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Forecasting the Colombian Exchange Rate: Capital Adjustments and Politics vs. Traditional IRP, Trade Adjustments and Random Walk Frameworks

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"Forecasting the Colombian Exchange Rate: Capital Adjustments and Politics vs. Traditional IRP, Trade Adjustments and Random Walk Frameworks"[♣]

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Abstract

Very few forecasting studies have been made for the Colombian exchange rate. In this paper I try to show what variables actually affect and determine the exchange rate in Colombia. I study 2 different models for forecasting the exchange rate and asses their forecasting ability by comparing them to 3 traditionally used benchmark models. The first model relies on the idea that a current account deficit and negative net foreign assets imply a future increase in either net exports or foreign portfolio returns which, in turn, imply an exchange rate devaluation. The second model tries to capture the effect of the country's political situation and its economic agents' perception of the current state of economic fundamentals, on future exchange rate movements. I will show that the second model performs well for short term horizons and that the first model is out-performed by at least one of the remaining models for every single forecasting horizon. The Colombian case is particularly interesting since there are many untraditional factors, such as social instability and illegality, which may affect the exchange rate. In the paper I will also show evidence of the influence of these untraditional factors on the exchange rate using the forecast results of the models studied.

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I. Introduction:

Models used to forecast the exchange rate have generally proven to be very unreliable and unsuccessful. In a ground-breaking paper published in 1983, Meese and Rogoff (1983) found that the exchange rate forecasting models based on fundamentals were out-performed in out of sample forecasting by a simple random walk. Since then, very few authors have been able to significantly improve these results. The general finding for most studies has been that models based on fundamentals perform significantly better over the long term than over the short term. Chinn and Meese (1995), MacDonald and Taylor (1994), Frankel and Foot (1991) and Taylor and Allen (1992) found that fundamentals-based models can beat a random walk in out of sample forecasting over long term horizons but not over shorter horizons. The basic idea behind this is that, 'while dealers in the foreign exchange market rely more heavily on charts or 'recent trend' for short run forecasting, they pay more attention to the economic variables for the long-run' (Kim and Mo (1995)). Purchasing power parity, uncovered interest rate parity, external trade adjustments and the quantity theory of money have been the basic concepts used so far to model the effects of fundamentals on the exchange rate.

In this paper I assess and compare the out-of-sample forecasting performance of two different exchange rate models using a Colombian weighted exchange rate. I chose to study the Colombian exchange rate for several reasons: The free floating exchange rate regime in Colombia is relatively recent so very few studies have been made on this subject. Colombia is a developing country inside Latin America. The exchange rate in developing countries in general and Latin-American countries in particular, has shown to be very volatile and difficult to determine, let alone accurately predict, which makes this study particularly interesting and challenging. Finally, Colombia's economy in general and its exchange rate market in particular is greatly affected by country-specific characteristics such as social instability, violence and illegal activities which, again, makes this study very challenging and interesting, since it requires taking these aspects into account.

The 2 models are compared in their out-of-sample forecasting performance with 3 benchmark models that have traditionally been used to forecast the exchange rate. The benchmark models used are the uncovered interest rate parity model, the trade adjustments model and the random walk with a drift model. Monthly data from January 1990 to November 2005 is used and the forecasting horizons studied are 1, 3, 6, 12 and 24 months.

The first model studied takes the methodology used by Campbell and Schiller (1998) and later followed by Lettau and Ludvigson (2001) and Gourinchas and Rey (2005). The accumulation budget constraint for net foreign assets will be solved forward to show how the relation between a country's net foreign assets and net exports may help explain movements in the exchange rate. This model will be named the *Capital Adjustments Model.* The second model studied will try to assess the importance of politics and internal stability in the determination of the exchange rate. It also explores a new way of including fundamentals in exchange rate models. The variables used for this model are a 1 to 100 grading scale of the business climate and political situation taken from a survey made to Colombian entrepreneurs, a dummy variable for the months before June 1991 used to capture exchange rate regime changes and, following Blomberg (1997), a dummy variable for the months before and after election periods. This approach is particularly interesting and relevant for the Colombian case since it tries to capture the country's political and social stability which, aside the illegal economy, are well known determinants of the exchange rate. For simplicity, this model will be named *The Political Model.* It is important to point out, though, that this model incorporates not only political effects, but also social, and economic effects. Both models will be compared on their forecasting performance against the benchmark models mentioned above.

In this study I show that, for the case of the Colombian Peso, the political model outperforms a random walk over short term horizons but has poor performance over long term horizons, whereas the capital adjustments model is outperformed by at least one of the benchmark models over all forecasting horizons.

The paper is organized as follows: In section II I present a brief description of the Colombian economy and the evolution of its exchange rate, emphasizing on certain unique characteristics which may affect its currency and that can be hard to measure and model. The framework for the models is explained in Section III. Section IV covers the construction of the monthly data set. Estimation results, the forecasting performance of the models and model comparisons are explained in Section V and, Section VI concludes.

