Chapter 6

INTERNATIONAL PARITY CONDITIONS AND MARKET RISK

THOMAS C. CHIANG, *Drexel University, USA*

Abstract

This article presents a set of international parity conditions based on consistent and efficient market behavior. We hypothesize that deviations from parity conditions in international bond, stock, and commodity markets are attributable mainly to relative equity premiums and real interest rate differentials. Testing this hypothesis against four European markets for the recent floating currency period, we gain supportive evidence. Moreover, the deviations of uncovered interest parity, international stock return parity, and purchasing power parity are not independent; the evidence suggests that deviations from the three parities are driven by two common factors: equity premium differential and real interest rate differential.

Keywords: international asset pricing; purchasing power parity; uncovered interest rate parity; exchange rate risk; equity premiums; real interest rate parity; unbiased forward rate hypothesis; Fisher equation; spot exchange rate; forward exchange rate

6.1. Introduction

In the past three decades of floating exchange rates, a substantial amount of research has been devoted to identifying linkages in international markets. The most prominent among these linkages are the uncovered interest parity (UIP), purchasing power parity (PPP), and international stock return parity (ISP).[1] The importance of these conditions stems not only from their significance as building blocks for international finance theory, but also from their application in guiding resource allocation in international money, capital, and goods markets.

Along with theoretical advancements, a large volume of empirical research has spawned an examination of the validity of these parities as applied to various market data. Hodrick (1987), Froot and Thaler (1990), Bekaert and Hodrick (1993), Lothian and Taylor (1997a,b), Engel (1996), and Rogoff (1996) provide summaries for various types of market behavior. A general consensus derived from these studies is that market imperfections, transaction costs, risk premiums, measurement errors, expectations errors, and the lack of more powerful statistical techniques are the main factors that frustrate parity conditions.

It is not our purpose to engage in an exhaustive review of all the parity conditions, nor is it our intention to provide a thorough empirical test. Rather, our goal is to provide a simple theoretical framework within which various asset return relationships can be illustrated and reasoned by established finance theories. From this framework, we are able to identify two common factors that contribute to deviations of the three parity conditions: equity premium differential and real interest rate

differential. The evidence based on data derived from four major European markets validates our arguments. Following this introductory section, Section 6.2 provides a simple and yet consistent market behavior to achieve the three parity conditions in the vein of a speculative efficient framework (Roll, 1979). Section 6.3 offers some empirical evidence for each parity condition. Section 6.4 provides a theoretical framework that relates deviations of the parity conditions to equity premiums and real interest rate differentials, and then reports the empirical evidence. Section 6.5 concludes the study. Further empirical evidence for additional parity conditions is offered in an appendix.

6.2. International Parity Conditions

Earlier contributions by Solnik (1978), Roll and Solnik (1979), and Roll (1979) laid a firm foundation for consolidating international parity conditions. Based on a few traditional assumptions, including the premises that both goods and financial markets are perfect and that there is an absence of transactional costs and barriers to trade, the "law of one price" implies that homogeneous goods or assets are expected to trade at the same exchange adjusted price in any two countries. Thus, international parity holds if expected asset returns claimed by investors are equal regardless of whether investments occur in domestic or foreign market.

Consider an economic agent engaging in a one-period investment who expects to claim x_{t+1} in domestic currency when the contract matures in the future. The agent then faces two options: invest in the domestic market or invest in the foreign market. The present values of these two investments are:

$$pv_{j,t} = \frac{x_{t+1}}{1 + R_{j,t+1}^e} \quad \text{and} \tag{6.1}$$

$$pv_{j,t}^* = \frac{x_{t+1}}{(1 + R_{j,t+1}^{*e})(1 + \Delta s_{t+1}^e)}, \tag{6.2}$$

where $R_{j,t+1}^e$ and $R_{j,t+1}^{*e}$ are expected returns in domestic and foreign markets for asset j, respectively; an asterisk denotes a foreign variable and a superscript e refers to an expectation operator; $\Delta s_{t+1}^e > 0$ denotes the expected rate of appreciation of the foreign currency; s_t is the spot exchange rate at time t, expressed as units of domestic currency per unit of foreign currency; and pv stands for the present value. An equilibrium condition leads to:

$$(1 + R_{j,t+1}^e) = (1 + R_{j,t+1}^{*e})(1 + \Delta s_{t+1}^e). \tag{6.3}$$

Applying "the law of one price" and aggregating over the entire market by taking natural logarithms throughout the equation allows us to write a general expression of an international parity relationship as:

$$R_{t+1}^e = R_{t+1}^{*e} + \Delta s_{t+1}^e, \tag{6.4}$$

where $\ln(1 + R_{t+1}^e) \cong R_{t+1}^e$. Notice that the variable x_{t+1}^e may be alternatively denoted by $E(x_{t+1}|I_t)$, indicating an expected value conditional on information available at time t. By defining $R_{t+1}^e = p_{t+1}^e - p_t$ and $\Delta s_{t+1}^e = s_{t+1}^e - s_t$, where p_{t+1}^e, p_t, s_{t+1}^e, and s_t are expressed in natural logarithms, the expected return, R_{t+1}^e, in this economy is simplified by the price appreciation of assets or goods.[2] Applying the indices of p_{t+1}^e and p_t to bond, equity, and commodity markets, Equation (6.4) implies three principal open-parity conditions as:

$$r_t = r_t^* + \Delta s_{t+1}^e, \tag{6.5}$$

$$R_{m,t+1}^e = R_{m,t+1}^{*e} + \Delta s_{t+1}^e, \text{ and} \tag{6.6}$$

$$\Delta p_{t+1}^e = \Delta p_{t+1}^{*e} + \Delta s_{t+1}^e, \tag{6.7}$$

where r_t is the short-term interest rate from time t to $t + 1$; $R_{m,t+1}^e$ denotes the expected return on the stock market; and Δp_{t+1}^e represents the expected inflation rate. The left-side variables of these equations are domestic expected returns, while the right-side variables are expected returns in foreign instruments plus expected appreciation of currency in the foreign country to engage investments.

The condition in Equation (6.5) is referred to as the uncovered interest rate parity (UIP), which

means that the risk-free return from a local invest-ment is equal to the comparable return in a foreign instrument plus an expected appreciation rate of the foreign currency. Since the outcome of the future spot rate is uncertain, an investor with risk aversion tends to sell the total proceeds (principal plus interest earned) in the forward market to hedge the risk. As a result, a covered version of interest rate parity is achieved as follows:

$$r_t = r_t^* + (f_t - s_t), \tag{6.8}$$

where f_t is the natural logarithm of the forward-exchange rate with a maturity that matches that of the instruments r_t and r_t^*. This equation states that a relatively higher interest rate in the domestic market must be offset by its currency discount in the forward market. Since all the parameters in Equation (6.8) are directly assessable, this condi-tion usually holds unless the financial market is imperfect or there are measurement errors for the data.

The parity in Equation (6.6) may be called the international stock return parity condition (ISP) – the return in the domestic equity market is expected to be equal to the exchange rate adjusted return in the foreign market.[3] For instance, an index return in the U.K. market is 10 percent, while the comparable index return in the U.S. market is 8 percent; the excess 2 percent return in the U.K. market will be offset by the same magni-tude of dollar appreciation. This condition is more complicated than that of UIP since it involves expectations for both stock returns and exchange rate changes. The expectations formation for stock returns and exchange rates are governed mainly by different sets of economic fundamentals and in-vestor sophistication (Albuquerque et al., 2004), although they might share some common factors. The volatile behavior of stock returns adds an additional risk to the parity condition.

