

NBER WORKING PAPER SERIES

TIME OF TROUBLES:
THE YEN AND JAPAN'S ECONOMY, 1985-2008

Maurice Obstfeld

Working Paper 14816
<http://www.nber.org/papers/w14816>

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2009

Prepared for the ESRI/Chicago GSB/Columbia Business School Conference on “Japan’s Bubble, Deflation, and Long-Term Stagnation,” Federal Reserve Bank of San Francisco, December 11-12, 2008. I thank Thomas Becker, Gabriel Chodorow-Reich, and Matteo Maggiori for excellent research assistance. The paper has benefited from the helpful suggestions of Mick Devereux, Kyoji Fukao, Linda Goldberg, Koichi Hamada, Takatoshi Ito, Anil Kashyap, Jaewoo Lee, Masao Ogaki, David Weinstein, and participants at the March 2008 Columbia University pre-workshop on “Japan’s Bubble,” the follow-up December 2008 San Francisco Federal Reserve conference, and the November 2008 Swiss National Bank/IMF conference on exchange rates, held in Zürich. Research support has been provided by the Class of 1958 chair and by the Coleman Fung Risk Management Research Center, both at UC Berkeley. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2009 by Maurice Obstfeld. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

Time of Troubles: The Yen and Japan's Economy, 1985-2008
Maurice Obstfeld
NBER Working Paper No. 14816
March 2009
JEL No. F14,F41,F42,F51,N15

ABSTRACT

This paper explores the links between macroeconomic developments, especially monetary policy, and the exchange rate during the period of Japan's bubble economy and subsequent stagnation. The yen experienced epic gyrations over that period, starting with its rapid ascent after the March 1985 Plaza Accord of major industrial countries. Two distinct periods of endaka fukyo, or recession induced by a strong yen, occurred in the late 1980s and the early 1990s at critical phases of the monetary policy cycle. My approach emphasizes the interaction of short-term developments driven by monetary factors (as they affect international real interest rate differentials) and the long-term determinants of the real exchange rate's equilibrium path. Chief among those long-run determinants are relative sectoral productivity levels and the terms of trade, including the price of oil. Since the mid-1990s, the yen's real exchange rate has generally followed a depreciating trend and Japan's comprehensive terms of trade have deteriorated.

Maurice Obstfeld
Department of Economics
University of California, Berkeley
508-1 Evans Hall #3880
Berkeley, CA 94720-3880
and NBER
obstfeld@econ.berkeley.edu

Introduction

In the late 1980s, Japan's economy embarked on a period of rapid escalation in the prices of shares and real estate. This "bubble economy" was followed by a collapse in asset values, a reduced pace of real economic growth, banking problems, and deflation. Nearly two decades after the demise of the bubble economy, the prognosis for Japanese growth is again bleak amid a turbulent global economic outlook. Japan's experience carries lessons for those hoping to understand and contain the 2007-09 financial crisis originating in the United States housing and financial markets.

Some observers of Japan blame its monetary policy for failing to react promptly and aggressively enough, both as asset prices exploded upward in the late 1980s and as they plummeted afterward. In these accounts, official concerns about the yen's foreign exchange rate and the competitiveness of the export sector were significant considerations for monetary policy. Indeed, the yen has experienced epic gyrations since the mid-1980s, starting with its rapid ascent after the March 1985 Plaza Accord of major industrial countries. Two distinct periods of *endaka fukyo*, or recession induced by a strong yen, occurred in the late 1980s and the early 1990s at critical phases of the monetary policy cycle. In general, Japan's real economic growth rate is rather strongly negatively correlated with the level of the yen's real effective exchange rate, as illustrated in Figure 1. Over 1978-2007, the correlation coefficient between the real exchange rate and real GDP growth is -0.38 .

Yet the determinants of the yen's short- and even longer-term movements remain mysterious in light of the development of Japan's macro economy. What factors, for example, can explain the yen's steady and dramatic appreciation against the dollar over

the early 1990s as Japan's real economy and its financial system deteriorated? In their prominent study of the Japanese economy through 1997, McKinnon and Ohno (1997, p. 2) go so far as to "treat the course of the yen-dollar exchange rate as a forcing variable for Japanese monetary policy, rather than assuming that monetary policy independently determines the exchange rate." While the U.S.-Japan trade tensions that McKinnon and Ohno view as the underlying determinant of yen/dollar movements undoubtedly influenced market expectations, their vision of yen fluctuations that are largely exogenous with respect to macro policies begs the question of how policymakers were able to direct market-determined exchange rates toward politically expedient levels.¹

This paper explores the links between macroeconomic developments, especially monetary policy, and the exchange rate during the period of Japan's bubble economy and subsequent stagnation. My approach emphasizes the interaction of short-term developments driven by monetary factors (as they affect international real interest rate differentials) and the longer-term determinants of the real exchange rate's equilibrium path. While I believe this approach to be fruitful, it raises further questions for future research as I describe below. Hopefully this exploration will nonetheless throw light on the general question of how major currency misalignments emerge and recede. The narrative focuses on how monetary and goods-market factors interacted with the exchange rate, but there is no doubt that the health of Japan's financial system was a critically important growth determinant during this period, in part through its effect on the monetary transmission mechanism.

¹ As McKinnon and Ohno (1997) express their thesis elsewhere, "The erratically appreciating yen has been an independent (or exogenous) source of disturbance. And since 1984, at least, it has imposed undue deflation on the Japanese economy" (p. 199).

The paper begins by reviewing the broad outlines of Japan's monetary policy experience and the yen's exchange-market behavior since the Plaza agreement of 1985.² The paper then sets out a simple framework relating real interest differentials to the exchange rate, and uses it to explore the role of monetary policies.

In the paper's second half I focus on the longer-term determination of the real exchange rate, which informs the exchange rate forecasts underlying international real interest rate differentials. Specifically, I consider the evolution of the yen's real exchange rate with reference to international and intersectoral productivity growth gaps, as posited by the Harrod-Balassa-Samuelson (HBS) model, and fluctuations in relative international prices for traded goods, including energy.

The rationale for carefully analyzing the benchmark is that real appreciations in accord with the HBS prediction – those driven by relatively high productivity growth in export and import competing industries – should not entail lower profitability in the manufacture of tradable Japanese goods. The analysis shows, however, that yen real exchange rate movements against the United States dollar are not closely related to HBS factors over any reasonable medium term, and in fact are negatively correlated on a year-to-year basis. Furthermore, year-to-year real yen depreciations are positively correlated with gains in competitiveness by Japanese exporters. (There is somewhat more evidence of a role for HBS factors against some nondollar currencies and on an effective basis). An important question is the extent to which sharp exchange rate movements have

² A complementary study exploring this ground is Hamada and Okada (2007). Hamada and Okada sometimes verge on language seeming to imply an exogenous yen real exchange rate, which on their p. 17 they compare to “an outside temperature that Japan faced during these 20 years” Elsewhere, however, they clarify their belief the yen exchange rate has reacted in part to domestic macro policies. Like McKinnon and Ohno they allude to trade conflict (through a theoretical analysis of current account targets), but place little emphasis on it in their detailed policy narrative.

themselves affected productivity levels in Japanese industry. Terms of trade movements, in particular fluctuations in global energy prices, are powerful correlates of changes in the yen's real exchange rate: declines in the terms of trade tend to coincide with real yen depreciation.

Overview of Japan's Monetary Experience

As the United States undertook a program of disinflation and fiscal expansion in the early 1980s, the yen and other world currencies depreciated sharply against the United States dollar. After averaging below 220 yen per dollar over 1978-81 – that level itself a very sharp appreciation relative to the average of 288 over 1974-77 – the yen depreciated to about 250 in 1982, before assuming an average value of around 238 for 1983-85. These annual averages in exchange rates disguise very high intra-year volatility, however.

Between March 1984 and February 1985, for example, the yen depreciated from 225.40 to 260.24 against the dollar, a move of more than 14 percent (in log points). The dollar's renewed strength reinforced trade tensions between the U.S. and its trading partners, and eventually led to the September 1985 Plaza Accord. The U.S. and four major allies – the United Kingdom, France, Germany, and Japan – pledged concerted policy intervention to bring the dollar down.

The aftermath of the Plaza accord saw a dramatic move in the yen's dollar exchange rate, as illustrated in Figure 2. Figure 2 displays the nominal yen/dollar exchange rate, quoted in yen per dollar but on an inverted scale so that a rise in the series is a nominal appreciation in the yen. The figure also plots two indexes of the yen's real

exchange rate on a secondary vertical axis, with a rise in the index being a real yen appreciation. One real exchange rate series is the bilateral rate against the United States dollar, while the second is a trade-weighted multilateral (effective) index. Both of these real exchange rates are computed with respect to consumer price indexes, and they move reasonably closely together most of the time. The real effective CPI rate, in turn, is highly correlated with the real effective rate based on unit labor costs, shown in Figure 1.

Having been around 260 yen per dollar in early 1985, the yen price of dollars had fallen to around 125 by early 1988, an appreciation of roughly 73 percent (in log points) over only three years. In its latter stages, the yen's rise was encouraged by somewhat easier U.S. monetary policy immediately following the October 1987 stock market crash. Estimates such as those reported by Ahearne and others (2002) suggest that Japan's GDP was below potential in 1986 and 1987 as exporters struggled. Very quickly, *enyasu* had become *endaka*.

Japan's policy interest rates, having been raised abruptly late in 1985 to support the Plaza policy, were lowered sharply through 1986 and 1987. (See Figure 3.) From a high point above 8 percent in late 1985, the overnight call money rate fell to just above 3 percent in the first half of 1987.

Early in 1986, the prices of equity and land began to rise appreciably more sharply than in previous years. Although it was not understood at the time, this marked the start of the great Japanese stock market and real estate bubbles. Figure 4 shows the trajectories of land prices in six major cities and of the Nikkei stock-price average. All categories of real estate appreciated, but commercial properties far outpaced industrial and residential real estate, rising in price by more than 75 percent between 1986 and their

1991-92 market peak. In percentage terms, however, the bubble in stock prices was much more extreme. The Nikkei 225 average rose from about 13,000 at the start of 1986 to about 39,000 at the end of 1989, when the bubble peaked. With the benefit hindsight, the steep price increases look wildly unsustainable. Yet the Bank of Japan did not raise interest rates until the bubble was roughly two and a half years old.

Many observers, for example, Okina, Shirakawa, and Shiratsuka (2001), Ahearne and others (2002), Ito and Mishkin (2006), and Hamada and Okada (2007), link the Japanese authorities' policy response to the emerging asset bubble to policy dilemmas embedded in the macro landscape in the late 1980s. With the yen historically strong, output below potential, and inflation therefore quiescent in 1986-88 during this first episode of *endaka fukyo*, there was no appetite to restrict monetary policy in the hope of moderating asset-price inflation. Such action would have risked further yen appreciation, and, as McKinnon and Ohno (1997) argue, the wealth effect of the bubble may have moderated the growth slowdown that otherwise would have occurred. In addition, concurrent trade tensions with the United States discouraged Japanese authorities from contractionary macroeconomic actions that foreigners would perceive as increasing Japan's current account surplus.³ This seems an odd concern, because generally it is a weaker currency, not a stronger one, that inflicts beggar-thy-neighbor trade-volume effects on trade partners. I discuss possible drivers of the yen's exchange rate below.

