

PREDICTING GLOBAL COMMODITY PRICES
USING SOUTH AMERICAN EXCHANGE RATES

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Abstract

This research demonstrates that the “commodity currencies” of South America can be used to predict the movement of both individual commodity prices and the aggregate commodities market as a whole. Based on the forward looking nature of exchange rates, commodity currency exchange rates prove to be a better predictor than forwards markets and the random walk in the majority of samples tested. This is a particularly compelling result given the continued growth of South America with respect to the world’s economy, and the rapid increase in volume and value of commodities trading across the globe. Consequently, the results of this research could have significant positive impacts on multinational corporations, government institutions and any market player engaging in international trade.

I. Introduction

Commodities are vital to the world's economy. From the soft commodities like coffee and wheat that feed global populations, to the metals and fuels that drive industry, every country ultimately plays a part in trade to get the supplies they need. As the world becomes increasingly connected by technology, the international commodities market is also growing in volume and value. Analysts estimate that the value of global physical exports of commodities increased by 17% in the five years leading up to 2007, coupled with an increase over 200% in commodities derivatives trading through exchanges like the CBOE.¹

However, the volatility and difficult-to-predict nature of these commodities make trading in them inherently risky. Consequently, governments and multinational corporations alike face many difficulties in planning for their successful economies and businesses, be it when setting monetary and fiscal policy or budgeting for production costs.

A model that predicts the spot prices of commodities more accurately than tools currently available to economists, such as the commodities futures market and simple time series forecasting models, could have a significant impact in reducing some of this risk, and consequently have vast effects on all market players. This model is made possible because today's exchange rates incorporate valuable information on tomorrow's commodity prices, so there is reason to believe that this predictive relationship exists. This paper extends previous research and demonstrates that movements in exchange rates can indeed be used to predict future movements in global commodity prices.

Previous research by Cashin, Cespedes and Sahay (2003) in association with the IMF, explores the existence of currencies that have this kind of close relationship with the prices of the commodities they export. They deem these currencies 'commodity currencies' and identify 58 of them. A commodity currency country has two important properties:

¹ *Global commodities futures trading hit record high in 2007*, Dhimant Bhatt, The Financial Express, (June) 2010

commodities make up a large proportion of their exports, yet they can all be considered small with respect to the global market, and therefore price takers.

This research explores whether five South American commodity currencies, those of Argentina, Brazil, Columbia, Paraguay and Peru, can be used to develop a model that predicts future prices for individual commodities, and aggregate commodities indices. All five countries in the sample have had flexible exchange rate systems for a period of at least seven years that can therefore move freely with market forces.

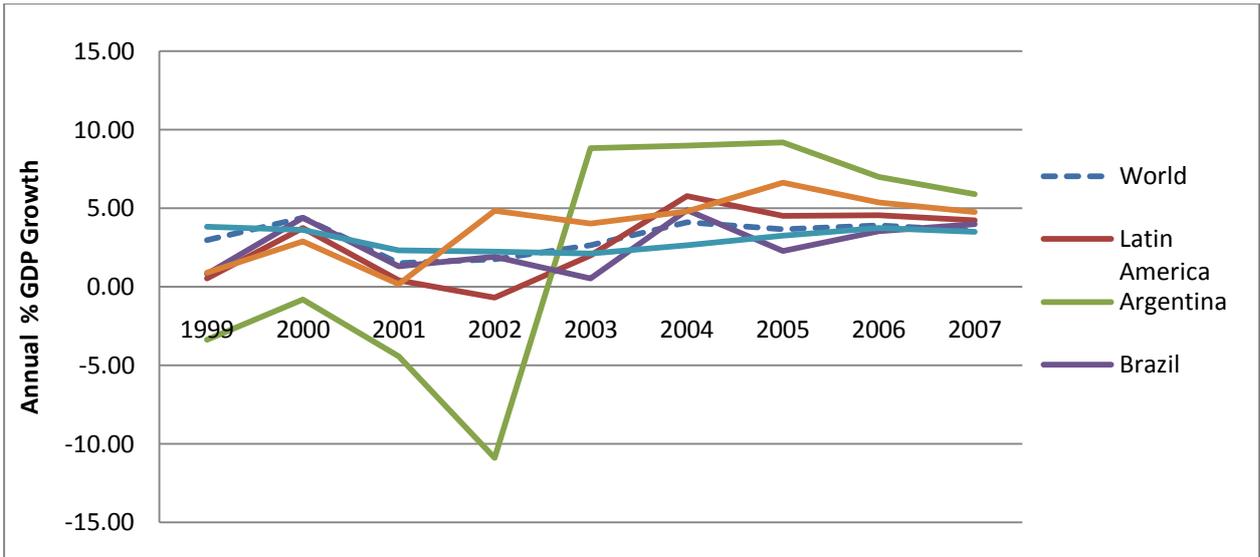
Consequently, these exchange rates are forward looking asset prices: they embody expectations of future movements in macroeconomic fundamentals, specifically ones that will directly affect the exchange rates. For commodity currencies, global commodity prices matter because they contain important information on the value of trade exports, that impact the country's income, that then impact the country's exchange rate.

The exports of these countries are affected by terms-of-trade shocks such as fluctuations in global commodity prices – fluctuations that are relatively frequent. These shocks are exogenous, as the countries in question can be considered price takers that are relatively small to the overall market.

As a result, when market participants foresee a commodity price shock, their expectations will be priced into the current exchange rate, because of its anticipated impact on future exchange rate values. In short, because information on future commodities prices are reflected in today's exchange rates, exchange rates can be used to forecast future commodity prices. This kind of model aims to interpret the information already embodied in the forward looking exchange rates of commodity currencies to bypass some of the forecasting failings of the futures market. Existing work by Chen, Rogoff and Rossi (2008) develops and tests an exchange rate forecasting model and concludes that exchange rates have remarkably robust forecasting power for commodity indices. They focus (as do other