The third condition, expressed in Equation (6.7), is the relative purchasing power parity, which states that the expected return speculated on domestic goods is equal to the expected return on the foreign goods market plus an expected foreign-currency gain. Alternatively, we can think about the fact that the speculative real re-turn to the domestic economic agent can be achieved by deflating the foreign nominal return $(\Delta p_{t+1}^{*e} + \Delta s_{t+1}^e)$ with the domestic inflation rate (Δp_{t+1}^e), i.e. $(\Delta p_{t+1}^{*e} + \Delta s_{t+1}^e) - \Delta p_{t+1}^e$. This expres-sion is a differenced form of the real exchange rate. In an efficient market, according to Roll (1979), such an excess return from speculation must be zero. In other words, $(\Delta p_{t+1}^{*e} + \Delta s_{t+1}^e) - \Delta p_{t+1}^e = 0$.

A common feature shared by these three princi-pal parities is that linkages between domestic re-turns and foreign-market returns all go through the channel of the foreign-exchange market. As a result, a shock in the currency market will create an exchange rate risk affecting three markets (goods, bonds, and stocks) simultaneously. More-over, if we view the exchange rate as an endogen-ous variable, the change in an exchange rate is seen to be associated with changes in relative returns, as reflected in the relative inflation differential, inter-est rate differential, and stock return differential. These relative return variables will be determined further by underlying supply and demand condi-tions in a general equilibrium framework.

Note that the relationships between pairwise variables such as $(\Delta p_{t+1}^e$ and $r_t)$ and $(r_t$ and $R_{m,t+1}^e)$ are well documented in the literature. First, the expected inflation rate in the goods market is linked to the return in the bond market through the Fisher equation. Formally, we write:

$$r_t = \bar{r}_{t+1}^e + \Delta p_{t+1}^e \tag{6.9}$$

and

$$r_t^* = \bar{r}_{t+1}^{*e} + \Delta p_{t+1}^{*e}, \tag{6.10}$$

where $\bar{r}_{t+1}^e$ and $\bar{r}_{t+1}^{*e}$ are expectations of real interest rates for the domestic and foreign countries, respectively. If both PPP and UIP hold, the expected real interest rate parity must be established, i.e.

$$\bar{r}_{t+1}^e = \bar{r}_{t+1}^{*e}. \tag{6.11}$$

The expected real interest rate parity implies that the expected real return on capital must be equal. It is of interest to point out that this condition holds independently of any exchange rate factors. Another implication of this parity condition is that $p_{t+1}^e - p_{t+1}^{*e} = r_t - r_t^*$, i.e. the interest rate differential reflects the expected inflation rate differential as inferred from Fama's efficient interest rate hypothesis (Fama, 1975). Due to the very nature of the information content involved in these markets, Marston (1997) observes that international-parity conditions, represented by a system formed by Equations (6.5), (6.7), and (6.11), are interrelated since their deviations from parity are driven by the same set of information, such as the interest rate differential and inflation rate differential. In particular:

$$\bar{r}_{t+1}^e - \bar{r}_{t+1}^{*e} = \left[r_t - \left(r_t^* + \Delta s_{t+1}^e\right)\right]$$
$$- \left[\Delta p_{t+1}^e - \left(\Delta p_{t+1}^{*e} + \Delta s_{t+1}^e\right)\right].$$

This equation states that an *ex ante* real interest rate differential is associated with deviations of UIP and PPP[4]; it reveals no direct connection with stock return differentials.

Second, the return in the bond market is linked to the return in the stock market through the Capital Asset Pricing Model (CAPM) and term-structure relationship (Campbell, 1987). In the international context, coexistence of a UIP and ISP must lead to the equity premium parity as:

$$R_{m,t+1}^e - r_t = R_{m,t+1}^{*e} - r_t^*. \tag{6.12}$$

It suggests that excess returns in international equity markets must be equal. Again, exchange rate variations play no explicit role in explaining the equity premium differential unless we want to consider the real term. The international CAPM implies that any divergence in the equity premium differential must reflect the risk differential (betas) associated with two markets. To decompose the equity premium differential, we yield:

$$\left(R_{m,t+1}^e - r_t\right) - \left(R_{m,t+1}^{*e} - r_t^*\right) = \left[R_{m,t+1}^e - \left(R_{m,t+1}^{*e} + \Delta s_{t+1}^e\right)\right]$$
$$- \left[r_t - \left(r_t^* + \Delta s_{t+1}^e\right)\right]. \tag{6.13}$$

This equation states that the disparity in the equity premiums between two markets is associated with deviations of the stock return parity and the UIP, and has no direct connection with the inflation rate differential.[5]

Before we move to the next section, it is useful to summarize the arguments that we have developed up to this point. Based on consistent market behavior, we have constructed a global financial market system in which international markets are linked through the PPP, UIP, and ISP for goods, bonds, and stocks, while the domestic goods market is linked to bond markets through the Fisher equation by a real interest rate, and the bond market is linked to the stock market via the CAPM by equity premiums. Any shocks to the system could directly or indirectly disturb the equilibrium conditions in the goods, bond, or stock markets through changes in relative asset returns. These changes, in turn, could alter equity premium differentials and real interest rate differentials, causing international capital movements and trade flows. As a result, we observe that deviations of parity conditions are associated with excess-return differentials. Checking into the factors behind the excess-return differentials, we perceive that excess returns reflect mainly compensation for excess risk associated with stock returns, inflation, and exchange rate variations.

6.3. Empirical Evidence

6.3.1. Data

Although a considerable amount of empirical research has been conducted in examining international parity conditions, the approaches utilized have varied in terms of countries, time periods, frequency, model specifications, and underlying theories, among other factors. To obtain a consistent comparison, we shall provide a unified approach by using a consistent data set to examine four major European countries, consisting of the United Kingdom (UK), Germany (GM), France (FR), and Switzerland (SW), and

employing the United States (US) as a reference country (with an asterisk in our notation).

In the empirical estimations, we treat the U.S. market as a price maker due to its relatively dominant size and effectiveness in information processing. As such, it allows us to examine the impact of the U.S. market on each of the four European markets. This study uses end-of-the-month spot exchange rates and one-month forward exchange rates, with the exchange rates expressed as prices of the local currency per unit of the U.S. dollar. Short-term interest rates are measured by the one-month euro-currency deposit rates for each country. These euro-currency deposit rates have been widely used in empirical studies due to their homogeneous features and their convenience in comparing across markets. The stock price indices for the five markets are the FTSE 100 (United Kingdom), CAC 40 (France), Dax 30 (Germany), Swiss Market Price (Switzerland), and S&P 500 Index (United States). Inflation rates are measured by the natural log difference of consumer price indices for the countries under investigation. All the rates are measured on a monthly basis, as dictated by the fact that consumer price indices are available only on a monthly basis.

In the meantime, employing monthly observations allows us to construct variables such as forward-exchange rates and short-term interest rates having the same maturity without experiencing a data overlap problem. Since stock indices for France and Switzerland are available only from late 1988 and the Basle Accord was effective at about the same time period, our empirical analysis is confined to the sample period from January 1989 through December 2001.[6] All data were taken from *Data Stream International*.

