BANK OF CANADA
BANQUE DU CANADA

Discussion Paper/Document d'analyse
2008-2

# The Carry Trade, Portfolio Diversification, and the Adjustment of the Japanese Yen

by Corinne Winters

www.bank-banque-canada.ca

Bank of Canada Discussion Paper 2008-2

January 2008

# The Carry Trade, Portfolio Diversification, and the Adjustment of the Japanese Yen

**by**

**Corinne Winters**

International Department
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
cwinters@bankofcanada.ca



ISSN 1914-0568

# Acknowledgements

I would like to thank Michael Francis, Jocelyn Jacob, Robert Lafrance, and Larry Schembri and other colleagues from the International Department for helpful comments and suggestions, and Sylvie Malette for excellent research assistance. All errors and omissions are my own responsibility.

## Abstract

In this paper, the author considers whether fundamentals or other factors can explain the yen's ongoing weakness. In particular, the importance of capital outflows due to the carry trade and longer-term portfolio investment outflows, which may be delaying the adjustment of the yen, are investigated. A simple portfolio model is developed, composed of a speculative component and a minimum variance portfolio, to address the underlying motivation for capital outflows from Japan over the past ten years. The author's main findings suggest that a substantial portion of outflows may be attributed to diversification. Furthermore, given that considerable 'home bias' remains in Japanese households' portfolios, the results suggest that capital outflows from households, largely driven by diversification, may continue to dampen a long-run appreciation of the yen going forward. That said, evidence of substantial speculative outflows, through carry trades, complicates the outlook for the yen.



*JEL classification: F21, F31, F32, G11*
*Bank classification: Exchange rates; International topics; Recent economic and financial developments*



## Résumé

L'auteure se demande si des facteurs fondamentaux ou d'autres éléments justifient la faiblesse prolongée du yen. Elle s'attache plus précisément à évaluer le rôle des sorties de capitaux liées aux opérations de portage et aux placements à long terme, sorties qui sont susceptibles de retarder l'ajustement du yen. Pour cerner les mobiles qui sous-tendent depuis dix ans les sorties de fonds hors du Japon, l'auteure élabore un modèle de gestion de portefeuille simple intégrant une composante spéculative et un portefeuille de variance minimale. Les principaux résultats obtenus indiquent que les sorties de capitaux sont en grande partie motivées par une volonté de diversification. Qui plus est, comme les portefeuilles des ménages nippons restent largement composés d'actifs japonais, les fonds expatriés par les ménages, surtout à des fins de diversification, pourraient encore freiner dans l'avenir l'appréciation du yen à long terme. Cela dit, les signes d'importantes sorties de capitaux spéculatifs induites par les stratégies de portage compliquent les perspectives du yen.



*Classification JEL : F21, F31, F32, G11*
*Classification de la Banque : Taux de change; Questions internationales; Évolution économique et financière récente*

# 1 Introduction

Some observers have recently expressed concerns about the weakness of the Japanese yen.[1] While many currencies, including the euro and the Canadian dollar, have appreciated markedly relative to the U.S. dollar since 2002, the yen, up until very recently, had not.[2] The lack of yen appreciation (relative to a longer-term trend) is perceived by these observers as an impediment to resolving global imbalances, because it hinders the necessary adjustment of relative prices and the rotation of demand among countries. One of the explanations commonly offered for this lack of yen adjustment is the 'carry trade.' Carry trades generally involve borrowing in low interest rate currencies (such as the Japanese yen and Swiss franc) and investing the proceeds in higher-yielding currency assets (such as the New Zealand dollar or the British pound), typically neglecting potential exchange rate movements, which should, if arbitrage were perfect, offset the interest rate differential.[3] The capital outflow driven by the carry trade has served to weaken the yen, especially against the high-yielding Australian and New Zealand dollars. Recent financial market developments have brought the yen back into the limelight: its daily ups and downs have been attributed by markets as signs of investors' changing risk tolerance for speculative, high-risk positions, such as 'yen carry trades.' With the removal of the benign conditions that underlie the profitability of this trading strategy, the future of the 'yen carry trade' and the continued weakness of the yen have come into question by market participants.

The purpose of this paper is to examine the yen carry trade to better understand its impact on the Japanese yen. In particular, we would like to consider whether the carry trade or other factors, including portfolio diversification, can explain the yen's ongoing weakness. This paper will address the underlying causes for the yen's weakness and will highlight factors that may be delaying its adjustment to a more appreciated long-run value. The paper is organized as follows: first, stylized facts of the Japanese economy are presented, as well as the fundamental factors that tend to be associated with movements in exchange rates. Second, longer-term portfolio adjustments, which have likely delayed an appreciation of the yen, are presented, followed by a discussion of the yen carry trade. The carry trade, which is largely driven by cyclical interest rate differentials, has also contributed to the weakness of the yen. A simple portfolio model is then presented to assess the relative importance of diversification and speculation in encouraging capital outflows from Japan, followed by a discussion of the outlook for the yen exchange rate.

---

1. For example, see Bini Smaghi (2007), IMF (2007a).
2. Since 2002, the euro and the Canadian dollar have appreciated by 64 and 59 per cent, respectively, relative to the U.S. dollar.
3. The failure of exchange rates to offset the gains from investing in the higher-yielding currency (at least in the short run) is known as the failure of uncovered interest rate parity and is discussed further in section 4.2.

## 2 The Yen and Macroeconomic Fundamentals

The yen nominal effective exchange rate has depreciated since 1999 and remains around its lowest level since September 1998 (Chart 1). However, once adjusted for relative inflation rates, the yen exchange rate, as measured on a real effective basis, remains lower than in 1985, just prior to the Plaza Accord.[4] On a nominal basis, the yen has been on a depreciating trend against the euro, the Australian dollar, and the British pound since mid-2000, and against the U.S. dollar since mid-2004. Exchange rate volatility remained low between 2002 and early 2007 for all bilateral exchange rates listed above, declining significantly from the peaks reached during the Asian financial crisis (Chart 2). Recent financial market turbulence has seen the yen reverse some of its depreciation relative to these currencies, and exchange rate volatility has generally increased (most significantly against the Australian dollar).

A number of macroeconomic fundamentals are identified in the literature associated with movements in real effective exchange rates.[5] One factor is the current account: large cumulative current account surpluses tend to be associated with long-run appreciations. Since mid-2001, the Japanese current account balance as a percentage of GDP has been on a rising trend (Chart 3), reaching around 5 per cent, above Japan's long-run norm of about 2 per cent (IMF 2007a). This development, according to studies by Rogoff (1996) and others, should be associated with a yen appreciation over the medium to long term, as countries with large cumulative current account surpluses amass large net foreign asset positions.[6] These countries tend to experience upward pressure on their real exchange rates as relative prices at home and abroad adjust to the current account surplus.[7]

---

4. The Plaza Accord was an agreement among France, West Germany, Japan, the United Kingdom, and the United States to intervene in currency markets to gradually depreciate the U.S. dollar relative to the yen and German mark.
5. For a comprehensive overview of the literature on exchange rate determination, see Bailliu and King (2005) or Rogoff (1996).
6. This increase in net foreign asset positions may be related to the ongoing aging of the Japanese population. Net foreign assets, which are accumulated through successive current account surpluses, tend to increase with the old-age dependency ratio and are used to pay for retirement spending (with this accumulation being aided by an initial real depreciation of the currency). This higher level of net foreign assets is later associated with a real appreciation of the currency.
7. Empirical studies by Lane and Milesi-Ferretti (2000, 2002), Gagnon (1996), and Faruqee (1995) show that, over long horizons, this relationship between net foreign assets (obtained from cumulative current account surpluses) and the real exchange rate holds.

A positive productivity differential in the tradable goods sectors between two countries is also associated with a real appreciation. This is known as the Balassa-Samuelson effect.[8] According to this effect, higher productivity in the tradable goods sector tends to put upward pressure on wages in the non-tradable goods sector, as wages in the tradable sector rise. If there is no corresponding increase in productivity in the non-tradable goods sector, then higher wages must be matched with increases in non-tradable goods prices, implying a real appreciation. Although evidence suggests that productivity growth in Japan's tradable goods sector has been consistently higher than in the non-tradable goods sector since 1990, the productivity gap between the tradable and non-tradable goods sectors in the United States has exceeded that of Japan since 2000 (IMF 2007b). Based on this effect, there should have been some pressure on the yen to depreciate on a real basis relative to the U.S. dollar since 2000. However, Japan's labour productivity growth has consistently exceeded the average of the other G-7 countries (Chart 4) and this gap, after narrowing in the mid-1990s, has begun to widen again since 2000.[9] For example, in 2000–06 annual labour productivity growth in Japan averaged 2.3 per cent, compared with 1.6 per cent, on average, for the other G-7 countries.[10] Based on this difference, the yen, which has depreciated by 3.4 per cent per year since 2002 (on a real effective basis), seems relatively weak.

Another factor that could have altered the relative price of non-tradable goods and tradable goods in Japan is government consumption, which (as a percentage of GDP) is associated with movements in real exchange rates, since increased expenditure tends to be biased toward non-tradable goods relative to tradables (Ostry 1994; De Gregorio, Giovannini, and Wolf 1994). This shift in expenditure would raise the relative price of non-tradable goods relative to tradables, implying a real appreciation. From 1997–2003, Japanese government consumption increased from 15 per cent of GDP to 18 per cent of GDP, which, in theory, should have put upward pressure on the yen real exchange rate. Since 2003, this level of stimulus has been maintained, implying a continued bias in expenditure toward non-tradable goods; yet, as noted above, the yen continued to depreciate over this period (with some reversal recently).

---

8. Studies by Hsieh (1982) and Marston (1987) find the Balassa-Samuelson effect to be a significant driver of the appreciation of the yen from 1954–76 and 1973–83. A more recent study by Tille, Stoffels, and Gorbachev (2001) finds that around two-thirds of the long-run movements in the yen/U.S.-dollar exchange rate between 1970 and 1999 could be accounted for by the Balassa-Samuelson effect.
9. Labour productivity growth is defined here as the annual change in real GDP per hour worked.
10. The Conference Board and Groningen Growth and Development Centre, Total Economy Database, January 2007, <http://ggdc.net>.

