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Can commodity prices predict exchange rates in developed commodity-exporting economies?

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Abstract

In this paper, we study the exchange rate behavior of the commodity exporting economies Canada, Norway, Australia, and New Zealand, by testing the relationship to commodity prices and macroeconomic fundamentals. We find that commodity prices do exhibit predictive ability on exchange rates on the monthly basis when using USD as the base currency. We also find that commodity prices have a different impact on commodity exporters compared to non-commodity exporters. We conclude that commodity prices are a more powerful explanatory variable than interest rates and purchasing power parity, when forecasting in-sample exchange rate changes and returns on a monthly basis with the U.S. dollar as the numeraire currency. However, we must raise awareness that our findings may be induced by the strong ties between the U.S. Dollar and the commodity markets, as our initial findings fails the robustness test where British Pound Sterling is used as the numeraire currency.

1.0 Introduction

The relationship between exchange rates and economic fundamentals is one of the most controversial issues in international finance. Ever since Meese and Rogoff in 1983 found that exchange rate models cannot outperform the random walk in out-of-sample forecasting of exchange rates, researchers have been trying to solve the exchange rate puzzle. Researchers have come a long way since then, but no model has yet accomplished to predict exchange rates at a satisfactory level. This paper aims to contribute to existing literature on exchange rate forecasting by investigating commodity price changes in developed commodity exporting countries. More specifically, we test whether changes in commodity prices can help explain exchange rate returns, in addition to traditional fundamentals, such as interest rates, inflation, and terms of trade. In order for the exporting commodities to have a significant impact on exchange rates, the research is conducted on the New Zealand Dollar (NZD), the Australian Dollar (AUD), the Canadian Dollar (CAD), and the Norwegian Krone (NOK), collectively referred to as commodity currencies. These are all floating currencies where commodities constitute a large fraction of total exports. We also use the Japanese Yuan (JPY), the Euro (EUR), and the British Pound Sterling (GBP) for the purpose of comparison. These are in the paper referred to as non-commodity exporters. All currencies are denominated in U.S. Dollar (USD). We have also performed a robustness test, where all currencies are denominated in GBP.

In the paper, we find that commodity prices do have predictive ability in exchange rate forecasting on the monthly basis, and that commodity prices have a different impact on exchange rate returns for commodity exporting countries compared to non-commodity exporting countries. However, our findings are not robust. When the USD is exchanged with GBP as the numeraire currency, the commodity price changes does not exhibit strong explanatory power.

Section 2 summarizes the existing literature on exchange rate forecasting, and provide an overview of theories, assumptions, and limitations applied in the paper. The research question and hypothesis is presented in Section 3. Moreover, the statistical method and data is presented in detail in Section 4 and 5. We discuss our empirical findings in Section 6, and conclude in Section 7.

2.0 Literature Review & Theory

In this section, existing literature on currency forecasting is summarized and discussed. Important theories applied in the paper is also addressed. A discussion of our independent variables is presented, and in the end, vital limitations and assumptions are addressed.

2.1 Literature review

The literature has come a long way since Meese and Rogoff's discouraging finding, but existing models are still not able to fully explain exchange rate movements. Several studies suggest that there does indeed exist a relationship between exchange rates and commodity prices. However, since most of the papers suggest that the causality runs from exchange rates towards commodity prices, exchange rates are still challenging to properly forecast. Chen, Rogoff, and Rossi (2010) found that while commodity prices can on the quarterly basis be predicted by exchange rates, the reverse relationship does not hold. They conclude that while exchange rates are highly forward looking, commodity prices are more sensitive to short-term demand imbalances.

The linkage between economic fundamentals and exchange rates has been severely debated over the last decades. It is now, however, a well-known fact that monetary fundamentals cannot forecast exchange rates out-of-sample at the monthly and quarterly frequencies. Cheung, Lai, and Bergmann explains in a paper from 2004 that none of the traditional macroeconomic exchange rate models could produce better predictive ability than a random walk model. Their findings are supported in several different studies (Chen et al., 2010; Engel & West, 2005)

Because the currency market is highly liquid and forward-looking, some researchers have proposed that a short-term relationship between commodity prices and exchange rates exists. Ferraro, Rogoff, and Rossi (2015) find a significant relationship between daily exchange rate changes and lagged daily oil price changes. More specifically, the paper demonstrates that commodity prices contain valuable information for predicting exchange rates in commodity-exporting countries when predictive ability is measured by out-of-sample fit. Finding this predictive ability is interesting, as it contradicts what is commonly found in the literature. However, because of a limited frequency of reporting, economic fundamentals are excluded from their paper.

Existing literature on the fundamentals-to-currency relationship usually apply *the Sticky Price Model, the Portfolio Rebalancing Model, and/or a model based on shocks in Terms-of-Trade.* The *sticky price model* suggests that for a commodity exporting country, a commodity price increase will result in an inflationary pressure on real wages, nontraded goods prices, and exchange rates. Since real wages and nontraded goods are "sticky prices", the exchange rate will quickly adjust (Bils & Klenow, 2004). The *Portfolio Rebalancing Model* explains that unhedged equity portfolio investors will rebalance their portfolios in order to limit their exchange rate exposure (Hau & Rey, 2004). The models focusing on shocks in *Terms of Trade* explains that an improvement in a country's terms of trade will result in an upwards shift in the demand curve for the country's currency, and thus lead to a currency appreciation (Mendoza, 1995).

In a recent paper, Riddiough and Sarno (2016) find that excess currency returns are related to countries' output gaps. More specifically, the study shows that an investment strategy that buys the currencies of countries with high output gaps and sells currencies of countries with low output gaps offers appealing risk-adjusted returns. The investment strategy is by the authors called the GAP strategy, and aims to exploit cross-country differences in business cycles.

One of the largest problems with existing literature on exchange rate forecasting is that even though sound economic rationale supports suggested theories, exchange rate fundamentals are basically all endogenous and jointly determined with exchange rates in equilibrium, rendering causal interpretation extremely challenging (Chen et al., 2010).

This paper aims to contribute to existing literature by creating a model explaining exchange rate returns by considering interest rates, inflation, terms of trade, and commodity price changes. Although several other variables have been proposed to explain exchange rates, only what we find to be the most important factors are included, as we want to keep the model parsimonious. Furthermore, the regressions in this paper apply lagged explanatory variables, mitigating the endogenous exposure.

In the following sub-sections, the control variables and theories applied in this paper are presented and discussed.

2.2 Purchasing Power Parity (PPP)

Purchasing Power Parity (PPP) is an interesting variable in exchange rate literature, as some researchers suggest that a relationship between exchange rates and prices exists (Taylor, 2003). PPP can in its simplest form be considered as the level of nominal exchange rate that must exist such that the purchasing power of a unit of currency is precisely equal in the foreign and domestic economy. Thus, if the above parity does not hold, arbitrageurs will exploit the mispricing until prices or exchange rates reverts to equilibrium. Bergman, Cheung, and Lai (2004) emphasized the latter, namely that while exchange rates adjust, prices are more sticky. Although empirical evidence on PPP is relatively weak, it is still embedded in the way many economists think about the world. Harvard professor Kenneth Rogoff (1996, p647) stated in his paper, The PPP Puzzle, that "most economists instinctively believe in some variant of purchasing power parity as an anchor for long-run real exchange rates."

The price level of the domestic currency is denoted by P_t, and is measured by the country's consumer price index (CPI). The corresponding foreign price level is measured in the same manner, and is denoted by P_t^*. If the nominal exchange rate is denoted by S_t, and if the PPP is assumed to hold, then the relationship can be expressed by the following formula: $P_t = \frac{P_{t^*}}{S_t}$

It is widely known that currencies can be over- or under-valued. This implies that the PPP does in fact not hold. For instance, transportation costs, information asymmetry, toll barriers, and trade restrictions can result in price level differences across countries. With this said, some researchers promote a long-run mean reversion towards PPP-equilibrium (Taylor, Peel, & Sarno, 2001). Because this paper is concerned with the relationship between two currencies, we find it more relevant to consider changes in the relative PPP. The PPP-variable is thus constructed by considering the relationship between two countries' consumer price index (CPI).

The following equation for PPP is applied in the forecasting regression:

$$\Delta \text{PPP} = \Delta \ln\left(\frac{CPI}{CPI^*}\right) \quad (1)$$

2.3 Terms of Trade (TOT)

Another interesting variable in exchange rate academia is the Terms of Trade (TOT). The ratio relates to a country's current accounts and the balance of trade. TOT can be defined in several different ways, but all measurements incorporate a country's exports and imports. In a paper written on behalf of the research department of the Federal Reserve Bank of New York, Chris Broda defines terms of trade as the ratio of export prices to import prices in the same currency (2002). The rationale behind the relationship between TOT and exchange rates is that whenever a country is exporting, demand for their currency will directly or indirectly increase. The currency will directly increase if settlement is in the exporting country's domestic currency, and the buyer must first acquire the currency before settlement. On the other hand, if the export is settled in foreign currency, the exporting company would want to exchange their foreign currency for domestic currency, and the domestic currency demand will indirectly increase. Both above examples will lead to an appreciation of the domestic currency

(Mendoza, 1995). On the contrary, when a country imports, the supply of domestic currency increase and domestic currency depreciates. Studies have found the existence of a long-run cointegrating relationship between TOT and exchange rates, and more importantly, that the causality runs from TOT to the exchange rate (Amano & Norden, 1998).

