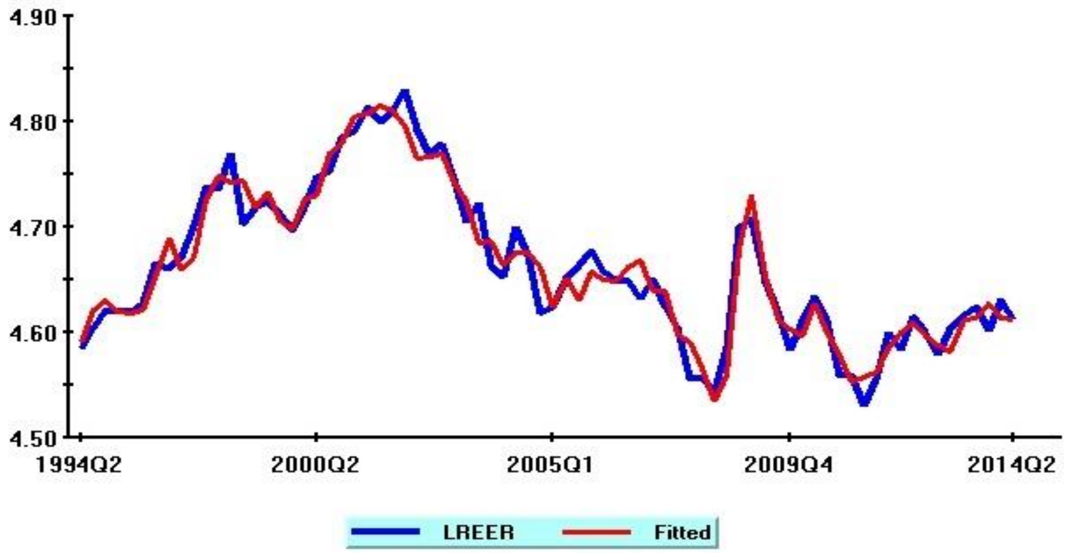
Testing for the existence of a level relationship among the variables in the ARDL model[b]

F-statistic	95% Lower Bound	95% Upper Bound	90% Lower Bound	90% Upper Bound
6.3809	3.5151	4.6262	3.0496	4.0607
***W*-statistic**	**95% Lower Bound**	**95% Upper Bound**	**90% Lower Bound**	**90% Upper Bound**
44.6662	24.6056	32.3836	21.3471	28.4252

[a] Order or ARDL = 2. ARDL estimation involved 2187 regressions. For definitions of variables, see notes in Table 2. The model passed all diagnostic tests (e.g. misspecification, ARCH, normality, heteroscedasticity). The CUSUM and CUMSUMSQ tests using OLS estimation tested for stability. Results of these diagnostic tests are available upon request. *W*-statistic is the Wald test for linear and non-linear restrictions on the coefficients. The intercept and trend were statistically insignificant.
[b] The critical value bounds are computed by stochastic simulations using 20,000 replications.

Table 4 reports the parsimonious ARDL estimates. From the *F*-statistic, the hypothesis of no level relationship is rejected. In other words, there exists a long-run relationship among the variables in the ARDL model. The table indicates that world price, US interest rate, US growth, US government foreign-financed debt, oil price, EU public foreign-financed debt, and the Transparency Index significantly impact the real effective exchange rate for the US over the long run. For the sake of graphical representation, Figure 2 plots of actual and fitted values for the ARDL model.

Figure 2: Plot of Actual and Fitted Values of LREER



With a long-run relationship of the variables given by the ARDL model, a long-run response can be calculated for the explanatory variables. While the response can be computed for all variables, only those that are statistically significant (variables from Table 3) are reported here. Table 5 reports the estimation results.

Table 5: Long-Run Response from ARDL Estimates[a]

Variable	*lwp*	*li*	*ly*	*fdgdp*	*fdgdp**	*loil*	*lindex*
LR Response	-0.06775	-0.07678	0.88294	-0.00755	0.00741	-0.08233	-0.17124
(τ-stat)	(-1.96)	(-2.80)	(2.36)	(-2.74)	(1.94)	(-4.31)	(-2.17)

[a] Autoregressive and distributed lag polynomials are extracted from the ARDL regression. The distributed lag polynomial is then divided by the autoregressive polynomial. Long-run responses reported are for statistically significant variables. For definitions of variables, see notes in Table 2.
LR = Long Run. The sample period is 1994Q2-2014Q2.