Charts 5 and 6 show that widening interest rate differentials between Japan and other countries have been associated with a depreciation of the yen. This co-movement appears to have strengthened since 2002, especially in the case of the yen exchange rate relative to the Australian dollar. Table 1 reports the correlation between the interest rate differential (defined as the difference between the foreign interest rate and the Japanese interest rate) and the percentage rate depreciation of the yen, and confirms that the correlation has increased since 2002 for all four currency pairs considered.[11] For example, the correlation between widening interest rate differentials and movements in the yen/New Zealand-dollar exchange rate increased from 0.47 in 1995–2002 to 0.79 since 2002. This development may suggest an increasing role for interest rate differentials in influencing the yen's movements in recent years. Interestingly, this increased correlation for the yen/New Zealand-dollar exchange rate occurred despite a moderate decrease in the average interest rate differential over the period 2002–07 (Table 1).[12]

Overall, according to the latest Article IV consultation by the IMF, the underlying Japanese macroeconomic fundamentals should put upward pressure on the yen. According to estimates by the IMF's Consultative Group on Exchange Rates, which takes into account many of the factors listed above, the yen's real effective exchange rate (in August 2007) was undervalued relative to fundamentals.[13] Other market-based estimates put the recent undervaluation of the yen relative to the U.S. dollar in the range of 14 to 37 per cent (IMF 2007b). Therefore, there is evidence supporting the proposition that the yen has recently been undervalued relative to longer-run fundamentals. Key factors that may be contributing to this divergence are discussed in the next section.

# 3 The Impact of Portfolio Shifts

Although the foregoing analysis suggests that the yen is undervalued relative to its long-run equilibrium value, there may be some financial pressures that could slow a yen appreciation. In this section, two key developments that may help explain the delayed adjustment of the yen are

11. However, the yen/U.S.-dollar exchange rate, unlike the other currency pairs, was not significantly correlated with the interest rate differential in the 2002–07 period.
12. The average interest rate differential between New Zealand and Japan decreased from 6.57 in 1995–2002 to 6.24 since 2002.
13. The IMF's Consultative Group on Exchange Rates uses several models to arrive at an average estimate of the equilibrium exchange rate. One involves evaluating a current account 'norm' from fundamentals and the current account balance projected over the medium term. Then, the exchange rate adjustment needed to arrive at that 'norm' over that period is calculated (macroeconomic balance approach). Another approach directly estimates an equilibrium exchange rate from fundamentals (equilibrium real exchange rate approach), and a third approach determines a current account balance (and therefore the exchange rate adjustment) that would be needed to stabilize the net foreign asset position to a target level (external stability approach). For more background on these estimation methods, see IMF (2006).

discussed: the recent observed change in Japanese household savings behaviour, and the decreasing share of the yen in global foreign currency reserves.

## 3.1 Household portfolio investment behaviour

Household portfolio investment behaviour may have delayed an appreciation of the yen by reducing household demand for yen-denominated assets. Risk appetite appears to have risen globally (with some likely decrease in recent months), probably due to a global reduction in volatility, low interest rates, and low expected inflation rates. This reduction in risk aversion may be more significant in Japan. Some market analysts claim that a recent structural break in Japanese household investment behaviour may have occurred. This may have been related to regulatory changes such as the privatization of the postal savings system and the increased availability of alternative investment vehicles (i.e., investment trust funds), as well as demographic factors.[14] Traditionally, Japanese households have held a relatively large portion of their assets in domestic currency and deposits; however, key subcomponents, such as post office deposits, have declined by 10 trillion yen a year, on average, since 2000, as assets are increasingly invested in riskier instruments.[15] Chart 7 shows that household risk appetite in Japan may have increased since 2003, as more assets are being invested in equities and investment trusts.[16]

Associated with this decrease in risk aversion is an apparent increased willingness of Japanese households to bear exchange rate risk, which has contributed to a reduction in 'home bias.' The reduction in 'home bias' is evidenced by increased demand for foreign assets by Japanese households, and is caused, in part, by the low expected returns at home (responsible for the increase in carry trade activity, discussed further in section 4.2), the desire for overall portfolio diversification, and some underlying structural changes.[17] Since 2000, for instance, the share of foreign assets in investment trusts has increased, and currently represents the main exposure of

14. Jen (2006) and Jen, Bindelli, and St-Arnaud (2007) claim that this structural break occurred around the summer of 2005. This could have been triggered by several factors, including the retirement of the first wave of baby boomers, who may have a higher risk preference for investing pension proceeds; a delayed impact of the 1998 pension reforms on portfolio diversification; the end of unlimited deposit insurance on domestic demand deposits (in 2005); the ongoing privatization of postal savings; and an increase in the availability of investment funds since 2004. For more details on these reforms, see IMF (2005).
15. In 2006, currency and deposits accounted for 51 per cent of all household assets, compared with 15 per cent in the United States.
16. Investment trust funds are similar to mutual funds in Canada.
17. See IMF (2005) for further details on the structural and regulatory changes over the past decade that may have contributed to the decline in 'home bias' in Japan.

Japanese households to foreign assets.[18] The share of investment funds allocated to foreign securities has increased from below 20 per cent in 2000 to 46 per cent in 2007Q2, as shown in Chart 8. Foreign currency exposure can also be obtained through purchases of uridashi bonds (Japanese foreign currency bonds issued outside Japan for sale to Japanese investors), as well as via direct holdings of foreign currency deposits and securities, which have also increased slightly in recent years.[19] Although this increase in foreign portfolio investment can be attributed, in part, to the overall rise in risk appetite and a search for yield, 'home bias' has been declining since the late 1990s, as shown in Chart 9. This trend persisted even when risk appetite contracted in 2000–03, implying that a reversal of the current increase in risk appetite may not necessarily result in a reduction in households' foreign investment share.

One typical benchmark used to gauge the extent of 'home bias' is to consider the International Capital Asset Pricing Model (ICAPM).[20] According to this model, the share of domestic assets held by investors should be roughly comparable to the size of the domestic market in the world market, assuming that expected returns are similar. A foreign asset acceptance ratio (FAAR) is then calculated. The share of foreign assets held by domestic residents should be proportional to the size of foreign market(s) in the world market. A FAAR of 100 indicates no 'home bias,' and a share below 100 implies that domestic residents underinvest in foreign securities relative to the size of foreign asset markets. Although the extent of 'home bias,' according to this measure, has declined over the past ten years in Japan, especially in equity investment (Chart 10), it has remained higher than in many other mature market economies (Chart 11). For example, in 2005 the FAAR for equity investments in Japan was 11 per cent, well below that of the United States, Canada, and the United Kingdom, which had FAARs of 30, 25, and 40 per cent, respectively. Despite the fact that most countries appear to have considerable 'home bias' based on this measure (Tesar and Werner 1995), this analysis nonetheless highlights the role that the ongoing reduction in 'home bias' may have in dampening a yen appreciation over the medium to long run.[21]

---

18. Shares of currencies that typically make up the 'foreign currency share' in income trusts are: the U.S. dollar (36.0 per cent), the euro (22.9 per cent), the Australian dollar (10.3 per cent), the U.K. pound (6.9 per cent), the Canadian dollar (5.0 per cent), the New Zealand dollar (1.6 per cent) and 'other currencies' (17.3 per cent), based on data from November 2007 (The Investment Trusts Association, Japan).
19. There has also been a rise reported in foreign exchange trading through margin accounts on behalf of individual investors, with deposits reaching US$5.75 billion in May 2007 (IMF 2007a).
20. See, for example, Adler and Dumas (1983), Solnik (1974), and Harvey (1991).
21. Although this reduction in home bias is likely to continue for some time, factor income gained from this investment in foreign assets will eventually put some upward pressure on the yen through an increase in the current account.

## 3.2 Foreign exchange reserve portfolio shifts

The yen has also been weakened by a reduction in the share of yen-denominated assets held by central banks. These foreign exchange reserve portfolio shifts, if continued, may further delay the long-run appreciation of the yen. In 2000, the yen accounted for 6.3 per cent of all foreign exchange reserves, and most recent IMF data show that this share has declined to 2.8 per cent in 2007Q2.[22] While the yen's share of reserves has declined, the share allocated to the euro has increased over the same period, from 17.5 per cent in 2000 to 25.6 per cent in 2007Q2, and the share allocated to the pound has also moved ahead of the yen. This reduction is in part due to interest rate differentials. Note, however, that this decline has not been observed for all low-yielding currencies. The Swiss franc, for example, has seen its share remain relatively flat over this period, suggesting that the global role of the yen may have changed.

# 4 The Impact of the Carry Trade

Although there are long-run portfolio shifts in Japan that could have contributed to the weakness of the yen, its depreciation has likely been exacerbated by the carry trade, which has led to an outflow of speculative investment from Japan. Carry trades typically involve borrowing in low-yielding currencies, such as the Japanese yen, and converting the funds into currencies with higher yields.[23] The increased demand for foreign currency and the excess supply of yen combine to put downward pressure on the yen on a bilateral and real effective basis.