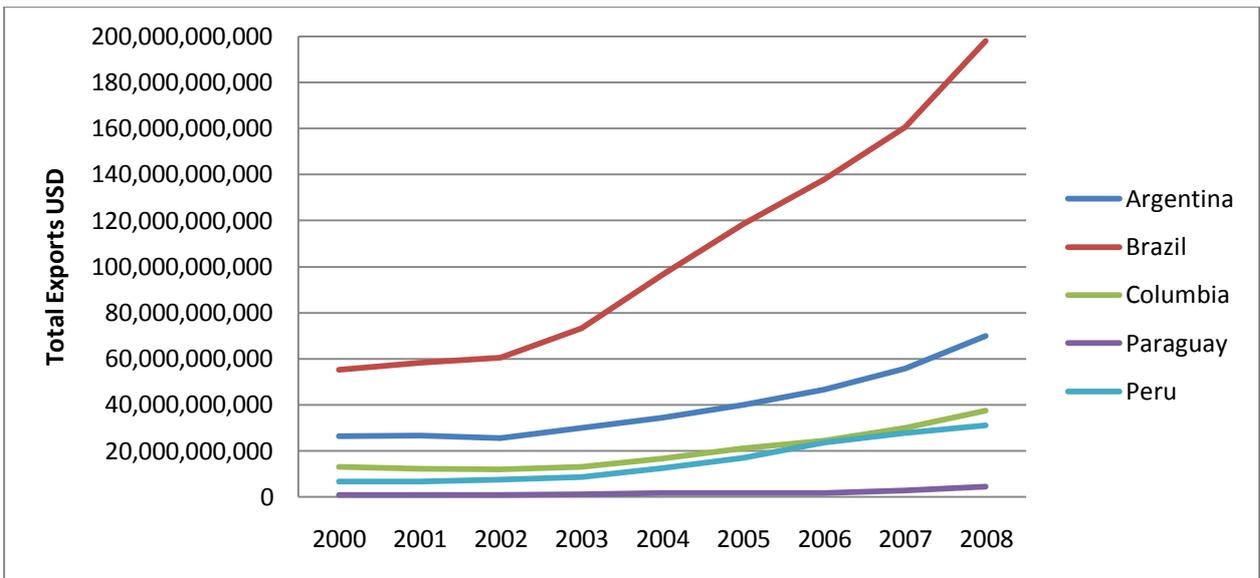
previous, related studies) on the four main exchange rates of Australia, South Africa, New Zealand and Canada, and also include Chile in their sample.

This research extends their work to a sample of developing countries (as defined by the IMF) in South America. These countries have yet to be looked at in depth for this kind of commodities forecasting study, yet are beginning to play an increasing role in the global economy. From Figure 1 below, it can be seen that South American economies have, over the past ten years, gone from lower than world average GDP growth to above or at average growth. South American GDP growth of 5.3% annually between 2004 and 2008, the strongest pace in the past three decades, is particularly impressive. This growth is in part driven by a strong and growing export market, as demonstrated in figure 2. Economists generally predict that this kind of high growth – growth driven largely by the commodities market - will help propel the world economy into the next decade, and perhaps even out of the world financial crisis, as emphasised in the UN October 2009 Economic Outlook. Brazil in particular is considered important to the growth of the world economy as it transitions into a more industrialised nation with the rest of the ‘BRICs’ (Brazil, Russia, India and China collectively). This makes predicting the export income of these countries particularly important to regional and world economies, and provides a worthwhile motivation for developing an accurate commodity price predicting tool.



Source: USDA Economic Research (2007)

Figure 1: South American growth rates have accelerated in recent years, compared to world growth



Source: UN Comtrade (2010)

Figure 2: GDP growth in all five sample countries is partly sustained by increasing commodity exports

There is a risk involved with working with these countries, as they have a shorter history of flexible exchange rates than do the countries used in Chen et al.’s paper. However, despite these limitations the results show that these currencies can be used in a present value model to predict commodity prices. That fact is that the majority of commodity currencies belong to developing countries with histories of instable financial systems and fluctuating exchange

rates. In addition, this project tackles a new set of commodities,, As each commodity operates in a unique futures market, and has specific price-influencing factors associated with it, broadening the scope of previous work in this way also has value. The more we can learn about whether this research can be extended to include additional countries, the more we will understand the nuances of the relationship between commodity currencies and commodities.

This research is focused on answering the following two questions:

- 1) How accurate are exchange rate movements as a tool for predicting commodity price movements? Commodity prices are regressed on the currency exchange rates of the sample countries that export them
- 2) Can multiple currencies be input into a model that predicts the aggregate movement of the commodity markets? The movement of a commodity index is regressed on the movements of all five currencies together. This is particularly useful as forwards markets do not exist for aggregate indices, so there is even less information regarding forecasting available.

This paper proceeds as follows: section II below outlines the current literature relevant to this research, section III discusses the economic theory and further motivates the model, section IV describes the data used for analysis, section V presents the empirical specification and the results it delivers in depth, and section VI offers some concluding remarks.

The success of this model in predicting future commodity prices using current exchange rates could have an immense impact on both a local and global level. Trading in commodities is fundamental to the 21st century world, a world which is becoming increasingly smaller and interlinked. Being able to predict future commodities prices will help reduce the risk associated with this trade, with positive ramifications for economic development and society at large.

II. Literature Review

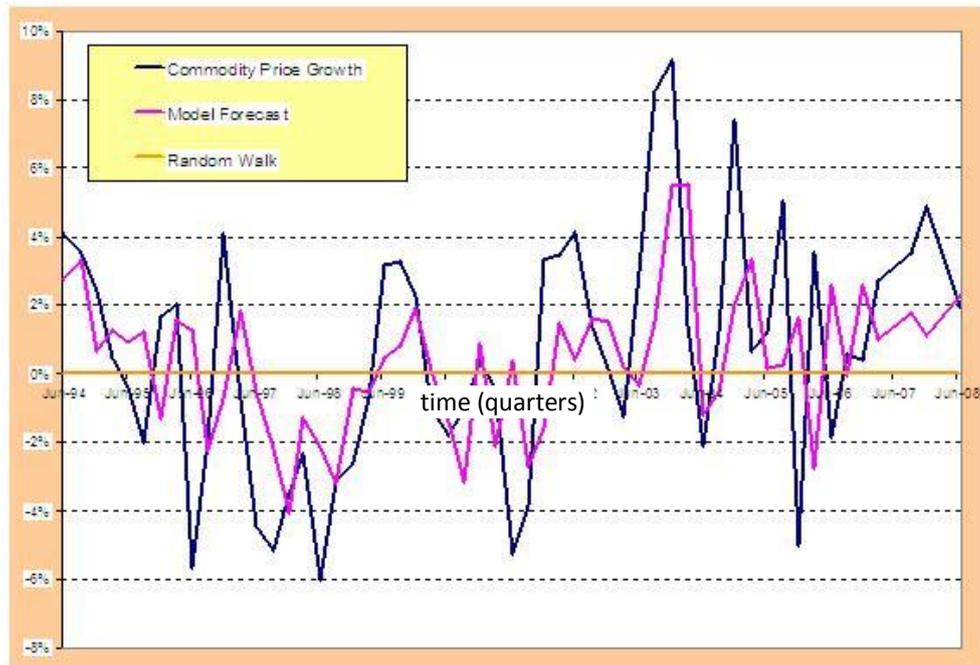
There are three main trends in current economic literature that support this project. The first deals with the commodities futures market, and investigates its failure to accurately forecast commodities spot prices. This helps demonstrate the need for a more accurate commodity price forecasting tool. The second explores the relationship between exchange rate movements and commodities prices, and attempts to quantify the relationship between them in both directions. The majority of this work focuses on the implications for trade in a post-Bretton Woods, floating exchange rate, world but it is later followed by research on more recent time periods. The third trend is focused on understanding commodities in developing countries, such as South America, amidst a 21st century environment of globalisation.

