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ΘΕΜΑ

Πρόβλεψη Συναλλαγματικών Ισοτιμιών: Μπορούμε να νικήσουμε το μοντέλο τυχαίου περιπάτου;

ΕΠΙΒΛΕΠΩΝ ΚΑΘΗΓΗΤΗΣ : Α.Α. ΑΝΤΖΟΥΛΑΤΟΣ

ΦΟΙΤΗΤΗΣ
ΠΑΠΑΓΕΩΡΓΙΟΥ ΓΙΩΡΓΟΣ ΜΧΡΗ/0225

ΠΕΙΡΑΙΑΣ ΙΟΥΝΙΟΣ 2004

1. Introduction

"A great journey begins with but a small step."
...some Chinese guy.

Exchange rates are the quintessential international variable, a factor in virtually every international financial market decision. Alas, virtually all structural models of exchange rate behavior are empirically outperformed by a simple random-walk model. This conclusion might suggest that nothing can be confidently said about the economic determinants of exchange rate behavior. Still, the presence of nonrandom-walk behavior offers market economists an opportunity to add value.

One need not be an acclaimed economist to observe that financial markets are preoccupied with news. What's important is to acknowledge that, in response to what seems to be the same news story, currencies sometimes rise in value and sometimes fall. One might suppose that rationality would dictate an unambiguous link between a news announcement and an exchange rate reaction. Examining the different responses of exchange rates to the same story leaves us with good news and with bad news. The good news is that exchange rate behavior could be rational after all, even though exchange rates have been shown to move in opposite directions in response to what appears to be the same news item. Our analysis shows that news items that appear to be the same may differ in some critical respect, and that this causes the exchange rate to respond differently following what seem to be similar economic events. The bad news of course is that exchange rate modeling-not to mention exchange rate prediction-can be extremely complex.

Still one can derive a set of basic principles insofar as exchange rate movement is concerned:

1. Only unanticipated events cause exchange rates to deviate from their expected path movement.
2. Factors that increase the demand for a currency tend to raise the price of that currency.
3. The "character" and the "context" of the economic news item will greatly influence the "nature" of the exchange rate response that follows.

In the last 20 years, economists have adopted the asset approach to exchange rates as the main paradigm for explaining exchange rate movements. The asset approach defines equilibrium as a set of prices where all assets are willingly held. In the monetary approach the exchange rate establishes the relative price of two

monies, while in the portfolio balance approach, the exchange rate equilibrates the relative risk and return of domestic and foreign assets. The asset approach is forward looking and emphasizes the role of expectations. Unfortunately, expectations cannot be observed directly, which complicates empirical testing and interpretation of market behavior.

Empirical evidence suggests that during some periods-the 1920 hyperinflation, the early 1970s and over the longer run-exchange rate behavior is significantly related to fundamentals. Also, in the very short run exchange rates often closely follow fundamental events interpreted within the context of an asset model. Still, economic models of exchange rates have often been unreliable and unsuitable for forecasting. This could be the result of underlying economic instability that makes regression estimation difficult, or it could be the result of misspecified economic models of the exchange rate.

2. ASSET MODELS OF THE SPOT EXCHANGE

In these models, perfect capital mobility is implied by the interest rate parity condition, for which there is strong empirical support. In the monetary approach the menu of assets under consideration is simple-the only assets are domestic and foreign money, M and M*. The monetary approach can also be characterized by the assumption that domestic and foreign currency denominated bonds display perfect substitutability, so that Risk Premium = Liquidity Premium = 0. In the portfolio balance approach, the menu of assets is expanded to include domestic and foreign monies, as well as domestic and foreign bonds (B and F), which do not display perfect substitutability. When investors require a risk premium in addition to the expected percentage exchange rate change to establish indifference between holding foreign and domestic bonds, the two bonds are imperfect substitutes.

2.1. The Monetary Approach

The monetary approach to exchange rate determination is a direct outgrowth of purchasing power parity and of the quantity theory of money. While PPP concludes that the exchange rate is the relative price of goods in two countries, monetary theory suggests that the spot exchange rate (S) is the relative price of two monies. In this context, it follows that exchange rate behavior reflects the evolution of the relative supplies and demands for two monies. Within the monetary approach are two models, the flexible-price model and the sticky-price model.

Flexible-Price Models. The flexible-price model assumes that domestic good prices are fully flexible, that is if the domestic money supply increases, then domestic currency will depreciate proportionately. It implies that purchasing power parity holds continuously and that the real exchange rate never changes. To begin, note that the price level (P) in each country can be related to the ratio of money supply (M) to money demand (L) as:

$P = M/L(Y,i)$ for the home country and $P^* = M^*/L(Y^*,i^*)$ for the foreign country.

The demand for money is hypothesized to be positively related to real income (Y), which represents the transactions demand for money, and negatively related to the interest rate (i), which represents the opportunity cost of holding money balances. According to the purchasing power parity condition:
$S_{home/foreign} = P/P^*$, by substituting, we have:

$S_{home/foreign}$ = P/P* = [M/L(Y,i)]/M*/L(Y*,i*)
A common specification of the money demand function is:

$$L(Y,i) = KY^{n}e^{-\varepsilon i}$$

where K is a constant (representing the inverse of the velocity of money), n is the income elasticity of the demand for money and ε is the interest rate semielasticity for the demand for money. Making these substitutions we get:

$$S = \frac{P}{P*} = \frac{\mathrm{MK*Y*}^{n}\,\mathrm{e}^{\varepsilon i}}{\mathrm{M*KY}^{n}\mathrm{e}^{\varepsilon i*}} \qquad (1)$$

Finally, taking natural logarithms of the above, we have:

$$\ln S_t = (m-m^*)_t + \eta(y^*-y)_t + (k^*-k)_t + \varepsilon(i-i^*)_t \qquad (2)$$

where lower case letters (m, k, y) represent the natural logarithms of upper case letters (M, K, Y) and t is a time subscript.

Equations (1) and (2) give us the "predictions" of the flexible-price monetary model. From equation (1) we can see that if the domestic money supply (M) increases, domestic currency will depreciate proportionately. Equation (1) also predicts that domestic currency will appreciate in response to a rise in domestic real income (Y) or a fall in domestic interest rates (i), because both changes would increase the demand for domestic money. Equation (2) is in "rate of change" form because the logarithm of a variable approximates its percentage change. Thus equation (2) predicts that the rate if change in the spot rate depends on the rate of change in foreign and domestic money supplies, on the rate of change in foreign and domestic real incomes, on the levels of foreign and domestic interest rates and on the rate of change in other factors that are lumped into the terms k and k*.

The model summarized in equations (1) and (2) assumes that the prices of goods are fully flexible and that PPP holds at all times using a broad price index. These are extreme assumptions given that the validity of PPP has been questioned. One natural modification is to assume that PPP holds, but only for traded goods. The presence of non-traded goods and services (labor services, in particular) may pose a significant barrier to the continuous validity of PPP. Since the importance of services in the economy tends to rise with income, taking account of relative price changes between traded and non-traded goods may be particularly important when applying the monetary approach to countries with substantial income differences.

The sticky-price monetary model was introduced by Rudiger Dornbusch (1976) to highlight the impact of assuming that the speed of adjustment of goods prices is slow relative to the speed of adjustment of asset prices. When goods prices are sticky, Dornbusch showed that it is necessary for asset prices to move by more than the flexible price case, in order for the markets to reach a temporary equilibrium. Dornbusch also showed that the gradual adjustment of goods prices following a monetary shock imparts a dynamic adjustment path to the exchange rate, so that while the real exchange rate changes in the short run (as there are PPP deviations), it reverts to its original level in the long run. Three assumptions go: perfect capital mobility (meaning the interest parity condition), slow price adjustment and perfect certainty.

The basic mechanics of the model can be understood with the help of the following scenario-example. We assume that the domestic money supply in the U.S. rises. In response to a one-time, permanent, unanticipated jump in the domestic money supply, the U.S. interest rate falls and the US$ depreciates. Over time the excess money supply leads to U.S. price inflation and U.S. interest rates rise as the liquidity effect dissipates and the US$ gradually appreciates. In the long run, U.S. interest rates return to their original level and the US$ has depreciated in nominal terms, but the real exchange rate is unaffected. This relationship, where the immediate, short-run change in the nominal exchange rate exceeds the long-run change in the nominal exchange rate, is defined as overshooting. Because goods prices are sticky in the short run, the real exchange rate also follows an overshooting path. Thus, a monetary disturbance, which in the long run has only nominal effects (changing the price level and the nominal exchange rate), has real effects in the short run by changing the real exchange rate and the competitiveness of firms in international trade.

Within the Dornbusch model, the magnitude of exchange rate overshooting depends on a variety of technical factors. The path of the exchange rate is given by the following equation:

$$S_t = (m-m^*)_t + \eta(y^*-y)_t + (1/\theta)(i-i^*)t \qquad (3)$$

where θ is the rate at which the exchange rate adjusts toward its long-run equilibrium and the other variables as in our earlier monetarist equation (2). Note that in the overshooting model of equation (3) the expected coefficient of (i-i*) is negative.

The Dornbusch overshooting model has been modified and extended by several authors. Jeffrey Frankel (1979) argued that the pure monetarist model was deficient because the nominal interest

rate (i) reflects both inflation and the real interest rate. Frankel's modification resulted in another exchange rate equation.

$$S_t = (m-m^*)_t + \eta(y^*-y)_t + (1/\theta)(r-r^*)_t + \varepsilon(\pi-\pi^*)_t \qquad (4)$$

where r and r* are the domestic and foreign real interest rates and π and π* are the domestic and foreign inflation rates. By placing (i-i*) with terms in r and π, equation (4) associates higher real interest rates with currency appreciation and higher inflation with currency depreciation. In other words, we expect the coefficient of (r-r*) to be negative and the coefficient of (π-π*) to be positive.

2.2. The Portfolio Balance Approach

Like other asset models of the exchange rate, the portfolio balance approach focuses on the excess demand for the financial assets relative to their supply. The portfolio balance model has two financial assets (money and bonds) and two countries (home and foreign). We assume that home country agents are free to allocate their wealth (W) among three holdings: domestic money (M), domestic bonds (B) and foreign bonds (F, valued as SF). The accounting identity W=M+B+SF defines home country wealth. In portfolio balance models the exchange rate establishes equilibrium in investor portfolios comprised as domestic money and domestic and foreign bonds.

The demand for bonds depends on two factors; first, the domestic demand for domestic bonds should be positively related to the domestic interest rate, i. And domestic demand for foreign bonds should be positively related to the foreign interest rate augmented by the expected exchange rate change, i*+E(s). Thus, the balance between domestic bonds and foreign bonds (B/SF) in a portfolio should be positively related to $\varphi = i - i^* - E(s)$. This quantity (φ) is the expected excess return on domestic currency bonds over foreign currency bonds. A rise in the domestic interest rate, a fall in the foreign interest rate, or a decrease in the expected rate of domestic currency depreciation will lead investors to reallocate their portfolios out of foreign bonds and into domestic bonds.

