Portfolio Balance Model of Exchange Rate Behavior: A Peso-Dollar Example[ψ]

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This study investigates the Portfolio Balance Model (PBM) of exchange rate behavior in the context of the Mexican Peso and the US dollar for the period from 1985Q4 to 2005Q3. Tests of the reduced-form exchange rate equation and perfect substitution of domestic and foreign bonds are conducted utilizing the unit root and cointegration techniques that avoid residual autocorrelation problems, which have plagued previous tests of Portfolio Balance Model (PBM) of exchange rate determination in accordance with Branson et al. (1977) and Pearce (1983). Other things considered, the results show a weak evidence of a long-run relationship between the peso-dollar equilibrium exchange rate and the PBM fundamentals.

Introduction

Despite the implementation of the North American Free Trade Agreement (NAFTA) on January 1, 1994, Mexico experienced macroeconomic instability in the late 1994, primarily due to excessive capital outflows and balance of payment deficits that led to the misalignment of the peso-dollar exchange rate. Subsequently, nominal devaluation of the peso-dollar exchange rate was adopted, the fluctuation band was jettisoned due to speculative attacks, and the floating rate policy produced a depreciation of about 15% (Dropsy, 1998). Consequently, exchange rate misalignment and misguided policies culminated in another peso crisis in 1995. According to Ramirez (2003), the evidence suggests that since NAFTA, trade and inflows of foreign direct investment have risen significantly.

Nevertheless, the Mexican economy faced a severe recession in 2000-2001 due to the downturn in economic activities in the United States and the resultant decline of the real peso-dollar exchange rate. It clearly indicates the essence of an exchange rate target that reflects economic fundamentals necessary for macroeconomic stability. To this end, the

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present paper investigates the portfolio balance model of exchange rate behavior from 1985Q4 to 2005Q3, based on the peso-dollar example.

As cited by MacDonald and Taylor (1992), the research that has been done in this area may be categorized into two: the short-run portfolio model as a reduced-form exchange rate equation (assuming expectations are static), and the portfolio balance model that assumes imperfect substitutability between domestic and foreign assets. Using the reduced-form exchange rate equations, Branson *et al.* (1977) estimated a log-linear version of an equation, similar to the one used in this study for the mark-dollar exchange rate. These estimates were in line with the portfolio balance model, although with the exception of the US money supply, all other variables were statistically insignificant in light of acute first-order residual autocorrelation.

Similar studies using the reduced exchange rate portfolio balance models have been plagued by empirical and theoretical uncertainties: partially due to the theoretical specification of a small country, lack of reliable international bilateral exchange rate data, and inconsistency in utilization of inside-outside money and financial asset distinctions (Bisignano and Hoover, 1982). Further studies however, have been conducted on the efficacy of the portfolio balance approach to exchange rate determination, in order to improve the model by using the two-country and multi-country approaches, respectively. For example, Enders (1977), Bisignano and Hoover (1982), and Lewis (1988) to mention a few. These studies commonly did not employ the modern econometric techniques for testing the portfolio balance model and perhaps led to the disappointing results. As such, this study attempts to address these problems by employing modern test techniques like unit root and cointegration in investigating the portfolio balance model of exchange rate determination based on the peso-dollar example.

Theoretical Framework

The portfolio balance model can be specified following the assumptions by Krueger (1983): that individuals allocate their wealth, which is fixed at a point in time, among alternative assets, especially domestic and foreign money, and domestic and foreign securities. Given a simple one-country model in which individuals cannot hold foreign currency, the basic equations are postulated as follows:

$$M = a(r, r^*)\, W \quad ...(1)$$

$$B = b(r, r^*)\, W \quad ...(2)$$

$$eF = c(r, r^*)\, W \quad ...(3)$$

$$W = M + B + eF \quad ...(4)$$

where M is domestic monetary base, B is the supply of domestic assets, F is the price of foreign exchange (foreign net claims), r is the nominal interest rate on B, e is the exchange rate, and W is initial wealth. Note that, $a + b + c = 1$, and F can be either positive or negative, depending on whether a country is a net creditor or debtor. Following Dornbusch (1980) in Bigman and Taya, and Bisignano and Hoover (1982), Equation 4 can be shown as a reduced form for the equilibrium exchange rate as follows:

$$e = e(M, B, F, r^*) \qquad ...(5)$$

where the expected signs in Equation 5 are (+), (+, –), (–), and (+), respectively. Furthermore, Equation 5 can be expressed in a logarithmic (testable equation) form as indicated by Pearce (1983):

$$e_t = d_o + d_1 M_t + d_2 B_t + d_3 F_t + d_4 r_t^* + u_t \qquad ...(6)$$

where,

e	=	Spot exchange rate defined as Mexican peso/US dollar
M	=	Monetary base in Mexico
B	=	Mexican Government debt held by the Mexican citizens
F	=	Net US dollar claims held by the Mexican citizens
r^*	=	Nominal interest rate in the US
u	=	Error term
t	=	Time subscript

Data and Methodology

In testing the Portfolio Balance Model (PBM), Mexico and the United States are examined within the context of the peso-dollar exchange rate, with Mexico as the base country. In addition to available data, both countries and Canada are members of the NAFTA. The time period chosen is from 1985Q4 to 2005Q3, particularly, because in July 1985, the Mexican Central Bank devalued the peso and embarked on a managed floating system. The data (quarterly) were retrieved from the *International Financial Statistics* (IMF, 2005). Peso exchange rates are taken as end-of-period units of foreign currency per dollar.

As Gujarati (1999) asserted, regression models involving time series data sometimes give results that are spurious, in the sense that superficially, the results look good but on further investigation they look suspect. Thus, indicating that the series might be non-stationary or contains unit root, a highly persistent time series process where the current value equals the last period's value, plus a weakly-dependent disturbance (Woolridge, 2006). Since the PBM studies have been limited by data problems, both Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1981), and the Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) test (Kwiatkowski *et al.*, 1992) are employed to test for the existence of unit root. Following Greene (2003), the ADF test is employed to test for unit root based on an equation of the following form:

$$w_t = \mu + \gamma w_{t-1} + \sum_{i=1}^{n} \gamma_j \Delta w_{t-i} + u_t \qquad ...(7)$$

where the ADF unit root test hypothesizes a null of $\gamma = 0$ versus an alternative $\gamma < 0$. Hence, implying that if the series has unit root, one can conclude that cointegration is necessary. In line with McNown and Wallace (1994), evidence shows that Dickey-Fuller tests have lower power against plausible trend stationary alternatives; therefore, the KPSS serves as a better alternative. The KPSS can be expressed as:

$$X_t = \alpha t + Y_t + e_t \quad ...(8)$$

where X_t is the sum of a time trend t, random walk Y_t, and stationary error e_t. Assuming e_t is stationary and Y_t is a random walk with,

$$Y_t = Y_{t-1} + u_t \quad ...(9)$$

such that the null hypothesis is that X_t is trend stationary, the variance of the random walk, σ^2 is zero. If σ^2 is zero, then Y_t is a constant and also the intercept in Equation 8. Thus, KPSS test states that the variance of the random walk component is equal to zero.

Applying the cointegration test methods of Johansen and Juselius (1990) and assuming a Vector Autoregressive (VAR) model:

$$\Delta x_t = \Sigma \Gamma_i \Delta x_{t-i} + \Omega x_{t-1} + \mu + \in_t \quad ...(10)$$

where x_t is the vector of non-stationary variables $p \times 1$ and $i = 1, \ldots\ldots, k$.

Thus, the Johansen and Juselius procedure verifies if the coefficient matrix Ω captures the fundamentals of long-run equilibrium consistent with the non-stationary variables. As a result, if $0 < \text{rank } \Omega = r < p$, then there are matrices α and β of dimension $p \times r$, where $\Omega = \alpha \beta'$ and there are r cointegrating relations among elements of x_t, where α and β are cointegration vectors and error correction parameters, respectively.