The notion of “efficiency” in futures markets is introduced early in the 80s with the initial growth of commodities derivatives trading. The cost of participating in the futures market is twofold, firstly, the risk premium demanded in exchange for assuming the risk of future spot price volatility, and second, the cost that arises from the failure of futures prices to accurately predict future spot prices. If a particular market is efficient, the excess returns beyond these two costs should be zero. Kaminsky and Kumar (1990) argue that some markets may be inefficient in both the short and long term as futures prices may be biased predictors of future spot prices. This makes the markets costly for participants and creates a dead weight loss.

Kallard, Newbold and Rayner (1999) explore the limited forecasting ability of the futures commodity market in great detail. (The economic theory underscoring the limitations of this market is further discussed in section III). They conclude that while in the long run, the futures market is a good predictor of future spot prices, ‘in the short run there is evidence of inefficiencies in most of the markets (7 in total) studied.’ (Unfortunately, they do not define ‘long run’ and ‘short run’ explicitly. Inefficiency here is defined as the failure of

futures price to predict spot prices.) The majority of the paper focuses on quantifying these inefficiencies – which they find to range from the gas oil market (1% “inefficient”) to the soybeans market (17% “inefficient”) and at worst in the cattle market (47% “inefficient”). This means that the variance of hedging costs would be 47% lower if the futures price was an efficient predictor of the spot price. These inefficiencies cost all market participants dearly, from countries that export trade to multinational corporations and society at large. If better information were available about the future spot prices of commodities, the “efficiency” of the futures market could be improved.

Chen, Rogoff and Rossi have done a substantial amount of work on the second trend, and specifically, using commodity currencies to predict commodity prices. This work is most closely based on their research. They use a sample of five commodity currencies taken as a basket to predict the aggregate movement of the commodities market as incorporated by the IMF index, which can be considered to be an accurate proxy for the overall market. They conclude that the currencies have remarkably robust forecasting power that is significantly better than that implied by the futures market, the random walk, and previous simple time series models, as illustrated in Figure 3 below. However, their study only focuses on the four main commodity currencies and Chile, and this research shows that their results can be extended to a broader set of developing countries and commodities, specifically in South America.



Source: Chen et al.

Figure 3: Chen’s exchange-rate based model is shown to be more accurate in predicting the movement of the IMF commodity index than the random walk, with respect to time

The following articles have also been invaluable in establishing the economic theory behind how these variables fit together. Paul Cashin and John McDermott’s work (2004) on the behaviour of commodity prices in the long run focuses on the increased volatility in commodity prices that was experienced after the Bretton Woods agreement broke down. From a US dollar-centric perspective, they illustrate that the exchange rates “affect the variability of dollar commodity prices, since such movements influence both the supply of, and demand for, commodities.” Chen et al later move to eliminate any potential dollar effect by testing their hypotheses in a base currency of pound sterling, showing that predictive power holds regardless of base currency.

Similarly, C.E. Smith’s work (1999) approaches post-Bretton Woods from a critical perspective, as the floating exchange rate system increased commodity price uncertainty worldwide. Smith’s research goes on to investigate the implications that this additional price uncertainty has on world trade, such as unprecedented foreign exchange volatility and

domestic price level variations. This work aims to support his by showing that this price uncertainty could be further reduced by implementing exchange rates as a forecasting tool – and consequently reduce some of the implications he discusses. This is clearly an issue of great importance to international trade, and reducing exchange rate risk would serve to further grow the world’s economy, as well as facilitate mutually beneficially relationships between commodity exporters and importers.

As more countries switched over to a flexible exchange rate system, more data became available to support trends and relationships between commodity prices and exchange rates. Robert Kayfitz’ work (2004) on modelling the impact of exchange rates on commodity prices considers instead an equilibrium model where changes in exchange rates have an impact not only on supply and demand, but also on income, which in turn feeds into a function for consumption and exports. While his research has extensive merit, it again focuses on the global economy broadly, incorporating 200 countries and 33 commodities. Consequently, his model depends on incorporating information that sums to 100% of commodities trade in the 33 commodities, and will not hold up on a country specific level. By making a distinction between commodity currencies and others, as well as focusing in on 5 specific countries, the methodology of this project approaches the topic from an alternative angle and produces results that can be more easily translated to tangible market efficiencies.

The work of P. Cashin et al in *Commodity Currencies and the Real Exchange Rate* especially focuses on developing countries. They work with the thesis that commodities price movements can predict exchange rates, as opposed to the other way round. Chen et al. dedicate a section of their paper to this idea, and find that there is much less robustness in the causality relationship working this way. This is in line with Cashin’s results that only about 1/3 of the 58 countries that he researches appear to have tangibly interlinked currencies and commodity exports. They state that part of the reason behind their limited findings could be

tied to the fact that these smaller economies typically experience significant turmoil due to exogenous shocks and policy change. These are still concerns for this research question, however, the countries in this sample have been more stable in the past decade than during the time period of Cashin's study (through 1999).

Cashin also make the bold claim that the kind of exchange rate system – floating, pegged, fixed – often does not have an impact on the relationship between currency and commodity. He and his colleagues classified 58 commodity currencies countries into three groups based on the Reinhart-Rogoff classification of pegs (single currency, SDR, and official basket pegs); limited flexibility or managed floats (including crawling-peg bands and cooperative arrangements); and flexible regimes. Their study surprisingly showed that the level of volatility between commodity currencies is similar across the classifications.

This is especially important as the countries used in this paper have gone through a history of mixed exchange rate regimes. Despite this, the results demonstrate that even the youngest floating exchange regime (Argentina) has significant predictive power. Together with Cashin's work, these ideas allows for the possibility of extending the conclusions of this research beyond the period of flexible exchange rates to work with a longer time periods and more sample currencies.

Cashin's work provides great promise that the work of Chen et al. can in fact be extended to commodity countries outside of the main four typically focused on - especially beginning with those included in this sample that have the ideal property of flexible exchange rates. The strength of this research in supporting this claim can have much wider implications to international trade, national economies, and multinational firms alike. If a model can be used to predict future fluctuations in commodity prices based on current movements in exchange rates, the risk of international trade will be significantly reduced beyond what is possible by existing hedging models and today's futures markets.

Previous research has spent time exploring this idea on a broad scale, mainly using the four main commodity currencies of Australia, New Zealand, South Africa and Canada. However, with increasing growth in South America, now is an appropriate time to focus in on a new set of countries and commodities. The conclusions later presented extend the literature described in this section to a new domain, consequently strengthening the results that have been proposed by other research in the field, namely, that exchange rates can in fact be used to predict commodity prices.

III. Economic Theory

The economic theory linking exchange rates to commodity prices supports this research by illustrating that it should be possible for exchange rates to predict commodity prices.

As described during the introduction, exchange rates are forward looking asset prices: they embody expectations of future movements in macroeconomic fundamentals, specifically ones that will directly affect the exchange rates. These fundamentals typically include the balance of payments, the flow of capital in and out of the country, inflation and political stability, amongst other things. This relationship is normally expressed using a present value approach, giving rise to a relationship between the current, nominal exchange rate and the discounted sum of its expected future fundamentals.