6.3.2. Evidence on the Parity Conditions

The goal of the empirical exercise in this section is to highlight the main features of each parity condition and to present the findings in a consistent fashion. As noted by Roll (1979), international parity conditions provide no specific guidance to the direction and extent of causation between relative returns and exchange rate changes. Placing the dependent and independent variables on each side of the test equation varies among different researchers. In this section, we shall keep the estimated equation consistent with the model forms expressed by Equations (6.5) through (6.7). In order to achieve a consistent estimator, procedures adopted by White (1980) and Newey and West (1987) have been used in estimating the following set of regressions:

uncovered interest rate parity:

$$r_t = \beta_0 + \beta_1 \left(r_t^* + \Delta s_{t+1} \right) + \varepsilon_t, \tag{6.14}$$

international stock return parity:

$$R_{m,t+1} = \beta_0 + \beta_1 \left(R_{m,t+1}^* + \Delta s_{t+1} \right) + \varepsilon_{t+1}, \tag{6.15}$$

and

purchasing power parity:

$$\Delta p_{t+1} = \beta_0 + \beta_1 \left(\Delta p_{t+1}^* + \Delta s_{t+1} \right) + \varepsilon_{t+1}, \tag{6.16}$$

where β_0 and β_1 are constant coefficients and ε_t is an error term. Since expectations are not directly measurable, we impose a rational expectations framework by using realizations of the variables as proxy.[7] Because our main concern is to examine a parity condition, a joint test to investigate the null hypothesis $(\beta_0 \ \beta_1)' = (0 \ 1)'$ will also be reported. If the null hypothesis cannot be rejected by the data, a parity condition holds. The estimates for three primary international-parity conditions are reported in Panels A, B, and C of Table 6.1.

Consistent with existing evidence (Solnik, 1982; Mishkin, 1984), none of the test equations gain much support from the data. The joint tests suggest that the null hypothesis of $(\beta_0 \ \beta_1)' = (0 \ 1)'$ is rejected uniformly. In particular, the estimated slopes of the interest rate parity in Panel A are negligible and statistically insignificant. These results, together with the low R-squares of the test equations, render no supportive evidence for the equality of the two exchange rate adjusted interest rates.

Table 6.1. Estimates of international parity conditions

Country	β_0	β_1	R^2	DW	Joint test
A. Uncovered Interest Rate Parity: $r_t = \beta_0 + \beta_1(r_t^* + \Delta s_{t+1}) + \varepsilon_t$					
UK	0.0066*	0.001	0.000	0.010	1.521e+04
	(28.96)	(0.169)			(0.000)
FR	0.0053*	−0.007	0.008	0.063	1.988e+04
	(27.56)	(0.923)			(0.000)
GM	0.0046*	−0.007	0.012	0.029	3.044e+04
	(29.42)	(1.190)			(0.000)
SW	0.0036*	−0.009	0.017	0.041	2.806e+04
	(19.07)	(1.510)			(0.000)
B. International Stock Return Parity: $R_{m,t+1} = \beta_0 + \beta_1(R_{m,t+1}^* + \Delta s_{t+1}) + \varepsilon_{t+1}$					
UK	−0.0001	0.625*	0.518	2.160	55.526
	(0.029)	(12.10)			(0.000)
FR	−0.0001	0.685*	0.425	2.233	26.501
	(0.022)	(10.49)			(0.000)
GM	0.0017	0.683*	0.360	2.183	16.139
	(0.395)	(7.837)			(0.000)
SW	0.0036	0.652*	0.475	2.023	24.443
	(1.094)	(9.222)			(0.000)
C. Purchasing Power Parity: $\Delta p_{t+1} = \beta_0 + \beta_1(\Delta p_{t+1}^* + \Delta s_{t+1}) + \varepsilon_{t+1}$					
UK	0.0028*	0.020	0.014	1.492	5206.828
	(7.461)	(1.448)			(0.000)
FR	0.0015*	0.008	0.014	1.674	3.553e+04
	(8.435)	(1.555)			(0.000)
GM	0.0019*	0.013	0.017	1.577	1.495e+04
	(7.870)	(1.589)			(0.000)
SW	0.0017*	0.008	0.007	1.729	1.608e+04
	(6.776)	(1.002)			(0.000)

a. The *indicates statistically significant difference from zero at the 1% level.

b. The numbers in parentheses are absolute values of the t-statistics.

c. DW denotes the Durbin-Watson statistic.

d. The joint test is to test $(\beta_0 \; \beta_1)' = (0 \; 1)'$; the joint test is the estimated statistic of $\chi^2(2)$ distribution with 2 degrees of freedom and the numbers in parentheses are the significance levels.

The results for estimating the ISP are presented in Panel B. The estimated coefficients indicate that correlations with the U.S. market are positive and statistically significant.[8] The values of the coefficients vary within a very narrow range, from 0.625 to 0.685 across the different European markets, supporting the efficient aspect of co-movements of international stock returns. However, the test results are still unable to provide supporting evidence for the null hypothesis $((\beta_0 \; \beta_1)' = (0 \; 1)'$. The rejection of the null hypothesis implies the violation of ISP. This is understandable since, in addition to preference differences and possible asymmetrical information (Frankel and Schmukler, 2000), the index composition varies among the nations, and the underlying industries are subject to their inherent, different volatility and price/interest rate sensibility (Roll, 1992).

Panel C reports estimates of PPP relative to the United States. Again, the estimated slopes are far from unity. None of the R-squares exceed the 2 percent level. This result is very comparable to those reported by Krugman (1978), Roll (1979), Frenkel (1981), Solnik (1982), and Mishkin (1984), among others.[9] This finding is not surprising since our data sample period is relatively short, while most of the evidence in favor of the PPP employs much longer data spans. For example, Abuaf and Jorion (1990), Lothian and Taylor (1997b), Jorion and Sweeney (1996), Cheung and Lai (1993, 1998), Fleissig and Strauss (2000), and Baum et al. (2001) are able to find evidence of mean reversion in deviations from PPP.

The failure of PPP in the short run is perceivable, since in the very nature of price behavior commodity prices are relatively sticky and exchange rates behave more or less like asset prices. Thus, the change in exchange rates as they adjust to news appears to be more sensitive and effective than that of commodity prices. In addition, failure to achieve PPP in the short run may also result from variation in the composition of consumer price indices across different countries (Patel, 1990), differing productivity shocks (Fisher and Park, 1991), and measurement errors in prices from aggregation (Taylor, 1988; Cheung and Lai, 1993).[10]

6.4. Deviations from Parity Conditions and Risk

6.4.1. Sources of Deviations

The analysis in Section 6.2 conveys two important messages: international-parity conditions are inter-related and departure from parity conditions is commonly associated with real interest rate differentials and equity premium differentials. Although some earlier researchers (Korajczyk, 1985; Levine, 1989; Huang, 1990; Chiang, 1991; Korajczyk and Viallet, 1992) recognize these key elements, their studies merely focus on a single parity (Hodrick, 1987) or a smaller set of parity conditions (Mishkin, 1984; Marston, 1997); an explicit role of inter-national stock markets is excluded from their analyses. The current study extends previous research by incorporating the linkage of stock markets into an integrated financial system. This research is bound to provide more insight into a multimarket analysis of international asset allocation, offering a broader spectrum of portfolio behavior in a general equilibrium framework.