One of the important features of this paper is the definition of the TOT-variable. As trade constitutes varying importance for the countries' overall economy, we introduced a discount multiplier based on total trade as a fraction of GDP. We find it reasonable to assume that a change in TOT will have a larger impact on the currency of a country whose economy is largely exposed to international trade, than what it has for a currency in a more self-sufficient economy. Moreover, since exchange rates concern with the relationship between two countries, the relative change in two countries' TOT is considered. In the forecasting regression, TOT is therefore expressed by the following formula:

$$\Delta TOT = \Delta\left(\frac{Exp}{Imp} * \frac{(Exp+Imp)}{GDP}\right) \quad (2)$$

2.4 Interest Rate Differential (IRD)

Interest rates are another factor addressed by economists when trying to predict exchange rates. Two important theories in financial literature is the Uncovered Interest Parity (UIP) and the Covered Interest Parity (CIP). Both theories are no-arbitrage theories and aims to explain how the interest rate differences relates to exchange rates. The UIP-theory propose a no-arbitrage condition based on differences in interest rates. Consider an investor who lends in one currency, converts the funds to another currency, and invests in the new currency's money market. The UIP then states that the future exchange rate must adjust so that no profit or loss can incur due to differences in the two currencies' interest rate. An implication of this is that the currency of a high-yielding economy must depreciate against the currency of a low-yielding economy. The CIP, on the other hand, suggests that forward exchange rates is set by differences in interest rates. The same no-arbitrage principle as in the UIP applies. Here, just like in the UIP, consider a trader who lends in one currency, converts the funds to a different currency, and invests the funds in the new currency's interest market. Also, consider that at the same time the trader would fix the future exchange rate by application of forward contracts. In this way, the trader would know the exact future exchange rate, and thus remove any risk of exchange rate fluctuation. The CIP-theory explains that the future forward exchange rate must be set so that there cannot be obtained any profit due to interest rate discrepancies.

Even though these parity theories are largely taught in financial theory, several researchers have questioned their validity. Empirical evidence has shown that in general, low-yielding currencies seem to depreciate against high-yielding currencies (Flood & Rose, 2002). This is quite contrary to what the UIP-theory suggests. For instance, a research paper by Rogoff et al. (2015) showed that when using daily frequencies, the UIP-model had no power in predicting exchange rates. Another study concluded that since the uncovered carry trade is risky, traders are likely to collect a profit (Cavallo, 2006). On the other hand, other studies found that when accounting for transaction costs in U.K and Germany after abolition of capital controls, there has been almost no arbitrage profit, lending support to CIP-theories (Feenstra & Taylor, 2008).

As it seems, while the empirical evidence for the UIP-theory is weak, evidence for the CIP-theory is more robust. A reasonable explanation is that whereas UIP is associated with risk, the CIP is risk-free and should not yield excess returns. Since empirical evidence suggests there does indeed exist a relationship between interest rates and exchange rates, the interest rate differential (IRD) is included as a control variable in our research. The IRD captures the differences in 1-month deposit rates between the US and the country of interest, and is expressed by Equation 3. Note that the interest rates are converted from nominal to real rates by application of CPI deflators.

$$\mathrm{IRD} = \frac{\mathrm{r_f}}{\mathrm{CPI}} - \frac{\mathrm{r_f^*}}{\mathrm{CPI^*}} \qquad (3)$$

2.5 Commodity Price Index (Com.Index)

This paper aims to establish a relationship between exchange rates and commodity prices. In order to statistically quantify this relationship, a variable considering country specific export-weighted commodity prices were developed. Chen et. al. (2010) provides a sound measure of commodity price index, which we use as a basis in defining our variable.

First, commodity exports were obtained from separating commodities from each country's total exports. The commodity exports were then inflated, to aggregate to a 100%. After this, the country specific export-weights were matched to its corresponding S&P and Goldman Sachs'(SPGS) commodity price index. As opposed to the research conducted by Chen et al, where aggregate export-weights were constant over the entire sample period, this study rebalance the export-weights every five years. Since countries' trading patterns change over the research period, it is our strong belief that the five-year rebalancing increases the quality and preciseness of the research. With this said, the mean of export-weights used in this study largely coincide with the ones presented in the study by Chen et. al. (2010). The export-weights are presented in Table 1. An important consideration is the varying ratio of exported commodities to total exports for the different countries. For instance, in Japan, the EU, and the UK, because commodities constitute such a small fraction of total exports, the commodity export weights are highly volatile. Moreover, the export weights in these countries are severely inflated, rendering the variables largely exposed to measurement errors. Because of unavailable data for EU exports, German exports are used for reference. The country-specific commodity price indexes are expressed as can be seen in the following equation.

$$\Delta Com.Index = \Delta(w_1 PM_i + w_2 IM_i + w_3 EN_i + w_4 LS_i + w_5 AG_i) \qquad (4)$$

where PM=Precious Metals, IM=Industrial Metals, EN=Energy, LS=Livestock, and AG=Agriculture, and w_n denotes country specific export-weights.

Table 1 - Country specific commodity export-weights from 1990-2016 with five year rebalancing

Export-weights are presented in percentage of total commodity exports

Country	SPGS Index	Period				
		1990-1994	1995-1999	2000-2004	2005-2009	2010-2016
Australia	Precious Metals	7,3	11,6	7,7	6,4	6,9
	Industrial Metals	28,7	27,9	32,0	39,7	44,9
	Energy	25,7	22,2	26,5	36,4	29,4
	Livestock	21,8	19,3	17,4	8,7	8,3
	Agriculture	16,5	19,1	16,3	8,9	10,4
New Zealand	Precious Metals	2,1	1,1	1,2	1,7	2,0
	Industrial Metals	5,5	6,0	4,4	5,0	3,0
	Energy	2,3	2,3	2,3	10,6	3,8
	Livestock	63,1	62,8	59,5	55,9	63,5
	Agriculture	26,9	27,8	32,6	26,8	27,6
Canada	Precious Metals	4,4	4,2	3,0	4,8	8,8
	Industrial Metals	17,7	16,3	13,1	17,6	13,8
	Energy	20,3	18,7	36,3	47,0	44,1
	Livestock	9,2	9,4	8,8	5,7	6,1
	Agriculture	48,4	51,4	38,8	24,9	27,2
Norway	Precious Metals	0,1	0,2	0,1	0,1	0,3
	Industrial Metals	12,0	12,2	9,0	8,8	5,5
	Energy	66,8	65,1	79,4	82,6	83,5
	Livestock	14,2	15,5	8,7	6,8	9,9
	Agriculture	6,8	7,0	2,8	1,7	0,8
UK	Precious Metals	26,3	25,7	21,6	19,2	21,9
	Industrial Metals	12,2	16,7	9,2	13,6	9,6
	Energy	26,5	20,2	39,7	43,2	41,2
	Livestock	25,3	26,9	22,0	17,6	21,7
	Agriculture	9,6	10,6	7,6	6,4	5,6
Japan	Precious Metals	3,9	8,7	2,0	24,9	25,8
	Industrial Metals	54,1	48,9	57,0	42,0	46,4
	Energy	6,0	5,2	5,6	4,1	2,8
	Livestock	24,9	24,9	26,8	22,7	20,6
	Agriculture	11,2	12,2	8,6	6,3	4,4
EU	Precious Metals	3,5	0,7	1,0	2,7	5,9
	Industrial Metals	32,3	36,2	31,4	34,8	24,1
	Energy	2,8	1,9	3,3	6,3	10,6
	Livestock	42,6	41,1	49,4	41,0	44,2
	Agriculture	18,7	20,1	14,9	15,2	15,3

2.6 Limitations

Due to the scope of this paper, certain simplifications have been made. We will leave it to future research to address these limitations and thus improve the quality of the research.

Firstly, this paper considers monthly data. As argued by Ferraro et al. (2015), monthly data may not be frequent enough, because the currency market is highly liquid and forward looking. However, due to limited availability of high-frequent data, a higher frequency is hard, or maybe even impossible, to implement. If possible, future research should increase frequency and thus also improve the robustness of the results.

The strong ties to the U.S. Dollar may induce endogenous parameters. This is apparent when considering the weaker results from the GBP robustness test. Another limitation of this paper is that the model is built entirely on econometric measures, i.e. no explanatory variables require subjective assessments. Commodity prices may in some cases be easily predicted by knowledgeable market participants, while at the same time fail to be predicted by econometric measures. For instance, a draught would likely increase the price of agricultural products and livestock. Such omitted variables could result in parameter instabilities. Even though some of the countries may have some market power for certain products, the countries are relatively small compared to the overall commodity market, and can thus be assumed to be price takers. As such, commodity price fluctuations can be considered an exogenous shock to the countries' exchange rates (Chen et al., 2010). With regards to interest rates, this paper only considers short-term rates. Some would argue that introducing long-term interest rates, or including both long- and short-term interest rates, would increase the quality of the research. (Ferraro et al., 2015)

Another limitation is the five-year rebalancing of the export weights with regards to the independent variable commodity price index. Although the weights are fairly stable over a five-year period, an increased frequency of rebalancing would further improve the precision of the research.