The period was the first of several episodes in which Japan's macro policies, perhaps lagging "behind the curve," contributed to a sequence of destabilizing exchange rate movements that ultimately worsened the bubble and its aftermath. These episodes

³ See, for example, Okina, Shirakawa, and Shiratsuka (2001, p. 421).

will be discussed in greater detail below. Okina and Shiratsuka (2002, p. 44), suggest that the monetary stance over 1986-88 might have fueled a “euphoric” expectation of “protracted low interest rates.”

Any such expectation was dashed in mid-1989, when the Bank of Japan finally did embark upon a cycle of sharply higher interest rates (see Figure 3). The Nikkei continued to rise through the end of 1989, however, and the yen, which had stopped appreciating in 1988 and then reversed course, depreciated through April 1990. But, with inflation finally on the rise, the policy interest rate was to continue rising for almost a full year, eventually reaching a level of about 8.2 percent (again, see Figure 3). As described by Ito and Mishkin (2006, p. 136), the Japanese government in 1990 began to deploy regulatory and fiscal weapons to counteract the land bubble. Land prices peaked in 1991 and declined relentlessly thereafter. By the end of 1990 the Nikkei stood at only around 23,000 – a 41 percent decline from the stock bubble’s peak. By the summer of 1992 the Nikkei stood at around 16,000.

Real GDP growth, which had proceeded at an average rate of nearly 5.8 percent per year over 1988-90, slowed to 3.3 percent in 1991, to just under 1 percent in 1992, and to 0.2 percent in 1993. It collapsed to –2.4 percent in 1994. From its peak of over 8 percent in the spring of 1991, the overnight call rate if interest fell to slightly over 2 percent by the summer of 1994. Throughout this period, however, the yen appreciated strongly, so the economy was again in the grip of *endaka fukyo*. As output growth slowed and then turned negative, core inflationary pressures subsided, as shown in Figure 5 (which does not adjust the Japanese CPI for two substantial increase in consumption

tax).⁴ Events of this period have sparked debate about whether the Bank of Japan lowered interest rates sufficiently quickly.⁵ I return to discuss the yen's seemingly perverse appreciation, which continued through April 1995, below. Ito and Mishkin (2006, p. 138) state that the damaging appreciation occurred “with no apparent macrofundamental reasons”

In the early 1990s Japan's financial sector came under increasing stress as a result of nonperforming loans, many extended to the construction and real estate sectors that were now suffering the effects of plummeting property values. Falling land and equity prices reduced the collateral available for new loans and tightened liquidity constraints, in a manner that has become all too familiar in recent years. Bank-sponsored mortgage lending companies called *jusen* had helped fuel the land bubble by lending aggressively to finance real estate development projects. They began to suffer in 1991 and after two failed rescue plans the government decided to close them in 1995. As far as the banks themselves were concerned, they too held mortgage loans; but in addition, stocks formed part of their assets, and a hefty percentage of unrealized capital losses counted against regulatory capital. To make matters worse, lightly regulated banks continued to extend credit to basically insolvent borrowers, thereby weakening their own balance sheets through a process of “evergreening.”

Over 1992-95 some smaller institutions began to fail. Banking and credit problems were to escalate over the decade, and became especially acute in the latter

⁴ The tax increases (from 0 to 3 percent and from 3 to 5 percent, respectively) took place on April 1, 1989 and April 1, 1997. The definition of core inflation that I use for Japan, reported by the Ministry of Internal Affairs and Communication, excludes the prices of food (other than alcoholic beverages) and energy.

⁵ See Kuttner and Posen (2001), Mori, Shiratsuka, and Taguchi (2001), Okina and Shiratsuka (2002), and Ito and Mishkin (2006) for alternative views. According to Ito and Mishkin (p. 138), “the BOJ might have underestimated deflationary forces.”

1990s after the outbreak of the Asian emerging-market financial crisis in the summer of 1997. The Ministry of Finance issued a deposit guarantee in 1995, and subsequently injected capital into banks in 1998-99 after the failures of three large Japanese banks, smaller banks, and securities firms starting late in 1997.⁶

The travails of the financial industry in Japan proved to be a serious drag on the economy, especially starting in the late 1990s; conversely, the stagnant economy impeded financial-sector recovery. Evergreening and government guarantees led to the survival of “zombie” firms and financial institutions, the continuing presence of which impeded restructuring and discouraged investment and productivity growth.⁷ Notwithstanding the difficulties the crippled financial system had in channeling credit to productive uses, the government did little to force a restructuring of banks’ balance sheets until late in 2002.

Buttressed in part by the depreciating yen, output growth recovered somewhat between the second half of 1995 and the first quarter of 1997. Core inflation continued slowly to decline (Figure 5). In April 1997 the government implemented two preannounced but contractionary fiscal moves, an increase in the consumption tax from 3 to 5 percent and the withdrawal of a temporary income tax cut. In the second half of the year, the Asian emerging-market financial crisis erupted, contributing to a fall in demand and to the financial instability described earlier.

The yen appreciated in both nominal and real terms between August 1998 and December 1999, a development that placed a further drag on the economy (Figure 2). In

⁶ See Hoshi and Kashyap (2004) for an extensive discussion.

⁷ For a theoretical model and evidence, see Caballero, Hoshi, and Kashyap (2008).

1998 real GDP fell by more than 2 percent, and with core inflation slightly negative by year's end, even the rate of nominal GDP growth was negative for the year.

On April 1, 1998, a new Bank of Japan Law came into effect, changing the de jure institutional balance of power between the central bank and the Ministry of Finance. The BOJ was given goal as well as instrument independence with respect to inflation; its official mandate under the new law was to maintain “price stability” – nowhere defined in the Law – and to share with the government in maintaining financial stability. Among the political factors underlying the grant of independence were the finance ministry's failure effectively to address financial-sector weaknesses and the suspicion that an independent BOJ might have responded more aggressively to the late 1980s asset bubble.⁸

At the time the BOJ became independent, the overnight call interest rate stood at around 40 to 50 basis points and core inflation remained slightly positive. In February 1999 after core inflation had become negative, the BOJ policy board, under Governor Masaru Hayami, lowered the policy interest rate effectively to zero. This action initiated the Zero Interest Rate Policy (ZIRP). But in spite of the economy's continuing weakness, the BOJ policy board, discerning signs of recovery and concerned about negative side-effects from holding interest rates at zero for too long, ended the ZIRP in August 2000 by moving to a policy rate of around 25 basis points.⁹

⁸ See Cargill, Hutchison, and Ito (2000, pp. 91-3).

⁹ In March 2000 Governor Hayami gave an influential speech on “Price Stability and Monetary Policy.” In it he rejected the idea of targeting a substantially positive inflation rate and questioned the controllability of inflation once it had reached a level as high as 2 to 3 percent per year. For discussion see Kuttner and Posen (2001, pp. 120-1).

In retrospect, this move appears to have been ill timed. True, real GDP growth, which had been roughly zero in 1999, registered about 2.8 percent for all of 2000. The economy was hardly in robust condition, however, even though the yen's foreign exchange value had stabilized after the appreciation of 1998-99. More remarkably, core inflation (excluding energy as well as food) had been zero or negative, with a growing deflationary trend, in every single month since September 1998! (See Figure 5.) The BOJ had earlier pledged to maintain the ZIRP "until deflationary concerns subside" (Ito and Mishkin 2006, p. 145). By instead lifting interest rates from zero despite ongoing and even accelerating deflation, the independent BOJ signaled that its discomfort with zero interest rates exceeded its fear of prolonging deflation. The economy deteriorated in the final quarter of 2000. Real GDP grew at rates of only 0.16 percent in 2001 and 0.26 percent in 2002 (Figure 1), and in both years the rate of core consumer price *deflation* was close to 1 percent.

On March 19, 2001, the BOJ again lowered the nominal interest rate, effectively bringing back the ZIRP, and clarified that the ZIRP would be abandoned only after the rate of CPI inflation, excluding fresh food, was "stably" at a positive value. The zero interest rate was to be brought about, however, by excess-reserve targeting – a policy of unconventional, quantitative easing. Originally set at ¥5 trillion (an amount in excess of the then required reserves of ¥4 trillion), the target for bank current accounts with the BOJ was raised to ¥15-20 trillion by the final quarter of 2002 (Ito and Mishkin 2006, pp. 146-7). But deflation continued. There is considerable debate about the effectiveness of the quantitative easing policy. Its success was certainly hampered by the BOJ's resistance to such measures prior to March 2001 and by the impression sometimes conveyed by

Bank officials, even after the policy's adoption, that it was unlikely to succeed. Moreover, the BOJ had signaled a degree of inflation aversion so high as to be inconsistent with a successful quantitative easing strategy.¹⁰ From this perspective, a change in regime at the BOJ probably was a necessary condition for progress in the battle against deflation.

Governor Toshihiko Fukui succeeded Governor Hayami in March 2003; in addition, two new deputy governors arrived, including Kasumasa Iwata, a supporter of inflation targeting. The new management increased the extent of quantitative easing sharply, at the same time clarifying that zero interest would not be abandoned in the future unless inflation was clearly positive. In October 2003, the BOJ announced that “necessary” (but not always sufficient) conditions for raising the interest rate from zero were that core CPI inflation be above zero “over a few months,” and that the Bank be convinced “that the prospective core CPI will not be expected to register below zero percent.”¹¹

These measures may have been helpful in clarifying the intention of monetary policymakers to indeed keep the policy interest rate at its lower bound until deflation had been decisively vanquished; that is, the intention not to withdraw monetary stimulus when the inflation rate was still nonpositive. In addition, some observers place considerable weight on a Ministry of Finance program of massive dollar purchases over 2003-04, which may have choked off another damaging yen appreciation cycle (see Hamada and Okada 2007, and the discussion below). Yet a third factor helping the

¹⁰ For a discussion of the issues, see Auerbach and Obstfeld (2005). It is certainly true that under quantitative easing, the increase in broad monetary aggregates was not nearly commensurate with the increase in the monetary base, nor did the additional liquidity lead still-troubled banks to extend much additional credit.

economy was the government effort led by economy and financial services minister Heizo Takenaka to curb regulatory forbearance and resolve the bad-loans problem of the banks. Prime Minister Junichiro Koizumi appointed Takenaka to head the financial services ministry in September 2002. Key subsequent events included the pre-emptive recapitalization and restructuring plan for Resona Bank in the spring of 2003, which arguably stabilized expectations of lending risk, as well as Takenaka's insistence on a timetable for other banks to dispose of nonperforming loans. Over 2004-07, the rate of real GDP growth was much more stable and averaged around 2.25 percent per year.

Deflation, measured by a core CPI excluding energy as well as food, decelerated but did not disappear completely over these years. In March 2006, however, the BOJ policy board took a major step toward clarifying its operational understanding of "price stability" – a clarification that, for the first time, specified at positive inflation as possibly consistent with the BOJ's goals. The minutes of the March 8-9, 2006 meeting state that "It was agreed that, by making use of the rate of year-on-year change in the consumer price index to describe the understanding, an approximate range between zero and two percent was generally consistent with the distribution of each Board member's understanding of medium- to long-term price stability."¹²

Notwithstanding the (at best) ambiguous evidence that deflation had receded, the BOJ, in July 2006 raised its lending rate to 0.25 percent. This was the end of the ZIRP. The rate was raised further, to 50 basis points, in March 2007 before being cut again in 2008 as the global financial crisis intensified, The BOJ cited improving economic activity levels and hinted that it would foster an "accommodative" environment by maintaining

¹¹ Ito and Mishkin (2006, p. 151).

