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## Introduction

Exchange rate prediction in a turbulent world market is as interesting as it is challenging. The different factors influencing exchange rates are many, and what factors to include in a predictive model has been a topic of discussion in the world of finance. However, most models constructed to predict exchange rates usually include real *interest rate differentials* (IRD) and *purchasing power parity* (PPP). In this thesis, we aim to assess whether commodity price changes can add predictive power to a model predicting nominal exchange rates of floating commodity currencies. In order to do so, we will also consider the countries' terms of trade (TOT). Furthermore, we want to establish an appropriate investing strategy, in order to make a profit on the predictive model.

In order for the exporting commodity to have a significant impact on the currency, we have decided to consider NOK (Norway), CAD (Canada), AUD (Australia), and NZD (New Zealand), commonly referred to as *commodity currencies*. These are all floating currencies where large parts of exports are commodities. (Chen & Rogoff, 2002)

Our working research question is: *Can commodity prices forecast exchange rates in developed economies, and what investment strategies can be used to derive profits?*

In the following chapter of this preliminary thesis, applied theory and literature are presented and discussed. We then proceed by presenting data-specifics, w.r.t. exchange rates, commodity prices, and other data. Furthermore, the methodological approach is also discussed and presented. We then conclude the preliminary thesis with a brief time plan for completing the thesis.

## Theory & Literature

The study, *Can Exchange Rates Forecast Commodity Prices*, conducted by Chen, Rogoff, and Rossi in 2008, is largely used as a reference study in our thesis. Their study provides evidence that commodity currency exchange rates possess a remarkable robust power in predicting global commodity prices, both in and out of sample. However, when checking for the reverse relationship, the findings were less robust. Although using commodity prices to forecast exchange rates worked fine in sample, the out of sample predictive power were unsatisfying. The paper concludes that the reason is that while exchange rates are highly forward looking, commodity prices are to a large extent influenced by short-term

demand imbalances. (Chen, Rogoff, & Rossi, 2008)

Moreover, a study conducted on behalf of IMF in 2002, aims to address whether commodity prices explain a significant share of exchange rate movements in Australia, New Zealand, and Canada. The study concluded that the dollar price of commodity exports had a strong and stable influence on the Australian and New Zealand floating real rates. The results were less significant for the Canadian real rates. This research included the factor TOT, a factor described and discussed later. (Chen & Rogoff, 2002)

Furthermore, we will also use the study *Commodity Currencies and Currency Commodities* in order to help understand the causality in our research. The paper addresses how currencies can affect commodities, and also the other way around. (Clements & Fry, 2007) The study found, just like Chen, Rogoff, and Rossi that exchange rates are a better predictor of commodity prices than the other way around.

Cashin, Cespedes, and Sahay (2004) examined how real commodity prices contribute to movements in real exchange rates in 58 different commodity-exporting countries. The study only found a stable long-run relationship for about one third of the countries. However, on average in these 19 countries, 85% of real exchange rate fluctuation could be explained by the real commodity prices. These findings suggest that commodity prices can increase predictive abilities of a currency-forecasting model for commodity currencies (Cashin, Céspedes, & Sahay, 2004).

In order to better understand how the IRD affects currency prices, several different studies are considered. In general, unexpected changes in interest rates will quickly be priced into the associated exchange rates. The reason is that traders constantly aim to take advantage of interest rate discrepancies by performing currency carry-trades. A currency carry-trade is an investment strategy where an investor borrows money in a currency with a relatively low interest rate, converts the funds to the currency with high interest yield, and then invests in the currency's high yield interest market. The investor will in the future want to convert his invested funds back. Establishing a relationship between IRD and exchange rates is of vital importance for our thesis, as it can help increase predictive ability in our model.

However, there are no-arbitrage theories stating that the above investment strategy cannot be used to obtain profits. The uncovered interest parity (UIP)

explains that the exchange rates will adjust according to the IRD, making an uncovered carry trade impossible to profit from. More specifically, the UIP states that the currency with a relatively high interest rate has to depreciate against the low interest rate currency. The gains from the difference in interest rates will then be offset by the change in the exchange rate (Heath, Galati, & McGuire, 2007). A similar, but slightly different theory, is the covered interest parity (CIP). While the UIP can be used to predict future actual exchange rates, the CIP is merely concerned with current price of forward rates. The theory states that there can be no profits from taking advantage of differences in interest rates, while at the same time fixing future exchange rates with financial instruments. That is, a currency with a relatively high interest rate must trade at a forward discount.