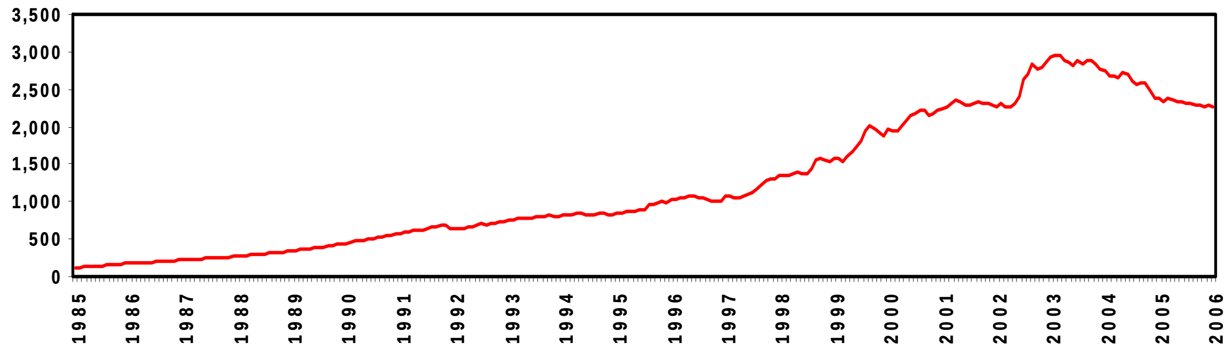
II. The Colombian Economy

In this section I briefly describe the evolution of the exchange rate in Colombia and name a few variables that may affect its dynamics. Up until 1991, the exchange rate in Colombia followed a crawling peg regime characterized by rigid controls to capital movements. From June 1991 to January 1994 there was more flexibility and the exchange rate was mostly determined by the markets. From January 1994 until September 1999 the central bank participated in the market and 'the regime very much resembled a managed float.'[1] From September 1999 onwards, there has been an official free floating regime. Figure 1 plots the Colombian Peso / US dollar exchange rate from January 1985 until January 2006. A clear devaluation path can be seen up until the end of 2003 when an 'unexpected' appreciation of the Colombian peso began to take place. This unexpected appreciation may partly be explained by the persistent fiscal and current account deficits observed recently in the US economy.

[1] Rowland and Oliveros (2003)

Figure 1

ColombianPeso / USDolar



Source: Banco de la República

There are a few characteristics about the Colombian economy that are worth pointing out as they have clearly affected the exchange rate over the last couple of decades. Even though the Colombian exchange rate market has been rapidly growing over the last few years, it still remains a relatively small market. This implies that large transactions can significantly affect the market price and volatility.

Political stability and country-associated risk play a key role in the economic situation of the country, since they have an effect on many economic variables including the exchange rate. A good variable that can be used to measure country-associated risk is the sovereign spread. The spread measures the difference between the returns from a Colombian Government bond and a US treasury bill.[2] Another important aspect which may affect the exchange rate in Colombia is the volume of remittances. As Solimano (2003) points out 'Remittances are currently the second most important source of external finance to developing countries, after foreign direct investment.' Finally, illegality and the camouflage economy also play a key role in determining the Colombian exchange rate. In 2005, the total value for

[2] For more detail see Rowland (2004).

money laundry operations in Colombia was 9,813 million US dollars[3]. This reflects the importance of illegal money in the economy, in general, and the exchange rate, in particular. It is very important to take all these aspects into account when trying to explain the behavior of the Colombian Peso. These particular aspects are indirectly included in the forecasting models studied in this paper. Country associated risk is reflected in the uncovered interest rate parity model since the difference in the interest rates between Colombia and the rest of the world, reflect, in a way, the perceived stability in the country's economic and political situation. The effects of illegal money are indirectly represented in the capital adjustments and trade adjustments models. The two models will use different data sets for trade and their relative forecasting performance may, in part, be explained by this difference, which intends to capture or approximate the effects of illegality over the exchange rate. This difference relies on whether unregistered transactions made in foreign currency are o are not included in the data. Finally, the effects of corruption are indirectly captured in the political model through the election dummy variable. This variable captures the final stage of a government term which is generally characterized by government overspending. This overspending has an effect on the following government's fiscal situation which, in turn, may affect the exchange rate in the near future. A more corrupt government will tend to spend more at the end of its political term than a less corrupt government.

Even though the focus of this paper is to asses the out of sample forecasting performance of exchange rate models, I feel it is important to mention these issues first as they may be very useful for understanding the results obtained from the models.

[3] Source: Fiscalía General de la Nación (Colombia's Attorney General's Office)

III. The Models

a. The Capital Adjustments Model

The capital adjustments model is based on the '*financial adjustments*' model presented by Gourinchas and Rey (2005). The basic idea behind the model is that a current account deficit and a negative position on net foreign assets are jointly unsustainable without an eventual devaluation of the exchange rate. This devaluation may come through trade adjustments or through the financial markets.

