The Predictive Power of Cumulative Exchange Rate Deviations and Its Applications

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Abstract

Empirical studies observe that currency exchange rates often deviate from the purchasing power parity (PPP) theoretical values. Previous literature also recognises that exchange rate deviations are self-correcting over time. This study shows that, for bilateral rates of eight developed country currencies for the period 1974 to 2004, exchange rate deviations accumulated over a five-year period were partially corrected over the following three years. Further, this research shows that cumulative PPP deviations can provide reliable information for predicting future directions of exchange rate movements.

A new approach to managing currency risk is proposed in this study to improve international stock portfolio performance. Constructing internationally diversified portfolios, the strategy explicitly recognises currency risk and manages this risk by excluding assets denominated in over-valued currencies. Using quarterly data from eight countries with freely floating currencies over the period 1991 to 2004, the strategy outperformed the MSCI world index in terms of risk reduction and return improvement between 2.18 and 5.08%. Depending on the country selected, the proposed strategy realized between 1.50 and 4.68% higher annualised returns than an equally-weighted total diversification strategy. Most of the improvements remained after adjusting for risk.

Next, a strategy for managing exposure to transactions denominated in foreign currencies is developed, which incorporates both forward rate premiums and predictions of exchange rate movements based on accumulated deviations from PPP. This strategy requires hedging long positions when a foreign currency is over-valued and the forward contract is trading at a premium. The exposures are left uncovered under other conditions. When this strategy was evaluated across seven currencies from the view points of eight countries; for the period 1986 to 2004, it increased domestic cash flow returns and reduced return volatilities when compared against an unhedged strategy.

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Introduction

1.1 Background and Introduction

With rapid developments in international trade and finance, exchange rate fluctuation has become an influential factor on the performance of international investment and business operating activities. Consequently, academic researchers and market participants are motivated to predict foreign exchange rates and use the predictions to manage currency risk. This dissertation first investigates whether cumulative exchange rate deviations from the purchasing power parity (PPP) can provide reliable predictions on the future directions of exchange rate movements. This dissertation also investigates whether the predictive power of cumulative exchange rate deviations can be used to improve international portfolio performance and to enhance transaction exposure management.

The theory of PPP provides a fundamental exchange rate determination mechanism which, in its most useful form (the relative version), states that changes in the exchange rate between two currencies should offset price level changes in the two countries to maintain a constant relationship between the relative purchasing power of the two currencies.

This theory, which has the beauty of simplicity and an attractive intuitiveness, has important implications in a variety of areas of economics and finance. Although short term deviations between exchange rates and PPP equilibrium values are often observed by empirical studies, the deviations are often reversed slowly over a long time, providing evidence that PPP holds reasonably well in the long-run. This phenomenon of slow long-run convergence of actual exchange rates to PPP in the presence of significant short-run deviations was termed the *purchasing power parity puzzle* by Rogoff (1996). Abuaf and Jorion (1990) showed that cumulative exchange rate deviations from PPP were self-corrected by half over a period of three to five years.

In practice, people often attempt to predict future exchange rate movements. Levich (1980) claimed, however, that such predictions seldom work, even for professional foreign exchange advisory services. Instead of forecasting exact levels of exchange rates, this study intends to predict only the directions of future exchange rate movements. It does this based on the observation that the exchange rate reverts towards the mean of historical PPP adjusted values over the long-term. To justify the basis of this method of prediction, Chapter Two of the dissertation applies regression tests to fifty-six bilateral exchange rates, and finds that directions of exchange rate movements are negatively related to cumulative deviations from PPP. It is also found that these movements are sufficiently reliable to use for predictive purposes. In particular, overvalued currencies tend to depreciate over time, while undervalued currencies tend to appreciate in subsequent periods.

The finding that exchange rate movements are predictable has significant implications in practice and this study demonstrates its practical value in the areas of international equity diversification and foreign currency transaction exposure management. In Chapter Three, a selective international diversification strategy is proposed which requires that only offshore markets with currencies which are not over-valued are selected as part of internationally diversified stock portfolios. The rationale is to improve international portfolio performance through efficient currency risk management by explicitly excluding assets denominated in currencies predicted to suffer future depreciation (over-valued currencies).

The ability to predict the direction of foreign exchange rate movements is also important for developing foreign exchange hedging strategies. Expectations theory, another exchange rate determination theory, states that the forward rate is an unbiased predictor of the future spot rate. Nonetheless, empirical studies do not, in general, support this theory. Fama (1984) and Engel (1996), for example, found that forward rates are often biased in predicting future spot rates. They reported that exchange rates often move in the opposite directions implied by forward premiums or discounts. The observation that the expectation theory does not hold is termed the *forward premium anomaly*. Therefore, selling a foreign currency forward at a premium can be profitable if that currency does not appreciate at the rate implied by the forward contract. Bilson (1984) reported that a currency trading strategy following exchange rate predictions based on forward rate premiums and exchange rate deviations from PPP is profitable. This finding provided evidence that forward rate premiums and exchange rate corrections to accumulated deviations from PPP are useful indicators of exchange rate movements.

Based on empirical observations of the forward premium anomaly and the finding that long-term accumulated exchange rate deviations from PPP tend to revert, Chapter Four of this study proposes a selective forward hedging strategy for managing foreign transaction exposures. The strategy looks at hedging three-month foreign receivables. The proposed forward hedging strategy calls for hedging only when spot rates are higher than PPP theoretical values, and that forward contracts are trading at premiums.

The rationale is to avoid losses associated with exposures to over-valued currencies and to lock-in favourable exchange rates offered by currency forward contracts.

The strategies considered in this thesis are designed to efficiently manage currency risk associated with international portfolio investment and foreign currency transactions. Both strategies call for directional predictions of foreign exchange rates based on the reverting property of historical cumulative exchange rate deviations from PPP. Strategy efficiencies are empirically examined across a sample of eight developed countries with free-floating currencies. By taking advantage of the predictive power of long-run exchange rate deviations from PPP, it is expected that the proposed international portfolio diversification and transaction exposure hedging strategies will generate significant economic gains for investors and corporations.

1.2 Sample Selection

The sample countries are required to meet the following five criteria: (1) the countries should have open economies with few restrictions on flows of goods and capital; (2) the countries must have well-developed stock markets allowing foreign investments; (3) the countries must have free-floating currency policies; (4) the currencies of the countries should have a free-floating history of at least fifteen years to allow for reliable statistical analysis; and (5) the countries' currencies can be hedged in the forward market.

The MSCI world index, which is designed to capture stock market movements of developed countries, provides a good starting point for the sample selection process. The index consists of twenty-three developed countries. For the twelve Euro countries, Germany is selected due to its relatively large scale of economy among the members, as measured by GDP. The 1990 reunification of Germany may confound the study, although the effect is not examined in this study. The final sample set includes eight countries: Australia, Canada, Germany, Japan, New Zealand, Switzerland, the UK and the US, as listed in Table 1.1.

Table 1.1 Exchange Rate Arrangements of Selected Countries

Country	Currency	Started to Free Float[1] on
Australia	Australian dollar	May 1983[2]
Canada	Canadian dollar	May 1970
Japan	Japanese yen	Feb 1973
New Zealand	New Zealand dollar	March 1985[3]
Germany	German mark / Euro	May 1971
Switzerland	Swiss franc	Jan 1973
United Kingdom	U. K. pound	June 1972
United States	U. S. dollar	March 1973

1.3 Introduction to Research Methodologies

In Chapter Two, an OLS regression model is used to examine empirical data in order to find out if cumulative exchange rate deviations from PPP can provide reliable information for predicting the directions of future exchange rate movements. Chapter Three evaluates the performances of international portfolios constructed under the proposed selective diversification strategy. A naïve total diversified international portfolio, the MSCI world index portfolio and the domestic-only portfolios are applied as benchmark portfolios. In Chapter Four, the relative performance of the proposed

[1] Source: Aldcroft and Oliver (1998, p 115), except for Australia and New Zealand.

[2] Refer to Tease (1986).

selective forward hedging strategy against the unhedged and passively hedged strategies is discussed.

The discussions on portfolio and hedging performance are mainly based on the popular mean-variance (M-V) analysis. Nonetheless, we must be aware that the M-V analysis only examines the first two moments of return distributions (the mean and the variance). Since the higher moments of return distributions are ignored, the validity of the M-V conclusions are restricted to certain types of return distributions, or to investors with certain types of indifference curves. For example, it works for normally distributed return series, or for investors with quadratic utility functions. Samuelson (1970) has justified that the M-V result is "a very good approximation" when variance of the data series is close to zero (a condition known as *compactness*). The approximation, however, may not be good enough under more general conditions, as argued by Hanoch and Levy (1970).

In recognition of the limitations that mean-variance methodology has in handling samples of limited size, and those which have undesirable distributions as in the case of this reserach, this study also compares strategy performances under the framework of stochastic dominance (SD). Stochastic dominance is an investment decision tool based on the expected utility theory which is not subject to specific requirement on return distributions. Since performance comparisons are based on the entire distribution of data under comparison, analyse results under the SD framework are more general than that from the M-V analysis; therefore, is valid to a broader set of investor preferences. As will be discussed in the next section, under a few general and

[3] Refer to Carew (1987, p112).

realistic assumptions of investor's attitude towards wealth and risk, investment decisions made under the SD criteria are uniform among all investors.

1.4 An Introduction to Stochastic Dominance Analysis

Developed by Hadar and Russell (1969) and Hanoch and Levy (1969), the SD framework has a great advantage over the mean-variance (M-V) approach in that it provides uniform dominance results for investors with different utility functions. Moreover, validity of SD results is not subject to problems arising from sample distributions.

The most appealing feature of stochastic dominance theory is its nonparametric property, due to the fact that ordering of investment preferences is assessed on entire distributions of uncertain economic outcomes. Since data used in financial studies is often non-normally distributed, the SD framework has seen some meaningful applications in portfolio performance evaluations and investment strategy comparisons. See, for example, Hadar and Russell (1971), Bawa, Bodurtha Jr., Rao and Suri (1985), Post (2003), Abhyankar and Ho (2004) and Meyer, Li and Rose (2005). As will be discussed later, most of the data under study in this dissertation is non-normally distributed and the nonparametric feature of the stochastic dominance framework makes it an appropriate measure of strategy performance. On the other hand, stochastic dominance analysis has the disadvantage that it sometimes gives out inconclusive results even when the two series under comparison are statistically significantly different. This is especially true for the first order stochastic dominance analysis where the dominance rules require that the cumulative distribution of one series stays uniformly above the other one, a requirement hard to satisfy in most comparisons. For this reason, the first order stochastic dominance analysis is often not able to provide much information and therefore, will not be conducted in this study. On the other hand, the second order stochastic dominance rules compare investment outcomes according to the spread of the probability mass of cumulative distributions. As will be seen later, the second order stochastic dominance analysis yields dominant results in many comparisons; therefore, will be discussed for complement to the mean-variance analysis. For the same reason, the more restrictive third order stochastic dominance analysis will be omitted for succinctness.

In particular, this study applies the second order stochastic dominance (SSD) criteria of Levy (1998) to evaluate: (1) the performances of different international portfolio strategies and (2) the efficiencies of different forward hedging strategies. To validate the analysis, two assumptions on risk-return preference are made: non-satiation and risk-aversion. The conditions are equivalent to non-decreasing and concave expected utility functions. This approach has a limitation that the analysis is based on the full empirical distribution function that doesn't account for sampling error. Some recent studies by, among the others, Anderson (1996), Davidson and Duclos (2000) and Barrett and Donald (2003) have extended the SD framework to introduce statistical tests that incorporate sampling errors. However, the auto-correlation in the data of this study makes the use of these new developments not suitable. The Levy (1998) criteria for SSD are briefly introduced as follows.

For a return series with N observations of equal opportunity, define p(x) as the probability of having a return of x and P(X) as the cumulative probability of obtaining a return no greater than x, then:

$$p(x) = 1/N \quad (1.1)$$

$$P(X) = P(X \leq x) = \sum_{X \leq x} p(x) \quad (1.2)$$

Since each return has an equal chance of 1/N, P(X) is effectively the proportion of returns having values no greater than x in the sample. This analogy will be used in computer programming.

For risk averters with non-decreasing utility functions, among the two investment return series F and G, having cumulative distribution functions of F(X) and G(X) respectively, F dominates G by the second order (denoted as (F)SSD(G)) if, and only if, both of the following two conditions are satisfied:

Condition 1: $$\sum_{X \leq x} [G(X) - F(X)] \geq 0 \quad (1.3)$$

Condition 2: There exists at least one x value for which function (1.3) is strictly greater than zero.

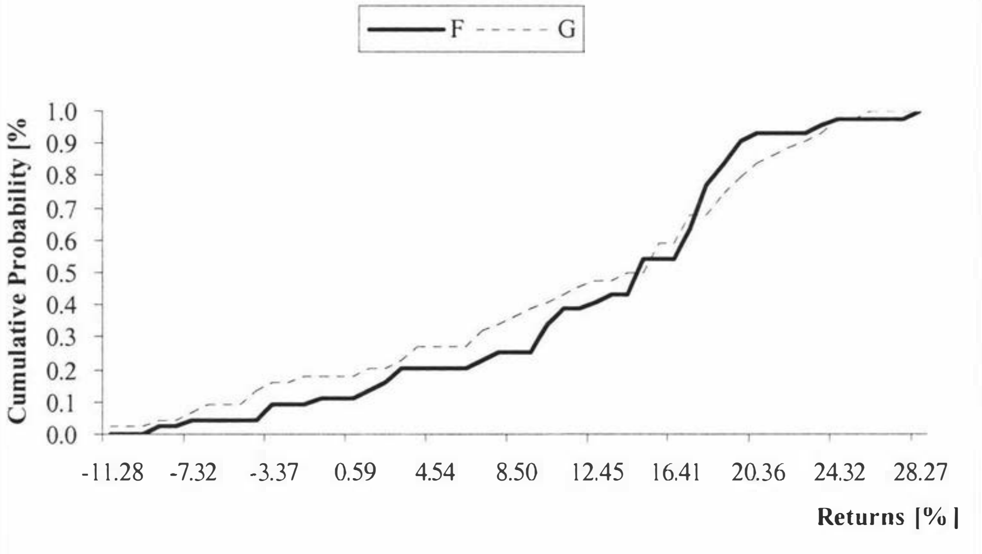
Figure 1.1 provides a graphical illustration of the concept of second order stochastic dominance, where the area between the return axis and the curve G(x) is greater than the area between the return axis and the curve F(x) at any value of returns, indicating dominance of A over B in the second order.

For discrete empirical return data series F and G with the same length of N, sorted in ascending order, condition (1.3) is equivalent to the condition (1.4) for any k within the range of 1 to N:

$$\frac{k}{N} \times [\sum_{i=1}^{k} X_i(F) - \sum_{i=1}^{k} X_i(G)] \geq 0 \quad (1.4)$$

The intuition of the stochastic dominance concept is that investors find larger chance of receiving a higher return from investing in F instead of investing in G. The analysis will be conducted in by a program developed by the author with the help of a computer expert.

Figure 1.1 Illustrations of Second Order Stochastic Dominance



1.5 Contributions and Limitations

This study shows that cumulative historical exchange rate deviations from PPP are partially corrected in subsequent periods. In the course of the study further evidence was obtained confirming the literature findings, using a totally different methodology. In this study, an intuitive linear regression test is applied to long-interval (of several years) exchange rate data. These cumulative exchange deviation corrections can be used to predict future exchange rate movements. Applied to international portfolio diversification, this research proposed that currency risk can be managed through a market-selection process which examines exchange rates' cumulative deviations from PPP. The proposed market-selecting international diversification strategy is the first one which uses information content of cumulative exchange rate deviations from PPP.

Although the self-corrections of PPP deviations and the forward premium anomaly were observed decades ago, this study is the first time that these observations have been linked to make selective hedging decisions for managing foreign currency transaction exposures. The proposed international portfolio diversification strategy and forward hedging strategy can provide substantial benefits in terms of return improvements and risk reductions, which are of both economic, and statistical, significance. The strategies are underpinned by robust economic observations, intuitively comprehensible and practically applicable.

This study also contributes to the existing literature in several other ways. First, this study examines the effectiveness of the two proposed strategies across a broad range of currencies, i.e. from the perspectives of eight different countries. This is a broader approach than in most other studies. Therefore, the conclusions drawn in this study are less subject to home-country bias. Second, by applying stochastic dominance analysis as a complement to the popular mean-variance analysis, the findings of this study are not subject to potential bias induced by undesirable sample distributions, and may be considered as being more robust.

It should be noted, however, that the proposed selective forward hedging strategy and international diversification strategy are only examined for limited terms of currency exposures and a certain portfolio holding period. It is expected that the strategies may be extended to managing currency risk in other contexts, although further examination is needed for confirmation of this. Moreover, although the proposed selective forward hedging strategy is appropriate for hedging currencies with sufficiently long freely-floating history, it may not work if applied to currencies with a short free-floating history. Finally, given the relatively short history of free-floating exchange rate systems and the limited number of samples meeting the sample selection criteria, sampling error may be a concern in this study. As a result, the conclusions drawn from this study should be taken with caution when applied to other markets, or different sample periods.

1.6 Layout of the Dissertation

The rest of dissertation is organised into three parts. In Chapter Two, exchange rate corrections to cumulative deviations from PPP are examined on fifty-six bilateral exchange rates among eight free-floating currencies, using quarterly data from 1974:Q1 to 2004:Q2. Chapter Three examines the performance of the proposed selective international diversification strategy against three benchmark strategies for the period 1991 to 2004, taking the viewpoints of investors based in each of the eight countries. In Chapter Four, the effectiveness of the proposed selective forward hedging strategy is examined across multi-currencies from the eight countries' perspectives for the period of 1st Jan 1986 to 31st Aug 2004. Chapter Five concludes and discusses future research opportunities.

Chapter 2

The Predictive Power of Cumulative Exchange Rate Deviations from PPP

2.1 Introduction

Purchasing power parity (PPP) is a fundamental exchange rate determination theorem which, in its strict form (called the absolute version), states that identical goods should sell at the same price in two countries if expressed in a common currency. By ignoring transportation costs, price equalities are ensured through international arbitrage activities. People buy goods in a country where the price is lower and then sell them at a higher price in another country. This process eventually eliminates any price differences across the countries. The less strict form of PPP (the relative version) states that any exchange rate changes between two currencies should equate to the relative price changes occurring between the two countries.

The theory of PPP, which has the beauty of simplicity and intuitive attractiveness, has received enormous attention in empirical studies over the last several decades. While empirical studies often observe short term disparities between realised exchange rates and estimated PPP equilibrium rates, the literature generally agrees that exchange rates do converge to PPP in the long-run. This point is discussed in the literature review of Samo and Taylor (2002). Rogoff (1996) argued that it is difficult to reconcile the slow convergences of exchange rates to PPP in the long run with the presence of significant short-term deviations. This phenomenon is known as the purchasing power parity puzzle. Abuaf and Jorion (1990) showed that exchange rates revert to PPP slowly, and that half of the deviations are corrected in the subsequent three-to-five years.

Nonetheless, previous studies using PPP are often based on data collected at monthly or quarterly frequencies. Abuaf and Jorion's (1990) study applied both monthly data and annual data, presenting evidence showing that studies on annual data have provided clearer evidence on the low-frequency mean-reversion behaviour of real exchange rates, compared with results gained from studying monthly data. Where evidence is reported that real exchange rates have actually reverted to PPP, half-lives of PPP deviations are translated from the coefficient estimates of the first order auto regression model of real exchange rates movements. For example, Abuaf and Jorion (1990) obtained the first order auto regression coefficient estimates between 0.98 and 0.99, using monthly data. These figures translate to three-to-five years' half-lives of exchange rate deviations from PPP.

None of the previous studies have used long-interval data of several years to examine whether cumulative deviations of exchange rates from PPP were corrected over time. Instead, the previous studies use weekly, monthly, quarterly, or at the most, annual data. Abuaf and Jorion (1990) used both monthly and annual data. They found that annual data are better capable of capturing the low frequency reversal of exchange rates. In the current study it will be argued that longer interval data of up to several years' intervals is probably more suitable in the detection of reversions of cumulative exchange deviations from PPP.

Furthermore, this study uses a simple OLS regression model to determine the relationship between five-year cumulative exchange rate deviations from PPP and the corrections over the subsequent three-year period. The three-year deviation correction period was established in the Abuaf and Jorion (1990) study on annual data, which reported a 3.3 years' estimation of the half-life of deviations. The choice of a five-year exchange rate deviation accumulation period is arbitrary, but is supported by the findings in Chapter Two of this study, which show that regression test results are more reliable when a period of five years is used.

Nominal rates are used in this study. The slope coefficient estimates obtained from this model are expected to be negative. Their absolute values represent the percentage corrections to PPP deviations accumulated over a five-year period. As will be seen, the results of this study confirm that cumulative exchange rate deviations from PPP do tend to revert in the long-run. Similar results were obtained when extending the test to other combinations of deviation accumulation periods and the subsequent correction periods. The findings are consistent with the evidence provide by Abuaf and Jorion (1990), indicating that cumulative exchange rate deviations from PPP can provide reliable information in predicting future directional changes of exchange rates.

It is also observed that exchange rate fluctuations are much larger than the movements which are required to adjust for differences in PPP. This fact highlights another difficulty in using PPP as a predictive tool. This study finds that exchange rate movements can be jointly explained by two factors, the reversion of the random exchange rate fluctuations and the power of PPP. The analysis reveals that exchange rate fluctuations are largely random, but revert to mean historical levels over the long term. At the same time, exchange rates adjust for PPP, although this is a relatively less significant component of the overall adjustment process.

2.2 Literature Review

According to Officer (1982), the concept that currency exchange rates are determined by relative price levels was originally proposed by Spanish scholars at the University of Salamanca in the fifteenth and sixteenth centuries. The idea was later formulized and termed purchasing power parity by the Swedish economist, Gustav Cassel, between 1918 and 1922.[4] The empirical study on PPP validity has attracted enormous research interest amongst academic researchers, which have reported inconclusive evidence in the last several decades. Lan (2002) observed that a large number of studies have been conducted on PPP following the shift to the free-floating exchange rate regime in the 1970s.

Empirical studies utilising early flexible exchange systems of the 1920s often provided evidence supportive of PPP. See, for example, Lee (1976) and Frenkel (1978). Frenkel (1981), however, claimed that the theory of PPP *collapsed* in the 1970s, as the exchange rate movements were observed to have little relationship with inflation rate differentials in relevant countries. He reported that PPP is only applicable to long term trends of exchange rates in the presence of monetary turbulence. These early studies often suffered from two problems which can limit the generality of research results: (1) applications of relatively short series of test data, and (2) restricted sample sizes due to the small number of free-floating currencies.

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[4] For reviews on the history of PPP, see Officer (1982), Dornbusch (1988), Lan (2002), Lothian (1997) and Sarno and Taylor (2002).

During the 1980s, empirical studies on PPP were greatly facilitated by the introduction of more advanced econometric methodologies into financial studies. As will be discussed shortly, evidence from the literature remains inconclusive and the results seem to relate to choices of test specifications. For this reason, the following discussions on the literature are organised in relation to the development of various test methodologies.

The Dickey and Fuller unit root test introduced in 1979 has been widely applied to stationarity tests of foreign exchange rates. A finding of no unit root is considered supportive evidence for PPP, and the presence of unit roots is regarded as evidence against PPP. Glen and Shibata (1992), for example, found supportive evidence for PPP in nine bilateral exchange rates. Lothian (1997) and Lothian and Taylor (2000) also found strong evidence supporting PPP in US dollar-sterling and French franc-sterling rates. The estimations of half-lives of deviations differ among currencies across different studies, ranging widely from one year to six years.

On the other hand, Cuddington and Liang (2000) and Patel (1990) found evidence against PPP, through studies of the exchange rates of six major currencies. Froot and Rogoff (1995) and Sarno and Taylor (2002) argued, however, that unit root tests may have rejected PPP more often than they should have, due to a loss of test power when using short time series with close-to-unity coefficient estimates.

As the limitations brought about by the short history of the free floating exchange rate system were recognised, the panel unit root test was developed to increase the test power of the unit root test. The panel unit root test applies a multivariate approach that tests for unit roots on a panel of a number of exchange rates at the same time. A prominent work which applies this approach is Abuaf and Jorion (1990), which supported PPP by producing rejections on unit root tests in monthly rates of ten currencies for the period 1973 to 1987, and in annual rates of nine currencies between 1900 and 1972. They observed substantial short-term deviations from PPP and reported that half-lives of short-term deviations vary between three years and five years. By testing a panel of 150 currencies, using annual data for 45 years of the post WWII period, Frenkel and Rose (1996) presented strong evidence that exchange rates do revert to PPP, with half of the deviations corrected in approximately four years.

Following a similar approach, Coakley and Fuertes (1997) presented additional evidence supporting PPP using the G10 currencies and the Swiss franc between 1973 and 1996. The corrections to deviations are estimated to have half-lives of less than three years. Fleissig and Strauss (2000) provided further evidence supportive of PPP. They reported that the speed of exchange rate adjustments differs considerably across different choices of price indices and test procedures. Choi (2003) tested a panel of twenty-one industrial countries' currencies for the period 1973 to 1998 and reported evidence in support of the long-run validity of PPP in the majority of the currencies. More evidence in support of PPP was reported by Lopez and Papell (2004), Lopez (2004) and Drine and Rault (2003). Chortareas and Driver (2001) found mixed evidence on the validity of PPP, however, even though their overall evidence from panel unit root tests is supportive of PPP.

Froot and Rogoff (1995) argued that the standard multivariate unit root test proposed by Abuaf and Jorion (1990) has a null hypothesis that all of the series under consideration are unit root processes. Therefore, the null hypothesis would be violated only if one exchange rate series in the panel is stationary, while the rest of the series are not stationary. As a result, while accepting that the null implies rejection of PPP, rejecting the null does not necessarily mean that PPP holds. O'Connell (1998) argued further that the failure to control for cross-sectional dependence or survivorship bias may lead to supporting PPP mistakenly. Instead, using a generalised least square (GLS) panel unit root test (controlled for cross-sectional dependence of real exchange rate time series) he reported clear evidence against PPP using quarterly data on sixty-four real exchange rates between 1973 and 1995.

The Engel and Granger cointegration test introduced in 1987 has also been widely applied in PPP testing. This test utilises evidence of cointegration between exchange rates and relative prices as support for PPP. Following this procedure and using monthly data, Enders (1988) and Taylor (1988) rejected PPP for developed country currency data between the mid-1970s and the mid-1980s. Cheung and Lai (1993) and Alves, Cati and Fava (2001), on the other hand, found favourable evidence for PPP during the periods of 1914 to 1989 and 1855 to 1996, respectively.

Johansen extended the Engel-Granger cointegration test in 1988 to encompass a multivariate context by using the maximum likelihood estimation procedure. This procedure is assumed to have more power than the Engel-Granger cointegration test. Following this approach, Macdonald (1995), Helg and Serati (1996), Kouretas (1997), Zhou (1997) and Flores (1999) all found evidence in favour of PPP. Macdonald (1995) reported that average adjustments to parity deviations across nine dollar rates were around -0.02 per month, indicating a deviation half-life of thirty-six months.

Sarno and Taylor (1998) examined monthly bilateral real dollar exchange rates of G5 countries for the post-Bretton Woods period and reported *unequivocal evidence* of exchange rate mean reversion to PPP. Some recent evidence in favour of PPP has been reported by Kargbo (2003a), Kargbo (2003b) and Siokis and Christodoulou (2004). Penm, Penm and Terrell (2002), however, presents mixed evidence.

Macdonald (1995) and Froot and Rogoff (1995) summarised the literature, and concluded that exchange rate deviations from PPP are short lived and the exchange rates converge to PPP in the long-run. They reported that studies on exchange rates among major industrialised countries show consensus estimations on half-lives of PPP deviations of around four years.

Rogoff (1996) argued that it is difficult to reconcile the observations of substantial short-term deviations and slow convergence to PPP in the long-term. This phenomenon is referred to as the *purchasing power parity puzzle*. Some possible explanations for the PPP puzzle are offered by the literature. These include price stickiness, transportation costs, tariffs, non-tariff barriers, information costs and the immobility of labour.

Some researchers have made efforts to resolve the PPP puzzle by modelling PPP reversions using non-symmetric and non-linear techniques. Wei and Parsley (1995) reported observations of non-linearity in PPP-reversions. They found that larger deviations of PPP are corrected more quickly than smaller ones. Estimations on half-lives of PPP deviations are within the range of four to five years. Goldberg, Gosnell and Okunev (1997), Sarno (2000), Enders and Dibooglu (2001) and Coakley and

Fuertes (2001a, 2001b, 2002) found that exchange rate reversions to PPP are not linear for some currencies, but are linear for other currencies.

Kapetanios, Shin and Snell (2003) reported evidence on the nonlinearity of PPP-reversions in dollar-rates of eleven OECD country currencies. Chortareas and Kapetanios (2004) reported non-linear mean reversions in bilateral yen real exchange rates in the post-Bretton Woods era. Sarno, Taylor and Chowdhury (2004) reported strong evidence of non-linear mean reversion of deviations from PPP on five major bilateral dollar rates. Peel and Venetis (2003) claimed that non-linear modelling on dollar-sterling and franc-sterling real exchange rates have resulted in faster reversions to PPP.

Morey and Simpson (2001a) found that exchange rate deviations from PPP are informative in predicting the directions of future exchange rate movements. They reported that PPP has correctly predicted the direction of exchange rate movements 57% of the time for a horizon of one month, to one year, ahead. When tested on nine dollar rates during the period 1985 to 1998, large deviations from PPP correctly predicted the directional changes on exchange rates in 69% of the cases.

Bilson (1984) showed that exchange rate deviations from PPP contain valuable information about future exchange rates. This study constructed an exchange rate forecasting model which incorporated information content of PPP deviations and forward rate premiums. Using this forecasting model, a currency trading strategy was developed to long foreign currencies and short US dollars when foreign currencies were expected to appreciate. The strategy proved to be profitable, indicating that exchange rate deviations from PPP have predictive power on exchange rate movements. Simpson (2004) demonstrated that information implied in discrepancies between exchange rates and their PPP equilibrium levels can help to improve the performance of a future contract hedging strategy.

To sum up, the existing literature provides inconclusive empirical evidence of PPP. Empirical studies, however, generally agree on three points: (1) exchange rates often deviate from PPP equilibriums in the short term, (2) short term deviations tend to be corrected in the long term, and (3) half-lives of PPP deviations are estimated to be in the range of three to five years.

2.3 Research Objectives and Significance of the Study

Although the literature generally agrees that PPP may hold in the long run, the theory has difficulty in explaining the following two observations. Firstly, the literature has not provided any reconciliation between the long run validity of PPP and short run exchange rate deviations. Secondly, the magnitudes of exchange rate fluctuations are far larger than can be explained only by an adjustment mechanism based on relative price changes in relevant countries. To resolve the difficulties of PPP just discussed, this study observes that shocks constantly occur in the foreign exchange market, and that exchange rates fluctuate randomly but tend to revert to their average historical levels, while PPP adjustments supplement this process. For free-floating exchange rates, random exchange rate movements are expected to be reverted, as these movements will influence the quantity of imports and exports, which will, in turn, correct the exchange rate relationship. Therefore, the objectives of this chapter are two-fold: (1) to determine whether cumulative deviations from PPP tend to be corrected over time and, (2) to identify the major force driving exchange rate movements. To fulfil these purposes, a two-step regression analysis will be carried out on empirical data.