Although the UIP & the CIP are important parity conditions used in many economic models, there are discussions about their validity. According to a study performed by Meese and Rogoff in 1983, models constructed on random walks are just as good in predicting future exchange rates. In fact, they found that the UIP has a weaker predictive ability than that of the random walks in 10 out of 12 times (Meese & Rogoff, 1983). This finding was further supported by a replicating study by Cheung, Chinn, and Pascual in 2005. In general, economic researchers widely agree that the UIP does not hold. They conclude that since the UIP involves a lot of risk, the investment strategy has to involve a risk premium. This is commonly referred to as the forward premium puzzle (Cheung, Chinn, & Pascual, 2005).

On the contrary, researchers generally lend more support to the CIP. Research suggests that on average, the CIP holds (Mancini-Griffoli & Ranaldo, 2011). The rationale behind it concludes that since a covered investing strategy does not involve any risk, it should also not be able to produce any excess returns.

In addition to the IRD, traditional exchange rate forecasting is also highly concerned with the theory of the PPP. The PPP is also a no-arbitrage theory, which states that there on the long run should be no differences between two countries' purchasing power. More specifically, the theory states that prices should be equal across countries, after accounting for exchange rates. The theory explains that if currency adjusted prices differs between two countries, traders would buy the service or product in the cheapest country, thus creating higher demand, which again will lead to an appreciation of that currency. This should therefore function as a mechanism to enforce exchange rate equilibrium. Research

in the area seems in general to suggest that there does in fact exist a relationship between PPP deviations and exchange rate developments. For instance, a study from 1994 did indeed find a long run convergence to PPP (Froot & Rogoff, 1994). Moreover, nominal exchange rate adjustment is important in determining PPP convergence (Cheung, Lai, & Bergman, 2004). Engel and Morley (2001) focused on determining the speed at which nominal exchange rates prices converge to equilibrium. They found that the relationship was converging at a low pace. The PPP-research is of interest for our thesis, as it concludes that there is in fact a relationship between exchange rates and purchasing power (Engel & Morley, 2001). This can be expected to increase the predictive ability of our model.

Another factor used in predicting exchange rates is a country's TOT. The TOT is a ratio comparing a country's exports to its imports (Chen & Rogoff, 2002). A country with a positive TOT is a country whose exports exceed its imports. 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 buy the currency in order to pay. 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 thus domestic currency demand will indirectly increase. Both of the above examples will lead to an appreciation of the domestic currency. On the contrary, whenever a country imports, the demand for domestic currency decrease, and domestic currency depreciates.

As can be understood from the above discussion, a country's TOT is related to exchange rates. It is also apparent that if the prices of a country's main exporting commodities increase, their terms of trade are likely to follow. Empirical studies have found that there is in fact a long-run cointegrating relationship between exchange rates and TOT (Amano & Norden, 1998; Gruen & Wilkinson, 1994). Moreover, the research has also shown that the causality runs from TOT to the exchange rate.

In order to derive an investing strategy, we will consider a study conducted by Bekaert and Hodrick). The study characterizes predictable components in excess rates of returns on foreign exchange markets using lagged excess returns (Bekaert & Hodrick, 1992). We will use regressions from this study as a fundamental in our model, before adding relative change in TOT as another explanatory variable.

## Data:

### Exchange rates:

All nominal and forward exchange rates are collected from Bloomberg. The currencies in question will be US dollar nominated ( $X_t/USD_t$ ) in order to maintain a robust comparison aligned with the research previously done by Chen, Rogoff and Rossi (2008). Monthly data is used for the following time periods: Australia (from 1990:M1 to 2015:M12), Canada (from 1990:M1 to 2015:M12), New Zealand (from 1990:M1 to 2015:M12) and Norway (from 1990:M1 to 2015:M12).