Estimation Results

ADF and KPSS unit root tests were performed on the time series variables of the portfolio balance model, based on the peso-dollar exchange rate. The results are illustrated in Tables 1 and 2, respectively. Assuming the restrictions—intercept and trend in the cointegrating equation and no trend in the vector autoregression—trace and

Table 1: Augmented Dickey-Fuller Test Statistics for Unit Roots Based on Modified Akaike Information Criterion with Maximum Lag Length = 11

Variable	*t*-Statistic	Probability*
Peso-Dollar	–5.75	0
Monetary Base	–2.62	0.09
Domestic Bonds	–2.24	0.19
Foreign Net Claims	–5.57	0
US Interest Rate	–2.54	0.11

Note: * Mackinnon (1996) one-sided *p*-values. In terms of rejecting the null of stationarity, the ADF critical values are: –3.52, –2.90 and –2.59 for 1%, 5% and 10% levels of significance, respectively.

maximum eigenvalue tests were conducted, and each test finds one cointegrating vector at the 1% level and 5% level, implying a long-run relationship among the peso-dollar exchange rate (*e*), monetary base (*M*), bonds (*b*), net US dollar claims held by the Mexican residents *(f)*, and US interest rate (*r*). *Ceteris paribus*, the cointegration test (see Table 3) barely supports the portfolio balance model of exchange rate behavior.

Table 2: KPSS Unit Root Test Results

Variable	LM-statistic	S
Peso-Dollar	1.16	S
Monetary Base	1.21	S
Domestic Bonds	1.12	S
Foreign Net Claims	1.09	S
US Interest Rate	0.64	S at 1% CV only

Note: Null hypothesis assumes stationarity. Critical Values (CVs) are: 0.74, 0.46 and 0.35 for 1%, 5% and 10% levels of significance, respectively. LM is an abbreviation for Lagrange Multiplier, while S stands for stationary.

Table 3: Johansen and Juselius Multivariate Cointegration Test Results

NH	TT	CV 5%	CV 1%	NH	λMAX	CV 5%	CV 1%
$r = 0$**	102.72	87.31	96.58	$r = 0$**	42.76	37.52	42.36
$r \leq 1$	59.96	62.99	62.99	$r \leq 1$	27.35	31.46	36.65
$r \leq 2$	32.61	42.44	42.44	$r \leq 2$	15.21	25.54	30.34
$r \leq 3$	17.39	25.32	25.32	$r \leq 3$	12.55	18.96	23.65
$r \leq 4$	4.84	12.25	16.26	$r \leq 4$	4.84	12.25	16.26

Note: NH = Null Hypothesis; TT = Trace Test; CV = Critical Values; *r* = Number of cointegrating vectors in the system indicated by asterisk (*); λMAX = Maximum eigenvalue test; Osterwald Lenum (1992) CVs are at 5% and 1% levels of significance; * (**) denotes rejection of the hypothesis at 5% (1%) level.

In line with McNown and Wallace (1992), the cointegrating vectors for *e* (peso/dollar), *M* (domestic monetary base), *B* (domestic bonds), *F* (foreign net dollar claims) and *r* (US nominal interest rate) with time *t* have been normalized, by dividing by the coefficient on peso-dollar to approximately yield a restricted peso-dollar equation of the form:

$$e_t = -1.30\ M_t + 0.45\ B_t + 1.06\ F_t + 0\ r_t \qquad ...(11)$$
$$(0.17) \qquad (0.08) \qquad (0.09) \qquad (0.02)$$

Standard errors are noted in parentheses below the coefficients in Equation 11. All coefficients appear to have incorrect signs, except for domestic bonds, and are inconsistent with PBM. In contrast, all coefficients are statistically significant, except for the foreign (US) interest rate. This could be explained by the restriction of a single country model, where the interest rate is exogenously determined outside the base country (Mexico).

Conclusion

Based on trace and maximum eigenvalue test statistics, the evidence shows that under favorable restrictions, the PBM produces only one cointegrating vector, that is, one common (stochastic) trend (co-movement) in the system—as in Equation 6. As a result, if one assumes that cointegrating vectors are restrictions within the model and are imposed on the movement of the variables in the system, it is fair to conclude that the PBM provides a weak long-run relationship for the peso-dollar exchange rate, in line with most of the past studies. ❖

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