Lastly, the forecasting model could be tested both in- and out-of-sample. By applying a forecasting loop, together with the inclusion of a sound investment strategy, the model could be able to establish profits in a more realistic scenario. Establishing an out-of-sample predictive ability would significantly enhance the contribution to existing literature, as no important previous study has managed to provide this on a monthly basis.

2.7 Assumptions

Commodities are grouped into five different categories (S&P and Goldman Sachs' commodity indices). This may be a somewhat simplified assumption, as there may be significant variations within a commodity group. Another important assumption is that Germany is a good proxy for EU pre-1999, with regards to total imports, total exports, exchange rates, CPI, and interest rates. Germany is also used as a proxy for EU over the entire sample period with regards to the commodity export weights. Moreover, inflation is measured by the countries' consumer price index (CPI).

3.0 Research Question & Hypotheses

As can be understood from the previous section, the subject of exchange rate forecasting is a vast field in finance. In a world market characterized by globalization and international trade, exchange rate prediction is as important as ever. No matter who you are, and what you do, you are either directly or indirectly subject to a significant exchange rate risk. For a multinational corporation, exchange rate exposure is of vital importance. Large multinationals spends great amounts of money each year to hedge their currency exposure (Allayannis, Ihrig, & Weston, 2001). Smaller companies operating exclusively on the national stage are exposed to currency fluctuations for instance through the cost of important business inputs. Even a common citizen, who is completely uninvolved in international business, is subject to exchange rate risks through the price of consumer goods. Knowledge and information about exchange rates is therefore important for all people living in the civilized world, and a better understanding of exchange rate fluctuations will promote stability and prosperity in the future world economy.

The main purpose of this paper is to contribute to existing literature by assessing whether commodity prices have predictive power with regards to exchange rates in developed commodity exporting countries. In order to consider our research question, *can commodity prices predict exchange rates in developed economies*, we will address the following main hypothesis:

H_0: Commodity prices cannot predict exchange rates in developed economies.

(1)

H_A: Commodity prices can predict exchange rates in developed economies.

Moreover, in order to test whether commodity prices have a different impact on commodity exporting countries compared to non-commodity exporting countries, we will also address the following sub-hypothesis:

H_0: Commodity prices have the same impact on exchange rates in commodity exporting countries and non-commodity exporting countries.

(2)

H_A: Commodity prices have a different impact on exchange rates in commodity exporting countries and non-commodity exporting countries.

Finally, we also test whether the traditional macroeconomic fundamentals of interest rates, purchasing power parity, and terms of trade can predict exchange rates in developed economies.

H_0: Traditional macroeconomic fundamentals cannot predict exchange rates in developed economies

(3)

H_A: Traditional macroeconomic fundamentals can predict exchange rates in developed economies.

4.0 Methodology

Explanatory variables applied in the research were calculated according to what is described in Section 2. Since the purpose of the paper is to explain a relationship between two currencies, relative factors are considered. This implies that several calculations were necessary with regards to the applied variables. The basic dependent variable of assessing exchange rate changes considers the natural log difference between two currencies (X^* / USD) from one month to the next, and is given by the following equation:

$$\Delta lnFX = ln\left(\frac{\frac{X^*_{t+1}}{USD_{t+1}}}{\frac{X^*_t}{USD_t}}\right) \tag{5.1}$$

where X denotes different currencies.

To consider this from an investor's point of view, as an investment strategy, we are also interested in considering the dependent variable of exchange rate returns. The dependent variable representing the investment strategy is given by the following formula:

$$\Delta lnRetFX = ln\left(\frac{\frac{X^*_{t+1}}{USD_{t+1}}}{F\left(\frac{X^*}{USD}\right)_{t,t+1}}\right) \tag{5.2}$$

where F denotes 1-month forward rates.

The investment strategy represents a zero net-investment by entering into a currency forward contract each month in our sample period.

In the first step of our research, we run a simple OLS-regression on all the different currencies separately. Previous studies have argued that co-integrated models and nonlinear models does not perform better than the simple OLS-regression (Ferraro et al., 2015). Running the different OLS-regressions allows us to examine the relationship between exchange rate changes and our explanatory variables. First, we run a simple OLS regression, including the traditional macroeconomic variables. The regression is as follows:

$$\Delta lnRetFX_t = \alpha + \beta_1 \Delta IRD_{t-1} + \beta_2 \Delta TOT_{t-1} + \beta_3 \Delta PPP_{t-1} + \varepsilon \tag{6}$$

We proceed by including the commodity price index in the regression, in order to assess whether commodity price changes can yield predictive ability for exchange rates.

$$\Delta lnRetFX_t = \alpha + \beta_1 \Delta IRD_{t-1} + \beta_2 \Delta TOT_{t-1} + \beta_3 \Delta PPP_{t-1} + \beta_4 \Delta Com.Index_{t-1} + \varepsilon \quad (7)$$

In order to improve the single equation estimates, a seemingly unrelated regression (SUR) are run. A SUR can improve the efficiency in estimation by combining information on different equations to utilize the equation's common factors and correlation of residuals (Moon & Perron, 2006). More precisely put, the SUR is applied to check whether the estimated coefficients are similar across countries. Furthermore, a Breusch-Pagan test of independence was applied to test for correlation between residuals. After obtaining the unrestricted SUR estimates we run a restricted SUR to test cross-equation constrains, where coefficients are constrained to be equal across countries.

Moreover, we introduce a new restricted SUR set of equations. A dummy variable is introduced, so that commodity exporting countries can be separated from non-commodity exporting countries. At first, $\Delta \mathrm{Com.Index}$ is excluded from the regression, and the effect of commodity price changes is relevant only for the commodity exporting countries. The SUR set of equations is as follows:

$$\Delta lnRetFX_t = \alpha + \beta_1 \Delta IRD_{t-1} + \beta_2 \Delta TOT_{t-1} + \beta_3 \Delta PPP_{t-1} + \boldsymbol{\phi} \beta_4 \Delta Com.Index_{t-1} + \varepsilon$$

where $\boldsymbol{\phi} \begin{cases} 1\ if\ com.exporter \\ 0\ if\ non-com.exp. \end{cases} \quad (8)$

We proceed by including $\Delta \mathrm{Com.Index}$ in the SUR set of equations. Here, the dummy variable tests whether the estimated coefficients have a different impact on commodity exporters compared to non-commodity exporters. The SUR set of equations looks as follows:

$$\Delta lnRetFX_t = \alpha + \beta_1 \Delta IRD_{t-1} + \beta_2 \Delta TOT_{t-1} + \beta_3 \Delta PPP_{t-1} + \beta_4 \Delta Com.Index_{t-1} + \boldsymbol{\phi} \beta_4' \Delta Com.Index_{t-1} + \varepsilon$$

$$\text{where } \boldsymbol{\phi} \begin{cases} 1\ if\ com.exporter \\ 0\ if\ non-com.exp. \end{cases} \quad (9)$$

From the estimated coefficients in the above equation, we get that

$\beta_{com} = \beta_4 + \beta_4'$

$\beta_{non-com} = \beta_4$

Hence, if $\beta_4' \neq 0$, commodity prices have a different impact on commodity currencies compared on non-commodity currencies.

In order to test the robustness of our findings, the exact same approach as outlined above is conducted while restating all the quantities with the GBP as numeraire currency. The robustness test only considers exchange rate changes.

5.0 Data

The data used in this paper is mainly collected via Datastream and the Bloomberg Terminal. All exchange rates are collected from Bloomberg, while macroeconomic fundamentals are collected from Thompson Reuter's. The country specific export-weights were constructed with data from The Center for International Data from Robert Feenstra (1990-2000) and from UN COMTRADE (2001-2016). The export-weights where collected via The Observatory of Economic Complexity, an online visualization supported by the MIT Media Lab. For commodity prices, Standard & Poors and Goldman Sachs (SPGS) Commodity Indices are applied. The commodity prices are categorized into the following categories: Energy, Livestock, Agriculture, Precious Metals, and Industrial Metals. The data for EU pre-1999 is proxied on Germany, and is collected from Deutsche Bundesbank. A summary of the data sources applied in this paper can be seen in Appendix 1.

All data used in this paper is from end-of-month, and our sample period is 1990-2016. Since all macro fundamentals as well as Australian and New Zealand CPI are reported on a quarterly basis, this data is transformed to monthly data with a twelve-month moving average for missing months. What is more, the entire dataset is untrimmed. As the summary statistics are almost identical for both exchange rate changes and exchange rate returns, only the exchange rate returns are presented in the paper. Summary statistics for exchange rate changes can be found in Appendix 2.

Table 2 - Summary statistics of dependent variables

Dollar denominated foreign exchange returns in natural logs.
A total of 319 end of month obervations from 1990M5 to 2016M12.

	Mean	Median	St.dev	Min	Max
Δln (CAD/ F(*))	-0.00016	6.10e-05	0.02315	-0.13157	0.09060
Δln (NOK/ F(*))	0.00037	0.0030	0.03189	-0.13535	0.07825
Δln (AUD/ F(*))	0.00175	0.0042	0.03360	-0.17273	0.10166
Δln (NZD/ F(*))	0.00230	0.0055	0.03372	-0.13720	0.12680
Δln (JPY/ F(*))	-0.00121	-0.0025	0.03157	-0.10144	0.15832
Δln (EUR/ F(*))	0.00473	0.0052	0.03148	-0.10598	0.09590
Δln (GBP/ F(*))	0.00016	1.62e-04	0.02795	-0.13020	0.09067

* Indicates the lagged dollar denominated forward rate for the applicable currency

The mean of exchange rate returns is, as expected when considering log-returns, close to zero for all currencies. The highest volatility is found in the returns for AUD and NZD. There are also some observations characterized by large amplitudes.