For commodity currencies, global commodity prices matter to the value of their currencies because they contain important information on the value of trade exports that consequently impact the exchange rate. Any fluctuation in global commodity-price fluctuations will affect the country's exports, and consequently represent a major terms-of-trade shock to the value of the currency. These shocks are exogenous, as the countries in question are commodity currencies, and therefore can be considered price takers that are relatively small to the overall market (see Appendix 1). It's important to note, therefore, that

the change in exchange rate movement does not *cause* the change in commodity price movement, and both may be moving with respect to other omitted variables.

As a result, when market participants foresee a commodity price shock, their expectations will be priced into the current exchange rate, because of its anticipated impact on future exchange rate values. This is due to the fact that exchange rates are forward looking and therefore incorporate this future expectation into present day value.

It follows that commodity currencies in time period t should have the ability to forecast future commodity prices in time period $t + 1$. A given commodity currency should hold information on the future price movements of the commodities that it exports. Furthermore, if we combine the five countries together, we should be able to obtain forecasts for price movements in the overall aggregate commodity market as represented in an index - in combination, the countries' export a wide range of both hard and soft commodities.

Chen et al outline that in order for this kind of study to be most effective, the commodity currencies being considered must have flexible exchange rates. This is to allow the exchange rate to move freely to incorporate future commodity price expectations. As a result, flexible exchange rates help smooth the impact such shocks may have on real output – as opposed to fixed regimes that would demand a change in domestic prices and wages to maintain output and employment. In short, fixed, crawling pegs and crawling band systems restrict movement of an exchange rate, preventing it from being an accurate gauge for future movements in macroeconomic fundamentals.

Exchange rates, being forward looking, may therefore offer a solution beyond the poor tools of the commodities futures markets and help us look past short-term imbalances that lead to volatility. Commodities futures markets are often prone to bubbles of speculation, due partly to the fact that it is not possible to 'short' a physical commodity. That is, if the price of coffee is currently high due to lack of supply, a prospective arbitrageur

cannot take advantage of the market's inaccurate forecast because it is not possible to borrow from the future expected excess in supply, as would analogously be done with a normal stock. Mathematically speaking, the price of a future has input variables that include the current spot price of the underlying commodity, the risk free rate, the cost of carry and the convenience yield. The future price of the commodity is only taken into account in a somewhat limited, inflexible manner.

In the present value model Chen et al use, it is shown that exchange rates directly embody information about future commodities prices, as exchange rate prices today can be used to predict their own future values. They also show in their paper that this should not be true the other way round, i.e. commodities prices cannot be used to predict future exchange rates as commodity prices cannot predict their own future values – a claim that has been debated by economists. This is mainly due to the fact that commodities futures markets are less developed and less regulated than the exchange rate market, as well as relatively inelastic supply and demand that are especially problematic for perishable commodities or those that require large storage space. These factors consequently lead to a breakdown of the reverse-relationship forecasting model.

This idea is further supported by the work of Lane and Shambough (2007). Their in-depth study into exchange rate valuations concludes that shocks to the exchange rate valuation are good predictors of the overall valuation shocks an economy faces. They found this to be especially true in developing countries, like those used in this sample. For example, they find that movements in absolute currency valuation in the 75th percentile (ranked by size) can have an impact of 3.8% on the GDP of emerging countries, and 5.3% in developing countries. In other words, the theoretical present value approach to exchange rates translates well to reality. The nature of these shocks to exchange rates lead to international wealth

distribution and are therefore especially important for analysing price shocks in other assets – namely, in this case, commodities.

Consequently, there is great value to quantifying this relationship, especially with respect to the recent turmoil and instability in the past five years, to analytically build upon the idea of exchange rates as an accurate prediction tool.

IV. Data

The International Monetary Fund (IMF) publishes a wide range of statistics online in its International Financial Statistics Database that, most importantly, includes exchange rate data for all five of the countries included in the regressions. The exchange rate data comes from member country statistical authorities (such as the central bank or finance ministry) and thus can be relied upon for accuracy.

The data is given at a monthly frequency, which appears to be the most appropriate time interval to use in the regressions. This is especially true as futures commodity contracts operate on a monthly basis – so when comparing the relative accuracy of exchange rates vs. the futures commodity market, a monthly basis is the most useful.

Currency values are measured in USD, that is, reflect the value of one unit of local currency in its equivalent number of USD: $s = \text{USD} / \text{local currency unit}$. Commodity prices are also measured in nominal USD (Chen et al concluded that real and nominal prices would have the same results, this should be especially true as the sample countries have shorter time ranges due to shorter floating exchange rate histories. They also conclude that results hold when expressed in the different numeraire currency of the GBP, concluding that the “dollar effect” of USD values should be minimal). Each currency has been abbreviated to a first letter that represents its country, and the first four letters of the name of the currency i.e. A. Peso stands for Argentinean Peso, P. Guar represents the Paraguayan Guaraní.

Each data set includes all available data from the country's most recent period of flexible exchange rates. A summary of the time periods used and the number of observations in each data set can be seen below in table 1. For regressions where several countries are considered together, data is used for the earliest date for which all countries operate in a flexible exchange rate regime (i.e. from 2002 for all data sets including Argentina.)

For each commodity and economy, the relevant spot prices have been obtained to provide a basis for correlation. Futures data has been obtained from the Chicago Board Options Exchange to provide a basis for comparing the accuracy of the model.

Table 1: Summary of Exchange Rate Data

Data Set	Month Beginning	Month Ending	Number of Observations
Argentinean Peso	2002.4	2010.1	93
Brazilian Real	1999.1	2009.11	130
Columbian Peso	2000.1	2010.1	120
Peruvian Sol	1992.1	2009.12	204
Paraguayan Guarani	1999.1	2009.12	228
GSCI Index	1994.4	2010.1	177

V. Empirical Specification

The models below regress the movement of historical commodity prices on historical currency movements to create a predictive model based on the work of Chen et al. This is a model that can be extrapolated to draw forward looking conclusions.

The dependent variable in each equation represents the change in commodity price (cp_{t+1}) in time $t+1$, with the independent variable being the change in nominal exchange rate in time t ($s_t = \text{USD} / \text{local currency unit}$). The time period used is a month, as information regarding the immediate future will be the least discounted in exchange rates. Each

commodity regressed on a given currency is amongst the top three commodity exports for that country. The error term (ϵ) completes the regression.

All values of movement in commodity prices and currencies are measured in logs. Due to the time-series nature of the data, estimation error will not be random and may increase with time. A log transform will reduce the impact that this may have on results, and the time-series nature of the data has also been incorporated into Stata to adjust standard errors for heteroskedasticity. Using logs will also allow for more useful interpretations, as forecasting the percentage change of a commodity price is arguably more useful than an absolute value.