Unlike the monetary approach, the portfolio-balance approach allows imperfect substitutability between domestic and foreign currency bonds, with φ different from 0. In principle, two assets could be imperfect substitutes for a variety of reasons: liquidity, tax treatment, default risk, political risk an exchange risk. In these stylized models of exchanges rate determination, the role of exchange risk is emphasized. The parameter φ defines the exchange risk premium.

The second element in the demand for bonds is wealth itself. As W increases, individuals hold more of each asset (M, B and F) in their portfolios. How individuals spread their wealth across M, B and F has an important impact on the exchange rate.

The simplest assumption about investors' asset preferences is that they are similar across countries. This similarity labeled The Uniform Preference Model would make sense if both domestic and foreign investors consumed the same basket of goods and therefore found it sensible to hold identical investment portfolios. Under the Uniform Preference Model, if wealth grows faster in the home or foreign country, there is no exchange rate impact because investors from both countries bid for assets in the same proportion. An alternative assumption is that residents of both the home and foreign countries prefer to hold a larger fraction of their wealth in local bonds. This is labeled the Preferred Local Habitat Model.

International trade provides an important channel for the transfer of financial wealth. A country's current account measures a country's change in its international investment position. For example, a home country with a current account deficit, where imports of goods and services exceed exports, pays for its excess current consumption and investment by lowering its stock of foreign assets (FH goes down) or issuing new bonds that are held by the foreign country (BF goes up).

The portfolio balance model, with demand given by preferred local habitat, predicts a correlation between current account surpluses (deficits) and strong (weak) currencies. Note carefully these relationships are derived ceteris paribus. Note also that the relationship between interest rates and exchange rates in the portfolio balance approach agrees with the overshooting model and real interest differential versions of the monetary approach.

3. What We Know So Far…

"Εν οίδα, ότι ουδέν οίδα."
…some Greek guy.

In the beginning, there were Meesse and Rogoff (1983) who conducted a monthly post sample fit analysis from 1976:11 to 1981:6 for U.S. dollar prices of the deutsche mark, the pound and the yen. Point predictions of the driftless random walk dominate those of their regressions for all three currencies at the 6- and 12-month horizons, and for two of the three currencies at the 1-month horizon. In Meesse and Rogoff (1988), changes in log real exchange rates are regressed on real interest rate differentials to forecast log real dollar prices of the deutsche mark, the pound, the yen and the implied cross rates at 1-, 6- and 12-month horizons. Over the 1980:11-1986:3 period (1980:11-1985:1 for yen rates) they find that forecasts from the random walk have lower root-mean-square error than those from their regressions in 32 out of 36 post-sample fit experiments. Furthermore on the basis of asymptotic tests, the regression forecasts are never significantly better than the driftless random walk.

Generally discouraging are the results of a paper by Chin and Meesse, in 1992. They fit the three representative exchange rate models using a variety of parametric and nonparametric techniques. They also impose long-run constraints on these models and fit them by a variety of techniques in hope of mitigating difficulties associated with problems of simultaneity, improper modeling of expectations formation, failure to account for nonlinearities in the data generation mechanism and over-reliance on the representative agent paradigm. They examine four bilateral rates (Canada, Germany, Japan and U.K.) relative to the U.S. dollar, and the DM-Japanese yen cross-rate, using monthly fundamental data. They give 1-month and 12-months forecasts, which they confirm the poor short-term forecasting performance of the three structural exchange rate models. Random walk "wins" even after imposing economic structure on the models using error correction terms. For long-term forecast horizons their results are slightly better than those of the random walk model but they-themselves-advise caution as positive in-sample results must be interpreted cautiously since out-of-sample forecasting test statistics rarely exhibit the same degree of statistical significance (relative to the "naïve" random walk model) as in-sample tests.

The first victory against the accursed random walk (though not the end of the war) is credited to Nelson Mark, who in 1995 provided strong evidence that the long-run path of the exchange rate can be

accurately gauged from knowledge of the current level of the rate relative to its equilibrium value in a monetary model. The adjustment path corresponds broadly to the overshooting path, which proclaims that the movement towards the equilibrium should be greater the farther into the future we forecast. Indeed, Mark's results conform to this hypothesis. Mark found that on an in-sample basis, his model explains (in terms of R^2) between 50-75 percent of the variations in the DM, SFr, and yen rates at the 3- and 4-year horizons (which is too long to be of any use in real-life investors!). Even in out of sample forecasts, Mark's model significantly outperforms the naïve random walk model, reducing the MSE from 20 to 59 percent. Overall the results suggest that at the long run horizon, there is considerable reason to be optimistic that one can construct a forecast of the real exchange rate that is superior to the random walk. This optimism relies on an assumption of stationarity in real rates, which implies a reversion to the real mean rate, or a reversion to the equilibrium exchange rate implied by macroeconomic fundamentals.

Following in the steps of Nelson Mark, Ronald McDonald and Ian Marsh in 1997 have taken the, then recent, empirical finding that there exists some form of long-run PPP for the recent float and they have attempted to explain why empirically estimated relationships for bilateral exchange rates do not conform to a traditional interpretation of PPP. Their explanation lays in what they refer to as Casselian PPP: the idea being that when considering data from the recent float, long-term capital flows may explain deviations from PPP. They demonstrated, using three currencies, that when an exchange rate is conditioned on long bond yields, in addition to relative prices, the hypothesis of homogeneity cannot be rejected. Based on the Casselian PPP relationships, they adopted a simultaneous-equation modeling strategy to produce dynamic exchange rate models. These models were shown to produce significantly better forecasts than the benchmark random walk and also the vast majority of professional forecasters polled by a commercial survey-gathering agency, over horizons as short as 3 months. Their methods are especially stringent since they constructed fully simultaneous forecasts of each variable of their model and held the model coefficients constant in their out-of-sample forecasting exercise. The models give superior results in comparison with the panelists even after significant structural changes in the economic system, such as the German reunification which took place in the middle of their forecast period (the model correctly predicts a rise in the mark in the run-up to unification, without any input knowledge of what was actually driving the system).

Then came the skeptics…

Lutz Kilian, also in 1997, claims that numerous studies have documented severe size distortions of long-horizon regression tests. He proposes a new bootstrap method for small-sample inference in long-horizon regressions. He presents simulation evidence that this bootstrap method greatly reduces the size distortions of conventional long-run regression tests in realistic situations. The remaining size distortions are typically small and the size of the test appears stable across forecast horizons. His results differ in important ways from the earlier literature. He showed that many of the differences in results could be traced to the implementation of the long-horizon regression tests. Two substantive results stand out: First, unlike earlier studies, he found only weak evidence that fundamentals help predict the Swiss Franc and the Canadian dollar rate, but no evidence for Germany and Japan. This finding is consistent with evidence based on the Horvath and Watson (1995) test of the null of no cointegration. It also appears remarkably robust to whether or not cointegration is assumed under the null hypothesis of no exchange rate predictability. Second, he found no evidence of patterns of increasing long-horizon predictability in exchange rates. The later finding " may seem surprising, given the fundamental premise of the long-horizon regression test literature that power improves at long forecast horizons. It is precisely at these long horizons that we would expect the exchange rate to be predictable based on the monetary model. However, it has not been demonstrated to date that in realistic situations power actually increases as the time horizon grows." He investigated the power of the bootstrap long-horizon regression test by Monte-Carlo simulation for each of the four currencies. The natural alternative against which to test the null hypothesis of no predictability is the vector error correction model implied by the underlying net present value model. He found that there is no evidence that long-horizon tests are systematically more powerful than standard tests if the net present value model holds true. This finding is consistent with the pattern of stable or increasing bootstrap p-values found in the data. In fact, in many cases the power of long-horizon tests declines with the forecast horizon. The evidence of lower power is quite intuitive in out-of-sample forecasts, given the shortening of the effective sample, as the forecast horizon increases. He reaches the same conclusion even after he considers a noise component thought of as fads in investors' behavior.

In the same spirit, Jeremy Berkowitz and Lorenzo Giorgianni (1998) seem skeptical on the basis of several considerations: first, by ignoring an absence of evidence on any short horizon relationships between fundamentals and exchange rates and focusing on the

long-horizons, the approach challenges the intuitive result that the long-horizon coefficients on error correction terms are inherently linked to their short-horizon counterparts. They show that if the slope coefficient from a one-period regression is 0, the coefficients of the long-horizon regressions will also be 0, regardless of the length of the horizon. In this sense, nothing seems to be gained by running a sequence of long-horizon regressions, absent evidence of nonlinear dynamics. They also show that, if the estimated one-step-ahead coefficient is nonzero, the estimated coefficients increase as the horizon increases. This implies that the empirical finding of increasing coefficients cannot be taken as evidence of a stronger impact of fundamentals on exchange rates as the horizon increases. Second, by imposing cointegration between the spot rate and the monetary fundamental a priori and deriving empirical critical values under this assumption, an interpretation of the evidence of a statistical relationship between fundamentals and exchange rates errs on the side of significance. If the long-horizon procedure is carried out when cointegration is not present, several diagnostic statistics falsely suggest evidence of long-horizon predictability. They demonstrate that Monte-Carlo critical values tabulated under the null hypothesis that cointegration does not hold are much higher. They compare out-of-sample forecasts for four U.S. dollar exchange rates (Swiss Franc, Canadian dollar, German mark and the Japanese yen) generated from long-horizon regressions to those critical values and find weak evidence of predictability at predominantly short horizons. For one of the exchange rates considered they find long-horizon predictability without finding short-horizon predictability.

And then came a time when yet another paper postulating linear models of exchange rate forecasting couldn't get you within a mile of a major journal publication. Lutz Kilian and Mark Taylor realized that and begun addressing all the aforementioned issues in the context of a specific NONlinear model which has at the time of their paper (1999) has gained popularity and that has been shown to have empirical support. They provide empirical evidence for nonlinear dynamics in seven real dollar exchange rates (Canada, France, Germany, Italy, Japan, Switzerland and the U.K.) They find that there is strong –albeit nonlinear- mean reversion in monthly dollar exchange rates. This evidence is important for a number of reasons. Firstly, allowing for this nonlinearity goes some way towards solving Rogoff's (1996) "purchasing power parity puzzle (PPPP J)" concerning the apparently very slow speed of adjustment of real exchange rates, since within the context of such model, the speed of adjustment of the real exchange rises as the size of the shock impinging on the real exchange rate increases, so that very small shocks will induce glacially slow speeds of adjustment.