The capital adjustments model uses the accumulation budget constraints for net foreign assets as a starting point. The budget constraint for net foreign assets is:

$$NA_{t+1} = R_{t+1}(NA_t + NX_t)$$

Where NA_t are net foreign assets defined as gross foreign assets at time t minus gross foreign liabilities at time t; NX_t are net exports defined as total exports for period t minus total imports for period t. Before proceeding with the log linearization, the following assumptions must be imposed:

$$xm_t \equiv x_t - m_t \text{ , } al_t \equiv a_t - l_t \text{ and } xa_t \equiv x_t - a_t \qquad \textit{must be stationary}$$

Where x_t, m_t, a_t and l_t are the logs of exports, imports, gross foreign assets and gross foreign liabilities at time t, respectively. Log-linearizing, expanding and with a bit of algebra, the above budget constraints for gross foreign positions can be written as:

$$|\mu_m|(x_t - m_t) + |\mu_l|(a_t - l_t) + xa_t = -\sum_{i=1}^{\infty} \rho^i \{r_{t+i} + \Delta nx_{t+i}\}$$

Where x_t, m_t, a_t and l_t are as before; μ_m and μ_m are sample weights which reflect the relative importance of imports with respect to exports for the first term and of gross foreign liabilities with respect to gross foreign assets for the second term; r_t is the return on the net foreign asset portfolio for period t; Δnx_t is the change in "net exports" defined as $\Delta nx_t = (x_t - m_t) - (x_{t-1} - m_{t-1})$ and $\rho = \frac{\gamma}{R}$, where *R* is as before and γ is the steady state growth rate of an aggregate variable *Y*, such as Total Wealth . This aggregate variable is used in this study for stationarity issues. Returns to *Net Foreign Assets*, R_t is stationary with steady state value $R > \gamma$. More detail on the derivation of the above equation can be found in Appendix A. The above equation must also hold in expectations, so:

$$|\mu_m|(x_t - m_t) + |\mu_l|(a_t - l_t) + xa_t = -\mathrm{E}_t\left[\sum_{i=1}^{\infty} \rho^i \{r_{t+i} + \Delta nx_{t+i}\} \right] \qquad (1)$$

Gourinchas and Rey (2005) call the left hand side of the above equation nxa_t and use this variable to forecast portfolio returns and changes in the exchange rate. They use total wealth to find the weights μ_l and μ_m, and use these weights to create nxa_t. I believe this procedure for constructing the weights is not robust since different choices for defining the variable wealth may yield completely different weight measures and hence, completely different values for nxa_t, hence affecting the validity of this variable as a good predictor. I therefore follow a different approach by considering the fact that $(x_t - m_t)$, $(a_t - l_t)$ and $(x_t - a_t)$ each help determine expectations for future foreign portfolio returns and future changes in trade. I take the cointegrating relation of these four variables and use the three cointegrating vectors as predictive variables for the model. I do this to insure stationarity and to try and correct any measurement errors from the data. This procedure will be discussed in more detail in Section V. Equation (1) can be written as:

$$|\mu_x|x_t - |\mu_m|m_t + |\mu_a|a_t - |\mu_l|l_t = -\mathrm{E}_t\left[\sum_{i=1}^{\infty}\rho^i\{r_{t+i} + \Delta nx_{t+i}\}\right] \qquad (2)$$

Where μ_x and μ_a are the relative importance weights for exports and assets, respectively.

In the above expression exports and assets have a positive sign and imports and liabilities have a negative sign. To understand the intuition behind this equation, consider a country that has a current account surplus and positive net foreign assets. This implies that the expression in the left hand side of (2) is positive. If this is true, then $\mathrm{E}_t\left[\sum_{i=1}^{\infty}\rho^i\{r_{t+i} + \Delta nx_{t+i}\}\right]$ has to be negative. This means that people expect either negative foreign portfolio returns in the future, or a future decrease in net exports. The left hand side of Equation (1) is stationary due to the assumptions imposed. This means that there has to be an adjustment: current account surplus and positive net foreign assets cannot be sustained indefinitely. If foreign portfolio returns are considered constant, then the adjustment must be made through shifts in trade. People will expect exports to fall and imports to rise, which may occur via an appreciation of the local currency. Alternatively, the adjustment may also come through an expected decrease in future portfolio returns. Particularly, this expected decrease may be caused by an appreciation of the local currency. Suppose gross foreign assets are held in foreign currency and gross foreign liabilities are held by foreigners in local currency. A local currency appreciation implies a wealth loss to local investors since their assets, which are held in foreign currency, loose value in terms of what they can spend in local currency. Therefore, expectations of a decrease in foreign portfolio returns can come in hand with expectations of an appreciation of the local currency.

Both adjustments channels show that the left-hand-side of equation (1) can be a good predictor for the exchange rate. One way is through trade, the other is through financial markets. If the left hand side of (1) is positive, then people will expect the local currency to appreciate. The adjustment through trade will usually take a longer time than the adjustment through the financial markets. Therefore, the left-hand-side of equation (1) may be a good predictor for the exchange rate for short horizons through the "*financial adjustments channel*"[4] and for longer horizons through the trade adjustments channel.

b. The Political Model

Variables related to the political and social situation of a country have rarely been included in models used to forecast the exchange rate. A free floating exchange rate is hard to determine since it depends on many different factors, whose importance depends on the country being studied and the period in time being considered. In this section I present a political approach for forecasting the exchange rate which may also serve as an alternative route for indirectly showing the effects of fundamentals in the behavior of the exchange rate.[5] The variables included in the model are the following:

1) Following Blomberg (1997) I use a dummy variable to capture government election periods. This dummy variable takes the value 1 for the 6 months preceding an election and the 3 months after it and the value 0 for the remaining months. The idea behind using this variable is to capture the effects of increased government spending and/or tax cutting which usually takes place at the end of a political term.

[4] Term taken from Gourinchas and Rey (2005)

[5] Fundamentals, such as unemployment, fiscal situation, productivity etc. are not directly included in the model. Instead, they are captured indirectly using the survey variable on the economic climate as an approximation for them.