This study is different from the existing literature in three ways. First, the reversion of random exchange rate movements is combined with PPP to explain exchange rate behaviour using two-step regression tests to determine the major driving force of the exchange rate movement. The second feature of this study is the use of multi-year long-interval empirical data to test exchange rate reversions to PPP, whereas the previous studies have been based on weekly, monthly, quarterly or, at most, annual data. As indicated by the Abuaf and Jorion (1990) study, the use of long-interval data provided the researchers greater ability to capture the long-run reversion behaviour of exchange rates. The tests here apply exchange rate deviation data obtained in a five-year interval. The future corrections to exchange rates are obtained from three-year intervals. To establish the robustness of the results, tests are also conducted using longer and shorter periods.

The third difference between this study and others in the existing body of literature is the use of a straightforward OLS regression to test the relationship between cumulative exchange rate deviations from PPP and the subsequent corrections to PPP. This method differs from other studies which assumed a first-order autoregressive process of exchange rate behaviour. The higher moments that had been ignored in those studies may turn out to be significant accumulated over time, especially when the AR(1) coefficients are close to one. Additionally, nominal rates are used as opposed to the logarithm of real exchange rates that other studies have often applied. Carrying out the tests in this way, the estimated slope coefficients can directly indicate what percentage of PPP deviations accumulated from the previous years are corrected in the subsequent years. This method differs from the Abuaf and Jorion (1990) study, which obtained estimates of the first order auto regression coefficients of 0.98 to 0.99, and then translated the values into three-to-five year half-lives.

If reliable negative relationships can be identified between cumulative exchange rate deviations from PPP and the subsequent changes of the exchange rates, then exchange rate deviations from PPP can be regarded as reliable indicators of future directions of exchange rate movements. This knowledge can be applied to control currency risk to improve international equity portfolio performance. Applied to manage transaction exposures, the knowledge can be used to make active hedging decisions in order to improve hedging performance. These strategies have the potential to create significant economic gain for investors and international corporations. Therefore, the findings in this chapter will form the basis for subsequent studies regarding profitable applications of the PPP-reversion property of exchange rates when managing international equity portfolios and hedging foreign currency transaction exposures. There are, of course, many other ways in which foreign exchange prediction can be used for improving financial performance, but these are beyond the scope of this study.

2.4 Data Description

Dollar exchange rates and consumer price indices (CPI) are employed in this study. Monthly data was obtained principally from Datastream, for eight developed countries: Australia, Canada, Germany, Japan, New Zealand, Switzerland, the UK and the US. Most of the data covers the period from January 1974 to February 2004. The exceptions are the data for Australia and New Zealand, as these currencies only started to float in 1983 and 1985, respectively. Data for Australia and New Zealand was collected for the periods beginning January 1984 and January 1986, respectively.

The primary data was each country's exchange rate against the US dollar at the end-of-month. Middle rates are applied for this study. Cross rates for other currency pairs are calculated from the US dollar rates. As dollar rates for the German mark were discontinued on 1st January 1999 when the Euro began circulation, subsequent German mark rates are obtained by multiplying euro rates by the fixed conversion rate of 1.95583, as announced by the council of the European Union.[5]

Monthly CPI data for Australia was provided by the Reserve Bank of Australia.[6] Since New Zealand CPI data is only produced at a quarterly frequency, monthly data is interpolated linearly from quarterly data. We need to be aware that CPI data may be biased due to sampling error. As a result, estimations on individual PPP rates may be biased, although the overall bias should be cancelled out with each other over long periods.

2.5 Research Hypothesis and Test Methodology

In this study, a two-step regression analysis will be carried out to determine: (1) if half of the deviations from PPP that are accumulated over a five year period are corrected in three years time, and (2) to quantify the importance of a simple reversal of

[5] Source: *Official Journal of the European Communities*. (Dec. 1998). V41, L359.

[6] The author acknowledges RBA staff member Roger Hall for help in obtaining this data.

cumulative deviation from historical exchange rates, to the exchange rate adjustment mechanism.

Let S and SP be, respectively, the spot exchange rate and the theoretical value of exchange rate if PPP holds. Referring to Figures 2.1a and 2.1b, it can be seen that the vertical distance between S_t and SP_t (measured by D_1) represents exchange rate deviations from PPP accumulated over a five-year period. The vertical distance between S_t and S_{t-5} (denoted by D_2) represents the random movement of the exchange rate, realised in the previous five-year period. The distance between the estimated PPP rate and the previous exchange rate level (measured by D_3) represents the pressure build-up on the exchange rate due to the relative change of purchasing power of the two currencies.

Figure 2.1a Decomposition of Exchange Rate Deviation from PPP

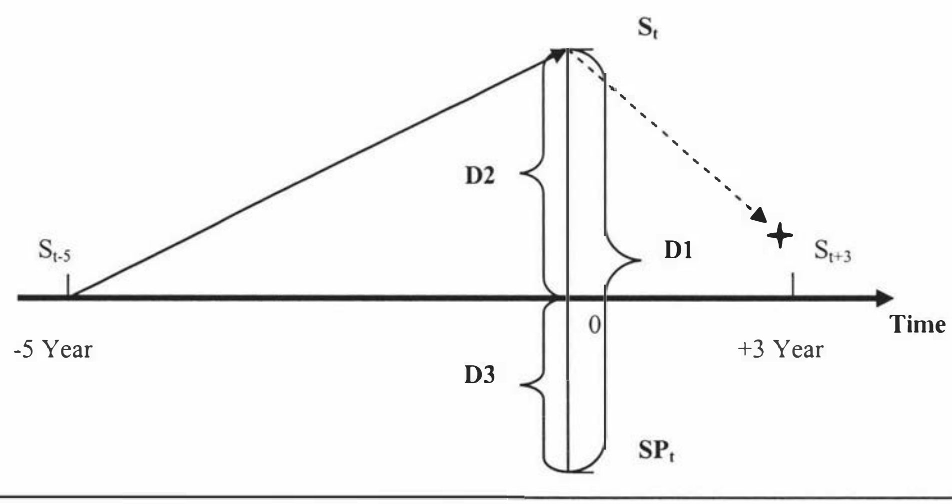

Figure 2.1b Decomposition of Exchange Rate Deviation from PPP

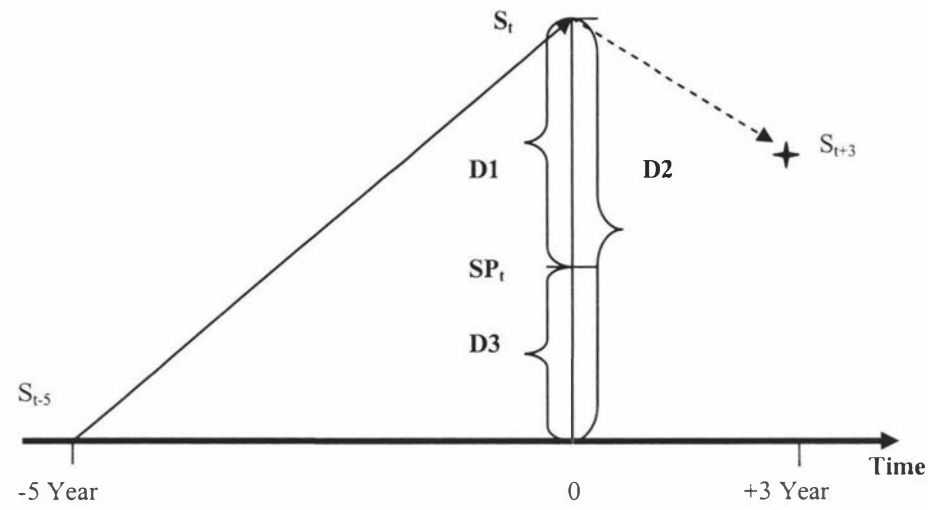

Figure 2.1a shows the circumstance where the exchange rate deviations from the historical mean and its expected PPP rate are in the opposite directions. Figure 2.1b shows the situation where the two deviations are in the same direction. The dashed line with an arrow indicates the expected movement in the next three years.

Three hypotheses and test equations are developed here to fulfil the research purposes:

Hypothesis 2.1: H0: The coefficient β_1 of Equation (2.1) is different from zero.

$$\Delta S_t = \alpha_1 + \beta_1 * (S_t - SP_t) + e_t \tag{2.1}$$

If this hypothesis holds and the coefficient estimate is negative, it indicates that exchange rate deviation from PPP accumulated in the past five years is partially corrected in the following three-year period.

Hypothesis 2.2: H0: The coefficient β_2 of Equation (2.2) is different from zero.

$$\Delta S_t = \alpha_2 + \beta_2 * (S_t - S_{t-5}) + e_t \quad (2.2)$$

If this hypothesis holds and the estimation on the slope is negative, then random movements of exchange rates over the previous period are expected to be reversed afterward. This is expected to happen because the random fluctuation of an exchange rate results from a series of noise effects that would not be expected to influence the exchange rate permanently. These random deviations unexplained by PPP are, therefore, expected to be reversed in the long run.

Hypothesis 2.3: H0: The coefficient β_3 of Equation (2.3) is different from zero.

$$\Delta S_t = \alpha_3 + \beta_3 * (S_{t-5} - SP_t) + e_t \quad (2.3)$$

The findings of negative slopes imply that the theoretical adjustment in exchange rates related to PPP will have significant explanatory power, over and above that caused by the reversal of cumulative movements of exchange rates from their historical values.

In the above three equations, $\Delta S_t = S_{t+3} - S_t$, represents the movement of an exchange rate over the next three-year period. The variable $(S_t - SP_t)$ describes the extent to which an exchange rate deviates from its estimated PPP theoretical value. The variable $(S_t - S_{t-5})$ represents the exchange rate movement realised over the past five-year period. Variable $(S_{t-5} - SP_t)$ is the divergence of PPP from the historical exchange rate observed five years ago. All of the exchange rates are expressed in terms of units of domestic currency per unit of a foreign currency. SP_t is the estimated PPP rate using Equation (2.4).

$$SP_t = S_{t-5} * \frac{CPI_t * CPI^*_{t-5}}{CPI_{t-5} * CPI^*_t} \qquad (2.4)$$

where SP_t stands for estimated PPP equilibrium value, and CPI and CPI* are the consumer price indices of the home and foreign countries, respectively.

The dependent variable of Equation (2.1) is essentially the combination of the dependent variables of Equations (2.2) and (2.3). By dividing it into two components, it is possible to quantify the individual importance of the two components. The variables used for tests are generated by taking differences between original exchange rate time series. For equation (2.1), both dependent and independent data set of all currencies will be tested for stationarity, with stationary results reported later in this chapter. For individual currency data series, some are non-stationary, among which, cointegration was rejected in some of the cases. This indicates that there are no stable economic relationship between the explanatory variables and the dependent variables. Therefore, test results from individual currency tests should be interpreted with caution.

A three-year correction period is chosen because Abuaf and Jorion (1990) showed that this is the estimated half-life of PPP deviations. A five-year deviation accumulation period is chosen to balance two factors. Firstly, historic economic relationships established a long time ago are of diminishing relevance in determining today's exchange rate, as permanent shifts in economic fundamentals have permanent effects on the relative currency exchange rates. Secondly, the time period chosen for this study should be long enough to allow the cumulative effect of deviations from PPP to force adjustments in exchange rates.

Since overlapped data are used for the OLS tests, sample sizes are enlarged artificially. Although the coefficient estimations will still be unbiased, t-statistics will be over-estimated and therefore, result in unreliable hypothesis test results. Valkanov (2003) showed that regressions involving long-horizon overlapping observations always gave out significant results even though a relationship didn't exist. This study also showed that the inefficient statistical tests of long-horizon regressions resulted from incorrect critical values. To deal with the problem of unreliable test statistics associated with the use of overlapping observations, Valkanov (2003) and a number of other econometric studies (Phillips (1986), Hjalmarsson (2004) and Hansen and Tuypens (2004)) provided easy solutions, which is to adjust the standard OLS t-statistics by dividing the square root, or 2/3 of the square root of forecast horizon. To be more conservative, this study scales down the standard t-statistics by dividing the square root of forecast horizon. Hansen and Hodrick (1980) argued that the use of more frequent observations was still beneficial even after the adjustment made on testing statistics.

In addition, a robustness check has been done to make sure that conclusions are not subject to the choice of the time periods defined in measuring exchange rate deviations and corrections. In particular, Equation (2.1) has been tested on the fifty-six bilateral rates across a broad range of combinations of deviation accumulation periods and correction periods. The relationship is also tested on the pooling data of all currency pairs for a generality check. The pooling data tests are repeated using the Cochrane-Orcutt procedure to correct for the serial correlation of data due to overlapping observations. Furthermore, OLS regression is repeated on non-overlapped data set to see if the results confirm those obtained from testing on overlapping observations.

2.6 Results and Discussions

2.6.1 Results of Tests on Individual Currency Pairs

A summary of key statistics from regression estimates of Equations (2.1), (2.2) and (2.3) is reported in Table 2.1. A five-year period is applied to estimate PPP theoretical values and calculate past cumulative exchange rate deviations. Exchange rate corrections to cumulative deviations from PPP, or historical values, are observed in the three-year period following the deviations. Detailed regression estimates obtained from each of the fifty-six bilateral rates are reported in Appendix 1, Tables A1.1 to A1.8, organised in order of the eight domestic currencies used in the study.

Table 2.1 Key Statistics of Regression Estimates on Exchange Rate Corrections to Cumulative Deviations from PPP

For each of the eight term currencies, key statistics obtained from regression estimations of each of the seven commodity currencies are averaged and reported. Domestic currencies are listed in the first row of the table. Coefficient β_1 measures the extent to which cumulative exchange rate deviations from PPP over a five-year period are corrected in the following three-year period. An estimation of -0.57 indicates a 57% correction to the cumulative deviation. Coefficient β_2 measures the correction to random movements of the exchange rates in the past five years. Coefficient β_3 indicates the relationship between future exchange rate movement and its expected adjustment towards PPP over the past five years. Adjusted R-square statistics for three regression estimations are also reported here. PPP theoretical values are estimated from relative price changes in two countries over a five-year period. Data covers the period from January 1979 to January 2001 for most of the currencies, with the Australian dollar and New Zealand dollar related rates covering shorter periods due to their shorter floating history. Detailed statistics obtained from testing each of fifty-six currency pairs can be found in Tables A1.1 to A1.8 of Appendix 1.

Base Currency	A$	C$	GM	NZ$	SF	UK£	Yen	US$	Ave.
β_1	-0.57	-0.55	-0.46	-0.67	-0.48	-0.52	-0.55	-0.42	-0.53
β_2	-0.48	-0.59	-0.35	-0.84	-0.33	-0.47	-0.40	-0.51	-0.50
β_3	-0.33	-0.81	-0.01	-0.20	0.10	-1.19	-0.36	-0.07	-0.36
Adj-R^2_1	34.6	46.2	32.7	53.8	38.4	41.7	35.1	27.3	38.7
Adj-R^2_2	27.2	41.3	29.2	66.5	29.1	29.1	23.2	29.1	34.3
Adj-R^2_3	10.9	15.5	12.3	2.6	13.0	22.8	16.3	6.9	12.5

From Table 2.1, it can be seen that the average values of the slope coefficient estimates from Equations (2.1) is -0.53, indicating that, on average, 53% of the cumulative exchange rate deviations from PPP were corrected over a three-year period. The estimated slope coefficients from Equation (2.2) are also negative, averaging at -0.50 across the currencies. This suggests that, on average, approximately 50% of the random exchange rate movements over the past five-year period reversed towards their historical levels in the following three-year period. The average coefficient estimates of the slopes from Equation (2.3) is -0.36. This indicates that the exchange rate adjustments towards PPP, which were expected but not realised in the past five-years, were observed to have been corrected by 36% in the next three-year period. By referring to the adjusted t-statistics reported in Tables A1.1 to A1.8, cumulative exchange rate deviations have significant power in explaining exchange rate movements in subsequent periods. Furthermore, the reversion of random exchange rate movement has more explanatory power than the force of PPP, as indicated by the statistical significance levels of slope estimates as indicated by the t-statistics adjusted for overlapping observation. For the 56 tests across individual currency pairs, all of the slope estimates of Equation (2.1) are negative and 42 are statistically significant at the 10% level or above.

According to Hansen and Tuypens (2004), R-square is a consistent indicator of the explanatory power of a regression model if the ratio of forecast horizon to sample size is close to zero. In the above tests, the ratios vary between 0.13 and 0.30. Refer to the R-square statistics reported in Table 2.1, we can see that the equation incorporating both the random movement and the adjustment towards PPP have higher explanatory power than do the individual regressions of each effect. Also the model which considers the reverting property of the random exchange rate movement shows greater explanatory power than the model which incorporates only the power of PPP. The joint consideration of the two components contributing to exchange rate fluctuations results in the highest adjusted R-square, with an average of 38.7%.

The overall evidence indicates that exchange rate fluctuations are largely a result of reversals of historical movements. Further, the expected adjustment of the exchange rates in response to price changes in the relevant countries also contributes to exchange rate movement. Of the two factors which influence future exchange rate movement, the reverting property of random exchange rate movement seems to dominate the adjustment mechanism. More importantly, when the two components are combined to form a uniform measure on the cumulative exchange rate deviation from PPP, significant power is found in predicting the future exchange rate movement.

To summarise, the test results indicate that cumulative exchange rate deviations from PPP tend to be reversed by half in the subsequent three-year period. This finding is consistent with Abuaf and Jorion (1990) and Macdonald (1995). Estimated slope coefficients of New Zealand dollar rates are averaged to -0.67, which is significantly higher than the average estimation of -0.42 from US dollar rates. This finding indicates that cumulative deviations from PPP in New Zealand dollar rates were corrected faster than those in US dollar rates. This may be due to the fact that New Zealand is more reliant on international trade than is the US. Further, the identified predictive power of cumulative deviations from PPP seems to be more reliable in New Zealand dollar rates than in US dollar rates. This finding is indicated by the average 53.8% adjusted R-square observed in relation to the New Zealand dollar rates, as opposed to the 27.3%

adjusted R-square observations in relation to the US dollar rate tests. This indicates that the adjustment mechanism may operate more powerfully for some currencies than for others.

The results will, of course, be more robust if the prediction technique is relatively insensitive to the time frames adopted for accumulating deviations from PPP, and to the future periods over which the prediction is applied. The test on exchange rate corrections to cumulative deviations from PPP is, therefore, repeated using Equation (2.1) over a range of time intervals. A summary of the test results is presented in Table 2.2, with detailed statistics presented in Appendix A1.9 to A1.26.

Table 2.2 Summary Statistics of Regression Estimations on Reversals of Cumulative Deviations from PPP across Different Time Intervals

Estimations of coefficient β_1 are reported, followed by adjusted R-square statistics presented in parenthesis. Reported values are averages across the different currencies. Deviations from PPP theoretical values are estimated over a three, four, five, six, seven, or eight year period, which are listed in the first row of the table. Corrections to PPP deviations are measured over a three, four, or five year period, as listed in the first column of the table. Logarithm data are applied covering the period Jan. 1979 to Jan. 2001 for currency pairs not involving the Australian dollar, or the New Zealand dollar. The Australian dollar and New Zealand dollar related exchange rates cover shorter periods due to their shorter floating history. Detailed statistics on test results of individual bilateral rates can be found in Tables A1.10 to A1.25 of Appendix 1.

Est. β_1	3 Years	4 Years	5 Years	6 Years	7 Years	8 Years
3 Years	-0.41 (24.6)	-0.48 (35.4)	-0.53 (39.1)	-0.52 (30.4)	-0.41 (19.8)	-0.35 (13.5)
4 Years	-0.54 (34.0)	-0.58 (41.5)	-0.57 (35.5)	-0.50 (26.3)	-0.46 (19.5)	-0.50 (18.9)
5 Years	-0.58 (33.8)	-0.53 (36.5)	-0.48 (28.3)	-0.46 (24.0)	-0.46 (22.1)	-0.44 (18.3)

As can be seen from Table 2.2, the coefficient estimates of the slopes averaged across the currencies are all negative for the different deviation accumulation periods and the correction periods. The average reversals to cumulative deviations ranged between -

0.35 and -0.58. This indicates that 35% to 58% of the exchange rate deviations from PPP accumulated over the three- to eight-year periods is reversed in the subsequent three- to five-year period. For exchange rate reversals happened in a three-year period, the five-year deviation accumulation period test is the most powerful test[7]. Refer to the results reported in Table A1.15 of Appendix One, for the tests on three-year reversal to five-year cumulative exchange rate deviations, all of the slope estimates are negative. Among the 28 estimates, 22 are statistically significantly different from zero at the ten percent level or above. The tests on the three-year reversal to cumulative deviations in the past five-year period have an average, adjusted R-square of 39.1. These results indicate that the predictive power of cumulative exchange rate deviations from PPP is reliable, and is not particularly sensitive to the time frames adopted for accumulating deviations from PPP, or to any predictions.

The overall results indicate that exchange rate movements are significantly negatively associated with the historical deviations accumulated over the years, although the correction speed varies across different currencies. Based on this observation, it is expected that a consistent negative relationship may exist across all currencies. In the next section, the test on research Hypothesis 2.1 will be repeated using the pooled data of exchange rate deviations and the future movements observed from individual currency pairs. An attempt is made to discover a uniform relationship applicable to any currency under this study. The finding on such a uniform relationship is interesting, because investment decision rules can then be developed for use by investors based in any of the countries covered by this study.

[7] Jegadeesh (1991) showed that for a class of regression tests on multiple-period observations, the most powerful test under the null was the one that maximized the slope. Therefore, the number of observation intervals should be chosen so that estimated slope is maximised.

2.6.2 Results of Tests on all Currency Pairs and Discussions on Data Problems

The testing of Hypothesis 2.1 is repeated using the pooled data of cumulative deviations and subsequent corrections observed across all currency pairs. The data set has 11,440 observations. The exchange rate deviation data series and the correction data series are standardised to percentage values across the currencies. First, the OLS estimates of Equation (2.1) is conducted on the pooled data set, with no corrections to serial correlation and overlapping observations. The results are reported in Table A1.27 of Appendix One.

From the Table A1.27 of Appendix One, the Durbin-Watson statistic of 0.067 indicates that serious positive autocorrelation is present in the sample. This implies that although the point estimates of coefficients are unbiased, standard error estimates are biased downward. The augmented Dickey-Fuller test is conducted on the data of both dependent and independent variables. Detailed results of unit root tests are presented in Table A1.28 of Appendix One, showing rejections of unit roots in both dependent and independent variables. To correct serial correlation in the linear regression estimation, the Cochrane-Orcutt (CO) procedure is applied to re-estimate Equation (2.1). Furthermore, non-overlapping observations are used for OLS estimates. Table 2.3 compares the results from CO procedure with the OLS estimations obtained from using both overlapping and non-overlapping data. Standard t-statistics have been scaled down to adjust for overlapping observations.

Refer to Table 2.3, comparing the results obtained from using different procedures, the estimates of regression slopes largely agree with each other, ranging from -0.35 to -0.41. All of the estimates are statistically significant at the one percent level. The negative slope estimates suggest that, in general, part of the five-year cumulative exchange rate deviations were corrected in the subsequent three-year period. The adjusted R-squares from the pooled data tests are much lower than those obtained from the individual currency tests. This is expected because the observed negative relationship is expected to be stronger and more consistent within the currency pairs than across all of the currencies.

Table 2.3 Regression Estimations on Exchange Rate Correction to Cumulative Deviations – Tested across All Currencies

Regression Equation (2.1) is applied to test the relationship between the future exchange rate movement and the cumulative historical deviations. Observations from all currency pairs are standardised by taking percentage values and pooling them to conduct this test. Percentage five-year deviation is treated as the independent variable. Percentage correction over a subsequent three-year period is treated as the dependent variable. There are in total 11,440 observations. The Cochrane-Orcutt estimations are reported, as well as the OLS regression results. Reported t-statistics for the overlapping OLS and the CO procedure have been adjusted by dividing the square root of forecast horizon.

		OLS Regression (overlapped observation)	**Cochrane-Orcutt Procedure**	**OLS Regression** (non-overlapped observation)
α_1	Estimation	0.03	0.03	0.09
	t-Statistic	17.21	2.33	5.45
	P-Value	0.00	0.02	0.00
β_1	Estimation	-0.35	-0.38	-0.41
	t-Statistic	-9.20	-8.41	-7.42
	P-Value	0.00	0.00	0.00
Adjusted R^2		0.18	0.21	0.23
Durbin-Watson		0.13	2.01	2.21

The overall results suggest that about 40% of the exchange rate deviations from PPP, accumulated over the previous five-year time period, were corrected in the subsequent three-year period. Around 20% of exchange rate movements can be explained by their historical cumulative deviations from PPP. This general relationship applies to all currency pairs under study here.

2.7 Conclusions

This chapter points out that divergences of exchange rates from PPP accumulated over a five-year period were, overall, partially reverted over the subsequent three-year period. The observations of such reversions have both economic and statistical significance, offering further evidence in support of the long-term validity of PPP. The study also finds that exchange rate movements in previous period tend to be reversed, while adjustments towards PPP complement this process.

The findings also indicate that cumulative exchange rate deviations from PPP may provide reliable information in predicting future exchange rate movements. This knowledge can be valuable when applied to foreign exchange market practices. In the next two chapters, the self-correcting nature of cumulative exchange rate deviations, demonstrated above, will be applied to two important practical areas in finance: international equity portfolio management, and foreign exchange transaction exposure management. It is expected that these applications may help investors and corporations to better capture gains from favourable exchange rate movements and avoid losses associated with adverse changes of future exchange rates by predicting directional movements of exchange rates based on the current knowledge about cumulative exchange rate deviations from PPP. The following chapters are devoted to formal examinations and discussions on these practical applications.

Chapter 3

Enhancing International Diversification Benefits: A Market Selection Approach to Managing Currency Risk

3.1 Introduction

Currency risk often confounds international equity diversification benefits, as recognised by Eun and Resnik (1988), amongst others. The literature offers two approaches to reducing currency risk, while retaining the benefits from investing globally. The first approach is to incorporate exchange rate fluctuations when calculating optimal asset weights. The second approach is to hedge foreign asset positions, passively or actively, using derivative contracts such as currency forward contracts.

The first approach to currency risk control offered in the literature has a difficulty that is inherent in the portfolio formation methodology. That is, it requires ex ante estimations on correlation matrices of currency and asset returns. Since such relationships are unstable over time, the expected optimal portfolio structures obtained from historical estimations may not necessarily be optimal in the presence of estimation errors created by using the optimal portfolio methodology. Eun and Resnick (1985), among others, claim that ex post estimations on optimal asset weights are not stable over time, indicating that backward-looking techniques may not be capable of providing reliable gains from international diversifications.

The second approach to currency risk control involves using derivative contracts, but this generates extra costs. Furthermore, the effectiveness of hedging strategies has found mixed support in empirical studies. For example, Eun and Resnick (1988, 1994) and Glen and Jorion (1993) showed that forward hedging strategies have increased diversification benefits, while Tezel and McManus (1998) argued that hedging resulted in deterioration in the performance of international portfolios.

This study proposes a new approach to managing exchange risk associated with international equity diversification. The strategy applies a forward-looking technique based on forecasts of the directional exchange rate movements developed from the findings of Chapter Two. Based on the findings of Chapter Two, holdings' international assets which are denominated in currencies at high risk of losing value during the term of the investments are explicitly excluded. A currency is regarded as having a high risk of losing value if it is over-valued against PPP. The motivation behind this strategy is to reduce portfolio risk associated with losses in currency values.

As proposed by Abuaf and Jorion (1990), and demonstrated in Chapter Two, the cumulative divergence between the exchange rate and PPP equilibrium tends to be reduced in a subsequent period. This means that it may be beneficial to incorporate these exchange rate predictions into decisions concerning the construction of international equity portfolios. Therefore, a strategy for selecting international markets, before seeking to diversify, is proposed in this chapter. This strategy only requires that offshore assets denominated in currencies not over-valued, be included into a portfolio. The key idea is to maintain diversification benefits, but to avoid excess currency risk associated with likely corrections to cumulative exchange rate deviations from PPP during the term of investment. As exchange rate movements are large in comparison to relative movements in stock market indices, the benefit from the strategy can be expected to outweigh the diversification benefits lost through reducing the potential number of asset choices.

A foreign currency is considered to be over-valued if the cumulative exchange rate deviation from PPP is positive for an exchange rate, expressed in terms of the home currency price of one unit of a foreign currency. The proposed diversification strategy requires that the national stock markets corresponding to the over-valued currencies should not be purchased in order to reduce exchange risk.

This strategy, as it has been developed upon a robust empirical finding of foreign exchange market behaviour, provides a new approach to managing currency risk associated with international portfolio diversifications. The new approach has advantages over the traditional techniques in that it is forward-looking, is easy to calculate and is simple to carry out in practice.

In this study, the global equity market is represented by national stock markets of the eight countries discussed in Chapter One, namely: Australia, Canada, Germany, Japan, New Zealand, Switzerland, the UK and the US. MSCI country indices are used as proxies for national stock market performances. The performance of the proposed portfolio strategy will be examined against three benchmarks, assuming a three-year investment holding period. These are: the naïve totally diversified portfolio, the MSCI world index portfolio and the domestic-only portfolio. Examinations will consider the viewpoint of domestic investors in each of the eight countries. The average annualised holding period returns of the portfolios are calculated using quarterly data for the period 1991:Q1 to 2004:Q4. Portfolios tested are equally weighted rather than market-value weighted, as size disparities between markets would render analysis of market weighted portfolios meaningless.

The finding here is that the proposed strategy improves investment returns and reduces investment risk, outperforming the other strategies on a risk-adjusted basis. These results are in contrast to the conventional view that adding more assets leads to greater diversification benefits. The study shows that the proposed strategy produces portfolios which hold, on average, 4.4 equity markets, as opposed to the eight markets held by the two benchmark international portfolios. Improved portfolio returns realised by using the proposed portfolio strategy are the result of effectively controlling currency risk.

3.2 Literature Review

3.2.1 Benefits of International Diversification

Modern portfolio theory suggests that diversification provides the benefit of risk reduction. As was demonstrated by Markowitz (1952), holding a portfolio of non-perfectly positively correlated assets can provide a better risk-return trade-off than investing in a single asset. International asset prices, determined by different economic fundamentals across nations, tend to be less correlated than are domestic assets. Therefore, international diversification is expected to offer domestic investors greater diversification benefits than investing in a purely domestic portfolio would do. Following this logic, Grubel (1968) confirmed the diversification concept of including foreign assets, and reported that international diversification provides additional economic benefits. Levy and Sarnat (1970) and Saunders and Woodward (1977) provided further evidence of international diversification benefits.

Solnik (1974) claimed that internationally diversified stock portfolios can eliminate almost half of the risk found in domestic stock portfolios when viewed from the perspective of investors based in the US, Germany, or Switzerland. Eun and Resnick (1985) reported that substantial gains can be obtained through international diversifications for investors based in fifteen countries. Jorion (1989) provided evidence that holding international assets can reduce the US equity portfolio risk levels. Soenen and Lindvall (1992) found that international diversification leads to significant risk reductions from different countries' perspectives. Diversification benefits in terms of increased returns, however, are only evident for investors based in some of the countries, not all.

Odier and Solnik (1993) provided evidence of both risk reduction and return enhancement from international diversification for US, Japanese, German and British investors in the 1980s. Bugar and Maurer (1999) reported similar results for German and Hungarian investors. Kempa and Nelles (2001) studied international stock market diversification benefits of EMU countries for the period 1994 to 1997 and provided more supportive evidence. They reported that internationally diversified portfolios have generated between 0.17% and 32.58% of returns in excess of that obtained from purely domestic investment.