Secondly, it can be shown that standard univariate tests of non-mean reversion may have very low power against *nonlinear* mean reversion, hence explaining why researchers have encountered such difficulty in rejecting the null hypothesis of linear unit roots in real exchange rate behavior. Thirdly, smooth transition dynamics provide a plausible source of increased long-horizon nominal exchange rate predictability. These dynamics take form within exponential smooth transition autoregressive models (ESTAR) fitted to quarterly data for the above seven countries over the entire post-Bretton Woods period. Their econometric model implies that close to equilibrium the real exchange rate cal well be approximated by a random walk. This fact helps to explain the apparent success of random walk point forecasts for nominal exchange rates, especially at short horizons. It also suggests that formal statistical tests of the random walk hypothesis against forecast models based on PPP fundamentals may have low power in small samples. The problem is that the nonlinear mean reversion in the real exchange rate can be detected statistically only following unusually large departures from equilibrium and such events may be rare along a given sample path. Finally, the presence of ESTAR dynamics in the real exchange rate suggests that the power of tests of the random walk hypothesis against forecast models based on PPP fundamentals should increase at longer forecast horizons, making it easier to detect predictability using long-horizon forecasts. They proposed a new bootstrap long-horizon regression test of the random walk benchmark model. This new test was shown to be reliable and powerful against some possible nonlinear alternatives. The test provided strong empirical evidence against the random walk model at horizons of 2 to 3 years. For example, based on in-sample tests, at the 3-year horizon they were able to reject the random walk for five or six of the seven countries, depending on the choice of test statistic. This evidence justifies the continued use of PPP to explain medium term exchange rate fluctuations. Their empirical results not only lend support to economists' beliefs that the exchange rate is inherently predictable, but, at the same time, they also rationalize the reluctance of foreign exchange traders to rely on economic fundamentals such as relative prices. "Most foreign exchange traders are interested in forecasts of less than 6 months. We found no evidence that the use of PPP fundamentals significantly improves forecast accuracy at such short horizons." Moreover, despite significant rejections of the random walk based on in-sample tests, they were typically unable to reject significantly the random walk forecast model in real time recursive forecasts. Their analysis suggests that this difficulty of beating the random walk model in real time need not reflect an inherent shortcoming of forecasting models based on economic fundamentals. Instead, they showed that this stylized empirical fact

appears to be a natural consequence of small time span of data available for empirical work.

Finally, in their 2003 paper "How is Macro news transmitted to exchange rates?", Martin Evans and Richard Lyons tested whether macroeconomic news is transmitted to exchange rates via the transactions process and if so, what share occurs via transactions versus the traditional direct channel. They identified the link between order flow and macro news using a heteroskedasticity-based approach, a la Rigobon and Sack (2002). Their model distinguished three sources of exchange rate variation. The first source mirrors traditional models; public news that is impounded in price immediately and directly (i.e. with no role for order flow). The second source is an indirect effect of public news that operates via induced order flow. The third source of exchange rate variation is order flow unrelated to public news arrival. Using DM/$ data from 1996, they showed that in both daily and intra-daily data order flow varies considerably with macro news flow and that at least half of the effect of macro news on exchange rates is transmitted via order flow.

4. What We Will Do…

One possible reason that explains the dominance that the random walk has over all the other exchange rate models is that the latter do not make use of all the useful information that exists in the international markets. We focus our attention on the Balance of Payments (BP), which equals one country's Current Account (CA) plus its Capital Flows (CF). A surplus in the balance of payments reflects excess demand for the domestic currency and excess supply of all foreign currencies in the international exchange markets. Accordingly, a deficit will reflect excess supply of the domestic currency. The main conclusion is that an external imbalance, that is $BP = CA + CF \neq 0$, will activate an automatic mechanism which will tend to restore the equilibrium ($BP=0$).

All the above outline the structural weaknesses that characterize the "traditional approaches of exchange rate forecasting: the portfolio balance approach and the monetary approach. The approach that makes use of the portfolio balance models draws its power from the Interest Rate Parity (IRP). This means that exchange rate movements are considered to be a direct result of the movement of interest rates between two countries, a fact that stimulates the buying or the selling of foreign currencies by the investors. Taking in mind that the Foreign Direct Investment (FDI) is relatively constant, then the aforementioned buying and selling of securities and currency is represented by the accounts of Capital Flows for each country. The portfolio balance models, however seem to ignore the respectable volume of foreign exchange transactions for commercial reasons that take place through the channels of Exports and Imports.

The exact opposite happens with the monetary models which study how the buying and selling of goods and services affect the exchange rates, always under the assumption that the PPP (Purchase Power Parity) holds at all times. In spite of that extreme assumption, given the fact that the validity of PPP has been extensively questioned in the scientific literature, these models seem to ignore another important factor: how exchange rates are affected by the speculative stance of a part of investors. Specifically, if speculators expect the domestic currency to appreciate vis-à-vis a foreign one, the demand for domestic currency will be higher than that suggested by current economic fundamentals alone, and visa versa.

In essence, the demand for domestic currency should depend upon the current economic fundamentals plus the expected capital gains (losses), the latter being due to the expected currency appreciation

(depreciation). This observation brings us to the formation of our ground-breaking model, whose basic function of the spot rate is derived from that of the monetary models (except for the logarithm).

$$S_t = FUND_t + \varepsilon(E_tS_{t+1} - S_t) \qquad (5)$$

where $FUND_t$ captures the economic fundamentals reflected on money supply and income, both domestic and foreign

$$M_t/M_t^* - k/k^* - Y_t^n/Y_t^{*n}$$

where η, ε are appropriate sensitivity coefficients.
Solving (5) for St gives:

$$S_t = (1/1+\varepsilon)FUND_t + (\varepsilon/1+\varepsilon)E_tS_{t+1}$$

This holds for every period in time. Hence,

$$S_{t+1} = (1/1+\varepsilon)FUND_{t+1} + (\varepsilon/1+\varepsilon)E_{t+1}S_{t+2}.$$

Taking expectations as of t,

$$E_tS_{t+1} = (1/1+\varepsilon)E_tFUND_{t+1} + (\varepsilon/1+\varepsilon)E_t(E_{t+1}S_{t+2}) =$$
$$= (1/1+\varepsilon)E_tFUND_{t+1} + (\varepsilon/1+\varepsilon)E_tS_{t+2},$$

And substituting into the previous equation gives:

$$St = (1/1+\varepsilon)FUND_t + \varepsilon/(1+\varepsilon)^2E_tFUND_{t+1} + (\varepsilon/1+\varepsilon)^2E_tS_{t+2}$$

Continuing iterating forward gives

$$S_t = \frac{1}{1+e}\sum_{j=0}^{\infty}(\frac{e}{1+e})^j E_t FUND_{t+j}$$

That is, the spot exchange rate, like the price of any financial asset, depends upon future economic fundamentals. With this insight, we can reconcile the observed behaviour of exchange rates with economic reason and logic.

4.1. Analysis of Economic Fundamentals

Having arrived at the conclusion that the exchange rate for a currency of a country vis-à-vis that of another country depends at large on the balance of payments of said country, let us examine more analytically all the elements the BP is consisted of.

CA

The fundamentals that give us the current account are Exports (X), Imports (IM), and National Foreign Income (NFI)

CF

We derive the fundamentals hat affect a country's capital flows from the Interest Rate Parity equation:

$$(1+i_t) = (1+i_t^*)\frac{ES_{t+1}}{S_t} \Leftrightarrow S_t = \frac{1+i_t}{1+i_t}ES_{t+1}$$

Taking logarithms:

$$\ln S_t = \ln(1+i_t^*) - \ln(1+i_t) + \ln E_t S_{t+1} \approx i_t^* - i_t + \ln E_t S_{t+1}$$

Thus, our fundamentals for the capital flows are the domestic interest rates (i_t), the foreign interest rates (i_t*), as well as the expected exchange rate (E_tS_{t+1}).

Since the exchange rate depends on both elements of the balance of payments, we take the following function:

$$S_t = X_t - IM_t + NFI_t + i_t - i_t^* + \varepsilon E_tS_{t+1} \Leftrightarrow$$
$$S_t = FUND_t + \varepsilon E_tS_{t+1}$$

Having clarified the fact that the exchange rate is a function of the balance of payments, $S_t = \varphi(BP_t)$ and since we can extract BP through a linear function of its fundamentals, such as:

$$BP = a_0 + a_1X_t + a_2IM_t + a_3NFI_t + a_4i_t + a_5i_t^* + \varepsilon E_tS_{t+1} ,$$

then we have:

$$S_t = a_0' + a_1'X_t + a_2'IM_t + a_3'NFI_t + a_4'i_t + a_5'i_t^* + \varepsilon' E_tS_{t+1}$$

Consequently we take the expected values of the next period, t+1:

$$E_tS_{t+1} = a_0' + a_1'E_tX_{t+1} + a_2'E_tIM_{t+1} + a_3'E_tNFI_{t+1} + a_4'E_ti_{t+1} + a_5'E_ti_{t+1}^* + \varepsilon' E_tS_{t+2}$$

In order to quantify the change in the exchange rate between periods, we take differentials

$$E_t\ln S_{t+1} - \ln S_t = a/(1+\varepsilon)[(E_tFUND_{t+1} - FUND_t) + \varepsilon/(1+\varepsilon)(E_tFUND_{t+2} - E_tFUND_{t+1}) + ...]$$

All the while, we have:

$$E_tFUND_{t+1} - FUND_t = a_1E_tX_{t+1} + \ldots - (a_1X_t + \ldots)$$
$$= a_1(E_tX_{t+1} - X_t) + a_2\ldots$$

All these mini-differentials are the terms we must predict using Ordinary Least Squares (OLS), having as dependant variable the term E_tX_{t+1} - X_t and as potential independent variables all the variables that are dated t. Producing vectors V of variables from each term:

$$E_tX_{t+1} - X_t = \delta_1V_t$$
$$E_tIM_{t+1} - IM_t = \delta_2V_t$$

we will have:

$$ElnS_{t+1} - S_t = (\delta_1 + \delta_2 + \ldots)V_t$$

By now, it should be obvious that the vector will have too many variables dated t for estimation but we can condense their information with the Principal Components Analysis method and let z_1, z_2, z_3 explain, say, 70% of variation of V_t. We can regress lnS_{t+1}- – S_t on z_1, z_2 and z_3 :

$$lnS_{t+1} - S_t = j_0 + j_1z_{1t} + j_2z_{2t} + j_3z_{3t}$$

Thus, we can estimate our "in-sample" period of, say, 1980:1 – 1990:12 and, then, use the estimated coefficients j0, j1, j2, j3 to form expectations for an "out-of-sample" period, say, 1991:1 – 2001:12. Alternatively, we will use rolling regressions for one-period-ahead forecasts:

- **Estimate 1980:1 – 1984:12**
  forecast 1985:1
- **Estimate 1980:2 – 1985:1**
  Forecast 1985:2 etc.

5. Where We Will Do It…

We will forecast log real American dollar prices of the Canadian dollar, the Deutsche mark, the Japanese yen, the Swiss franc, the E.C.U. and the Euro, for their respective periods. We will cover a total period of twenty-four years (1980:1 – 1993:12) using monthly and quarterly data.