¹² Bank of Japan (2006, p. 61).

rates at low positive levels for some time. Nonetheless, the move was controversial, with Prime Minister Koizumi, for one, arguing that the end of deflation was near but not yet fully achieved. As in previous episodes (see Cargill, Hutchison, and Ito 2000, p. 173), one motivation for the BOJ's action seems to have been a desire to underscore its independence. As one press account put it, "Yesterday's rate rise was the end of a prolonged bout of shadow boxing between government ministers, who believed a rate rise would dent the recovery, and the BoJ, which wanted to raise rates to demonstrate its independence and show it was able to take pre-emptive action."¹³

Even if Japan was truly at the end of its period of stagnation in 2006, its economy was overtaken by the events of 2007-09. With global financial markets in turmoil and Governor Fukui's five-year term coming to a close early in 2008, the Japanese government and the upper house of the Diet found themselves deadlocked over the choice of a successor. The parliamentary opposition argued that the government's initial nominees would compromise BOJ independence. In March, the two sides agreed to appoint as governor Masaki Shirakawa of the BOJ, who had initially been nominated along with Takatoshi Ito, a vocal proponent of inflation targeting, to be one of two deputy governors. Ito was a casualty of the political wrangling. Japan's financial sector, unlike those in the United States and Europe, was fortunately minimally exposed to subprime products. But as the word financial crisis intensified, the yen assumed the role of safe-haven currency, appreciating multilaterally and bilaterally against the dollar. In 2008,

¹³ See "Bank of Japan acts to end its era of zero interest rates," *The Independent*, July 15, 2006, at: <http://www.independent.co.uk/news/business/news/bank-of-japan-acts-to-end-its-era-of-zero-interest-rates-408064.html>

Japan suffered the dual blows of falling export demand and an asset-market driven appreciation. These both put renewed downward pressure on the price level.

Real Interest Differentials, Natural Real Rates, and the Real Exchange Rate

The open or uncovered interest rate parity theory of the exchange rate predicts that any nominal interest differential between currencies must be offset by expected depreciation of the high-interest currency against the low-interest currency. A corollary, derived by subtracting the expected inflation difference from both sides of the preceding relationship, is that expected *real* interest differentials are offset by expected movements in *real* exchange rates. These predictions have received quite limited support from the empirical record of the modern floating exchange rate era. I will nonetheless rely upon interest parity as a basic framework for thinking about the link between monetary policy and the yen. Why could this be a reasonable approach? There are three reasons:

1. Some framework is essential, and our knowledge of risk premia is rudimentary at best. It thus seems prudent to start with the simplest framework, even if it does not fit the data exactly, and then, if necessary, add additional conjectural factors such as risk premia.
2. If risk premia or other deviations from interest parity move slowly over time, a first-differenced relationship could be useful even if level deviations from interest parity are significant.

3. My focus will be on long-horizon interest parity, and the evidence (partial as it is) suggests that interest parity may hold more closely for long-term interest rates (see, for example, Alexius and Sellin 2002; Chinn 2006).

Modern discussions of monetary transmission – echoing the classic insights of Wicksell more than a century ago – stress the link between the real interest rate implied by the monetary policy stance and the natural, market-clearing real interest rate. The interest-parity relation suggests, moreover, that relative international discrepancies between natural and market real interest rates have consequences for real exchange rates. Thus, the interest-parity relationship, once reinterpreted, is a natural vehicle for linking the expansiveness or restrictiveness of monetary policy to the exchange rate. This approach is most likely to be informative when applied to long-term interest-parity,

If r_t is the long-term real rate of interest at home, r_t^* the long-term real rate abroad, and q_t the real exchange rate (defined as the domestic consumption cost of foreign consumption), then if \bar{q}_t is the expected long-run real exchange rate as of date t , the (open) interest-parity condition is

$$r_t - r_t^* = \bar{q}_t - q_t. \quad (1)$$

Observe that in this notation, a rise in q is a real depreciation of the domestic currency. A rise in $r_t - r_t^*$, holding \bar{q}_t constant, elicits a real domestic appreciation. The convention I am following – in which a rise in q is a real depreciation – is opposite to the one typically used for real exchange rate indexes such as those in Figure 2, which are meant to measure the real external values of currencies. Notice that for the sake of easier visual

interpretation in Figures 2, 6, and 7, I measured even the bilateral dollar-yen real exchange rate so that an increase is a real yen appreciation, contrary to the convention in equation (1).

Let a tilde over a variable denote its “natural” level: the level consistent with market clearing in a flexible-price world. In particular, \tilde{q}_t denotes the flex-price equilibrium real exchange rate and, \bar{q}_t denotes the expected long-run “natural” real exchange rate, which – importantly – coincides with \bar{q}_t . In the flex-price equilibrium the analog of eq. (1) holds:

$$\tilde{r}_t - \tilde{r}_t^* = \bar{q}_t - \tilde{q}_t. \quad (2)$$

By subtracting (2) from (1), we obtain a simple relationship that ties the current deviation of the real exchange rate from its flex-price level to the relative expansiveness of domestic monetary policy, as represented by deviations of market from natural long-term real rates of interest:

$$q_t = \tilde{q}_t + (r_t^* - \tilde{r}_t^*) - (r_t - \tilde{r}_t). \quad (3)$$

If the domestic real rate of interest rises relative to its natural level, for example, then the domestic currency will appreciate in real terms relative to its own full-employment level (everything else equal). For example, a decline in economic growth prospects would naturally be associated with a fall in the natural long-term real interest rate, \tilde{r}_t , but if monetary policy is expected to remain restrictive over the medium term, the result could well be a real currency appreciation and recession.

Of course, equation (1) by itself also has implications for the real exchange rate. Rewrite (1) as

$$q_t = \bar{q}_t - (r_t - r_t^*).$$

This relationship implies that if changes in the expected long-run real exchange rate \bar{q}_t are small and if risk premia changes are excluded, the currency will appreciate in real terms when the domestic-foreign real interest differential rises. This pattern is most likely when the main shocks hitting the economy are monetary, for pure monetary shocks do not alter the long-run real exchange rate. In reality, the implied relation between current real exchange rates and real interest differentials seems to be rather loose for most currencies. In the Japanese case, however, I will argue that monetary shocks were important and do provide some traction for understanding exchange rate movements. This approach still leaves most of short-term exchange rate movements unexplained, of course, so it is important to keep in mind that expected real interest rates are measured with some error (due to the use of inflation-expectations proxies), that variable risk premia indeed are relevant, and that changes in expectations of long-run real exchange rates are likely to have occurred at various points. An advantage of formulation (3) is that it may be more robust than (1) to the presence of risk premia, but on the other hand, empirical implementation of (3) requires assumptions on the “natural” levels of real interest rates and exchange rates.

Figure 6 displays the monthly time series of Japan less United States real interest differentials and the real yen/dollar exchange rate index, calculated on the basis of CPIs (with an upward move in the exchange rate index being a real yen appreciation). The real interest rate is calculated as the 10-year government bond rate less the centered twelve-month ex post inflation rate.

For the period from June 1980 to July 2008, the correlation coefficient between the real interest differential and the log real exchange rate is +0.45. Evidently real interest differentials do not explain everything, but they are surprisingly highly correlated with real yen/dollar movements, and in the direction that a simplified interest parity theory would suggest.¹⁴ Figure 7 parallels Figure 6 with a comparison of Japanese and German real interest differentials. There are clearly periods of medium-term comovement between the Japan-Germany real exchange rate and the corresponding real interest differential, but in the case shown in Figure 7, the short-term correlation is far below that in Figure 6, and is in fact negative (-0.11). In both figures there is a real depreciation in the 2000s beyond what real interest differentials would predict, perhaps reflecting revisions in expectations of the long-run real exchange rate.

Patterns in Nominal and Yen Real Exchange Rates since 1988

Figure 2 shows that, as far as the nominal exchange rate is concerned, the yen depreciated after late 1988 through April 1990, then embarking upon a sharp appreciation trajectory that would culminate in a nominal rate near 80 yen per dollar in April 1995. After depreciating again through late 1998, the yen reversed course and appreciated sharply through end-1999. Since then it has remained in a range of roughly 95 to 130 yen per dollar.

¹⁴ The bilateral real exchange rate measure and the Japanese CPI inflation measure used in calculating the real interest rate are adjusted to remove the effects of the consumption tax increases of April 1, 1989 and April 1, 1997.

More relevant for assessing the competitiveness of Japan's exports is the yen's *real* exchange rate, also shown in Figure 2 for the case of consumer-price deflators. The cycles are similar to those for the nominal exchange rate, but some distinct trends are now apparent. Most importantly, after the April 1995 peak for the yen, there is a strong trend of real depreciation, whether the real exchange rate is measured in real effective terms or bilaterally against the dollar. Between April 1995 and mid-2008, the yen depreciated in real effective terms (based on the CPI, as a log difference) by 57 percent. For the bilateral yen/dollar rate, the corresponding real depreciation rate is 60 percent.

Strikingly, the real depreciation trend is driven entirely by the relatively higher inflation rates in Japan's trading partners over a period when Japan at times suffered from outright deflation. The *nominal* exchange rate, in contrast, has remained within a relatively narrow range since around 2000. This unusual pattern – typically observed only in gold standard and other “hard peg” countries painfully unwinding an overvalued currency – is itself symptomatic of Japan's post-bubble stagnation.

Figure 2 suggests that the yen *real* exchange rate's history since 1988 can be divided into (at least) six periods, characterized by the following given changes in the extreme month-average *nominal* exchange rates against the dollar:

1. December 1988–April 1990: Depreciation (123 ¥/\$ – 158 ¥/\$).
2. April 1990–April 1995: Appreciation (158 ¥/\$ – 84 ¥/\$).
3. April 1995–August 1998: Depreciation (84 ¥/\$ – 145 ¥/\$).
4. August 1998–December 1999: Appreciation (145 ¥/\$ – 103¥/\$).
5. December 1999–July 2007: Depreciation (103¥/\$ – 122 ¥/\$).
6. July 2007–December 2008: Appreciation (122 ¥/\$ – 90¥/\$).

Our question is how the cycles and trends in real exchange rates are driven by monetary policy actions as well as by the longer-run evolution of the Japanese economy.

Period 1. After the protracted appreciation period that followed the Plaza agreement, the yen appeared to stabilize early in 1988. Japanese authorities welcomed that development, which boosted the economy. The asset-price boom continued, however, and inflationary forces, which remained muted after a period of yen strength, were in fact gathering (Figure 5). Apparently unwilling to risk renewed appreciation, however, the Japanese authorities did not aggressively raise target interest rates (Figure 3). Inflationary pressures were evident earlier in the United States economy, and the Fed did respond with a series of interest rate hikes starting in the second half of 1988 (Figure 8).¹⁵ The yen started to depreciate late in 1988.

The Bank of Japan began to raise short-term interest rates in mid-1989 (Figure 3). Core inflation was significantly higher by the spring of 1990 – by which time the price-level effects of the April 1989 consumption tax increase are no longer distorting the data in Figure 5. Yen depreciation continued. Even after the stock market peaked early in 1990 and the yen hit bottom in April 1990, and with Japanese and U.S. long-term real interest rates close once again (Figure 6), the BOJ continued to tighten short rates. Around that time Japanese inflation also took a ratchet-step upward.