Table 3 - Correlation matrix of dependent variables

Dollar denominated foreign exchange returns in natural logs. A total of 319 end of month obervations from 1990M5 to 2016M12.

	Δln (CAD/ F(*))	Δln (NOK/ F(*))	Δln (AUD/ F(*))	Δln (NZD/ F(*))	Δln (JPY/ F(*))	Δln (EUR/ F(*))	Δln (GBP/ F(*))
Δln (CAD/ F(*))	1.0000						
Δln (NOK/ F(*))	0.4961	1.0000					
Δln (AUD/ F(*))	0.6579	0.5297	1.0000				
Δln (NZD/ F(*))	0.5706	0.5146	0.8072	1.0000			
Δln (JPY/ F(*))	0.0658	0.2575	0.1369	0.1976	1.0000		
Δln (EUR/ F(*))	0.3832	0.7928	0.4937	0.5488	0.3055	1.0000	
Δln (GBP/ F(*))	0.3614	0.6302	0.3890	0.4159	0.1709	0.6358	1.0000

* Indicates the lagged dollar denominated forward rate for the applicable currency

First, it is apparent that the correlations between the exchange rate returns for commodity exporting countries are generally higher than what it is for non-commodity exporters. Secondly, there are no negative correlations between any of the exchange rate changes. Also, note that the exchange rate changes/returns between EUR & NOK and AUD & NZD are highly correlated. This is rather unsurprising, as the economies have strong economic ties and similarities.

Table 4 - Summary statistics of independent variables.

IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity.
Com.Index = Country specific Commodity index. A total of 319 end of month obervations from 1990M5 to 2016M12.

	Mean	Median	St.dev	Min	Max
CAD					
IRD	-0.00422	-0.0038	0.01152	-0.04328	0.02125
ΔTOT	0.00060	8.87e-04	0.00923	-0.04326	0.03277
ΔPPP	0.00002	1.06e-04	0.00439	-0.02720	0.02297
ΔCom.Index	0.00331	0.0072	0.05149	-0.21126	0.15139
NOK					
IRD	-0.01350	-0.0112	0.02126	-0.11969	0.02072
ΔTOT	0.00109	6.49e-04	0.03938	-0.23354	0.15012
ΔPPP	-1.02e-06	1.58e-04	0.00579	-0.02546	0.02332
ΔCom.Index	0.00472	0.0075	0.07171	-0.21144	0.22878
AUD					
IRD	-0.01859	-0.0196	0.01398	-0.05571	0.01117
ΔTOT	0.00051	8.54e-04	0.00761	-0.0503	0.04276
ΔPPP	8.94e-06	-1.37e-05	0.00450	-0.01730	0.02208
ΔCom.Index	0.00318	0.0075	0.04819	-0.20891	0.14268
NZD					
IRD	-0.02312	-0.0230	0.01190	-0.05324	0.01506
ΔTOT	0.00024	-9.61e-05	0.01205	-0.07045	0.05470
ΔPPP	4.82e-07	-3.08e-06	0.00407	-0.01226	0.02268
ΔCom.Index	0.00142	0.0016	0.03551	-0.18868	0.13090
JPY					
IRD	0.01720	0.0107	0.01905	-0.01817	0.05433
ΔTOT	0.00006	9.39e-05	0.00247	-0.01746	0.01199
ΔPPP	-2.22e-06	-1.93e-04	0.00509	-0.01922	0.01761
ΔCom.Index	0.00296	0.0031	0.03999	-0.15442	0.14967
EUR					
IRD	-0.00090	0.00092	0.01696	-0.05362	0.02468
ΔTOT	0.00139	0.00220	0.00634	-0.03588	0.02678
ΔPPP	8.16e-06	1.73e-04	0.00524	-0.01854	0.01792
ΔCom.Index	0.00207	0.00300	0.03694	-0.20206	0.11904
GBP					
IRD	-0.01221	-0.0061	0.01511	-0.05868	0.00856
ΔTOT	0.00071	0.0011	0.01076	-0.09143	0.04105
ΔPPP	5.06e-06	3.14e-04	0.00634	-0.02827	0.02877
ΔCom.Index	0.00336	0.0031	0.04813	-0.17631	0.15230

Table 5 - Correlation matrices of variables used in OLS regression for exchange rate returns.

IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity.
Com.Index = Country specific Commodity index. A total of 319 end of month obervations from 1990M5 to 2016M12.

	Δln (X/USD)	IRD	ΔTOT	ΔPPP	ΔCom.Index
Canada					
Δln (CAD/F(*))	1.0000				
IRD	-0.0187	1.0000			
ΔTOT	-0.0702	-0.0769	1.0000		
ΔPPP	-0.0473	-0.0006	0.0036	1.0000	
ΔCom.Index	0.1974	0.0268	-0.0188	0.0230	1.0000
Norway					
Δln (NOK/F(*))	1.0000				
IRD	0.0396	1.0000			
ΔTOT	0.0694	0.0314	1.0000		
ΔPPP	-0.0080	0.0019	-0.1554	1.0000	
ΔCom.Index	0.1059	0.0608	0.0913	0.0644	1.0000
Australia					
Δln (AUD/F(*))	1.0000				
IRD	-0.0653	1.0000			
ΔTOT	-0.0080	-0.0222	1.0000		
ΔPPP	-0.0625	-0.0299	-0.0486	1.0000	
ΔCom.Index	0.1414	-0.0326	-0.1000	0.1867	1.0000
New Zealand					
Δln (NZD/F(*))	1.0000				
IRD	0.0061	1.0000			
ΔTOT	0.0867	0.0404	1.0000		
ΔPPP	-0.0739	-0.0263	-0.0196	1.0000	
ΔCom.Index	0.1413	0.0256	-0.0633	0.0261	1.0000
Japan					
Δln (JPY/F(*))	1.0000				
IRD	-0.0511	1.0000			
ΔTOT	-0.0082	0.0267	1.0000		
ΔPPP	-0.1102	0.0034	0.0209	1.0000	
ΔCom.Index	-0.0478	0.0188	0.0779	0.0957	1.0000
Eurozone					
Δln (EUR/F(*))	1.0000				
IRD	-0.0129	1.0000			
ΔTOT	-0.0635	0.1803	1.0000		
ΔPPP	-0.0769	-0.0048	0.0499	1.0000	
ΔCom.Index	0.0934	0.0511	0.1345	0.0484	1.0000
United Kingdom					
Δln (GBP/F(*))	1.0000				
IRD	0.0167	1.0000			
ΔTOT	0.0260	0.0075	1.0000		
ΔPPP	-0.0015	-0.0155	0.0767	1.0000	
ΔCom.Index	0.1562	0.0286	0.0902	0.0532	1.0000

* Indicates the lagged dollar denominated forward rate for the applicable currency

From the above table, we can see that *Δ*PPP is negatively correlated with exchange rate change/return for all of the currencies, implying that higher inflation will generally lead to a depreciation of the currency. We also see that *Δ*Com.Index is positively correlated with exchange rate changes in all countries except for Japan.

6.0 Analysis (Results & Discussion)

The regression results are quite similar for exchange rate changes and exchange rate returns. Because the interest rates and forward rates are closely related, the IRD variable produce stronger statistical significance for exchange rate returns than what it does for exchange rate changes. Hence, only the exchange rate returns are presented in the paper. Results for exchange rate changes can be found in Appendix 3. Moreover, note that when discussing appreciation and depreciation with regards to foreign exchange returns, we consider an appreciation or a depreciation of the currency compared to what is implied by the forward rates.

Table 6 - Predicting USD denominated currency returns with fundamentals

Simple OLS Regression results for individual U.S. dollar nominated exchange rate returns in natural logs.
$\Delta \ln (X / F(Y^t)) = \alpha + IRD + \Delta TOT + \Delta PPP$. Where Y^t indicates the lagged dollar denominated forward rate for the applicable currency. IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis.
319 end of month obervations from 1990M5 to 2016M12.

	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	-0.001	0.000	-0.003	0.000	0.002	0.005	-0.001
	(0.628)	(0.934)	(0.307)	(0.921)	(0.405)	(0.006)***	(0.720)
IRD, t-1	-0.151	-0.036	-0.271	-0.106	-0.183	-0.306	-0.069
	(0.192)	(0.668)	(0.048)**	(0.506)	(0.047)**	(0.003)***	(0.507)
ΔTOT, t-1	-0.182	0.056	-0.047	0.238	-0.056	-0.294	0.063
	(0.196)	(0.225)	(0.848)	(0.129)	(0.936)	(0.298)	(0.660)
ΔPPP, t-1	-0.239	0.053	-0.514	-0.610	-0.668	-0.407	0.026
	(0.417)	(0.866)	(0.218)	(0.189)	(0.054)*	(0.220)	(0.915)
R^2	0.012	0.005	0.017	0.014	0.024	0.039	0.002

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels. 319 monthly observations.