6. Data

Using as data source the International Monetary Fund's International Financial Statistics database I have collected the series of data pertaining to the elements of the balance of payments and economic activity of the U.S.A., U.K., Canada, Switzerland and Japan on a quarterly basis, starting from 1980:1 to 2003:4. The same series of date were also collected on a monthly basis and for the same duration (1980:1-2003:12). A bird's eye view of the data gathered is given in the following chart:

Total reserves minus gold	services: debit
money, seasonally adjusted	balance on goods and services
overnight interbank min	current account, n.i.e.
treasury bill rate	Direct investment abroad
government bond yield: long-term	dir. invest. in rep. econ., n.i.e.
share prices: industrial	portfolio investment assets
prices: industrial output	PI equity securities assets
consumer prices	PI debt securities assets
AV earn prod ind. s.a.	PI equity securities liab
industrial product (unadjusted)	PI debt securities liab
unemployment rate	Deficit(-) or surplus
exports FOB	exports of goods and services
imports CIF	Government consumption expend. s.a.
goods exports: FOB	gross fixed capital formation s.a.
goods imports: FOB	household consumption expend., including NPIS HS s.a.
trade balance	imports of goods and services s.a.
services: credit	gross domestic product s.a.

Absence of many of these series and severe inconsistencies and irregularities in the existing ones, for example in the data sample of Switzerland and Japan, has rendered further statistical analysis for these countries dubious in execution. In addition, the relatively short life-span of the Euro has excluded it from our analysis, as well. Thus, I focused my attention to the CAD$/US$ and £/US$ exchange rate forecasting, since these countries (U.S.A., U.K. and Canada) featured the most complete and extensive series of data.

In some cases, series with long inconsistencies were excluded from my analysis so as not to taint the whole sample during the principal components generation, while country-specific series were used according to availability and differ from country to country. (See detailed presentation of country data series in Appendix A).

In addition, the various interest rates and exchange rates for the countries included in this dissertation were gathered-on a monthly and quarterly basis- via the DATASTREAM and EcoWin databases.

7. Empirical Analysis and Results

"Youth is wasted on the young."
...some Uni-Pi supervising professor.

In order to condense the enormity of information given by 30 to 35 series of data times 96 of quarterly observations, we used principal components analysis. We used as potential explanatory variables the first six principal components which explain more than 95% of the variability of the 30-35 series for each country. We have generated these principal components for each country using the econometric program "Econometric Views" (v. 4.1). These are the principal components weights, as taken from the analysis of the U.S.A. dataset, as well as the six principal components themselves:

Variable Index Table

x1=total reserves minus gold	x19=services: debit
x2=M1, s.a.	x20=balance on goods and services
x3=M2, s.a.	x21=current account, n.i.e
x4=M3, s.a.	x22=direct investment abroad
x5=federal funds rate	x23=direct investment in rep. econ. n.i.e
x6=treasury bill rate	x24=PI equity securities assets
x7=government bond yield:10 year	x25=PI dept securities assets
x8=share prices: industrial	x26=PI equity securities liabilities
x9=consumer prices	x27=PI debt securities liabilities
x10=wages: hourly earnings, mfg	x28=deficit(-) or surplus
x11=industrial production s.a.	x29=exports of goods and services, s.a.
x12=unemployment rate	x30=general government exp & investment
x13=exports fas	x31=private gross fixed capital formation...
x14=imports cif	x32=...of which: gross fixed capital formation
x15=goods exports: f.o.b.	x33=household consumption expenditure, incl. NPISHS s.a.
x16=goods imports: f.o.b.	X34=imports of goods and services, s.a.
x17=trade balance	x35=gross domestic product, s.a.
x18=services: credit	

U.S.A. Principal Components' Weights

Sample(adjusted): 1 95
Included observations: 95 after adjusting endpoints
Correlation of X1 X10 X11 X15 X16 X17 X18 X19 X2 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X3 X30 X31 X32 X33 X34 X35 X4 X5 X6 X7 X8 X9

	Comp 1	Comp 2	Comp 3	Comp 4	Comp 5	Comp 6	Comp 7	Comp 8
Eigenvalue	24.49046	2.413262	1.800771	0.825224	0.541015	0.505047	0.449317	0.273091
Variance Prop.	0.765327	0.075414	0.056274	0.025788	0.016907	0.015783	0.014041	0.008534
Cumulative Prop.	0.765327	0.840741	0.897016	0.922804	0.939710	0.955493	0.969534	0.978068

Eigenvectors:

Variable	Vector 1	Vector 2	Vector 3	Vector 4	Vector 5	Vector 6	Vector 7	Vector 8
X1	0.153389	0.302118	-0.202546	-0.149391	-0.193245	-0.165131	0.048257	-0.136099
X10	0.200047	0.068611	0.001923	0.014671	-0.038109	-0.035300	0.006154	-0.041511
X11	0.198519	-0.069421	-0.032582	0.071283	-0.067199	-0.064922	0.075576	0.042840
X15	0.193881	-0.014946	-0.145420	0.082223	-0.103130	-0.168546	0.023462	-0.132858
X16	-0.199726	0.057667	-0.020363	-0.081141	0.010374	0.085920	0.003282	-0.002384
X17	-0.183907	0.109868	-0.247290	-0.069934	-0.119195	-0.038679	0.039887	-0.189205
X18	0.197904	0.034543	-0.094138	0.052287	-0.087507	-0.097478	0.033309	0.006769
X19	-0.199575	0.015441	-0.035524	-0.015788	0.087940	-0.002135	0.036290	-0.042046
X2	0.186001	0.198060	-0.117827	-0.050800	-0.067845	0.008543	-0.020123	-0.042963
X20	-0.164583	0.152618	-0.354904	-0.049930	-0.150277	-0.109622	0.083743	-0.225451
X21	-0.169550	0.131794	-0.336108	-0.037087	-0.141989	-0.100460	0.078261	-0.247190
X22	-0.169267	0.079831	0.129552	-0.047219	0.265247	-0.084255	-0.167914	-0.537192
X23	0.120640	-0.354423	-0.221526	-0.376560	0.284426	-0.091905	0.214090	0.132576
X24	-0.124729	0.169262	0.276174	0.535839	-0.335989	0.241230	0.304970	-0.070998
X25	0.012286	-0.206537	0.549302	-0.501658	-0.361397	-0.115401	0.127928	-0.374108
X26	0.124946	-0.337041	-0.122591	0.253411	0.350391	0.291701	0.353485	-0.520937
X27	0.162271	0.027344	0.078686	0.243621	0.250397	-0.179890	-0.610027	-0.218731
X28	0.051261	-0.435075	-0.265567	-0.045385	-0.468108	0.488461	-0.472989	-0.094333
X29	0.196177	0.002550	-0.123516	0.079674	-0.103279	-0.146234	0.034696	-0.073900
X3	0.198389	0.055911	0.098489	-0.013692	-0.026529	-0.011007	0.007808	-0.040101
X30	0.199437	0.080736	0.037465	-0.008809	-0.040295	-0.023059	-0.002038	-0.065307
X31	0.199313	-0.070838	-0.002329	0.062349	-0.025890	-0.044294	0.049462	0.052205
X32	0.198054	-0.015749	0.084324	0.055745	-0.017251	-0.088695	-0.035060	-0.070130
X33	0.201184	0.032351	0.017010	0.027975	-0.047845	-0.056564	0.004658	-0.029497
X34	0.200242	-0.049502	0.025550	0.073114	-0.024226	-0.078560	0.013231	-0.010643
X35	0.201209	0.032748	-0.004466	0.028013	-0.056967	-0.057229	0.015743	-0.026072
X4	0.196311	0.004139	0.150487	0.012888	-0.012938	-0.021983	0.001594	-0.026450
X5	-0.156960	-0.318802	-0.027743	0.211916	-0.143940	-0.414713	0.003568	0.031287
X6	-0.159011	-0.308917	-0.042864	0.214213	-0.140948	-0.421251	0.023843	0.026463
X7	-0.180116	-0.198193	0.058176	0.142585	-0.048524	-0.239410	-0.061552	0.006488
X8	0.187162	-0.175183	-0.100375	0.066490	-0.036153	0.030754	0.244371	0.036042
X9	0.198173	0.093745	-0.059200	0.006717	-0.071803	-0.049990	0.010768	-0.072418

	Comp 9	Comp 10	Comp 11	Comp 12	Comp 13	Comp 14	Comp 15	Comp 16
Eigenvalue	0.248285	0.129336	0.111138	0.066285	0.048043	0.031210	0.022913	0.014985
Variance Prop.	0.007759	0.004042	0.003473	0.002071	0.001501	0.000975	0.000716	0.000468
Cumulative Prop.	0.985827	0.989869	0.993342	0.995414	0.996915	0.997890	0.998606	0.999075

Eigenvectors:

Variable	Vector 9	Vector 10	Vector 11	Vector 12	Vector 13	Vector 14	Vector 15	Vector 16
X1	0.242749	-0.142698	-0.664795	-0.093108	-0.036048	-0.300017	0.111291	0.240309
X10	0.021461	-0.035332	0.070215	-0.188408	-0.087452	0.122512	0.152964	0.077657