Nonetheless, the level of international diversification benefits may not be stable. This is due to the changing nature of international financial markets. Erb, Harvey and Viskanta (1994) and Shawky, Kuenzel and Mikhail (1997) made observations of increasing global stock market correlations over time. They argued that international diversification benefits may decrease as a result of the integration of global financial markets. Harvey (1991) reported that correlation coefficients of dollar returns from major stock markets vary between 0.12 and 0.86 for the period of 1970 to 1989. Much higher correlation coefficients are, however, observed by Bodie, Kane and Marcus (2005) for the period of 1996 to 2001. These vary between 0.46 and 0.95. Kalra, Stoichev and Sundaram (2004) provided further evidence on unstable correlations between national stock market returns. They observed increasing correlations since 1988. Longin and Solnik (2001) found that international equity market correlations increase in bear markets. Meyer and Rose (2003), however, reported that international diversification still benefits investors during periods of market crisis.

Yang, Khan and Pointer (2003), on the other hand, argued that the increasing integration of global stock markets with the US market is only observed in small markets, and not in major ones. De Santis and Gerard (1997) argued that international diversification benefits continue to be significant over time. They reported that over the period from 1970 to 1994, US investors earned an average of 2.11% annual excess returns through diversifying equity holdings in G7 countries and Switzerland.

Most of the international portfolio studies require ex ante estimation on optimal asset structures using realised historical data, causing estimation error of optimal portfolio structures. Shawky, Kuenzel and Mikhail (1997) argued that unstable correlations between national stock markets make it hard for investors to construct optimal portfolios, ex-ante. Therefore, investors are not likely to fully capture potential gains from international diversifications. Bodie, Kane and Marcus (2005) also argued that constructing optimal portfolios using realised historical returns has exaggerated diversification benefits and lack practicality in real-life. Eun and Resnick (1985) showed that ex post estimations on optimal asset allocations are not stable over time, and exchange rate volatilities erode some diversification benefits, although they hold that diversifying internationally remains beneficial overall.

3.2.2 Currency Risk of International Portfolio Diversifications

Exchange rate fluctuations have been recognised in the literature as having confounding effects on the performance of internationally diversified portfolios. An early study by Biger (1979) claimed that international diversification efficiencies are dominated by correlations among the local markets ignoring currency effects. He also argued that exchange rate fluctuations do not have much influence on diversification effects. Eaker, Grant and Woodard (1991) showed, however, that currency fluctuations significantly increased the international portfolio risk of Japanese and US investments. Odier and Solnik (1993) reported that currency risk contributes 10 to 15% to the risk of a global portfolio. Eun and Resnick (1985) found that exchange rate movements have reduced diversification gains for investors based in most of the countries, but had increased the gains for investors based in some countries.

Eun and Resnick (1988) reported that currency fluctuations adversely affect investment returns to US investors holding foreign equity assets from six countries. They claimed that, since the dollar exchange rates are highly correlated, the exchange risk is largely unable to be diversified. Kaplanis and Schaefer (1991) provided further evidence that exchange risk has eroded part, or all, of the benefits from international diversification. Ajayi and Mougoué (1996) found that currency fluctuations have a negative influence on stock market performance. Johnson and Soenen (2004) observed contemporaneous positive correlation between the movements of the US stock markets and the changes in the US dollar value, in terms of seven foreign currencies. The overall evidence discussed above indicates that currency fluctuation is a significant risk factor in global stock market diversification for most of the countries and periods studied.

Recognising that currency fluctuations may impair gains from international diversifications, various strategies have been developed to control exchange rate risk while retaining the benefits of investing internationally. One approach in the literature is to incorporate exchange rate variations when constructing optimal portfolios. This technique calls for ex post estimations of correlations between stock market returns, after adjusting for exchange rate fluctuations. As discussed before, the technique is exposed to estimation errors and lacks practicality in real world.

Alternatively, the currency risks of international portfolio diversification can be managed by hedging using derivative products, among which the forward contract is often recommended in the literature. Eun and Resnick (1988) showed that, for the period between 1980 and 1985, some ex ante forward hedging strategies have significantly improved international portfolio returns to US investors holding equity assets from six major developed markets. The use of currency forward contracts also provides the benefit of risk reduction on international portfolio investments. They reported that hedging increases returns of equally weighted international stock portfolios, on average, by 0.058% per week, which is equivalent to 3.0% annual excess returns, over the unhedged portfolio (Eun and Resnick, 1988). Jorion (1989) provided further evidence that hedging foreign asset positions improves portfolio return.

Eaker and Grant (1990) showed that passive hedging using futures contracts reduces international portfolio risk, however, this is at the cost of lower returns from the US point of view. They found that hedging selectively at forward premiums leads to improved portfolio performance in terms of both risk reduction and return enhancement. Using forward contracts to hedge, Glen and Jorion (1993) also found supportive evidence on the efficiencies of passive hedging strategies. Their study on international portfolios of five major developed markets over the period 1974 to 1990, used a hedging strategy which calls for actively adjusting hedging positions according to ex ante estimations of optimal hedge ratios. This strategy can increase portfolio returns by 0.30% per month, which is equivalent to 3.56% per annum. Portfolio return volatilities, however, increase at the same time. The hedging efficiency measured by the Sharpe ratio is inconclusive.

Kaplanis and Schaefer (1991) showed that currency hedging with perfect prediction on hedge ratios leads to substantial risk reductions. They admitted, however, that applying hedge ratios estimated ex post may not be able to offer the same benefit. Gardner and Stone (1995), however, argued that estimation error inherent in estimated the optimal hedging ratio is too large to have any practical use for investors who have low to medium tolerances towards risk.

Eun and Resnick (1997) offered more evidence on the usefulness of currency hedging via forward contracts. They found that two conditional forward hedging, or trading, strategies can improve international portfolio performances. One strategy is to hedge forward only when forward contracts are trading at premiums, and another one is to take long speculative forward positions when forward contracts are trading at discounts. The positive evidence obtained from these strategies implies that forward premiums and discounts can provide valuable insights to investors making hedging decisions. Morey and Simpson (2001a) introduced a hedging strategy conditional on large forward rate premiums and found that the strategy outperformed other hedging strategies. They also found that *never-hedge* strategies outperformed *always-hedge* strategies. Van der Linden, Jiang and Hu (2002), Topaloglou, Vladimirou and Zenios (2002) and Thorp (2005) provided further evidence on forward hedging efficiencies.

Eun and Resnick (1994), on the other hand, presented mixed evidence on the hedging efficiency of international portfolio diversification from two countries' perspectives. They reported that, while US investors enjoy benefits of forward hedging, Japanese investors receive little benefit from currency hedging. Levy and Lim (1994) found conflicting evidence on hedging efficiencies during two different periods of the 1980s. This suggested that the benefits of passively hedging activities are not consistent over time.

De Roon, Nijman and Werker (1999), however, reported that static forward hedging does not improve stock portfolio performance for US investors. Soenen and Lindvall (1992) reported that, although currency hedging reduces portfolio risk, a price is paid in terms of lower returns. They further argued that *currency* exposures can be controlled through holding multi-currency assets, making currency hedging unnecessary. Tezel and McManus (1998) reported evidence that currency hedging has worsened the performance of international portfolios. Grandmont-Gariboldi and Soenen (2000) presented further evidence against hedging efficiencies.

3.2.3 The Power of PPP as an Indicator of Future Exchange Rate Directional Movements

Purchasing power parity is a fundamental exchange rate determination theorem. Both the existing literature and the findings in Chapter Two indicate that cumulative exchange rate deviation from PPP tends to be corrected in the future. Key literature on this topic includes, Abuaf and Jorion (1990), Coakley and Fuertes (1997) and Sarno and Taylor (1998), although their estimations of half-lives of PPP deviations differ slightly.

In general, the literature confirms that international diversification benefits domestic investors in terms of risk reduction, and sometimes also in terms of return improvement. Further, currency fluctuation is recognised as a significant factor which may confound diversification benefits. The literature also provides a robust finding of foreign exchange market regularity, in that, exchange rates often move in opposite directions to their deviations from PPP. This observation implies that parity deviations can provide reliable information on future exchange rate movement directions.

Nevertheless, the literature has, thus far, paid no attention to application benefits available to international investors from utilising information about exchange rate deviations from PPP. To fill the gap, this chapter offers an innovative approach to managing currency risk associated with international portfolio diversifications. This approach controls currency risk through market-selection, when constructing portfolios, by incorporating the expected corrections to cumulative exchange rate deviations from PPP. The procedure will be developed and discussed in detail and the strategy's efficiency will be formally examined using empirical data from the perspective of eight different countries.

3.3 A Strategy for Effective International Equity Diversification

Given that currency risk is a significant factor of international portfolio risk, this study proposes an active portfolio-constructing strategy, which incorporates exchange rate disparities from PPP. The motivation is to improve international portfolio performance through controlling the downside risk of holding assets denominated in currencies which are more likely to depreciate.

To include a national market into the internationally diversified portfolio, it must meet the criterion that the country's currency is correctly priced, or undervalued, relative to the investor's home currency. By avoiding assets denominated in currencies having high risk of devaluation, domestic investors may reduce the currency risk component of overall portfolio risk. Even though the number of assets held by the portfolio will be reduced following this rule, investors may still be able to capture most of the possible diversification benefits by splitting funds over assets denominated in other currencies.

The portfolio constructing criterion can be simplified as:

A foreign stock market is selected into an internationally diversified portfolio if, and only if, $DSt \leq 0$.

where DS_t measures the divergence of the exchange rate from PPP, calculated using Equation (3.1):

$$DS_t = S_t - PS_t \tag{3.1}$$

where S_t is the observed actual exchange rate and PS_t represents the estimated PPP rate, should PPP hold over the past five years, calculated using Equation (3.2):

$$PS_t = S_{t-5} * \frac{(1+i)}{(1+i^*)} \tag{3.2}$$

where S_{t-5} represents the actual exchange rate observed five years ago; and I and i* stand for the five-year cumulative inflation rates of the home country and the foreign country, respectively. Exchange rates are expressed in terms of domestic prices for one unit of the foreign currency. A five-year period is used for estimating cumulative exchange rate deviation from PPP, as it was found in Chapter Two that the five-year deviation accumulation period provides the most reliable results when predicting exchange rate corrections over the subsequent three-year horizon.

Note that equity assets of domestic markets are not necessarily included in the diversified portfolios at all times. The condition for domestic asset inclusion is: to include a domestic asset if, and only if, at least one foreign currency exists that is overvalued against the domestic currency. As a domestic currency is considered to be risky if it is overvalued against all of the other seven currencies, holding a domestic asset should be avoided. It is assumed that funds are equally weighted among national markets held in the portfolios.[8] For demonstration purposes, investment horizons are assumed to be three years (twelve quarters), which is a common term for medium-term investments. It is also assumed that there is no rebalancing[9] within each holding period.

For ease of expression, an international equity portfolio constructed under the proposed portfolio strategy is referred to as a *PPP-efficient portfolio* (PPPEP). The strategy is termed a *PPP-efficient strategy*. Determined by the portfolio strategy, the total number of national markets included in PPP-efficient portfolios varies from time to time, with a maximum of eight markets (the total number of markets under considerations). In fact, averaged across the investors' origins, the PPP-efficient portfolio holds only 4.4

[8] This procedure is applied in order to avoid the dominating effects that US and UK markets have under the market-value weighting scheme.

[9] Kalra, Stoichev and Sundaram (2004) found that periodic rebalancing and associated transaction costs greatly reduced international diversification benefits.

national markets. This may be an indication that, by incorporating directional predictions on exchange rates, diversification efficiency has improved.

Compared to the Markowitz mean-variance efficient portfolio model, the proposed market-selecting portfolio strategy has three major advantages. First, under the proposed portfolio strategy, portfolio decisions can be made by analysing one simple criterion which explicitly incorporates exchange risk. The criterion is set upon the economic observation that cumulative exchange rate deviations from PPP tend to be corrected. Construction of mean-variance efficient models, however, relies on complicated mathematic calculations. Second, mean-variance efficient portfolio estimations rely on ex post empirical data, assuming that historical relationships among national stock market returns and currency returns can be maintained into the future. As was discussed in the literature review, this assumption seems unrealistic. The proposed portfolio strategy, on the other hand, is forward-looking. Third, while the mean-variance efficient portfolio model requires intensive calculation, the proposed portfolio strategy only requires minimum calculation. Therefore, the selective portfolio strategy proposed by this study is more appealing theoretically, and also more easily applicable in practice.

It is noteworthy that the methodology used to estimate the PPP rate in this study differs from the existing literature. Previous studies often use fixed base periods, making assumptions on foreign exchange market *equilibrium periods.*[10] This study argues against those approaches on two grounds. First, arbitrary choices of market equilibrium

[10] Morey and Simpson (2001a) choose the period from Jan. 1980 to Dec. 1982 as the base period for their PPP rate calculations. Their choice of exchange rate equilibrium period is based on findings by Hakkio (1992). This study, however, does not intend to join the argument regarding exchange market equilibrium periods.

periods are hard to justify in the presence of structural breaks observed by studies in foreign exchange markets resulting from permanent shifts of country-specific economic fundamentals. Consequently, historical exchange rates and national price levels could be of little relevancy to today's exchange market. Second, misspecifications in *equilibrium periods* may lead to severe biases in PPP estimations, which, in turn, will bias portfolio decisions. By using a five-year estimation period to estimate the PPP rate, the observations of this study may be less subject to distortions resulting from permanent shifts experienced by the exchange markets.

A robustness check on the strategy efficiency is then conducted by repeating the strategy using a ten-year PPP rate estimation and an historical exchange rate deviation accumulation period. The results are reported in Appendix 2. As will be reported, consistent findings are obtained from employing different estimation periods, indicating that the conclusions of this study are largely independent of estimation period choices.

3.4 Research Data Description

Three sets of data were collected from Datastream; currency exchange rates, country inflation rates and national stock market prices represented by MSCI country indices. The MSCI world index is used as a benchmark. Since total return index data are not available for all the countries, return index data that exclude dividend yield were collected. All data was collected at quarterly intervals covering the period from 1986:Q1 to 2004:Q4 (inclusive) for the eight markets selected in Chapter One. These are: Australia, Canada, Germany, Japan, New Zealand, Switzerland, the UK and the US.

The year 1986 is chosen as the starting point of the study to allow the New Zealand dollar to establish an equilibrium level following its float in 1985. Portfolio formations based on the diversification strategy started from 1991:Ql to allow for the five-years of data needed for estimating cumulative PPP deviations. The data set for each domestic country ends up with forty-four (overlapping) single-period return observations, sufficient to cover at least one whole cycle of ups and downs in the stock markets and foreign exchange markets. For PPP rate estimations based on a ten-year period, the strategies start from 1996:Q1, providing twenty-four overlapped single-period return observations for investors based in each of the countries under study.

3.5 Portfolio Performance Evaluating Methodologies

International stock market investment returns are composed of two parts: (1) local stock market returns in terms of local currencies, and (2) returns from foreign currency movements against the domestic currency. Single period returns to domestic investors (R_H) holding a foreign equity asset over one period can be calculated by the use of Equation (3.3):

$$R_H = \frac{S_{t+3} * X_{t+3}}{S_t * X_t} - 1 \qquad (3.3)$$

where X represents national equity asset price levels in terms of local currencies; and S stands for exchange rates expressed in terms of domestic prices of one unit of a foreign currency. The subscript, *t+3,* indicates the observations three-years ahead, representing the investment horizon under this study.

Three benchmarks are chosen for portfolio performance evaluations. The first one is a hypothetically constructed total diversification portfolio: the *global portfolio* (GP), which includes equal weights of the eight markets. The second benchmark is the MSCI world index portfolio (MWIP), a free float-adjusted market capitalisation index. The final benchmark is the domestic-only portfolio (DOP).

Annualised single-period returns are calculated for the PPP-efficient portfolios and the three benchmark portfolios. T-tests are applied to test the equalities between returns from the PPP-efficient portfolios and the benchmark portfolios. The null hypothesis of the t-test is: the PPP-efficient portfolio return has the same mean value as that of a benchmark portfolio. The t-statistics will be reported, which are not adjusted for overlapping observations[11], therefore, should be interpreted with caution because of the use of non-independent overlapping observations.

Assessments on overall portfolio performance follow the Eun and Resnick (1988) definition of Sharpe measurements (SHP), which is effectively the reward-to-risk ratio, as defined by Equation (3.4)[12]:

$$SHP = R_p / \sigma_P \tag{3.4}$$

where R_p stands for the average portfolio return and σ_P represents portfolio risk measured by the standard deviations of the portfolio returns.

Under the central limit theorem, the combination of sample mean and variance can provide sufficient information on sample distributions. This study, however, has a limited sample size. Further, as evident in most other financial studies, the majority of return series in this study exhibit non-normal distributions. As a result, mean-variance

[11] The method of adjusting t-statistics proposed by Phillips (1986), Valkanov (2003) and Hjalmarsson (2004) requires that the ratio of number of overlaps to the sample size is close to zero. This condition is not satisfied here.

analysis may lead to misleading conclusions. Moreover, the reward-to-risk measure only considers risk compensation on the first moment of return variation and the ranking of portfolios may not be uniformly acceptable to investors with different attitudes towards risk.

In recognition of the limitations that mean-variance analysis may have, the second order stochastic dominance analysis is also applied to evaluate portfolio returns. The methodology was briefly discussed in Section 1.3. Strategy performances are evaluated taking the view points of investors based in each of the eight countries included in this study.

3.6 Characteristics of International Equity Markets

3.6.1 Correlations of National Stock Market Returns

Relationships between the eight national stock markets can be described by the correlation coefficients of the market returns in terms of US dollars (from the view point of US investors). The results are presented in Table 3.1.

Table 3.1 Correlation Coefficients of US$ Returns of National Stock Markets
The coefficients are estimated on quarterly stock market return data in terms of US dollar returns , realised between 1986:Q1 and 2004:Q4. All of the coefficients are significant at the 5% level.

	AUS	CAN	GERM	JAP	NZ	SW	UK
CAN	0.666						
GERM	0.586	0.649					
JAP	0.367	0.413	0.300				
NZ	0.753	0.538	0.463	0.396			
SW	0.453	0.458	0.663	0.396	0.417		
UK	0.662	0.658	0.743	0.280	0.525	0.684	
US	0.632	0.771	0.680	0.424	0.468	0.595	0.723

[12] Eun and Resnick (1988) assume zero risk-free rates.

Referring to Table 3.1, the national stock markets are positively correlated, indicating the integration of global stock markets. The results generally agree with previous findings in the literature, for example, those of Bodie, Kane and Marcus (2005). The estimated correlation coefficients vary between 0.28 and 0.77, and average to 0.55. The fact that the correlation coefficients are all less than one, and none are negative, suggests that some diversification benefits may be achieved through international diversification.

3.6.2 Risk-Return Characteristics of International Investments – The US Perspective

The literature provides evidence that investing overseas may enhance earning potential for domestic investors. Here the risk-return opportunity of investing in the foreign stock markets from the perspective of a US investor is examined. The results are reported in Table 3.2.

Table 3.2 Risk-return Characteristics of Investing Abroad – the US Viewpoint

Average annualised returns are reported in terms of foreign currency and domestic currency for US investors. Quarterly data are used covering the period 1991:Q1 to 2004:Q4. Risk is measured by standard deviation of the quarterly returns. FX risk measures exchange rate fluctuations against the US dollar. Total risk measures uncertainty of US dollar returns on foreign investments. Data are expressed in percentage terms. Cross-correlations are correlation coefficients between local stock market return and exchange rate returns against the dollar. ** and * indicate that the correlation coefficient is significant at the 1% and the 5% levels, respectively.

	AUS	CAD	JAP	NZ	GM	SW	UK	US
Local Market Return	2.92	2.91	2.74	-0.04	2.84	3.59	2.53	3.11
Return in US$	2.97	2.88	2.51	0.55	3.27	3.53	2.42	3.11
Local Market Risk	5.77	8.53	12.74	9.51	8.12	9.90	7.75	7.86
FX Risk	5.06	2.98	6.06	6.59	5.04	6.42	4.67	0.00
Total Risk in US$	8.26	9.87	11.94	11.75	10.80	9.00	8.21	7.86
Cross-correlation	0.14	0.33*	-0.40	0.02	0.13	-0.47**	-0.22	-

Referring to Table 3.2, a US investor may achieve higher returns from investing in Germany and Switzerland, but at the cost of higher risk. Risk associated with investing overseas comes from two sources: local stock market risk ignoring exchange rate fluctuations, and currency risk induced by unexpected changes in foreign exchange rates.

As shown in Table 3.2, exchange rate risk adds to the risk associated with foreign stock market returns in five out of the seven foreign markets, from the US viewpoint. The two exceptions are Japanese and Swiss investments, where currency fluctuations mitigated volatilities of local stock market returns in terms of the US dollar. These mixed findings are consistent with Eun and Resnick (1985).

3.6.3 Cross-correlations of Stock Market and Currency Returns

Table 3.3 reports cross-correlations between local stock market returns (in terms of local currencies) and returns of foreign currencies, taking the viewpoints of the eight different countries. The results show that cross-correlations between foreign stock market returns, in terms of local currencies and foreign currency returns, are found to vary within a range of -0.54 to 0.46, averaged to -0.01 across different country perspectives. Among the fifty-six estimations, half of the cross-correlation observations are positive, while the other half are negative. This suggests that currency fluctuations may reinforce foreign investment returns in some cases, but reduce the returns in other cases. This mixed evidence agrees with the findings of Eun and Resnik (1985).

Table 3.3 Co-movements of Stock Market and Currency Returns
Correlation coefficients are calculated based on quarterly data for the period from 1991:Q1 to 2004:Q4. Local stock market returns are estimated in terms of local currency returns. Changes in currency values are measured against the US dollar.

Markets	AUS	CAD	JAP	NZ	GM	SW	UK	US
Australia Based	-	-0.04	-0.13	0.00	-0.46	-0.51	-0.40	-0.20
Canada Based	0.00	-	-0.09	0.09	-0.10	-0.14	-0.26	-0.19
Japan Based	0.22	0.12	-	0.05	0.05	-0.30	-0.01	-0.45
New Zealand Based	-0.02	0.06	-0.03	-	-0.39	-0.51	-0.37	-0.14
Germany Based	0.36	0.44	0.22	0.34	-	-0.22	0.19	0.27
Switzerland Based	0.38	0.46	0.28	0.32	0.34	-	0.27	0.32
UK Based	0.29	0.28	0.16	0.18	-0.27	-0.34	-	0.12
US Based	0.13	0.33	0.03	0.14	-0.43	-0.54	-0.27	-

3.7 Strategy Performance and other Findings

3.7.1 Mean-Variance Analysis

Using the proposed international diversification strategy, at any point of time, a PPP-efficient portfolio can be formed by investing equally in the national stock markets denominated in currencies that do not have positive cumulative deviation from PPP over the past five years. Each month, a new portfolio can be formed, to be held for three consecutive years. Average annualised holding period returns from holding portfolios formed using the proposed selective diversification strategy being tested are simulated and compared with those of the benchmarks. The results are presented in Table 3.4. Percentage returns of PPP-efficient portfolios in excess of the benchmark portfolios are reported in Table 3.5.

Table 3.4 Portfolio Return Comparisons

Annualised portfolio returns are averages of portfolio returns that have been realised over the period from 1991 to 2004. Returns are presented in percentage terms. P-values from t-tests on comparing historical returns obtained under the proposed portfolio strategy against a benchmark portfolio are reported in parentheses. PPP-efficient portfolios are constructed based on five-year PPP rate estimations.

Base Country	**PPPEP** (PPP-efficient portfolio)	**GP** (global portfolio, equally weighted)	**MWIP** (MSCI world index portfolio)	**DOP** (domestic-only portfolio)
Australia	12.86	10.85 (0.002)	10.24 (0.056)	10.00 (0.005)
Canada	13.42	11.02 (0.000)	10.16 (0.002)	11.07 (0.006)
Japan	10.26	8.76 (0.002)	8.01 (0.032)	-2.41 (0.000)
New Zealand	14.18	9.51 (0.000)	9.10 (0.008)	8.32 (0.006)
Germany	12.19	10.57 (0.020)	10.01 (0.065)	9.22 (0.006)
Switzerland	11.60	9.24 (0.000)	8.69 (0.012)	13.30 (0.085)
UK	11.28	9.55 (0.000)	8.70 (0.006)	8.72 (0.001)
US	11.26	9.25 (0.000)	8.32 (0.002)	11.95 (0.549)

Table 3.5 Excess Returns of PPP-efficient Portfolio over the Benchmarks

The excess returns are calculated as: average annualised returns of a PPP-efficient portfolio minus that of a benchmark portfolio return. Average return data are from Table 3.4. Excess returns are presented in percentage terms. The PPP-efficient portfolios are constructed based on five-year PPP estimations. PPPEP stands for PPP-efficient portfolio, GP stands for the global portfolio, MWIP represents the MSCI world index portfolio and DOP is the domestic-only portfolio. The holding period is three years for all of the portfolios.

Base Country	**Returns in Excess over GP**	**Returns in Excess over MWIP**	**Returns in Excess over DOP**
Australia	2.01	2.61	2.85
Canada	2.41	3.27	2.35
Japan	1.50	2.25	12.67
New Zealand	4.68	5.08	5.86
Germany	1.62	2.18	2.97
Switzerland	2.37	2.92	-1.70
UK	1.72	2.57	2.56
US	2.01	2.94	-0.70

Referring to Tables 3.4 and 3.5, the average returns from holding the PPP-efficient portfolio (PPPEP) are substantially higher than those obtained by holding the global portfolio (GP) and the MSCI world index portfolio (MWIP). Depending on the country of origin of the investors, the PPP-efficient portfolio has realised average returns of 1.50 to 4.68% per annum in excess of that obtained from the global portfolio. The PPPEP returns are higher than the returns from MWIP, at between 2.18 and 5.08% per annum, varying according to the home country. The superior performance of the PPP-efficient portfolio appears to be significant both economically and statistically (at the 5% level, or better, in most cases). The evidence is consistent from the different countries' perspectives.

Comparing the performance of the domestic-only portfolio (DOP) with the PPP-efficient portfolio (PPPEP), the PPP-efficient portfolio strategy has realised higher returns for investors in six out of the eight countries under study. The strategy excess returns vary between -1.70 and 12.67%, from the different countries' perspectives. Japanese investors have harvested the highest gain from adopting the PPP-efficient diversification strategy. The US and Swiss investors would not have benefited from adopting the PPP-efficient portfolio strategy. The PPPEPs yielded slightly lower returns than the DOPs for both countries, although the results were not statistically significant at the 5% level.

The reason that the Swiss and US investors would not have benefited from any of the internationally diversified portfolios is probably due to the fact that the Swiss franc has been appreciating continuously (against the major currencies), and the US stock market[13] has performed extraordinarily well over the last two decades. By referring to Table 3.4, it appears that investors from the US and Switzerland failed to benefit from internationally diversifying their investments by following the MSCI world index, or by adopting a naïve diversification strategy. In fact, among the three international diversification strategies, the PPP-efficient strategy yielded the highest returns for US and Swiss investors.

Risks associated with international diversification are examined and reported in Table 3.6. Risk-adjusted returns measured by the SHP ratios of each portfolio strategy are calculated and presented in Table 3.7.

Table 3.6 Risk Comparison of Different Portfolio Strategies

Portfolio risks are measured by standard deviations of portfolio returns realised over the period from 1991 to 2004. Standard deviations are expressed in normal forms. PPPEP stands for PPP-efficient portfolio, GP stands for the global portfolio, MWIP represents the MSCI world index portfolio and DOP is the term for the domestic-only portfolio. The PPP-efficient portfolios are constructed on the basis of five-year PPP estimations. The holding period is three years for all of the portfolios.

Base Country	**PPPEP**	**GP**	**MWIP**	**DOP**
Australia	0.092	0.103	0.154	0.045
Canada	0.100	0.101	0.133	0.097
Japan	0.127	0.115	0.154	0.067
New Zealand	0.109	0.121	0.179	0.096
Germany	0.135	0.114	0.165	0.172
Switzerland	0.126	0.117	0.167	0.157
UK	0.100	0.094	0.126	0.114
US	0.102	0.090	0.118	0.148

13 Jorion and Goetzmann (1999) reported that averaged over the period 1921 to 1996, the US equities had experienced the highest real capital gains of 4.3%, among thirty-eight stock markets, compared with the 0.8% gain averaged across the other markets.

Table 3.7 Sharpe Ratio of Different Portfolio Strategies

The SHP ratios are reported as the risk-adjusted return performances of each portfolio strategy, examined over the period between 1991 and 2004. PPPEP stands for PPP-efficient portfolio, GP stands for the global portfolio, MWIP represents the MSCI world index portfolio and DOP is the term for the domestic-only portfolio. The PPP-efficient portfolios are constructed on the basis of five-year PPP estimations. The holding period is three years for all of the portfolios.

Base Country	**PPPEP**	**GP**	**MWIP**	**DOP**
Australia	1.395	1.057	0.666	2.236
Canada	1.339	1.086	0.763	1.147
Japan	0.809	0.763	0.522	-0.357
New Zealand	1.296	0.783	0.508	0.864
Germany	0.905	0.925	0.608	0.535
Switzerland	0.918	0.788	0.521	0.850
UK	1.129	1.013	0.690	0.764
US	1.100	1.023	0.705	0.810

Compared to the naïve diversified global portfolio, the PPP-efficient portfolio is less risky for investors based in Australia, Canada and New Zealand, but is riskier for investors based in the other countries. The overall evidence on risk-adjusted returns, however, indicates that the PPP-efficient international diversification strategy outperformed the naïve international diversification strategy from the domestic viewpoint in seven out of the eight countries, the only exception being the Germany-based portfolios.

When evaluated against the MSCI world index, the PPP-efficient portfolio reduced investment risk and improved the risk-adjusted return significantly. For investors based in Australia and New Zealand, the SHP ratios of the PPP-efficient portfolio are more than double that of a portfolio duplicating the MSCI world index. The superior performance of the proposed international diversification strategy is economically significant for all countries in the study.

Compared to the domestic-only portfolios, the PPP-efficient portfolios have reduced investment risk for the European and US investors. Risks are increased for investors based in the other four countries. SHP ratios for the PPP-efficient portfolio are higher than for the domestic-only portfolio for investments based in seven out of the eight countries, indicating the overall superior performance of the PPP-efficient portfolio strategy. The only exception is the Australian-based investment, where the higher returns obtained from applying the strategy are not enough to justify the increased investment risk.

In general, the empirical evidence obtained above suggests that the proposed PPP-efficient international diversification strategy leads to substantial diversification benefits for domestic investors in terms of improved returns and risk-adjusted returns. Further, the strategy has outperformed the naïve total diversification strategy and the MSCI world index portfolio strategy by increasing investment returns and, in some cases, reducing risks. Measured by the SHP reward-to-risk ratio, overall performance of the proposed diversification strategy exhibits significant improvements over the other diversification strategies.

According to Glen and Jorion (1993), adding more assets to a portfolio often improves portfolio performance. The superior performance of the proposed selective international diversification strategy, however, does not result from increasing asset holdings in the portfolio. It is observed that portfolios constructed under the proposed market-selecting strategy generally hold less than eight foreign assets most of the time. Averaged over time, and across the base countries, the number of equity markets held in individual portfolios is 4.4, and varies between 2.48 and 4.45 depending on the country studied. The numbers of markets held by portfolios constructed under the proposed strategy are significantly less than that held under the naïve diversification strategy and the strategy of duplicating the MSCI world index, which held eight markets all the time.