Overspending or tax cutting may have large effects on the newly elected government's fiscal balance which may eventually cause shifts in the exchange rate. This phenomenon is particularly relevant in Colombia since, up to 2005, presidential re-election was not permitted and governments looked to boost approval ratings over their political mandate by increasing government spending and/or reducing taxes at the end of their term.

2) Answers to a 1 – 100 scale opinion survey made to business managers in Colombia on the current business climate surrounding their firm. The specific variable that is used in the model is the percentage of interviewees who felt their firm's situation was *bad* at the time. The remaining possible answers were *good* and *average*. I decided to use the percentage of *bads* instead of the percentage of *goods* because I think many interviewees may have found themselves indifferent between answering *good* and answering *average,* whereas those who answered *bad* were probably less willing to answer *average*. The intuition behind using this variable is quite clear. If the business climate is not good and entrepreneurs feel their firms are in a bad situation, demand for local currency will decrease and the exchange rate will depreciate. This variable represents an alternative way of including fundamentals in the model since it indirectly captures the view of economic agents on the current situation of economic fundamentals. A basic advantage of using this variable in the model is that the endogeneity problems and the causality issues generally present when using fundamentals are less of a problem.

3) A dummy variable for the months preceding July 1991. The variable takes the value 1 for the period between January 1990 up until June 1991 and 0 for the remaining sample. This is done to capture the crawling peg regime and the strict capital controls that were present before June 1991.

This model should have a better performance in the short run than in the long run. For instance, the dummy variable that captures election periods should have practically no effect after a certain period of time. The same applies to the survey question on business climate. This model is quite simple and attempts to capture the short run effects of politics, general views on economic fundamentals and stability over the exchange rate.

Fundamentals are not directly included in the model and there is no theoretical framework behind it to prove that there are direct effects. Instead, fundamentals are included indirectly. Without a theoretical framework, the model simply seeks to show that fundamentals may be important in determining the exchange rate, even for short term horizons. Economic fundamentals and stability are captured in the business survey question and politics and exuberance are controlled for in the election dummy variable.

IV. The Data

In this section I describe the finding and construction of the data set for the 2 models being studied. I use monthly data from January 1990 until November 2005. For both models I use the International Monetary Fund (IMF) Special Drawing Rights (SDR) basket of currencies, taken from the International Financial Statistics (IFS) services of the IMF. The data for the exchange rate is therefore the amount of Colombian pesos per SDR. The SDR is a basket of currencies composed of the US dollar, the Japanese Yen, the Sterling Pound and the Euro. The relative weight for each currency depends on its relative importance in the world's financial and trading markets. Before deciding to use the Colombian Peso/SDR exchange rate, I constructed a trade weighted exchange rate using Colombia's ten main trading partners.[6] I leveled the 10 currencies by indexing them to a base year and created a trade weighted exchange rate using normalized trade weights. Data for this series was available from January 1993 until December 2005. I

[6] The data for this series was taken from different sources. The weights were taken from the Colombian Central Bank, *Banco de la República*. The different exchange rates were taken from the IFS in the IMF, from the Banco de la República and from each country's central bank. The ten countries or areas used were: The United States (41.0%), The Euro Zone (20.7%), Venezuela (15.0%), Japan (7.1%), Ecuador (5.6%), Mexico (2.7%), Brazil (2.5%), Peru (2.3%), Chile (1.6%) and Argentina (1.4%).

then leveled the constructed exchange rate with the Colombian Peso/SDR exchange rate and compared both measures for the period of data that was available. I found both series to be almost identical so I decided to use the larger sample that I had in the Colombian Peso/SDR exchange rate.

a. Capital Adjustments Model

The main data source used for this model is the Colombian Central Bank, *Banco de la República de Colombia*. I constructed the data on gross foreign assets and gross foreign liabilities using data available on foreign investment positions and filling in the remaining sample using data on investment flows. Data on investment flows was taken from the exchange market balance. The exchange rate market balance registers all the transactions that actually pass through the official exchange rate market. Data for exports and imports was taken from the balance of payments.

The data for gross foreign assets and gross foreign liabilities was not available for the whole desired period so it had to be constructed using an initial value and data on capital flows. The variable *Gross foreign assets* was separated into 3 categories: *Investment abroad, International reserves held by the Central Bank* and *Other Assets*. The variable *Gross foreign liabilities* was separated into 2 categories: *Foreign Investment in the economy*; and *Other Liabilities*. The categories *Investment Abroad* and *Foreign Investment in the economy* include direct investment, portfolio investment, debt and any other financial investments made by the public sector. The category denominated by *Other Assets* basically covers loans, commercial credit and reimbursement accounts held abroad in foreign currency. The category *Other Liabilities* basically covers loans and commercial credit.