X11	0.007477	0.130767	0.141313	0.075348	0.041191	0.102510	0.311224	0.043784
X15	0.003933	0.096903	0.189592	0.099999	0.143221	-0.003792	-0.191627	0.147484
X16	-0.064183	-0.027272	-0.081392	-0.061797	-0.166831	0.060533	0.152409	-0.135811
X17	-0.139855	0.072322	0.078050	-0.001543	-0.179529	0.131791	0.079908	-0.103407
X18	0.047892	-0.013662	0.128847	-0.005442	0.131351	-0.312147	-0.137458	-0.402326
X19	-0.148045	0.111303	0.018712	0.031263	0.077695	0.230785	0.039375	0.655010
X2	0.033040	0.042290	-0.100930	-0.145857	0.572290	0.475182	-0.025119	-0.115862
X20	-0.192493	0.123275	0.182263	0.009245	-0.074807	0.044335	0.014717	-0.079374
X21	-0.171795	0.039333	0.117779	-0.023688	-0.207228	-0.014410	-0.080677	0.010758
X22	0.660552	0.050048	0.264670	0.099946	0.036884	-0.046449	0.137992	0.016907
X23	0.225662	0.563132	-0.133958	-0.227423	-0.173197	0.083003	-0.190765	-0.042832
X24	0.174601	0.488568	-0.121234	-0.139681	-0.079410	0.005831	-0.105761	-0.006743
X25	-0.261638	0.097875	-0.035429	-0.006294	0.133494	-0.057289	0.020035	-0.036495
X26	-0.184233	-0.257633	-0.234258	-0.034792	0.085241	0.056932	-0.038332	-0.071943
X27	-0.377816	0.398054	-0.218022	-0.087249	-0.055230	-0.126022	0.095946	-0.059563
X28	0.178402	0.001850	-0.016755	-0.011173	-0.039381	0.031971	-0.011027	0.069709
X29	0.012305	0.052830	0.167360	0.059482	0.124498	-0.111228	-0.179967	-0.075576
X3	0.040740	-0.099162	-0.019745	-0.025020	-0.348183	0.228895	0.051524	-0.127254
X30	0.056908	-0.067306	-0.044212	-0.070860	-0.193959	0.159903	-0.017756	-0.048779
X31	-0.000809	0.074810	0.115290	0.017830	0.057939	0.083342	0.411748	0.185509
X32	-0.029741	-0.107551	0.078214	0.145145	-0.225135	-0.076021	-0.524286	0.342658
X33	0.005009	-0.044967	0.075870	-0.019874	-0.061120	0.118081	-0.022592	0.035270
X34	0.033352	0.005072	0.072603	0.045294	0.061115	0.018968	-0.143015	0.158146
X35	0.011131	-0.014327	0.074854	-0.036232	-0.041884	0.113144	0.061487	0.024171
X4	0.028063	-0.120163	0.038217	0.030722	-0.446766	0.252174	0.061518	-0.077355
X5	0.091205	-0.054230	-0.188735	0.282550	-0.024725	0.194460	0.045735	-0.151726
X6	0.088765	-0.060019	-0.178526	0.099096	0.032033	0.101161	0.060898	0.006566
X7	0.021423	-0.243134	0.184275	-0.812018	0.013934	-0.079521	-0.045817	0.090231
X8	-0.060454	0.065561	0.176407	0.035509	-0.054759	-0.444206	0.417739	0.121509
X9	0.044619	-0.033539	0.056514	-0.194000	-0.005952	0.082476	0.068552	-0.026196

	Comp 17	Comp 18	Comp 19	Comp 20	Comp 21	Comp 22	Comp 23	Comp 24
Eigenvalue	0.008465	0.006003	0.004268	0.003440	0.002406	0.001662	0.001124	0.000885
Variance Prop.	0.000265	0.000188	0.000133	0.000107	0.000075	0.000052	0.000035	0.000028
Cumulative Prop.	0.999339	0.999527	0.999660	0.999767	0.999843	0.999895	0.999930	0.999957

Eigenvectors:

Variable	Vector 17	Vector 18	Vector 19	Vector 20	Vector 21	Vector 22	Vector 23	Vector 24
X1	0.092090	-0.003311	-0.098777	-0.038312	0.105566	-0.085664	-0.069460	0.009739
X10	-0.162695	-0.419622	0.078469	0.275827	-0.038917	0.103932	0.307651	0.174691
X11	0.125942	0.056390	-0.124095	-0.566201	0.397851	-0.161414	0.439863	0.115383
X15	0.432876	0.025607	-0.171222	0.164349	-0.086658	0.175375	-0.043615	0.346668
X16	-0.253038	-0.013567	-0.069485	-0.144992	0.005962	0.006493	-0.017092	-0.213148
X17	0.026065	0.004723	-0.394199	-0.100850	-0.106413	0.257377	-0.099051	-0.002936
X18	-0.227309	-0.155510	0.094186	0.093803	0.116682	-0.462101	0.041716	-0.115511
X19	-0.058033	0.021104	0.039515	0.289049	0.080809	-0.390904	0.159067	-0.160581
X2	-0.280349	0.395918	0.061487	-0.029634	-0.075701	0.011622	-0.117300	0.043188
X20	-0.151207	-0.089571	-0.356341	0.086248	-0.001924	-0.207866	-0.007588	-0.156142
X21	0.081850	0.116107	0.758541	-0.153452	0.096851	0.055436	-0.034869	0.096659
X22	-0.073869	0.054445	0.014908	-0.017410	-0.007814	-0.016301	-0.004294	-0.012895
X23	-0.033795	-0.020824	0.007724	0.001462	0.007254	-0.011858	-0.035341	0.010998
X24	-0.025270	-0.007682	0.004032	0.008026	0.003965	-0.006190	-0.036349	0.009443
X25	0.002967	-0.025753	0.022849	0.002750	0.007788	-0.003782	0.009012	-0.001440
X26	0.031039	-0.087448	-0.029810	-0.037235	0.041176	-0.032232	-0.001190	0.007385
X27	-0.022232	0.056190	0.007946	0.009503	-0.010317	-0.005548	-0.003105	-0.002011
X28	-0.018398	-0.004038	0.008199	0.024191	0.002632	-0.060390	0.011125	-0.019482

X29	0.176196	-0.055188	-0.049381	0.016701	-0.013584	-0.064969	-0.055448	-0.245411
X3	0.117129	0.194361	0.018172	0.059828	-0.094406	-0.131323	0.063109	-0.069113
X30	0.004019	0.172003	0.025579	-0.034898	-0.019120	0.267386	0.271523	-0.319267
X31	-0.085862	-0.363785	0.119584	-0.205168	0.039988	0.111850	-0.611282	-0.139708
X32	-0.541579	0.038553	-0.117035	-0.288169	0.052042	0.120212	-0.051276	0.106103
X33	-0.044489	0.031815	-0.009255	0.029707	-0.061132	-0.215837	-0.165814	0.179988
X34	0.210489	0.033135	0.051829	-0.009699	-0.007551	0.110174	0.000798	-0.681999
X35	-0.036430	-0.040558	-0.019936	-0.038133	0.016743	-0.099601	-0.047654	0.123758
X4	0.128021	0.139405	-0.023685	0.149874	-0.022626	-0.320082	-0.257405	0.059595
X5	-0.147802	0.070915	0.000466	0.329560	0.509638	0.195031	-0.058038	0.003608
X6	-0.050920	-0.090129	0.080225	-0.235241	-0.659707	-0.165233	0.158010	0.000824
X7	0.061883	0.133054	-0.104241	-0.063039	0.150009	-0.028198	-0.095917	-0.005914
X8	-0.248885	0.508259	-0.005158	0.229871	-0.180258	0.116964	0.032451	0.013297
X9	-0.158707	-0.292294	0.090844	0.202841	-0.068063	0.264563	0.241809	-0.024496

	Comp 25	Comp 26	Comp 27	Comp 28	Comp 29	Comp 30	Comp 31	Comp 32
Eigenvalue	0.000538	0.000306	0.000288	0.000107	0.000101	2.44E-05	3.18E-12	2.08E-12
Variance Prop.	0.000017	0.000010	0.000009	0.000003	0.000003	0.000001	0.000000	0.000000
Cumulative Prop.	0.999974	0.999984	0.999993	0.999996	0.999999	1.000000	1.000000	1.000000

Eigenvectors:

Variable	Vector 25	Vector 26	Vector 27	Vector 28	Vector 29	Vector 30	Vector 31	Vector 32
X1	0.018043	-0.039140	0.002576	0.007194	0.000319	-0.001086	2.36E-06	4.14E-07
X10	-0.081948	-0.303688	0.516426	0.242864	0.060582	0.076230	2.73E-06	-2.57E-06
X11	0.080577	-0.134232	-0.062160	-0.043408	0.006118	0.055784	2.19E-05	-2.77E-06
X15	-0.212414	-0.030955	-0.027303	-0.159385	-0.119378	-0.009733	-0.186532	-0.465409
X16	0.167566	-0.002306	0.048909	0.100679	0.065019	0.003504	-0.305198	-0.761538
X17	0.085425	-0.048094	0.072969	0.007364	-0.017956	-0.005662	0.682644	-0.049094
X18	-0.239936	-0.003485	0.005665	-0.203502	-0.125033	-0.014013	0.331755	-0.233439
X19	-0.092897	0.107065	-0.142128	0.030496	0.038097	0.024239	0.230549	-0.162215
X2	-0.029036	-0.188339	0.019415	0.044926	0.015652	-0.024991	-7.28E-06	-1.08E-06
X20	-0.109983	-0.005711	0.018450	-0.114555	-0.086311	-0.004319	-0.492791	0.346752
X21	0.032637	-0.037433	0.043894	0.000602	0.004242	-0.015932	-8.22E-07	2.32E-06
X22	0.015353	-0.001650	0.015222	0.007615	-0.005029	-0.002540	8.59E-08	-9.43E-07
X23	0.009333	0.004687	0.008393	-0.001223	0.001516	-3.56E-05	1.06E-06	6.25E-07
X24	0.001952	0.001751	0.004924	-0.002221	-0.005150	0.000679	1.64E-06	1.70E-06
X25	-0.001179	0.002906	-0.002239	-0.001398	0.002990	0.001200	2.80E-07	1.18E-06
X26	-0.004683	0.009394	-0.001690	-0.002564	-0.000112	0.001795	1.38E-06	1.27E-06
X27	0.016247	-0.008657	-0.001820	-0.001428	-0.001511	-0.004154	9.31E-07	3.48E-07
X28	-0.010980	0.006728	-0.004297	0.003982	-0.000306	0.002130	6.32E-07	7.74E-07
X29	0.145602	0.056371	-0.172949	0.645992	0.449706	0.149610	9.83E-06	1.33E-05
X3	-0.148769	0.067385	-0.170498	0.423789	-0.638048	0.085947	3.00E-06	1.46E-05
X30	-0.481095	0.389652	0.061455	-0.234118	0.336045	0.177163	-2.26E-06	-3.31E-06
X31	-0.281555	0.042644	-0.098975	-0.001319	-0.075598	0.100472	-1.03E-05	5.12E-06
X32	-0.045724	-0.116944	-0.058654	0.059073	-0.045950	-0.014781	-3.87E-07	-1.66E-06
X33	0.481420	0.402400	0.255230	-0.205635	-0.033398	0.554064	4.63E-05	1.15E-05
X34	0.302425	-0.231472	0.305407	-0.204575	-0.240051	-0.151980	-1.20E-05	-1.66E-05
X35	0.124023	0.513905	0.193265	0.098260	0.049631	-0.749975	-2.61E-05	-7.66E-06
X4	0.030412	-0.420266	-0.121404	-0.214500	0.395710	-0.142072	-1.29E-05	-8.55E-06
X5	0.046100	0.045413	0.025969	0.037024	-0.030344	0.017707	1.88E-06	-5.61E-09
X6	-0.031807	-0.023060	-0.012118	-0.041567	0.031586	-0.019978	-3.12E-06	-1.64E-07
X7	-0.041641	-0.011883	-0.010612	0.013631	-0.015754	0.008366	3.52E-07	3.00E-07
X8	0.049065	-0.040726	0.020449	0.030335	0.018196	-0.017846	-4.68E-06	-2.39E-06
X9	0.349389	0.025665	-0.640225	-0.216103	-0.047421	-0.062601	2.17E-06	8.89E-07