To illustrate, assuming that expected changes in spot exchange rates can be predicted by a linear relation of the expected inflation rate differential, short-term interest rate differential, and expected national stock return differential as implied by the three parity conditions, we write:

$$\Delta s_{t+1}^e = \alpha(\Delta p_{t+1}^e - \Delta p_{t+1}^{*e}) + \eta(r_t - r_t^*) \\ + \gamma(R_{m,t+1}^e - R_{m,t+1}^{*e}). \quad (6.17)$$

The arguments on the right side of Equation (6.17) are considered to be the key variables that affect international transactions involving a na-tion's balance of payments. In particular, the variable of the expected inflation differential dic-tates trade flows in a country's current account,[11] while the other two arguments govern capital flows involving bonds and stocks in the capital accounts. The weight of each component will be reflected, respectively, in the parameters α, η, and γ; the restriction $\alpha + \eta + \gamma = 1$ is constrained by the sum of components of the balance of pay-ments. Subtracting $(r_t - r_t^*)$ from both sides of

Equation (6.17) and rearranging the variables yields:[12, 13]

$$\Delta s_{t+1}^e - (r_t - r_t^*) = \gamma[\ R_{m,t+1}^e - r_t) - (R_{m,t+1}^{*e} - r_t^*)] \\ + \alpha[\ \Delta p_{t+1}^e - r_t) - (\Delta p_{t+1}^{*e} - r_t^*)] \quad (6.18)$$

An important message emerging from Equation (6.18) is that the deviation from UIP is essentially due to the excess relative returns prevailing in stock and goods markets as compared with the risk-free rate in the bond markets. A study by Giovannini and Jorion (1987) finds evidence that foreign exchange-risk premiums are correlated with interest rates. In fact, the information from Equation (6.18) indicates that the sources of uncertainty arise from the stochastic nature of discount factors associated with stock returns and inflation rates relative to interest rates. Using Equations (6.9) and (6.10) and defining $\delta_{t+1}^e = \Delta s_{t+1}^e - (r_t - r_t^*)$, we obtain:

$$\delta_{t+1}^e = \gamma[\ R_{m,t+1}^e - r_t) - (R_{m,t+1}^{*e} - r_t^*)] - \alpha(\bar{r}_{t+1}^e - \bar{r}_{t+1}^{*e}). \quad (6.19)$$

The *ex ante* excess depreciation of a national currency beyond its interest rate parity condition, where δ_{t+1}^e is positive, is seen to be associated with relatively higher risk in stock returns and/or infla-tion variations, reflected in a relatively higher equity premium and/or lower expected real inter-est rate differential. These parameters are the main factors that cause international capital flows. Thus, violations of UIP correspond to inter-national capital flows.

Comparing Equation (6.19) with existing litera-ture, it is easy to see that the real interest rate differential hypothesis proposed by Korajczyk (1985) is equivalent to requiring that $\gamma = 0$, while the equity premium differential hypothesis sug-gested by Chiang (1991) is to impose the restriction that $\alpha = 0$. Of course, the UIP holds when $\alpha = \gamma = 0$.

Next, let us consider the deviation of the ISP, defined as $\phi_{t+1}^e = \Delta s_{t+1}^e - (R_{m,t+1}^e - R_{m,t+1}^{*e})$. This expression can be further decomposed as:

$$\phi_{t+1}^e = [\Delta s_{t+1}^e - (r_t - r_t^*)] - [\ R_{m,t+1}^e - r_t) - (R_{m,t+1}^{*e} - r_t^*)].$$

Using the information in Equation (6.18), we then derive:

$$\phi_{t+1}^e = -(1-\gamma)[\ R_{m,t+1}^e - r_t) - (R_{m,t+1}^{*e} - r_t^*)]$$
$$- \alpha(\bar{r}_{t+1}^e - \bar{r}_{t+1}^{*e}). \tag{6.20}$$

Equation (6.20) indicates that the deviation of the ISP is attributable to the equity premium differential and real interest rate differential. By the same token, it can be shown that:

$$\theta_{t+1}^e = \gamma[\ R_{m,t+1}^e - r_t) - (R_{m,t+1}^{*e} - r_t^*)]$$
$$+ (1-\alpha)(\bar{r}_{t+1}^e - \bar{r}_{t+1}^{*e}), \tag{6.21}$$

where $\theta_{t+1}^e = \Delta s_{t+1}^e - (\Delta p_{t+1}^e - \Delta p_{t+1}^{*e})$, which denotes the *ex ante* value of the deviation of the relative PPP. By checking the right-hand side variables of Equation (6.19) through Equation (6.21), we observe that departures from parity conditions are all attributable to the same factors: the equity premium differential and the real interest rate differential.[14] This is equivalent to saying that the following conditions must be satisfied in order for these parity conditions to hold: expected real returns on bonds are equal across markets and expected excess returns in national equity markets are equal across trading countries. The emphasis on the real interest rate parity to explain the departure of the three parities has been well documented (Mishkin, 1984; Marston, 1997). However, our analysis identifies an additional factor, the equity premium differential, in interpreting the deviations of the three parities.

Another feature of our model is that deviations from parity conditions for the three markets are not independent. The interdependency among them is rooted essentially in the interdependency of financial markets; dynamic adjustments are sensitive to differences in relative asset returns in an integrated and united financial system. From a policy point of view, a parametric change in interest rates made by monetary authorities will create a gap in both the equity premium differential and the real interest rate differential. These would cause investors to reallocate their portfolios, thereby in-

ducing capital and trade flows, and hence disturbing the parity conditions.[15]

6.4.2. Evidence for Deviations from Parity Conditions

In this section, we present evidence for estimating deviations from the three international parity conditions. The estimated equation is written in the following regression form:

$$y_{t+1} = \beta_0 + \beta_1[\ R_{m,t+1} - r_t) - (R_{m,t+1}^* - r_t^*)]$$
$$+ \beta_2(\bar{r}_{t+1} - \bar{r}_{t+1}^*) + \varepsilon_{t+1}, \tag{6.22}$$

where y_{t+1} applies to δ_{t+1}, ϕ_{t+1}, or θ_{t+1}; β_0 is an intercept term; β_1 and β_2 are constant parameters; and ε_{t+1} is the random error term. The restrictions of β_1 and β_2 for each parity condition follow the coefficients contained in Equation (6.19) through Equation (6.21).

Utilizing the same set of data presented in Section 6.2.2, the consistent estimates for the four European markets are reported in Table 6.2. As the theory predicts, all the estimated coefficients have the anticipated signs and are statistically significant. The only exception is the variable of the real interest rate differential in PPP for the United Kingdom, where the coefficient is not significant. In terms of explanatory power, the test equations perform reasonably well. The average values of R^2 are: 10 percent, 13 percent, and 56 percent for PPP, UIP, and ISP conditions, respectively. The Durbin–Watson statistics in Table 6.2 do not indicate first-order serial correlation. Taking these statistics together, the null hypothesis that deviations from parity conditions are independent of the equity premium differential and real interest rate differential is decisively rejected.