Unsurprisingly, it is apparent the traditional macroeconomic variables produce little statistical significance. This result is aligned with previous studies, suggesting that no link between economic macro-fundamentals and exchange rates exist (Meese & Rogoff, 1983). However, the IRD variable is significant for EUR, JPY, and AUD. Since the same is untrue when considering exchange rate changes (See Appendix 3), we believe that this is a direct result of the ties between forward rates and interest rates.

Table 7 - Predicting USD denominated currency returns with fundamentals and commodity indices.

Simple OLS Regression results for individual U.S. dollar nominated exchange rate returns in natural logs.
$\Delta \ln (X / F(Y^1)) = \alpha + IRD + \Delta TOT + \Delta PPP + \Delta Com.Index$. Where Y^1 indicates the lagged dollar denominated forward rate for the applicable currency. IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity.
Com.Index = Country specific commodity index. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis. 319 end of month obervations from 1990M5 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	-0.001	0.000	-0.003	0.000	0.002	0.005	-0.001
	(0.456)	(0.819)	(0.275)	(0.974)	(0.394)	(0.007)***	(0.581)
IRD, t-1	-0.161	-0.044	-0.259	-0.012	-0.183	-0.311	-0.076
	(0.157)	(0.602)	(0.056)*	(0.443)	(0.049)**	(0.003)***	(0.459)
ΔTOT, t-1	-0.174	0.048	0.019	0.266	-0.029	-0.365	0.028
	(0.209)	(0.299)	(0.937)	(0.087)*	(0.968)	(0.199)	(0.844)
ΔPPP, t-1	-0.262	0.008	-0.736	-0.645	-0.652	-0.430	-0.003
	(0.364)	(0.980)	(0.080)*	(0.161)	(0.062)*	(0.194)	(0.990)
ΔCom.Index, t-1	0.089	0.043	0.115	0.145	-0.023	0.086	0.090
	(0.000)***	(0.090)*	(0.004)***	(0.006)***	(0.609)	(0.073)*	(0.005)***
R^2	0.052	0.014	0.043	0.037	0.025	0.049	0.027

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels.

We find that the explanatory variable *Δ*Com.Index is statistically significant for all countries except for Japan. On the contrary, other explanatory variables are mainly insignificant for all independent variables in all countries. The significance of the variables is quite similar to what found in table 6, with the only difference being somewhat stronger results for AUD in table 7. It is also apparent that when introducing the commodity index-variable, the R^2 improves for all currencies. This finding is unsurprising, as the introduction of a new significant variable will increase the precision of the model. A possible explanation for why commodity prices are significant even for non-commodity currencies is that the same commodity indices are used as a proxy for all different countries. This again relates to the strong ties between commodity prices and the USD, as argued by Ferraro et al. (2015).

Table 8 - Predicting USD denominated currency returns using unrestriced SUR

Unrestricted seemingly unrelated regression results for individual U.S. dollar nominated exchange rate returns in natural logs.
$\Delta \ln (X / F(Y^1)) = \alpha + IRD + \Delta TOT + \Delta PPP + \Delta Com.Index$. Where Y^1 indicates the lagged dollar denominated forward rate for the applicable currency. IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity.
Com.Index = Country specific commodity index. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis. 319 end of month obervations from 1990M5 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	-0.001	-0.001	-0.001	0.001	0.002	0.005	0.000
	(0.606)	(0.731)	(0.758)	(0.805)	(0.372)	(0.004)***	(0.966)
IRD, t-1	-0.089	-0.069	-0.130	-0.090	-0.185	-0.259	0.010
	(0.319)	(0.236)	(0.136)	(0.397)	(0.036)**	(0.000)***	(0.902)
ΔTOT, t-1	0.002	0.055	0.087	0.097	0.378	-0.336	-0.011
	(0.986)	(0.030)**	(0.520)	(0.290)	(0.575)	(0.033)**	(0.916)
ΔPPP, t-1	-0.057	0.131	-0.689	-0.682	-0.538	-0.122	0.142
	(0.788)	(0.458)	(0.006)***	(0.021)**	(0.100)*	(0.518)	(0.430)
ΔCom.Index, t-1	0.047	0.011	0.022	0.042	-0.034	0.019	0.060
	(0.023)**	(0.503)	(0.413)	(0.237)	(0.431)	(0.521)	(0.017)**
R^2	0.036	0.009	0.021	0.022	0.023	0.040	0.021

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels.

Utilizing the equation's common factors in an unrestricted SUR does not improve our estimates, as the R^2 is lower for all currencies. This is expected because we have several parameters and set of equations, yet relatively few observations. The lower R^2 implies that the independent variables are significantly less correlated than their error terms. Hence, we must impose restrictions to fully utilize the error terms' common factors (Zellner, 1962). We observe that the same variables have significance as the ones in the single OLS equations, but notably less robust.

Furthermore, a Breusch-Pagan test of independence with χ^2 (21) = 1512.86 shows a strong correlation between the residuals, implying that endogenous factors exists.

Table 9 - Predicting USD denominated currency returns using restriced SUR

Restricted seemingly unrelated regression results for individual U.S. dollar nominated exchange rate returns in natural logs. $\Delta \ln (X / F(Y^1)) = \alpha + IRD + \Delta TOT + \Delta PPP + \Delta Com.Index$. Where Y^1 indicates the lagged dollar denominated forward rate for the applicable currency. IRD = Interest rate differential. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis. 319 end of month obervations from 1990M5 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.799)	(0.799)	(0.799)	(0.799)	(0.799)	(0.799)	(0.799)
IRD, t-1	-0.052	-0.052	-0.052	-0.052	-0.052	-0.052	-0.052
	(0.087)*	(0.087)*	(0.087)*	(0.087)*	(0.087)*	(0.087)*	(0.087)*
ΔTOT, t-1	0.048	0.048	0.048	0.048	0.048	0.048	0.048
	(0.041)**	(0.041)**	(0.041)**	(0.041)**	(0.041)**	(0.041)**	(0.041)**
ΔPPP, t-1	-0.136	-0.136	-0.136	-0.136	-0.136	-0.136	-0.136
	(0.148)	(0.148)	(0.148)	(0.148)	(0.148)	(0.148)	(0.148)
ΔCom.Index, t-1	0.025	0.025	0.025	0.025	0.025	0.025	0.025
	(0.060)*	(0.060)*	(0.060)*	(0.060)*	(0.060)*	(0.060)*	(0.060)*
R^2	0.021	0.012	0.015	0.010	0.007	-0.010	0.013

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels. 319 monthly observatios

While the unrestricted SUR fails to improve our estimates, the same is not true for the restricted. Even though the R^2 is lower than for the unrestricted SUR, the coefficient estimates improve significantly. This is expected due to the strong correlation of the disturbance terms of the independent variables (ref. Breusch-Pagan test), and also because the error term's common factors are now utilized better than in the unrestricted version set of equations. By exploiting some of the endogeneity for the independent variables, it is also apparent that the restricted SUR obtains statistical significance for the macroeconomic variables interest rates and terms of trade.

As can be read from the above table, the interest rate differential is negative and statistically significant. A negative IRD-variable implies that the currency of a country with a relatively high interest rate is likely to appreciate over the next month. This is quite the contradictory to what the UIP-theory predicts. This again implies that a carry-trade investment strategy will on average produce profits, consistent with existing literature (Brunnermeier, Nagel, & Pedersen, 2008).

Moreover, the restricted SUR yields a positive and significant TOT-variable, suggesting that a country whose relative TOT improves is likely to experience an appreciation of its currency over the next month. This finding is aligned with what is predicted by existing models built on TOT, namely that an improvement in terms of trade will lead to an increase demand for that country's currency, again leading to an inflationary pressure on the currency.

The negative coefficient on the PPP-variable implies that a country with a relatively high inflation rate is likely to experience a depreciation of its currency over the next month. The robustness of this finding is, however, rather weak, as the PPP-coefficients are statistically insignificant.

Furthermore, it is apparent that the commodity price index has significant predictive ability in the restricted SUR. The positive coefficient implies that when the price of a country's exporting commodities increase, the country's currency will in general strengthen over the next month. A parallel can be drawn to the Norwegian Krone, which has tracked the price of oil quite closely over the last decades (Ferraro et al., 2015).

Considering this from an investor's point of view, the results yields a clear indication that profits can be made. Even though this paper does not provide evidence of actual accumulated profits over time, the statistical significance found in table 9 does imply that there is predictive power, and thus also a possibility of making a profit. With this said, in order to draw any robust conclusions, an investment model where exchange rates are invested in through a rolling out-of-sample forecast should be applied. Due to the limited scope of this paper, we leave this to future researchers.