### Commodity prices:

All different commodity prices labeled, both spot prices and futures, will be US dollar nominated to provide a standard measure of comparison and are collected from various sources such as Chicago Mercantile Exchange (CME), Commodity Research Bureau (CRB), and Commodity Futures Trading Commission (CFTC). For all four commodity economies in question, a country-specific price index  $cp_t^X$  will be constructed. These indices are export-weighted and reflect the total exports revenues for the economy. The export weights used for Canada, New Zealand and Australia in the article by Chen, Rogoff and Rossi (2008) are deemed insufficient, and will be updated in our research. Instead of applying average export weights for the entire period, we will adjust them every 5 years. The export weights for Norway are collected from Statistics Norway (SSB). In order to control for overall price movement in the global commodity markets, we use an aggregate commodity price index  $cp_t^W$  from International Monetary Fund (IMF) and Goldman Sachs. If commodity prices are not available in USD, they will be converted with the applicable conversion rate to maintain a common measure.

### Interest rates, Purchaser Price Index and Consumer Price Index:

Interest rates in the various economies are collected from the respective central banks' websites. In addition, the PPI and CPI are collected from the countries different national statistics bureaus.

## Methodology:

Chen, Rogoff and Rossi (2008) provide the basic framework for our research. They argue that the model's exchange rates have a significant impact on

commodity prices and then test the model backward to see if commodity prices impact exchange rates. We will conduct a replication study of some of their research with newer and more frequent data in our regressions, in order to easier control for structural breaks.

The structural model discusses a present value approach from an asset pricing perspective and argues that spot rates have forecasting ability in terms of commodity prices. The regression is as follows:

$$s_t = \gamma \sum_{j=0}^{\infty} \psi^j E_t[f_{t+j} | I_t]$$

Where  $s_t$  is the nominal exchange rate to its fundamentals  $f_t$  given the information  $I_t$ .  $E_t$  is the expected value of this information, and the parameters  $\gamma$  and  $\psi^j$  are specified by the different regressions.

Chen, Rogoff and Rossi (2008) shows that this present value approach for nominal exchange rates Granger-cause its fundamentals  $f_t$ . That is, the time-series of nominal exchange rates forecast the time-series of its fundamentals (Granger, 1969). The commodity prices are assumed to be part of the expected fundamentals.

Although the currencies in question are labeled commodity currencies, other factors such as central bank interventions and change in interest rates will affect the nominal exchange rates. We therefore need an error term  $z_t$  in the equation to explain other shocks that impact nominal exchange rates other than changes in commodity prices. When assuming that markets forecast commodity prices perfectly, equation (1) and  $f_t = cp_t$  implies a more robust equation:

$$\Delta s_t = \gamma \sum_{j=0}^{\infty} \psi^j \Delta cp_{t+j} + z_{t+1}$$

Where  $\Delta cp_t$  is the commodity price change specified in the previous chapter. This equation is shown to Granger-cause exchange rates on commodity prices.

The part of the study we will replicate in our paper is whether commodity prices can forecast exchange rates. By first ignoring the possibility of structural breaks, we investigate if commodity prices Granger-cause exchange rates. The test will be conducted with the following regression for each of the currencies individually:

$$E_t[\Delta s_{t+1}] = \beta_0 + \beta_1 \Delta cp_t + \beta_2 \Delta s_t$$

With the simultaneous investment strategy:

$$E_t[r_{FX_{t+1}}] = \beta_0 + \gamma_1(r_{fd} - r_{ff})_t + \beta_1\Delta cp_t$$

Where  $E_t[r_{FX_{t+1}}]$  is the expected return of the foreign exchange trade using FX-futures as our trading instruments with US dollars as our common measure.

Moreover, an aggregate regression of all four currencies will be tested to see if the exchange rate series Granger-cause the aggregate commodity price index with the following regression:

$$E_t[\Delta cp_{t+1}^w] = \beta_0 + \beta_1\Delta s_t^{AUD} + \beta_2\Delta s_t^{CAD} + \beta_3\Delta s_t^{NZD} + \beta_4\Delta s_t^{NOK} + \beta_5\Delta cp_t^w$$

The regression's out-of-sample mean square forecasting errors (MSFE) will be compared to a random walk (RW) and autoregressive (AR) forecast.

Different number of lags will be tested in our predictive regressions, since we use more frequent data than Chen, Rogoff and Rossi (2008) (monthly versus quarterly).

Rossi's *Exp - W\** approach will be used to control for parameter instabilities in the data (Rossi, 2005), since Chen, Rogoff and Rossi (2008) found strong evidence for structural breaks in the early 2000's. In order to identify parameter instabilities, Andrew's QLR test for predictive regressions will be used (Andrews, 1993). Consumer price indices (CPI) will be used to control for inflation.