A. Forecasting Individual Commodities Prices with Single Currencies

Table I regresses a commodity price in time period t with the exchange rate of a commodity currency that exports it, and is based on the following model:

$$\Delta cp_{t+1}^{Commodity\ Price} = \beta_0 + \beta_1 \Delta s_t^{Currency} + \epsilon$$

Each commodity can be considered to be in the top five commodity exports for its respective commodity currency country, hence the forecasting relationship between them should be strong (also see Appendix 1). Data from the IMF was used to rank the top commodity exports of each sample country with respect to the value in USD. Out of the rankings, the three most valuable commodities, for each respective sample, for which data could be found, were input into a model. For example, the C. Peso is regressed against its first, second and fourth most valuable export commodities (petroleum- crude, coal and coffee) as price data could not be found for its third most valuable export, petroleum oil-not including crude. Consequently, regression inputs have been selected in a systematic manner.

Table 2: Regression Analysis using Single Currencies

Commodity cp_{t+1}	Currency s_t	Constant B₀	Coefficient B₁	Root MSE	Random Walk (1)	Futures (2)
1. Soy Oil	A. Peso	0.0103 (0.0073)	-0.2058 (0.3101)	0.0705	0.0852	0.0853
2. Soybeans	A. Peso	0.0089 (0.0080)	0.0426 (0.3368)	0.0761	0.0998	0.0885
3. Petroleum	A. Peso	0.0121 (0.0113)	0.2562** (0.1137)	0.1100	0.1133	0.0955
4. Petroleum	B. Real	0.0094 (0.0084)	-0.3791** (0.1665)	0.0916	0.1133	0.0955
5. Soybeans	B. Real	0.0064 (0.0063)	-0.3693*** (0.1251)	0.0912	0.0998	0.0885
6. Sugar	B. Real	0.0111 (0.0073)	-0.2882** (0.1453)	0.0799	0.0792	0.0780
7. Petroleum	C. Peso	0.0026 (0.0043)	0.8668*** (0.0374)	0.0395	0.1133	0.0955
8. Coal	C. Peso	0.0094 (0.0084)	-0.3166 (0.2281)	0.0804	0.813	0.0912
9. Coffee	C. Peso	0.0029 (0.0074)	0.2714 (0.2001)	0.0803	0.1100	0.1016
10. Soybeans	P. Guar	0.0084 (0.0075)	-0.5797* (0.2213)	0.0731	0.0998	0.0885
11. Beef	P. Guar	0.0016 (0.0047)	-0.2615* (0.13762)	0.0454	0.0441	n/a (3)
12. Maize	P. Guar	0.0067 (0.0065)	-0.5406*** (0.1928)	0.0640	0.1019	0.1016
13. Gold	P. Sol	0.0051 (0.0032)	-0.2417 (0.1467)	0.0466	0.0454	0.0429
14. Copper	P. Sol	0.0076 (0.0051)	-1.8148*** (0.3904)	0.0682	0.6954	0.0413
15. Zinc	P. Sol	0.0066 (0.0048)	-1.3611*** (0.3682)	0.0643	0.0658	0.0493

Standard errors in parenthesis

Asterisks mark significance at the 10% () 5% (**) and 1% (***) level respectively*

(1) Root mean square error for random walk prediction

(2) Root mean square error for futures market prediction

(3) Appropriate futures data for beef was not available

The results below demonstrate that the chosen commodity currencies do indeed have value as predictive tools, or at least in 2/3 of the 15 regressions above. Regressions 3, 4, 6, 10 and 11 in particular all have significant beta coefficients at the 5% level or higher and this can be interpreted as strong evidence of a predictive relationship between the two variables.

Beginning with regression 3, we can see that an appreciation of 1% in the value of the A. Peso forecasts an increase of 0.26% in the price of petroleum in the following month. Likewise, an appreciation of 1% in the value of the C. Peso (7) forecasts an increase of 0.86% in the value of petroleum.

The other significant regressions also signify a useful forecasting relationship, but in a reverse direction to that seen in regressions (3) and (7). For example, a depreciation of 1% of the Brazilian Real forecasts an increase of approximately 0.4% in the price of petroleum (4) or soybeans (5).

Chen and Rogoff dedicate research to interpreting the sign and magnitude of these coefficients with respect to the stickiness of the traded goods (2003). If the price of non-traded goods is not sticky, they deduce that, in theory, a unit change in the price of exportables should have a 0.75% change to the CPI, dependent also on the country's utility curve and their consumables. Secondly, if the price of non-traded goods is assumed to be sticky, the exchange rate should adjust one-to-one with changes in the world price of exportable commodities. On a sample of the three commodity currencies of Australia, New Zealand and Canada, Chen and Rogoff find that coefficients are largely between 0.5 and 1.0, which is consistent with their model for sticky and non-sticky commodity prices. However, in their most recent research, they do not make any generalizations as to the signs of the coefficients and instead focus on their significance.

This research supports theirs by demonstrating that commodity currencies do have predictive value, even if the coefficients here do not fall strictly within the 0.5 – 1 range that

they estimate. The wider range of the coefficients in this sample could be the result of South American governments adopting a more active monetary and fiscal policy than those of Australia, Canada and New Zealand. If a central bank is using policy tools to stabilise for its inflation, this would prevent the exchange rate moving by the amount required to reach a free market equilibrium, and so the price elasticity would be less than the estimated 0.5 – 1. For example, the Argentinean government acknowledges their use monetary policy as a tool to keep exchange rates between a narrow range of 2.90 and 3.10 peso to the USD. Columbia and Brazil cut interest rates by 100bps after the financial crisis and Peru by 50bps. This could help explain the lower value of the coefficients in comparison to Chen and Rogoff's original research.

Another factor that could influence the signs and magnitudes of the coefficients could be the importance of each commodity to its respective country's economy, as represented by the proportion it represents of the total amount of commodity exports. It's possible that the larger the proportion of exports that a specific commodity represents, the more an exchange rate would move in anticipation of a change in price. This could also be a deciding factor in whether an exchange rate has significant predictive power or not. However, work to establish a relationship between the two variables has yet to prove successful – see appendix 2.

Investigating the signs and magnitudes of the coefficients found here and in other research would be a worthwhile extension of this kind of commodity currency research.

As expected, the values of all the constants were close to zero and insignificant. It makes sense that a zero movement in exchange rate forecasts a zero movement in commodities export, especially as the time series nature of the data was taken into account when the regressions were run.

The last and second last column included in the table allow comparisons between the tested model, the futures market and the random walk. The random walk model was

constructed on the assumption that the forecast error in time t of the change in commodity price in $t+1$ is zero. It is encouraging to see that several of the regressions (1, 2, 4, 7, 8, 9, 10, 12) all indicate that the constructed model has a smaller RMSE than the random walk and the futures market, implying that it is indeed a better predictive tool. That being said, it is interesting to note that all three of the metals regressions, gold (13), copper (14) and zinc (15) fail to predict at a lower MSE than the futures market. This can be attributed to the fact that metals futures markets – especially in gold - are well established and relatively more liquid than futures contracts in general.

Figure 4 below shows the predicted change in cp against the actualised commodity spot prices, in comparison the movement predicted by the forwards market and the random walk.