In conclusion, it is important to stress that these findings are not specific to the choice of estimation period for calculating exchange rate deviations from PPP. To demonstrate this point, the performance of portfolios constructed according to ten-year cumulative exchange rate deviations are also compiled, with the results reported in Tables A2.1 to A2.4 of Appendix 2. These results are generally consistent with the findings discussed above. The results are even more promising, as the SHP ratios achieved by following the PPP-efficient diversification strategy are more than double the SHP ratios obtained from applying the MSCI world index strategy for investors based in every country. The results using a ten-year exchange rate deviation rule show that the findings appear to be robust over different estimation periods, which supports the findings of Chapter Two. The time parameters have not been tested on a wide range of years as this stage of the research is designed to establish the validity of the strategy, not to fine tune it.

3.7.2 Stochastic Dominance Discussions

Since most of the portfolio returns series have non-normal distributions, conclusions drawn from the mean-variance analysis may be biased and that t-tests on equal mean statistics may not be reliable. Therefore, portfolio returns are also compared under the framework of stochastic dominance. As discussed in Chapter One, the most general form of dominance of the first order requires that the one series dominate the other at all data points under comparison, a condition extremely hard to satisfy in small samples. Since the first order stochastic dominance comparisons yields inconclusive results too often, it is not conducted here. Instead, the second order stochastic dominance approach is applied to assess the performance of the PPP-efficient portfolio against the benchmarks. The results are reported in Table 3.8.

In Table 3.8, the PPP-efficient strategy stochastically dominates the naïve diversification portfolios from five out of the eight countries' viewpoints. It also dominates the MSCI world index portfolios for investments made in seven out of the eight countries. The proposed portfolio strategy dominates the domestic-only strategy from the viewpoints of investors based in four countries. On the other hand, none of the three benchmark strategies dominates the PPP-efficient diversification strategy. Therefore, while it cannot be positively concluded that all the results are statistically valid once skewness of return distributions are taken into account, the evidence is still strong that the PPP-efficient international diversification strategy is superior to the benchmark strategies.

Table 3.8 Stochastic Dominance between the PPP-efficient and Benchmark Portfolios

Results reported in the table indicate whether the PPP-efficient portfolios dominate the three benchmark portfolios in the second order sense. Y indicates that PPPEP did dominate a benchmark portfolio, while N means that PPPEP did not dominate a benchmark portfolio. PPPEP stands for PPP-efficient portfolio, GP stands for the global portfolio, MWIP represents the MSCI world index portfolio and DOP is short for the domestic-only portfolio.

Base Country	**PPPEP Vs. GP**	**GP Vs. PPPEP**	**PPPEP Vs. MWIP**	**MWIP Vs. PPPEP**	**PPPEP Vs. DOP**	**DOP Vs. PPPEP**
Australia	Y	N	Y	N	N	N
Canada	Y	N	Y	N	Y	N
Japan	N	N	Y	N	Y	N
New Zealand	Y	N	Y	N	N	N
Germany	N	N	N	N	Y	N
Switzerland	N	N	Y	N	N	N
UK	Y	N	Y	N	Y	N
US	Y	N	Y	N	N	N
Total no. of dominance	5	0	7	0	4	0

3.8 Conclusions

In this chapter, a selective international diversification strategy is proposed which incorporates directional predictions of exchange rate movements based on cumulative deviations from PPP. Tested on empirical data of eight countries, the proposed international portfolio strategy provided enhanced diversification benefits, when compared to the naïve international diversification and the MSCI world index portfolio strategies. The superior performance of the proposed diversification strategy is evident from improved portfolio returns, which remain economically significant after adjusting for risk. The benefits after adjusting for risk are not universal, however, as German investors would have been better off investing in the naively diversified global portfolio.

Overall performances, measured by SHP reward-to-risk ratios, indicate that the proposed PPP-efficient diversification strategy significantly outperformed the naïve international diversification and the MSCI world index portfolio strategies for domestic investors in any of the countries under examination. Evaluated against the domestic-only strategy, the PPP-efficient strategy appears to be superior for investments made in seven out of the eight nations. The exception was the Australian domestic portfolio.

Excess returns over the naïve diversification strategy obtained by the PPP-efficient diversification strategy vary between 1.50 and 4.68% per annum, depending on the investor's country of origin. The proposed strategy realized 2.18 to 5.08% higher returns than those obtained by a strategy of following the MSCI world index.

The evidence presented indicates that the proposed selective international diversification strategy is superior to traditional diversification strategies. The enhanced diversification benefits result from the efficient controls of currency risk. The strategy has significant implication for fund managers who may be seeking to improve international portfolio performance over the medium to long run.

The study makes three major contributions to the literature. First, it presents the first strategy that manages currency risk through a country-selecting process when constructing international equity portfolios. Second, this is the first time in international equity diversification study that currency risk is explored based on observations of cumulative exchange rate deviations from PPP. It is also the first time that prediction of directional movements of exchange rates is used as an investment country criterion. Third, the application of the Levy (1998) stochastic dominance criteria in portfolio performance evaluation reinforces findings from the mean-variance analysis. Therefore, the findings can be considered reliable, and independent from sample distribution assumptions.

Chapter 4

Using Directional FX Prediction and Forward Premium to Selectively Hedge Transaction Exposure: A Multi-country Perspective

"We tried to hedge using our brains ..., but it wasn't successful, so we gave up".[14]

— A Hitachi manager on abandoning the active hedging strategy.

Are there market regularities that can be used to improve hedging effectiveness? This is the question this chapter sets out to answer.

4.1 Introduction

To hedge or not to hedge is the million dollar question. It is a practical issue frequently challenging corporations exposed to foreign exchange risk. With significant development in global economic integration and international trade and finance activities, the need to hedge foreign exchange risk has increased dramatically over the last few decades. While enjoying the great opportunities brought about by doing business internationally, corporations are exposed to the risk associated with unexpected foreign exchange rate fluctuations. Under the current floating exchange rate system which replaced the fixed rate regime in the early 1970s, managing currency risk has become more challenging due to the increasing volatility of exchange rates.

[14] Source: Eiteman, Stonehill and Moffett (1998, p186).

There are three types of exposures to foreign exchange risk: transaction exposure, translation exposure, and economic exposure. Transaction exposure is the most frequently managed due to its ease of management, frequent occurrence and its direct impact on cash flows. Transaction exposure arises whenever there is a receivable, or payable, to be settled at a future time denominated in a foreign currency. Since the actual exchange rate on settlement day is unknown at the time of entering into a contract, the actual amount of cash flow in terms of domestic currency on payment day is subject to changes in the foreign exchange rates between the contract day and the settlement day.

Transaction exposures are often dealt with by using money market hedging instruments, among which, currency forward contracts are one of the most commonly used by international corporations. Duangploy, Bakay and Belk (1997) and Prevost, Rose and Miller (2000) provided empirical evidence on this. Unlike other instruments, forward hedging has advantages of no up-front cost requirement, and contract sizes can be tailored to suit individual hedging need. Further, the currency forward market is well developed which is huge in size and actively traded[15].

The effectiveness of hedging activities has been the subject of considerable debate over the past several decades. There are basically three views on this issue. The first view is based on the efficient financial market hypothesis, which holds that hedging or not hedging should lead to the same results over the long run. People suggesting hedges do not work believe that the forward rate is an unbiased predictor of future spot rates and hedging offers no advantage to corporations, therefore, hedging costs should be

[15] According to a survey done by the Bank of International Settlements (2005, p16), average daily transaction of OTC foreign exchange forwards and swaps averaged to 1,152 billions of US dollars in 2004, compared to 23 billions of US dollars of exchange-traded foreign exchange derivatives.

avoided. The second view believes that exposures should always be hedged, or partially hedged, in order to reduce cash flow variability and any related costs of financial distress. Under this view, hedging costs are merely a small price to pay for insurance. The third view is to hedge selectively, based on foreign exchange rate forecasts. Under this view, corporations only hedge when they believe that exchange rates are moving unfavourably, but leave the exposures uncovered at other times. People holding this view believe that they can often forecast correctly the directions of foreign exchange rate movements.

Moosa (2004b) examined the hedging efficacies of managing three foreign currency payables from the US viewpoint and reported evidence of hedging irrelevancy. The literature, however, yields little further evidence on the cash flow effects of hedging foreign currency transactions. It seems that the academic studies are more interested in studying the hedging effectiveness associated with international portfolio diversifications which also reported inconclusive evidence. This study intends to introduce a forward hedging strategy which can be used by international corporations to more efficiently manage their expected transactions in foreign currencies. The strategy calls for forward hedging, conditional on two robust foreign exchange market observations: the forward premium anomaly, and the cumulative exchange rate deviations from PPP.

The expectations theory states that the forward rate is an unbiased predictor of future spot rates. Being one of the fundamental exchange rate determination theorems, the theory has often been observed to fail. Fama (1984) reported that the actual movements of exchange rates are often in opposite directions to those implied by forward premiums, or discounts. The observation is known as the forward premium anomaly and has received further support from Bekaert and Hodrick (1993). Froot and Thaler (1990) and Engel (1996) claimed that the forward premium anomaly is a robust finding, supported by the literature on the subject.

Another equally important observation of the literature is that cumulative deviations of the exchange rates from purchasing power parity are self-correcting in the long run. Abuaf and Jorion (1990) reported that approximately half of the exchange rate deviations from PPP accumulated over a five year period is reversed over the following three to five year period. This observation suggests that directions of future exchange rate movements are predictable.

Morey and Simpson (2001a) reported that using purchasing power parity to predict directions of future exchange rate movements can beat the odds, based on nine US dollar rates between 1985 and 1998. They reported that large exchange rate deviations from parity have successfully predicted exchange rate movement directions 69% of the time. Similar evidence, however, cannot be found for the period 1974 to 1984. Bilson (1984) showed that combining information contained in exchange market disequilibrium and forward rate premiums improved the performance of currency portfolios. He claimed that both the forward premium component and the parity deviation component contribute to the currency trading strategy's superior performance.

This study proposes a selective forward hedging strategy that incorporates information implied in exchange rate deviations from PPP and forward rate premiums. Under the proposed strategy, hedging decisions should be made conditional on cumulative exchange rate deviations from PPP and the signs of forward rate premiums. This strategy, referred to here as the PFH strategy, states that corporations exposed to long positions in foreign currencies should only hedge when forward rates are at premiums to spot rates, and that the exchange rates have accumulated positive deviations from PPP.[16] The rationale is that overvalued currencies are more likely to depreciate in the future; therefore, protective positions should be established to prevent exchange rate losses. By selling forward at premiums, more favourable exchange rates are locked in. When either the forward rate is trading at a discount, or the cumulative deviations from PPP predict a depreciation of the foreign currency, no predictions can be accurately made due to conflicting signals.

The proposed conditional hedging strategy is unique in the literature of transaction exposure management. A similar idea, however, can be traced back to Bilson (1984), but his theories are different from this work in several aspects. First, Bilson applied a similar idea to profit from currency trading speculations, but this study promotes transaction risk management. In essence, the strategy proposed in this study should be viewed as a risk management strategy, while the Bilson strategy is a currency speculation strategy. Second, this study only calls for predictions on directional movements of future exchange rates, unlike the Bilson strategy, which requires estimating exact exchange rates using regression models with fairly low explanatory powers. Third, the Bison strategy was examined against a specific utility function, while this study will be examined jointly by mean-variance single period return analysis and the stochastic dominance analysis, which has less strict requirements on utility functions. Finally, this study will examine the effectiveness across seven foreign currencies from perspectives of market participants in eight countries. This is much

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[16] An '*or*' rule was also tested but the results are not reported here because this rule did not perform better than the '*and*' rule.

broader than the Bilson study which considered portfolios of only five currencies from one country's viewpoint.

Using daily data between 1st Jan. 1986 and 31st Aug. 2004, the effectiveness of the proposed hedging strategy is examined for foreign exchange exposures of three-month receivables from eight countries' perspectives. A three-month exposure is examined following Moosa (2004b). Strategy performances are compared to the never-hedging strategy (NH), the always-hedging strategy (AH), the hedging strategy based only on PPP deviations (PH), and the strategy based solely on forward-premium anomaly (FH).

The results of the proposed conditional hedging strategy proved to be superior as the strategy reduces risk, increases return and improves risk-adjusted return of domestic cash flows. The improvements were both economically and statistically significant. As will be seen, over the entire period of study, the proposed hedging strategy generated excess returns over the unhedged strategy as high as 45% for Switzerland-based exporters. Excess returns from the other countries' viewpoints vary between 4% and 33%. Using the second order stochastic dominance criteria, the proposed conditional hedging strategy outperformed the unhedged strategy in forty-four out of the fifty-six cases studied. Both corrections to exchange rate deviations from PPP, and the forward premium component contribute to the success of the proposed strategy. The results can be equally applied to hedging foreign payables, by switching the positions of the base currencies with those of the foreign currencies.

4.2 Literature Review

Three areas of literature are relevant to this study: the reversion characteristic of exchange rates towards PPP, the forward premium anomaly or failure of the expectations theory, and the evidence on forward hedging effectiveness. Since exchange rate reversion of exchange rate towards PPP has already been discussed in Chapter Two, the following reviews will focus on the literature concerning the other two areas.

4.2.1 The Expectations Theory and Purchasing Power Parity

The *expectations theory* states that differences between the forward rate and the spot rate equates with the expected change in spot rates. In other words, the forward rate is an unbiased predictor of the future spot rate. Since the theory is theoretically appealing and has potential for practical application in forecasting exchange rates, it has received enthusiastic attention by academics.

Early studies by Kohlhagen (1975) and Cornell (1977) provided general support to the expectations theory. Later studies, however, cast some doubts on the validity of the theory. Hansen and Hodrick (1980) reported mixed evidence on the unbiased forward rate predictor hypothesis from seven major dollar rates in the early floating system of the 1970s. They found supportive evidence for the hypothesis in three currencies, but evidence rejecting the theory was observed in the remaining four currencies. Chiang (1988) found that the unbiased hypothesis held for four US dollar rates in the sample period between 1974 and 1983, but failed in the sub-periods. The Hodrick survey summarised the evidence against the unbiased predictor hypothesis and stated that it "appears to be very strong and consistent across currencies, maturities and time periods" (1987, p155).

Delcoure (2003) provided further evidence that the expectations theory has not been uniformly supported, by considering the dollar rates of eight major currencies observed for the post-Bretton Woods era. The hypothesis was strongly rejected by Bekaert and Hodrick (1993). Levy and Lim (1994) reported that, in the short term, the forward rate tends to underestimate the magnitude of exchange rate movements. Moosa (2004a) examined the forward rate and spot rate relationships of four major currencies over a twenty-year period, and reported that the forward rate and spot rate are actually moving contemporaneously, indicating the failure of the expectations theory.

Moreover, Bilson (1981) and Fama (1984) reported that actual changes in spot rates are often in the opposite directions to that predicted by forward premiums or discounts. Cumby and Obstfeld (1982) reported that forward premiums have, generally, mistakenly predicted the directions of future spot rate movements for dollar rates of the UK pound, the German mark, the Swiss franc and the Japanese yen, during the period between 1976 and 1981. Hai, Mark and Wu (1997) also observed negative relationships between forward premiums and spot dollar rates of the UK pound, Swiss franc and Japanese yen on monthly data from 1976 to 1992.

The phenomenon that spot rates often move in the opposite direction implied by forward premiums is known as the *forward premium anomaly*. More evidence on the anomaly comes from many other studies following Fama (1984). Boothe and Longworth summarised the post-1980 studies in that "the empirical regularities are that the future spot rate will move in the direction opposite to that indicated by the forward premium" (1986, p139). Froot and Thaler (1990) claimed the forward premium anomaly to be a robust finding of the literature. Engel concluded that the unbiased forward rate prediction hypothesis has been “”routinely rejected" and that “the forward discount is strongly (negatively) correlated with subsequent changes in the exchange rates" (1996, p124, p179). Zhou and Kutan (2005) found evidence of forward premium anomalies in the 1980 to 1987 period, but not in the other period of their study, from 1977 to 1998. They claimed that the anomaly may relate to the possible peso problem of the US dollar in 1980s.

At the same time, empirical studies report frequent short term violations of PPP. Disparities between actual exchange rates and the parity levels, however, tend to be corrected in the long term. Abuaf and Jorion (1990) found that approximately half of the cumulative exchange rate deviations from PPP were corrected over a three to five year period. Coakley and Fuertes (1997) provided more evidence on exchange rate reversions towards PPP and reported half-life estimations shorter than three years. More evidence on this subject has been presented in Section 2.2.

Moery and Simpson (2001a) examined whether the forward rate premium and purchasing power parity can be used to predict future directions of exchange rate movements. They found that the forward rate seems to be a poor predictor, but that exchange rate deviations from PPP are more informative. They reported that, on average, parity has correctly predicted the direction of exchange rate movements 57% of the time, for nine monthly dollar rates during the period 1985 to 1998. The predictive power of PPP is not evident in the 1974 to 1984 period, however. Furthermore, large deviations from PPP have a prediction success rate of 69%. They also observed that parity has more power in predicting longer periods into the future (Morey and Simpson, 2001a). In their study, a fixed *equilibrium* base period is chosen for estimating the exchange rate deviations from PPP, whereas this study uses exchange rate deviations from PPP accumulated over the past five-year period, with changing base periods. I argue that the method of this study is superior in presence of exchange rate structural breaks as observed by Zurbruegg and Allsopp (2004) and Kang (1999).

To summarise, the existing literature suggests that forward rates are not unbiased predictors of future spot rates. Indeed, spot rates are often observed to move in the direction opposite to that implied by forward rate premiums. The observation of the forward premium anomaly is robust across currencies over different time periods.

4.2.2 Hedging Strategies and Efficacies

Nance, Smith and Smithson (1993) and Smith and Stultz (1985) claimed that, in practice, most companies hedge their currency exposures in the belief that hedging leads to increased company value, through reductions in earning variability and the costs of financial distress. Pramborg (2004) surveyed 455 Swedish firms, and reported that approximately 85% of the companies are exposed to foreign exchange risk and more than 50% of the surveyed companies hedge the exposures. The study identifies positive relationships between company values and the usage of derivative hedging.

Eaker and Lenowitz (1986) demonstrated that a decision rule based on forward premium observations can reduce costs of borrowing in the international capital market. Allayannis and Ofek (2001) claimed that hedging using currency derivatives has significantly reduced the foreign exchange risk faced by S&P 500 non-financial companies. Hagelin (2003) and Hagelin and Pramborg (2003) found similar evidence in regards to Swedish companies. Allayannis and Weston (2001) reported that derivative hedging applications increase large US corporations' values by an average of 4.87%. Pramborg (2004) confirmed that company values are positively related to transaction risk hedging activities.

The literature, however, provides limited evidence on forward hedging effectiveness in terms of cash flow effects in the context of transaction exposure management. Moosa (2004b) claimed that hedging makes no significant difference in managing three-month US payables over the long run from the viewpoints of three major developed countries. Further, even selectively hedging using perfect ex post exchange rate forecasts cannot lead to a significant gain when compared with an always hedging, and a never hedging, strategy. Moosa argued that hedging, or not hedging, does not matter because short-term gains and losses resulting from forward hedging tend to average to zero in the long run. In fact, if hedging costs are taken into account, not to hedge would be more desirable in terms of maximising profits.

On the other hand, there has been more research interest focused on the effectiveness of currency trading strategies and international portfolio hedging strategies incorporating the forward premium anomaly, and/or exchange rate corrections to PPP. Bilson (1984) proposed that a currency trading strategy based on an exchange rate forecasting model incorporating information implied in exchange rate deviations from PPP and forward rate premiums. Although the model itself has little predictive power, the currency trading strategy was profitable on a risk-adjusted basis, when applied on six major currencies during the period of 1973 to 1982. It is demonstrated that both the forward premium component and the PPP deviation component contribute to the strategy's superior performance.

Eun and Resnick (1988), Eaker and Grant (1990), Glen and Jorion (1993) and Eun and Resnick (1997) found that currency forward hedging strategies which are conditional on forward rate premiums have improved hedging benefits in international portfolio diversifications. Morey and Simpson (2001a) reported that a hedging strategy conditional on large forward rate premiums enhanced hedging benefits. Van der Linden, Jiang and Hu (2002) proposed a *real forward hedge rule,* which calls for hedging when the forward contract is trading at a premium and when the inflation-adjusted foreign interest rate is less than the domestic rate. They reported that, by applying this hedging strategy to currency portfolios, equity portfolios and bond portfolios, the performance of the portfolios is significantly improved. Thorp (2005) provided further evidence on forward hedging effectiveness.

Simpson (2004) demonstrated that a conditional currency future hedging strategy based on large exchange rate deviations from PPP has outperformed the hedging strategy based on future contract premiums. This finding indicates that the disparity between exchange rates and their parity levels contains valuable information for making hedging decisions. Morey and Simpson (2001b) found that non-hedged international stock portfolios often dominated their passively hedged pairs. They reported that a selective hedging strategy based on large forward rate premiums, and a hedging strategy which calls for hedging when exchange rates exceed PPP, has performed well for UK-based investors. The findings provide further evidence on the usefulness of forward premiums and PPP deviations in making hedging decisions.

Eun and Resnick (1994), on the other hand, presented mixed evidence on forward hedging effectiveness. They claimed that, while US investors benefit from hedging the currency exposures of international portfolios, Japanese investors gain little from forward hedging. Levy and Lim (1994) found conflicting evidence regarding forward hedging effectiveness for two periods of the 1980s, suggesting that benefits from a passive forward hedging strategy are not consistent over time. Soenen and Lindvall (1992), De Roon, Nijman and Werker (1999) and Tezel and McManus (1998) reported neutral, or negative, evidence on forward hedging effectiveness.

4.2.3 Summary of Literature

In summary, the literature recognises that exchange rate deviations from PPP provide useful indications on future directions of exchange rate movements. Empirical studies also suggest that actual exchange rates often move in the opposite directions to those implied in forward premiums, or discounts. The information content of PPP deviations and forward premiums has valuable applications in currency trading and international portfolio hedging practices. What is not mentioned in the literature, is the potential value of the information content of exchange deviations from PPP and the forward premium anomaly, together or separately, when used to make hedging decisions in a different context of transaction exposure management. This study intends to explore this potential and proposes a selective hedging strategy which takes advantages of the two robust exchange market prediction tools.

4.3 Development of Selective Forward Hedging Strategies

The findings in Chapter Two of this dissertation show that exchange rate deviations from PPP accumulated over the past several years are partially corrected in the subsequent period. Also evident from the literature is that exchange rates often move in the opposite direction predicted by forward premiums, or discounts. Inspired by the two foreign exchange market regularities, three conditional hedging strategies are developed to manage three-month foreign receivables in an effort to capture potential gains from selectively forward hedging. By calculating PPP theoretical values using Equation (2.4) on page 27, the strategies are illustrated as follows.

Conditional Hedging Strategy 1 – PPP-hedging (PH):

Rule 1: Hedge by selling forward a foreign currency when the current spot rate is higher than the estimated PPP rate. Stay un-hedged otherwise. The strategy is graphically illustrated by Figure 4.1.

Conditional Hedging Strategy 2 – Forward-at-premium-hedging (FH):

Rule 2: Hedge by selling forward a foreign currency if the forward rate is at a premium to the spot rate. Stay un-hedged otherwise, as illustrated by Figure 4.2.

Conditional Hedging Strategy 3 – PPP and forward-at-premium-hedging (PFH):

Rule 3. Hedge by selling a foreign currency at the prevailing forward rate if the spot rate is higher than the PPP equilibrium rate and the forward rate is at a premium to the spot rate. Otherwise, remain un-hedged. Figure 4.3 illustrates this strategy. In the graph, immediately after the spot rate dropped below the estimated PPP rate, one should stop to hedge. Although the spot rate rose above the spot rate after some time, one should remain to be not hedged because the forward contracts were traded at discounts.

Fig 4.1 Illustration of PPP-Hedging Strategy

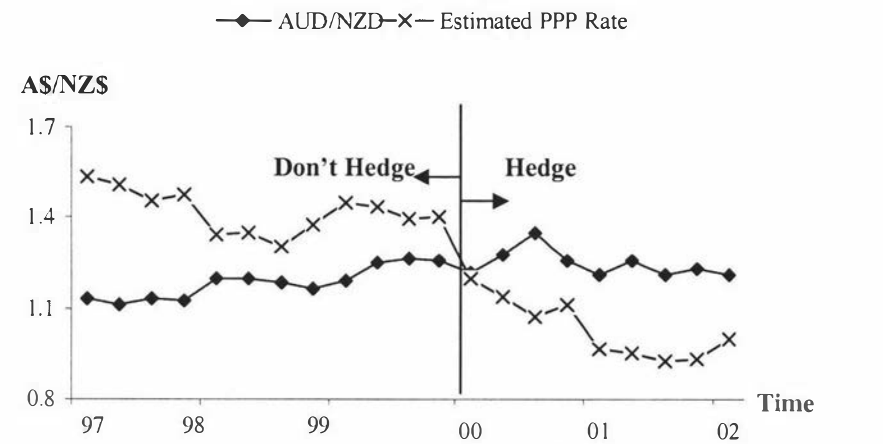


Fig 4.2 Illustration of Forward-at-Premium-Hedging Strategy

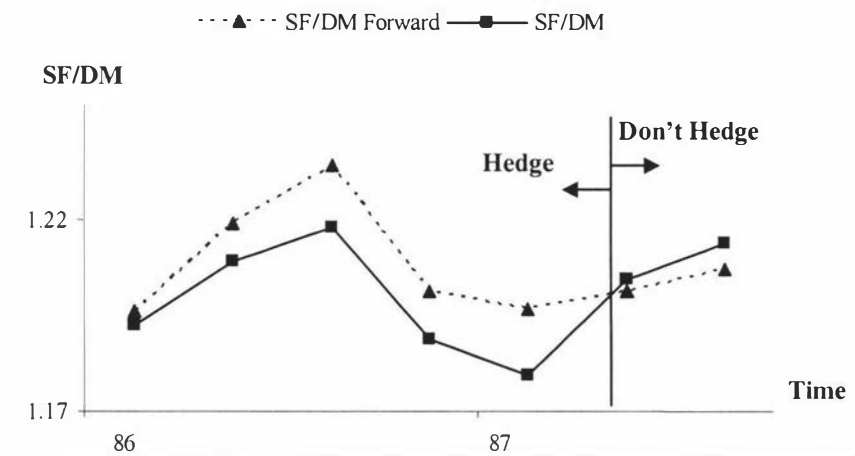
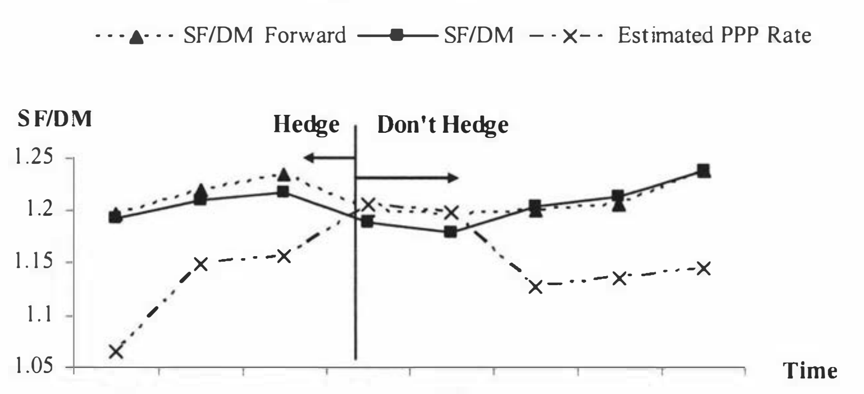


Fig 4.3 Illustration of PPP& Forward-at-Premium-Hedging Strategy



4.4 Research Questions

The effectiveness of the three conditional, forward-hedging strategies will be compared with the never-hedging strategy. Hedging effectiveness will be evaluated from four aspects: percentage change of single-period cash flows in terms of domestic currencies (returns), fluctuations of cash flows' returns (risk), the ratio of cash flow returns to return fluctuations (risk-adjusted returns), and the terminal wealth effects accumulated over the eight-year period of study. Performance of the always-hedging strategy will also be presented for reference, although detailed discussions will be based on comparisons to the never-hedging strategy. It is observed that although the always-hedging strategy often reduces cash flow fluctuations, the reductions in risk are achieved at costs of reduced cash flows, as will be discussed shortly.

Using empirical data, the study aims to answer three questions.

(1) Does the PPP and forward-at-premium-hedging strategy consistently perform better than the never-hedging strategy and the passive-hedging strategy?

(2) Does the PPP-hedging strategy consistently perform better than the never-hedging strategy and the passive-hedging strategy?

(3) Does the forward-at-premium-hedging strategy consistently perform better than the never-hedging strategy and the passive-hedging strategy?

By applying the forward-at-premium-hedging strategy, it is expected that hedging performance can be improved by exploiting the forecasting errors implied by forward premiums. Using the PPP-hedging strategy, the hedging performance is also expected to be improved, resulting from avoiding predictable downward adjustments to foreign currency values. The combined strategy (the PPP and forward-at-premium hedging strategy) indicates hedging only when the two hedging criteria confirm each other to take advantage of both the forward rate premiums and corrections towards PPP. Therefore, this strategy would give out more accurate hedging signals, and is expected to be able to perform the best among the three selective hedging strategies. If this is the case, then positive evidence on Research Questions 2 and 3 would be indications that both the forward premium factor and the PPP correction factor contribute to the superior performance of the PPP-efficient portfolio strategy.

4.5 Significance of the Research

Previous literature provides little evidence on hedging effectiveness, in terms of cash flow effects relating to managing foreign transaction exposures. Moosa (2004b) provided evidence on hedging irrelevancy in managing three-month payables of the British pound, the German mark and the Japanese yen by a US company. This study intends to enrich the literature in this area by proposing an efficient forward hedging strategy developed from two robust empirical observations on foreign exchange markets.

The basic ideas behind the proposed hedging conditions are similar to two previous studies by Bilson (1984) and Morey and Simpson (2001b). The strategy employed and the way in which the techniques are applied is, however, different in this study from that employed in the two earlier studies.

Bilson (1984) made similar use of the information contents of the forward premium anomaly and the purchasing power parity puzzle. His research, however, differed from this study in several aspects, as discussed in Section 4.1. Unlike Bilson (1984), which required exact forecasts of foreign exchange rates, the proposed hedging strategy in the current study only requires directional predictions on exchange rate movements. Moreover, the hedging effectiveness of this study is examined across a much broader range of currencies, taking the viewpoints of many more countries, over much longer time periods. Further, the utility function definitions are relatively relaxed in this study. Finally, the two strategies have different purposes and are applied in different contexts, as discussed in Section 4.1.

The study by Morey and Simpson (2001b) used a similar idea, although it is applied to a different area, namely international portfolio diversification. They reported that hedging selectively at large forward premiums improves international stock portfolio performance. They also found that hedging selectively when exchange rates exceeded the PPP equilibriums improved the portfolio performances of the UK based investments. The current research differs from their study in two respects. First, this study looks at hedging effectiveness in the context of managing transaction exposure, while Morey and Simpson (2001b) examined international portfolio hedging effectiveness. Second, the methodology on the PPP rate estimations employed in this study differs from that used in their study. Morey and Simpson made the assumption of an *equilibrium period* in the foreign exchange market during the period from 1980 to 1982, and estimated PPP equilibrium rates relative to that fixed equilibrium period. This research, however, applies a fixed five-year PPP estimation period with shifting base dates. It is argued that arbitrary choices on fixed equilibrium periods are potentially problematic, in that biased results may be obtained if the choice on the market equilibrium period is wrong. Furthermore, permanent shifts of economic fundamentals of the foreign exchange market may introduce further bias to the Morey and Simpson methodology. The methodology on PPP rate calculations of this study, on the other hand, only requires that the foreign exchange markets are efficient more often than not; therefore, effectively avoiding the potential problems discussed above.