U.S.A. Principal Components

obs	V1USA	V2USA	V3USA	V4USA	V5USA	V6USA
1	-7.291774	-2.061350	0.260227	0.579397	-0.127870	-0.652146
2	-6.946863	-1.540901	-0.008612	0.017907	-0.166715	0.429078
3	-6.764139	-1.010951	0.169959	-0.200923	0.109235	0.592100
4	-7.186211	-1.914599	0.027849	0.626553	-0.367216	-1.007136
5	-7.113103	-1.989373	0.045836	0.775529	-0.408467	-1.331386
6	-7.041019	-2.631291	-0.261350	0.935176	-0.868284	-1.136293
7	-7.145772	-2.443678	0.049879	0.945965	-0.673777	-1.518541
8	-6.774711	-1.396850	0.058523	0.492682	0.094372	-0.964387
9	-6.832322	-1.652418	0.159784	0.628799	-0.368062	-0.919420
10	-6.783652	-1.694822	0.060814	0.481352	-0.491126	-0.742352
11	-6.331469	-0.796009	0.372266	0.249487	0.272203	-0.089951
12	-6.020832	-0.083329	0.383162	-0.236565	0.636480	0.311899
13	-5.935519	-0.051400	0.388120	-0.280424	0.461004	0.417453
14	-5.651012	-0.421219	0.395869	-0.266707	0.271889	0.592163
15	-5.513229	-0.686282	0.697007	-0.069473	0.201851	0.297148
16	-5.581215	-0.368740	0.721787	-0.017110	0.348541	0.131888
17	-5.344839	-0.508575	0.834610	-0.070320	0.284863	0.147237
18	-5.168836	-1.121238	0.803061	0.180177	0.039828	-0.077494
19	-5.105741	-1.098503	0.965258	0.299045	0.014618	-0.318473
20	-4.764903	-0.367549	0.885795	0.282042	0.597817	-0.158360
21	-4.792272	-0.228542	0.826975	-0.126810	0.368817	0.115762
22	-4.307323	-0.335214	0.899676	0.032364	0.373871	0.639387
23	-4.124143	-0.168614	1.141762	-0.127291	0.539463	0.602518
24	-3.927603	0.058916	1.183620	-0.021749	0.817955	0.339694
25	-3.716833	0.170602	0.657672	0.031695	0.684304	0.726130
26	-3.310042	0.011942	0.882779	-0.368053	0.444486	1.175574
27	-3.126313	0.421945	1.082758	-0.413416	0.647010	1.201076
28	-3.175593	0.556961	1.162167	-0.744269	0.699111	0.923476
29	-2.979018	0.350375	0.780406	-0.494442	0.777021	1.134745
30	-2.789978	-0.319673	0.770463	-0.324581	0.120006	1.499375
31	-2.713083	-0.251554	0.808213	-0.360167	0.391731	1.071184
32	-2.881759	0.716582	0.954349	-0.051332	0.491096	0.356451
33	-2.778283	0.472594	0.499237	-0.097412	0.292961	0.704914
34	-2.663123	-0.161500	0.544191	-0.260588	-0.227393	0.872795
35	-2.619994	0.020078	0.512307	-0.220581	-0.160212	0.397899
36	-2.597102	0.191251	0.627749	-0.192768	0.312965	-0.304203
37	-2.518817	-0.011753	0.279392	0.094828	-0.095438	-0.522442
38	-2.225867	-0.591356	-0.325894	-0.179203	-0.854398	0.207661
39	-1.802491	0.180325	0.071326	-0.130590	-0.068835	-0.330053
40	-1.865125	0.612921	0.134423	-0.551183	-0.147067	-0.641760
41	-1.991921	1.156636	-0.461724	-0.021992	-0.349123	-0.594035
42	-1.764982	0.554480	-0.607747	-0.399617	-0.828015	-0.300428
43	-1.370999	0.839053	0.174075	-0.226082	-0.920803	-0.481895
44	-1.560822	1.643767	-0.101508	-0.012420	-0.191978	-0.839777
45	-1.623015	1.535871	-0.802109	-0.546705	-0.705567	-0.227964
46	-1.296756	1.014540	-0.897547	-0.667597	-0.360146	0.113301
47	-1.145266	1.780432	-0.273423	-0.432888	-0.212639	-0.248286
48	-0.980859	2.084599	-0.471460	-0.522414	-0.167285	-0.127491
49	-0.920838	2.483994	-0.404009	-0.852740	-0.409311	-0.281383
50	-0.576076	1.888828	-0.677568	-0.507807	-0.654968	0.538433
51	-0.327496	2.284542	-0.274872	-0.993995	-0.361212	0.398324
52	-0.147734	2.416971	-0.341562	-0.571546	0.793069	-0.020779
53	-0.197786	2.436491	-1.706093	0.043211	0.359553	0.824091
54	0.344466	1.886427	-1.595150	-0.414705	-0.133585	1.052122
55	0.557857	2.402472	-2.156792	0.223068	1.203262	0.838871
56	1.035819	1.935367	-1.365180	-0.256608	1.143059	0.356946
57	0.797342	1.760958	-0.738482	-1.053185	-0.382497	0.339172

58	0.709574	1.270885	-0.258901	-1.112564	-1.259311	0.379774
59	1.172065	1.512422	-0.236252	-0.103111	-0.283570	-0.122601
60	1.059368	1.568498	-0.517697	0.114098	0.110592	-0.720907
61	1.069942	1.845351	-0.508269	0.081937	-0.813480	-0.983599
62	1.713067	1.024462	-1.608364	0.494944	-0.545121	-0.005244
63	2.150697	1.293096	-1.667148	0.181939	0.304569	-0.716623
64	2.011640	1.437520	-2.411683	0.373775	0.062133	-0.339863
65	2.156936	1.496326	-2.009784	-0.340954	0.429607	-1.058048
66	2.454195	0.328200	-1.504744	-0.437731	-0.897946	-0.014447
67	2.774771	1.369665	-1.154595	1.322203	0.312084	-0.617942
68	2.952437	1.531207	-1.883071	1.454398	0.938257	-1.001772
69	3.005602	0.629114	-1.018067	0.194584	-0.052088	-0.983456
70	3.418843	-0.676204	-2.220641	0.893540	-0.722656	0.652535
71	3.743672	0.370642	-2.491224	2.170870	1.085886	0.164843
72	3.330713	0.636106	-1.049957	0.871195	-0.462716	-0.369547
73	3.778613	0.135917	-1.512188	1.311341	-0.447740	0.218090
74	4.460817	-0.589260	-2.791918	1.850388	-1.128534	1.334786
75	3.891053	0.261572	0.801016	-0.597922	-2.386356	-0.070303
76	5.677716	-1.544975	-1.705175	-4.266422	1.603896	-2.254357
77	4.934486	-0.078766	-0.513075	0.686106	-2.285926	0.622987
78	6.901362	-4.506125	-2.874117	-3.448076	0.661681	0.375217
79	6.809616	-1.700397	-0.863581	0.409010	-0.126742	0.140789
80	6.545311	-2.082495	-0.045499	0.244613	0.432841	-0.064622
81	7.063933	-2.327473	-0.941414	2.029683	1.472991	0.420863
82	8.055557	-5.037095	-1.128420	-1.535422	-1.317813	0.833728
83	8.161121	-3.462845	-0.812598	1.789639	0.962609	0.694915
84	7.750838	-2.941737	0.285986	0.163478	1.076722	-0.615362
85	7.371790	-1.488508	0.534695	1.165072	1.116727	-0.478362
86	8.204222	-3.691255	-0.674947	-1.433537	-0.467995	1.035088
87	7.264895	-0.398428	2.977939	-0.625473	-1.568686	-0.139401
88	7.440716	0.033301	0.914094	0.941082	1.182312	0.313609
89	7.062886	1.003734	2.025636	1.148255	-0.170735	0.263286
90	8.115333	0.023746	2.616926	0.105353	-0.881191	0.222115
91	8.163507	0.849080	3.529008	1.192431	-0.848223	0.344648
92	8.440682	1.214215	3.332544	0.445918	0.594417	-0.540041
93	8.642576	1.415297	2.741745	-0.983828	0.920067	-1.477551
94	9.520710	-0.194226	3.886228	-0.344256	-0.083459	-0.127129
95	9.399726	1.506794	2.955249	-0.039580	0.392447	-0.828525

As we can see from the principal components' weights table, more than 95% of the series' information is explained cumulatively by the first six principal components. The principal components of both Canada and the U.S. served as the potential independent variables which were regressed against the CAD/US$ exchange rate (the dependant variable, also on a quarterly basis and lagged plus one period).

The nature of the series used here for the analysis commanded that the principal components and the exchange rate should be tested for unit roots. I have used all unit root tests available (adf, Kpss, pp_sp, to name some of the best known). Examples of such tests proving the sixth principal component of U.S.A. to be I(0) (v6usa) and the first principal component of U.S.A. to be I(1) (v1usa) can be found on Appendix B.

In the case of the CAD/US$ exchange rate analysis three of the nine variables were found to be non-stationary (I(1)) (v1c, v1usa, v3usa). After using a VAR(1) model on these three, no cointegration relations were found which meant that the error correction model was not applicable. Thus, I proceeded using a first-differences model in order to work in a stationary environment. The statistic significance of these variables was tested using the least squares model. At this point, my analysis of the British pound/ American dollar exchange rate ended, since all variables were found to be statistically insignificant. However, in Canada's case, consequent exclusion of the most statistically insignificant variables left a smaller set of significant ones (as declared of their probabilities):

Dependent Variable: D(CANMR)
Method: Least Squares
Date: 05/25/04 Time: 15:15
Sample(adjusted): 3 96
Included observations: 94 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.006408	0.007518	-0.852406	0.3962
D(V1USA(-1))	0.057006	0.019486	2.925563	0.0043
D(V3USA(-1))	0.018867	0.009052	2.084421	0.0399

R-squared	0.088308	Mean dependent var	0.004255
Adjusted R-squared	0.068271	S.D. dependent var	0.066211
S.E. of regression	0.063911	Akaike info criterion	-2.631270
Sum squared resid	0.371695	Schwarz criterion	-2.550101
Log likelihood	126.6697	F-statistic	4.407212
Durbin-Watson stat	1.931963	Prob(F-statistic)	0.014897

7.1. In-sample Results

In-sample analysis of an exchange rate model is structured to test whether the relationship between an economic variable and the exchange rate (meaning the regression coefficient) is predicted by the model, and whether the variables taken as a group (the model) explain a significant portion of the exchange rate variability in the sample. The analysis focuses on a time series of observations for a single exchange rate. The model is supported when the regression coefficients are significant, and the proportion of exchange rate variability explained (measured by R^2) is significant.