## 4.1 Size of carry trade activity

The size of the carry trade is a matter of debate.[24] For example, some carry trade positions (i.e., swap positions) are off-balance-sheet items, making them difficult to measure. Nevertheless, the increase in uridashi outflows, margin trading, and the growth in investment trust shares suggest the increasing significance of the carry trade. Since 2004, there has been a slight pickup in uridashi bond issuance, particularly denominated in higher-yielding currencies, such as in Australian and New Zealand dollars (Galati, Heath, and McGuire 2007). Margin trading has also increased in popularity for retail investors, with the number of margin accounts growing rapidly

22. This refers to the share of allocated reserves from the IMF's Currency Composition of Official Foreign Exchange Reserves (COFER) database.
23. These borrowed funds may be exchanged for higher-yielding currency assets on the spot market, though more complex strategies exist. See Jen, Bindelli, and St-Arnaud (2007) and Galati, Heath, and McGuire (2007) for a discussion of various ways in which carry trades may be implemented.
24. Market-based estimates place the size of the carry trade between US$100 billion and US$2 trillion (IMF 2007b).

in recent years, enabling investors to take leveraged currency positions.[25] As for investment trust funds (ITFs), foreign securities now account for approximately 46 per cent of all investments, and are increasingly held by Japanese households. This pickup in the foreign share of ITFs is likely driven by widening interest rate differentials, although ITF flows are also associated with equity investment flows and are therefore not pure carry trades like uridashi flows (i.e., driven primarily by interest rate differentials).[26]

Another important flow frequently attributed to the carry trade is non-Japanese residents borrowing in yen outside of Japan. This type of flow has been on the rise and incorporates borrowing for investment in higher-yielding assets, as well as mortgage borrowing.[27] Short positions taken in the yen by speculators (non-commercial investors) in the International Money Market (IMM) suggest a potential rise in carry trade activity.[28] Chart 12 shows that speculative short positions in the yen have been at record highs in the first half of 2007, with a reduction in these positions in March and August.[29] These speculative positions have matched changes in the U.S.-dollar/yen exchange rate quite closely, highlighting the role of carry trades as a likely contributor to the weakness of the yen. Foreign banks (as well as global domestic banks) positioned in Japan also show increasing participation in yen carry trades. Anecdotal evidence suggests that borrowing in Japan on behalf of foreign banks (call market borrowing and loans) has been on the rise since 2005, corresponding to an increase in remittances to overseas branches, presumably taking advantage of carry trades. Therefore, while the size of the carry trade is not agreed upon, its substantial presence is evident.

---

25. The number of margin accounts operated by Gaitame (a Japanese company that provides foreign exchange margin-trading facilities in Japan) increased from under 2,000 at the beginning of 2003 to around 120,000 in June 2007 (Galati, Heath, and McGuire 2007). However, total capital outflows from margin accounts are lower than from investment trust funds.
26. Foreign currency ITFs are significantly larger than uridashi flows – approximately US$6.6 billion per month in 2006, compared with US$2 billion per month for uridashi flows (Jen, Bindelli, and St-Arnaud 2007) – and remain larger than retail margin-trading outflows.
27. In Korea, for example, yen-denominated loans increased by around $5 billion in 2006 (IMF 2007b).
28. The Commodity Futures Trading Commission (CFTC), in its Commitments of Traders Report (COTR), separates commercial from non-commercial (speculative) positions in the IMM. Commercial positions (in the case of yen positions in the IMM) are generally those taken for hedging currency exposure incurred through business operations, while non-commercial positions (such as those referred to in Chart 12) are those that generally reflect the speculative positioning of investors. Although investors self-report whether they are commercial or non-commercial, the exchanges monitor firms' behaviour to ensure consistency. See Mogford and Pain (2006) for more details.
29. Most recent data show that some (albeit relatively small) net long non-commercial IMM positions in the yen were established relative to the U.S. dollar in November 2007.

## 4.2 Factors underlying the profitability of carry trades

A key underlying determinant of carry trade profitability, beyond the essential conditions of a low interest rate in a funding currency and a higher yield in a target currency, is the forward premium (discount) puzzle, or the failure of uncovered interest rate parity (UIP).[30] UIP states that differences in interest rates between two countries should reflect the rate at which the currency with the low interest rate is expected to appreciate relative to the currency with the high interest rate. Therefore, given that interest rates in Japan have been low relative to other currencies, this implies that, on average, the yen should be appreciating. If this condition holds, then movements in the exchange rate would reduce the gains from investing in the higher-yielding currency, leaving no expected excess returns from engaging in a carry trade. However, extensive research has shown that this condition is violated, at least in the short run.[31] The Japanese yen is no exception: despite its expected low return, the yen has continued to depreciate, rather than appreciate. The yen depreciation has increased the excess returns from investing in a higher-yielding currency. Further background on the forward premium puzzle and evidence that UIP fails in Japan is provided in Appendix A.

Given that interest rates have been low in Japan relative to other countries since the early 1990s, another contributing factor to the profitability of carry trades, in addition to the failure of UIP, is the role of declining transactions costs and low volatility. Burnside et al. (2006) note that carry trade strategies yield high Sharpe ratios (relative to investments bearing a similar amount of risk) due to the low standard deviation of payoffs; however, the existence of transactions costs drastically reduces the returns to currency speculation.[32] As a result, investors must hold on to carry trades for longer periods of time to make substantial returns. The generally benign risk environment of global markets from around 2003 to early 2007, characterized by high liquidity, narrower credit and yield spreads, and low volatility, may have encouraged investors to hold these investments for longer periods of time. This relatively low volatility environment may have increased the expected profitability of carry trades, encouraging further speculative positioning. One way that markets have assessed the ex-ante profitability of carry trades is to look at a carry-to-risk ratio, which is defined as the interest rate differential (3-month interest rate differential between the high-yielding and low-yielding currencies) divided by the implied

30. Average interest rates between 2000 and mid-2007 in Japan (funding currency) were 0.09 per cent, compared with 6.25 and 5.38 per cent, respectively, in New Zealand and Australia, two potential target currencies for carry trades.
31. See Fama (1984) and Burnside et al. (2006), among others. Chinn and Meredith (2004), however, show that UIP may hold in the long run.
32. The Sharpe ratio is the risk-adjusted return of an asset; typically, it is the return of an asset relative to a benchmark asset, weighted by the standard deviation of excess return.

volatility of the respective bilateral exchange rate (a proxy for expected exchange rate movements). By this measure, from 2004 to early 2007, yen carry trades could have been viewed as an increasingly profitable investment strategy by market participants, especially with regard to the yen/Australian-dollar and the yen/pound exchange rates (Chart 13).[33]

Another contributing factor to the profitability of yen carry trades is the lack of inflationary pressure in Japan, which has resulted in delayed monetary policy normalization after Japan emerged from quantitative easing in March 2006. This has directly encouraged the carry trade, since relatively large interest rate differentials between Japan and other industrialized countries are expected to persist for some time, given current yield curves. Greater volatility in foreign exchange markets and relatively higher interest rates in Japan could have large implications for the yen by affecting the perceived profitability of carry trades.[34] Movements in the yen exchange rate in 1998, discussed below, highlight the potential that a reversal in speculative outflows has to drive an appreciation of the yen.

## 4.3 Past episodes of carry trades in Japan

From 1995 to mid-1998, the yen depreciated 16 per cent against the U.S. dollar, despite relatively strong Japanese fundamentals. This was partly attributed to carry trade strategies, since interest rates in Japan were much lower than in the United States (the average interest rate differential between the United States and Japan was roughly 5 percentage points). A reversal in this trend came on 7 October 1998, when the yen appreciated by 11 per cent over that day relative to the U.S. dollar (Chart 14), and a period of high volatility in the foreign exchange market followed (Chart 2).[35] It is widely accepted that this appreciation was associated with a reassessment of risk and a liquidity crunch caused by a number of factors, including hedge fund losses in emerging markets and the near collapse of Long Term Capital Management. This increased volatility reduced the apparent profitability of these speculative investments, and a reduction in carry trades reportedly followed. Capital inflows into Japan put upward pressure on the yen exchange rate, further reducing the profitability of carry trades, and likely triggering a mass reversal of yen exposures by investors. A study by Cai et al. (2001) addresses the role that

33. The South African rand and the Brazilian real may also have been targets for the carry trade during this period, with high interest rates in these countries, combined with declining volatility.
34. The carry-to-risk ratio (in several currency pairs) has declined since late 2006, with large declines in the summer of 2007, as shown in Chart 13. There also was a reported partial unwinding of carry trade positions in March and August of 2007.
35. On 17 June 1998, the U.S. Treasury and the Japan Ministry of Finance agreed to a joint intervention in the foreign exchange market, to strengthen the yen to better reflect fundamentals; however, even after this intervention the yen continued to depreciate.

carry trades had on movements in the yen/U.S.-dollar exchange rate during 1998 by proxying carry trades with order flow.[36] The authors find that macroeconomic announcements had a significant effect on exchange rate movements. But order flow may have played an even more important role.

## 4.4 Possible future implications of carry trade activity

Given that speculative short positions in the yen through the first half of 2007 exceeded levels established in the IMM in 1998, such an unwinding may have large implications for the yen exchange rate going forward. Recently, some appreciation in the yen, especially relative to the high-yielding Australian and New Zealand dollars, was attributed to a partial unwinding of short-yen positions (relative to these currencies) in March and August 2007. This appreciation followed an increase in the volatility of asset markets, stemming from concerns surrounding the implications of widespread defaults in the U.S. subprime mortgage market. Some reports from market participants suggest that this may have resulted from institutional investors unwinding some of their positions, similar to what took place in 1998. However, it is currently believed that households are also participating in the carry trade (as evidenced by the increase in margin accounts). Therefore, the future of this speculative strategy (and portfolio outflows more generally) depends, in part, on how Japanese households view the recent bout of volatility. A reversal of households' speculative outflows would likely be more prolonged than institutional investors' (who would be expected to take larger leveraged currency positions), potentially resulting in more subdued exchange rate movements.[37]

Capital outflows may have also been encouraged by overall portfolio diversification, in addition to taking advantage of higher interest rates outside of Japan. Such diversification-driven outflows, as argued above, reflect a decline in 'home bias' in Japanese households' portfolios, and, given the evidence of considerable remaining 'home bias' in Japan, such capital outflows may persist. In the face of volatility shocks, these diversification outflows, such as the increasing share of investment trust funds allocated to foreign securities, may be unwound more slowly than leveraged carry trades (Galati, Heath, and McGuire 2007). Therefore, the outlook for the yen depends in part on the underlying motivation behind the capital outflows from Japan. Box 1 examines the relative importance of portfolio diversification and speculation in

36. Order flow is defined as the difference between the number of buyer-initiated and seller-initiated orders, which measures net buying pressure (in this case for the yen). Cai et al. (2001) consider order flow a good proxy for carry trade positions, because an unwinding of these positions would not be learned about through public announcements but through trading activity.
37. The average size of margin accounts in Japan is relatively small, estimated at US$6,000 (IMF 2007b).

determining the portfolio investment decisions of households, estimating an optimal portfolio for a typical Japanese investor, which is composed of a speculative component and a minimum variance portfolio (proxy for diversification). Results show that recent capital outflows from Japanese households may have been motivated, to a large extent, by diversification, and households may therefore choose to maintain these positions even if many of the underlying conditions for carry trade profitability (i.e., low volatility) are removed.