This study contributes to the current body of literature in several aspects: (1) It is the first strategy to selectively hedge transaction exposures conditional on two robust observations of exchange rate regularities, namely, the predictive power of cumulative exchange rate deviations from PPP and the forward premium anomaly. The strategy is easy to carry out in practice. (2) The strategy's effectiveness is examined across a broader range of currencies and from a broad range of base countries, ensuring that the results are robust across currencies and not subject to base-currency bias. (3) Instead of testing on monthly or quarterly data, as most other studies did, this research applies higher frequency daily data over a much longer period. This has an advantage in mitigating potential bias in the results, induced by abnormal month-end or quarter-end exchange rates. (4) Both single period returns, and cumulative long-term effects of the proposed strategy are examined, whereas other studies often look at one of the effects only. (5) It is the first research of this topic which applies stochastic dominance rules as a compliment to the popular mean-variance analysis, in an effort to mitigate potential bias related to undesirable sample distributions.

It should be noted, however, that the strategy is only appropriate for applications by international corporations which have long-term, frequent exposures to foreign currencies that are free-floating which have a sufficiently long history of floating. The strategy is not designed to work reliably for one-off transactions, or for multiple transactions over short time periods.

4.6 Research Data

Three types of data are used in this study: spot exchange rates, three-month forward rates, and consumer price indices (CPI). For the period between January 1st 1986[17] and August 31st 2004, US dollar exchange rates are downloaded at daily intervals from Datastream. The data covers eight countries: Australia, Canada, Germany, Japan, New Zealand, Switzerland, the UK and the US. Exchange rates for the German mark after January 1st 1999 are obtained by converting the euro rates using the fixed conversion rate of 1.95583, as announced by the council of the European Union. The dollar rate indices for seven currencies are graphed in Appendix 3.1.

Cross rates between any two currencies are derived from their dollar rates. Since a five-year estimation period is required for calculating PPP rates, a longer history of spot rates and CPI data for the five currencies with longer histories of floating are required for the period between January 1st 1981 and December 31st 1985. This extra data was collected from the Database Retrieval System (V2.11) provided on the web-site of the University Of British Columbia Sauder School Of Business Pacific Exchange Rate Services.[18]

CPI data for the period between January 1st 1981 and August 31st 2004 was obtained for monthly intervals from Datastream, except for Australia and New Zealand. Australian CPI data are collected from the website of the Reserve Bank of Australia.[19] For the New Zealand CPI, only quarterly data are available, and monthly data was created by interpolating linearly from the quarterly data. Daily CPI data is assumed to be the same

[17] This starting date is chosen because forward exchange rate data is only available after this date from Datastream.

[18] The URL of the database is: http://fx.sauder.ubc.ca/.

as the CPI data for the same month. PPP rates and exchange rate deviations from PPP are estimated using Equation (2.4) on page 27.

Daily data is used in this study to mitigate potential bias of test results induced by the small sample problem and the influence of unusual end-of-month, or end-of-quarter, fluctuations in the foreign exchange market.

4.7 Research Assumptions

In the following discussions of strategy performance, positions are taken from the viewpoint of domestic exporters facing transaction exposures to three-month receivables denominated in foreign currencies. It is assumed that each strategy starts with foreign currency values equivalent to 1,000 units of a domestic currency. All hedging activities are carried out using three-months forward contracts, and the full amount of cash obtained at the end of each period is rolled forward to the next period. Where decisions are made to hedge, hedge ratios are set to one to simplify comparisons among different hedging strategies.

Three-month single period percentage changes of cash flows are obtained to compare the single period returns for each strategy. End-of-period cumulative wealth for each strategy is also calculated and compared. The results are taken from the perspectives of companies based in each of the eight countries. Transaction costs are ignored[20] and tax effects are also excluded.

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[19] I am grateful to Roger Hall at the Reserve Bank of Australia who kindly directed me to this database.

[20] Morey and Simpson (2001b) estimated that one-half of average bid-ask spreads on monthly three-month forward contracts for five major US dollar exchange rates vary between 0.05 and 6.53 basis points during the period from 1991 to 1998. Jorion and Khoury (1996) reported that the spread between bid and ask quotations from forward dealers is around 0.05% for large transactions above US$1 million.

The results of this study can be applied to managing on-going frequent exposures to foreign exchange transactions of equal sizes in domestic terms. Although calculations and discussions are based on the assumption of exposure to foreign receivables, the conclusions can be generalised in order to be used by importers with foreign payable exposures. To illustrate, consider company A, which is an Australia-based exporter expecting receivables in Canadian dollars in three months time, and company B, which is a Canada-based importer planning to pay Australian dollar bills in three months time. Under both scenarios, the businesses need to exchange Canadian dollars for Australian dollars in three months time. Therefore, company A and B have essentially the same, but opposite foreign currency positions. Situations of exposures to large one-off foreign transactions, however, should be treated differently.

4.8 Research Methodologies

Strategy performances are evaluated using three-month single-period returns, as well as the end-of-period cumulative wealth effects. For each comparison, strategies are evaluated for managing seven foreign currencies from the perspectives of each of the eight countries, resulting in fifty-six hedging outcomes for each strategy.

Except for managing Australia- and New Zealand-related transactions, each strategy starts from Jan. 1^{st} 1986 and finishes on Jun. 31^{st} 2004, covering seventy-two quarters. The Australian and New Zealand related studies, however, cover shorter periods, because their currencies started to float later than the other currencies.

Daily equilibrium PPP rates are estimated using Equation (2.4) on page 27, assuming a five-year estimation period. Starting with a three-month foreign receivable equivalent to

1,000 units of domestic currency, the value in a foreign currency equals $(1{,}000 / S_0)$ units, where S_0 is the spot rate at the beginning of period.

At the end of the 1st period, the $(1{,}000 / S_0)$ units of foreign currency will be converted to domestic currency at either the forward rate determined at the beginning of the period, or the spot rate prevailing at period-end. This value will then replace the 1,000 units of domestic currency to become the new cash position starting the next period, etc. Equations (4.1) and (4.4) provide calculations for the domestic values of cash positions at period-ends, fully hedged, or not hedged, respectively. Equations (4.2) and (4.5) are used to calculate single period returns under the hedging and the not-hedging decision, respectively. Equations (4.3) and (4.6) provide calculations on annualised three-month single period returns.

If a foreign currency position is not hedged, then:

The end-of-period value in domestic currency $(VB_t) = (VB_{t-1} / S_{t-1}) * S_t$ (4.1)

The percentage single-period return $(R_t) = [(S_t / S_{t-1}) - 1] * 100$ (4.2)

The annualised percentage return $(AR_t) = [(S_t/S_{t-1})^4 - 1] * 100$ (4.3)

If a foreign currency position is hedged-forward in full, then:

The end-of-period value in domestic currency $(VB_t) = (VB_{t-1} / S_{t-1}) * F_{t-1}$ (4.4)

The percentage single-period return $(Rt) = [(F_{t-1} / S_{t-1}) - 1] * 100$ (4.5)

The annualised percentage return $(ARt) = (AR_t) = [(F_{t-1} / S_{t-1})^4 - 1] * 100$ (4.6)

End-of-period cash flows are calculated by taking averages of daily cash flows occurring in the last quarter of the study in order to avoid possible bias associated with extraordinary daily data. Maturity of a forward contract is defined as the same day of the month as the forward position was entered into, provided that day is a business day. If the day is not a business day, the next trading day is chosen.[21] The total sample includes 1,899 contracts for the Australian and New Zealand dollar related calculations and 4,566 contracts for the other calculations.

The average single period returns, return volatilities, and risk-adjusted returns are calculated. The reward-to-risk ratio (RTR) is applied as a measure of risk-adjusted return and defined as:

$$RTR = \frac{\bar{r}}{\sigma} \tag{4.7}$$

where $\bar{r}$ represents average, percentage single period returns and σ stands for risk measured by the standard deviation of the single period returns.

Discussions on performance evaluations will mainly be based on mean-variance analysis, which is commonly applied in the literature because of its simplicity and its having the merit of always being able to give unambiguous rankings among the strategies. To avoid possible bias in the results, resulting from unfavourable return distributions, the distribution-free second order stochastic dominance criteria (SSD) is applied as a complement to the mean-variance analysis. The concept of the SSD rules was discussed in Chapter One of this dissertation. Percentage times that the proposed hedging strategy signals hedge will be reported with regard to the concern of hedging costs.

[21] This date matching procedure was undertaken by a VB computer program. Thanks are due to my husband, Bo Gao, for assisting with the programming, which sped up this research.

4.9 Findings and Discussions

Research findings are presented and discussed in two parts: (1) single-period return analysis, including mean-variance analysis and stochastic dominance analysis, and (2) cumulative long-term end-of-period wealth comparisons.

4.9.1 Single-period Return Analysis

Annualised single period returns from different hedging strategies are calculated from the viewpoints of exporters based in each of the eight countries. Exposures to seven foreign currencies are managed from each country's perspective. There are fifty-six applications for each strategy. Average returns and standard deviations of return series are calculated to evaluate strategy returns and risks. Risk, return and reward-to-risk ratios (RTR) are calculated and reported in Tables A3.1 to A3.8 of Appendix 3. They are presented from the perspectives of each country in the study. Appendix 3.3 reports the statistics of the return distributions.

From Tables A3.1 to A3.8 in Appendix 3[22], it can be seen that, compared with the never-hedging strategy, the always-hedging strategy always reduced the volatilities of single-period returns, however, this was often at the cost of reduced returns. This finding agrees with that of Morey and Simpson (2001b).

For corporations based in each country, return, risk and risk-adjusted returns of cash flow obtained under the three conditional hedging strategies are compared to those obtained under the un-hedged strategy. Table 4.1 reports the success rates at which the

[22] Please note that the reported statistical test results from t-tests have not been adjusted to account for overlapping observations. Therefore, the statistical significant levels should be treated with caution.

conditional hedging strategies have outperformed the never-hedging strategy. It can be seen that all three conditional hedging strategies have improved single period returns from that achieved by the never-hedging strategy. The PPP and forward-at-premium-hedging (PFH) strategy produced higher returns than that of the never-hedging strategy in 84% of the cases under study (forty-seven out of fifty-six). The PPP-hedging (PH) strategy gave higher returns than the unhedged strategy in 66% of the cases, while the forward-at-premium-hedging (FH) strategy obtained higher returns in 52% of the cases. The results indicate that both PPP deviation criterion and the forward premium criterion can be used to increase hedging returns, although the strategy combining both criteria improved cash flow returns most consistently across the currencies.

Table 4.1 Relative Performance of Selective Hedging Strategies against the Un-hedged Strategy

The chance that a selective hedging strategy beats the never-hedging strategy is reported in percentage form. The total number of comparisons is fifty-six . NH stands for the never-hedging strategy, PH refers to the PPP-hedging strategy, FH denotes the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy. The 66% success rate obtained for the PH strategy means that 66% of the fifty-six performance comparisons suggest that the PH strategy outperformed the NH strategy in terms of higher returns.

Strategy	**PH**	**FH**	**PFH**
Percentage chance of return improvement	66%	52%	84%
Percentage chance of statistically significant return improvement (at the 5% level)	55%	38%	57%
Percentage chance of risk-reduction	100%	100%	100%
Percentage chance of improvement in risk-adjusted returns	77%	56%	89%

All three conditional hedging strategies have reduced risk associated with cash flow return fluctuations, compared with the never-hedging strategy. Evaluated in terms of the risk-adjusted returns, the PFH strategy has outperformed the unhedged strategy in 89% of the currency combinations studied. In other words, the proposed strategy only failed to beat the unhedged strategy in six out of the fifty-six comparisons made. At the same time, the PH and the FH strategy have outperformed the never-hedging strategy for 77 and 56% of the currency combinations, respectively.

These findings are in sharp contrast to those found in Moosa (2004b) which claims that hedging does not matter in managing US dollar payables transactions from the perspectives of three countries. That study was conducted using forty-two items quarterly data. Since the current study has been conducted on much larger sample size, across more foreign currencies, from the viewpoints of multiple countries, the findings of this study should be more convincing.

Table 4.2 reports excess returns achieved through the conditional hedging strategies, over those achieved through the never-hedge strategy. T-test results on equalities between the means of single period returns from a conditional hedging strategy and the never-hedging strategy are presented in Table 4.3.

Table 4.2 Selective Hedging Strategy Excess Returns over Unhedged Strategy

The excess return (ER) is calculated by subtracting the average return of the never-hedging strategy from the average return of a conditional hedging strategy, expressed in terms of percentage annualised returns. For each base currency, excess returns from hedging each of the seven foreign currencies are averaged and reported. PH refers to the PPP-hedging strategy, FH denotes for the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy.

	PH	FH	PFH
A$ Based	0.15	-0.44	1.40
C$ Based	0.02	-0.07	0.42
DM Based	0.91	0.60	1.03
NZ$ Based	1.75	-0.79	2.18
SF Based	0.66	0.00	0.49
UK£ Based	1.60	1.27	1.42
Yen Based	-0.14	0.09	0.11
US$ Based	-1.56	0.55	-0.31
Average	0.42	0.15	0.84

By referring to Table 4.2, it can be seen that, for exporters based in different countries, the PFH strategy realised between -0.31 to 2.18% returns in excess of that obtained by the unhedged strategy. Averaged across all currency combinations, the PFH strategy generated 0.84% excess return over the unhedged strategy. The strategy only failed to work for the US based studies. The PH strategy obtained 0.02 to 1.75% excess returns over the never-hedging strategy, for investors based in six countries under the study, with the exceptions of the Japanese and US perspectives. The FH strategy has also outperformed the unhedged strategy for exporters based in five out of the eight countries under the study.

In summary, the PPP and forward-at-premium-hedging strategy improved the single-period cash flow returns when compared to the unhedged strategy. Its superior performance is retained after adjusting for risk. Both the PPP deviation component and the forward premium component contribute to the superior performance of the PFH strategy. It appears, however, that the PPP deviation component contributes more than the forward premium component.

While in general the PFH strategy provides superior performance, this was not found to be the case for managing exposures faced by the US exporters. As reported in Table A3.8 of Appendix 3, the PFH strategy has realised significantly less returns than the never-hedging strategy for US corporations hedging Deutsche mark, Swiss franc and Japanese yen positions. The reason for these exceptions is probably due to the fact that the US dollar is treated as an international commodity currency and is less susceptible to the pressure of cumulative deviations from PPP than some other currencies. This result is consistent with Levy and Lim (1994), who claimed that an un-hedged strategy outperformed hedge strategies when the domestic currency, the US dollar, depreciates.

This observation may be explained by Levy and Lim's (1994) finding that forward rates have generally underestimated the magnitude of domestic currency depreciations. Consequently, leaving foreign receivables uncovered would be the optimal strategy to capture the benefits of home currency depreciations.

It can be seen from the statistics presented in Table A3.9 of Appendix 3 that most return series in the study are not normally distributed. Nevertheless, the fact that return distributions under the never-hedging strategy are often more left-skewed than those under the conditional hedging strategies indicates that the above discussions are conservative, and are reliable even in the presence of non-normal return distributions.

T-tests were applied to test the average risk-return of each hedging strategies obtained from the view points of eight different countries. The p-values are reported in Table 4.3. The tests were carried out on two different samples: one sample including US based hedges, and the other sample excluding US based hedges. Although the always-hedging strategy was the lowest risk strategy, it also yielded significantly lower average returns.

It can be seen from Table 4.3 that, compared with the un-hedged strategy, all of the three conditional hedging strategies outperformed the un-hedged strategy on a risk-adjusted basis at the 1% level of statistical significance. The superior performances are statistically significant at the 1% level. Among the three conditional-hedging strategies, the PFH strategy generated the highest returns. The difference between the returns from the PFH strategy and from the un-hedged strategy is both economically and statistically significant at the 1% level. The returns from the PH and FH strategies are also higher than that of remaining un-hedged at the 10% statistical significance level, or are not statistically significant. On the other hand, the risk-adjusted returns of the always-hedging strategy are not significantly different from that of remaining un-hedged at the 10% significance level. Excluding the US perspective, the return from the PH strategy is significantly improved. As a result, returns from the PH strategy are significantly statistically improved over remaining un-hedged at the 1% level.

Table 4.3 Summary Statistics on Single-period Risk-return Comparisons

The reported values of return, risk and reward-to-risk ratios are values averaged across perspective countries and hedged currencies. Panel A reports the results with the US perspective included in the study, and Panel B presents the results with the US viewpoint excluded. T-statistics are reported for t-tests with the null of an selective hedging strategy having equal means of the never hedging strategy. ***, ** and * denote statistical significance at the 1%, 5% and the 10% levels.

Panel A – US Perspective Included					
	NH	AH	PH	FH	PFH
Returns					
Mean	2.40	0.07	2.82	2.55	3.26
t-stat.		8.92***	-1.98*	-0.84	-5.95***
Standard deviations					
Mean	0.22	0.02	0.16	0.14	0.19
t-stat.		28.20***	13.81***	7.97***	7.22***
Reward-to-risk ratio					
Mean	10.14	-0.63	17.64	28.83	18.22
t-stat.		0.70	-5.59***	-4.91***	-7.55***
Panel B – US Perspective Excluded					
Returns					
	NH	AH	PH	FH	PFH
Mean	2.25	0.11	2.95	2.34	3.27
t-stat.		7.62***	-3.39***	-0.54	-6.95***
Standard deviations					
Mean	0.22	0.02	0.16	0.14	0.19
t-stat.		26.38***	12.78***	7.47***	6.83***
Reward-to-risk ratio					
Mean	9.51	1.68	18.63	29.05	18.58
t-stat.		0.46	-6.73***	-4.53***	-7.84***

The overall evidence from the t-tests confirms the finding that the PFH strategy has significantly improved hedging effectiveness in terms of increased returns, reduced risk and improved risk-adjusted returns. This strategy for managing foreign transaction exposures is recommended. Both the PPP component and the forward premium component contribute to the superior performance of the PFH strategy, although the PPP deviation information seems to be more valuable, which is consistent with the findings of Bilson (1984). Furthermore, it is found that, on average, the proposed PFH hedging strategy give out hedging signals 23% of the time. Therefore, hedging cost is not a significant factor concerns the proposed selective hedging strategy.

Note that the finding that a selective forward hedging strategy can improve transaction exposure management is in sharp contrast to Moosa (2004b), which claimed that even perfect hedging cannot benefit US companies managing three-month foreign payables in the UK pounds, German marks and Japanese yen. In this study, Moosa assumes three-month short positions in foreign currencies equivalent to US$100. By replicating Moosa's test on the yen hedge using the same data set of forty-four quarters, the same conclusion was reached when testing the means of quarterly cash flows from perfect hedging and not hedging. Further examination of the percentage cash flow differences between the perfect hedging and the un-hedged transactions, however, uncovers the difference between the two strategies. It appears that the perfect hedging strategy can save quarterly payables by 3.06%, on average, in terms of US dollars. The difference is statistically significantly different from zero at the 1% level. Therefore, it can be argued that as Moosa tested cash flows but not returns, his test was not sensitive enough to detect benefits which were actually present.

4.9.2 Stochastic Dominance Analysis

Second order stochastic dominance rules are applied to compare the strategies' performances in terms of single-period cash flow returns. For each pair of strategies, there are fifty-six comparisons, obtained from hedging seven currencies from the perspectives of eight countries. The numbers of comparisons in which one strategy stochastically dominates the other are reported in Table 4.4. Detailed results on stochastic dominances between the PFH strategy and the never-hedging strategy on hedging individual currencies are reported in Table A3.10 of Appendix 3.

Table 4.4 Summary of Stochastic Dominance of Different Hedging Strategies

Reported are the numbers of comparisons that one strategy stochastically dominates (in the second order) the other, following the criteria discussed in Section 4. There are fifty-six comparisons for each pair of strategies. Reported numbers should be interpreted as: for fifty-six comparisons, X strategy stochastically dominates Y strategy N number of times in the second order sense. The names of the X strategies are listed in the first column of the table while the first row gives the Y strategy names.

Total = 56	NH	PH	FH	PFH
NH	-	0	0	0
PH	36	-	14	22
FH	29	0	-	18
PFH	44	0	1	-

From Table 4.4, it can be seen that the conditional hedging strategies, PH, FH and PFH, dominate the never-hedging strategy in thirty-six, twenty-nine and forty-four cases, respectively, out of the fifty-six cases under study. Conversely, the unhedged strategy never dominates any of the three conditional hedging strategies. The evidence indicates that the three conditional hedging strategies are superior to the never-hedging strategy. Since sufficient evidence in supportive of the proposed hedging strategy has been obtained from the second order stochastic dominance analysis, dominance analysis of the third order is not conducted for succinctness.

Among the three conditional hedging strategies, the PFH strategy is sometimes dominated by the PH, or the FH strategy, however, the PFH strategy rarely dominates the other two. The results indicate that the PH strategy and the FH strategy are sometimes superior to the PFH strategy, but it is the PFH strategy that dominates the un-hedged strategy most often. Further, the PH strategy has been found to dominate the FH strategy in fourteen out of the fifty-six cases under study, but no reverse dominance can be found. This finding suggests that the PH strategy generally performed better than the FH strategy. Nevertheless, this study recommends the PFH strategy because its superior performance produced the most consistent evidence across currencies and from different countries' viewpoints. The dominance analysis results confirm the mean-variance analysis results.

4.9.3 Cumulative Hedging Effects

For large multinational corporations with ongoing foreign exchange transactions over the long term, it is worthwhile to quantify the effects that the conditional hedging strategies may have on business wealth over time. This section will analyse cumulative wealth effects of the conditional hedging strategies by comparing the end-of-period cash flows obtained under the different hedging strategies. Table 4.5 reports the end-of-period domestic values of hedging outcomes, assuming each strategy starts with 1,000 units of domestic currency. End-of-period cash flows are rolled forward until the end of the examination period. The strategies are carried out over seventy-two quarters for most currencies and for shorter periods for the Australian dollar and the New Zealand dollar. End-of-period wealth is represented by average daily domestic cash flows received in the last quarter of the study.

Table 4.5 End-of-period Wealth of Different Hedging Strategies

For each hedging strategy, average cash flows received in the last quarter are reported in terms of domestic values. The strategies start with 1,000 units of domestic values, and roll forward thirty quarters for Australia and New Zealand related transactions, and roll forward seventy-two quarters for the other transactions. In comparing strategy performances, each of the highest end-period wealth figures is designated by an *. Where the cash flows obtained under the PFH strategy are higher than that from the un-hedged strategy, the values are highlighted with bold characters.

Base Country	Foreign Currency	A$	C$	DM	NZ$	SF	UKP	Yen	US$
Australia	NH		1113	1109	1014	1228	1208	1186	1084
	AH		1089	1141	942	1311	983	1432	1085
	PH		1265	1453*	1135*	1646*	1128	1563	1016
	FH		1136	1191	1018	1282	1267	1466	1599*
	PFH		**1309***	**1427**	**1071**	**1617**	**1324***	**1596***	**1497**
Canada	NH	899		1398	912	1499	1212	1659	967
	AH	919		1275	865	1629	785	2002	1207
	PH	1044*		1820	1030*	2146	1031	2836*	1017
	FH	939		1829*	992	1995	1410*	2016	1482*
	PFH	**906**		**1828**	**935**	**2274***	**1378**	**2835**	**1246**
Germany	NH	902	716		914	1073	868	1186	692
	AH	876	787		825	1282	617	1575	950
	PH	1149*	1022		1068*	1382*	905	2070	773
	FH	942	1027*		890	1277	1007*	1725	1445*
	PFH	**958**	**1023**		**917**	**1333**	**975**	**2124***	**1040**
New Zealand	NH	1018	1097	1094		1211	1192	1170	1070
	AH	1062	1156	1213		1392	1044	1521	1152
	PH	1172*	1305	1416*		1715*	1260	1727	1261
	FH	1083	1257	1180		1366	1131	1496	1351
	PFH	**1139**	**1384***	**1375**		**1689**	**1284***	**1732***	**1456***

Table 4.5 (Cont') End-of-period Wealth of Different Hedging Strategies

For each hedging strategy, average cash flows received in the last quarter are reported in terms of domestic values. The strategies start with 1,000 units of domestic values, and roll forward thirty quarters for Australia and New Zealand related transactions, and roll forward seventy-two quarters for other transactions. In comparing strategy performances, each of the highest end-period wealth figures is designated by an *. Where the PFH strategy cash flows are higher than that of the un-hedged strategy, figures are highlighted by bold characters.

Base Country	Foreign Currency	A$	C$	DM	NZ$	SF	UKP	Yen	US$
Switzerland	NH	815	667	932	826		809	1106	645
	AH	763	615	783	718		482	1230	742
	PH	1023*	880*	1007*	1017*		775	1749	744
	FH	796	818	930	810		816*	1567	819*
	PFH	811	**773**	**964**	822		**810**	**2013***	**761**
UK	NH	828	825	1153	839	1237		1369	798
	AH	1018	1275	1624	958	2076		2552*	1539
	PH	949	1080	1700	1013*	1981		2194	1353
	FH	1066*	1482*	1881*	909	2092*		2528	1655*
	PFH	**908**	**1107**	**1754**	**891**	**1993**		**2194**	**1400**
Japan	NH	843	604	844	855	906	733*		585
	AH	699	500	637	658	814	392		603
	PH	921*	854*	1111*	971*	1286*	632		604
	FH	863	609	927	841	1153	726		734*
	PFH	841	**609**	**898**	838	**1007**	726		**664**
US	NH	923	1034	1446	935	1551	1254	1717	
	AH	922	829	1056	868	1349	650	1659	
	PH	865	871	1180	1023	1556	1102	1717	
	FH	1360*	1270*	2194*	1097*	1711*	1349*	2067*	
	PFH	**923**	**1036**	**1624**	**950**	**1674**	**1298**	**1881**	

It can be seen from Table 4.5 that end-of-period cash flows obtained from the PFH strategy are higher than those obtained from the un-hedged strategy in fifty-one out of the fifty-six cases under study. The other two selective hedging strategies, PH and FH, have also provided higher end-of-period wealth figures than the un-hedged strategy. The PFH strategy, however, seems to have outperformed the un-hedged strategy most consistently across the currencies.

Special attention should be given to the hedging outcomes relating to Japanese- and Swiss-based transactions, where the effectiveness of the PFH strategy was found to have mixed results. On the other hand, it should be noted that the PPP-hedging strategy has performed especially well for exporters based in these two countries. Note that the currencies of both countries have appreciated substantially against the other currencies over the period under study. This evidence indicates that the PPP-deviation rule is more capable of picking up long-lasting trends in exchange rates than is the forward premium rule.

For exporters based in each of the eight countries, cash flows to be received at the end of the study period are obtained and averaged across seven currencies and presented in Table 4.6. It can be seen that both the FH strategy and the PFH strategy have generated significantly greater wealth than the un-hedged strategy for corporations based in all countries. The PH strategy has obtained similar results, except for in the US-based study. Except for the Japanese- and the US-based studies, the wealth created by taking the PFH strategy exceeded that which can be achieved by the never-hedging strategy, by 20 to 45% over the entire period.

From different countries' perspectives, the best performing strategies vary among the three conditional hedging strategies. The PFH strategy has performed the best for managing foreign receivables from the perspectives of Australian, Canadian and New Zealand exporters. From the viewpoint of Japanese and Swiss exporters, the PH strategy has generally performed the best. The FH strategy has performed the best for the UK- and US-based studies. The overall results suggest that the PFH strategy has performed consistently well across countries, and that both the PPP deviation and the forward premium criteria contribute to the superior performances of the PFH strategy.

Table 4.6 End-of-period Wealth of Different Hedging Strategies Averaged across Currencies

For each hedging strategy, end-of-period wealth under different hedging strategies is obtained by taking averages across seven foreign currencies taking the viewpoints of specific countries. From each country's perspective, the highest value obtained among the strategies is highlighted by an *. Where a strategy beats the never-hedging strategy, the values are highlighted by bold numbers. The last row reports percentage excess cash obtained by the PFH strategy over the never-hedging strategy.

Hedging Strategy	Base Country							
	Australia	Canada	Germany	New Zealand	Switzerland	UK	Japan	US
NH	1130	1388	904	1151	827	1004	760	1261
AH	**1132**	1172	**989**	**1210**	765	**1577**	618	1050
PH	**1289**	**1445**	**1195***	**1441**	**1025***	**1462**	**916***	1191
FH	**1268**	**1408**	**1182**	**1250**	**937**	**1653***	**830**	**1570***
PFH	**1380***	**1515***	**1191**	**1464***	**993**	**1459**	**793**	**1335**
Excess	22%	33%	32%	27%	20%	45%	4%	6%

To have a clearer idea of how hedging effects accumulate over time, average quarterly cash flows under different strategies are plotted in Figures 4.4 to 4.10. For the sake of brevity, only the positions for Australian based exporters are presented for illustration purpose.