Why did the yen depreciate through April 1990 and not begin to appreciate sooner after Japanese monetary policy began to tighten? One possibility is that falling Japanese equity prices prompted an international portfolio shift out of yen. It may also be that the

¹⁵ The “Record of Policy Actions of the Federal Open Market Committee,” Meeting of May 17, 1988 (<http://www.federalreserve.gov/monetarypolicy/fomchistorical1988.htm>), noted that “consumer and producer prices have risen more rapidly recently. In addition, labor costs increased substantially in the first quarter.”

markets had some doubts about the willingness of the BOJ, not a formal inflation targeter, to do what was necessary to keep inflation down. As the policy interest rate continued to climb, however, markets became convinced that the BOJ meant to limit inflation. At this point, Japanese long-term real interest rates had generally been above U.S. rates for some time (Figure 6).¹⁶

Period 2. With long-term Japanese real interest rates exceeding those of the U.S. in the spring of 1990, and Japanese short-term rates continuing to rise, the yen began to appreciate sharply. In the last quarter of 1990 the Japanese long-term nominal interest rate fell below the overnight rate, which stood at better than 8 percent throughout the first quarter of 1991. The sharp reversal in interest-rate policy that began in the spring of 1991 moderated the pace of yen appreciation but did not induce depreciation. One reason was that the U.S. monetary tightening cycle had peaked in the fall of 1990, and U.S. policy rates were falling rapidly from the end of the year. The Fed's view was that, despite the possible inflationary effects of a rise in oil prices, U.S. real activity was slowing.¹⁷ By the final quarter of 1991, the Japanese economy was suffering the coincidence of a strengthening currency, uncomfortably high inflation, and asset-price collapse. In 1991, Japan's real GDP growth slowed whereas the U.S. entered a mild recession. As U.S. growth recovered in 1992, however, Japan's slowed further and it remained low in 1993. In 1994, Japanese growth turned sharply negative (Figure 9).

Contributing to poor growth performance was a sharp upward movement of the yen (roughly 25 percent) between mid-1992 and the last quarter 1993. This was the start

¹⁶ Clarida and Waldman (2008) show that the response of exchange rates to inflation news has been quite different as between inflation-targeting central banks and non-targeters (such as the BOJ and the Fed).

of a second great episode of *endaka fukyo*. At this point U.S. inflation had largely stabilized but Japanese inflation was falling (Figure 5). Inflation expectations may therefore have played some role in the yen appreciation over 1992-93, but from a macro perspective the appreciation remains puzzling. It seems likely, however, that U.S.-Japan trade tensions created expectations that the Japanese authorities would limit potential yen depreciation. This is the interpretation favored by McKinnon and Ohno (1997). In January 1992, President George H. W. Bush visited Japan and secured commitments to specified increases in imports of autos and auto parts from the U.S.¹⁸ The election of the Democratic Clinton administration in November 1992 may well have raised expectations of a more confrontational U.S. trade stance. Coupled with Japan's slow growth, U.S. recovery was leading to an expansion in American imports from Japan, and this, paradoxically, added to the tense atmosphere regarding trade.

As Japan's short-term interest rate fell and the Fed kept short-term rates on hold, the yen stabilized, but a renewed appreciation episode started in mid-1994, just as the yen overnight interest rate stopped falling and began to inch upward (Figure 3). Between June 1994 and April 1995, when the yen reached its all-time peak, the yen appreciated by 12.5 percent (log points) in real effective terms and by 18 percent (log points) in real terms against the dollar. This episode has puzzled observers, as it occurred when the Japanese economy was already quite weak and about to fall into deflation.

As of early 1994, however, private and policy forecasts discerned signs of recovery, and indeed, at that point the long-term yen nominal interest rate began to move

¹⁷ See The "Record of Policy Actions of the Federal Open Market Committee," Meeting of November 13, 1990 (<http://www.federalreserve.gov/monetarypolicy/fomchistorical1990.htm>). The average price of crude petroleum doubled temporarily between the summer and fall of 1990 as Iraq invaded Kuwait in August.

up. Ahearne and others (2002, p. 17) quote the BOJ *Quarterly Bulletins* for May and November 1994 as pointing, respectively, to stabilization of the economic growth rate and to strength in “all categories of spending....” Short-term interest rates remained on hold, however, and with the fundamentals of the economy in reality deteriorating, it is possible, as Ahearne and others (2002, p. 18) suggest, that the market real interest rate rose above the natural rate, prompting the sharp yen appreciation of early 1995. This result is consistent with the prediction of equation (3). The sharp appreciation itself, coupled with the Kobe earthquake and falling equity prices, helped snuff out a possible of economic recovery. Early in 1995, headline CPI inflation, which had risen slightly toward the end of 1994, dropped to around zero. Core inflation also was low and declining (Figure 5).

Period 3. In April 1995, a series of dramatic policy interventions, carried out by both Japanese and foreign authorities, initiated a new, long-term weakening trend for the yen. The BOJ discount rate was slashed and the yen overnight interest rate fell dramatically, reaching a level of about 0.5 percent by the fall of 1995 (Figure 3). As described by McKinnon and Ohno (1997, pp. 226-8), the U.S. eased mercantile pressures and Japan, while several countries carried out joint foreign exchange market interventions to support the dollar in currency markets. The Japanese authorities had purchased dollars in unilateral official intervention operations on 21 days in March 1995 as the yen continued to rise. They intervened on eight more days between April 3 and 18, purchasing about \$500 billion for the month.

¹⁸ This visit may best be remembered as the one in which President Bush, at a state dinner, vomited into Japanese Prime Minister Miyazawa’s lap.

Nominal long-term interest rates in Japan fell dramatically as expectations of low growth and low inflation took hold. As Figure 6 shows, Japan's long-term real interest rate fell far below that of the United States. From a level of around 4.2 percent per year in March 1995, the nominal 10-year JGB rate fell to a low of around 0.9 percent in the fall of 1998. The upward spike in domestic financial instability late in 1997, after the outbreak of the crisis in Asian emerging markets, no doubt contributed to the yen's rather rapid depreciation through August 1998.

Not only did Japanese nominal long-term rates start to rise in the fall of 1998, but also, accelerating Japanese CPI deflation had started to cause the long-term *real* Japanese interest rate to start trending upward. Even before then, U.S. short and real long-term rates had started to decline in the aftermath of the Asian financial crisis. Eventually those factors halted the yen's depreciation and reinforced a new appreciation cycle.

Period 4. It was in August 1998 that the yen's next real appreciation cycle began. During this period, Japan's real long-term interest rate rose relative to that in the United States. In Japan the overnight interest rate stood at just under 0.5 percent and would fall effectively to zero within a year, but in the presence of deflation expectations, yen appreciation continued. At the point when the zero lower bound was reached late in February 1999, the BOJ had no further ability to lower the short-term nominal interest rate. By the end of 1999, Japanese and U.S. real long-term interest rates were again very close, and the upward trend in the (negative) Japan-U.S. differential had ceased (Figure 6), in part because U.S. headline inflation had moved upward.

Over the entire period from August 1998 to December 1999, the yen appreciated in real effective terms by 29.8 percent and in real bilateral terms against the dollar by 31.2 percent.

Period 5. In the subsequent long real depreciation phase, a falling yen price level reinforced the yen's nominal depreciation against the dollar. The yen fell sharply in real terms through the end of 2001 as Japan's relative real interest rate fell. From August 2000 to March 2001 the BOJ held policy interest rates above zero, as described earlier, having perceived signs of recovery despite a core inflation rate that remained negative.¹⁹ This move caused a small temporary strengthening of the yen, but economic activity slowed and deflation accelerated.

The yen stabilized and even rose (against the dollar) after early 2002 as Japan's real interest rate rose toward the U.S. level (Figure 6), but depreciation returned early in 2005 despite a relative Japanese real interest rate that continued to rise for several months (part of the Greenspan "conundrum" period).

Hamada and Okada (2007) argue that the yen would have appreciated far more in 2003-04, crippling Japanese recovery, if not for the energetic dollar purchases carried out by Japan's Ministry of Finance under Vice Minister Zembei Mizoguchi. Between January 2003 and the end of March 2004, the MOF sold ¥35,256.4 billion for dollars in the foreign exchange market.²⁰ Ito (2004) discusses the rationale and context for these interventions in detail and suggests that while they could have had a weakening effect on the yen of up to 13 percent compared to the counterfactual of no intervention, it is also possible that their effects were mostly temporary. In any case, the Fed had begun to

¹⁹ Ito and Mishkin (2006, pp. 145-6).

tighten U.S. monetary conditions in mid-2004 in the face of mounting inflation pressure (Figures 5 and 8). From April 2005 Japanese long-term real rates began to fall compared to the U.S., and yen depreciation accelerated.

In July 2006, the BOJ definitively ended its zero-interest policy regime, as we have seen (Figure 3). Even with some signs of Japanese recovery and Japan's relative real long-term interest rate rising, yen depreciation continued through July 2007. It could be that markets perceived unusually high risks in a period of monetary policy transition, or that market expectations of Japanese long-term growth were again being revised downward.

Period 6. Yen behavior during this period is dominated by Japan's emergence as a relative safe haven in a period of global financial market crisis. Paradoxically, the weakness of Japan's financial system over prior years may have deterred Japanese institutions from overextending themselves during the 2000s, unlike institutions in Europe and especially the United States. The yen strengthened sharply starting in the fall of 2008. At that time, emerging markets and industrial countries came under financial pressure and the world price of oil plummeted from the unprecedented heights reached the previous summer. By the end of 2008 the yen was around the ¥90 per dollar level. Of course, the yen was much weaker in *real* terms by 2008 than when the yen had reached that nominal rate in the mid-1990s. Even so, a higher yen, coupled with rapidly shrinking markets for Japanese exports, threw Japan's growth sharply into reverse.

²⁰ See Ministry of Finance Japan, "Foreign Exchange Intervention Operations," <http://www.mof.go.jp/english/e1c021.htm>.

Long Run Trends in the Yen: The Role of Productivity Growth

Movements in relative real long-term interest rates offer some insight into short-term exchange rate dynamics, but it is also likely that perceptions of long-run real exchange rates changed over the period following the collapse of Japan's asset bubble. We would like to understand whether and when such changes in long-term perceptions may have occurred. A closely related challenge is to explain the observed long-term trends in the yen's real exchange rate. I therefore turn to the question of long-term movements in the yen and their relationship to underlying economic fundamentals. This section focuses on productivity trends, the next, on trends in international trade.

The Harrod-Balassa-Samuelson Approach

Perhaps the most fundamental benchmark model for thinking about real exchange rates is the Harrod-Balassa-Samuelson (HBS) model (see Rogoff 1992; Obstfeld 1993; Asea and Mendoza 1994; Obstfeld and Rogoff 1996, Chapter 4). The model posits economies with two sectors, tradable and nontradable goods. In essence, the real exchange rate depends on the international "difference in differences" between the economies' tradable-sector and nontradable-sector productivity growth rates. The HBS model provides a key benchmark, because real appreciations consistent with the model's predictions are purely productivity driven and do not entail a decline in the competitiveness of exports.

To understand the HBS approach, let P be Japan's consumer price level and P^* that of the United States, with E the price of yen in terms of dollars. Then the real exchange rate of the yen against the dollar (defined so that an increase is a relative real

depreciation of the yen) is $q = EP^*/P$. In this notation, a rise in E (nominal yen depreciation) or rise in P^*/P (fall in Japan's relative money price level) lowers the price of consumer goods in Japan compared to the U.S.

Each country's consumer price level, in turn, depends on the domestic price indexes for tradable and nontradable goods, denoted P_T and P_N for Japan and P_T^* and P_N^* for the United States. In general, as shown by Obstfeld and Rogoff (2007, p. 356), a useful approximation for the change in the log yen real exchange rate is

$$\Delta \log q \approx (1 - \gamma) \Delta \log \left(\frac{P_N^* / P_T^*}{P_N / P_T} \right) + \Delta \log \left(\frac{EP_T^*}{P_T} \right), \quad (4)$$

where γ is the share of tradables in the CPI (the same in the two countries). This equation discloses the two main determinants of the real exchange rate: the international ratio of relative nontradables prices, and the relative international price of tradables.