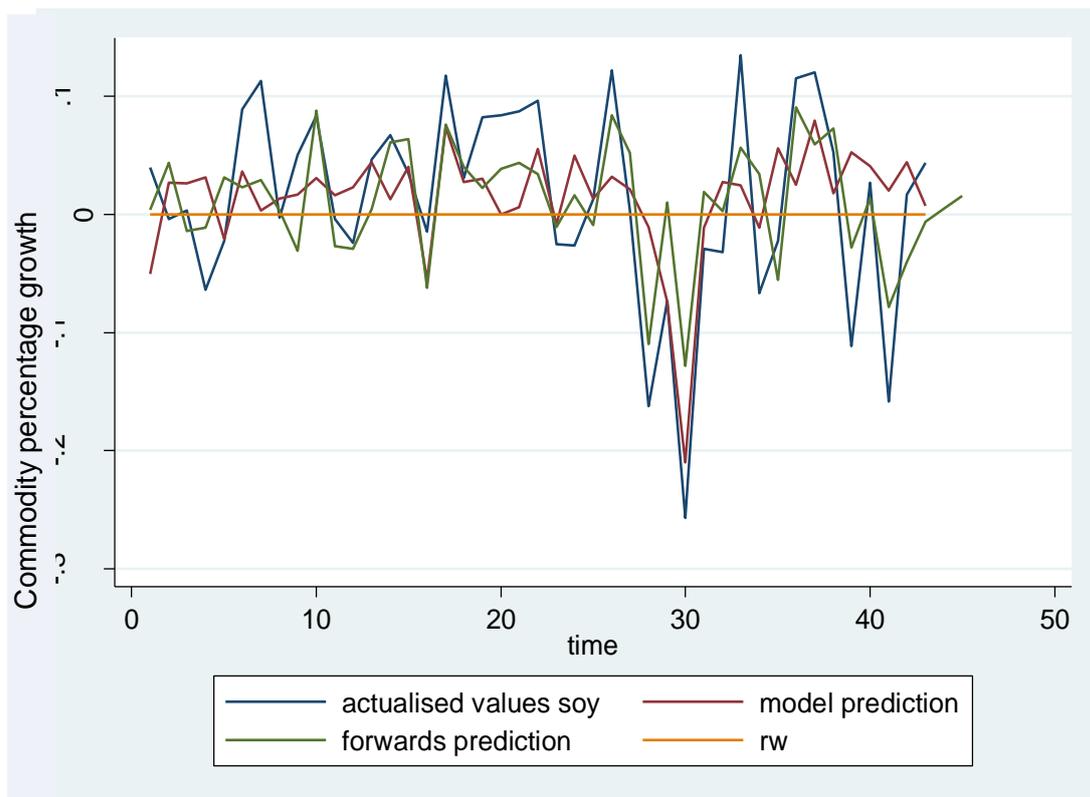


Fig 4: Regression 6 - Model forecast (red) better captures commodity price movements (blue) when compared to the forwards markets (green) and random walk (orange) between February 2006 ($t=0$) and November 2009

B. Forecasting Index Movement with Multiple Currencies

Chen et al show that there is value in aggregating individual currency movements to predict broader commodity indices. The following regressions aggregate two, three and five of the currencies to test their accuracy in predicting the movements of the S&P Goldman Sachs Commodity Index (GSCI). This index comprises 24 commodities from all sectors, classified as energy, industrial metals, agriculture, livestock and precious metals. The weightings are based on the average quantity produced of each commodity in the index worldwide. The GSCI was chosen from many similar options, all with broad positions across the main commodities markets. Consequently, commodity indices can be considered good proxies for the aggregate movement of the commodities market as a whole.

Several combinations of the five currencies were trialled and the table below represents the most significant equations with two and three commodity currency variables, as well as including a regression on the single currency of the A. Peso and a regression including all five currencies. This allows for analysis as to how the coefficients and root mean square error changes as more variables are added to the model.

The regressions in the table correspond to the following:

1. $\Delta cp_{t+1}^{GSCI} = \beta_0 + \beta_{11} \Delta S_t^{ARG}$
2. $\Delta cp_{t+1}^{GSCI} = \beta_0 + \beta_{21} \Delta S_t^{ARG} + \beta_{22} \Delta S_t^{BRA}$
3. $\Delta cp_{t+1}^{GSCI} = \beta_0 + \beta_{31} \Delta S_t^{ARG} + \beta_{32} \Delta S_t^{BRA} + \beta_{33} \Delta S_t^{SOL}$
4. $\Delta cp_{t+1}^{GSCI} = \beta_0 + \beta_{41} \Delta S_t^{ARG} + \beta_{42} \Delta S_t^{BRA} + \beta_{43} \Delta S_t^{COL} + \beta_{44} \Delta S_t^{GUA} + \beta_{45} \Delta S_t^{PER} + \varepsilon$

Table 3: Predicting the GSCI

	(1)	(2)	(3)	(4)
A. Peso	0.135 (1.25)	0.179* (1.73)	0.184* (1.81)	0.185* (1.80)
B. Real		-0.469*** (-3.33)	-0.390*** (-2.70)	-0.323* (-1.86)
P. Sol			-0.912* (-1.97)	-0.729 (-1.51)
C. Peso				0.125 (0.54)
P. Guarani				-0.286 (-1.28)
Constant	0.0108 (1.36)	0.00870 (1.15)	0.00726 (0.97)	0.00767 (1.03)
N	95	95	95	95
Root MSE	0.07595	0.07214	0.07109	0.07104

Standard errors in parenthesis

Asterisks mark significance at the 10% () 5% (**) and 1% (***) level respectively*

The results above show that aggregating two or more currencies together can be used as a tool to predict an overall commodity index. Equations (2) and (3) in particular suggest that when the Argentine peso, Brazilian real and Peruvian sol are grouped together, they have significant predictive power. It is also interesting to note that the root MSE error decreases slightly between columns (1) and (4), implying that introducing additional commodity currencies to an aggregate index regression reduces the prediction error. The MSE of the random walk is 0.7429, higher than all models but (1). This is consistent with Chen et al's work that demonstrated aggregating commodity currencies could have significant power in predicting the movement of a commodity index. It is promising to see that the results hold when extended beyond their original sample of commodity currencies. (Note that futures markets do not exist for commodity indices so an additional comparison could not be done.)