As explained in the theory-part of this preliminary thesis, we want to apply change in TOT as an explanatory variable in our regression. Normal measurement of Terms of Trade is given by the ratio of exports to imports. However, since we are considering exchange rates, which is a relative relationship between two currencies, we also have to consider the countries' relative change in TOT.

Since exports constitutes varying importance for the researching countries' overall economy, we have to adjust for this in our regressions. We are going to multiply the relative change in TOT by a factor, depending on exports' significance for the country's overall economy. This factor will be strongly related to trade as a proportion of GDP. ((Imports+Exports)/GDP)



## Hypothesis:

Can commodity prices predict future exchange rates in developed economies?

$H_0$ : Commodity prices cannot predict future exchange rates.

$H_A$ : Commodity prices can predict future exchange rates.

## Time plan

This preliminary thesis will be handed in by January 16<sup>th</sup>. After this, we will start to collect the data that is required for conducting our research. At the same time, we are also going to further indulge ourselves in existing research on currency prediction. We will then start to process the data, and build necessary foundations for our continued research. Consequently, the methodological approach outlined in the above chapter will be conducted. After this, the findings from our regressions will be analyzed and interpreted. The above time-plan will be carried out with guidance from our supervisor, Prof. Bruno Gerard.

## References:

- Amano, R. A., & Norden, S. v. (1998). Exchange Rates and Oil Prices. *Review of International Economics*, 6(4), 683-694.
- Andrews, D. W. K. (1993). Tests for Parameter Instability and Structural Change with Unknown Change Point. *Econometrica*, 61(4), 821-856.
- Bekaert, G., & Hodrick, R. (1992). Characterizing Predictable Components in Excess Returns on Equity and Foreign Exchange Markets. *The Journal of Finance*, 47(2), 467-509.
- Cashin, P., Céspedes, L. F., & Sahay, R. (2004). Commodity currencies and the real exchange rate. *Journal of Development Economics*, 75(1), 239-268. doi:10.1016/j.jdeveco.2003.08.005
- Chen, Y.-c., & Rogoff, K. (2002). Commodity Currencies and Empirical Exchange Rate Puzzles. *IMF Working Paper*.
- Chen, Y.-c., Rogoff, K., & Rossi, B. (2008). Can Exchange Rates Forecast Commodity Prices? *The Quarterly Journal of Economics*, 125(3), 1145-1194.
- Cheung, Y.-W., Chinn, M. D., & Pascual, A. G. (2005). Empirical exchange rate models of the nineties: Are any fit to survive? *Journal of International Money and Finance*, 24(7), 1150-1175. doi:10.1016/j.jimonfin.2005.08.002
- Cheung, Y.-W., Lai, K. S., & Bergman, M. (2004). Dissecting the PPP puzzle: the unconventional roles of nominal exchange rate and price adjustments. *Journal of International Economics*, 64(1), 135-150. doi:10.1016/s0022-1996(03)00076-x
- Engel, C., & Morley, J. C. (2001). The Adjustment of Prices and the Adjustment of the Exchange Rate. *NBER Working Paper*.
- Froot, K. A., & Rogoff, K. (1994). Perspectives on PPP and Long-Run Real Exchange Rate. *Handbook of International Economics*, 3, 1647-1688.
- Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, 37(3), 424-438.
- Gruen, D. W. R., & Wilkinson, J. (1994). Australia's Real Exchange Rate - Is it Explained by the Terms of Trade or by Real Interest Differentials. *The Economic Record*, 70, 204-219.
- Heath, A., Galati, G., & McGuire, P. (2007). Evidence of Carry Trade Activity. *BIS Quarterly Review*.
- Mancini-Griffoli, T., & Ranaldo, A. (2011). Limits to arbitrage during the crisis: funding liquidity constraints and covered interest parity. *Swiss National Bank*.
- Meese, R. A., & Rogoff, K. (1983). Empirical Exchange Rate Models of the Seventies. *Journal of International Economics*, 14(1-2), 3-24.
- Rossi, B. (2005). Optimal Tests for Nested Model Selection with Underlying Parameter Instability. *Econometric Theory*, 21(5), 962-990. doi:0.1017/S0266466605050486