The HBS theory presumes that the law of one price holds for every tradable good and that consumers in the two countries have identical preferences over the tradable goods. Thus, $EP_T^* = P_T$, so that the HBS theory operates entirely through the determination of the relative price of nontradables in terms of tradables. There is considerable evidence, however, that relative international tradables prices vary greatly, at least for some country pairs and over some horizons. Moreover, they tend to covary positively and strongly with nominal exchange rates, so that nominal yen depreciation, for example, raises the price level of tradables in Japan relative to tradable price levels abroad. For Japan, the terms of trade closely mirror the evolution of the exchange rate, with nominal (and real) yen depreciation generally associated with deterioration in Japan's terms of trade – a rise in import price relative to export prices. I temporarily put

this evidence aside to focus on the HBS predictions about relative nontraded-goods prices, predictions that are quite robust as longer-term predictions and are broadly consistent with data from many countries.

Over a sufficiently long horizon – one in which goods prices are flexible and domestic factor markets can adjust to ensure the equality of factor rewards across sectors of the economy – relative productivity growth is a prime determinant of the first term on the right-hand side of equation (4). To see this, assume that outputs in the tradable and nontradable sectors are given by the constant-returns production functions of capital and labor:

$$Y_T = A_T F(K_T, L_T),$$

$$Y_N = A_N G(K_N, L_N),$$

where A_T and A_N measure total factor productivity (TFP).²¹ Let μ_{LT} denote labor's income share in tradables, μ_{LN} its share in nontradables, and \hat{x} the proportional rate of change of variable x . Furthermore, define the relative price of nontradables as $p \equiv P_N / P_T$. Proceed as in Obstfeld and Rogoff (1996, Section 4.2.1) but allow for the possibility that both the real (tradable) wage w and the real (tradable) return to capital r can change. Log differentiation of zero-profit conditions, assuming firm optimization and free domestic factor mobility, yields:

²¹ It would be simple to include nontraded goods as an input to tradables (think of retailing services required to deliver tradables to final consumers). That change would not alter the main qualitative predictions concerning relative sectoral TFP and the relative price of nontradables, but it would place a wedge between different countries' price indexes for tradable consumption. That additional wedge would, however, depend mainly on relative nontradables prices.

$$\begin{aligned}\hat{A}_T &= \mu_{LT} (\hat{w} - \hat{r}) + \hat{r}, \\ \hat{p} + \hat{A}_N &= \mu_{LN} (\hat{w} - \hat{r}) + \hat{r}.\end{aligned}\tag{5}$$

Combining these, one obtains a relationship linking the change in the real exchange rate to relative TFP growth,

$$\hat{p} = \hat{A}_T - \hat{A}_N + (\mu_{LN} - \mu_{LT})(\hat{w} - \hat{r}).\tag{6}$$

In general, the change in p depends not only on the sectoral difference in TFP growth, but also on the evolution of the wage-rental ratio, with a rise in the latter raising p when nontradables are relatively labor intensive.²² If there are significant movements in relative factor rewards over time and intersectoral differences in functional income shares, then the relation between the relative price of tradables and sectoral TFP growth rates may not be straightforward. Evolution in the relative price of nontradables will depend exclusively on differential TFP growth only in very special cases, for example, when sectoral factor shares are the same.

One way to circumvent the problem is to focus on labor productivity rather than total factor productivity, as Canzoneri, Cumby, and Diba (1999) do. That approach potentially confounds long-term TFP movements with other factors, but it has a number of countervailing advantages, as Canzoneri, Cumby, and Diba show.

To understand their approach, note that along the economy's long-run production possibilities frontier, p equals the ratio of labor's marginal physical productivity in

²² One could solve for the endogenous wage-rental ratio in terms of exogenous variables by imposing further structure on the consumption side and assuming a balanced growth path, as Asea and Mendoza (1994) do, but at the cost of restricting generality. For my purposes it is not necessary to follow that route. In the context of a growth model, and assuming a balanced growth path with a constant marginal product of

tradables to its marginal physical productivity in nontradables. Let $f(k_T) \equiv F(K_T/L_T, 1)$ and $g(k_N) \equiv G(K_N/L_N, 1)$. Under the tentative assumption that *marginal* labor products are proportional to *average* labor products, one can therefore write

$$p = \frac{A_T [f(k_T) - f'(k_T)k_T]}{A_N [g(k_N) - g'(k_N)k_N]} = \frac{\varphi A_T f(k_T)}{\psi A_N g(k_N)}$$

for suitable constants φ and ψ . Log differentiating this expression, one finds that

$$\hat{p} = \hat{A}_T + (1 - \mu_{LT}) \hat{k}_T - [\hat{A}_N - (1 - \mu_{LN}) \hat{k}_N].$$

Here, $\hat{A}_T + (1 - \mu_{LT}) \hat{k}_T$ is the growth rate of (average) labor productivity in tradables (in contrast to TFP in tradables), whereas $\hat{A}_N + (1 - \mu_{LN}) \hat{k}_N$ is the growth rate of labor productivity in nontradables. (In general, labor productivity growth rates exceed TFP growth rates when there is capital deepening over time.)

The earlier tentative assumption that marginal and average labor products coincide can hold true only if the last equation is the same as equation (6). Let σ_T and σ_N be the elasticities of factor substitution in the traded and nontraded goods sectors. Then one can express the last equation in terms of factor-price changes as

capital r , equation (5) would imply that $\hat{w} = \hat{A}_T / \mu_{LT}$. Accordingly, (6) implies $\hat{p} = \left(\frac{\mu_{LN}}{\mu_{LT}} \right) \hat{A}_T - \hat{A}_N$. This is the formula in Obstfeld and Rogoff (1996, Chapter 4) for the case of a constant world real interest rate.

$$\hat{p} = \hat{A}_T + (1 - \mu_{LT}) \sigma_T (\hat{w} - \hat{r}) - \left[\hat{A}_N - (1 - \mu_{LN}) \sigma_N (\hat{w} - \hat{r}) \right].$$

This equation is valid – that is, it agrees with equation (6) – when (and only when) $\sigma_T = \sigma_N = 1$. Thus, for Cobb-Douglas production functions, the long-run relative price of nontradables depends exclusively on differential labor-productivity growth in nontradables and tradables. I will assume that Cobb-Douglas production functions adequately represent Japanese industry.

Below I explore the relationship between the preceding labor productivity differential and the yen's real exchange rate. One point to notice, however, is that for the tradable and nontradable sectors, short-term movements in labor productivity and TFP are very highly positively correlated. The six panels of Figure 10 (a through f) illustrate this correlation for the tradable and nontradable sectors of Japan, the United States, and Germany. Productivity growth rate data are from the EU KLEMS database (URL: <http://www.euklems.net/>, March 2008), and sectoral value-added productivity figures are constructed from less aggregated industry figures using a Törnqvist index with value-added weights.²³ As an example, for Japanese tradables the contemporaneous correlation coefficient between labor productivity and TFP growth rates is 0.95; for Japanese nontradables the corresponding correlation coefficient is 0.94. Note that, as the HBS literature suggests, productivity growth in tradables is generally higher than that in

²³ Tradables consist of agriculture, hunting, forestry, and fishing; mining and quarrying; total manufacturing; and electricity, gas, and water supply. Nontradables consist of construction; wholesale and retail trade; hotels and restaurants; transport, storage, and communication; finance, insurance, real estate, and business services; public administration and defense; compulsory social security; education, health, and social work; and other community, social, and personal services.

nontradables, with the implication that the relative price of services should rise secularly.²⁴

Evidence on HBS and Its Component Sub-theories

For much of its postwar history Japan was a poster-child for the HBS theory. In an early study, Hsieh (1982) derived a one-factor version of the HBS theory and tested it on labor productivity data for Japan and Germany versus aggregates of major trading partners. For his study, tradables were defined as manufacturing and nontradables as nonmanufacturing. The theory received support for both countries, but over a sample period (1954-1976) containing very few observations from the post-1973 floating exchange rate era. As I argue below, however, deviations from the HBS model are likely to be larger and more persistent under floating exchange rates.²⁵

Marston (1987) offered the first detailed study of Japan based on a substantial span of data from the floating exchange rate period (1973-1983). Marston found that in the U.S. over that period, tradables productivity growth exceeded that in nontradables by 13.2 percent. For Japan, he found that the same cumulative differential was 73.2 percent. Japanese relative nontradables prices rose by 56.9 percent as opposed to only 12.3 percent in the U.S. The yen appreciated significantly against the U.S. dollar in real terms. These results seemed strikingly to confirm the HBS approach.²⁶

²⁴ Lee and Tang (2007) find that logarithmic levels of TFP and labor productivity need not be highly or (even positively) correlated for the U.S. and Germany, although they are for Japan. In panel regressions on an industrial-country sample, they find that labor productivity variables and TFP variables have opposite effects on real exchange rates.

²⁵ Hsieh's findings in support of HBS went against previous negative cross-section work reported by Officer (1976).

²⁶ In a related vein, Yoshikawa (1990) claimed an important role for relative labor productivities in determining the long-run nominal yen/dollar exchange rate over 1973-87. Yoshikawa's model assumed an average law-of-one-price relationship for tradables, and allowed for changes in the relative price of energy

Subsequent research has focused on larger samples of countries. De Gregorio, Giovannini, and Wolf (1994), using the newly assembled OECD sectoral database for 1970-85, showed a strong relationship between differential sectoral TFP growth and the growth of relative nontradables prices for a sample of 14 countries including Japan. They did not look explicitly at real exchange rates. Asea and Mendoza (1994) reached similar conclusions regarding relative sectoral prices levels within the OECD sample, but found that TFP differentials were much less useful in understanding even low-frequency movements in real exchange rates.

That failure is not surprising in view of equation (4), as a major role in movements of the real exchange rate, alongside that of relative sectoral prices, is played by the relative international price of tradables. Under floating exchange rates, the latter relative price is highly correlated with the nominal exchange rate in the short run, and hence is much more volatile than either of the relative prices p and p^* that enter the first right-hand term in (4). The volatility in relative international tradables prices, to some degree, reflects widespread violations of the law of one price; it also reflects terms of trade changes (given international differences in consumer preferences) as well as the nontradable content of final “tradable” consumption goods. Engel (1999) argues that even over longer horizons, variation in the relative international prices of *tradables* dominates real exchange rate movements of the United States dollar; this point has implications for the yen that I will explore later. Were Hsieh’s (1982) tests to be carried out over post-

inputs. Rather than focusing on relative productivity in nontraded and traded sectors, however, Yoshikawa’s model focuses on the relative importance of labor and energy in producing export goods. I return to the importance of energy prices below.