The results also show that, as the theory predicts, the estimated coefficient of the real interest rate differential, β_2, produces an identical estimated value for both the UIP and ISP equations; it also holds true for the estimated coefficient of the equity premium differential, β_1, in the UIP and PPP equations. The evidence thus suggests that

Table 6.2. Estimates of deviations from parity conditions

Country	β_0	β_1	β_2	R^2	DW
A. Deviation from the Uncovered Interest-Rate Parity					
UK	0.0023	0.297*	−1.088*	0.125	1.838
	(1.024)	(2.993)	(2.424)		
GM	0.0026	0.131*	−2.666*	0.124	1.871
	(1.101)	(2.901)	(3.700)		
FR	0.0048*	0.174*	−2.459*	0.138	2.014
	(1.975)	(3.542)	(3.042)		
SW	0.0002	0.232*	−2.709*	0.145	1.908
	(0.069)	(3.642)	(3.520)		
B. Deviation from the International Stock-Return Parity					
UK	0.0023	−0.703*	−1.088*	0.427	1.838
	(0.960)	(6.328)	(2.336)		
GM	0.0026	−0.869*	−2.666*	0.691	1.871
	(1.085)	(18.28)	(3.729)		
FR	0.0048*	−0.826*	−2.455*	0.607	2.014
	(2.075)	(15.52)	(2.975)		
SW	0.0002	−0.768*	−2.709*	0.503	1.908
	(0.067)	(11.57)	(3.494)		
C. Deviation from the Relative Purchasing-Power Parity					
UK	0.0023	0.297*	−0.088	0.106	1.838
	(1.000)	(2.993)	(0.195)		
GM	0.0026	0.131*	−1.666*	0.079	1.871
	(1.064)	(2.901)	(2.312)		
FR	0.0047*	0.174*	−1.455*	0.096	2.014
	(1.975)	(3.542)	(1.803)		
SW	0.0002	0.232*	−1.709*	0.106	1.908
	(0.063)	(3.642)	(2.221)		

a. Sample period: January 1989–October 2001.
b. Numbers in parentheses are absolute value of the *t*-statistics. The **,* and *indicate statistically significant difference from zero at the 1%,5%, and 10% levels for the *t*-ratios, respectively.*
c. DW denotes the Durbin-Watson statistic.

deviations for the three parity conditions are not only interdependent, but also share the same set of information. The results are consistent with the evidence provided by Mishkin (1984) and Marston (1997). However, the information being used in our empirical study is derived directly from the theory. A special feature of this study is that, in addition to real interest rate differentials, depar-

tures from parity conditions are found to be driven by equity premium differentials. It can be concluded that the effect of the risk premium not only presents in pricing domestic equity risk, but is also used in pricing relative risk, and thus is dictating international capital flows.

6.5. Conclusion

This study presents a consistent market behavior framework to establish three parity conditions in bond, stock, and goods markets. Due to the existence of inflation risk and exchange rate risk, earlier studies recognize the significance of a real interest rate differential as a key element in explaining deviations of interest rate parity or PPP. However, the real interest rate differential does not seem adequate to explain capital movements involving the trading of international stocks. On the other hand, the equity premium differential hypothesis highlights the relative risk factor in equity markets; however, inflation rate uncertainty has been ignored. In the current model, both the real interest rate differential and the equity premium differential are used to explain the departures. The statistical results derived from the four European markets relative to the United States validate our argument. The evidence further suggests that deviations from the three international parity conditions are driven by common factors as represented by the equity premium differentials and real interest rate differentials. The intriguing informational content of these differentials is that they reflect not only relative risk across countries, but also relative risk as compared with fixed-income investment.

Appendix

This Appendix provides additional empirical evidence on the popular parity conditions prevailing in international markets. The regression models are:

A. Efficient Interest Rate Parity:
$$s_{t+1} - \left(r_t - r_t^*\right) = \beta_0 + \beta_1 s_t + \varepsilon_{t+1}$$

B. Efficient International Stock Parity:
$$s_{t+1} - \left(R_{m,t+1} - R^*_{m,t+1}\right) = \beta_0 + \beta_1 s_t + \varepsilon_{t+1}$$

C. Efficient Purchasing Power Parity:
$$s_{t+1} - \left(\Delta p_{t+1} - \Delta p^*_{t+1}\right) = \beta_0 + \beta_1 s_t + \varepsilon_{t+1}$$

D. International Fama Parity:
$$\left(\Delta p_{t+1} - \Delta p^*_{t+1}\right) = \beta_0 + \beta_1 \left(r_t - r^*_t\right) + \varepsilon_{t+1}$$

E. Real Interest Rate Parity:
$$\bar{r}_{t+1} = \beta_0 + \beta_1 \bar{r}^*_{t+1} + \varepsilon_{t+1}$$

F. Equity Premium Parity:
$$R_{m,t+1} - r_t = \beta_0 + \beta_1 \left(R^*_{m,t+1} - r^*_t\right) + \varepsilon_{t+1}$$

G. Covered Interest Rate Parity:
$$r_t - r^*_t = \beta_0 + \beta_1 (f_t - s_t) + \varepsilon_t$$

H. Unbiased Forward-Rate Hypothesis I:
$$f_t - s_{t+1} = \beta_0 + \beta_1 (f_t - s_t) + \varepsilon_{t+1}$$

I. Unbiased Forward-Rate Hypothesis II:
$$s_{t+1} - s_t = \beta'_0 + \beta'_1 (f_t - s_t) + \varepsilon'_{t+1}$$

Models A through C are efficient versions of the UIP, ISP, and PPP proposed by Roll (1979). An efficient market implies that $\beta_0 = 0$ and $\beta_1 = 1$. The evidence presented in Panels A, B, and C of Table 6.3 is quite consistent with the efficient nature of the spot exchange rate, suggesting that all

Table 6.3. Estimates of international parity conditions

Country	β_0	β_1	R^2	DW	Joint Test
A. Efficient Interest-Rate Parity: $s_{t+1} - (r_t - r^*_t) = \beta_0 + \beta_1 s_t + \varepsilon_{t+1}$					
UK	−0.0315	0.933*	0.858	1.692	2.556
	(1.553)	(20.87)			(0.279)
FR	0.0452	0.975*	0.934	1.848	1.558
	(1.128)	(43.14)			(0.459)
GM	0.0123	0.980*	0.941	1.774	1.153
	(1.027)	(45.83)			(0.562)
SW	0.0162	0.958*	0.993	1.721	3.065
	(1.678)	(40.19)			(0.216)
B. Efficient International-Stock Parity: $s_{t+1} - \left(R_{m,t+1} - R^*_{m,t+1}\right) = \beta_0 + \beta_1 s_t + \varepsilon_{t+1}$					
UK	−0.0281	0.943*	0.857	1.716	3.100
	(1.359)	(20.68)			(0.212)
FR	0.0316	0.982*	0.932	1.800	0.594
	(0.770)	(42.42)			(0.743)
GM	0.0097	0.984*	0.939	1.747	0.667
	(0.800)	(45.37)			(0.716)

Table 6.3. (*Continued*)