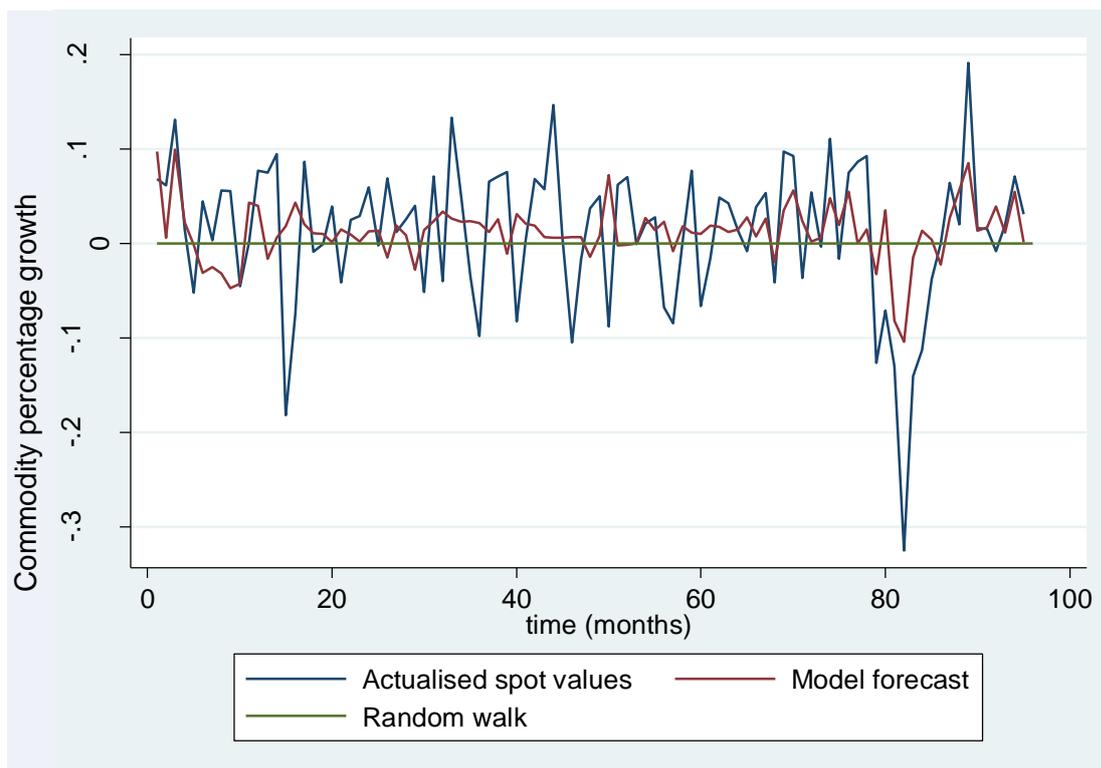


Fig 5: The model prediction of regression 3 (blue) captures the main movements of the actualized spot prices of the GSCI (red) over the past 8 years ($t(0)$ = Jan 02)

However, the results also show that not all commodity currencies are useful when trying to predict a commodity index. Particularly, the coefficients for the Columbian peso and the Paraguayan Guaraní were not found to be significant. This could be because these two countries place a comparatively smaller export emphasis on commodities. Alternatively, it could be because Brazil and Argentina have economies that eclipse the other three countries included in the sample, although this does not explain the predictive power of Peru when included in the sample (Argentina and Brazil are ranked by the IMF at 30 and 10 in terms of the world's highest GDPs, Columbia, Paraguay and Peru at 34, 108 and 55, respectively.) Regardless, both countries can be considered as exogenous variables in the regressions as even together, they can only account for a fraction of all commodities trade.

A third explanation could have to do with the specific commodities that each country exports. However, the graph below shows that in 2009, Argentina, Brazil and Peru together

are even less representative of the GSCI than the whole sample of five. This surprising result would make for a worthwhile extension of this research into determining why some countries have more significant power in predicting an aggregate index than others.

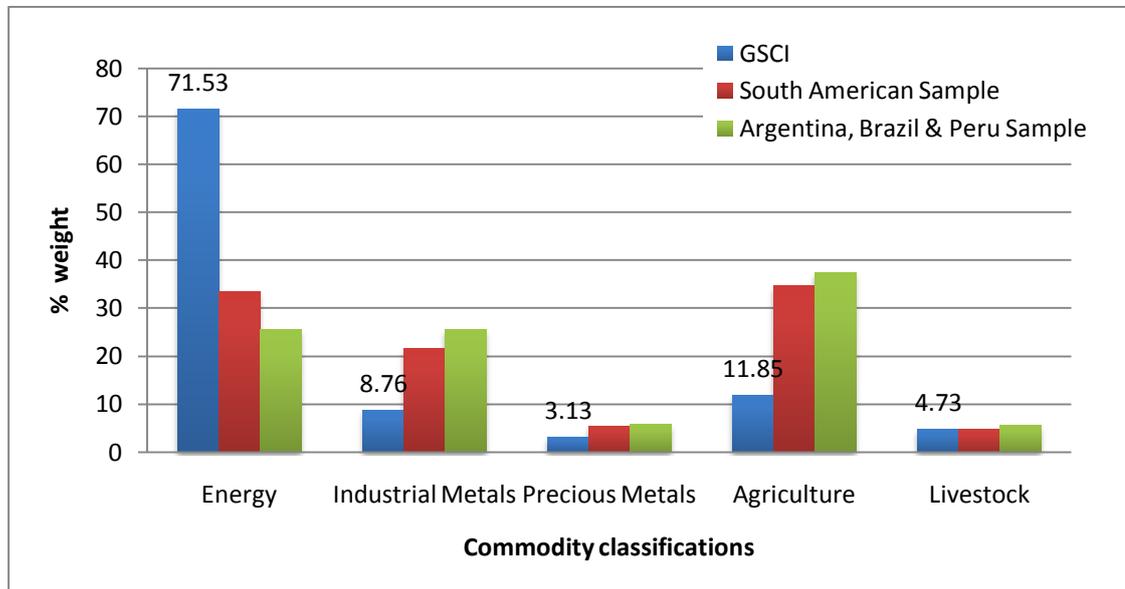


Fig 6: Despite having greater predictive power, Argentina, Brazil and Peru together seem less representative of the GSCI than the entire sample, particularly in energy and agriculture

VI. Concluding Remarks

This study focuses on testing the accuracy of five South American commodity currencies in predicting future fluctuations in commodity prices. Results shows that in ten out of fifteen regressions, the currencies tested have significant predictive power beyond what is demonstrated by the random walk and the futures market. The model proposed in this paper is therefore a better predictive model than current tools available to economists. Furthermore, three out of the five currencies have significant power in predicting a commodity index, and hence, the aggregate movement of commodities markets as a whole.

The strength of these results shows that previous research on the dynamic relationship between commodity currencies and their respective currencies extends to developing countries and thus a wider range of commodity exports. Despite having a shorter history of

floating exchange rates, the present value model of exchange rates holds, allowing current exchange rates to move freely in expectation of a future change in the price of a commodity which is fundamental to the exporting country's economy. The analysis that this model allows for is particularly important given South America's increasing importance in the world. It also opens the door for further investigation as to what determines the signs and magnitudes of a relationship between a commodity currency and a commodity, which in turn will allow for a better understanding of both variables.

Hopefully, this research can be developed to include other commodity exports and commodity currencies. By extending the model to a wider range of countries and observations, more conclusions could be drawn regarding when this model is most effective, and in what cases it fails. It can also be hypothesised that a model including more commodity currency exchange rates will be an even more accurate tool when predicting or forecasting the aggregate movement of commodity markets.