Data on gross foreign assets and gross foreign liabilities for Colombia is only available every six months and has only been published since 1997. I therefore had to construct the time series using flows and an initial value. I took data on gross foreign assets and gross foreign liabilities for the last term of 2005 and divided it into the categories mentioned above. I then took monthly data from January 1990 to November 2005 from the exchange market balance for each of these categories and constructed each category moving backward using data for the last term of 2005 as a starting point[7]. The following updating equation taken from Gourinchas and Rey (2005) was used for each individual category.

$$X_t^i = X_{t-1}^i \left(1 + r_t^{x^i}\right) + FX_t^i$$

Where X_t^i is category i's position at time t; FX_t^i is category i's flow for time t; and r_t^i corresponds to category i's valuation gains for period t. Valuation gains were only used for the categories *Investment Abroad* and *Foreign Investment in the economy.* For the remaining categories, r_t^i took the value zero. The r_t^i used for *foreign investment* in the assets category was a weighted average of stock market index returns and government bonds.[8] The same country weights used for the trade weighted exchange rate mentioned above were used. The valuation gains used for foreign direct investment in the Liabilities category was a weighted average of the Colombian 3 month deposit rate and the IBB stock market index returns.[9] Each category was constructed and then correspondingly added to obtain the values for gross foreign assets and gross foreign liabilities for the period and frequency studied. Finally, the constructed series was compared to the true data available from 1997 onward and was found to be quite similar.

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[7] The data on investment flows is not available on-line. It is published in the bank's monthly economic report on monetary and exchange rate data (*Estadisticas Monetarias y Cambiarias*). This report publishes data on the official foreign currency transactions and captures unofficial foreign currency transaction with data on flows of reimbursements accounts held abroad. Therefore, every change in each of the categories is accounted for. I gathered this data manually and it is available upon request.

[8] Weights used: 30% for the stock market and 70% for government bonds.

[9] The IBB (Indice de Precios de Acciones de la Bolsa de Bogotá) index returns are used between January 1991 and June 2001. After June 2001, the IGBC (Indice de Precios de Acciones de la Bolsa de Colombia) is used, following the merger of the 3 regional stock markets. For 1990, only the 3 month loan rate is used for valuation effects, since stock market participation then was very small.

b. The Political Model

The data used for this model was taken from a survey conducted by the ANDI (*Asociación Nacional de Empresarios de Colombia*) to Colombia's 500 leading firms. The percentage of managers who answered the option *bad* to the question: *How do you perceive your firm's current situation?* was used. The time span and frequency are the same as in the previous model. The remaining 2 variables are just time dummy variables for election months and months preceding June 1991.

c. Benchmark Models

The data used for the Benchmark models was taken from Colombia's Central Bank and from the IMF international statistics. For the uncovered interest rate parity model I used the 3-month deposit rate, for the Colombian case and a weighted average of the 3 month deposit rate of Colombia's main trading partners, for the foreign case.[10] For the Trade adjustment model I used the value of exports and imports taken from the exchange market balance rather than the current account balance as in the capital adjustments model. As mentioned earlier, the exchange market balance only registers the transactions in foreign currency that actually pass through the exchange rate market at a given point in time and omits other foreign trade transaction that do not use foreign currency.[11]

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[10] The same country weights as used previously are considered.

[11] Exports and Imports for the capital adjustments model were not taken from this source because the net foreign assets budget constraint would not hold.

Estimation Results and Forecasting Performance

In this section I describe the estimation procedure and the results for the capital adjustments model and the political model and compare their forecasting performance over 1, 3, 6, 12 and 24 months with the benchmark models. The first step I took was to check for unit roots to see if the variables were stationary. The Augmented Dickey Fuller test from Table 1 shows that the logs of the exchange rate, gross foreign assets, gross foreign liabilities, exports and imports all have one unit root.

Table 1

	Level		1st Difference
IMF Exchange Rate	-3.023971	**	-7.148384
Gross Foreign Assets	-1.863739	**	-5.288773
Gross Foreign Liabilities	-2.118185	**	-11.51601
Exports	-2.213628	**	-4.859867
Imports	-3.254979	**	-9.942129

All Variables Expressed in Logarithmic terms
Values for the Augmented Dickey-Fuller Unit-Root Test.
*: Reject Null Hypothesis of Unit root at 5% Level (based on the Akaike Criterion)
**: Reject Null Hypothesis of Unit root at 1% Level (based on the Akaike Criterion)

The expression $|\mu_m|(x_t - m_t) + |\mu_l|(a_t - l_t) + (x_t - a_t)$ was shown earlier to have some forecasting power over the exchange rate. The variables $(x_t - m_t)$, $(a_t - l_t)$ and $(x_t - m_t)$ should be stationary from the assumptions imposed earlier. Therefore x_t, m_t, a_t and l_t should have 3 cointegrating vectors. To check this I used Johansen's Cointegration test (Johansen (1988)).[12] The results are shown in Table 2. The maximum lag length chosen is long enough to insure independence and normality in the errors. The exogenous variables included in the test were orthogonalized dummy variables for the months preceding June 1991, as well as the months of December and January. These were included to capture the exchange rate regime change and seasonal effects. Both the trace statistic and the maximum eigenvalue statistic tests in table 2 show that x_t, m_t, a_t and l_t have 3 cointegrating relations.

[12] See Appendix B for more detail on Johansen's Cointegration test.