The outlook for interest rates and volatility in foreign exchange and asset markets will likely have a large bearing on established carry trade positions. Interest rate differentials between Japan and other industrialized countries are expected to persist for some time, given the current yield curves. Markets expect a slight reduction in interest rate differentials between Japan and the United States over 2008, potentially putting upward pressure on the yen relative to the U.S. dollar; however, the narrowing of return differentials between Japan and other economies is expected to occur more slowly. As interest rate differentials begin to decrease, this narrowing is expected to occur gradually, and may therefore have little effect on investors' perceived carry trade profits in the near term.

Japan's monetary policy normalization depends heavily on the outlook for inflation. Opinion surveys carried out by the Bank of Japan indicate that inflation expectations have generally increased since the beginning of 2006 (when Japan first emerged from deflation), despite some variation in recent months. Consensus forecasts for inflation remain around zero in the medium term, slowly moving into positive territory through 2008. Interest rates are expected to remain low for some time, likely prolonging the perceived profitability of carry trades and the weakness in the yen.

## Box 1: A Simple Model of Optimal International Portfolio Selection and Diversification

There appear to be two key factors motivating capital outflows from Japan. On the one hand, capital outflows are being encouraged by ongoing diversification of Japanese households' portfolios, and on the other hand, higher returns abroad are leading to speculative flows, which in part reflect carry trade transactions. To get a sense of the relative importance of these two factors in driving Japanese capital outflows, a simple portfolio allocation model developed by Dornbusch (1980) can be used to approximate an optimal foreign portfolio share, composed of a 'minimum variance portfolio,' which proxies for diversification flows, and a 'speculative portfolio,' which depends on interest rate differentials and risk aversion (proxy for carry trades). In this model, an individual investor is faced with two assets: a domestic (Japanese) and a foreign (U.S.) government bond.[1] The investor allocates wealth between these two assets to maximize utility, which is positively related to average wealth ($\overline{w}$) and negatively related to the variance of wealth ($s_w^2$):

$$U = U(\overline{w}, s_w^2). \tag{1}$$

The mean and variance of wealth are defined as:

$$\overline{w} = w(1+\overline{r}) + xw(\overline{r}^* - \overline{r}) \tag{2}$$

$$s_w^2 = w^2[(1-x)^2 s_r^2 + x^2 s_{r^*}^2 + 2x(1-x)s_{rr^*}], \tag{3}$$

where * refers to the foreign country and $x$ refers to the share of assets allocated to the foreign asset (more details on the model are provided in Dornbusch 1980). Key to this model is the inflation process. The inflation rate introduces uncertainty into the model, as real returns become random.

The inflation rate faced by the home investor is given by:

$$\tilde{p} = ap + (1-a)(p^* + d), \tag{4}$$

where (1-$a$) is the share of foreign goods in total consumption, which will be proxied by the import penetration ratio; i.e., the percentage of imports in total domestic sales [=imports/(GDP-exports)].[2] The rate of depreciation, $d$, follows purchasing power parity (PPP), but contains a random element ($u$), representing random deviations from PPP:

$$d = p - p^* + u. \tag{5}$$

Combining equations (4) and (5), and optimizing equation (1) with respect to $x$, yields the optimal portfolio (the ratio allocated to the foreign bond):

$$x = \frac{(\overline{r}^* - \overline{r})}{qs^2} + \frac{s_p^2 - s_{pp^*} + (1-a)s_u^2}{s^2}, \tag{6}$$

where $s^2 = s_p^2 + s_{p^*}^2 - 2s_{pp^*} + s_u^2$ and $q = -2U_2 w/U_1$.

Therefore, the optimal portfolio can be split into two components. The first component (the first expression on the right-hand side of equation (6)) is the speculative component, which depends on yield differentials and relative risk aversion ($q$); the second component is the minimum variance portfolio, which is independent of the degree of risk aversion.

One can analyze how the optimal portfolio could have changed over the past 20 years by using different values of the risk-aversion parameter ($q$).[3] Splitting the period 1986–June 2007 (chosen for data purposes) into two 10-year periods and obtaining estimates for the various parameters in equation (6), one can observe the factors that could have influenced portfolio changes. These estimates are provided in Table A.

---

1. The overnight rate will be used as a proxy for 1-year government bond returns due to data availability for the time period under consideration. Using longer-term government bonds, such as 10-year bonds, does not significantly change the results.
2. Dornbusch approximated the share of foreign goods in total consumption by the relative size of the foreign country, assuming the world was made up of the home and foreign country. However, due to evidence of significant home bias in consumption across countries, this assumption is relaxed here.
3. The values for $q$ are taken from Lewis (1999). Bliss and Panigirtzoglou (2004) show that estimated values for $q$ generally range from zero to 12.

## Box 1 (continued)

### Table A: Summary Statistics

| | 1986–96 | 1997–June 2007 |
|---|---|---|
| Foreign share in Japanese consumption basket (1-$a$) | 0.09 | 0.15 |
| Mean CPI inflation Japan | 1.25 | -0.05 |
| Standard deviation of inflation in Japan | 1.25 | 0.87 |
| Mean PCE inflation U.S. | 3.09 | 2.06 |
| Standard deviation of inflation in the U.S. | 0.97 | 0.70 |
| Covariance of Japanese and U.S. inflation | 0.74 | -0.13 |
| Standard deviation of depreciation | 13.12 | 10.16 |
| Mean real interest rate differentials of bonds $(\bar{r}^* - \bar{r})$ | 0.09 | 3.59 |

### Table B: Optimal Portfolio Allocation

| | Minimum Variance portfolio (% wealth) | Foreign portfolio share in per cent of wealth (minimum variance portfolio + speculative portfolio) for $q$ = | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 10 |
| 1986–96 | 9.42 | 9.47 | 9.45 | 9.44 | 9.43 |
| 1997–June 2007 | 15.63 | 19.06 | 17.35 | 16.78 | 15.97 |

From 1986–96 to 1997–June 2007, the estimated minimum variance portfolio increased from 9.42 per cent to 15.63 per cent, while the estimated speculative portfolio increased from nearly zero per cent to under 4 per cent. From the standpoint of bond portfolio investment, increased capital outflows over this period should have been driven largely by diversification rather than speculation. This being said, if the two assets in question were equities instead of bonds (as measured by the S&P500 and Nikkei indexes), then speculative flows could have played a larger role, since equity returns in the United States were much higher, on average, than in Japan.[4]

According to data from the IMF's Co-ordinated Portfolio Investment Survey (CPIS) and the Bank of International Settlements (BIS), in 2005 the amount of foreign bonds in total bond investment stood at 17 per cent in Japan and the percentage of foreign equities in total equity investment stood at 31 per cent.[5] Although there is some uncertainty surrounding these estimates, the actual percentage of foreign bonds (equities) in total bond (equity) investment does not appear to be significantly different from the optimal foreign share shown in Table B. In fact, when considering equities (not presented above) and assuming a low relative risk aversion ($q$ =1), the optimal foreign security share was around 26 per cent, on average, between 1997 and June 2007. This was lower than the 31 per cent of equities, which for the aggregate Japanese economy were actually held in foreign currency in 2005. When considering bond and equity investment alone, from this measure of the optimal foreign currency share, aggregate bond and equity portfolios may not suffer from 'home bias.' However, 'home bias' in Japanese investment behaviour arises from the fact that they hold such a large percentage of assets in domestic currency and deposits (51 per cent of assets in 2006). As a result, total foreign exposure as a ratio of total financial assets for Japanese households just reached approximately 4.5 per cent in 2006. As Japanese households reduce their holdings of domestic currency and deposits, largely driven by the minimum variance portfolio, outflows can be expected to put continued downward pressure on the yen, delaying its adjustment to a more appreciated value. This ongoing reduction in the holdings of low-yielding assets is largely a positive development, since the low share of foreign investments currently represents an unexploited opportunity for higher returns and a partial hedge against consumption shocks and inflation variance (due to the presence of imports in a typical household's consumption basket).

4. Using New Zealand interest rates would likely have also increased the optimal speculative portfolio, since rates averaged 6.2 per cent between 1997 and June 2007.
5. This includes all cross-border holdings of securities (not only the holdings of households), excluding reserve assets.

Lastly, current carry trade positions appear to present a limited risk to financial stability, since the impact of a disorderly unwinding of speculative outflows on Japanese banks (and global banks) would likely be smaller and more dispersed with the expected presence of households than would be the case solely with institutional investors. Studies by Gagnon and Chaboud (2007) suggest that the Japanese banking sector has a modest net carry position of around US$40 billion, and may therefore present a limited risk to stability. Moreover, banking sector reforms since 1997 and improved banking profits since 2002 will likely help the Japanese banking sector withstand potential volatility.

# 5 Conclusion

Evidence reviewed in this paper supports the proposition that the yen has recently been undervalued relative to longer-run fundamentals. A key factor that has likely delayed the adjustment of the yen to a more appreciated value is the outflow of domestic capital. Using a simple portfolio model, we find that continued capital outflows may place further downward pressure on the yen as households diversify their portfolios (given the considerable 'home bias' in existing portfolios). However, there is evidence (presented in this paper) to suggest that part of these outflows has been speculative, and is related to low yields in Japan and a potential decline in risk aversion by investors. Past experience shows that these speculative carry trade flows are highly dependent on the outlook for interest rate differentials and overall foreign exchange market volatility. Although volatility has increased since the beginning of 2007, interest rate differentials will likely continue to motivate speculative outflows, placing downward pressure on the yen. Because some of the recent carry trade activity in the yen is reportedly due to Japanese households, the outlook for the yen exchange rate will depend, in part, on the investment behaviour of these individuals.