Figure 4.4 Quarterly Cash Flows - A$ Based C$ Hedging

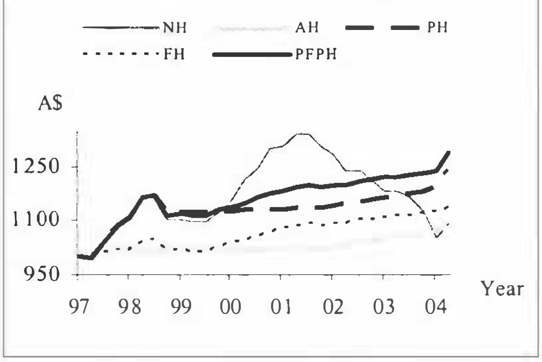


Figure 4.5 Quarterly Cash Flows - A$ Based German mark Hedging

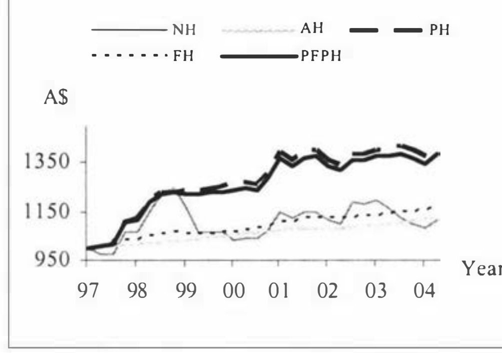


Figure 4.6 Quarterly Cash Flows - A$ Based Swiss franc Hedging

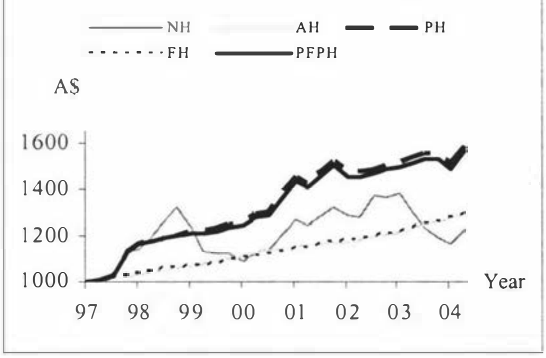


Figure 4.7 Quarterly Cash Flows - A$ Based Japanese yen Hedging

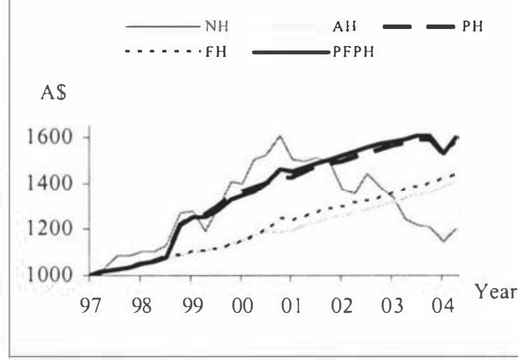


Figure 4.8 Quarterly Cash Flows - A$ Based NZ$ Hedging

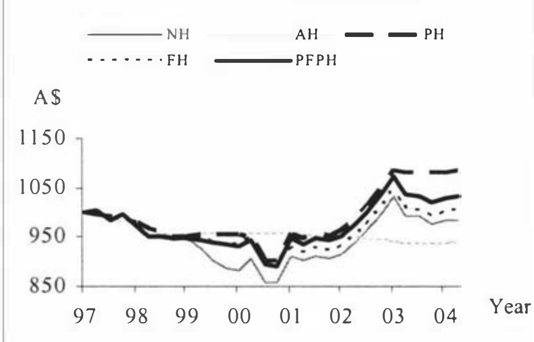


Figure 4.9 Quarterly Cash Flows - A$ Based UK pound Hedging

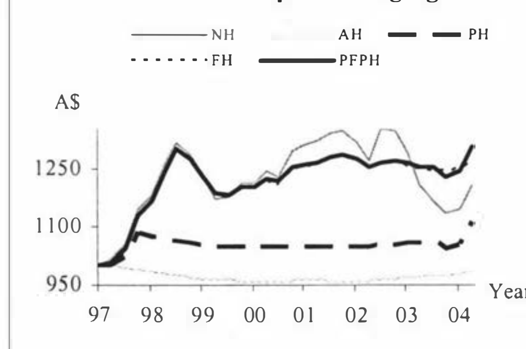
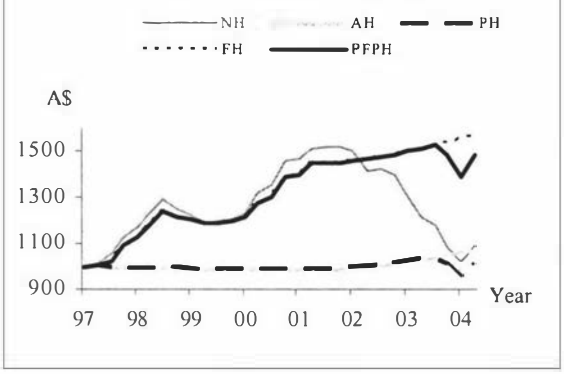


Figure 4.10 Quarterly Cash Flows - A$ Based US$ Hedging



Average quarterly cash flows from the PFH strategy and the NH strategy are plotted using bold solid lines and light solid lines, respectively in the graphs. In Figures 4.5, 4.6 and 4.8, the PFH strategy cash flows remain substantially higher than that of the NH strategy after the first couple of years. In the remaining four graphs, the cash flow levels of the PFH strategy relative to that of the NH strategy shift over time. Comparing the cash flows with that of the always-hedging strategy, the PFH strategy cash flows are substantially higher in six of the eight graphs except for Figures 4.8 and 4.10. In general, the graphs show that, across currencies, the PFH strategy has consistently achieved superior performances in terms of cash flow levels and cash flow stabilities.

4.10 Conclusions

Three conditional hedging strategies are tested in this chapter. The strategy which captures the information contents of cumulative exchange rate deviations from PPP is combined with the conventional forward rate premium strategy to form a strategy which incorporates the benefits of both. The efficacies of the strategies are examined against the never-hedging strategy, for hedging three-month exposures to foreign receivables, taking the perspectives of eight developed countries.

For the period between 1986 and 2004, the passive always hedge strategy often reduced return volatilities at the cost of substantially reduced returns. The PPP and forward-at-premium-hedging strategy is found to have performed consistently better than the unhedged strategy from the perspective of the eight countries in the study. The superior performances of the PFH strategy is demonstrated by, increased single-period returns, reduced return volatilities, improved risk-adjusted returns and substantially higher end-of-period cash flows. Average annualised single period returns under the PFH strategy exceed those of the never hedging strategy by 0.42 to 2.18% for exporters based in seven countries. The only exception to this was when the US dollar was used as the base currency. On average, the PFH strategy gave out hedging signals 23% of the time.

The conditional hedging strategy based on the forward premium anomaly alone, has generally outperformed the unhedged strategy as well, however, this is mainly in terms of risk reduction. Improvements over single-period returns under the FH strategy, however, are limited when compared to those obtained under the PH and the PFH strategies.

Another conditional hedging strategy based solely on observations of five-year cumulative exchange rate deviations from PPP also outperformed the unhedged strategy for corporations based in six out of the eight countries under study. For exporters based in countries other than Japan and the US, the PH strategy has offered benefits of both risk reduction and return improvement.

It is noteworthy that, for exporters based in Switzerland and Japan; two countries whose currencies have experienced continuing appreciation against the other countries in the study; the PPP-hedging strategy often appears to be the best strategy. This evidence indicates that the PPP-deviation rule is more capable of picking up long-lasting trends of exchange rate movements than is the forward premium rule.

Second order stochastic dominance analysis results confirm the above findings by showing that, the selective hedging strategy combining both PPP deviation and forward premium information dominates the never-hedging strategy in 79% of the comparisons (forty-four out of fifty-six comparisons). The PPP-hedging and forward-at-premium hedging strategies sometimes dominate the strategy of combined conditions. Nevertheless, both strategies failed to dominate the unhedged strategy as consistently as did the PFH strategy. Consequently, the PPP and forward-at-premium-hedging strategy is recommended for managing foreign transaction exposures.

The overall evidence indicates that, both the information contents of exchange rate deviations from PPP and the forward premiums contribute to the success of the proposed selective forward hedging strategy. The strategy, developed from robust observations of exchange market behaviour, is theoretically intuitive and easy to carry out in practice. It is appealing to international corporations wishing to manage expected foreign receivables more efficiently under the current floating exchange rate system. The results can be generalised to situations of importers exposed to foreign payables. For dealing with occasional large foreign currency transactions, or dealing with a foreign currency showing long-term trends of appreciation, however, the strategy should be used with caution.

One possible extension to this study is an examination of the hedging effects of managing different terms' exchange exposures. The study can also be extended to use other derivative products as hedging vehicles. Further, adding more hedging criteria for hedging decision, such as filter rules or interest rate differentials, may also improve hedging performance. It would also be interesting to see possible applications of the proposed hedging strategy in managing currency risk of internationally diversified portfolios. Such a strategy could be combined with the portfolio diversification strategy developed in Chapter Three.

Chapter 5

Summary Conclusion and Future Work

One of the great mysteries of economics is why PPP, one of the most compelling theorems of foreign exchange rate determination, has poor predictive power. Most studies attempt to predict exchange rates using forecasted inflation. This research, however, takes a different approach, which predicts future directions of exchange rate movements using the knowledge of exchange rate deviations from PPP accumulated over a specific period of time.

In this study, exchange rate reversions from historical cumulative deviations from PPP are decomposed into two parts: the correction pressure built up due to the power of PPP, and the reversion of exchange rate movements unexplained by PPP. In doing so, the weakness confounding conventional predictions using PPP; the large seemingly random movement of exchange rates that masks the effects of PPP; becomes the very strength of this study's predictions. These large random deviations accumulate over time and create incorrect pricing of exchange rates that cannot correctly reflect the effect of the economic forces which act upon exchange rates. It is found that corrections to historical cumulative deviations from PPP were mainly driven by the reversion of the exchange rate's historical movements, not by the adjustment to PPP.

The fact that PPP works in the long run is well known. It is also well documented that exchange rate deviations from PPP have a half life of three to five years. Unfortunately, this well-known observation has seen little application in international asset allocations where significant economic value can be created through a workable means of exchange rate prediction.

Using the historical data from eight developed countries for the period between January 1974 and February 2004, this study found that divergences of exchange rates from PPP, accumulated over the past five-year period, reverted partially over the subsequent three-year period. The finding of deviation correction is robust across a number of combinations of deviation accumulation periods and the subsequent correction periods.

The finding of exchange rate correction to cumulative deviations from PPP is consistent with the literature, with some new features in this study. Firstly, it is the first study that combines the reversion of historical exchange rate movement and the PPP to explain exchange rate behaviour. Secondly, this is the first study to use long-interval data of several years' exchange rate movements to examine exchange rate behaviour. The tests are, therefore, more able to capture the long-run movements of exchange rates. Thirdly, instead of modelling exchange rate movements with a commonly used AR(1) model, this study uses simple regression models. It is argued that the first-order autoregressive models applied in most of the other studies have an disadvantage of ignoring higher moments of exchange rate behaviour which may have significant influence accumulated over time, especially when the coefficients for AR(1) are close to one.

The findings from Chapter Two indicate that cumulative exchange rate deviations from PPP can provide reliable information in predicting future directions of exchange rate movements. This knowledge is proved to have significant economic value when applied to foreign exchange market practices. Based on the current knowledge of cumulative exchange rate deviations from PPP, investors can develop strategies to not only capture gains from favourable exchange rate movements, but also to reduce losses associated with unfavourable forecasted exchange rate movements in the future. While there are many potential applications for foreign exchange predictions, this study proposes and examines the effectiveness of such strategies on just two applications.

The first application of the predictive power of cumulative exchange rate deviations from PPP is a selective international asset allocation strategy aimed to more effectively manage diversified international equity portfolios. The proposed new approach to managing currency risk associated with international portfolio investment is to control currency risk through selectively choose the market to diversify. The market-selection decisions are made in the construction of portfolios through forecasting the future directions of exchange rate's movements by look at the historical cumulative exchange rate deviations from PPP. Under the proposed portfolio strategy, a particular national stock market should not be included in the internationally diversified portfolio if its currency has accumulated a positive deviation from PPP over the past several years. Therefore, currency risk associated with the expected reversal of cumulative historical exchange rate deviations can be avoided, resulting in superior performance of international portfolios.

Looking at the question from the perspectives of investors based in each of the eight markets studied, the empirical analysis reveals that the proposed international diversification strategy leads to substantial diversification benefits for domestic investors, in terms of improved returns on a risk-adjusted basis. The proposed strategy outperformed the naïve diversification strategy and the MSCI world index portfolio strategy, measured by the Sharpe ratio. The average number of markets held by the proposed diversification strategy is 4.4, significantly less than the eight assets held by the benchmark portfolios. This result indicates that the superior performance of the strategy comes from the effective management of currency risk, instead of increasing the number of assets held. The proposed strategy is the first of this kind in the literature which controls currency risk through active market-selections based on the observation that historical cumulative exchange rate deviations from PPP are indicative of future exchange rate moving directions. Compared to other strategies in the previous literature, which control currency risk through forward hedging or optimal weighting schemes, the proposed portfolio strategy has advantages of intuitively understandable, is forward-looking and easy to carry out in practice.

The second application of the predictive power of cumulative exchange rate deviations is explored in this study is to improve the management of foreign exchange transaction exposures. This has been done through selectively hedging foreign exchange risk, using forward contracts based on the predicted directions of foreign exchange rate movement. Under this strategy, hedging decisions are made based on the current knowledge of cumulative exchange rate deviations from PPP and whether forward contracts are trading at premiums or discounts to spots. For exposures to long positions in foreign currencies, the proposed strategy calls for hedging when the exchange rates have accumulated positive deviations from PPP and the forward contracts are trading at premiums. This approach to active forward hedging is new in the literature.

When tested on empirical data of seven foreign currencies, taking the viewpoint of each of the eight developed countries, the proposed selective hedging strategy is proved to be superior, in that it not only reduced cash flow fluctuations in domestic terms, but also improved return and risk-adjusted return of domestic cash flows. The improvements show both statistical and economic significance. The overall evidence indicates that both the information contents of cumulative exchange rate deviations from PPP, and the forward premiums contribute to the success of the proposed selective forward hedging strategy.

Although the proposed international diversification strategy and the forward hedging strategy are appealing to investors and corporations operating in the international financial market, the proposed strategies have some limitations that should be noted. Firstly, the strategies are only examined for limited terms of portfolio holding period and currency exposures. It is expected that the strategies may be applicable to managing currency risk of different terms, although further examinations need to be done for confirmation of this. Secondly, although the proposed selective forward hedging strategy is appropriate for hedging currencies with sufficiently long histories of being freely-floating, its application to currencies with relatively short histories of free-floating should be undertaken with caution. Given the relatively short history of free-floating exchange rate systems, and the limited number of samples used in this study, the conclusions of this study could be subject to sampling error, and should be treated with caution when applied to other markets or different sample periods. Further, hedging decisions regarding one-off large foreign currency transactions should be treated differently.

There are, of course, many other ways in which the predictive power of cumulative foreign exchange rate deviations can be used for improving financial performance. These applications can be examined in the future as extensions to the current study. In addition, the rules adopted are deliberately chosen for their simplicity, as simple solutions are the best for demonstration purposes. It is possible to add sophistication to the predicting techniques, for example, by adding filter rules in the market selection, or hedging decision process. For example, it would be possible to selectively hedge when the foreign currency exceeds some thresholds; e.g. greater than a 10% deviation. What this study has developed is a simple, robust method with good predictive power, and this is something that other studies have, so far, failed to achieve.

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Appendices

Appendix 1 Regression Estimations of Exchange Rate Corrections of Cumulative Deviations from PPP[23]

Table A1.1 Regression Results on Exchange Rate Corrections to Cumulative Deviations from the Mean and PPP – Australian dollar Rates

Coefficient β_1 measures the extent to which cumulative exchange rate deviations from PPP over a five-year period are corrected in the following three-year period. Coefficient β_2 measures the correction to random movements of the exchange rate in the past five years. Coefficient β_3 tells the relationship between future exchange rate movement and its expected adjustment towards PPP over the past five years. Estimations of 10, 5 and 1% significance levels are denoted by *, ** and ***, respectively. PPP theoretical values are estimated from relative price level changes in two countries over a five-year period. Data covers Jan. 1979 to Jan. 2001 for most of the currencies. The reported t-statistics have been adjusted by dividing the square root of forecast horizon to account for the overlaps in data.

Statistics	C$	GM	NZ$	SF	UK£	Yen	US$	Ave.
β_1	-0.79	-0.25	-0.51	-0.35	-0.67	-0.92	-0.50	-0.57
t-stat.	-2.53***	-0.79	-1.45*	-1.16	-1.63*	-1.89**	-0.99	
β_2	-0.59	-0.01	-0.71	-0.29	-0.31	-0.87	-0.60	-0.48
t-stat.	-1.38*	-0.05	-2.97***	-0.85	-0.72	-1.60*	-1.09	
β_3	-0.52	-0.68	0.46	-0.27	-0.51	-0.76	-0.04	-0.33
t-stat.	-0.75	-1.45*	0.68	-0.45	-0.72	-0.45	-0.05	
Adj-R^2_1	61.3	13.0	38.0	24.5	39.5	46.7	19.3	34.6
Adj-R^2_2	31.7	0.0	72.3	14.8	10.7	38.5	22.3	27.2
Adj-R^2_3	11.6	33.9	11.4	4.1	10.9	4.1	0.0	10.9
no. of Obs.	146	146	122	146	146	146	146	

[23] Estimations for different combinations of deviation cumulating period between three-years and twelve-years with correcting periods of three-years up to seven-years have been calculated. To save space, only part of these estimations is reported here. Other statistics are available from the author upon request.

Table A1.2 Regression Results on Exchange Rate Corrections to Cumulative Deviations from the Mean and PPP – Canadian dollar Rates

Coefficient β_1 measures the extent to which cumulative exchange rate deviations from PPP over a five-year period are corrected in the following three-year period. Coefficient β_2 measures the correction to random movements of the exchange rate in the past five years. Coefficient β_3 tells the relationship between future exchange rate movement and its expected adjustment towards PPP over the past five years. Estimations of 10, 5 and 1% significance levels are denoted by *, ** and ***, respectively. PPP theoretical values are estimated from relative price changes in two countries over a five-year period. Data covers Jan. 1979 to Jan. 2001 for most of the currencies. The reported t-statistics have been adjusted by dividing the square root of forecast horizon to account for the overlaps in data.

Statistics	A$	GM	NZ$	SF	UK£	Yen	US$	Ave.
β_1	-0.67	-0.52	-0.79	-0.59	-0.54	-0.64	-0.09*	-0.55
t-stat.	-2.43***	-2.54***	-2.59***	-3.13***	-3.05***	-2.11**	-0.33	
β_2	-0.53	-0.55	-0.82	-0.69	-0.59	-0.68	-0.28	-0.59
t-stat.	-1.30*	-2.20**	-2.68***	-3.41***	-2.58***	-1.95**	-0.94	
β_3	-0.48	-0.87	-0.41	-0.49	-1.31	-3.02	0.92	-0.81
t-stat.	-0.87	-1.14	-0.17	-0.53	-1.77**	-1.58*	1.36*	
Adj-R^2_1	59.2	46.5	66.5	57.0	55.8	37.5	1.1	46.2
Adj-R^2_2	29.0	39.6	68.0	61.1	47.3	33.9	10.4	41.3
Adj-R^2_3	15.4	14.8	0.0	3.3	29.7	25.2	19.9	15.5
no. of Obs.	146	266	122	266	266	266	266	

Table A1.3 Regression Results on Exchange Rate Corrections to Cumulative Deviations from the Mean and PPP – German mark Rates

Coefficient β_1 measures the extent to which cumulative exchange rate deviations from PPP over a five-year period are corrected in the following three-year period. Coefficient β_2 measures the correction to random movements of the exchange rate in the past five years. Coefficient β_3 tells the relationship between future exchange rate movement and its expected adjustment towards PPP over the past five years. Estimates of 10, 5 and 1% significance levels are denoted by *, ** and ***, respectively. PPP theoretical values are estimated from relative price changes in two countries over a five-year period. Data covers Jan. 1979 to Jan. 2001 for most of the currencies. The reported t-statistics have been adjusted by dividing the square root of forecast horizon to account for the overlaps in data.

Statistics	A$	C$	NZ$	SF	UK£	Yen	US$	Ave.
β_1	-0.10	-0.60	-0.55	-0.24	-0.38	-0.90	-0.42	-0.46
t-stat.	-0.42	-3.03***	-2.71***	-0.71	-1.88**	-2.22**	-1.51*	
β_2	0.13	-0.56	-0.53	0.02	-0.15	-0.91	-0.43	-0.35
t-stat.	0.74	-2.91***	-2.42***	0.06	-0.66	-2.38***	-1.68**	
β_3	-0.39	0.12	-0.06	-0.61	-0.25	0.46	0.63	-0.01
t-stat.	-2.05**	0.20	-0.10	-1.26	-1.02	0.32	0.61	
Adj-R^2_1	3.6	55.3	68.4	6.0	32.3	40.0	23.5	32.7
Adj-R^2_2	11.5	53.4	63.5	0.0	5.3	43.4	27.6	29.2
Adj-R^2_3	50.8	0.1	0.0	17.5	12.1	1.0	4.5	12.3
no. of Obs.	146	266	122	266	266	266	266	

Table A1.4 Regression Results on Exchange Rate Corrections to Cumulative Deviations from the Mean and PPP – New Zealand dollar Rates

Coefficient β_1 measures the extent to which cumulative exchange rate deviations from PPP over a five-year period are corrected in the following three-year period. Coefficient β_2 measures the correction to random movements of the exchange rate in the past five years. Coefficient β_3 tells the relationship between future exchange rate movement and its expected adjustment towards PPP over the past five years. Estimates of 10, 5 and one 1% significance levels are denoted by *, ** and ***, respectively. PPP theoretical values are estimated from relative price changes in two countries over a five-year period. Data covers Jan. 1979 to Jan. 2001 for most of the currencies. The reported t-statistics have been adjusted by dividing the square root of forecast horizon to account for the overlaps in data.

Statistics	A$	C$	GM	SF	UK£	Yen	US$	Ave.
β_1	-0.28	-0.74	-0.51	-0.57	-0.73	-1.19	-0.68	-0.67
t-stat.	-0.95	-2.45***	-2.37***	-2.25**	-2.05**	-3.42***	-1.41*	
β_2	-0.69	-0.82	-0.54	-0.69	-0.78	-1.36	-1.02	-0.84
t-stat.	-3.07***	-2.78***	-2.63***	-2.38***	-2.17**	-3.34***	-2.16**	
β_3	0.19	-0.14	0.02	-0.28	-0.09	-1.25	0.13	-0.20
t-stat.	0.46	-0.09	0.04	-0.39	-0.06	-0.62	0.09	
Adj-R^2_1	20.5	64.0	62.4	59.9	55.3	77.7	36.9	53.8
Adj-R^2_2	73.7	69.6	67.1	62.6	58.1	76.8	57.9	66.5
Adj-R^2_3	5.1	0.0	0.0	3.5	0.0	9.6	0.0	2.6
no. of Obs.	122	122	122	122	122	122	122	

Table A1.5 Regression Results on Exchange Rate Corrections to Cumulative Deviations from the Mean and PPP – Swiss franc Rates

Coefficient β_1 measures the extent to which cumulative exchange rate deviations from PPP over a five-year period are corrected in the following three-year period. Coefficient β_2 measures the correction to random movements of the exchange rate in the past five years. Coefficient β_3 tells the relationship between future exchange rate movement and its expected adjustment towards PPP over the past five years. Estimates of 10, 5 and 1% significance levels are denoted by *, ** and ***, respectively. PPP theoretical values are estimated from relative price changes in two countries over a five-year period. Data covers Jan. 1979 to Jan. 2001 for most of the currencies. The reported t-statistics have been adjusted by dividing the square root of forecast horizon to account for the overlaps in data.

Statistics	A$	C$	GM	NZ$	UK£	Yen	US$	Ave.
β_1	-0.17	-0.60	-0.14	-0.58	-0.48	-0.90	-0.48	-0.48
t-stat.	-0.76	-3.73***	-0.47	-2.68***	-2.52***	-2.27**	-1.93**	
β_2	0.02	-0.43	0.06	-0.67	-0.05	-0.72	-0.50	-0.33
t-stat.	0.09	-3.04***	0.27	-2.45***	-0.31	-2.05**	-2.53***	
β_3	0.55	0.27	-0.57	-0.36	-0.20	0.32	0.70	0.10
t-stat.	0.96	0.67	-1.41*	-0.51	-1.12	0.33	1.16	
Adj-R^2_1	12.0	65.3	2.5	68.1	46.3	41.0	33.4	38.4
Adj-R^2_2	0.0	55.7	0.6	63.9	0.9	36.1	46.4	29.1
Adj-R^2_3	27.6	5.3	21.1	6.6	14.4	1.1	15.1	13.0
no. of Obs.	146	266	266	122	266	266	266	

Table A1.6 Regression Results on Exchange Rate Corrections to Cumulative Deviations from the Mean and PPP – UK pound Rates

Coefficient β_1 measures the extent to which cumulative exchange rate deviations from PPP over a five-year period are corrected in the following three-year period. Coefficient β_2 measures the correction to random movements of the exchange rate in the past five years. Coefficient β_3 tells the relationship between future exchange rate movement and its expected adjustment towards PPP over the past five years. Estimates of 10, 5 and 1% significance levels are denoted by *, ** and ***, respectively. PPP theoretical values are estimated from relative price changes in two countries over a five-year period. Data covers Jan. 1979 to Jan. 2001 for most of the currencies. The reported t-statistics have been adjusted by dividing the square root of forecast horizon to account for the overlaps in data.

Statistics	A$	C$	GM	NZ$	SF	Yen	US$	Ave.
β_1	-0.49	-0.55	-0.34	-0.73	-0.45	-0.51	-0.58	-0.52
t-stat.	-1.49*	-3.26***	-1.57*	-2.17**	-2.10**	-2.65**	-2.74***	
β_2	-0.18	-0.62	-0.21	-0.78	-0.41	-0.55	-0.56	-0.47
t-stat.	-0.49	-2.71***	-0.73	-2.12**	-1.45*	-1.56*	-2.20**	
β_3	-0.38	-1.22	-0.82	-0.74	-0.85	-2.91	-1.43	-1.19
t-stat.	-0.87	-1.98**	-1.92**	-0.39	-1.56*	-1.56*	-1.54*	
Adj-R^2_1	35.2	59.0	24.9	58.2	37.3	26.9	50.4	41.7
Adj-R^2_2	4.9	49.8	6.4	56.9	21.9	24.7	39.4	29.1
Adj-R^2_3	15.2	34.5	33.1	3.6	24.7	24.6	24.1	22.8
no. of Obs.	146	266	266	122	266	266	266	

Table A1.7 Regression Results on Exchange Rate Corrections to Cumulative Deviations from the Mean and PPP – Japanese Yen Rates

Coefficient β_1 measures the extent to which cumulative exchange rate deviations from PPP over a five-year period are corrected in the following three-year period. Coefficient β_2 measures the correction to random movements of the exchange rate in the past five years. Coefficient β_3 tells the relationship between future exchange rate movement and its expected adjustment towards PPP over the past five years. Estimates of 10, 5 and 1% significance levels are denoted by *, ** and ***, respectively. PPP theoretical values are estimated from relative price changes in two countries over a five-year period. Data covers Jan. 1979 to Jan. 2001 for most of the currencies. The reported t-statistics have been adjusted by dividing the square root of forecast horizon to account for the overlaps in data.

Statistics	A$	C$	GM	NZ$	SF	UK£	US$	Ave.
β_1	-0.36	-0.59	-0.33	-1.05	-0.55	-0.53	-0.47	-0.55
t-stat.	-0.87	-3.01***	-0.92	-3.27***	-1.60*	-1.92**	-1.79**	
β_2	-0.06	-0.39	-0.46	-1.02	-0.46	-0.03	-0.39	-0.40
t-stat.	-0.18	-1.68**	-1.50*	-2.33**	-1.75**	-0.11	-1.39*	
β_3	-0.42	-0.77	0.78	-0.90	0.42	-0.75	-0.89	-0.36
t-stat.	-0.77	-1.24	1.13	-0.64	0.75	-2.39***	-0.91	
Adj-R^2_1	15.3	55.1	10.0	76.0	25.7	33.3	30.1	35.1
Adj-R^2_2	0.1	27.5	23.2	61.6	29.2	0.0	20.6	23.2
Adj-R^2_3	12.3	17.1	14.4	10.0	6.8	43.5	9.7	16.3
no. of Obs.	146	266	266	122	266	266	266	

Table A1.8 Regression Results on Exchange Rate Corrections to Cumulative Deviations from the Mean and PPP – US dollar Rates

Coefficient β_1 measures the extent to which cumulative exchange rate deviations from PPP over a five-year period are corrected in the following three-year period. Coefficient β_2 measures the correction to random movements of the exchange rate in the past five years. Coefficient β_3 tells the relationship between future exchange rate movement and its expected adjustment towards PPP over the past five years. Estimates of 10, 5 and 1% significance levels are denoted by *, ** and ***, respectively. PPP theoretical values are estimated from relative price changes in two countries over a five-year period. Data covers Jan. 1979 to Jan. 2001 for most of the currencies. The reported t-statistics have been adjusted by dividing the square root of forecast horizon to account for the overlaps in data.