Table 2

Hypothesis No. of Equations		Eigenvalue	Test Statistic	5% Critical Value
Trace Statistic				
None	**	0.758918	252.4184	47.85613
At least 1	**	0.644769	125.8054	29.79707
At least 2	**	0.290732	33.69144	15.49471
At least 3		0.034427	3.11803	3.841466
Maxim-Eigen Statistic				
None	**	0.758918	126.613	27.58434
At least 1	**	0.644769	92.11396	21.13162
At least 2	**	0.290732	30.57341	14.2646
At least 3		0.034427	3.11803	3.841466

Johansen Cointegration Test: Both the trace and maximum eigenvalue statistics reflect 3 cointegration relations among the 4 variables

*: Reject Null Hypothesis of Unit root at 5% Level (based on the Akaike Criteri

**: Reject Null Hypothesis of Unit root at 1% Level (based on the Akaike Crite

The 3 cointegrating vectors from the variables x_t, m_t, a_t and l_t can be normalized and expressed as $(x_t - \beta_1 m_t)$, $(a_t - \beta_2 l_t)$ and $(x_t - \beta_3 a_t)$. They are denoted by xm'_t, al'_t and xa'_t, respectively. The results obtained are:

$$xm'_t = x_t - 0.6304 * m_t$$

$$al'_t = a_t - 1.2118 * l_t$$

$$xa'_t = x_t - 1.1414 * a_t$$

- The capital adjustments model has the following form:

$$\Delta s_t = \pi_0 + \pi_1 xm'_{t-1} + \pi_2 al'_{t-1} + \pi_3 xa'_{t-1} + \varepsilon_t$$

Where s_t is the natural logarithm of the Colombian Peso/SDR exchange rate.

- For the political model the forecasting regression used is:

$$\Delta s_t = \gamma_0 + \gamma_1 dum91_t + \gamma_2 dumelec_{t-1} + \gamma_3 busclmte_{t-1} + \upsilon_t$$

Where *dum91* is the dummy variable used to control for the months before June 1991, *dumelec* is the election period dummy variable and *busclate* is the business survey variable. To verify that the above equation is valid, I performed a unit root test on the variable *busclate* and found it to be stationary.

- The uncovered interest rate parity model has following form:

$$\Delta s_t = \delta_0 + \delta_1 (i_{t-1} - i^*_{t-1}) + \varsigma_t$$

Where i_{t-1} and i^*_{t-1} respectively denote the local market and foreign market interest rates at *t-1*.

- The trade adjustment forecasting model has the following form:

$$\Delta s_t = \varphi_0 + \varphi_1 (x'_{t-1} - m'_{t-1}) + u_t$$

Where x'_{t-1} and m'_{t-1} respectively denote exports and imports at time *t-1* taken from the external market balance data.

- The remaining benchmark model is a simple random walk with a variable drift:

$$\Delta s_t = \alpha + e_t$$

The resulting 5 equations obtained from the regression are:

$$\Delta s_t = -\underset{(0.1668)}{0.4724} - \underset{(0.0306)}{0.0862}\, al'_{t-1} - \underset{(0.0159)}{0.0377}\, xa'_{t-1} + \underset{(0.0062)}{0.0191}\, xm'_{t-1} + \varepsilon_t \qquad R^2_{Adj} = 4.1\%$$

$$\Delta s_t = -\underset{(0.0031)}{0.0022} + \underset{(0.0063)}{0.0164}\, dum91_t + \underset{(0.0050)}{0.0154}\, dumelec_{t-1} + \underset{(0.0004)}{0.0013}\, busclmte_{t-1} + \upsilon_t \qquad R^2_{Adj} = 10.8\%$$

$$\Delta s_t = -\underset{(0.0044)}{0.0011} + \underset{(0.0198}{0.0507}(i_{t-1} - i^*_{t-1}) + \varsigma_t \qquad R^2_{Adj} = 2.9\%$$

$$\Delta s_t = \underset{(0.0034)}{0.0166} + \underset{(0.0060)}{0.0171}(x'_{t-1} - m'_{t-1}) + u_t \qquad R^2_{Adj} = 3.7\%$$

All the coefficients are statistically different than zero except for a few of the constant terms and the signs of the coefficients are generally the expected ones, except for those from the trade adjustments model. If net exports increase, then there is more demand for local currency, so there would be an appreciation of the exchange rate. This means that the coefficient should be negative. There may be a problem of endogeneity in this model so the estimators could be inconsistent for this short term regression. This is probably not a problem for the long term forecasting regressions, which is more relevant in this particular model, since adjustments through trade are usually much slower. The most surprising result is the relatively high R^2_{Adj} found for the political model.

For each model I performed out-of-sample forecasts using a rolling re-estimation procedure. I first estimated the coefficients for each model using only data from January 1990 until December 1998 and made out-of-sample forecasts for 1, 3, 6, 12 and 24 month horizons. I then re-estimated the coefficients adding one month to the sample, in other words, using data from January 1990 to January 1999, and, once again, performed the out-of-sample forecasts. I followed this same procedure until I used up the entire sample. To asses the out-of-sample forecasting performance of the models I used the following 2 statistics:

$$RMSE = \left[\sum_{i=0}^{N_j - 1} \frac{\left(F(t+i+j) - A(t+i+j)\right)^2}{N_j} \right]^{\frac{1}{2}}$$ And

$$MAE = \sum_{i=0}^{N_j - 1} \frac{\left|F(t+i+j) - A(t+i+j)\right|}{N_j}$$

Where *RMSE* denotes root mean squared error and *MAE* denotes mean absolute error. N_j is the number of forecasts made; *j* denotes the forecasting horizon used; *t* denotes the forecasting starting period and $A(t+i+j)$ and $F(t+i+j)$ denote the true value and the forecast value for the log of the Colombian IMF weighted exchange rate at time $t+i+j$. The results for the RMSE and the MAE of the capital adjustment model, the political model and the 3 benchmark models are presented in table 3. A lower RMSE and MAE means a more accurate forecast since the errors are less far away than the true values.