Contrasting the obtained fitted values against the actual ones we see that the model predicts correctly the movement of the exchange rate in 59 out of the 94 observations (62.76% accuracy). The results are summed in the following chart:

	FITTED		
ACTUAL		+	-
	+	34	17
	-	18	25

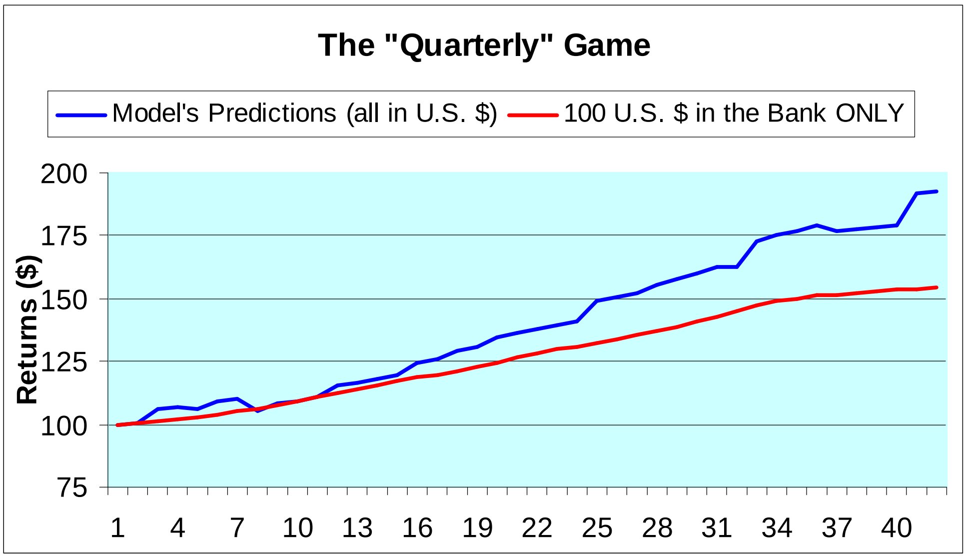
On the first line we see that our model predicted 34 times correctly and 18 times wrongly the appreciation of the American dollar. On the second line we see that the model predicted 25 times correctly and 18 times wrongly the depreciation of the American dollar. The upper-left and lower-right quarters show the number of times the model succeeded at predicting correctly the movement of the exchange rate.

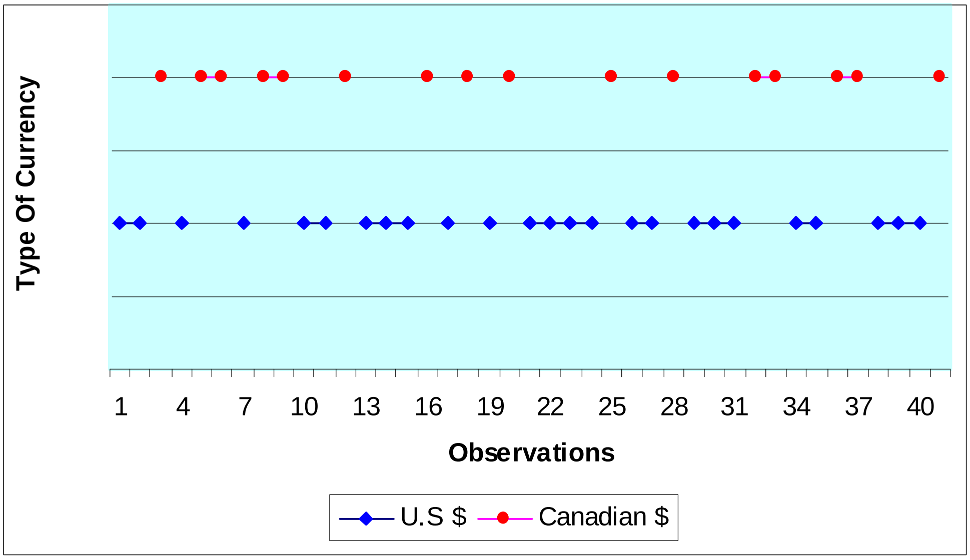
The following investment game attaches some real-life economic significance to these results. The concept here is to compare the returns by the investment of 100 American dollars under two different cases. In the first case we invest 100$ in an American bank for three months on a given interest rate. At the end of the three-month period we re-invest the initial 100$, plus interest, on the new interest rate level, and so on. We do the same in Canadian dollars (using a Canadian interest rate this time), after transforming the 100 American dollars in Canadian ones, at the beginning of the investment period, using the exchange rate at that time. For convenience in our comparison of the results, the final amount of Canadian dollars was converted in American ones.

In the second case, we begin our investment with 100 American dollars and we check with the predictions of our model. If the model predicts an appreciation of the American dollar, we invest the money in a bank, using the American interest rate. If the model predicts that the U.S. dollar will depreciate, then we exchange the American dollars with Canadian ones, using the actual exchange rate at that time, and we invest those in the bank with the Canadian interest rate and so on.

Using the DATASTREAM and EcoWin databases we take the U.S. T-Bill 3-month interest rate and the Canadian interbank 3-month interest rate, both on quarterly basis. Since the data available begin at the first quarter of 1993, we set the duration of the investment game from the beginning of 1993 until the end of 2003. The results featured below put a smile on our faces...

American $ Placement Under The Model's Predictions	Canadian $ Placement Under The Model's Predictions	American Dollars In The Bank Only	Canadian Dollars In The Bank Only
100,00		100,00	180,00
100,74		100,74	182,40
	193,58	101,51	184,47
107,15		102,27	186,72
	212,05	103,04	188,52
	215,15	103,99	191,28
110,39		105,11	194,45
	229,30	106,38	197,03
	233,38	107,90	200,53
109,63		109,48	204,67
111,17		111,01	208,19
	229,30	112,52	211,54
116,69		113,95	214,52
118,19		115,41	217,23
119,73		116,92	219,84
	238,27	118,41	222,07
125,69		119,93	223,81
	243,40	121,52	225,73
130,47		123,12	227,71
	254,18	124,69	229,85
136,29		126,36	232,58
138,03		127,97	235,40
139,79		129,60	238,35
141,27		130,97	241,53
	293,19	132,44	244,53
150,48		133,90	247,50
152,23		135,47	250,51
	305,28	137,11	253,71
157,79		138,90	256,97
160,10		140,94	260,47
162,31		142,89	264,32
	322,77	145,10	268,18
	327,39	147,23	272,02
175,07		148,80	275,25
176,68		150,17	278,34
	356,21	151,07	280,59
	358,08	151,72	282,06
178,05		152,39	283,75
178,80		153,03	285,77
179,49		153,62	287,84
	365,13	154,08	289,87
American $ Placement Under The Model's Predictions	Canadian $ Placement Under The Model's Predictions	American Dollars In The Bank Only	Canadian Dollars In The Bank Only
192,70	**371,91**	**154,50**	**292,25**





7.2. Out-of-sample Forecasting

The above exercise does not measure the real time forecasting performance of our model. A working forecaster uses all data that have been released up to the current time, say, *T* in forming a forecast for *T+k*. Another technique to measure the validity and usefulness of a model of exchange rate determination is to estimate the model using data from one time period (the in-sample period) and then to measure its forecasting properties in a subsequent period (the post-sample period). A post-sample analysis is sometimes seen as a "horse race" among models-to judge which model performs best and at a minimum to see whether any model consistently outperforms a naïve benchmark (such as the random walk with no drift forecast).

Results obtained via the post-sample analysis are of great economic importance because an analysis of data from a specified period forms a forecast for a period for which we-supposedly-have no data whatsoever and this is a real-life mirroring procedure.

The out-of-sample analysis was performed for the CAD/American dollar exchange rate, since the in-sample analysis for this exchange rate presented the most optimistic results. The rolling nature, though, of the predictions called for a larger number of observations. Thus, the series of data for the countries of U.S.A. and Canada were recollected on a monthly basis. Unfortunately, almost half the series were rendered useless since most of the Current Account related series feature only quarterly observations. These are the series of data finally used for the principal component formulation for Canada and the U.S.A.:

CANADA	U.S.A.
total reserves minus gold	total reserves minus gold
money	M1, s.a.
overnight money market rate	M2, s.a.
treasury bill rate	M3, s.a.
government bond yield>10 years	federal funds rate
CL. Toronto stock prices, 75=100	treasury bill rate
aggregate industrial selling prices	government bond yield: 10 year
consumer prices	share prices: industrial
wages: hourly earnings	consumer prices
industrial production, s.a.	wages: hourly earnings
	industrial production, s.a.
	deficit (-) or surplus

Four principal components were enough to cover for approximately 96% of the information in the samples of both countries. The principal components of both Canada and the U.S. served as the independent variables which were regressed as first differences against the CAD/US$ exchange rate (the dependant variable, also on a monthly basis, first differences and lagged plus one period). We decided our estimation window to be five years long (60 months-observations). Thus, we estimated our data from January 1988 to December 1992 and formed a prediction for 1993 January's exchange rate change, then from February 1988 to January 1993, predicting the exchange rate change of February 1993, and so on until December 2003 (11 years).

Contrasting the fitted values against the actual ones we see that the model predicts correctly the movement of the exchange rate in 73 out of the 132 observations (53.303% accuracy). The results are summed in the following chart:

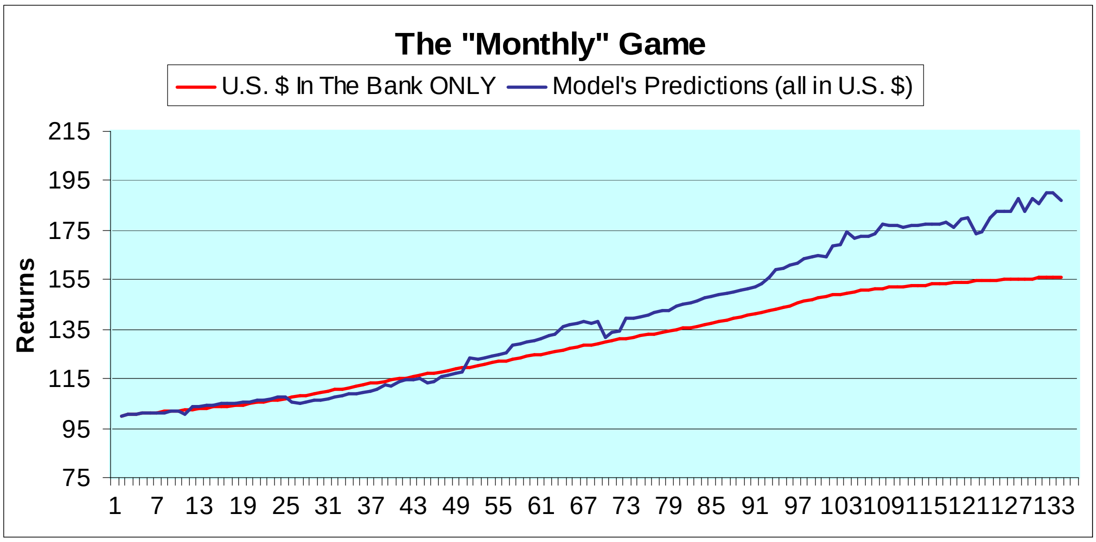
	FITTED		
ACTUAL		+	-
	+	41	21
	-	38	32

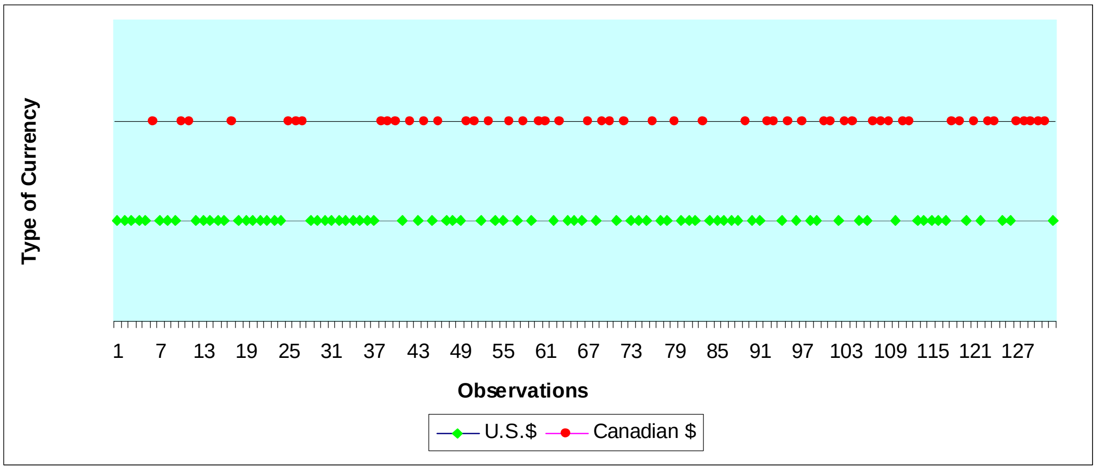
This means that our model predicted correctly the sign of the exchange rate change a little more than half the times. In contrast with the in-sample analysis, these results seem discouraging, to say the least. But are they?... Replaying the investment game of 100 American dollars, on a monthly basis this time, starting at the beginning of 1993 and for eleven years (132 months) we obtained the following results:

U.S. $ Placement Under The Model's Predictions	Canada $ Placement Under The Model's Prediction	U.S. Dollars In The Bank ONLY	Canada Dollars In The Bank ONLY
100,00		100,00	
100,27		100,27	175,98
100,53		100,53	176,94
100,77		100,77	177,80
101,02		101,02	178,56
	183,46	101,27	179,35
101,33		101,52	180,07
101,59		101,78	180,76
101,85		102,04	181,38
	190,09	102,30	182,10
	190,82	102,55	182,80
103,92		102,81	183,47
104,19		103,08	184,10
104,45		103,34	184,69
104,72		103,60	185,25
105,00		103,88	185,84
	206,19	104,18	186,68
105,31		104,51	187,58
105,68		104,87	188,57
106,05		105,24	189,62
106,44		105,62	190,54
106,83		106,02	191,38
107,25		106,43	192,23
107,69		106,87	193,09
	216,75	107,34	194,02
	218,04	107,84	195,18
	219,49	108,36	196,48
105,93		108,89	197,75
106,44		109,41	199,11
106,94		109,92	200,42
107,45		110,45	201,65
107,94		110,95	202,78

108,43		111,46	203,90
108,92		111,96	204,98
109,40		112,45	206,08
109,88		112,95	207,10
110,37		113,45	208,11
	224,98	113,94	209,07
	225,94	114,41	209,96
	226,92	114,88	210,87
114,39		115,35	211,75
	226,69	115,83	212,58
115,20		116,32	213,40
	227,83	116,81	214,24
113,55		117,32	215,03
	227,30	117,81	215,75
116,41		118,32	216,46
116,89		118,81	217,04
117,38		119,31	217,52
	231,67	119,80	218,03
	232,22	120,30	218,55
123,18		120,80	219,07
	237,14	121,32	219,65
124,82		121,84	220,23
125,36		122,36	220,78
	240,88	122,86	221,30
128,88		123,38	221,92
	244,60	123,91	222,49
130,16		124,42	223,07
	254,58	124,94	223,74
	255,34	125,47	224,41
133,00		126,01	225,24
	261,46	126,55	226,03
136,62		127,09	226,89
137,19		127,62	227,75
137,76		128,15	228,67
	269,14	128,69	229,57
137,96		129,22	230,50
	278,30	129,76	231,45
	279,43	130,29	232,39
134,04		130,81	233,35
	292,27	131,25	234,27
139,49		131,74	235,21
140,01		132,22	236,13
140,51		132,70	237,05
	290,34	133,19	238,00
142,23		133,69	238,94
142,74		134,17	239,86
	283,94	134,67	240,74
144,98		135,19	241,67
145,54		135,70	242,61
146,11		136,24	243,58
	299,24	136,78	244,53
147,93		137,34	245,52
148,56		137,92	246,51
149,21		138,52	247,52

149,87		139,13	248,56
150,57		139,78	249,61
	296,10	140,45	250,71
152,25		141,11	251,85
153,00		141,80	253,05
	304,04	142,48	254,23
	305,47	143,19	255,42
159,83		143,92	256,61
	314,07	144,63	257,80
161,55		145,37	259,01
	319,61	146,12	260,25
164,28		146,83	261,46
165,00		147,47	262,58
	326,68	148,08	263,63
	327,93	148,63	264,64
169,24		149,12	265,61
	329,36	149,57	266,58
	330,52	150,01	267,52
172,12		150,45	268,42
172,60		150,88	269,27
	352,13	151,24	269,95
	352,88	151,52	270,53
	353,53	151,76	271,02
176,93		151,98	271,48
	350,54	152,19	271,92
	351,14	152,41	272,39
176,99		152,64	272,92
177,24		152,85	273,47
177,50		153,08	274,07
177,75		153,29	274,69
178,00		153,51	275,35
	369,20	153,72	276,03
	370,07	153,93	276,68
179,71		154,13	277,33
	373,39	154,29	277,96
174,00		154,45	278,58
	367,13	154,60	279,23
	368,01	154,75	279,90
182,44		154,89	280,63
182,62		155,04	281,39
	356,32	155,18	282,14
	357,25	155,30	282,87
	358,08	155,41	283,54
	358,89	155,54	284,17
	359,67	155,66	284,79
190,45		155,78	285,42
	358,85	155,90	286,06
U.S. $ Placement Under The Model's Predictions	Canada $ Placement Under The Model's Prediction	U.S. Dollars In The Bank ONLY	Canada Dollars In The Bank ONLY
186,90	**358,85**	**155,90**	**286,06**





At the end of the eleven-year-long game, the investment of American dollars in the bank produced a 56% return of the original capital (100$), while the same money, when invested at both the exchange market (under the directives of our model) and the bank, produced an 87% return. That's 31% more than the standard placement in the bank in an eleven-years window, which translates as roughly 2,8% excess return per year.

Disappointment was succeeded by enthusiasm after the results of the investment game, which was, in turn, succeeded by bewilderment since our model predicted only a mere 53,3% of the time the correct sign of the exchange rate change. The Gods of Money clearly favored us, but why and how? Could it be that our model predicted correctly the big changes in the exchange rate while it was confused by small changes? That would mean more money for us when we were right and little harm done when we were wrong...

What we did was to short the fitted values of the exchange rate change by order of the biggest one to the smallest one and in pairs

with the corresponding actual exchange rate changes. Then we divided our sample in three groups. The first group included the forty biggest fitted values, the second included the middle fifty two and the third the forty smallest ones. The results, summed up in the three following charts, solve the mystery:

TOP 40			
	FITTED		
ACTUAL		+	-
	+	16	6
	-	6	12

MIDDLE 52			
	FITTED		
ACTUAL		+	-
	+	15	5
	-	20	10

BOTTOM 40			
	FITTED		
ACTUAL		+	-
	+	10	8
	-	12	10

Correct:28 *Correct:25* *Correct:20*
Wrong :12 *Wrong :25* *Wrong :20*

Again, on the upper-left corner we see how many times our model predicted correctly the appreciation of the American dollar and on the lower-right corner we see how many times our model predicted correctly the depreciation of the American dollar. The upper-right and lower-left quarters show the number of times the model failed at predicting correctly the movement of the exchange rate.

8. Concluding Remarks

"Give your client a 3% return and he will trust you to look after his children during the week-end!"
...from some Hollywood b-movie about the stock market.
(seriously, I haven't made up this line!)

In this paper we have sought to construct an exchange rate model that would overcome many of the weaknesses of the "traditional" approaches to exchange rate forecasting. Having arrived at the conclusion that the exchange rate for a currency of a country vis-à-vis that of another country depends at large on the balance of payments of said country, we combined the elements of the portfolio-balance model and the monetary model into a new model. The sheer bulk of the information contained therein was condensed using principal components analysis in order to make the model more efficient and convenient. We have focused our research on the Canadian $/ American $ and the British pound/ American $ exchange rates, since it was the countries of U.K., Canada and the U.S.A. that has provided us with a relatively wholesome and untroubled set of data for the duration of the 24-year window (1980-2003) we selected.

While we may not have had prior hypotheses about parameter values or even signs, we do have some expectations regarding the relationships between variables. The British pound/ American $ exchange rate analysis met an untimely end with our model showing little to none predictive ability since all the principal components used as independent variables were of no statistical significance, in spite of removing a large number of insignificant lagged terms. In the case of the Canadian exchange rate, however, our model outperformed the random walk not only in the in-sample tests, but also in the more stringent predictive environment of the post-sample analysis. Let's bear in mind that, under the random walk hypothesis, the expected change of the exchange rate from period *T* to *T+1* is zero. In the investment game that we played an investor who would not expect the exchange rate to change would keep his money on one currency and invest only in the bank. We showed that she would be significantly better off following the predictions of our model.

What we really ought to focus our attention to, though, is the model's ability to predict correctly where it matters. The higher the exchange rate change, the bigger the probability that the model will point at the right direction. That indicates that it assimilates the trends in the data to a very large degree and it would also seem to point out that the model does not contain at least one factor that

determines the path of the Canadian dollar, but which is incorporated by a substantial subgroup of the panel.

In their paper "Why Is So Difficult to Beat the Random Walk Model" Mesrrs Lutz Kilian and Mark P. Taylor have poetically observed that "Like the true Holy Grail, the goal of exploiting economic models of exchange rate determination to beat naïve constant change forecasts has remained elusive." In our paper, the search for the Holy Grail took us on a path that, to the best of our knowledge, has never been walked upon before. We believe that our combined approach on exchange rate forecasting and the ability to produce statistically superior forecasts with a very simple exchange rate model represent a substantial contribution to the literature on the economics of exchange rates. Of course, this is only the first step towards a very promising direction. One way in which our work could be extended is the same examination of many more exchange rates.

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