# References


Adler, M. and B. Dumas. 1983. "International Portfolio Choice and Corporation Finance: A Synthesis." *Journal of Finance* 38 (3): 925–84.

Amiti, M. and K. Stiroh. 2007. "Is the United States Losing Its Productivity Advantage?" *Federal Reserve Bank of New York Current Issues in Economics and Finance* 13 (8).

Bailliu, J. and M. King. 2005. "What Drives Movements in Exchange Rates?" *Bank of Canada Review* (Autumn): 27–39.

Bilson, J. 1981. "The 'Speculative Efficiency' Hypothesis." *Journal of Business* 54 (3): 435–51.

Bini Smaghi, L. 2007. "The Euro as an International Currency: Implications for Exchange Rate Policy." Speech to the Euro50 Group Meeting, Rome, Italy, 3 July.

Bliss, R. and N. Panigirtzoglou. 2004. "Option-Implied Risk Aversion Estimates." *Journal of Finance* 59 (1): 407–46.

Burnside, C., M. Eichenbaum, I. Kleshchelski, and S. Rebelo. 2006. "The Returns to Currency Speculation." NBER Working Paper No. 12489.

Cai, J., Y.-L. Cheung, R.S.K. Lee, and M. Melvin. 2001. " 'Once-in-a-Generation' Yen Volatility in 1998: Fundamentals, Intervention, and Order Flow." *Journal of International Money and Finance* 20: 327–47.

Chinn, M. and G. Meredith. 2004. "Monetary Policy and Long-Horizon Uncovered Interest Parity." *IMF Staff Papers* 15 (3): 409–30.

De Gregorio, J., A. Giovannini, and H. Wolf. 1994. "International Evidence on Tradables and Non-Tradables Inflation." *European Economic Review* 38 (6): 1225–44.

Dornbusch, R. 1980. "Exchange Rate Risk and the Macroeconomics of Exchange Rate Determination." NBER Working Paper No. 493.

Fama, E. 1984. "Forward and Spot Exchange Rates." *Journal of Monetary Economics* 14 (3): 319–38.

Faruqee, H. 1995. "Long-Run Determinants of the Real Exchange Rate: A Stock-Flow Perspective." *IMF Staff Papers* 42 (3): 80–107.

Froot, K. and R. Thaler. 1990. "Foreign Exchange." *Journal of Economic Perspectives* 4 (3): 179–92.

Gagnon, J. 1996. "Net Foreign Assets and Equilibrium Exchange Rates: Panel Evidence." International Finance Discussion Paper No. 574. Washington: Board of Governors of the Federal Reserve System.

Gagnon, J. and A. Chaboud. 2007. "What Can the Data Tell Us about Carry Trades in Japanese Yen?" International Finance Discussion Paper No. 899. Washington: Board of Governors of the Financial Reserve System.

Galati, G., A. Heath, and P. McGuire. 2007. "Evidence of Carry Trade Activity." *BIS Quarterly Review* (September): 27–41.

Harvey, C. 1991. "The World Price of Covariance Risk." *Journal of Finance* 46 (1): 111–57.

Hsieh, D. 1982. "The Determination of the Real Exchange Rate: The Productivity Approach." *Journal of International Economics* 12 (3–4): 355–62.

International Monetary Fund. 2005. "Chapter IV. Home Bias in Japan." In *Japan: Selected Issues 2005*.

_____. 2006. "Methodology for CGER Exchange Rate Assessments."

_____. 2007a. "Japan: 2007 Article IV Consultation."

_____. 2007b. "Japan: Selected Issues 2007."

Jen, S. 2006. "Declining 'Home Bias' and the Japanese Yen." *Morgan Stanley Research Global.*

Jen, S., L. Bindelli, and C. St-Arnaud. 2007. "Further Thoughts on the JPY Carry Trades." *Morgan Stanley Research Global*.

Lane, P. and G. Milesi-Ferretti. 2000. "The Transfer Problem Revisited: Net Foreign Assets and Real Exchange Rates." Centre for Economic Policy Research Discussion Paper No. 2511.

_____. 2002. "External Wealth, the Trade Balance, and the Real Exchange Rate." IMF Working Paper No. 02/51.

Lewis, K. 1999. "Trying to Explain Home Bias in Equities and Consumption." *Journal of Economic Literature* 37 (2): 571–608.

Marston, R. 1987. "Real Exchange Rates and Productivity Growth in the United States and Japan." In *Real-Financial Linkages Among Open Economies,* 71–96, edited by S. Arndt and J.D. Richardson. Cambridge, MA: MIT Press.

Mogford C. and D. Pain. 2006. "The Information Content of Aggregate Data on Financial Futures Positions." In *Bank of England Quarterly Bulletin* 46 (1): 57–65.

Ostry, J. 1994. "Government Purchases and Relative Prices in a Two-Country World." *Economic Record* 70 (209): 149–61.

Rogoff, K. 1996. "The Purchasing Power Parity Puzzle." *Journal of Economic Literature* 34 (2): 647–68.

Solnik, B. 1974. "An Equilibrium Model of the International Capital Market." *Journal of Economic Theory* 8 (4): 500–24.

Standard & Poor's. 2006. *Global Stock Markets Factbook.* New York, NY: McGraw-Hill.

Tesar, L. and I. Werner. 1995. "Home Bias and High Turnover." *Journal of International Money and Finance* 14 (4): 467–92.

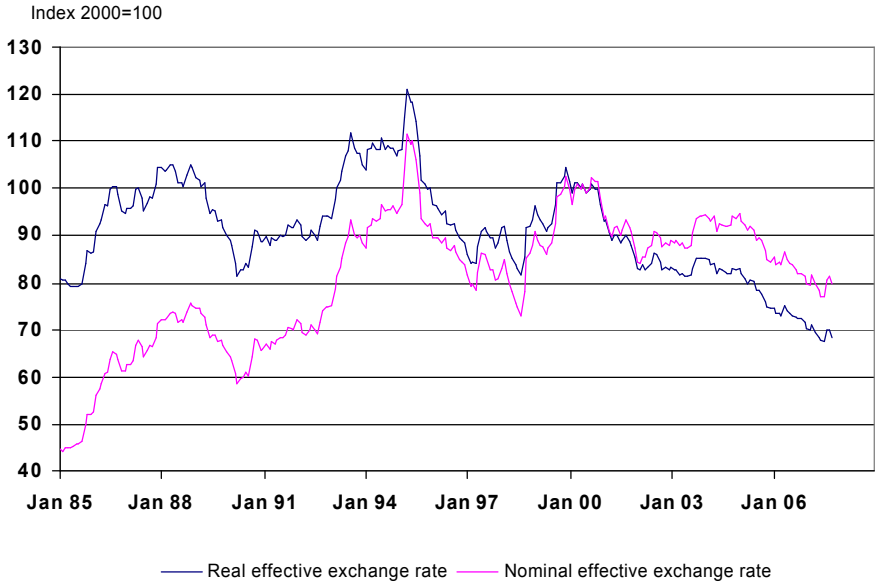
Tille, C., N. Stoffels, and O. Gorbachev. 2001. "To What Extent Does Productivity Drive the Dollar?" *Federal Reserve Bank of New York Current Issues in Economics and Finance* 7 (8).

**Table 1**
**Movements in the Yen Exchange Rate and Interest Rate Differentials**

| | Period | Mean interest rate differential ($i^{f}$-$i^{Japan}$) | Mean monthly year-over-year depreciation of the yen (in per cent) | Correlation between the nominal depreciation of the yen and interest rate differentials |
|---|---|---|---|---|
| Yen/U.S. dollar | 1995–2002 | 4.92 | 3.30 | -0.13 |
| | 2002–Aug 2007 | 2.72 | -0.11 | 0.12 |
| Yen/pound | 1995–2002 | 5.59 | 2.50 | 0.60* |
| | 2002–Aug 2007 | 4.31 | 5.32 | 0.76* |
| Yen/Australian dollar | 1995–2002 | 5.45 | -1.54 | -0.02 |
| | 2002–Aug 2007 | 5.23 | 7.81 | 0.88* |
| Yen/New Zealand dollar | 1995–2002 | 6.57 | -1.36 | 0.47* |
| | 2002–Aug 2007 | 6.24 | 9.58 | 0.79* |

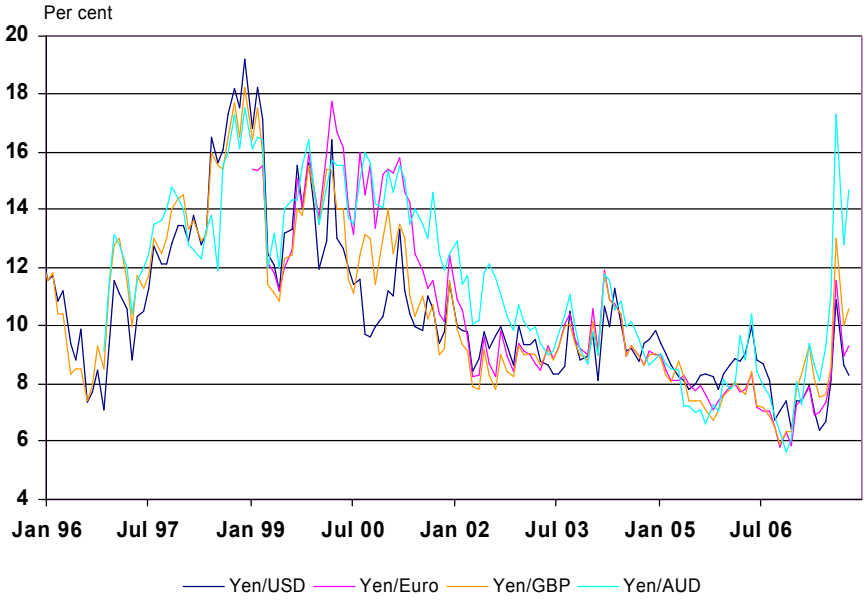
* Significantly correlated at the 1 per cent level. A correlation coefficient without an asterisk is insignificant.
NB: 'f' refers to the foreign country relative to Japan.
Source: BIS, Bank of Canada staff calculations