Country	β_0	β_1	R^2	DW	Joint Test
SW	0.0167	0.958*	0.912	1.679	3.026
	(1.706)	(39.35)			(0.220)
C. Efficient Purchasing Power Parity: $s_{t+1} - \left(\Delta p_{t+1} - \Delta p^*_{t+1}\right) = \beta_0 + \beta_1 s_t + \varepsilon_{t+1}$					
UK	−0.0357*	0.918*	0.789	2.095	6.127
	(2.221)	(26.52)			(0.047)
FR	0.1003*	0.945*	0.853	2.317	3.677
	(1.833)	(30.59)			(0.159)
GM	0.0226	0.961*	0.841	2.207	1.879
	(1.365)	(31.36)			(0.391)
SW	0.0160	0.954*	0.857	2.088	1.823
	(1.264)	(28.22)			(0.402)
D. International Fama Parity: $\left(\Delta p_{t+1} - \Delta p^*_{t+1}\right) = \beta_0 + \beta_1 \left(r_t - r^*_t\right) + \varepsilon_{t+1}$					
UK	−0.0003	0.339	0.021	1.898	20.754
	(0.587)	(1.517)			(0.000)
FR	−0.0009*	0.070	0.007	2.103	335.354
	(5.056)	(1.055)			(0.000)
GM	−0.0005*	0.384*	0.081	1.760	25.218
	(2.040)	(3.106)			(0.000)
SW	−0.0004	0.311*	0.058	2.057	57.229
	(1.357)	(3.015)			(0.000)
E. Real Interest-Rate Parity: $\bar{r}_{r+1} = \beta_0 + \beta_1 \bar{r}^*_{t+1} + \varepsilon_{t+1}$					
UK	0.0032*	0.249	0.013	1.660	28.741
	(5.267)	(1.478)			(0.000)
FR	0.0032*	0.217*	0.028	1.014	91.299
	(9.547)	(2.092)			(0.000)
GM	0.0021*	0.253*	0.032	1.570	42.080
	(5.404)	(2.192)			(0.000)
SW	0.0012*	0.263*	0.035	1.869	57.168
	(3.958)	(2.672)			(0.000)
F. Equity-Premium Parity: $R_{m,t+1} - r_t = \beta_0 + \beta_1 \left(R^*_{m,t+1} - r^*_t\right) + \varepsilon_{t+1}$					
UK	−0.0038*	0.793*	0.525	2.028	32.905
	(2.579)	(13.78)			(0.000)
FR	−0.0024	0.907*	0.401	2.092	2.010
	(0.667)	(10.75)			(0.366)
GM	−0.0000	0.921*	0.357	2.051	0.495
	(0.001)	(7.827)			(0.781)
SW	0.0021	0.937*	0.477	1.957	0.639
	(0.650)	(9.600)			(0.726)
G. Covered Interest Rate Parity: $r_t - r^*_t = \beta_0 + \beta_1 (f_t - s_t) + \varepsilon_t$					
UK	0.0002	1.018*	0.810	1.847	11.045
	(1.300)	(28.52)			(0.004)
FR	0.0001	1.025*	0.887	2.015	8.607
	(0.997)	(56.17)			(0.014)

Table 6.3. (*Continued*)

Country	β_0	β_1	R^2	DW	Joint Test
GM	0.0000	1.004*	0.854	2.001	0.075
	(0.161)	(28.24)			(0.963)
SW	0.0000	0.988*	0.830	1.679	0.144
	(0.124)	(25.63)			(0.931)

H. Unbiased Forward-Rate Hypothesis I:
$f_t - s_{t+1} = \beta_0 + \beta_1(f_t - s_t) + \varepsilon_{t+1}$

Country	β_0	β_1	R^2	DW	Joint Test
UK	0.0007	0.510	0.001	1.737	0.127
	(0.217)	(0.369)			(0.938)
FR	0.0007	1.057	0.008	1.902	0.065
	(0.219)	(0.875)			(0.968)
GM	0.0005	1.210	0.010	1.818	0.064
	(0.184)	(1.007)			(0.969)
SW	0.0017	2.182*	0.026	1.742	6.455
	(0.486)	(1.704)			(0.040)

I. Unbiased Forward-Rate Hypothesis II:
$s_{t+1} - s_t = \beta_0' + \beta_1'(f_t - s_t) + \varepsilon_{t+1}$

Country	β_0	β_1	R^2	DW	Joint Test
UK	−0.0007	0.490	0.001	1.737	0.881
	(0.287)	(0.372)			(0.644)
FR	−0.0007	−0.057	0.000	1.902	1.074
	(0.219)	(0.047)			(0.584)
GM	−0.0005	−0.210	0.000	1.818	1.042
	(0.184)	(0.175)			(0.594)
SW	−0.0017	−1.182	0.008	1.742	2.942
	(0.486)	(0.923)			(0.230)

a. The numbers in parentheses are absolute values of the *t*-statistics.
b. The **,*and †indicate statistically significant difference from zero at the 1%,5%,and 10% levels for the *t*-ratios, respectively.
c. DW denotes the Durbin-Watson statistic.
d. The joint test is to test $(\beta_0 \; \beta_1)' = (0 \; 1)'$; the joint test is the statistics of the χ^2 (2) distribution with 2 degrees of freedom and the numbers in parentheses are the significance levels.

information concerning future exchange rate adjusted return differentials is incorporated into the current spot exchange rate. The supportive evidence holds true for all three parity conditions. However, it should be pointed out that specifying the model in this form tends to lead to not rejecting the efficient-market hypothesis. In particular, Roll's specification is more or less to test spot exchange rate efficiency rather than to test parity conditions. If we check the estimated equations, the series of return differentials is stationary and its magnitude is rather small as compared

with the level of exchange rates. As a result, the dominance of the lagged exchange rate variable in the test equation gives rise to a high *R*-square.

Next let us consider the efficient-market hypothesis for U.S. Treasury bills. Fama (1975) argues that the one-month nominal interest rate can be viewed as a predictor of the inflation rate. Applying this notion in international markets implies that the nominal interest rate differential can be used to predict the inflation rate differential. The evidence in Panel D does provide some predictive evidence for the German and Swiss markets. However, the efficient-market hypothesis is rejected in the international context. This also casts doubt on the validity of real interest rate parity. The results from Panel E confirm this point; the correlations of real interest rates for three of the four markets are positive and statistically significant, but the parity condition still fails. The reasons advanced by Koraczyk (1985) are the existence of risk premiums and market imperfections.

In the text as well as in the finance literature, we are concerned with the relationship between stock equity premiums. The evidence derived from Panel F indicates that the correlation for each country is highly significant, although we are unable to find strong support for the parity condition. If we view the U.S. equity premium as a proxy for the world-portfolio premium, the slope coefficient for each estimated equation can be treated virtually as a beta coefficient in light of the CAPM framework.[16]

Panel G contains the results for testing covered interest rate parity. Since all the variables in this equation are directly observable and readily assessed by economic agents, the estimated equation is closest to the parity condition. It is generally recognized that arbitrage profit derived from this equation is very negligible, if there is any. Thus, any gap in this equation must reflect country risk (Frankel and MacArthur, 1988), transaction costs (Fratianni and Wakeman, 1982), or simply data errors.

The forward premium (or discount) has been commonly used to predict foreign-exchange risk premiums as well as currency depreciation as

denoted by the equations in Panels H and I. The unbiasedness hypothesis in Panel H requires that $\beta_0 = \beta_1 = 0$; however, the unbiasedness hypothesis in Panel I implies that $\beta_0' = 0$ and $\beta_1' = 1$ (Hansen and Hodrick, 1980; Cornell, 1989; Bekaert and Hodrick, 1993). Fama (1984) notes the complementarity of the regressions in Panels H and I and suggests that $\beta_0 = -\beta_0'$, that $\beta_1 = 1 - \beta_1'$, and that $\varepsilon_{t+1} = -\varepsilon_{t+1}'$. Consistent with the existing literature, the evidence presented in Panel H and Panel I apparently rejects the unbiasedness hypothesis.[17] However, the complementary nature of the coefficients appears consistent with Fama's argument. The puzzle entailed in this set of equations is that the estimated slope in the Panel I equation is typically negative. This interpretation has been attributable to risk premium (Fama, 1984; Giovannini and Jorion, 1987; Hodrick, 1987; Mark, 1988; and Jiang and Chiang, 2000), forecast errors (Froot and Thaler, 1990), and regime shifting (Chiang, 1988; Bekaert and Hodrick, 1993).