Table 10 - Predicting USD denominated currency returns using commodity dummy in a restriced SUR

Restricted seemingly unrelated regression results for individual U.S. dollar nominated exchange rate returns in natural logs.
$\Delta \ln (X / F(Y^1)) = \alpha + IRD + \Delta TOT + \Delta PPP + \phi^* \Delta Com.Index$. Where Y^1 indicates the lagged dollar denominated forward rate for the applicable currency. ϕ represents a dummy variable that takes value of 1 for commodity exporter, 0 for non-commodity exporter.
IRD = Interest rate differential. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index.
All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis.
319 end of month obervations from 1990M5 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.825)	(0.825)	(0.825)	(0.825)	(0.825)	(0.825)	(0.825)
IRD, t-1	-0.051	-0.051	-0.051	-0.051	-0.051	-0.051	-0.051
	(0.096)*	(0.096)*	(0.096)*	(0.096)*	(0.096)*	(0.096)*	(0.096)*
ΔTOT, t-1	0.046	0.046	0.046	0.046	0.046	0.046	0.046
	(0.052)*	(0.052)*	(0.052)*	(0.052)*	(0.052)*	(0.052)*	(0.052)*
ΔPPP, t-1	-0.136	-0.136	-0.136	-0.136	-0.136	-0.136	-0.136
	(0.152)	(0.152)	(0.152)	(0.152)	(0.152)	(0.152)	(0.152)
ϕ*ΔCom.Index, t-1	0.015	0.015	0.015	0.015			
	(0.260)	(0.260)	(0.260)	(0.260)			
R^2	0.014	0.009	0.011	0.007	0.002	-0.014	0.000

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels.

By only considering commodity index variable for commodity exporters, we find notably less robust estimates compared to the results in table 11. This is somewhat surprising, as one would think that the commodity price index should have yielded stronger results in this particular case.

Table 11 - Predicting USD denominated currency returns using commodity dummy and commodity index in a restriced SUR

Restricted seemingly unrelated regression results for individual U.S. dollar nominated exchange rate returns in natural logs.
$\Delta \ln (X / F(Y^1)) = \alpha + IRD + \Delta TOT + \Delta PPP + \Delta Com.Index + \phi^* \Delta Com.Index$.
Where Y1 indicates the lagged dollar denominated forward rate for the applicable currency.
ϕ represents a dummy variable that takes value of 1 for commodity exporter, 0 for non-commodity exporter.
IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index
All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis.
319 end of month obervations from 1990M5 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.792)	(0.792)	(0.792)	(0.792)	(0.792)	(0.792)	(0.792)
IRD, t-1	-0.053	-0.053	-0.053	-0.053	-0.053	-0.053	-0.053
	(0.085)*	(0.085)*	(0.085)*	(0.085)*	(0.085)*	(0.085)*	(0.085)*
ΔTOT, t-1	0.047	0.047	0.047	0.047	0.047	0.047	0.047
	(0.045)**	(0.045)**	(0.045)**	(0.045)**	(0.045)**	(0.045)**	(0.045)**
ΔPPP, t-1	-0.139	-0.139	-0.139	-0.139	-0.139	-0.139	-0.139
	(0.140)	(0.140)	(0.140)	(0.140)	(0.140)	(0.140)	(0.140)
ΔCom.Index, t-1	0.025	0.025	0.025	0.025	0.025	0.025	0.025
	(0.066)*	(0.066)*	(0.066)*	(0.066)*	(0.066)*	(0.066)*	(0.066)*
ϕ*ΔCom.Index, t-1	0.008	0.008	0.008	0.008			
	(0.522)	(0.522)	(0.522)	(0.522)			
R^2	0.022	0.014	0.016	0.012	0.007	-0.010	0.013

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels.

In Table 11 it is apparent that estimated coefficients from $\boldsymbol{\phi}\beta_4' \Delta Com.Index_{t-1}$ is different from zero, implying that $\Delta Com.Index$ has a different impact on commodity exporting currencies than for non-commodity exporting currencies. In this particular case, the statistical significance is not important, as the $\phi\beta_4' \Delta Com.Index_{t-1}$-variable will only capture the additional explanatory power of the commodity price index on commodity exporting countries' exchange rate.

Table 12 - Correlation of USD denominated currency changes with commodities.

Correlation coefficients of USD denominated currency changes with GSCI world commodity index (GSCIW)

	CAD	NOK	AUD	NZD	JPY	EUR	GBP
GSCIW	0.8442	0.6376	0.8038	0.7949	0.6042	0.5661	0.2087

The GSCIW contains 24 commodities from the five commodity sectors: six energy products, five industrial metals, eight agricultural products, three livestock products and two precious metals.

A weakness of our initial findings is that commodities in international markets are quoted in U.S. dollar, and because the analysis is concerned with dollar denominated currencies, we expect correlation as a consequence of the common denomination.

By restating all the quantities with the GBP as the numeraire currency, we were able to consider the model from a British investor's point of view. We did this in order to check the robustness of our results, because of the problems imposed by the strong ties between the USD and the commodity prices. The robustness test proved that our concerns were indeed justified, as the significance of our findings with regards to the explanatory power of the commodity index were largely reduced. However, the robustness test yielded strong coefficients for TOT. All the results for the GBP denominated regression tests can be found in Appendix 4.

To summarize, while some of our findings are inconclusive, the restricted SUR in table 9 shows that the commodity prices does indeed yield predictive ability in forecasting exchange rates. However, because our findings fail the robustness test, we cannot trust our initial estimates. We believe that our initial significant findings on commodity prices are mainly due to the correlation with the USD, and not due to the explanatory power of commodity prices. Consequently, we keep the null in Hypothesis 1, stating that commodity prices cannot forecast exchange rates in developed economies.

Given the results in table 11, where we show that commodity prices have a different impact on commodity exporting economies compared to non-commodity exporting economies, Hypothesis 2 is rejected. The same is also apparent when using the GBP as numeraire currency.

Lastly, while TOT and IRD are statistically significant in the restricted SUR, table 6 provides no strong explanatory power for the traditional macroeconomic variables. Because of conflicting results with regards to the macroeconomic variables, we choose to keep Hypothesis 3, as no clear inferences can be made. With this said, we would like to emphasize that the TOT-variable provided strong results in the restricted SUR-tests, including the robustness test. It may be interesting for future research to look closer into our definition of this variable, as our research implies that TOT can be used to forecast exchange rates on the monthly basis.

7.0 Conclusion

This paper shows that commodity prices have predictive power on exchange rate returns when USD is used as the numeraire currency. However, because the same is not true when GBP is used as the base currency, we believe that the initial significance is due to the strong ties between commodity prices and the USD. Moreover, the paper demonstrates that commodity prices have a different impact on the exchange rates of the commodity exporting countries Norway, Australia, New Zealand, and Canada, compared to what it has on the exchange rate of similar non-commodity exporting countries. The answer to our research question is therefore; Yes, commodity prices can predict exchange rates in developed economies, but only when the USD is used as numeraire currency. The paper also shows that the traditional macroeconomic variables, interest rates, and purchasing power parity, has no concise predictive ability on exchange rates. However, our findings suggest that terms of trade exhibits predictive power on exchange rate returns on a monthly basis.

Our findings are aligned with Chen et al. (2010), in that commodity prices possess in-sample predictive ability of exchange rates, when USD is used as the numeraire currency. The findings in our paper is also consistent with existing literature, with regards to the limited predictive power of traditional macroeconomic variables (Engel et al. 2005).

For further research, we suggest employing an out-of-sample investment strategy by applying a rolling forecast. Moreover, using a larger sample size, either by increasing the sample period or by increasing the frequency, may provide stronger estimates. We also believe that the robustness of our findings should be further analyzed by considering even more currencies. Given our significant findings on TOT, we would also recommend this relationship for further research.

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9.0 Appendices

Appendix 1. Detailed Data Source Description

Appendix 1 - Detailed list of sources and platforms for data

Type	Country	Source	Platform
Exchange rates	All	Bloomberg	Bloomberg Terminal
Commodity indices	World	Standard & Poors	Datastream
CPI	U.S.	U.S. Bureau of Labor Stat.	Datastream
	Canada	CANSIM - Stat. Canada	Datastream
	Norway	Stat. Norway (SSB)	Datastream
	Australia	Australian Bureau of Stat.	Datastream
	New Zealand	Stat. New Zealand	Datastream
	Japan	Ministry of Int. Affairs & Communication	Datastream
	EU	Eurostat	Datastream
	U.K.	Office for National Stat.	Datastream
Imports/Exports/GDP	Canada	CANSIM - Stat. Canada	Datastream
	Norway	Stat. Norway (SSB)	Datastream
	Australia	Australian Bureau of Stat.	Datastream
	New Zealand	Stat. New Zealand	Datastream
	Japan	Cabinet Office Japan	Datastream
	EU	Eurostat	Datastream
	U.K.	Office for National Stat.	Datastream
Export-weights	All	1990-2000: Center for International Data from Rob. Feenstra	OEC Atlas
	All	2000-2014: UN COMTRADE	OEC Atlas
Interest Rates	U.S.	Thomson Reuters	Datastream
	Canada	Thomson Reuters	Datastream
	Norway	Thomson Reuters	Datastream
	Australia	Thomson Reuters	Datastream
	New Zealand	Thomson Reuters	Datastream
	Japan	Thomson Reuters	Datastream
	EU	Thomson Reuters	Datastream
	U.K.	Thomson Reuters	Datastream

Appendix 2. Summary Statistics on Exchange Rate Changes

Table 2.2 - Summary statistics of dependent variables for exchange rate changes

Dollar denominated foreign exchange changes in natural logs.
A total of 321 end of month obervations from 1990M3 to 2016M12.