## Chart 1
## Yen Real and Nominal Effective Exchange Rates



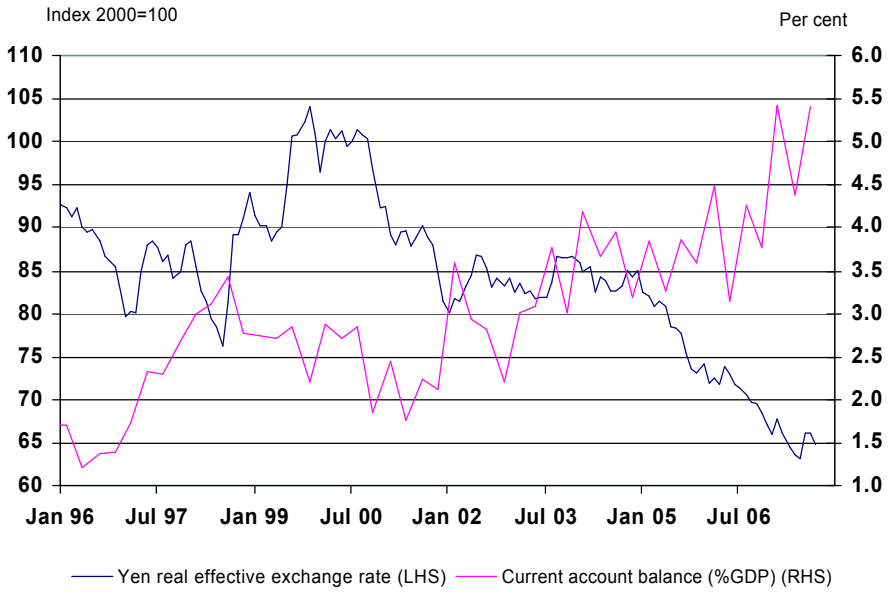

(+) appreciation, (-) depreciation
Source: JPMorgan

## Chart 2
## Implied Volatility of Yen 3-Month Exchange Rate



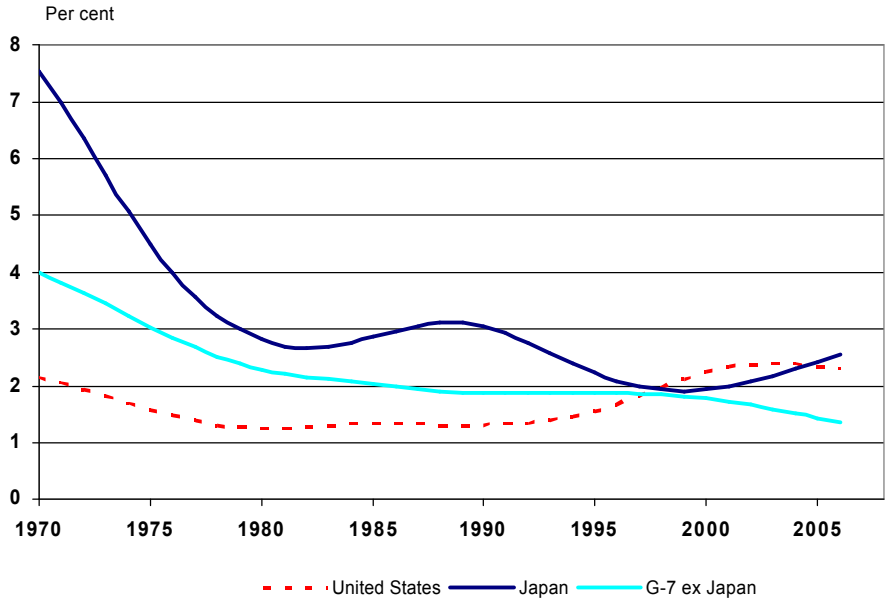

Source: Reuters

## Chart 3
## Japan's Real Effective Exchange Rate and the Current Account



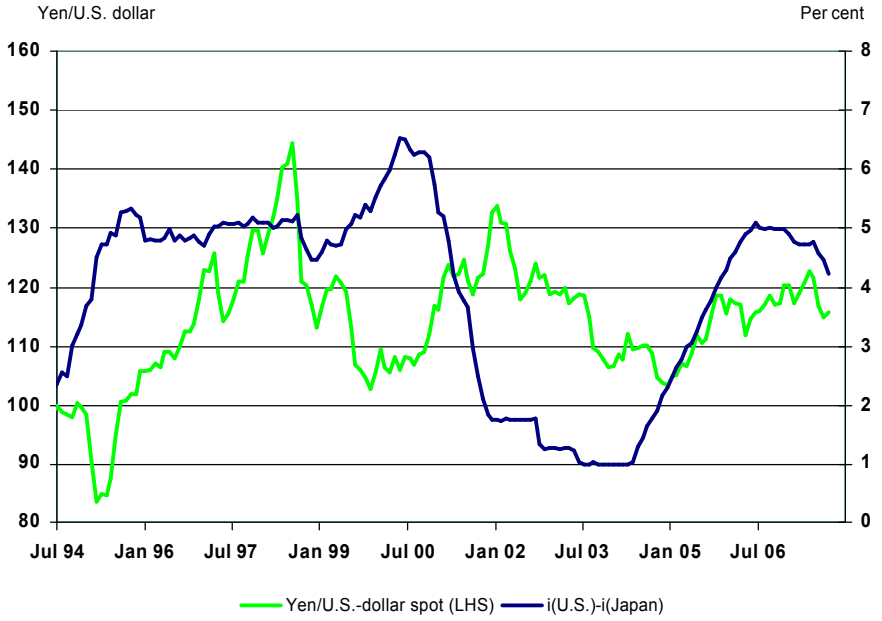

(+) appreciation, (-) depreciation
Source: BIS, Bank of Japan

## Chart 4
## Trend Labour Productivity Growth



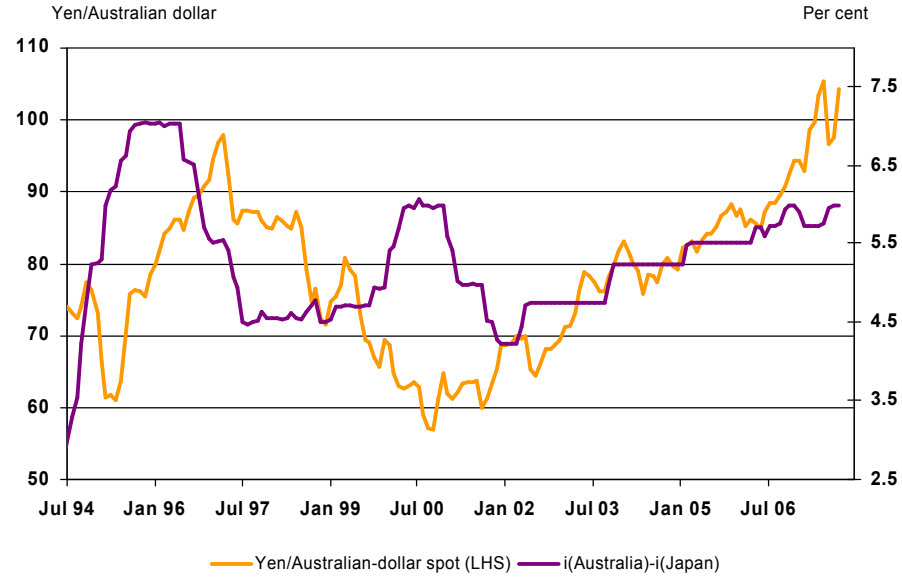

Note: Labour productivity growth is defined as the annual change in real GDP per hour worked, and the trend is estimated using a Hodrick-Prescott filter, as in Amiti and Stiroh (2007).
Source: The Conference Board and Groningen Growth and Development Centre, Total Economy Database, January 2007, <http://www.ggdc.net> and Bank of Canada staff calculations.