NOTES

1. Other parity conditions, including an unbiased forward-rate hypothesis, covered interest rate parity, and real interest rate parity will be discussed at a later point. A formal derivation of these parity conditions can be achieved by employing a consumption-based approach in the Lucas framework (Lucas, 1982; Roll and Solnik, 1979; Chiang and Trinidad, 1997; Cochrane, 2001).
2. In order to simplify the analysis, we ignore the coupon payment (c_{t+1}) to the bond and the dividend payment (d_{t+1}) to the stock by assuming $c_{t+1} = d_{t+1} = 0$. Different tax effects are also abstracted from the calculations. We can link the current model to a Lucas – Cochrane framework by setting $pv_{jt} = p_t$. Thus, $p_t = E(m_{t+1}x_{t+1})$, where p_t is the current asset price; m_{t+1} is the stochastic discount factor; and x_{t+1} is the payoff at time $t + 1$. By setting $x_{t+1} = p_{t+1}$, we have:
$$p_t = \frac{1}{R_{t+1}^e} E_t(p_{t+1}).$$
3. An equilibrium relationship between asset returns based on a continuous-time model can be found in Stulz (1981).
4. Frankel and MacArthur (1988) further decompose UIP into two parts: the covered interest differential and the currency risk premium. Thus, Equation (6.11) becomes:
$$\bar{r}_{t+1}^e - \bar{r}_{t+1}^{*e} = \left[(r_t - r_t^*) - (f_t - s_t)\right] + \left[(f_t - s_t) - \Delta s_{t+1}^e\right] + \left[\Delta s_{t+1}^e - (\Delta p_{t+1}^e - \Delta p_{t+1}^{*e})\right].$$

The first term on the right-hand side of this expression is a deviation of the covered interest rate, which is considered a country premium; the second term is the currency risk premium; and the third term is the change in the real exchange rate. Branson (1988) interprets these three components as the measure of a lack of integration of the bond, currency, and goods markets, respectively.
5. A systematic relationship between stock returns and inflation can be found in Stulz's study (1986).
6. The Basle Accord was a landmark regulatory agreement affecting international banking. The agreement was reached on July 12, 1988. Its goals were to reduce the risk of the international banking system, and to minimize competitive inequality due to differences among national banking and capital regulations (Wagster, 1996).
7. Using realizations to proxy expectations could generate an error-in-the-variables problem. In fact, the formation of expectations has long been a challenging issue in empirical estimations. Expectations range from rational expectations, distributed lag expectations, adaptive expectations, regressive expectations, and random walk to expert expectations based on survey data (Frankel and Froot, 1987).
8. In the finance literature, expected returns are related to risk, which can be modeled by ARCH or GARCH in mean (Baillie and Bollerslev, 1990). Also, many recent studies incorporate conditional variance and covariance into various models to examine the relationship between excess returns and risk (Domowitz and Hakkio, 1985; Hodrick, 1987; Bekaert and Hodrick, 1993; Hu, 1997; De Santis and Gerard, 1998; Jiang and Chiang, 2000; Cochrane, 2001). In this chapter, we do not intend to explore these types of models.
9. Our test here follows the traditional approach by focusing on examining whether the slope coefficient differs significantly from unity. Rogoff (1996) provides a good review. Recent research pays particular attention to the stochastic properties of dynamics of adjustments toward PPP, and employs more powerful statistical techniques. Cheung and Lai (1993, 1998), Jorion and Sweeney (1996), Lothian and

Taylor (1997b), and Baum et al. (2001) present evidence in favor of PPP.

10. Roll's efficient estimations and other parity conditions are provided in the Appendix.

11. Expected inflation rate differentials can also affect the capital account through their effects on real interest rate differentials (Frankel, 1979).

12. As mentioned earlier, Frankel and MacArthur (1988) decomposed UIP into two parts: the covered-interest differential and the currency risk premium, while Gokey (1994) decomposed UIP into a real interest rate differential and an *ex ante* deviation from relative PPP as:

$$\Delta s_{t+1} - \left(r_t - r_t^*\right) = \left[\Delta s_{t+1}^e - \left(\Delta p_{t+1}^e - p_{t+1}^{*e}\right)\right] \\ + \left[\bar{r}_{t+1}^{*e} - \bar{r}_{t+1}^e\right].$$

Basically, Frankel and MacArthur's decomposition (1988) is achieved by subtracting and adding the forward premium, $(f_t - s_t)$, into the UIP as we showed in Note 4, while Gokey's decomposition (1994) is obtained by subtracting and adding the expected inflation rate differential, $(\Delta p_{t+1}^e - \Delta p_{t+1}^{*e})$, into the equation.

13. The long-term interest rate differential can also be added to the right side of Equation (6.17) as an independent argument. As a result, difference in long – short rate spreads will be shown on the right side of Equation (6.18) to capture the information of relative liquidity risk, as implied by the expectations hypothesis of the term-structure of interest rates.

14. Using Equations (6.19) through (6.21), we obtain the following two equations as:

$$\bar{r}_{t+1}^e - \bar{r}_{t+1}^{*e} = \theta_{t+1}^e - \delta_{t+1}^e, \text{ and}$$

$$\left(R_{m,t+1}^e - r_t\right) - \left(R_{m,t+1}^{*e} - r_t^*\right) = \delta_{t+1}^e - \phi_{t+1}^e.$$

15. A precise process and speed of adjustment to restore a new equilibrium can be very complicated, and so cannot be answered without having a complete specification of the model, which is beyond the scope of the current study.

16. Cumby (1990) tests whether real stock returns from four countries are consistent with consumption-based models of international asset pricing. The hypothesis is rejected by including a sample that began in 1974. However, the null cannot be rejected when only the 1980s are considered.

17. Estimates of the unbiasedness hypothesis are based on the sample period from 1989.1 to 1998.12 due to unavailability of FR, GM, and SW forward markets and the switch to the euro starting in January 1999.

REFERENCES

Albuquerque, R., Bauer, G., and Schneider, M. (2004). "International equity flows and returns: A quantitative equilibrium approach." Working Paper, National Bureau of Economic Research.

Abuaf, N. and Jorion, P. (1990). "Purchasing power parity in the long run." *Journal of Finance*, 45: 157–174.

Baillie, R.T. and Bollerslev, T. (1990). "A multivariate generalized ARCH approach to modeling risk premia in forward foreign exchange rate markets." *Journal of International Money and Finance*, 9: 309–324.

Baum, C.F., Barkoulas, J.T. and Caglayan, M. (2001). "Nonlinear adjustment to purchasing power parity in the post-Bretton Woods era." *Journal of International Money and Finance*, 20: 379–399.

Bekaert, G. and Hodrick, R.J. (1993). "On biases in the measurement of foreign exchange risk premiums." *Journal of International Money and Finance*, 12: 115–138.

Branson, W.H. (1988). "Comments on political vs. currency premia in international real interest differentials: a study of forward rates for 24 countries." by J.A. Frankel and A.T. MacArthur. *European Economic Review*, 32: 1083–1114.

Campbell, J.Y. (1987). "Stock returns and the term structure." *Journal of Financial Economics*, 18: 373–399.

Cheung, Y.W. and Lai, K.S. (1993). "Long-run purchasing power parity during the recent float." *Journal of International Economics*, 34: 181–192.

Cheung, Y.W. and Lai, K.S. (1998). "Parity reversion in real exchange rates during the post-Bretton Woods period." *Journal of International Money and Finance*, 17: 597–614.