It should be noted that as an added measure of robustness, ARDL models were constructed in both RATS 9.0 and Microfit 5.0 software packages. That is, both traditional and bounds testing strategies for ARDL models were used in testing for the long-run relationship. Both of these approaches yielded long-run relationships consisting of the same variables. Long-run responses were computed for both methods and were identical in sign and similar in value. For example, the long-run response for world price, *lwp*, is -0.06775 using the bounds testing method, compared to -0.06872 using the traditional method. The long-run response for the transparency index, *lindex*, using the traditional method is -0.16225. A full comparison of the long-run responses for both methods is available upon request.

C. Short-Run Dynamics

Having established in the previous section that a long-run relationship describing the real effective exchange rate and its determinants exists, it is necessary to specify the ECMs (error correction models) that are implied by the long-run relationship. Following Granger (1986), it should be noted that if small equilibrium errors in the market are overlooked, while large equilibrium errors are recognized and markets react substantially to these, then the error correcting equation is non-linear. Thus, different possible kinds of non-linear specifications (e.g. squared, cubed and fourth powered) of the equilibrium errors were included. To avoid biased results, a large lag profile is necessary, and lags were determined using AIC and SBIC. These tests determined a lag profile of seven quarters. Additionally, since having too many coefficients can lead to inefficient estimates, I ensure parsimonious estimation by selecting the final ECM on the basis of Hendry's General-to-Specific approach. Assuming US government expenditures, US government foreign-financed debt per GDP, foreign variables (excluding foreign interest rate[1]), and the Transparency Index are exogenous, there are eight endogenous variables in the system. Therefore, there are eight error-correction models. For the sake of brevity, I only report the parsimonious ECM for the growth of the real effective exchange rate. Table 6 reports the parsimonious results of the estimation of the ECM.

Table 6: Error Correction Model for the Growth of the Real Effective Exchange Rate
Dependent Variable = Δ*lreer*[a]

Variable	Coefficient	Standard Error	Hansen's (1992) stability L_i test (*p*-value)
$\Delta lreer_{t-6}$	0.21	0.11	0.99
Δli_{t-2}	-0.03	0.01	0.97
$\Delta\ li_{t-3}$	-0.03	0.01	1.00
Δly_{t-2}	1.72	0.64	0.24
$\Delta loil_{t-2}$	0.04	0.02	0.57
$\Delta loil_{t-3}$	0.05	0.02	0.85
$\Delta lindex_{t-1}$	-0.10	0.04	0.21
$\Delta lindex_{t-2}$	-0.12	0.05	0.18
$\Delta lindex_{t-3}$	-0.15	0.05	0.24
$\Delta lindex_{t-4}$	-0.11	0.04	0.80
EC_{t-7}	-0.34	0.12	0.82
$(EC)^2_{t-2}$	0.82	0.22	0.84

Hansen's (1992) stability L_i test for the variance of the ECM = 0.25
Joint (coefficients and the error variance) Hansen's (1992) stability L_c test = 0.87

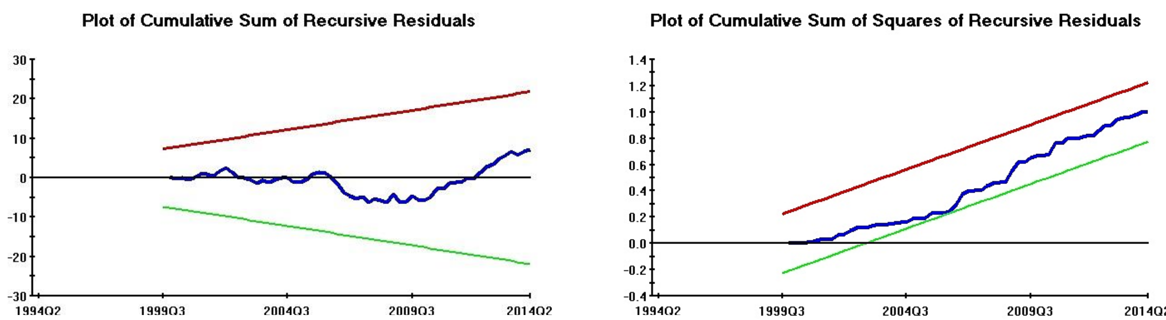
[a] The sample period is 1994Q2 to 2012Q2. Δ is the first difference, mean of the dependent variable = -0.0001. Constant term = 0.02, and statistically insignificant. Variable EC is the error correction term from the long-run relationship. For the definitions of the other variables see notes in Table 2. The estimation method is Ordinary Least Squares. $R^2 = 0.47$, $\sigma = 0.026$, DW = 2.18, Godfrey (6) = 0.78 (significance level = 0.58), White = 71 (significance level = 1.00), ARCH(5) = 6.41 (significance level = 0.27), RESET(3) = 1.62 (significance level = 0.20), Normality ($\chi^2 = 2$) = 0.27 (significance level = 0.87).