## Chart 5
## Interest Rate Differentials and the Bilateral Exchange Rate with the United States



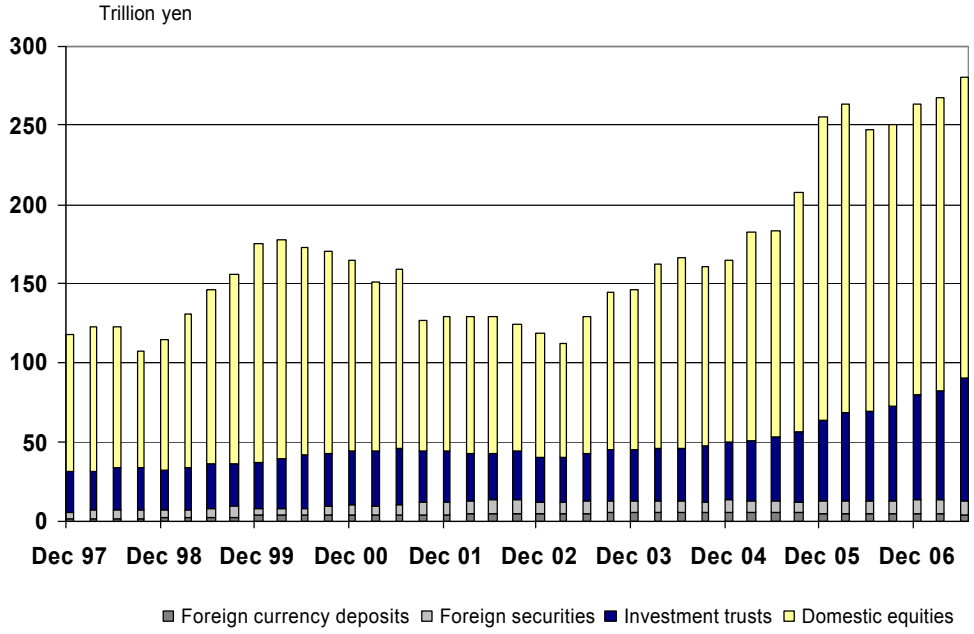

(+) depreciation, (-) appreciation
Source: BIS

## Chart 6
## Interest Rate Differentials and the Bilateral Exchange Rate with Australia



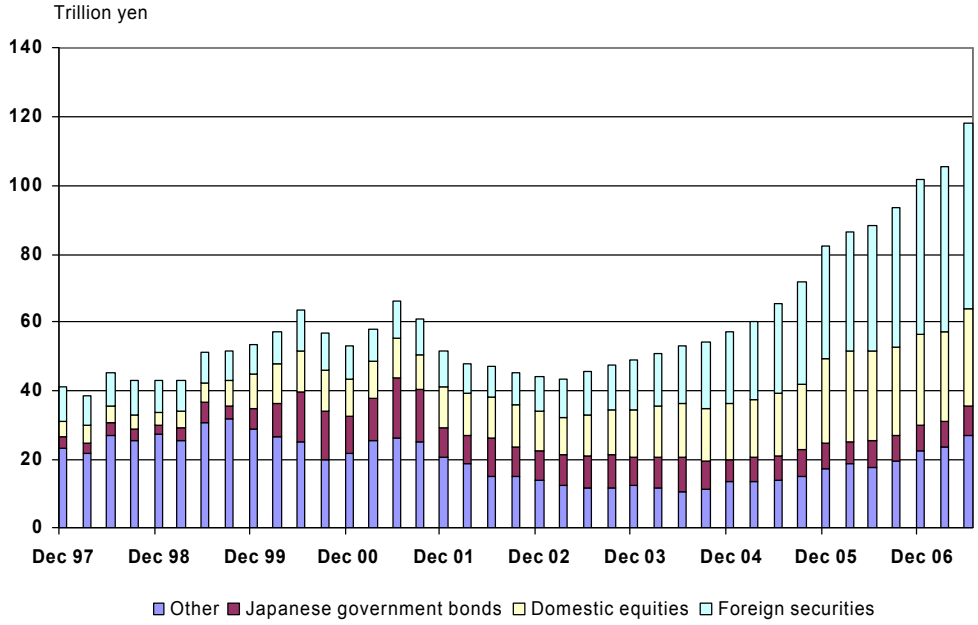

(+) depreciation, (-) appreciation
Source: BIS

## Chart 7
## Households' Holdings of Risk-Bearing Assets



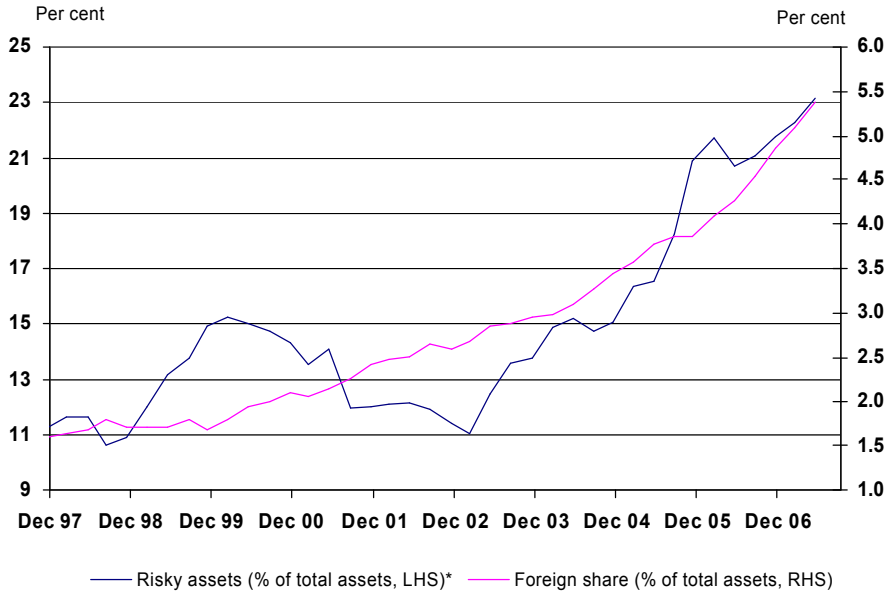

Source: Bank of Japan, Bank of Canada staff calculations

## Chart 8
## Components of Japanese Investment Trusts



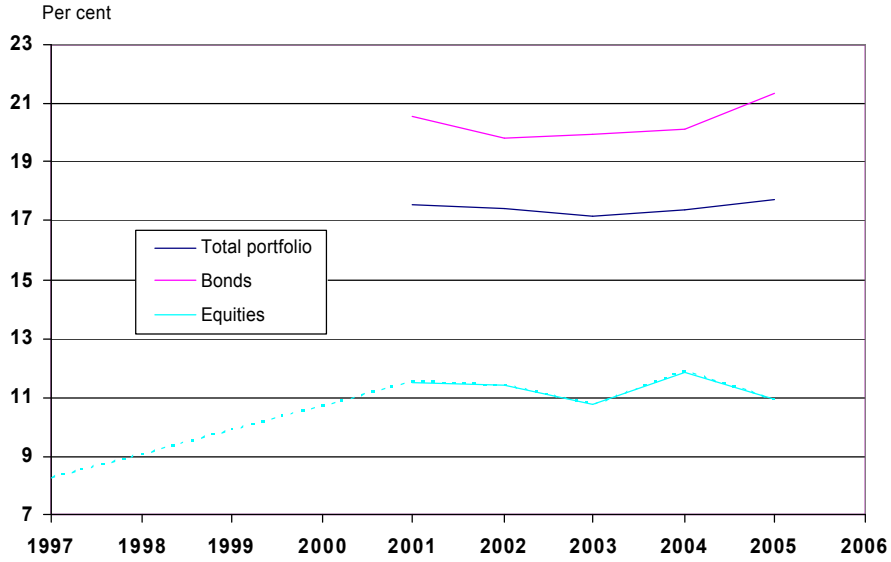

Source: Bank of Japan

## Chart 9
## Portfolio Allocation of Japanese Households



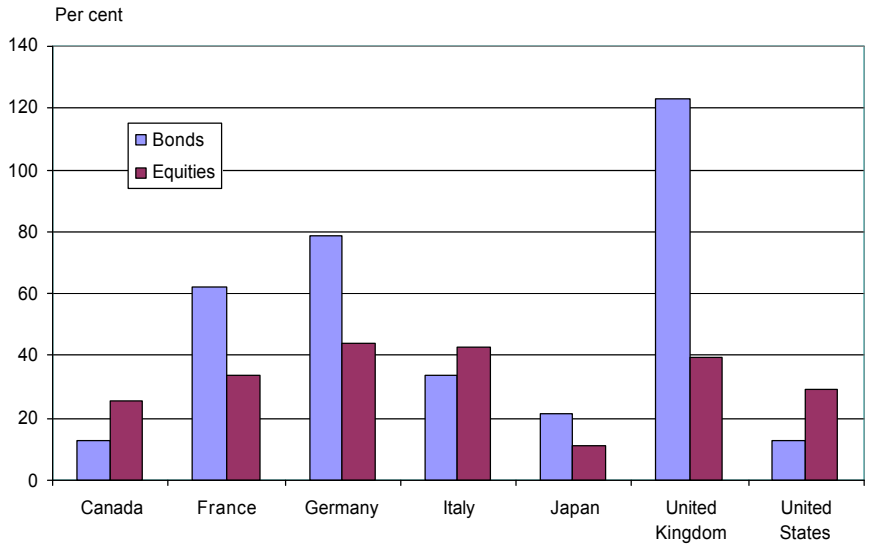

* Risky assets are composed of domestic equities, investment trusts, foreign securities, and foreign security deposits.
Source: Bank of Japan, Bank of Canada staff calculations

## Chart 10
## Foreign Asset Acceptance Ratios (FAAR) by Instrument in Japan



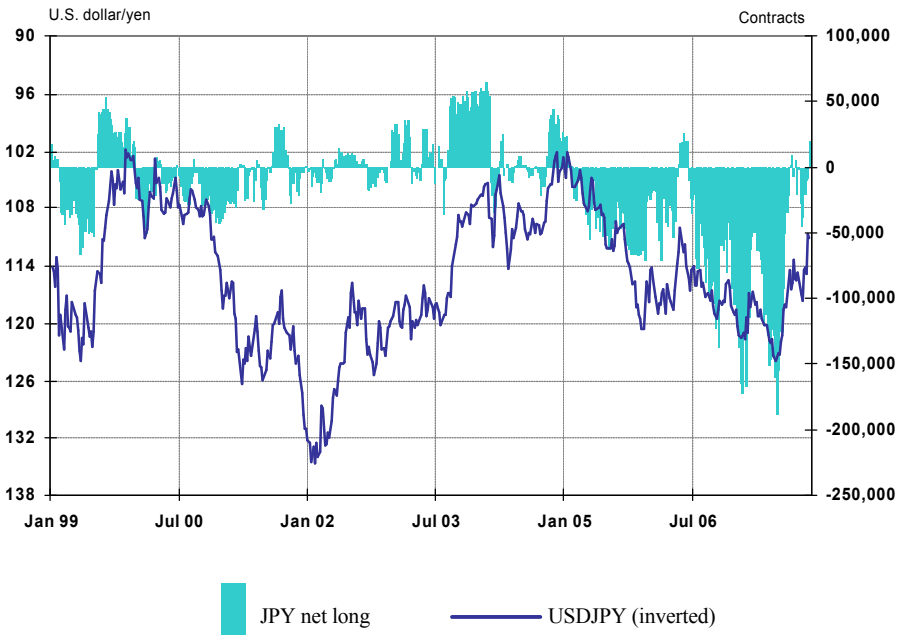

Note: FAAR = [(foreign assets held by domestic residents)/(domestic market capitalization + foreign assets held by domestic residents – domestic assets held by foreign residents)]/[(world market capitalization – domestic market capitalization)/(world market capitalization)], as in IMF (2005).
Source: Standard & Poor's (2006), IMF CPIS, BIS