Statistics	A$	C$	GM	NZ$	SF	UK£	Yen	Ave.
β_1	-0.40	-0.07	-0.34	-0.79	-0.42	-0.63	-0.32	-0.42
t-stat.	-1.21	-0.29	-1.31*	-1.80**	-1.73**	-3.26***	-1.01	
β_2	-0.57	-0.22	-0.37	-1.00	-0.52	-0.52	-0.37	-0.51
t-stat.	-1.20	-0.82	-1.31*	-2.39***	-2.13**	-2.04**	-1.06	
β_3	0.31	0.72	-0.17	0.07	0.33	-0.98	-0.80	-0.07
t-stat.	0.59	1.19	-1.34*	0.03	0.32	-1.47*	-0.36	
Adj-R^2_1	23.4	0.7	18.6	48.9	28.7	58.9	11.9	27.3
Adj-R^2_2	26.0	8.1	19.4	62.9	38.0	36.0	13.0	29.1
Adj-R^2_3	7.4	16.0	0.0	0.0	1.0	22.5	1.3	6.9
no. of Obs.	146	266	266	122	266	266	266	

Table A1.9 Regression Estimations of Three-year Corrections to Three-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that are significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 3 Years								
Deviation Correction Period = 3 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.38						
	t-stat.	-1.13						
	Sig.							
	Adj-R^2	21.0						
GM	β	-0.22	-0.37					
	t-stat.	-0.96	-1.28					
	Sig.							
	Adj-R^2	15.8	16.8					
NZ$	β	-0.27	-0.46	-0.63				
	t-stat.	-0.69	-1.12	-2.49				
	Sig.			**				
	Adj-R^2	10.0	23.3	60.4				
SF	β	-0.19	-0.36	-0.22	-0.51			
	t-stat.	-0.81	-1.24	-0.35	-1.88			
	Sig.				**			
	Adj-R^2	11.8	15.9	3.2	46.5			
UK£	β	-0.35	-0.48	-0.19	-0.53	-0.27		
	t-stat.	-1.28	-2.01	-0.67	-1.41	-1.02		
	Sig.		**		*			
	Adj-R^2	25.5	33.3	5.0	32.8	11.3		
Yen	β	-0.65	-0.57	-0.77	-0.89	-0.79	-0.53	
	t-stat.	-2.20	-2.25	-2.40	-3.30	-2.49	-2.01	
	Sig.	**	**	***	***	***	**	
	Adj-R^2	50.7	38.6	41.7	72.9	43.4	33.2	
US$	β	-0.21	-0.09	-0.14	-0.53	-0.18	-0.47	-0.34
	t-stat.	-0.56	-0.28	-0.39	-1.26	-0.54	-1.58	-1.09
	Sig.						*	
	Adj-R^2	5.7	0.7	1.6	27.8	3.2	23.5	12.6
Ave. β	-0.41							
Ave.Adj-R^2	24.6							

Table A1.10 Regression Estimations of Four-year Corrections to Three-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates are that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 3 Years								
Deviation Correction Period = 4 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.56						
	t-stat.	-1.40						
	Sig.	*						
	Adj-R^2	37.2						
GM	β	-0.28	-0.56					
	t-stat.	-0.79	-1.77					
	Sig.		**					
	Adj-R^2	15.6	35.0					
NZ$	β	-0.34	-0.78	-0.69				
	t-stat.	-0.57	-1.54	-2.11				
	Sig.		*	**				
	Adj-R^2	9.8	45.9	61.5				
SF	β	-0.33	-0.54	-0.23	-0.62			
	t-stat.	-1.02	-1.86	-0.42	-1.80			
	Sig.		**		**			
	Adj-R^2	23.8	37.4	2.7	53.7			
UK£	β	-0.50	-0.60	-0.36	-0.71	-0.41		
	t-stat.	-1.50	-2.51	-0.95	-1.53	-1.26		
	Sig.	*	***		*			
	Adj-R^2	40.4	52.0	13.2	45.7	21.3		
Yen	β	-0.70	-0.70	-0.73	-1.01	-0.73	-0.57	
	t-stat.	-2.63	-2.61	-1.89	-4.89	-2.08	-1.77	
	Sig.	***	***	**	***	**	**	
	Adj-R^2	67.8	54.0	38.0	89.6	42.7	35.0	
US$	β	-0.38	-0.13	-0.32	-0.75	-0.35	-0.65	-0.45
	t-stat.	-0.89	-0.37	-0.71	-1.39	-0.89	-1.99	-1.19
	Sig.				*		**	
	Adj-R^2	19.2	1.4	7.7	41.0	11.7	40.6	19.5
Ave. β	-0.54							
Ave.Adj-R^2	34.0							

Table A1.11 Regression Estimations of Five-year Corrections to Three-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 3 Years								
Deviation Correction Period = 5 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.68						
	t-stat.	-1.56						
	Sig.	*						
	Adj-R^2	50.1						
GM	β	-0.26	-0.73					
	t-stat.	-0.68	-2.20					
	Sig.		**					
	Adj-R^2	15.7	52.3					
NZ$	β	-0.52	-1.07	-0.71				
	t-stat.	-0.71	-2.17	-2.22				
	Sig.		**	**				
	Adj-R^2	19.5	70.0	71.0				
SF	β	-0.37	-0.73	-0.10	-0.74			
	t-stat.	-1.16	-2.62	-0.23	-2.19			
	Sig.		***		**			
	Adj-R^2	35.3	60.8	0.1	70.3			
UK£	β	-0.52	-0.59	-0.56	-0.93	-0.60		
	t-stat.	-1.20	-2.42	-1.23	-1.75	-1.62		
	Sig.		***		**	*		
	Adj-R^2	37.2	57.0	25.4	60.1	37.2		
Yen	β	-0.47	-0.63	-0.44	-0.73	-0.49	-0.51	
	t-stat.	-1.49	-2.21	-0.98	-2.02	-1.14	-1.36	
	Sig.	*	**		**		*	
	Adj-R^2	47.6	52.4	17.6	66.8	22.4	29.5	
US$	β	-0.41	-0.16	-0.59	-0.87	-0.62	-0.73	-0.46
	t-stat.	-0.78	-0.31	-1.10	-1.23	-1.41	-2.18	-1.09
	Sig.					*	**	
	Adj-R^2	19.6	1.6	21.3	42.5	31.0	51.8	20.8
Ave. β	-0.58							
Ave.Adj-R^2	33.8							

Table A1.12 Coefficient Estimations of Three-year Corrections to Four-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 4 Years								
Deviation Correction Period = 3 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.55						
	t-stat.	-1.80						
	Sig.	**						
	Adj-R^2	42.6						
GM	β	-0.19	-0.48					
	t-stat.	-0.67	-2.11					
	Sig.		**					
	Adj-R^2	8.9	36.5					
NZ$	β	-0.34	-0.60	-0.50				
	t-stat.	-1.01	-1.84	-2.53				
	Sig.		**	***				
	Adj-R^2	21.1	47.7	63.3				
SF	β	-0.22	-0.49	-0.27	-0.46			
	t-stat.	-0.77	-2.28	-0.88	-1.89	0.00		
	Sig.		**		**	***		
	Adj-R^2	11.5	40.3	8.9	49.1			
UK£	β	-0.49	-0.52	-0.28	-0.59	-0.36		
	t-stat.	-1.68	-3.11	-1.18	-1.79	-1.60		
	Sig.	**	***		**	*		
	Adj-R^2	39.0	55.6	14.9	46.2	24.6		
Yen	β	-0.78	-0.63	-0.69	-0.99	-0.80	-0.52	
	t-stat.	-2.73	-3.05	-2.31	-5.63	-2.60	-2.09	
	Sig.	***	***	**	***	***	**	
	Adj-R^2	63.0	54.6	40.9	89.6	46.6	36.0	
US$	β	-0.34	-0.10	-0.28	-0.64	-0.33	-0.54	-0.46
	t-stat.	-0.97	-0.35	-0.91	-1.72	-1.14	-2.42	-1.41
	Sig.				**		***	*
	Adj-R^2	17.3	1.2	9.4	44.3	14.2	43.1	20.2
Ave. β	-0.48							
Ave.Adj-R^2	35.4							

Table A1.13 Coefficient Estimations of Four-year Corrections to Four-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 4 Years								
Deviation Correction Period = 4 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.72						
	t-stat.	-2.00						
	Sig.	**						
	Adj-R^2	56.6						
GM	β	-0.35	-0.63					
	t-stat.	-0.79	-2.48					
	Sig.		***					
	Adj-R^2	16.7	52.7					
NZ$	β	-0.61	-0.91	-0.63				
	t-stat.	-1.09	-2.31	-2.46				
	Sig.		**	***				
	Adj-R^2	31.5	67.8	70.6				
SF	β	-0.44	-0.65	-0.18	-0.67			
	t-stat.	-1.13	-3.05	-0.45	-2.33			
	Sig.		***		**			
	Adj-R^2	29.3	62.7	3.2	68.2			
UK£	β	-0.61	-0.58	-0.46	-0.85	-0.55		
	t-stat.	-1.61	-3.05	-1.47	-1.99	-2.03		
	Sig.	*	***	*	**	**		
	Adj-R^2	45.9	62.8	28.1	61.1	42.5		
Yen	β	-0.65	-0.69	-0.58	-0.93	-0.63	-0.56	
	t-stat.	-1.75	-2.85	-1.48	-2.83	-1.54	-1.80	
	Sig.	**	***	*	***	*	**	
	Adj-R^2	50.2	59.5	28.2	76.0	29.9	36.8	
US$	β	-0.41	-0.11	-0.45	-0.81	-0.50	-0.68	-0.48
	t-stat.	-0.97	-0.29	-1.13	-1.40	-1.45	-2.69	-1.41
	Sig.				*	*	***	*
	Adj-R^2	23.4	1.1	18.7	43.4	27.5	56.7	26.3
Ave. β	-0.58							
Ave.Adj-R^2	41.5							

Table A1.14 Coefficient Estimations of Five-year Corrections to Four-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 4 Years								
Deviation Correction Period = 5 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.82						
	t-stat.	-2.04						
	Sig.	**						
	Adj-R^2	65.1						
GM	β	-0.31	-0.71					
	t-stat.	-0.62	-2.33					
	Sig.		**					
	Adj-R^2	14.1	56.1					
NZ$	β	-0.65	-1.06	-0.58				
	t-stat.	-0.92	-2.58	-1.65				
	Sig.		***	*				
	Adj-R^2	31.4	78.6	59.8				
SF	β	-0.36	-0.70	-0.17	-0.63			
	t-stat.	-0.75	-2.57	-0.35	-1.47			
	Sig.		***		*			
	Adj-R^2	19.9	60.9	2.5	54.1			
UK£	β	-0.62	-0.51	-0.63	-0.97	-0.66		
	t-stat.	-1.19	-2.12	-1.62	-1.81	-1.93		
	Sig.		**	*	**	**		
	Adj-R^2	38.8	51.4	38.1	64.2	46.9		
Yen	β	-0.36	-0.59	-0.28	-0.56	-0.19	-0.50	
	t-stat.	-0.82	-2.05	-0.62	-1.19	-0.39	-1.38	
	Sig.		**				*	
	Adj-R^2	22.8	49.9	8.0	43.4	3.1	30.9	
US$	β	-0.26	-0.10	-0.62	-0.78	-0.64	-0.68	-0.48
	t-stat.	-0.43	-0.22	-1.30	-0.92	-1.51	-2.32	-1.19
	Sig.			*		*	**	
	Adj-R^2	7.1	0.8	28.3	31.2	34.9	55.9	25.0
Ave. β	-0.53							
Ave.Adj-R^2	36.5							

Table A1.15 Coefficient Estimations of Three-year Corrections to Five-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 5 Years								
Deviation Correction Period = 3 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.73						
	t-stat.	-2.48						
	Sig.	***						
	Adj-R^2	60.3						
GM	β	-0.18	-0.56					
	t-stat.	-0.62	-2.78					
	Sig.		***					
	Adj-R^2	8.1	51.2					
NZ$	β	-0.40	-0.77	-0.53				
	t-stat.	-1.22	-2.56	-2.55				
	Sig.		***	***				
	Adj-R^2	30.1	65.9	65.9				
SF	β	-0.26	-0.61	-0.19	-0.58			
	t-stat.	-0.99	-3.51	-0.59	-2.48			
	Sig.		***		***			
	Adj-R^2	19.2	62.5	4.1	64.5			
UK£	β	-0.60	-0.55	-0.36	-0.74	-0.46		
	t-stat.	-1.61	-3.16	-1.69	-2.13	-2.27		
	Sig.	*	***	**	**	**		
	Adj-R^2	38.9	57.4	27.6	57.2	40.9		
Yen	β	-0.65	-0.68	-0.61	-1.12	-0.73	-0.51	
	t-stat.	-1.40	-2.79	-1.57	-3.37	-1.94	-1.77	
	Sig.	*	***	*	***	**	**	
	Adj-R^2	32.5	51.2	24.9	77.1	33.7	29.7	
US$	β	-0.45	-0.08	-0.38	-0.74	-0.45	-0.61	-0.39
	t-stat.	-1.06	-0.32	-1.41	-1.62	-1.83	-3.00	-1.32
	Sig.			*	*	**	***	*
	Adj-R^2	21.5	1.0	20.9	43.6	31.1	54.9	18.8
Ave. β	-0.53							
Ave.Adj-R^2	39.1							

Table A1.16 Coefficient Estimations of Four-year Corrections to Five-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 5 Years								
Deviation Correction Period = 4 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.87						
	t-stat.	-2.32						
	Sig.	**						
	Adj-R^2	65.8						
GM	β	-0.25	-0.64					
	t-stat.	-0.53	-2.49					
	Sig.		***					
	Adj-R^2	8.5	53.9					
NZ$	β	-0.50	-1.08	-0.60				
	t-stat.	-0.89	-2.99	-1.69				
	Sig.		***	**				
	Adj-R^2	25.2	79.7	55.6				
SF	β	-0.32	-0.64	-0.23	-0.65			
	t-stat.	-0.72	-2.80	-0.58	-1.69			
	Sig.		***		**			
	Adj-R^2	15.4	59.8	5.6	55.5			
UK£	β	-0.66	-0.53	-0.54	-0.98	-0.62		
	t-stat.	-1.32	-2.20	-1.81	-2.00	-2.18		
	Sig.	*	**	**	**	**		
	Adj-R^2	38.3	47.8	38.1	63.7	47.4		
Yen	β	-0.50	-0.69	-0.38	-0.86	-0.36	-0.56	
	t-stat.	-0.77	-2.20	-0.78	-1.53	-0.73	-1.54	
	Sig.		**		*		*	
	Adj-R^2	20.7	47.7	10.1	50.5	8.9	30.9	
US$	β	-0.29	-0.07	-0.48	-0.87	-0.50	-0.68	-0.45
	t-stat.	-0.49	-0.21	-1.34	-1.06	-1.56	-2.58	-1.21
	Sig.			*		*	***	
	Adj-R^2	7.2	0.4	25.1	32.5	31.3	55.8	21.6
Ave. β	-0.57							
Ave.Adj-R^2	35.5							

Table A1.17 Regression Estimations of Five-year Corrections to Five-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 5 Years								
Deviation Correction Period = 5 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.88						
	t-stat.	-1.74						
	Sig.	**						
	Adj-R^2	60.0						
GM	β	-0.16	-0.65					
	t-stat.	-0.28	-1.97					
	Sig.		**					
	Adj-R^2	2.9	49.1					
NZ$	β	-0.49	-1.01	-0.44				
	t-stat.	-0.76	-1.78	-0.82				
	Sig.		**					
	Adj-R^2	25.6	66.0	28.9				
SF	β	-0.21	-0.60	-0.27	-0.51			
	t-stat.	-0.38	-1.85	-0.60	-0.85			
	Sig.		**					
	Adj-R^2	6.0	45.8	7.8	30.2			
UK£	β	-0.80	-0.48	-0.66	-0.99	-0.67		
	t-stat.	-1.36	-1.95	-1.77	-1.45	-1.80		
	Sig.	*	**	**	*	**		
	Adj-R^2	47.5	43.1	43.7	56.5	44.4		
Yen	β	-0.17	-0.52	-0.30	-0.33	-0.21	-0.56	
	t-stat.	-0.29	-1.35	-0.62	-0.48	-0.42	-1.32	
	Sig.		*				*	
	Adj-R^2	3.2	30.9	8.3	11.9	3.8	29.9	
US$	β	0.07	-0.11	-0.58	-0.52	-0.56	-0.67	-0.43
	t-stat.	0.08	-0.26	-1.33	-0.44	-1.35	-2.20	-0.96
	Sig.			*		*	**	
	Adj-R^2	0.0	1.3	30.4	9.7	31.0	54.7	18.3
Ave. β	-0.48							
Ave.Adj-R^2	28.3							

Table A1.18 Regression Estimations of Three-year Corrections to Six-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 6 Years								
Deviation Correction Period = 3 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.99						
	t-stat.	-2.93						
	Sig.	***						
	Adj-R^2	69.8						
GM	β	-0.08	-0.55					
	t-stat.	-0.31	-2.40					
	Sig.		***					
	Adj-R^2	1.8	45.0					
NZ$	β	-0.43	-1.00	-0.52				
	t-stat.	-1.05	-2.94	-1.28				
	Sig.		***					
	Adj-R^2	26.1	74.0	34.7				
SF	β	-0.17	-0.60	-0.24	-0.57			
	t-stat.	-0.67	-2.76	-0.81	-1.49			
	Sig.		***		*			
	Adj-R^2	10.2	51.9	8.2	41.9			
UK£	β	-0.43	-0.47	-0.42	-0.97	-0.53		
	t-stat.	-0.96	-2.04	-1.99	-1.91	-2.45		
	Sig.		**	**	**	***		
	Adj-R^2	19.4	37.1	35.8	54.3	46.0		
Yen	β	-0.27	-0.73	-0.39	-1.39	-0.46	-0.53	
	t-stat.	-0.37	-2.09	-0.88	-2.03	-1.00	-1.52	
	Sig.		**		**		*	
	Adj-R^2	2.8	38.1	9.5	57.4	12.0	24.6	
US$	β	-0.21	-0.06	-0.38	-0.84	-0.44	-0.60	-0.37
	t-stat.	-0.29	-0.24	-1.47	-1.15	-1.78	-2.67	-1.14
	Sig.			*		**	***	***
	Adj-R^2	1.6	0.4	23.3	30.0	30.9	50.3	15.3
Ave. β	-0.52							
Ave.Adj-R^2	30.4							

Table A1.19 Regression Estimations of Four-year Corrections to Six-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 6 Years								
Deviation Correction Period = 4 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-1.07						
	t-stat.	-2.10						
	Sig.	**						
	Adj-R^2	63.2						
GM	β	-0.04	-0.56					
	t-stat.	-0.09	-1.85					
	Sig.		**					
	Adj-R^2	0.0	40.4					
NZ$	β	-0.58	-1.24	-0.45				
	t-stat.	-0.89	-2.00	-0.45				
	Sig.		**					
	Adj-R^2	27.8	66.3	16.4				
SF	β	-0.16	-0.53	-0.30	-0.54			
	t-stat.	-0.37	-1.72	-0.84	-0.84			
	Sig.		**					
	Adj-R^2	4.4	37.0	12.0	25.1			
UK£	β	-0.68	-0.46	-0.57	-1.30	-0.63		
	t-stat.	-1.28	-1.63	-1.91	-1.64	-2.01		
	Sig.		*	**	*	**		
	Adj-R^2	39.0	34.5	41.9	56.9	44.5		
Yen	β	-0.12	-0.70	-0.40	-0.80	-0.37	-0.64	
	t-stat.	-0.13	-1.48	-0.83	-0.76	-0.73	-1.50	
	Sig.		*				*	
	Adj-R^2	0.0	30.1	11.9	21.6	9.3	30.7	
US$	β	0.30	-0.09	-0.44	-0.61	-0.43	-0.65	-0.42
	t-stat.	0.33	-0.27	-1.28	-0.42	-1.30	-2.30	-0.99
	Sig.					*	**	***
	Adj-R^2	3.5	1.0	24.5	7.1	25.0	51.1	15.9
Ave. β	-0.50							
Ave.Adj-R^2	26.3							

Table A1.20 Regression Estimations of Five-year Corrections to Six-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 6 Years								
Deviation Correction Period = 5 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.94						
	t-stat.	-1.33						
	Sig.	*						
	Adj-R^2	49.1						
GM	β	-0.12	-0.60					
	t-stat.	-0.21	-1.74					
	Sig.		**					
	Adj-R^2	1.6	44.1					
NZ$	β	-0.48	-0.97	-0.31				
	t-stat.	-0.62	-1.10	-0.33				
	Sig.							
	Adj-R^2	20.7	45.9	6.3				
SF	β	-0.20	-0.54	-0.36	-0.39			
	t-stat.	-0.40	-1.47	-0.86	-0.44			
	Sig.		*					
	Adj-R^2	7.1	36.1	15.9	10.9			
UK£	β	-0.81	-0.38	-0.67	-1.14	-0.71		
	t-stat.	-1.35	-1.28	-1.72	-0.98	-1.82		
	Sig.	*		**		**		
	Adj-R^2	49.9	29.9	43.6	40.0	46.3		
Yen	β	-0.01	-0.48	-0.36	-0.24	-0.41	-0.60	
	t-stat.	-0.01	-1.14	-0.77	-0.21	-0.86	-1.16	
	Sig.							
	Adj-R^2	0.0	16.6	13.2	1.9	16.1	25.9	
US$	β	0.43	-0.19	-0.57	-0.34	-0.52	-0.61	-0.41
	t-stat.	0.40	-0.45	-1.46	-0.19	-1.39	-2.04	-0.84
	Sig.			*		*	**	
	Adj-R^2	7.2	4.6	35.8	1.5	33.3	51.9	15.4
Ave. β	-0.46							
Ave.Adj-R^2	24.0							

Table A1.21 Coefficient Estimations of Three-year Corrections to Seven-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 7 Years								
Deviation Correction Period = 3 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.83						
	t-stat.	-1.54						
	Sig.	*						
	Adj-R^2	41.1						
GM	β	-0.04	-0.43					
	t-stat.	-0.16	-1.51					
	Sig.		*					
	Adj-R^2	0.0	25.3					
NZ$	β	-0.36	-1.23	-0.25				
	t-stat.	-0.98	-1.79	-0.48				
	Sig.		**					
	Adj-R^2	25.8	54.2	7.0				
SF	β	-0.03	-0.46	-0.27	-0.38			
	t-stat.	-0.10	-1.35	-1.08	-0.71			
	Sig.		*					
	Adj-R^2	0.0	21.0	14.5	15.0			
UK£	β	-0.39	-0.31	-0.45	-0.81	-0.50		
	t-stat.	-0.83	-1.08	-1.97	-1.08	-1.84		
	Sig.			**		**		
	Adj-R^2	16.4	14.5	36.6	29.6	33.3		
Yen	β	0.44	-0.75	-0.42	-1.80	-0.48	-0.60	
	t-stat.	0.53	-1.29	-1.00	-1.24	-0.96	-1.41	
	Sig.						*	
	Adj-R^2	6.9	19.6	12.6	36.1	11.7	22.6	
US$	β	0.84	-0.07	-0.33	-0.41	-0.35	-0.54	-0.31
	t-stat.	1.05	-0.30	-1.25	-0.39	-1.20	-1.99	-0.81
	Sig.						**	
	Adj-R^2	24.2	0.9	18.6	4.4	17.4	37.0	8.5
Ave. β	-0.41							
Ave.Adj-R^2	19.8							

Table A1.22 Coefficient Estimations of Four-year Corrections to Seven-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 7 Years								
Deviation Correction Period = 4 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.92						
	t-stat.	-1.30						
	Sig.	*						
	Adj-R^2	42.0						
GM	β	-0.13	-0.48					
	t-stat.	-0.29	-1.45					
	Sig.		*					
	Adj-R^2	2.7	30.3					
NZ$	β	-0.31	-1.33	-0.23				
	t-stat.	-0.51	-1.06	-0.30				
	Sig.							
	Adj-R^2	12.0	38.4	3.7				
SF	β	-0.11	-0.43	-0.34	-0.32			
	t-stat.	-0.25	-1.08	-1.11	-0.41			
	Sig.							
	Adj-R^2	1.8	19.2	20.2	7.8			
UK£	β	-0.64	-0.25	-0.59	-0.75	-0.66		
	t-stat.	-1.17	-0.78	-1.77	-0.56	-1.76		
	Sig.			**		**		
	Adj-R^2	37.2	10.9	39.4	14.3	39.2		
Yen	β	0.13	-0.79	-0.46	-1.42	-0.60	-0.68	
	t-stat.	0.11	-1.07	-1.06	-0.82	-1.22	-1.28	
	Sig.							
	Adj-R^2	0.0	19.2	18.7	26.9	23.4	25.2	
US$	β	0.67	-0.16	-0.43	-0.16	-0.39	-0.55	-0.40
	t-stat.	0.65	-0.49	-1.35	-0.10	-1.15	-1.77	-0.82
	Sig.			*			**	
	Adj-R^2	14.9	4.4	27.3	0.0	21.4	39.4	12.0
Ave. β	-0.46							
Ave.Adj-R^2	19.5							

Table A1.23 Coefficient Estimations of Five-year Corrections to Seven-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 7 Years								
Deviation Correction Period = 5 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.77						
	t-stat.	-0.84						
	Sig.							
	Adj-R^2	29.9						
GM	β	-0.28	-0.60					
	t-stat.	-0.58	-1.71					
	Sig.		**					
	Adj-R^2	16.3	44.5					
NZ$	β	-0.26	-0.85	-0.43				
	t-stat.	-0.46	-0.58	-0.52				
	Sig.							
	Adj-R^2	13.8	21.1	17.1				
SF	β	-0.23	-0.52	-0.45	-0.45			
	t-stat.	-0.46	-1.17	-1.38	-0.54			
	Sig.							
	Adj-R^2	10.6	27.1	34.2	18.3			
UK£	β	-0.71	-0.15	-0.73	-1.06	-0.73		
	t-stat.	-1.07	-0.49	-1.76	-0.72	-1.50		
	Sig.			**		*		
	Adj-R^2	41.3	5.7	45.9	29.2	38.2		
Yen	β	-0.05	-0.51	-0.26	-0.64	-0.29	-0.47	
	t-stat.	-0.05	-0.64	-0.61	-0.39	-0.58	-0.72	
	Sig.							
	Adj-R^2	0.0	9.7	9.0	10.2	8.0	12.0	
US$	β	0.70	-0.33	-0.61	-0.68	-0.56	-0.48	-0.44
	t-stat.	0.52	-0.84	-1.82	-0.38	-1.50	-1.46	-0.81
	Sig.			**		*	*	
	Adj-R^2	13.6	16.0	47.6	9.7	38.2	36.9	15.1
Ave. β	-0.46							
Ave.Adj-R^2	22.1							

Table A1.24 Coefficient Estimations of Three-year Corrections to Eight-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 8 Years								
Deviation Correction Period = 3 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.66						
	t-stat.	-0.90						
	Sig.							
	Adj-R^2	20.7						
GM	β	-0.05	-0.39					
	t-stat.	-0.23	-1.24					
	Sig.							
	Adj-R^2	0.9	19.2					
NZ$	β	-0.35	-0.77	0.23				
	t-stat.	-0.80	-0.67	0.33				
	Sig.							
	Adj-R^2	20.6	15.3	3.3				
SF	β	0.04	-0.34	-0.33	0.32			
	t-stat.	0.14	-0.78	-1.48	0.36			
	Sig.			*				
	Adj-R^2	0.0	8.4	25.2	4.0			
UK£	β	-0.40	-0.14	-0.41	-0.46	-0.47		
	t-stat.	-0.88	-0.47	-1.45	-0.49	-1.15		
	Sig.			*				
	Adj-R^2	19.9	2.9	24.5	8.2	16.8		
Yen	β	-0.04	-0.69	-0.54	-1.43	-0.81	-0.66	
	t-stat.	-0.05	-0.93	-1.41	-1.04	-1.77	-1.26	
	Sig.			*		**		
	Adj-R^2	0.0	11.6	23.4	30.8	32.7	19.6	
US$	β	0.44	-0.14	-0.36	-0.27	-0.33	-0.45	-0.29
	t-stat.	0.61	-0.58	-1.35	-0.31	-1.04	-1.50	-0.69
	Sig.			*			*	
	Adj-R^2	10.1	4.6	21.9	2.9	14.1	25.9	6.5
Ave. β	-0.35							
Ave.Adj-R^2	13.5							

Table A1.25 Coefficient Estimations of Four-year Corrections to Eight-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 8 Years								
Deviation Correction Period = 4 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.80						
	t-stat.	-0.82						
	Sig.							
	Adj-R^2	24.2						
GM	β	-0.26	-0.52					
	t-stat.	-0.65	-1.52					
	Sig.		*					
	Adj-R^2	16.3	33.5					
NZ$	β	-0.24	-0.56	-0.26				
	t-stat.	-0.39	-0.33	-0.27				
	Sig.							
	Adj-R^2	7.9	5.7	3.2				
SF	β	-0.18	-0.42	-0.43	-0.24			
	t-stat.	-0.36	-0.85	-1.75	-0.21			
	Sig.			**				
	Adj-R^2	5.1	13.3	40.3	1.4			
UK£	β	-0.69	-0.06	-0.64	-0.85	-0.70		
	t-stat.	-1.26	-0.19	-1.61	-0.77	-1.22		
	Sig.			*				
	Adj-R^2	43.6	0.3	36.1	27.4	24.4		
Yen	β	-0.67	-0.91	-0.43	-1.55	-0.60	-0.58	
	t-stat.	-0.88	-1.05	-0.98	-1.18	-1.09	-0.85	
	Sig.							
	Adj-R^2	27.1	19.4	17.2	47.4	20.6	13.3	
US$	β	0.24	-0.30	-0.52	-0.49	-0.46	-0.42	-0.43
	t-stat.	0.25	-0.95	-1.73	-0.48	-1.25	-1.19	-0.85
	Sig.			**				
	Adj-R^2	2.1	16.2	39.6	12.0	25.5	23.6	13.4
Ave. β	-0.50							
Ave.Adj-R^2	18.9							

Table A1.26 Coefficient Estimations of Five-year Corrections to Eight-year Cumulative Deviations from PPP

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. Logarithm data are applied. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data. Coefficient estimates that significant at the 10, 5 and 1% levels are denoted by *, ** and ***, respectively. The term currencies are listed in the first column, and the third row of the table is a list of tested foreign currencies.

Deviation Accumulation Period = 8 Years								
Deviation Correction Period = 5 Years								
Base Cur.	Stat.	A$	C$	GM	NZ$	SF	UK£	Yen
C$	β	-0.71						
	t-stat.	-0.63						
	Sig.							
	Adj-R^2	21.3						
GM	β	-0.08	-0.60					
	t-stat.	-0.13	-1.52					
	Sig.		*					
	Adj-R^2	0.1	40.1					
NZ$	β	0.04	-0.12	-0.32				
	t-stat.	0.06	-0.07	-0.25				
	Sig.							
	Adj-R^2	0.0	0.0	4.4				
SF	β	0.05	-0.46	-0.44	-0.18			
	t-stat.	0.08	-0.77	-1.44	-0.11			
	Sig.			*				
	Adj-R^2	0.0	14.4	37.4	0.0			
UK£	β	-0.53	0.02	-0.74	-1.03	-0.63		
	t-stat.	-0.76	0.71	-1.56	-0.76	-0.88		
	Sig.			*				
	Adj-R^2	28.3	0.0	41.3	35.2	18.1		
Yen	β	-0.61	-0.82	-0.29	-0.95	-0.18	-0.26	
	t-stat.	-1.12	-0.90	-0.70	-0.78	-0.33	-0.33	
	Sig.							
	Adj-R^2	46.6	19.0	12.1	36.8	2.6	2.7	
US$	β	-0.04	-0.50	-0.66	-0.57	-0.57	-0.33	-0.51
	t-stat.	-0.03	-1.36	-1.91	-0.42	-1.28	-0.81	-0.91
	Sig.		*	**				
	Adj-R^2	0.0	34.9	51.5	13.5	32.3	15.9	19.1
Ave. β	-0.44							
Ave.Adj-R^2	18.3							

Table A1.27 OLS Estimations of Exchange Rate Corrections to Cumulative Deviations across All Currencies

Regression Equation (2.1) is applied to test exchange rate corrections to cumulative historical deviations from PPP. The dependent variable is the percentage change of exchange rates over a three-year period. The independent variable is the percentage exchange rate deviation from PPP accumulated over the previous three-year period. Observations from all of the currency pairs are put together to conduct the test. The total number of observations is 11,440. The reported t-statistics have been adjusted by dividing the square root of the forecast horizons to account for the overlaps in data.

	Coefficient	Std. Error	t-Statistic	Significance Level
β_1	-0.35	0.007	-8.41	1%
α_1	0.03	0.002	2.87	1%

Adjusted R-squared	0.182
Durbin-Watson stat	0.067

Table A1.28 Unit Root Test on Exchange Rate Correction Data

Two variables are tested: the percentage change of exchange rates over a three-year period, and the percentage exchange rate deviation from PPP, accumulated over the previous five-year period. The augmented Dickey-Fuller test is conducted. The total number of observations is 11,440. The null hypothesis is that a unit root is present.

Tested Variable		t-Statistic	p-Value
Percentage Change of FX Rate		-14.988	0.000
Percentage Cumulative FX Deviation		-14.988	0.000
Test critical values:	1% level	-3.431	
	5% level	-2.862	
	10% level	-2.567	

Appendix 2 Portfolio Performance – Using a Ten-year Cumulative Deviation Rule

Table A2.1 Portfolio Return Comparisons (Ten-year Cumulative Deviation)

PPPEP stands for the PPP-efficient portfolio, GP stands for the Global portfolio, MWIP represents the MSCI-World-Index portfolio and DOP is the short for the Domestic-only portfolio. Annualised portfolio returns are obtained by taking the averages of the portfolio returns that have been realised over the period 1991 to 2004. Returns are presented in percentage terms. The P-values from the t-tests on comparing historical returns obtained under the proposed portfolio strategy against a benchmark portfolio are reported in the brackets. The PPPEP portfolios are held for three consecutive years.

Base Country	PPPEP	Global	MSCI-World	Domestic
Australia	11.79	6.61 (0.000)	7.03 (0.052)	8.06 (0.008)
Canada	9.68	4.40 (0.000)	4.52 (0.018)	8.32 (0.221)
Japan	5.00	3.42 (0.002)	3.32 (0.315)	-4.64 (0.000)
New Zealand	11.36	6.86 (0.012)	7.51 (0.231)	2.41 (0.002)
Germany	8.85	5.85 (0.000)	6.27 (0.222)	3.42 (0.012)
Switzerland	6.65	4.59 (0.000)	4.97 (0.383)	4.17 (0.031)
UK	5.26	3.78 (0.001)	3.90 (0.442)	2.85 (0.022)
US	7.18	3.99 (0.000)	3.90 (0.022)	5.98 (0.456)

Table A2.2 Excess Returns of PPP-efficient Portfolio over Benchmark Portfolio (Ten-year Cumulative Deviation)

The excess returns are calculated as: the average annualised returns of a PPP-efficient portfolio, minus that of a benchmark portfolio return. Average return data are from Table 3.4. Excess returns are presented in percentage terms.