	Mean	Median	St.dev	Min	Max
Δln (CAD/USD)	-0.00043	-0.00074	0.02294	-0.13009	0.08936
Δln (NOK/USD)	-0.00087	0.00180	0.03180	-0.13739	0.07785
Δln (AUD/USD)	-0.00015	0.00160	0.03330	-0.17108	0.09900
Δln (NZD/USD)	0.00056	0.00210	0.03345	-0.13931	0.12507
Δln (JPY/USD)	0.00093	-0.00025	0.03138	-0.09698	0.16273
Δln (EUR/USD)	-0.00050	0.00120	0.02975	-0.11235	0.09609
Δln (GBP/USD)	-0.00090	-0.00081	0.02712	-0.13137	0.09044

Table 3.2 - Correlation matrix of dependent variables for exchange rate changes

Dollar denominated foreign exchange rate changes in natural logs. A total of 321 end of month obervations from 1990M3 to 2016M12.

	Δln (CAD/USD)	Δln (NOK/USD)	Δln (AUD/USD)	Δln (NZD/USD)	Δln (JPY/USD)	Δln(EUR/USD)	Δln(GBP/USD)
Δln (CAD/USD)	1.0000						
Δln (NOK/USD)	0.5000	1.0000					
Δln (AUD/USD)	0.6584	0.5295	1.0000				
Δln (NZD/USD)	0.5705	0.5131	0.8039	1.0000			
Δln (JPY/USD)	0.0605	0.2523	0.1338	0.1943	1.0000		
Δln (EUR/USD)	0.4068	0.8392	0.5060	0.5544	0.3126	1.0000	
Δln (GBP/USD)	0.3589	0.6330	0.3870	0.4108	0.1679	0.6648	1.0000

Appendix 3. Regression Results for Exchange Rate Changes

Table 6.2 - Predicting USD denominated currency changes with fundamentals.

Simple OLS Regression results for individual U.S. dollar nominated exchange rate changes in natural logs.
Δln (X/USD) = α + IRD + ΔTOT + ΔPPP. IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis. 321 end of month obervations from 1990M3 to 2016M12.

	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	-0.001	0.000	-0.003	0.001	0.002	0.000	0.000
	(0.702)	(0.934)	(0.317)	(0.893)	(0.315)	(0.945)	(0.764)
IRD, t-1	-0.048	0.056	-0.160	0.002	-0.083	-0.004	0.029
	(0.665)	(0.505)	(0.229)	(0.989)	(0.365)	(0.965)	(0.770)
ΔTOT, t-1	-0.179	0.056	-0.055	0.237	-0.058	-0.279	0.066
	(0.201)	(0.220)	(0.821)	(0.128)	(0.935)	(0.297)	(0.642)
ΔPPP, t-1	-0.246	0.055	-0.482	-0.594	-0.678	-0.420	-0.014
	(0.401)	(0.861)	(0.246)	(0.197)	(0.050)**	(0.187)	(0.953)
R^2	0.008	0.006	0.009	0.013	0.015	0.010	0.001

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels.

Table 7.2 - Predicting USD denominated currency changes with fundamentals and commodity indices.

Simple OLS Regression results for individual U.S. dollar nominated exchange rate changes in natural logs.
Δln (X/USD) = α + IRD + ΔTOT + ΔPPP + ΔCom.Index. IRD = Interest rate differental. TOT = Terms of Trade.
PPP = Puchasing Power Parity. Com.Index = Country specific commodity index. All dependent variables are lagged one month.
Estimated beta-coefficients are listed in the table with p-values in paranthesis.
321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	-0.001	0.000	-0.003	0.000	0.002	0.000	-0.001
	(0.522)	(0.819)	(0.286)	(0.988)	(0.303)	(0.902)	(0.623)
IRD, t-1	-0.058	0.047	-0.150	-0.010	-0.082	-0.010	0.021
	(0.595)	(0.571)	(0.257)	(0.949)	(0.370)	(0.922)	(0.830)
ΔTOT, t-1	-0.170	0.048	0.008	0.263	-0.023	-0.343	0.032
	(0.214)	(0.295)	(0.974)	(0.088)*	(0.974)	(0.202)	(0.820)
ΔPPP, t-1	-0.270	0.011	-0.692	-0.626	-0.657	-0.446	-0.045
	(0.348)	(0.971)	(0.098)*	(0.170)	(0.058)*	(0.160)	(0.850)
ΔCom.Index, t-1	0.088	0.044	0.108	0.141	-0.029	0.086	0.087
	(0.000)***	(0.082)*	(0.006)***	(0.007)***	(0.516)	(0.057)*	(0.006)***
R^2	0.047	0.016	0.032	0.035	0.016	0.021	0.025

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels.

Table 8.2 - Predicting USD denominated currency changes using unrestriced SUR

Unrestricted seemingly unrelated regression results for individual U.S. dollar nominated exchange rate changes in natural logs.
Δln (X/USD) = α + IRD + ΔTOT + ΔPPP + ΔCom.Index. IRD = Interest rate differental. TOT = Terms of Trade.
PPP = Puchasing Power Parity. Com.Index = Country specific commodity index. All dependent variables are lagged one month.
Estimated beta-coefficients are listed in the table with p-values in paranthesis. 321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	-0.001	-0.001	-0.001	0.001	0.002	0.000	-0.001
	(0.692)	(0.586)	(0.716)	(0.843)	(0.350)	(0.971)	(0.752)
IRD, t-1	0.014	-0.003	-0.035	0.005	-0.066	0.015	0.045
	(0.868)	(0.959)	(0.686)	(0.959)	(0.453)	(0.814)	(0.563)
ΔTOT, t-1	-0.014	0.057	0.073	0.093	0.395	-0.344	0.004
	(0.889)	(0.015)**	(0.590)	(0.308)	(0.555)	(0.009)***	(0.968)
ΔPPP, t-1	-0.078	0.139	-0.667	-0.634	-0.538	-0.133	0.113
	(0.712)	(0.386)	(0.007)***	(0.031)**	(0.098)*	(0.407)	(0.523)
ΔCom.Index, t-1	0.047	0.016	0.019	0.041	-0.038	0.024	0.006
	(0.023)**	(0.293)	(0.487)	(0.247)	(0.370)	(0.356)	(0.015)**
R^2	0.032	0.010	0.012	0.021	0.014	0.012	0.021

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels.

Table 9.2 - Predicting USD denominated currency changes using restriced SUR

Restricted seemingly unrelated regression results for individual U.S. dollar nominated exchange rate changes in natural logs.
Δln (X/USD) = α + IRD + ΔTOT + ΔPPP + ΔCom.Index. IRD = Interest rate differental. TOT = Terms of Trade.
PPP = Puchasing Power Parity. Com.Index = Country specific commodity index. All dependent variables are lagged one month.
Estimated beta-coefficients are listed in the table with p-values in paranthesis. 321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.771)	(0.771)	(0.771)	(0.771)	(0.771)	(0.771)	(0.771)
IRD, t-1	0.005	0.005	0.005	0.005	0.005	0.005	0.005
	(0.862)	(0.862)	(0.862)	(0.862)	(0.862)	(0.862)	(0.862)
ΔTOT, t-1	0.043	0.043	0.043	0.043	0.043	0.043	0.043
	(0.046)**	(0.046)**	(0.046)**	(0.046)**	(0.046)**	(0.046)**	(0.046)**
ΔPPP, t-1	-0.120	-0.120	-0.120	-0.120	-0.120	-0.120	-0.120
	(0.169)	(0.169)	(0.169)	(0.169)	(0.169)	(0.169)	(0.169)
ΔCom.Index, t-1	0.028	0.028	0.028	0.028	0.028	0.028	0.028
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
R^2	0.020	0.012	0.011	0.011	-0.002	0.007	0.013

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels. .

Table 10.2 - Predicting USD denominated currency changes using commodity dummy in a restriced SUR

Restricted seemingly unrelated regression results for individual U.S. dollar nominated exchange rate changes in natural logs.
Δln (X/USD) = α + IRD + ΔTOT + ΔPPP + ϕ*ΔCom.Index.
ϕ represents a dummy variable that takes value of 1 for commodity exporter, 0 for non-commodity exporter.
IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index.
All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis.
321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.819)	(0.819)	(0.819)	(0.819)	(0.819)	(0.819)	(0.819)
IRD, t-1	0.005	0.005	0.005	0.005	0.005	0.005	0.005
	(0.848)	(0.848)	(0.848)	(0.848)	(0.848)	(0.848)	(0.848)
ΔTOT, t-1	0.040	0.040	0.040	0.040	0.040	0.040	0.040
	(0.061)*	(0.061)*	(0.061)*	(0.061)*	(0.061)*	(0.061)*	(0.061)*
ΔPPP, t-1	-0.117	-0.117	-0.117	-0.117	-0.117	-0.117	-0.117
	(0.187)	(0.187)	(0.187)	(0.187)	(0.187)	(0.187)	(0.187)
ϕ*ΔCom.Index, t-1	0.019	0.019	0.019	0.019			
	(0.108)	(0.108)	(0.108)	(0.108)			
R^2	0.014	0.011	0.009	0.009	0.002	0.001	-0.001

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels.