1973 data, it seems certain that any measured effects of intersectoral productivity differentials would be swamped by the influence of nominal exchange rate movements.²⁷

Many recent studies employ error-correction models to look for cointegrating relationships among real exchange rates and the other variables that underlie the HBS model. The basic presumption of these models is that real exchange rates contain unit roots. While the unit-root hypothesis has proved difficult to reject in the spans of data that are typically used, the question of mean reversion in real exchange rates in fact remains quite open, with many researchers believing in some degree of slow mean reversion, a belief derived in part from the analysis of longer time series samples. Thus, Taylor and Taylor (2004, p. 154) describe as a “consensus view” the propositions “that short-run PPP does not hold, that long-run PPP may hold in the sense that there is significant mean reversion of the real exchange rate, although there may be factors impinging on the equilibrium exchange rate through time” It should be kept in mind that the statistical tests described next all rely on the hypothesis that real exchange rates and their determinants are $I(1)$ random variables,

Retaining a focus on the OECD sectoral data but working in terms of labor productivity as noted above, Canzoneri, Cumby, and Diba (1999) looked separately at the two components of the HBS model: the ability of sectoral productivity differences to explain the relative price of nontradables in terms of tradables, and the validity of purchasing power parity (PPP) with respect to indexes of tradables prices. Using 1970-1993 data, carry out a panel cointegration analysis aimed at ascertaining long-run dynamic features of the data record. They found that relative sectoral prices and relative

²⁷ Park and Ogaki (2007) caution, however, against drawing long-run implications from data samples of the size that Engel uses.

productivities were cointegrated with a coefficient near 1.0.²⁸ However, nominal exchange rates against the U.S. dollar were not cointegrated with tradables prices relative to those of the U.S. Interestingly, the hypothesis of PPP for tradables fared much better when Germany rather than the United States was used as the comparison country. Kakkar and Ogaki (1999), also using cointegration techniques, explicitly studied long-run comovements in real exchange rates and relative nontradables prices. Their long data sample, ranging from as early as 1929 to the late 1980s, contained several spans with fixed exchange rates. Particularly in floating-rate data, they found mixed support for a close long-run relationship between relative nontradables prices and real exchange rates.²⁹ This is consistent, once again, with a large role for nominal exchange rate movements in driving deviations from PPP for tradable goods. In a panel cointegration study covering 48 countries, Ricci, Milesi-Ferretti, and Lee (2008), relate real exchange rates to a range of explanatory variables. They find a statistically significant productivity effect consistent with the HBS theory, but regard it as relatively small in magnitude.³⁰

A number of studies focus explicitly on real exchange rates of East Asian countries. Some authors, such as Chinn (2000, p. 20), argue that “The East Asian economies are exactly the type for which Balassa posited the relevance of the HBS effect: economies characterized by rapid growth, presumably due to rapid manufacturing—and hence traded—sector productivity growth.” Ito, Isard, and Symansky (1999), Drine and Rault (2003), and Thomas and King (2004), however, all find mixed evidence concerning the HBS theory. Chinn (2000) himself studies the bilateral real exchange rates of a group

²⁸ Kakkar (2003) established the same result for a model based on TFP measures.

²⁹ Similarly mixed evidence is found by DeLoach (1997), who uses CPI/WPI ratios to proxy relative nontradables prices.

³⁰ Further analysis and discussion can be found in Lee et al. (2008).

of nine East Asian countries, including Japan and China, against the U.S. dollar. He finds that for Japan, Malaysia, and the Philippines, the real exchange rate is cointegrated with relative sectoral labor productivities based on a 1970-93 sample. He notes, however, that real exchange rates display protracted swings away from the levels predicted either by relative nontradables prices or by relative productivity levels. Kakkar and Yan (2006) assemble a disaggregated data set of TFPs for Hong Kong, Indonesia, Korea, Malaysia, Singapore, and Thailand. They find that in panel data, real exchange rates appear cointegrated with relative sectoral productivity differentials, but whereas long-run PPP for tradables appears reasonable when East Asian currencies are compared to the yen, it fails when the dollar is the comparison currency. This difference could result from the closer trading linkages among the East Asian countries, including Japan.³¹ Choudhri and Khan (2005) present a panel study of 16 emerging market countries, including some in East Asia, over 1976-94. They find that bilateral real exchange rates against the dollar are related to relative nontraded goods prices and that the latter are, in turn, related to relative labor productivity as the HBS theory suggests, but they do not test directly for a link between real exchange rates and relative sectoral productivity differences. They also find a role for the terms of trade in determining real exchange rates. Chen and Rogoff (2003) document a positive and significant HBS effects in the bilateral real exchange rates of Australia and New Zealand against the United States.

³¹ Kakkar and Yan (2006) combine the equations in (5) by eliminating $\hat{w} - \hat{r}$ rather than \hat{r} . The result is

$$\hat{p} = \frac{\mu_{LN}}{\mu_{LT}} \hat{A}_T - \hat{A}_N + \left(\frac{\mu_{LT} - \mu_{LN}}{\mu_{LT}} \right) \hat{r},$$

rather than equation (6). The authors then work with the level form of this equation under the hypothesis that the real return to capital, r , is an $I(0)$ random variable. Their methodology obviously obliges them to supply labor-income shares in tradables and nontradables.

The body of evidence on the HBS theory indicates a definite connection between international differences in relative sectoral productivity levels and international differences in the price of nontraded in terms of traded goods. The connection seems valid whether productivity is measured by output-labor ratios or by TFP. Direct linkages between productivity variables or relative price variables and real exchange rates is more tenuous, especially under floating nominal exchange rates, because of large and persistent deviations from purchasing power parity for tradables; see equation (4). These deviations may limit the usefulness of the HBS theory for explaining or predicting real exchange rates over all but the longest horizons. PPP for tradables – and therefore the HBS connection between relative productivity levels and real exchange rates – may hold more closely for pairs of countries with relatively extensive mutual trading links.

Sectoral Productivity and the Yen's Real Exchange Rate

A real yen appreciation caused by high productivity growth in tradables would not undermine the competitive position of Japanese exporters. The available evidence indicates, however, that at least in the short run, episodes of sharp yen appreciation have indeed harmed the fortunes of Japan's manufacturing exporters, with negative implications for overall Japanese economic growth (as suggested by Figure 1). Dekle and Fukao (2008) document how the yen's 1985-95 appreciation raised average costs levels in Japanese industries relative to those in the United States.

A first regularity to examine is the short-run relationship between real exchange rate movements and changes in the HBS relative productivity variable, which I define in terms of relative labor productivity as $\hat{Y}_T - \hat{L}_T - (\hat{Y}_N - \hat{L}_N) - [\hat{Y}_T^* - \hat{L}_T^* - (\hat{Y}_N^* - \hat{L}_N^*)]$. In

practice, I take Japan as the home country and take the “starred” foreign country to be either the U.S. or Germany. Figures 11a and 11b, respectively, plot the data, which show no evidence of short-run positive correlation. Indeed the sample correlation coefficients are slightly negative, equal to -0.14 for the comparison with the U.S. and to -0.16 for the comparison with Germany. These short-term comovements are the opposite of what the HBS theory predicts as a longer-term correlation.

In the short term, when prices are sticky and factors are immobile between sectors, real yen appreciation reduces the demand for Japanese exports and puts downward pressure on exporters’ profit margins. This account is consistent with the evidence in Dekle and Fukao (2008). The appreciation could result from monetary factors as discussed earlier, from changed perceptions of the long-run equilibrium real exchange rate, or from shifting risk premia. Faced with reduced demand, Japanese exporters react immediately by reducing levels of capacity utilization and working existing labor pool less intensely. These adjustments, in turn, lower measured productivity, whether measured as TFP or as labor productivity.

For the United States, Basu (1996) has made a compelling case that procyclical rates of factor utilization play the main role in explaining the observed high degree of procyclical overall productivity.³² His analysis uses data on material inputs effectively to track firms’ use of capital and labor inputs. It would be interesting to use methods like Basu’s to more closely isolate the exogenous technological shocks driving observed

³² See also Basu and Fernald (2001). For a related analysis using Japanese data, see Vecchi (2000).

productivity movements in traded and nontraded sectors. The resulting data would deliver a sharper test of the HBS theory.

In Figures 11a and 11b, real exchange rate movements are more volatile than the contemporaneous movements in international relative productivity ratios. The latter are, however, still surprisingly large. A yen appreciation lowers demand for tradable goods and may raise the demand for nontradables. To the extent that slow growth in the export sector depresses overall demand, however, any resulting rise in the cyclical component of nontraded-sector productivity may be dampened. In fact, over 1978-2005, the correlation between changes in Japanese tradable and nontradable productivity is only 0.05, effectively zero.

An analysis of longer-term changes in productivity *levels* and real exchange rates gives a sense of whether the historical trends are consistent with the HBS theory. For this purpose, I use the log levels version of equation (4), taking $\gamma = 0.25$ and identifying the relative prices p and p^* with the tradables-to-nontradables labor productivity ratios. Figures 12a and 12b present the data for the comparison of Japan against the U.S. and Germany, respectively, over the nearly three decades from 1978-2005. Against the U.S., over this entire period, Japan experiences a small real depreciation and a small decline in the HBS relative intersectoral productivity variable. In the interim, however, the swings away from “Harrod-Balassa-Samuelson” parity are huge and persistent. On this metric, the yen was about 50 percent “undervalued” during the strong dollar of the Reagan years, and about 40 percent “overvalued” during the height of the mid-1990s appreciation, which pushed Japan into protracted deflation. The “overvaluation” of the first *endaka fukyo* of the late 1980s is comparatively small and briefer, as is the “overvaluation” that

emerges after the Asian crisis (August 1998–December 1999, described as Period 4 above). In all of these episodes, often identified as misalignments, sharp movements in the yen’s nominal exchange rate were associated with commensurately sharp movements in relative international tradables prices. As in equation (4), those developments helped to drive the real exchange rate far from the HBS benchmark. I return to this point in the next section, which explicitly introduces international trade in different products.

Figure 12a shows that in many of the subperiods of the 1978-2007 span, the yen’s evolution vis-à-vis the U.S. dollar is in fact the opposite of what the HBS theory would imply. I have already observed (in connection with Figures 11a and 11b) that year-to-year *changes* in bilateral real exchange rates and the bilateral HBS productivity variable are slightly negatively correlated. The correlation between log *levels* in Figure 12a is a much more dramatic -0.46 . Furthermore, the relevant productivity trends seem quite minor in magnitude compared to the long swings in the exchange rate – for example, over the 1995-2004 subperiod, when the HBS theory does get at least the *direction* of change in the real exchange rate right. But the magnitude is way off. Changes in real exchange rates are more volatile than changes in productivity, yet are quite persistent.³³ Lane (2008) finds that the yen’s multilateral real exchange rate is positively and significantly related to a multilateral HBS variable, but all in all, there is little evidence that this relationship is important for the bilateral yen rate against the dollar.

³³ Caballero, Hoshi, and Kashyap (2008) observe that from the early 1990s to the early 2000s, there was positive TFP growth in Japanese manufacturing while TFP stagnated in nontraded sectors such as construction. They attribute this in part to the concentration of “zombie” firms in nontraded sectors. Taken alone, this pattern would cause a real yen appreciation according to the HBS theory. However, U.S. productivity developments also played a role. Furthermore, Caballero, Hoshi, and Kashyap argue that sectors heavily populated with zombie firms could be characterized by excessive supply and hence lower prices.

The bilateral real exchange rate of the yen against Germany puts the HBS theory in a slightly better light; see Figure 12b. The real exchange rate still fluctuates about the HBS trend, but the departures are smaller and less persistent than in the yen/dollar case. Notable examples of “misalignment” – in the narrow sense of a significant departure from the HBS trend – are the yen’s real depreciation against the deutsche mark at the time of the second oil shock of the late 1970s, real appreciation in the mid-1990s (less pronounced than that against the United States), and a substantial real appreciation around the launch date of the euro in 1999. Notwithstanding the negative correlation in annual changes shown in Figure 11b, the correlation between log levels is strongly positive and equal to 0.61, which is suggestive a reasonably strong HBS effect over the medium term.