Base Country	Exc. over Global	Exc. over MSCI-World	Exc. over Domestic
Australia	5.19	4.77	3.73
Canada	5.28	5.16	1.36
Japan	1.58	1.68	9.65
New Zealand	4.50	3.85	8.94
Germany	3.00	2.57	5.43
Switzerland	2.06	1.67	2.48
UK	1.48	1.36	2.41
US	3.19	3.28	1.20

Table A2.3 Portfolio Risk Comparisons (Ten-year Cumulative Deviation)

The portfolio risks are measured by the standard deviations of the portfolio returns, realised over the period 1991 to 2004. Standard deviations are expressed in normal forms. PPPEP stands for the PPP-efficient portfolio, GP stands for the Global portfolio, MWIP represents the MSCI-World-Index portfolio and DOP is short for the Domestic-only portfolio.

Base Country	PPPEP	Global	MSCI-World	Domestic
Australia	0.091	0.117	0.189	0.041
Canada	0.100	0.094	0.155	0.115
Japan	0.072	0.077	0.128	0.076
New Zealand	0.097	0.149	0.222	0.064
Germany	0.116	0.124	0.193	0.200
Switzerland	0.120	0.126	0.191	0.143
UK	0.087	0.086	0.149	0.119
US	0.112	0.090	0.136	0.163
Average	0.099	0.108	0.170	0.115

Table A2.4 Sharpe Ratio of Portfolio Performance (Ten-year Cumulative Deviation)

The SHP ratios are reported as the risk-adjusted return performances of each portfolio's strategy, examined over the period between 1991 and 2004. PPPEP stands for the PPP-efficient portfolio, GP stands for the Global portfolio, MWIP represents the MSCI-World-Index portfolio and DOP is short for the Domestic-only portfolio.

Base Country	PPPEP	Global	MSCI-World	Domestic
Australia	1.296	0.566	0.372	1.980
Canada	0.965	0.470	0.291	0.724
Japan	0.696	0.443	0.259	-0.608
New Zealand	1.176	0.460	0.338	0.378
Germany	0.761	0.471	0.325	0.171
Switzerland	0.555	0.365	0.260	0.291
UK	0.608	0.441	0.261	0.239
US	0.641	0.441	0.286	0.368
Average	0.837	0.457	0.299	0.443

Appendix 3 Efficiency of Selectively Hedging Transaction Exposures

Figure A3.1 Foreign Exchange Rate Indices (Jan 1986-Aug 2004)

Figure A3.1a US dollar Exchange Rates (Indices)

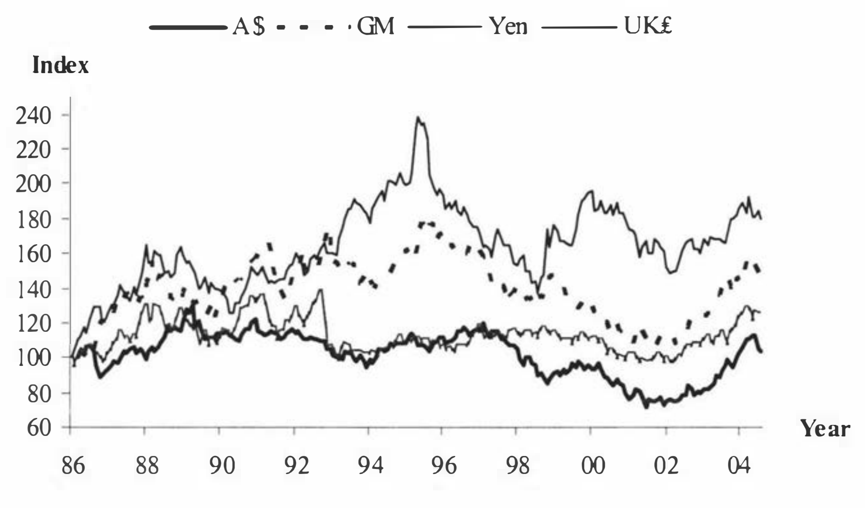

Figure A3.1b US dollar Exchange Rates (Indices)

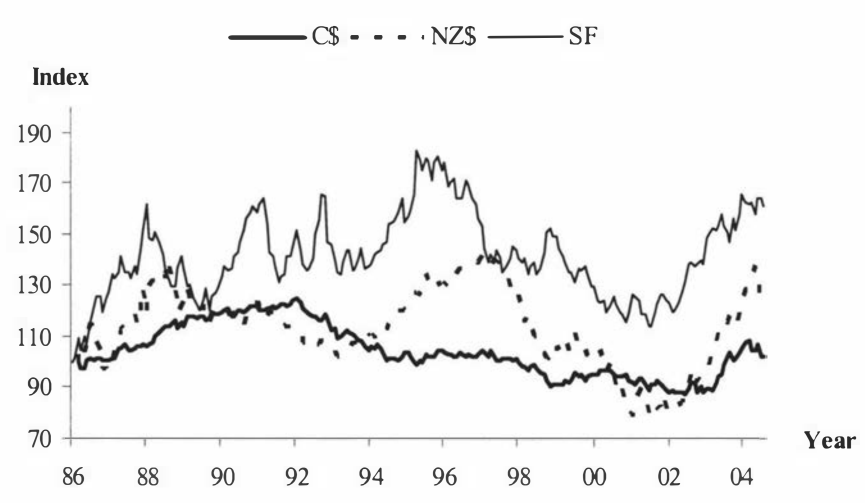

Table A3.1 Mean-Variance Return Comparisons of Forward Hedging Strategies – the Australian Perspective

NH stands for the never-hedging strategy, AH represents the always-hedging strategy, PH denotes the PPP-hedging strategy, FH refers to the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy. Mean stands for the average returns, annualised and expressed in percentage terms. Std. is a risk representative, measured by the standard deviation of the returns. RTR is short for reward-to-risk ratio, a combined measure of the risk-return trade-off. P-values are reported for t-tests, with the null hypothesis that a strategy has an equal mean to the NH strategy. Where a strategy has a mean return greater than that of the NH strategy, the mean is highlighted and the relevant t-test statistic is also highlighted if the difference in the mean is statistically significant at the 10% level or above.

	NH			AH			PH				FH				PFH			
	Mean	Std.	RTR	Mean	Std.	RTR	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test
C$	2.93	0.17	17.37	1.17	0.02	58.17	**3.84**	0.10	36.79	**0.044**	2.03	0.07	27.33	0.033	**4.49**	0.12	38.35	**0.001**
GM	4.19	0.23	17.96	1.81	0.02	90.67	**6.42**	0.18	36.43	**0.001**	2.50	0.09	29.23	0.003	**6.21**	0.18	34.29	**0.003**
NZ$	1.05	0.13	8.04	-0.79	0.02	-44.10	**2.05**	0.10	20.19	**0.008**	0.86	0.11	7.71	0.627	**1.58**	0.12	12.96	0.198
SF	6.14	0.26	23.74	3.70	0.02	163.72	**8.05**	0.18	45.84	**0.008**	3.77	0.06	61.20	0.000	**7.88**	0.18	44.28	**0.016**
UK£	5.00	0.22	22.88	-0.16	0.02	-7.78	2.09	0.10	20.11	0.000	4.51	0.17	25.91	0.442	**5.33**	0.18	29.35	0.615
Yen	6.37	0.30	21.56	4.86	0.02	206.87	**7.34**	0.16	45.10	0.212	5.38	0.08	66.89	0.158	**7.78**	0.18	43.62	**0.075**
US$	3.85	0.24	16.35	1.10	0.02	46.82	0.77	0.10	8.09	0.000	**7.41**	0.16	46.32	**0.000**	**7.08**	0.19	38.13	**0.000**
Percentage of means that are no less than that of the NH strategy (percentage that are statistically significant at the 5% level)							71.4% (51.7%)				14.3% (14.3%)				100% (57.1%)			
percentage of risks that are no greater than that of the NH strategy							100%				100%				100%			
Percentage of returns-per-unit-of-risk that are no less than that of the NH strategy							71.4%				85.7%				100%			

Table A3.2 Mean-Variance Return Comparisons of Forward Hedging Strategies – the Canadian Perspective

NH stands for the never-hedging strategy, AH represents the always-hedging strategy, PH denotes the PPP-hedging strategy, FH refers to the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy. Mean stands for the average returns, annualised and expressed in percentage terms. Std. is a risk representative, measured by the standard deviation of the returns. RTR is short for the reward-to-risk ratio, a combined measure of the risk-return trade-off. P-values are reported for t-tests, with the null hypothesis that a strategy has an equal mean to the NH strategy. Where a strategy has a mean return greater than that of the NH strategy, the mean is highlighted and the relevant t-test statistic is also highlighted if the difference in the mean is statistically significant at the 10% level or above.

	NH			AH			PH				FH				PFH			
	Mean	Std.	RTR	Mean	Std.	RTR	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test
A$	-0.26	0.16	-1.58*	-1.12	0.02	-59.40	**1.40**	0.13	10.77	**0.001**	**0.10**	0.15	0.69	0.475	**-0.25**	0.16	-1.62*	0.991
GM	4.56	0.24	18.73	1.40	0.04	34.36	4.27	0.15	28.70	**0.000**	4.13	0.14	29.73	0.000	**4.67**	0.17	26.79	**0.000**
NZ$	0.79	0.21	3.75	-1.92	0.02	-93.98	**1.60**	0.18	8.88	0.208	**1.32**	0.20	6.70	0.429	**0.96**	0.21	4.60	0.810
SF	5.57	0.27	20.56	2.73	0.03	102.47	5.27	0.15	34.65	0.000	4.35	0.11	37.87	0.000	**5.77**	0.16	35.06	**0.000**
UK£	3.06	0.20	15.00	-1.31	0.02	-73.17	0.56	0.10	5.64	0.000	**3.52**	0.19	18.76	**0.000**	**3.49**	0.19	18.16	**0.000**
Yen	6.19	0.29	21.34	3.88	0.02	168.84	**7.06**	0.19	36.53	**0.000**	3.97	0.04	89.95	0.000	**7.08**	0.19	36.37	**0.000**
US$	0.21	0.10	2.11	1.05	0.02	55.28	0.13	0.06	2.38	0.000	**2.26**	0.05	44.39	**0.000**	**1.35**	0.07	18.18	**0.000**
Percentage of means that are no less than that of the NH strategy (percentage that are statistically significant at the 5% level)							42.9% (42.9%)				57.1% (28.6%)				100% (71.4%)			
Percentage of the risks that are no greater than that of the NH strategy							100%				100%				100%			
Percentage of the returns-per-unit-of-risk that are no less than that of the NH strategy							85.7%				100%				100%			

Table A3.3 Mean-Variance Return Comparisons of Forward Hedging Strategies – the Germany Perspective

NH stands for the never-hedging strategy, AH represents the always-hedging strategy, PH denotes the PPP-hedging strategy, FH refers to the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy. Mean stands for average returns, annualised and expressed in percentage terms. Std. is a risk representative measured by the standard deviation of the returns. RTR is short for the reward-to-risk ratio, a combined measure of the risk-return trade-off. P-values are reported for t-tests, with the null hypothesis that a strategy has an equal mean to the NH strategy. Where a strategy has a mean return greater than that of the NH strategy, the mean is highlighted and the relevant t-test statistic is also highlighted if the difference in the mean is statistically significant at the 10% level or above.

	NH			AH			PH				FH				PFH			
	Mean	Std.	RTR	Mean	Std.	RTR	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test
A$	0.61	0.22	2.83	-1.74	0.02	-94.24	**2.63**	0.16	16.76	**0.001**	**0.69**	0.20	3.44	0.901	**1.07**	0.21	5.19	0.496
C$	0.93	0.24	3.90	-1.22	0.04	-31.06	**2.01**	0.20	10.03	**0.000**	**1.94**	0.20	9.93	**0.000**	**2.46**	0.22	11.08	**0.000**
NZ$	0.47	0.20	2.40	-2.54	0.02	-134.31	**1.86**	0.13	13.82	**0.011**	-0.07	0.19	-0.37	0.386	**0.47**	0.19	2.42	1.000
SF	0.84	0.09	9.10	1.42	0.03	41.28	**1.96**	0.06	31.44	**0.000**	**1.51**	0.06	26.15	**0.000**	**1.85**	0.07	25.14	**0.000**
UK£	0.63	0.16	3.84	-2.54	0.04	-66.14	0.27	0.13	2.05	0.000	**1.13**	0.15	7.63	**0.000**	**1.09**	0.16	6.96	**0.000**
Yen	3.77	0.25	15.00	2.58	0.04	69.16	**5.22**	0.18	29.60	**0.000**	3.47	0.10	34.55	0.000	**5.67**	0.19	29.50	**0.000**
US$	0.57	0.23	2.44	-0.19	0.04	-4.66	0.21	0.19	1.10	0.000	**3.34**	**0.17**	19.70	0.000	**2.42**	0.22	11.05	**0.000**
Percentage of means that are no less than that of the NH strategy (percentage that are statistically significant at the 5% level)							71.4% (71.4%)				71.4% (42.9%)				100% (71.4%)			
Percentage of risks that are no greater than that of the NH strategy							7 - 100%				7 - 100%				7 - 100%			
Percentage of returns-per-unit-of-risk that are no less than that of the NH strategy							5 – 71.4%				6 – 85.7%				7 - 100%			

Table A3.4 Mean-Variance Return Comparisons of Forward Hedging Strategies – the New Zealand Perspective

NH stands for the never-hedging strategy, AH represents the always-hedging strategy, PH denotes the PPP-hedging strategy, FH refers to the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy. Mean stands for the average returns, annualised and expressed in percentage terms. Std. is a risk representative, measured by the standard deviation of returns. RTR is short for the reward-to-risk ratio, a combined measure of the risk-return trade-off. P-values are reported for t-tests, with the null hypothesis that a strategy has an equal mean to the NH strategy. Where a strategy has a mean return greater than that of the NH strategy, the mean is highlighted and the relevant t-test statistic is also highlighted if the difference in the mean is statistically significant at the 10% level or above.

	NH			AH			PH				FH				PFH			
	Mean	Std.	RTR	Mean	Std.	RTR	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test
A$	0.58	0.13	4.58	0.83	0.02	47.17	**2.49**	0.08	30.09	**0.000**	**1.06**	0.07	16.13	0.142	**1.99**	0.09	21.01	**0.000**
C$	3.49	0.21	16.56	2.00	0.02	94.62	**4.15**	0.12	33.86	0.237	3.09	0.08	40.47	0.437	**4.96**	0.14	35.87	**0.011**
GM	3.58	0.21	16.70	2.64	0.02	133.07	**6.52**	0.17	37.60	**0.000**	2.34	0.05	45.20	0.014	**6.16**	0.18	34.43	**0.000**
SF	5.40	0.23	22.99	4.54	0.02	195.78	**9.15**	0.18	50.87	**0.000**	4.41	0.04	119.0	0.069	**9.03**	0.18	49.58	**0.000**
UK£	4.83	0.22	22.14	0.64	0.02	36.65	3.92	0.12	32.03	0.112	2.00	0.12	17.09	0.000	4.42	0.16	27.94	0.506
Yen	6.72	0.31	21.42	5.72	0.02	230.74	**10.18**	0.24	42.86	**0.000**	5.92	0.09	63.52	0.290	**10.47**	0.25	41.55	**0.000**
US$	4.24	0.26	16.26	1.92	0.02	88.33	**4.68**	0.16	28.76	0.538	**4.47**	0.12	36.36	0.731	**7.06**	0.20	35.59	**0.000**
Percentage of means that are no less than that of the NH strategy (percentage that are statistically significant at the 5% level)							85.7% (57.1%)				28.6% (0%)				85.7% (85.7%)			
Percentage of risks that are no greater than that of the NH strategy							100%				100%				100%			
Percentage of returns-per-unit-of-risk that are no less than that of the NH strategy							100%				85.7%				100%			

Table A3.5 Mean-Variance Return Comparisons of Forward Hedging Strategies – the Swiss Perspective

NH stands for the never-hedging strategy, AH represents the always-hedging strategy, PH denotes the PPP-hedging strategy, FH refers to the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy. Mean stands for the average returns, annualised and expressed in percentage terms. Std. is a risk representative, measured by the standard deviation of the returns. RTR is short for the reward-to-risk ratio, a combined measure of the risk-return trade-off. P-values are reported for t-tests, with the null hypothesis that a strategy has an equal mean to the NH strategy. Where a strategy has a mean return greater than that of the NH strategy, the mean is highlighted and the relevant t-test statistic is also highlighted if the difference in the mean is statistically significant at the 10% level or above.

	NH			AH			PH				FH				PFH			
	Mean	Std.	RTR	Mean	Std.	RTR	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test
A$	-0.33	0.23	-1.39	-3.52	0.02	-172.74	**1.51**	0.19	8.07	**0.008**	-0.52	0.23	-2.26	0.799	**-0.26**	0.23	-1.15	0.936
C$	1.04	0.26	4.00	-2.59	0.03	-101.12	**1.70**	0.23	7.52	**0.000**	**1.62**	0.24	6.74	**0.000**	**1.55**	0.25	6.19	**0.000**
GM	0.00	0.09	0.05	-1.29	0.03	-37.80	**0.29**	0.08	3.72	**0.000**	-0.14	0.08	-1.88	0.000	**0.15**	0.09	1.68	**0.000**
NZ$	-0.59	0.21	-2.81	-4.30	0.02	-202.25	**1.25**	0.15	8.31	**0.002**	-0.82	0.21	-3.95	0.736	-0.62	0.21	-2.94	0.967
UK£	0.39	0.18	2.21	-3.90	0.02	-176.31	-0.44	0.15	-3.02	0.000	**0.42**	0.18	2.38	0.639	**0.40**	0.18	2.23	0.882
Yen	3.13	0.24	13.16	1.15	0.02	56.78	**4.18**	0.17	24.66	**0.000**	2.87	0.11	27.06	0.000	**5.21**	0.18	28.24	**0.000**
USD	0.54	0.25	2.16	-1.58	0.03	-54.19	0.30	0.21	1.45	0.000	**0.78**	0.20	3.92	**0.000**	**1.16**	0.24	4.82	**0.000**
Percentage of means that are no less than that of the NH strategy (percentage that are statistically significant at the 5% level)							71.4% (71.4%)				42.9% (28.6%)				85.7% (57.1%)			
Percentage of risks that are no greater than that of the NH strategy							100%				100%				100%			
Percentage of returns-per-unit-of-risk that are no less than that of the NH strategy							71.4%				57.1%				85.7%			

Table A3.6 Mean-Variance Return Comparisons of Forward Hedging Strategies – the UK Perspective

NH stands for the never-hedging strategy, AH represents the always-hedging strategy, PH denotes the PPP-hedging strategy, FH refers to the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy. Mean stands for the average returns, annualised and expressed in percentage terms. Std. is a risk representative, measured by the standard deviation of the returns. RTR is the short term for the reward-to-risk ratio, a combined measure of risk-return trade-off. P-values are reported for t-tests, with the null hypothesis that a strategy has an equal mean to the NH strategy. Where a strategy has a mean return greater than that of the NH strategy, the mean is highlighted and the relevant t-test statistic is also highlighted if the difference in the mean is statistically significant at the 10% level or above.

	NH			AH			PH				FH				PFH			
	Mean	Std.	RTR	Mean	Std.	RTR	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test
A$	-0.85	0.19	-4.42	0.20	0.02	10.09	**0.65**	0.18	3.62	**0.013**	**1.37**	0.13	10.57	**0.000**	**0.11**	0.19	0.57	0.118
C$	1.11	0.22	5.12	1.37	0.02	73.69	**2.20**	0.20	11.03	**0.000**	**2.50**	0.09	27.75	**0.000**	**2.41**	0.20	11.79	**0.000**
GM	2.31	0.19	12.28	2.76	0.04	67.61	**3.64**	0.13	27.44	**0.000**	**3.85**	0.09	41.02	**0.000**	**3.91**	0.14	27.83	**0.000**
NZ$	-0.50	0.20	-2.47	-0.61	0.02	-34.59	**1.59**	0.18	8.87	**0.001**	**-0.37**	0.17	-2.14	0.826	**0.12**	0.20	0.58	0.344
SF	2.90	0.20	14.59	4.11	0.02	171.70	**4.59**	0.14	33.15	**0.000**	**4.16**	0.03	149.1	**0.000**	**4.63**	0.14	33.34	**0.000**
Yen	4.92	0.29	16.93	5.28	0.02	236.87	**6.22**	0.23	26.49	**0.000**	**5.27**	0.04	137.2	**0.000**	**6.23**	0.24	26.47	**0.000**
US$	0.95	0.23	4.04	2.42	0.02	100.30	**3.15**	0.20	15.38	**0.000**	**2.92**	0.05	55.99	**0.000**	**3.40**	0.21	16.39	**0.000**
Percentage of means that are no less than that of the NH strategy (percentage that are statistically significant at the 5% level)							100% (100%)				100% (85.7%)				100% (71.4%)			
Percentage of risks that are no greater than that of the NH strategy							100%				100%				100%			
Percentage of returns-per-unit-of-risk that are no less than that of the NH strategy							100%				100%				100%			

Table A3.7 Mean-Variance Return Comparisons of Forward Hedging Strategies – the Japanese Perspective

NH stands for the never-hedging strategy, AH represents the always-hedging strategy, PH denotes the PPP-hedging strategy, FH refers to the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy. Mean stands for the average returns, annualised and expressed in percentage terms. Std. is a risk representative, measured by the standard deviation of the returns. RTR is short for the reward-to-risk ratio, a combined measure of the risk-return trade-off. P-values are reported for t-tests, with the null hypothesis that a strategy has an equal mean to the NH strategy. Where a strategy has a mean return greater than that of the NH strategy, the mean is highlighted and the relevant t-test statistic is also highlighted if the difference in the mean is statistically significant at the 10% level or above.

	NH			AH			PH				FH				PFH			
	Mean	Std.	RTR	Mean	Std.	RTR	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test
A$	0.77	0.26	2.99	-4.59	0.02	-219.72	**1.44**	0.23	6.23	0.396	0.75	0.25	3.03	0.979	**0.81**	0.26	3.14	0.964
C$	0.57	0.25	2.25	-3.69	0.02	-172.79	**1.17**	0.21	5.51	**0.000**	0.51	0.25	2.05	0.292	0.55	0.25	2.20	0.515
GM	2.02	0.25	8.17	-2.38	0.04	-66.72	**2.28**	0.20	11.29	**0.000**	1.95	0.22	8.77	0.000	**2.21**	0.24	9.12	**0.005**
NZ$	1.70	0.29	5.78	-5.36	0.02	-239.36	**2.04**	0.24	8.60	0.693	1.07	0.27	3.92	0.498	1.54	0.29	5.28	0.871
SF	2.31	0.24	9.42	-1.10	0.02	-56.08	**2.97**	0.20	15.18	**0.000**	**2.96**	0.22	13.48	0.000	**2.59**	0.24	10.92	**0.000**
UK£	1.23	0.24	5.23	-4.97	0.02	-248.47	-1.17	0.17	-6.78	0.000	1.11	0.23	4.79	0.580	1.13	0.23	4.83	0.655
US$	0.15	0.25	0.63	-2.69	0.03	-107.46	-0.93	0.19	-4.76	0.000	**1.05**	0.23	4.47	**0.000**	**0.71**	0.24	2.92	**0.001**
Percentage of means that are no less than that of the NH strategy (percentage that are statistically significant at the 5% level)							71.4% (42.9%)				28.6% (28.6%)				57.1% (42.9%)			
Percentage of risks that are no greater than that of the NH strategy							100%				100%				100%			
Percentage of returns-per-unit-of-risk that are no less than that of the NH strategy							71.4%				57.1%				71.4%			

Table A3.8 Mean-Variance Return Comparisons of Forward Hedging Strategies – the U.S. Perspective

NH stands for the never-hedging strategy, AH represents the always-hedging strategy, PH denotes the PPP-hedging strategy, FH refers to the forward-at-premium-hedging strategy and PFH stands for the PPP and forward-at-premium-hedging strategy. Mean stands for the average returns, annualised and expressed in percentage terms. Std. is a risk representative, measured by the standard deviation of the returns. RTR is short for the reward-to-risk ratio, a combined measure of the risk-return trade-off. P-values are reported for t-tests, with the null hypothesis that a strategy has an equal mean to the NH strategy. Where a strategy has a mean return greater than that of the NH strategy, the mean is highlighted and the relevant t-test statistic is also highlighted if the difference in the mean is statistically significant at the 10% level or above.

	NH			AH			PH				FH				PFH			
	Mean	Std.	RTR	Mean	Std.	RTR	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test	Mean	Std.	RTR	t-test
A$	1.19	0.23	5.30	-1.04	0.02	-47.43	0.01	0.20	0.07	0.090	**5.35**	0.18	29.84	**0.000**	**1.19**	0.23	5.30	1.000
C$	0.81	0.10	7.79	-1.01	0.02	-54.08	-0.37	0.09	-4.12	0.000	**1.78**	0.09	19.57	**0.000**	0.79	0.10	7.69	0.749
GM	4.82	0.24	19.91	0.36	0.04	8.88	1.96	0.15	12.66	0.000	**5.60**	0.17	33.88	**0.000**	4.58	0.20	22.71	0.000
NZ$	2.10	0.26	8.10	-1.84	0.02	-87.94	**2.54**	0.21	12.03	0.572	**3.41**	0.24	14.44	0.105	**2.23**	0.26	8.62	0.879
SF	5.66	0.26	21.62	1.69	0.03	57.30	3.58	0.16	21.70	0.000	3.99	0.15	26.87	0.000	4.70	0.20	23.31	0.000
UK£	3.40	0.21	16.55	-2.31	0.02	-101.43	1.25	0.13	9.45	0.000	**3.67**	0.20	18.44	**0.000**	**3.53**	0.20	17.43	0.108
Yen	6.36	0.28	22.44	2.83	0.03	107.00	4.46	0.19	22.96	0.000	4.36	0.09	47.66	0.000	5.14	0.20	25.17	0.000
Percentage of means that are no less than that of the NH strategy (percentage that are statistically significant at the 5% level)							14.3% (0%)				71.4% (57.1%)				42.9% (0%)			
Percentage of risks that are no greater than that of the NH strategy							100%				100%				100%			
Percentage of returns-per-unit-of-risk that are no less than that of the NH strategy							42.9%				100%				85.7%			

Table A3.9 Skewness Statistics of Hedging Return Distributions

Reported are the skewness statistics for the return distributions. Jarque-Bera normality tests have been done on the return distributions. The results show non-normal distributions in most of the series. Detailed statistics are not reported.

	Hedged Currencies						
A$ Based	C$	GM	NZ$	SF	UK£	Yen	US$
NH	0.483	0.748	0.444	0.727	0.772	0.970	0.637
PH	1.192	1.451	0.843	1.791	4.012	3.438	1.407
FH	1.227	2.978	0.428	5.578	1.572	2.593	1.913
PFH	0.850	1.307	0.404	1.688	1.341	2.709	1.189
C$ Based	A$	GM	NZ$	SF	UK£	Yen	US$
NH	0.444	0.525	0.633	0.649	0.315	1.270	0.085
PH	0.545	1.361	0.979	1.857	2.722	3.090	0.839
FH	0.408	0.879	0.605	3.129	0.376	0.082	0.890
PFH	0.405	0.697	0.617	1.432	0.361	3.006	0.573
GM Based	A$	C$	NZ$	SF	UK£	Yen	US$
NH	0.348	0.675	0.155	0.160	0.017	0.712	0.605
PH	1.115	1.024	1.370	0.587	0.675	1.767	1.084
FH	0.358	0.604	0.142	-1.154	0.028	-0.005	0.294
PFH	0.363	0.696	0.151	-0.125	0.096	1.199	0.594
NZ$ Based	A$	C$	GM	SF	UK£	Yen	US$
NH	0.128	0.357	0.812	0.697	0.548	0.827	0.575
PH	0.438	1.057	1.425	1.244	2.585	1.620	1.340
FH	-0.494	0.741	-1.867	-4.425	1.328	1.579	2.695
PFH	0.061	0.688	1.263	1.166	1.205	1.353	0.993
SF Based	A$	C$	GM	NZD	UK£	Yen	US$
NH	0.379	0.620	0.476	0.177	0.746	0.567	0.637
PH	0.820	0.934	0.820	1.018	2.026	1.676	1.213
FH	0.385	0.672	0.059	0.161	0.749	1.344	0.368
PFH	0.390	0.682	0.413	0.179	0.748	1.072	0.676

Table A3.9 Skewness Statistics for Hedging Return Distributions (Cont')

Reported are the skewness statistics for the return distributions. Jarque-Bera normality tests have been done on the return distributions. The results show non-normal distributions in most of the series. Detailed statistics are not reported.

	Hedged Currencies						
UK £ Based	A$	C$	GM	NZD	SF	Yen	US$
NH	0.089	1.256	1.533	0.361	1.618	2.114	2.483
PH	0.076	1.501	2.629	0.479	2.936	3.489	3.508
FH	0.277	2.742	3.432	0.392	-0.223	-2.091	0.072
PFH	0.091	1.414	2.135	0.340	2.899	3.468	3.324
Yen Based	A$	C$	GM	NZD	SF	UK£	US$
NH	0.298	0.687	0.791	0.822	0.919	0.369	0.520
PH	0.553	1.378	1.599	2.012	1.786	1.713	1.270
FH	0.270	0.694	0.722	0.698	1.005	0.362	0.513
PFH	0.296	0.637	0.811	0.843	0.999	0.670	0.512
US$ Based	A$	C$	NZ$	GM	SF	UK£	Yen
NH	0.487	0.812	0.501	0.639	0.583	0.358	1.151
PH	0.511	1.507	1.165	0.942	1.734	1.679	2.436
FH	0.963	1.068	0.788	0.723	1.144	0.346	2.871
PFH	0.487	0.813	0.543	0.635	0.827	0.338	2.115

Table A3.10 Stochastic Dominance between PFH and NH Strategies

Reported are the results on the second order stochastic dominance comparisons between the PFH and NH strategies. PFH refers to the PPP and forward-at-premium-hedging strategy. NH stands for the never-hedging strategy. Y indicates that one strategy dominates the other in the second order sense. N implies no stochastic dominance in the second order.

	Hedged Currencies						
A$ Based	C$	DM	NZ$	SF	UK£	Yen	US$
PFH vs. NH	Y	Y	Y	Y	Y	Y	Y
NH vs. PFH	N	N	N	N	N	N	N
C$ Based	A$	DM	NZ$	SF	UK£	Yen	US$
PFH vs. NH	Y	Y	Y	Y	Y	Y	Y
NH vs. PFH	N	N	N	N	N	N	N
DM Based	A$	C$	NZ$	SF	UK£	Yen	US$
PFH vs. NH	Y	Y	N	Y	Y	Y	Y
NH vs. PFH	N	N	N	N	N	N	N
NZ$ Based	A$	C$	DM	SF	UK£	Yen	US$
PFH vs. NH	Y	Y	Y	Y	N	Y	Y
NH vs. PFH	N	N	N	N	N	N	N
SF Based	A$	C$	DM	NZD	UK£	Yen	US$
PFH vs. NH	Y	Y	Y	N	Y	Y	Y
NH vs. PFH	N	N	N	N	N	N	N
UK £ Based	A$	C$	DM	NZD	SF	Yen	US$
PFH vs. NH	Y	Y	Y	Y	Y	Y	Y
NH vs. PFH	N	N	N	N	N	N	N
Yen Based	A$	C$	DM	NZD	UK£	Yen	US$
PFH vs. NH	Y	N	Y	N	N	Y	Y
NH vs. PFH	N	N	N	N	N	N	N
US$ Based	A$	C$	DM	NZD	SF	Yen	UK £
PFH vs. NH	N	N	N	N	N	N	Y
NH vs. PFH	N	N	N	N	N	N	N