[5] Since the United States is a large country, the foreign interest rate can be influenced by US variables. Therefore, the foreign interest rate is endogenous.

In Table 5, Δ denotes a first difference operator and EC, R^2, σ, and DW, respectively, denote the error correction term from the long-run equation for the real effective exchange rate, the adjusted squared multiple correlation coefficient, the residual standard deviation, and the Durbin–Watson statistic. White is White's (1980) general test for heteroscedasticity, ARCH is five-order Engle's (1982) test, Godfrey is five-order Godfrey's (1978) test, RESET is Ramsey's (1969) misspecification test, Normality is Jarque-Bera's (1987) normality statistic, L_i is Hansen's (1992) stability test for the null hypothesis that the estimated *i*th coefficient or variance of the error term is constant and L_c is Hansen's (1992) stability test for the null hypothesis that the estimated coefficients as well as the error variance are jointly constant.

From the table, the diagnostic tests for specification are statistically insignificant. The Hansen stability test indicates that coefficients, individually or jointly, are stable. Furthermore, Figure 3 shows the results of CUSUM and CUSUMSQ tests for stability. The tests indicate that the error correction model is stable.

Figure 3: CUSUM and CUSUMSQ Plots[a]



[a] The straight lines represent critical bounds at the 5%.

From the error correction model, none of the domestic fiscal variables has any impact on the growth of the real effective exchange rate in the short-run, while interest rate, growth, oil and monetary policy transparency do. The estimated coefficient of the error correction term is negative and statistically significant. Furthermore, the impact of the equilibrium error is non-linear, given that squared error term is statistically significant. And since the coefficient is positive, this implies that market agents may ignore small deviations from equilibrium and react drastically to large deviations. However, a large deviation can create further deviation. The growth of the interest rate impacts the growth of the real effective exchange rate as expected, as does real GDP. The change in oil price, in the short-run, has a positive impact on the real effective exchange rate. The sign is contrary to the long-run situation. However, as explained, oil price exhibits two opposing effects. The ECM implies that in the short-run, oil's impact on the exchange rate, E_i, increases the real effective exchange rate. In the long-run, however, oil's impact on the domestic price, P_i, results in a net negative effect. Monetary policy transparency impacts the real effective exchange as expected. In both the short- and long-run, the change in transparency negatively impacts the change in the exchange rate, implying that an increase in monetary policy transparency, everything else being equal, attracts market participants and international investors, thus an increase in the value of the US dollar and the subsequent decrease in the real effective exchange rate. Also, according to the error correction model, monetary policy transparency can affect the real effective exchange rate for four quarters, or one year.

V. Conclusion

While the literature is well-furnished with studies of both monetary policy transparency and the behavior of foreign exchange rates, there are relatively few studies in the literature that attempt to combine the two. One explanation is that no objective monetary policy transparency index existed before Kia's work in 2011. Therefore, it is possible that researchers could not objectively study the impact of transparency on exchange rates. This paper does so by adopting the methodology of Kia (2013), in which Kia developed a theoretical monetary model of the real exchange rate that incorporates fiscal and monetary factors, and by borrowing elements from Wilson's (2009) monetary approach to exchange rate determination model. Following these methodologies, this paper examines the impact of monetary policy transparency on the real effective exchange rate, with monetary policy transparency measured by the index developed by Kia (2011), an index that is market-based, objective, dynamic, and continuous.

This study finds that the transparency index is statistically significant in measuring the impact of monetary policy transparency on the real effective exchange rate for the United States. Furthermore, using both the Fully Modified-Ordinary Least Squares estimation and the ARDL approach to cointegration advanced by Pesaran and Shin (1999), this study finds that monetary policy transparency has a negative impact on the real effective exchange rate, that is, a more transparent monetary policy attracts more domestic and international investors. This creates higher demand for the currency and leads to a higher value of the US currency and thus a lower real effective exchange rate. Additionally, this study finds that oil price has a negative impact on the real effective exchange rate in the long run and a positive impact in the short-run, and that oil is statistically significant in both situations. While oil price impacts both price level and exchange rate, the impact on the US price is greater than the impact on the nominal exchange rate. Consequently, the net effect of the change in the oil price over the long run is negative, or the net effect results in a decrease in the real effective exchange rate for the United States.

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