An interesting question is why HBS has a bit more success in explaining swings of the Japanese currency against Germany than against the United States. Canzoneri, Cumby, and Diba (1999) likewise found that convergence to PPP for tradables held more closely when they compared OECD countries to Germany, rather than the U.S. As the world’s premier exporter, Germany’s integration into global markets exceeds that of the larger and more insular United States economy. This may explain the greater apparent coherence between world and German tradables prices, which, in turn, might reduce the size and persistence of departures from an HBS benchmark. An interesting general question is whether predictions of the HBS theory holds more closely for economies that are more open to international trade.

The figures leave open the possibility that the real exchange rate might appear to be cointegrated with the HBS relative productivity variable, Lane (2008), who examines

the real effective CPI exchange rate in a multivariate context using an effective HBS variable as a regressor, finds this to be the case. However, Figures 12a and 12b suggest that HBS factors could have little explanatory power for real exchange rates over medium-term horizons, and that forecasters would face considerable uncertainty in predicting when a real exchange rate might converge near to the HBS benchmark.³⁴

Overall Productivity and the Yen's Real Exchange Rate

Another regularity worth noting is the relationship between overall productivity growth measures and the real exchange rate, shown in Figure 13. As argued by Hayashi and Prescott (2002), Japan's stagnation has been characterized by a reversal in the earlier increasing trend of TFP relative to the United States. In addition, overall labor productivity leveled off in the mid-1990s (again relative to the U.S.).

The arc of relative productivity is roughly captured by the real exchange rate – in a manner more consistent with the Kravis-Lipsey effect (price levels are relatively low in relatively poor countries) than with the HBS effect.³⁵ One channel through which overall productivity growth could affect the real exchange rate is through the terms of trade. The strict HBS theory's apparent assumption that terms of trade movements are unimportant for the real exchange rate, except insofar as they affect productivity growth, is quite wrong for Japan, as I document next. No discussion of the real exchange rate is complete unless one integrates the implications of international trade in heterogeneous goods.

³⁴ Two important future research issues are to take into account both the endogeneity of the traded versus nontraded categories, as well as the importance of nontraded distribution services in determining the consumer price of tradable goods. See also Lee and Tang (2007). Devereux (1999) presents a model in which endogenous growth of the distribution sector affects the path of the real exchange rate.

Long-Term Trends in the Yen: International Trade.

The simplest versions of the HBS theory ignore variation in the relative prices of different tradable goods. There is considerable cross-country evidence, however, that such variation is an important (if not dominant) source of real exchange rate variation. In turn, that evidence makes it plausible that factors related to international trade can help explain the real exchange rate deviations in Figures 12a and 12b.

The Yen's Real Exchange Rate and the Terms of Trade

A very basic fact about the yen's real exchange rate is that its level has an extremely high positive correlation with Japan's terms of trade – the ratio of export price to import prices.

Figure 14 graphs both the terms of trade and the yen's real effective exchange rate based on unit labor costs in Japan and its main trade partners (these are monthly data in logs). In the figure, the terms of trade measure is constructed as an aggregate export price index divided by an aggregate import price index (both from IMF, *International Financial Statistics*), so that a rise in the terms of trade causes a welfare-enhancing shift in Japan's national budget constraint. Evidently, the terms of trade closely mirror both the trends and cycles in the real exchange rate; the correlation between the two series' log levels is 0.75. This measure of the overall terms of trade – despite including volatile components such as oil prices – generally shows somewhat less volatility than the real exchange rate. Were the export and import indexes restricted to manufactured products, the resulting terms of trade measure would be much less variable, as is shown below.

³⁵ I am grateful to Mick Devereux for discussions on this point.

An important empirical mechanism behind the high correlation displayed in Figure 14 is that the terms of trade and the real exchange rate both respond, and in the same direction, to shocks to the nominal exchange rate. With pervasive labor-cost stickiness, no segmentation between domestic and export markets, and producer-currency pricing of exports, both the real exchange rate based on unit labor costs the terms of trade would both move in proportion to a nominal exchange rate change, whatever its cause.

Let us provisionally maintain the assumptions that there is no international market segmentation and no pricing to market in order to gauge their usefulness in explaining how the terms of trade and the real exchange rate are related in the data. For this purpose, I focus on bilateral comparisons between Japan and the U.S. or Germany, assuming for simplicity a Cobb-Douglas form for various price indexes.

Retaining the earlier notation, I assume that overall CPI P for Japan is given by $P = P_T^\gamma P_N^{1-\gamma}$. If P_X is the price index of Japanese exports and P_M the Japanese export index, then the price index for tradables is $P_T = P_X^\alpha P_M^{1-\alpha}$. Once again, the provisional assumption behind this definition – one that I will modify later – is that exporters do not price to market, so that the price of exported goods is the same as that of exportables sold domestically. The terms of trade are P_X / P_M . Parallel price indexes characterize foreign countries.

The real exchange rate (expressed as the price of the foreign CPI in terms of Japan's) is:

$$\begin{aligned}
q &= \frac{EP^*}{P} = \frac{EP_T^{\gamma} P_N^{*1-\gamma}}{P_T^{\gamma} P_N^{1-\gamma}} = \frac{E \left(P_X^{*\alpha} P_M^{*1-\alpha} \right)^{\gamma} P_N^{*1-\gamma}}{\left(P_X^{\alpha} P_M^{1-\alpha} \right)^{\gamma} P_N^{1-\gamma}} \\
&= \frac{EP_X^*}{P_X} \cdot \frac{\left(P_X / P_M \right)^{\gamma(1-\alpha)}}{\left(P_X^* / P_M^* \right)^{\gamma(1-\alpha)}} \cdot \frac{\left(P_N^* / P_X^* \right)^{1-\gamma}}{\left(P_N / P_X \right)^{1-\gamma}}.
\end{aligned} \tag{7}$$

This equation shows that the bilateral real exchange rate between Japan and a foreign competitor is the product of three factors. First is the relative price of Japanese exports in head-to-head competition with the other exporter, EP_X^* / P_X . A rise in domestic export prices relative to foreign export prices raises the relative domestic price level for tradables, reducing q (a real appreciation in the present notation). A second international trade factor entering the real exchange rate reflects a comparison of the Japanese and

foreign *overall* terms of trade, $\frac{\left(P_X / P_M \right)^{\gamma(1-\alpha)}}{\left(P_X^* / P_M^* \right)^{\gamma(1-\alpha)}}$. Other things equal, a rise in Japanese

import prices P_M , for example, pushes up Japan's tradable price level and causes real

appreciation of the yen.³⁶ Finally, the third factor above, $\frac{\left(P_N^* / P_X^* \right)^{1-\gamma}}{\left(P_N / P_X \right)^{1-\gamma}}$, reflects the relative

price of nontradable and tradable production, the focus of the HBS model.

A related calculation shows the role of the terms of trade in determining the (multilateral) real effective exchange rate, denoted q_m . In essence this approach uses the calculation from Obstfeld and Rogoff (2007), assuming (purely for notational parsimony) that Japanese exports play a negligible role in the rest of the world's tradable consumption, so that $P_T^* = P_X^* = P_M / E$. In that case the real effective exchange rate is:

³⁶ In models such as that of Obstfeld and Rogoff (2007), $P_M = EP_X^*$ and $\alpha > 1/2$, so a rise in import prices implies real currency depreciation.

$$\begin{aligned}
q_m &= \frac{EP^*}{P} = \frac{EP_T^* P_N^{*1-\gamma}}{P_T^\gamma P_N^{1-\gamma}} = \frac{EP_X^* P_N^{*1-\gamma}}{\left[P_X^\alpha (EP_X^*)^{1-\alpha} \right]^\gamma P_N^{1-\gamma}} \\
&= \left(\frac{P_M}{P_X} \right)^{1-\gamma(1-\alpha)} \cdot \frac{(P_N^* / P_X^*)^{1-\gamma}}{(P_N / P_X)^{1-\gamma}}.
\end{aligned} \tag{8}$$

This expression shows that, other things equal, a fall in the terms of trade (a rise in P_M / P_X) feeds directly into multilateral real depreciation with an elasticity $1 - \gamma(1 - \alpha)$ that is likely to be large.

Taking the tradables share in the CPI to be $\gamma = 0.25$ in equation (7) and the export share in tradables to be $\alpha = 0.15$, one can construct the product of the two trade factors,

$$\frac{EP_X^*}{P_X} \cdot \frac{(P_X / P_M)^{\gamma(1-\alpha)}}{(P_X^* / P_M^*)^{\gamma(1-\alpha)}},$$

and ascertain its contribution to the evolution of the overall bilateral real exchange rate. In constructing this variable, I use aggregate export and import price indexes for Japan, the United States, and Germany.

Figure 15a shows the result for yen/dollar pairing. (The figure graphs all variables in logs.) The constructed data for the log relative tradables price is positively correlated with the real exchange rate (the correlation coefficient is 0.40), but the series of international tradables prices is less volatile than the real exchange rate – as was the overall terms of trade in comparison to the effective real exchange rate. When the relative tradables component is added to the HBS component graphed in Figure 12a to form a composite simulated real exchange rate, the fit is worsened compared to that of the tradables component alone (consistent with the findings of Engel 1999 for the U.S.).

The figure illustrates how inaccurate are our temporary assumptions on the international pricing of tradable goods, which rule out internationally segmented markets

and the resulting pricing to market by imperfectly competitive manufacturing exporters. Although, at least some of the strong correlation between real exchange rates and terms of trade is due to nominal exchange rate movements driven by asset-market shocks, pricing to market tends to make the non-commodity terms of trade smoother than the real exchange rate in practice; see Atkeson and Burstein (2008) for a recent discussion. When the yen appreciates in nominal terms against the dollar, Japanese exporters lower the yen prices of exports relative to domestic sales, whereas U.S. exporters raise the dollar prices of their exports to partially exploit their enhanced competitiveness. Thus, in terms of equation (7), when E falls, the ratio P_X^* / P_X rises, muting (but not reversing) the impact of the nominal yen appreciation on the head-to-head competitiveness measure EP_X^* / P_X . Were these pricing-to-market effects absent, the relative tradables price in Figure 15a would track the real exchange rate much more closely.

Indeed, the two most glaring deviations in the figure are the *endaka fukyo* episodes of the late 1980s and early 1990s, when Japanese exporters suffered compressed profits as they lowered yen export prices in the face of a sharply appreciating currency.

In the Japan/Germany pairing in Figure 15b, the correlation between the relative tradables price and the real exchange rate is 0.62, considerably higher than in the U.S. case. But in addition, the HBS variable now actually improves the composite simulation's ability to track the real exchange rate. Pricing to market behavior is still very evident, however, particularly during the euro's sharp depreciation in the years immediately following its introduction. Once one allows for pricing to market, the large deviations between the real exchange rate and the HBS benchmark appear to be substantially accounted for (at least in a mechanical sense) by nominal exchange rate movements. One

would reach the same conclusion using equation (8) to construct the real effective exchange rate.

While these results are illuminating, they do not provide a truly causal account of the yen's evolution because the terms of trade and nominal exchange rate, like the real exchange rate, are endogenous and jointly determined, even at low frequencies. Only *exogenous* shocks to the terms of trade can be identified with confidence as causal drivers of the yen's long-term evolution.