Table 11.2 - Predicting USD denominated currency changes using commodity dummy and commodity index in a restriced SUR

Restricted seemingly unrelated regression results for individual U.S. dollar nominated exchange rate changes in natural logs.
Δln (X/USD) = α + IRD + ΔTOT + ΔPPP + ΔCom.Index + ϕ*ΔCom.Index.
ϕ represents a dummy variable that takes value of 1 for commodity exporter, 0 for non-commodity exporter.
IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index.
All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis.
321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR	GBP
α (intercept)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.765)	(0.765)	(0.765)	(0.765)	(0.765)	(0.765)	(0.765)
IRD, t-1	0.005	0.005	0.005	0.005	0.005	0.005	0.005
	(0.859)	(0.859)	(0.859)	(0.859)	(0.859)	(0.859)	(0.859)
ΔTOT, t-1	0.043	0.043	0.043	0.043	0.043	0.043	0.043
	(0.047)**	(0.047)**	(0.047)**	(0.047)**	(0.047)**	(0.047)**	(0.047)**
ΔPPP, t-1	-0.121	-0.121	-0.121	-0.121	-0.121	-0.121	-0.121
	(0.168)	(0.168)	(0.168)	(0.168)	(0.168)	(0.168)	(0.168)
ΔCom.Index, t-1	0.032	0.032	0.032	0.032	0.032	0.032	0.032
	(0.086)*	(0.086)*	(0.086)*	(0.086)*	(0.086)*	(0.086)*	(0.086)*
ϕ*ΔCom.Index, t-1	0.005	0.005	0.005	0.005			
	(0.772)	(0.772)	(0.772)	(0.772)			
R^2	0.019	0.012	0.011	0.011	-0.003	0.007	0.014

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels.

Appendix 4. Regression results for GBP as numeraire currency

Table 6.3 - Predicting GBP denominated currency changes with fundamentals.

Simple OLS Regression results for individual British Pound nominated exchange rate changes in natural logs. Δln (X/USD) = α + IRD + ΔTOT + ΔPPP. IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis.
321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR
α (intercept)	-0.001	0.000	0.000	-0.001	0.000	0.002
	(0.579)	(0.939)	(0.965)	(0.619)	(0.904)	(0.162)
IRD, t-1	0.061	0.060	0.094	0.022	-0.049	-0.100
	(0.684)	(0.500)	(0.451)	(0.871)	(0.674)	(0.305)
ΔTOT, t-1	0.244	-0.088	-0.160	-0.154	0.738	-0.619
	(0.160)	(0.016)**	(0.524)	(0.333)	(0.401)	(0.002)***
ΔPPP, t-1	0.263	-0.081	0.203	0.275	0.458	0.010
	(0.209)	(0.669)	(0.457)	(0.339)	(0.179)	(0.965)
R^2	0.011	0.020	0.005	0.006	0.008	0.031

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels

Table 7.3 - Predicting GBP denominated currency changes with fundamentals and commodity indices.

Simple OLS Regression results for individual British Pound nominated exchange rate changes in natural logs. Δln (X/USD) = α + IRD + ΔTOT + ΔPPP + ΔCom.Index. IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis.
321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR
α (intercept)	-0.001	0.000	0.000	-0.001	-0.001	0.002
	(0.562)	(0.974)	(0.967)	(0.625)	(0.806)	(0.160)
IRD, t-1	0.062	0.056	0.094	0.022	-0.042	-0.010
	(0.678)	(0.524)	(0.456)	(0.875)	(0.712)	(0.307)
ΔTOT, t-1	0.246	-0.090	-0.161	-0.157	0.592	-0.606
	(0.159)	(0.014)**	(0.522)	(0.324)	(0.500)	(0.003)***
ΔPPP, t-1	0.265	-0.086	0.205	0.273	0.427	0.012
	(0.206)	(0.650)	(0.456)	(0.342)	(0.209)	(0.959)
ΔCom.Index, t-1	0.012	0.013	-0.003	-0.018	0.105	0.017
	(0.691)	(0.524)	(0.944)	(0.744)	(0.005)**	(0.637)
R^2	0.011	0.021	0.005	0.006	0.020	0.032

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels

Table 8.3 - Predicting GBP denominated currency changes using unrestriced SUR

Unrestricted seemingly unrelated regression results for individual British Pound nominated exchange rate changes in natural logs. Δln (X/USD) = α + IRD + ΔTOT + ΔPPP + ΔCom.Index. IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis. 321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR
α (intercept)	-0.001	0.000	-0.001	-0.001	0.000	0.001
	(0.755)	(0.986)	(0.786)	(0.634)	(0.983)	(0.741)
IRD, t-1	0.013	-0.023	0.036	0.036	-0.069	0.035
	(0.912)	(0.724)	(0.670)	(0.701)	(0.505)	(0.624)
ΔTOT, t-1	-0.030	-0.050	-0.036	-0.128	-0.636	-0.339
	(0.805)	(0.032)**	(0.795)	(0.173)	(0.410)	(0.009)***
ΔPPP, t-1	0.203	-0.073	0.292	0.297	0.332	-0.002
	(0.202)	(0.577)	(0.125)	(0.156)	(0.272)	(0.988)
ΔCom.Index, t-1	0.005	-0.003	0.004	-0.020	0.096	-0.006
	(0.854)	(0.845)	(0.869)	(0.593)	(0.051)*	(0.808)
R^2	0.003	0.013	0.003	0.006	0.013	0.021

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels

Table 9.3 - Predicting GBP denominated currency changes using restriced SUR

Restricted seemingly unrelated regression results for individual British Pound nominated exchange rate changes in natural logs. Δln (X/USD) = α + IRD + ΔTOT + ΔPPP + ΔCom.Index. IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis. 321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR
α (intercept)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.972)	(0.972)	(0.972)	(0.972)	(0.972)	(0.972)
IRD, t-1	0.000	0.000	0.000	0.000	0.000	0.000
	(0.994)	(0.994)	(0.994)	(0.994)	(0.994)	(0.994)
ΔTOT, t-1	-0.062	-0.062	-0.062	-0.062	-0.062	-0.062
	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.004)***
ΔPPP, t-1	0.057	0.057	0.057	0.057	0.057	0.057
	(0.410)	(0.410)	(0.410)	(0.410)	(0.410)	(0.410)
ΔCom.Index, t-1	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(0.864)	(0.864)	(0.864)	(0.864)	(0.864)	(0.864)
R^2	-0.002	0.015	0.001	0.001	-0.002	0.005

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels

Table 10.3 - Predicting GBP denominated currency changes using commodity dummy in a restriced SUR

Restricted seemingly unrelated regression results for individual British Pound nominated exchange rate changes in natural logs. Δln (X/USD) = α + IRD + ΔTOT + ΔPPP + ϕ*ΔCom.Index.
ϕ represents a dummy variable that takes value of 1 for commodity exporter, 0 for non-commodity exporter.
IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity.
Com.Index = Country specific commodity index. All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis. 321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR
α (intercept)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.984)	(0.984)	(0.984)	(0.984)	(0.984)	(0.984)
IRD, t-1	0.001	0.001	0.001	0.001	0.001	0.001
	(0.979)	(0.979)	(0.979)	(0.979)	(0.979)	(0.979)
ΔTOT, t-1	-0.062	-0.062	-0.062	-0.062	-0.062	-0.062
	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.004)***
ΔPPP, t-1	0.057	0.057	0.057	0.057	0.057	0.057
	(0.409)	(0.409)	(0.409)	(0.409)	(0.409)	(0.409)
ϕ*ΔCom.Index, t-1	-0.007	-0.007	-0.007	-0.007		
	(0.551)	(0.551)	(0.551)	(0.551)		
R^2	-0.003	0.014	0.001	0.002	-0.002	0.005

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels

Table 11.3 - Predicting GBP denominated currency changes using commodity dummy and commodity index in a restriced SUR

Restricted seemingly unrelated regression results for individual British Pound nominated exchange rate changes in natural logs.
$\Delta \ln (X/USD) = \alpha + IRD + \Delta TOT + \Delta PPP + \Delta Com.Index + \phi^{*}\Delta Com.Index.$
ϕ represents a dummy variable that takes value of 1 for commodity exporter, 0 for non-commodity exporter.
IRD = Interest rate differental. TOT = Terms of Trade. PPP = Puchasing Power Parity. Com.Index = Country specific commodity index.
All dependent variables are lagged one month. Estimated beta-coefficients are listed in the table with p-values in paranthesis.
321 end of month obervations from 1990M3 to 2016M12.

X	CAD	NOK	AUD	NZD	JPY	EUR
α (intercept)	0.000	0.000	0.000	0.000	0.000	0.000
	(0.968)	(0.968)	(0.968)	(0.968)	(0.968)	(0.968)
IRD, t-1	0.000	0.000	0.000	0.000	0.000	0.000
	(0.999)	(0.999)	(0.999)	(0.999)	(0.999)	(0.999)
ΔTOT, t-1	-0.063	-0.063	-0.063	-0.063	-0.063	-0.063
	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.004)***	(0.004)***
ΔPPP, t-1	0.057	0.057	0.057	0.057	0.057	0.057
	(0.413)	(0.413)	(0.413)	(0.413)	(0.413)	(0.413)
ΔCom.Index, t-1	0.014	0.014	0.014	0.014	0.014	0.014
	(0.458)	(0.458)	(0.458)	(0.458)	(0.458)	(0.458)
ϕ*ΔCom.Index, t-1	-0.024	-0.024	-0.024	-0.024		
	(0.354)	(0.354)	(0.354)	(0.354)		
R^2	-0.003	0.013	0.001	0.002	0.002	0.003

Asterisks indicate 1% (***), 5% (**), and 10% (*) significance levels