Table 3 shows that, for short term horizons, the model with the best performance is the Political model, since it has the lowest error statistics. For medium horizons, the best performing model is the uncovered interest rate parity model. The trade adjustment model has the best forecasting results for the long term horizon of 24 months. The most shocking result from the table is the fact that the Capital adjustments model is outperformed by at least one of the remaining models for every forecasting horizon. The alleged good performance for both short horizon and long horizon forecasts obtained by Gourinchas and Rey (2005) is not empirically sustained in this study.

Table 3

	1 Month	3 Months	6 Months	12 Months	24 Months
RMSE					
Model 1 : Capital Adjustments	0.01277	0.02907	0.04919	0.07671	0.32424
Model 2 : Political Model	**0.01213**	**0.02462**	0.04343	0.06718	0.12760
Interest Rate Parity	0.01249	0.02778	**0.04095**	**0.06551**	0.12528
Trade Adjustments	0.01247	0.02718	0.04297	0.06588	**0.09273**
Random Walk w/ Drift	0.01257	0.02810	0.04380	0.06841	0.10137
MAE					
Model 1 : Capital Adjustments	0.01029	0.02253	0.03834	0.06476	0.24188
Model 2 : Political Model	**0.00988**	**0.01957**	0.03606	0.05958	0.10533
Interest Rate Parity	0.01031	0.02177	**0.03230**	**0.05541**	0.09939
Trade Adjustments	0.01037	0.02214	0.03670	0.05703	**0.07459**
Random Walk w/ Drift	0.01057	0.02326	0.03776	0.05907	0.07511

Root Mean Squared Error (RMSE) and Mean Absolute Error (MAE) for the 5 models used to forecast
the IMF trade weighted exchange rate over short and long term horizon spans
The lowest value for each statistic and each horizon is highlighted with bold letters

The political model tries to capture stability, exuberance and short term expectations and it performs quite well over short horizons but quite poorly over horizons greater than a year. Fundamentals have generally proven to explain long term movements in the exchange rate with some success but have failed to do so in the short run. This political model uses a different approach for measuring fundamentals by using a survey question instead of a measurement variable. In some sense, the results show that the economic fundamentals may determine movements in the exchange rate for short term horizons of up to 6 months. The uncovered interest rate parity model, as expected, has a relatively good forecasting performance over a period of about one year, and the trade adjustment model does well over longer horizons. This can be explained from the fact that financial markets adjust relatively quickly, whereas, adjustments in trade tend to be a lot slower.

V. Conclusions

In this study, 2 models were assessed on their forecasting ability to explain and predict movements in the Colombian exchange rate. The results found were quite interesting and meaningful. The political model used in this study meant to capture the effects of the exchange rate on political stability and fundamentals, captured through the perception of economic agents. The surprising results showed that the political model had quite a high R^2_{Adj} compared to the rest of the models and its forecasting performance was clearly superior for 1 and 3 month horizons. On the other hand, the capital adjustments model was out-performed by at least one of the remaining models studied for every single forecasting horizon. This result is shocking since, in theory, the capital adjustment model should perform well over short and long term horizons.

As explained in Section II, the exchange rate in Colombia also depends on other, less traditional factors, which may help explain the performance of the models studied in this paper. Country stability, behavior characteristics of election periods and corruption were captured in the political model, which performed quite well over short term horizons. Country-associated risk was captured in the uncovered interest rate parity model, which performed quite nicely over medium term horizons. The trade adjustment model outperformed the capital adjustment model for every forecasting horizon which shows that the difference used in the data, which intended to reflect the effects of illegal money in the exchange rate, was very important. All this indirectly shows that these untraditional factors are also key determinants of the exchange rate in Colombia and must be taken into account when studying these types of issues.

Even though the capital adjustments model was shown to have a poor performance for the case of the Colombian exchange rate, I believe that, in a few years time, when more quantity and better quality of data is available and when capital markets become more mature and relative investment gets closer to a stationary steady state, this particular model may have a much better performance. It has a theoretical base and has proven to perform well for US data.

An interesting approach for further research on this subject is to directly measure the effects of the untraditional variables on the exchange rate. With more quantity and better quality of data on the sovereign spread, remittances, money laundry volume, proceeds from corruption etc., I believe very interesting results can be obtained.

Appendix A:

The following procedure is taken partly from Gourinchas and Rey (2005).