## Chart 11
## Foreign Asset Acceptance Ratios (FAAR) for Various Countries in 2005



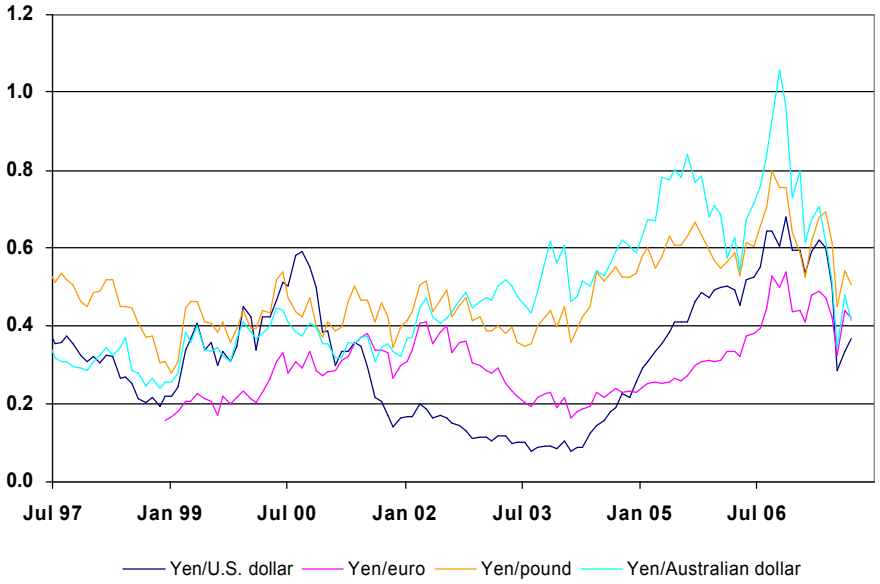

Note: International financial centres' holdings of foreign assets may be overestimated (such as the U.K.) due to the fact that they often hold foreign securities that are owned by non-residents. This results in an overestimation of the amount of foreign assets that are in fact owned by residents of these financial centres. Due to a lack of available data for the countries under consideration, it is difficult to correct for such discrepancies. Other estimates for the U.K.'s bond FAAR is in the range of 70–80 per cent, which is consistent with the view that the U.K. has much less home bias in bond investment than other industrialized countries.
Source: Standard & Poor's (2006), IMF CPIS, BIS

## Chart 12
## Net Speculative IMM Positions in the U.S. Dollar/Yen



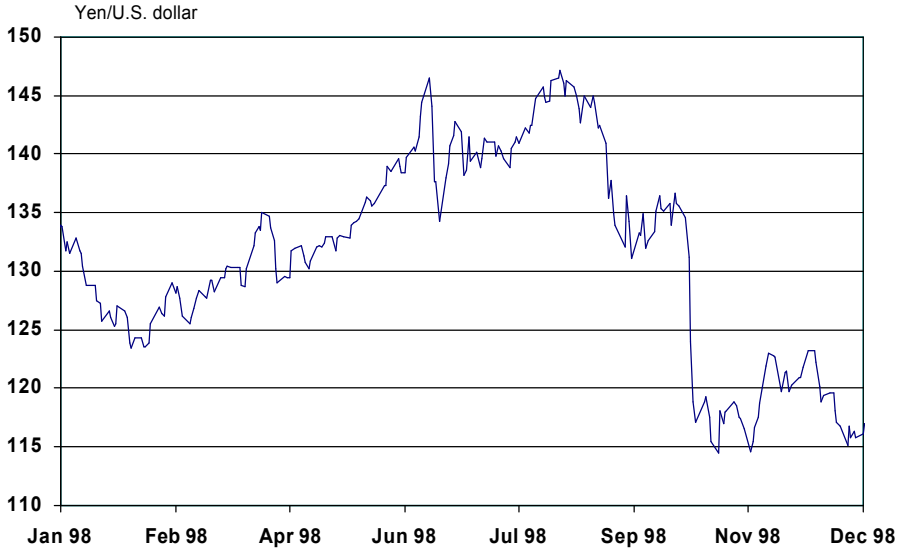

(+) appreciation, (-) depreciation
Source: Bloomberg

## Chart 13
## Carry-to-Risk Ratios




Note: Carry-to-risk ratios are defined as the 3-month interest rate differential between the foreign interest rate and the Japanese interest rate divided by the implied volatility of the respective bilateral exchange rate.
Source: Reuters, BIS, Bank of Canada staff calculations

## Chart 14
## Yen/U.S.-Dollar Spot in 1998




Source: BIS

# Appendix A: The Forward Premium Puzzle

For carry trades to be profitable, the interest rate differential obtained from investing in the higher-yielding currency must outweigh any expected exchange rate movement that could reduce these gains. According to the theory of uncovered interest rate parity (UIP), these excess returns obtained from investing in the higher-yielding currency should equal the expected rate of its depreciation, leaving no expected excess returns from engaging in carry trades. Extensive research has shown that, at least in the short run, the lower-yielding currency has been expected to depreciate (rather than appreciate) relative to the higher-yielding currency, further adding to the returns from carry trade strategies.[1] This appendix provides evidence that this necessary condition for carry trade profitability (the expected failure of UIP) may hold in the near term, so these speculative strategies may be profitable over this horizon. In the case of Japan, the capital outflows driven by the carry trade have likely delayed the adjustment of the yen to a more appreciated long-run value.

To show that UIP fails in the case of Japan, as it does in most countries, one can regress the change in exchange rates over *k* periods on the corresponding *k* period interest rate differential, or equivalently the *k* period forward premium.[2] By running the following regression, one can show that UIP fails by observing a value for $\beta$ that is statistically different from 1, at least in the short run:

$$\left(\frac{S_{t+k} - S_t}{S_t}\right) = a + b\left(\frac{F_t^k - S_t}{S_t}\right) + e_{t+k}. \qquad \text{(A1)}$$

Results for the yen/U.S.-dollar exchange rate are reported in Table A1.

1. See, for example, Fama (1984); Bilson (1981); Froot and Thaler (1990).
2. This replacement is valid because the forward premium of one currency equals the interest rate differential between them, which is an arbitrage condition used in foreign exchange markets to set forward rates. Therefore, on average, this condition can be expected to hold. This relationship is known as covered interest parity (CIP) and this replacement will be used because data are more readily available.

**Table A1**
**Japan UIP Regressions (Bilateral Rates with the United States)**

| *k* | Dates | *a* | *b* | $R^2$ | Obs. |
|---|---|---|---|---|---|
| 1-month regression | 1978-2007 | -0.008<br>(0.001)* | -2.28<br>(0.231) | 0.025 | 3766 |
| | 1978-1990 | -0.016<br>(0.002) | -3.535<br>(0.339) | 0.067 | 1527 |
| | 1990-2000 | -0.004<br>(0.001) | -1.069<br>(0.445) | 0.005 | 1283 |
| | 1990-1997** | -0.005<br>(0.001) | -2.496<br>(0.512) | 0.025 | 893 |
| | 2000-2007 | -0.006<br>(0.002) | -2.889<br>(0.541) | 0.029 | 956 |
| 3-month regression | 1978-2007 | -2.727<br>(0.288) | -2.684<br>(0.286) | 0.016 | 5409 |
| | 1978-1990 | -3.585<br>(0.438) | -3.525<br>(0.434) | 0.028 | 2285 |
| | 1990-2000 | -2.205<br>(0.481) | -2.168<br>(0.477) | 0.011 | 1891 |
| | 1990-1997** | -3.512<br>(0.630) | -3.475<br>(0.627) | 0.023 | 1332 |
| | 2000-2007 | -2.977<br>(0.802) | -2.941<br>(0.796) | 0.011 | 1233 |
| 6-month regression | 1978-2007 | -0.057<br>(0.002) | -2.923<br>(0.097) | 0.152 | 5073 |
| | 1978-1990 | -0.100<br>(0.004) | -4.230<br>(0.163) | 0.242 | 2110 |
| | 1990-2000 | -0.040<br>(0.003) | -2.073<br>(0.162) | 0.086 | 1757 |
| | 1990-1997** | -0.041<br>(0.003) | -3.294<br>(0.192) | 0.193 | 1236 |
| | 2000-2007 | -0.044<br>(0.003) | -3.444<br>(0.170) | 0.255 | 1206 |

* Standard errors are in parentheses.
** Excludes the Asian financial crisis.

Therefore, not only does the yen violate the UIP condition ($\beta$ is statistically different from 1), but $\beta$ is negative, which is consistent with the literature. This implies that when the yen is low-yielding (as at present) or, similarly, at a forward premium, it tends to depreciate, rather than appreciate as UIP would suggest. Furthermore, at the 6-month horizon, forward premiums (interest rate differentials) explain 15 per cent of the movements in the yen exchange rate.

Burnside et al. (2006) perform the above regression on bilateral exchange rates relative to the pound sterling, and all the industrialized countries examined show evidence of the forward premium puzzle.[3] Furthermore, interest rate differentials (forward premiums) between Japan and the United Kingdom have been associated with larger exchange rate movements in the yen/pound exchange rates than for any other bilateral rates considered.[4] Therefore, UIP appears to fail, at least in the short run, which provides a necessary condition for carry trade profitability. In addition, Burnside et al. (2006) show that the yen's depreciation, while low yielding, is relatively larger than other bilateral exchange rates with the pound, which may provide further incentives for capital outflows beyond pure interest rate differentials. These factors provide a potential rationale behind carry trade positions, which lead to capital outflows from Japan that are likely delaying a yen appreciation.

3. Burnside et al. (2006) do not directly attempt to explain this failure, but rather, they address the characteristics of speculative strategies that exploit this anomaly. Countries included in the study are Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland, and the United States.
4. In particular, a 1 per cent difference between the spot rate and the 3-month forward rate (i.e., the yen at a forward premium relative to the pound) has been associated (ex post) with a 4.5 per cent depreciation of the yen (against the pound), on average, over the 3-month horizon.