In a global economy where countries become increasingly interlinked and interdependent, the ability to forecast future commodity price movements is incredibly useful in minimising the risk that comes from international trade. The results of this research have the potential to benefit governments, private corporations and national economies as a whole, consequently encouraging trade and global efficiencies.

Appendix 1

Primary Commodity Exports (in order of export value) by Country

Column1	Rank	Commodity	Value (USD mn)	% of total comm. exports	% of world share	Regression ref #
Argentina	1	Oil-cake and other solid residues	5748	10.3%	14.3%	-
	2	Soy-bean oil	4419	7.9%	19.1%	1
	3	Petroleum oils, other than crude	3281	5.9%	2.0%	-
	4	Soybeans	3435	6.2%	9.6%	2
	5	Petroleum oils, crude	1296	2.3%	2.0%	3
Brazil	1	Iron Ore	16539	8.4%	25.2%	-
	2	Petroleum oils, crude	13683	6.9%	2.0%	4
	3	Soybeans	10952	5.5%	21.8%	5
	4	Cane or beet sugar and pure sucrose	5483	2.8%	22.9%	6
Columbia	1	Petroleum oils, crude	9306	24.7%	2.0%	7
	2	Coal	4594	12.2%	4.9%	8
	3	Petroleum oils, other than crude	2736	7.3%	2.0%	-
	4	Coffee	1917	5.1%	7.5%	9
Paraguay	1	Soybeans	890	32.0%	3.2%	10
	2	Meat of bovine animals	193	6.9%	2.0%	11
	3	Maize (corn)	283	10.2%	0.6%	12
	4	Oil-cake and other solid residues	209	7.5%	2.0%	-
Peru	1	Gold	5543	17.8%	5.2%	13
	2	Copper ores	4898	15.7%	13.1%	14
	3	Refined Copper	2700	8.7%	2.5%	-
	4	Petroleum Oils, other than crude	2236	7.2%	2.0%	-
	5	Zinc	1292	4.1%	10.7%	15

Certain commodities (those without regression reference numbers) have not been included in this study due to lack of comprehensive spot price data

Appendix 2

Investigating the relationship between coefficient significance and sign, and the value of export commodity

In the effort to explain in which cases commodity currencies are significant in predicting commodity prices and what determines the direction of the relationship, work was done relating each commodity to specific properties of its exporting countries.

The figures below attempt to derive a relationship between each commodity and the percentage of total export value that it constitutes for a respective exporter. It can be hypothesised that commodities that are more valuable to an exporting country (higher percentage value) will be more represented in exchange rate value (higher level of significance). This is because they bring in a greater proportion of GDP and so a price change of a given percent should have a larger potential impact on an economy than that of a less valuable commodity. However, Figure 1 shows that this is not the case by plotting each of the fifteen sample commodities with respect to whether they could be predicted at a significant level, and the percentage of total commodities trade that they represent.

Figure 2 plots each commodity's β_1 coefficient against the percentage of total commodities trade that the commodity constitutes for an exporter. Again, no relationship between each β_1 coefficient and respective commodity's percentage of country or world commodity trade can be seen when analysed for each regression tested.

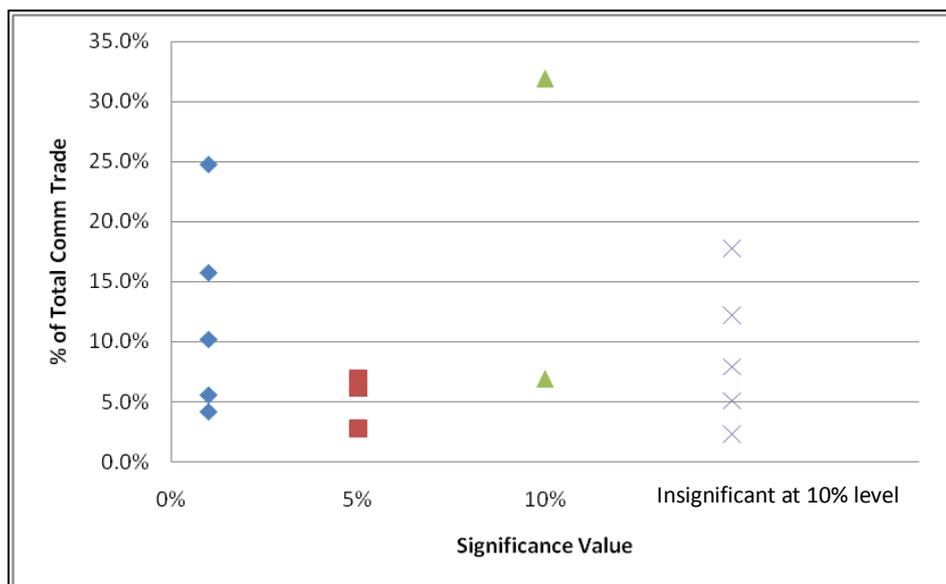


Fig 1: The prices of more highly valued commodities (higher percentage of exporter's trade) are not necessarily predicted with more significance

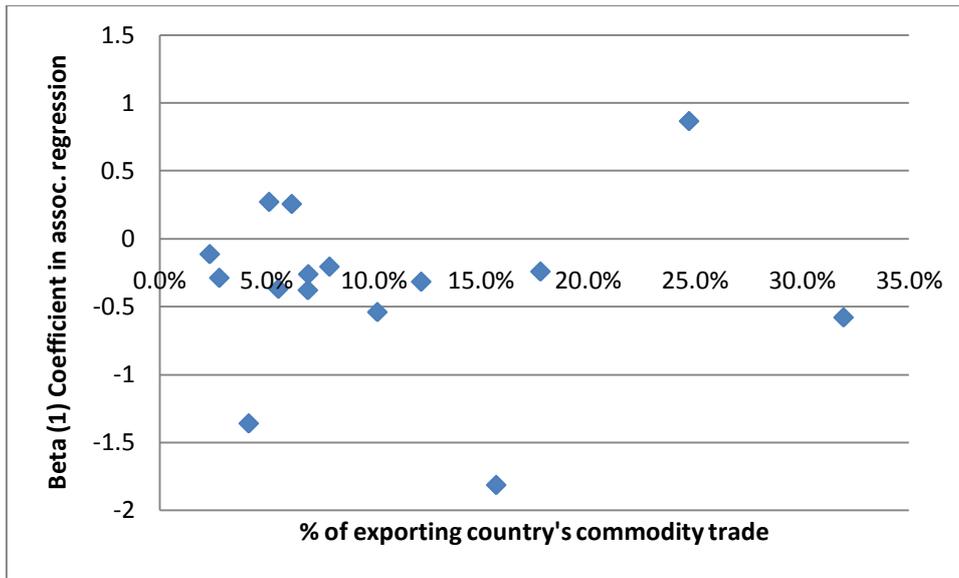


Figure 2: There appears to be no relationship between the β_1 coefficient and its associated commodity's importance to the exporter's economy

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