The Asset accumulation budget constraint $NA_{t+1} = R_{t+1}(NA_t + NX_t)$ can be written as:

$$\frac{NA_{t+1}}{Y_{t+1}}\frac{Y_{t+1}}{Y_t} = R_{t+1}\left(\frac{NA_t}{Y_t} + \frac{NX_t}{Y_t}\right) \qquad (1)$$

Where Y is an aggregate variable such as total household wealth. Assuming $\frac{A_t}{Y_t}$, $\frac{X_t}{Y_t}$, $\frac{M_t}{Y_t}$ and $\frac{L_t}{Y_t}$ are stationary with respective steady state values of μ_{ay}, μ_{xy}, μ_{my} and μ_{ly}. Call a_t, x_t, m_t and l_t the logs of A_t, X_t, M_t and L_t. Define ay_t, xy_t, my_t and ly_t such that $\frac{A_t}{Y_t} = \mu_{ay}\exp(ay_t)$, $\frac{X_t}{Y_t} = \mu_{xy}\exp(xy_t)$, $\frac{M_t}{Y_t} = \mu_{my}\exp(my_t)$ and $\frac{L_t}{Y_t} = \mu_{ly}\exp(ly_t)$ respectively. A first order Taylor expansion around the stationary ratios for the right hand side of (1) gives:

$$(\mu_{ay} - \mu_{ly})\gamma\left[1 + \mu_a r^a_{t+1} - \mu_l r^l_{t+1} + \frac{\mu_{ay} - \mu_{ly}}{\mu_{ay} - \mu_{ly} + \mu_{xy} - \mu_{ly}}(\mu_a ay_t - \mu_l ly_t) + \frac{\mu_{xy} - \mu_{my}}{\mu_{ay} - \mu_{ly} + \mu_{xy} - \mu_{ly}}(\mu_x xy_t - \mu_m my_t)\right]$$

Where $\mu_x = \frac{\mu_{xy}}{\mu_{xy} - \mu_{my}}$, $\mu_a = \frac{\mu_{ay}}{\mu_{ay} - \mu_{ly}}$, $\mu_m = \mu_x - 1$, $\mu_l = \mu_a - 1$ and also using the steady state condition $(\mu_{ay} - \mu_{ly})\gamma = R(\mu_{ay} - \mu_{ly} + \mu_{xy} - \mu_{my})$.

Operating on the left hand side of (1):

$$\left[\mu_{ay}(1 + ay_{t+1}) - \mu_{ly}(1 + ly_{t+1})\right]\gamma(1 + \Delta y_{t+1})$$

Considering that $ay_t = a_t - y_t - \ln(\mu_{ay})$, $xy_t = x_t - y_t - \ln(\mu_{xy})$, $my_t = m_t - y_t - \ln(\mu_{my})$, $ly_t = l_t - y_t - \ln(\mu_{ly})$ and using $\Delta y_{t+1} = y_{t+1} - y_t - \ln\gamma$ one car rearrange the previous 2 equations and get:

$$(\mu_a a_{t+1} - \mu_l l_{t+1}) - (\mu_a a_t - \mu_l l_t) = \mu_a r^a_{t+1} - \mu_l r^l_{t+1} + \left[1 - \frac{1}{\rho}\right]\{(\mu_x x_{t+1} - \mu_m m_{t+1}) - (\mu_a a_t - \mu_l l_t)\}$$

where $\rho = \frac{\gamma}{R}$

Defining $na_t = |\mu_a| a_t - |\mu_l| l_t$, $nx_t = |\mu_x| x_t - |\mu_m| m_t$, $r_{t+1} = |\mu_a| r_{t+1}^a - |\mu_l| r_{t+1}^l$ you can get:

$$\Delta na_{t+1} = r_{t+1} + \left[\frac{1}{\rho} - 1\right](nx_t + na_t)$$

nx_t and na_t can be seen as the log-linearized trade balance and net foreign positions.

$$na_{t+1} - na_t + nx_{t+1} - nx_t = r_{t+1} + \left[\frac{1}{\rho} - 1\right](nx_t + na_t) + nx_{t+1} - nx_t$$

$$nx_{t+1} + na_{t+1} = r_{t+1} + \Delta nx_{t+1} + \frac{1}{\rho}(nx_t + na_t) \qquad (2)$$

Since $\rho < 1$ and using $\mu_m = \mu_x - 1$ and $\mu_l = \mu_a - 1$ equation (2) can be solved forward to obtain:

$$|\mu_m|(x_t - m_t) + |\mu_l|(a_t - l_t) + xa_t = -\sum_{i=1}^{\infty} \rho^i \{r_{t+i} + \Delta nx_{t+i}\}$$

Appendix B:

Johansen's cointegration test is a method of estimating the number of cointegrating relations between a set of variables. Define $Y_t = \{y_t^1, y_t^2,,,, y_t^n\}$ as the vector of n I(1) variables that is being tested and X_t as a vector of deterministic variables.

$$Y_t = c_1 Y_{t-1} + c_2 Y_{t-2} + \ldots + c_k Y_{t-k} + \delta X_t + \varepsilon_t$$

The lag length k should be big enough for the residuals to be serially uncorrelated.

We can rewrite the above expression as:

$$\Delta Y_t = c Y_{t-1} + \gamma_1 \Delta Y_{t-1} + \ldots + \gamma_{k-1} \Delta Y_{t-k-1} + \delta X_t + \varepsilon_t$$

Define:

$$c = -\mathrm{I}_n + c_1 + c_2 + \ldots + c_k$$

Where I is the identity matrix and c has rank r < n. The matrix a is now decomposed into two $n \ x \ r$ matrices such that

$$c = \alpha \beta'$$

β's rows define the cointegrating relations between the n variables (i.e. $y\beta'$ is I(0)) and α is known as the adjustment parameter. Johansen estimates c using an unrestricted VAR and tests restrictions derived from the reduced rank of c.

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