Chiang, T.C. (1988). "The forward rate as a predictor of the future spot rate – a stochastic coefficient approach." *Journal of Money, Credit and Banking,* 20: 210–232.

Chiang, T.C. (1991). " International asset pricing and equity market risk." *Journal of International Money and Finance*, 10: 349–364.

Chiang, T.C. and Trinidad, J. (1997). "Risk and international parity conditions: a synthesis from consumption-based models." *International Economic Journal*, 11: 73–101.

Cochrane, J.H. (2001). *Asset Pricing*. Princeton and Oxford: Princeton University Press.

Cornell, B. (1989). "The impact of data errors on measurement of the foreign exchange risk premium." *Journal of International Money and Finance*, 8: 147–157.

Cumby, R. (1990). "Consumption risk and international equity returns: some empirical evidence." *Journal of International Money and Finance*, 9: 182–192.

De Santis, G. and Gerard, B. (1998). "How big is the premium for currency risk?" *Journal of Financial Economics*, 49: 375–412.

Domowitz, I. and Hakkio, C.S. (1985). "Conditional variance and the risk premium in the foreign exchange market." *Journal of International Economics*, 19: 47–66.

Engel, C. (1996). "The forward discount anomaly and the risk premium: a survey of recent evidence." *Journal of Empirical Finance*, 3: 123–192.

Fama, E.F. (1975). "Short-term interest rates as predictors of inflation." *American Economic Review*, 65: 269–282.

Fama, E.F. (1984). "Forward and spot exchange rates." *Journal of Monetary Economics*, 14: 319–338.

Fisher, E. and Park, J. (1991). "Testing purchasing power parity under the null hypothesis of cointegration." *Economic Journal*, 101: 1476–1484.

Fleissig, A.R. and Strauss, J. (2000). "Panel unit root tests of purchasing power parity for price indices." *Journal of International Money and Finance*, 19: 489–506.

Frankel, J.A. (1979). "On the mark: a theory of floating exchange rates based on real interest differential." *American Economic Review*, 69: 610–622.

Frankel, J.A. and Froot, K.A. (1987). "Using survey data to test standard propositions regarding exchange rate expectations." *American Economic Review*, 77: 133–153.

Frankel, J.A. and MacArthur, A.T. (1988). "Political vs. currency premia in international real interest differentials: a study of forward rates for 24 countries." European Economic Review*, 32: 1083–1114.*

Frankel, J.A. and Schmukler, A.L. (2000). "Country funds and asymmetric information." *International Journal of Finance and economics*, 5: 177–195.

Fratianni, M. and Wakeman, L.M. (1982). "The law of one price in the Eurocurrency market." *Journal of International Money and Finance*, 3: 307–323.

Frenkel, J.A. (1981). "The collapse of purchasing power parities during the 1970s." *European Economic Review*, 16: 145–165.

Froot, K.A. and Thaler, R.H. (1990). "Anomalies: foreign exchange." *Journal of Economic Perspective*, 4: 179–192.

Giovannini, A. and Jorion P. (1987). "Interest rates and risk premia in the stock market and in the foreign exchange market." *Journal of International Money and Finance*, 6: 107–124.

Gokey, T.C. (1994). "What explains the risk premium in foreign exchange returns." *Journal of International Money and Finance*, 13: 729–738.

Hansen, L.P. and Hodrick, R.J. (1980). " Forward exchange rates as optimal predictors of future spot rates: an econometric analysis." *Journal of Political Economy*, 88: 829–853.

Hodrick, R.J. (1987). *The Empirical Evidence on the Efficiency of Forward and Futures Foreign Exchange Markets*. New York: Harwood Academic.

Hu, X. (1997). "Macroeconomic uncertainty and the risk premium in the foreign exchange market." *International Journal of Finance and Finance*, 16: 699–718.

Huang, R.D. (1990). "Risk and parity in purchasing power." *Journal of Money, Credit and Banking*, 22: 338–356.

Jiang, C. and Chiang, T.C. (2000). "Do foreign exchange risk premiums relate to the volatility in the foreign exchange and equity markets?" *Applied Financial Economics*, 10: 95–104.

Jorian, P. and Sweeney, R.J. (1996). "Mean reversion in real exchange rates." *International Journal of Finance and Economics*, 15: 535–550.

Korajczyk, R.A. (1985). "The pricing of forward contracts for foreign exchange." *Journal of Political Economy*, 93: 346–368.

Korajczyk, R.A. and Viallet, C.J. (1992). "Equity risk premia and the pricing of foreign exchange risk." *Journal of International Economics*, 33: 199–220.

Krugman, P. (1978). "Purchasing power parity and exchange rate, another look at the evidence." *Journal of International Economics*, 8: 397–407.

Levine, R. (1989). "The pricing of forward exchange rates." *Journal of International Money and Finance*, 8: 163–180.

Lothian, J.R. and Taylor, M.P. (1997a). "The recent float from the perspective of the past two centuries." *Journal of Political Economy*, 104: 488–509.

Lothian, J.R. and Taylor, M.P. (1997b). "Real exchange rate behavior." *Journal of International Money and Finance*, 16: 945–954.

Lucas, R.E., Jr. (1982). "Interest rates and currency prices in a two-country world." *Journal of Monetary Economics*, 10: 335–360.

Mark, N.C. (1988). "Time-varying betas and risk premia in the pricing of forward foreign exchange contracts." *Journal of Financial Economics*, 22: 335–354.

Marston, R.C. (1997). "Tests of three parity conditions: distinguishing risk premia and systematic forecast errors." *Journal of International Money and Finance*, 16: 285–303.

Mishkin, F.S. (1984). "Are real interest rates equal across countries: an empirical investigation of international parity conditions." *Journal of Finance*, 39: 1345–1357.

Newey, W.K. and West, K.D. (1987). "A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix." *Econometrica*, 55: 703–708.

Patel, J. (1990). "Purchasing power parity as a long run relation." *Journal of Applied Econometrics*, 5: 367–379.

Rogoff, K. (1996). "The purchasing power parity puzzle." *Journal of Economic Literature*, 34: 647–668.

Roll, R. (1979). "Violations of purchasing power parity and their implications for efficient international commodity markets," in M. Sarnat and G.P. Szego (eds.) *International Finance and Trade*. Cambridge, MA: Ballinger.

Roll, R. and Solnik, B. (1979). "On some parity conditions encountered frequently in international economics." *Journal of Macroeconomics*, 1: 267–283.

Roll, R. (1992). "Industrial structure and the comparative behavior of international stock market indexes." *Journal of Finance*, 47: 3–41.

Solnik, B. (1978). "International parity conditions and exchange risk." *Journal of Banking and Finance*, 2: 281–293.

Solnik, B. (1982). "An empirical investigation of the determinants of national interest rate differences." *Journal of International Money and Finance*, 3: 333–339.

Stulz, R.M. (1981). "A model of international asset pricing." *Journal of Financial Economics*, 9: 383–406.

Stulz, R.M. (1986). "Asset pricing and expected inflation." *Journal of Finance*, 41: 209–223.

Taylor, M. (1988). "An empirical examination of long run purchasing power parity using cointegration techniques." *Applied Economics*, 20: 1369–1381.

Wagster, J.D. (1996). "Impact of the 1988 Basle Accord on international banks." *Journal of Finance*, 51: 1321–1346.

White, H. (1980). "A heteroscedasticity–consistent covariance matrix estimator and a direct test for heteroscedasticity." *Econometrica*, 48: 55–68.