Oil and the Yen

The leading candidate for an exogenous cause of the close correlation in Figure 14 is the world price of energy. Over the last three decades, the share of mineral fuels in total Japanese imports has ranged from 50.6 percent in 1981 to 15.9 percent in 1995 and 27.7 percent in 2007. Japan's high dependence on energy imports compared to its many of its trading partners suggests several mechanisms through which world energy prices could affect the real exchange rate.³⁷

Figure 16 shows monthly log levels of the yen price of oil in terms of Japan's PPI and the effective yen real exchange rate based on normalized unit labor costs. Here the real exchange rate is plotted on an inverted scale, so that a move upward in the figure is a real depreciation. The data start in January 1978. The correlation coefficient between the two series, equal to -0.83 , is remarkably high in absolute terms, indicating a strong tendency for the yen to be relatively weak when the price of oil is relatively high.

³⁷ Amano and van Norden (1998) contend that oil prices Granger cause real exchange rates but not vice versa.

Evidently, an exogenous rise in the world price of oil causes a real yen depreciation.³⁸

Observe, however, that the real oil price is several times more variable than the real exchange rate – indeed, much of the variability in Japan’s comprehensive terms of trade is due to energy, which currently carries a weight above 0.25 in the overall import price index published by Japan’s government.³⁹

Recently several papers have documented the strong effect of a dominant commodity export price on the exporter’s real exchange rate.⁴⁰ From this perspective, the yen appears to be a “commodity currency” on the import side. Although commodity terms of trade appear to be an important determinant of real exchange rates in broader samples of countries (see Ricci, Milesi-Ferretti, and Lee 2008),⁴¹ the close link between the yen and energy prices evident in Figure 16 is especially striking. The main departure from the dominant pattern appears to be in the period from late 1997 to late 1999. Over those months, the yen first depreciated sharply under the pressure of low interest rates

³⁸ Lane (2008) documents an empirical relationship between the real price of oil and the yen real exchange rate within an error-correction model.

³⁹ Rogoff (1992, p. 18) displayed a similarly high correlation for the period 1975-90, as did Amano and van Norden (1998) for 1973-1993 data. (The latter authors also show a high correlation for the deutsche mark, and present regression evidence consistent with their graphical findings. They interpret that evidence as showing that a 10 percent rise in the real oil price causes a 1.7 percent real yen depreciation.) What is remarkable is that the correlation shown by Rogoff and by Amano and van Norden has held up so well over many more years and several further cycles in the yen exchange rate. As noted above, the real oil price measure I use is the *yen* price of oil divided by the Japanese PPI. That variable is roughly congruent to the yen real exchange rate multiplied by the real *dollar* price of oil (in terms of a U.S. price index). One might worry that because my measure includes the log real yen exchange rate as an additive factor, it is not really exogenous with respect to the real exchange rate; furthermore, the close correlation in Figure 15 could in theory be driven mostly by variability in the real exchange rate. These theoretical possibilities are not significant in practice because the world oil price is so much more variable than the real exchange rate. The correlation between the real exchange rate and the real dollar price of oil (in terms of the U.S. CPI) is – 0.79, only slightly less in absolute value than the correlation cited in the text. Indeed, Rogoff (1992) graphed the bilateral real yen/dollar CPI exchange rate against the world price of oil in terms of the U.S. CPI. His discussion of the relation between the two variables focuses on HBS productivity effects.

⁴⁰ See, for example, Chen and Rogoff (2003) and Cashin, Céspedes, and Sahay (2004).

⁴¹ See also Kohli and Natal (2008), who find no significant role for the HBS effect in determining the real exchange rate of the Swiss franc, but do detect a strong terms-of-trade effect.

and domestic financial turmoil while the price of oil fell in the backwash of the Asian crisis; afterward both the yen and the price of oil recovered lost ground.

Figure 17 graphs annual data on the real effective exchange rate (starting in 1975), the overall terms of trade, and an “ex-oil” terms of trade measure adjusted to remove energy prices.⁴² The terms of trade less energy are much less variable than the overall terms of trade, and, as is typical of industrial countries, much less variable than the real exchange rate (Atkeson and Burstein 2008). Indeed, it is apparent that fluctuations in energy prices are responsible for most of the variance in Japan’s terms of trade. The correlation between even the ex-oil terms of trade and the real exchange rate (in log levels) is high (0.56), but not as high as that between the overall terms of trade and the real exchange rate (0.77 in annual data). Thus, the oil price is an arguably exogenous variable with a quantitatively important impact on the real exchange rate.

While a broad-based deterioration in the terms of trade directly enters the real exchange rate through the first multiplicative factor on the right-hand side of equation (8), the same formula cannot be mechanically applied to the case of an energy-price increase. Taken alone, and absent changes in the prices of other tradable and nontradable goods, that shock might not have positive impact on the relative foreign price level for tradables, and therefore it might not result in a rise in q_m (an effective yen depreciation). The root cause of the high correlation shown in Figure 16 is therefore likely to lie in other factors that transform the real exchange rate over time and move the nominal exchange rate in the short term.

⁴² Makoto Hosoya at the Price Statistics Section of the Bank of Japan graciously provided disaggregated historical data underlying the BOJ’s import and export price indexes. The component weights allowed me to strip out energy prices.

A primary mechanism through which energy prices could affect the long-run real exchange rate is through the HBS channel, which modifies the second multiplicative

factor on the right-hand side of equation (8), $\frac{(P_N^* / P_X^*)^{1-\gamma}}{(P_N / P_X)^{1-\gamma}}$. Let us now write the

production functions for traded and nontraded goods as functions of capital, labor and oil inputs,

$$\begin{aligned} Y_T &= A_T F(K_T, L_T, O_T), \\ Y_N &= A_N G(K_N, L_N, O_T), \end{aligned}$$

and denote the world price of oil in terms of tradable goods by p_O . With the simplifying assumption of a constant rental rate on capital ($\hat{r} = 0$), the change in the relative price of

nontradables will be $\hat{p} = \frac{\mu_{LN}}{\mu_{LT}} \hat{A}_T - \hat{A}_N + \mu_{LN} \left(\frac{\mu_{ON}}{\mu_{LN}} - \frac{\mu_{OT}}{\mu_{LT}} \right) \hat{p}_O$. To the extent that tradables are

relatively energy intensive and nontradables relatively labor intensive, a rise in the energy price lowers the relative price of nontradables. If this effect operates asymmetrically across countries because, for example, Japanese manufacturing is more energy intensive than manufacturing abroad, a real depreciation of the yen would result. That mechanism works, however, by lowering manufacturing wages and is likely to play out only over time (though it might well affect long-term real exchange rate expectations immediately).

In an analysis based on relative labor productivities (rather than TFPs), the effect of energy prices would work *entirely* through labor productivity. A rise in energy prices would lower relative labor productivity in the energy-intensive tradable sector and cause a real depreciation. The incorporation of energy prices into the standard HBS framework

would not alter Figures 12a or 12b at all, although some of the productivity changes shown would be attributable to changing energy prices.

The high correlation in Figure 16 plausibly also reflects other mechanisms operating in the short term.⁴³ If wages are sticky and labor immobile in the short run between the economy's sectors, a rise in energy prices raises production costs and potentially creates unemployment. In this circumstance, real yen depreciation can substitute for a reduction in wages, shifting world demand toward Japanese exports and shifting Japanese demand toward Japanese nontradables. Because an oil shock is a global shock, however, this mechanism relies on the fact that Japan is more energy-dependent than most other energy importers.⁴⁴ Other potential channels for energy prices (or commodity prices in general) to influence the real exchange rate rely on wealth effects, as postulated by Ricci, Milesi-Ferretti, and Lee (2008). If market participants view higher energy prices as permanent, they might also adjust their expectations of long-run capital intensity and possibly growth downward, with immediate repercussion on the real exchange rate.⁴⁵ Through myriad channels, the price of oil has had a decisive influence on the yen's real exchange rate over the period of this study, with the yen generally depreciating when the real price of oil is rising and appreciating when it is falling.

⁴³ These short-run effects are strengthened if monetary policy systematically responds expansively to increases in the oil price.

⁴⁴ Findlay and Rodríguez (1977) present a short-term Mundell-Fleming type model that can deliver this sort of result.

⁴⁵ Sachs (1983) explores a growth model with flexible exchange rates and energy inputs.

Secular Deterioration in Japan's Terms of Trade

Between 1988 and 2007, Japan's comprehensive terms of trade declined by more than 54 percent (in log points). The decline in the ex-energy terms of trade, at only about 18 percent, is much less dramatic; see Figure 17. Much of the latter decline occurred after 1994, and it has arguably contributed to the yen's real depreciation since then. Any definitive account of Japan's terms of trade would require a close analysis of disaggregated import and export price and quantity data, an undertaking that is beyond the scope of this paper (but a very worthy area for future research). Here I simply offer a few observations and conjectures.

IMPLICATIONS OF SLOWER GROWTH AND REDUCED INNOVATION. Slower growth and dynamism in Japan's economy may have resulted in relatively more growth along the intensive than the extensive margin. Krugman (1989) has emphasized that growth in exports of new products need not depress the terms of trade, in contrast to growth at the intensive margin. Thus, a reduced pace of growth and innovation in Japan could contribute to declining terms of trade.

An additional implication of slower growth is that imperfectly competitive Japanese exporters could have experienced declining market power in world markets, leading to lower export prices. As noted above, pricing-to-market appears to be widespread in global markets for manufactures, a fact that has inspired theoretical analyses over more than two decades, ranging from Dornbusch (1987) and Krugman (1987) to Atkeson and Burstein (2008) and Burstein and Jaimovich (2008). In a model of Bertrand competition among sellers, in which buyers have a constant elasticity of

substitution ε among varieties of a good, the markup charged by a monopolistic producer of a particular variety is given by

$$\frac{\text{price}}{\text{marginal cost}} = \frac{\varepsilon(1-s)}{\varepsilon(1-s)-1},$$

where s is the exporter's global market share. Between 1993 and 2003, Japan's share in world exports of manufactured goods declined from 12.5 to only 7.5 percent (Gaulier, Lemoine, and Ünal-Kesenci 2007),⁴⁶ while Japan's share in world income likewise declined. This dynamic would have led to lower markups over time; and with labor costs and markups both declining, export prices had to fall as well. Intuitively, the pricing decisions of a larger player have bigger effects on the global price index for the good, thereby reducing the perceived price elasticity of demand. As the Japanese economy shrank, Japanese exporters therefore perceived increasingly intense competition abroad.

CHANGING TRADE PATTERNS AND CHINA'S ROLE. China's emergence as a leading exporter no doubt has numerous implications for Japan's economy. Chinese export products display a surprisingly large overlap with those of OECD countries (Schott 2006; Amiti and Freund 2009; Wang and Wei 2009), so it is conceivable that the country's rapid export growth has undercut the prices of Japanese exports. Coleman (2007) develops a global growth model in which such effects drive resource reallocation among trade partners. He argues that price and production trends in Asian-Pacific countries are broadly consistent with the model's predictions.

⁴⁶ Interestingly, and possibly relevant to the terms-of-trade trend, Japanese imports as a share of world imports declined by much less in percentage terms, from 5.1 to 4 percent.

Japan's trade patterns have indeed changed radically since the mid-1990s, with a general reorientation of its import and export trade toward Asia and significant changes in the composition of its trade. Japan now exports more parts and components and semi-finished goods relative to capital goods, with much of the flow going to China for processing, assembly, and re-export. At the same time, Japan's imports have swung toward parts and components and capital goods produced in China. These changes have been driven by a number of factors, including structural changes within Asia, greater regional integration, and the birth in 1995 of NAFTA, the trade-diverting effects of which have helped make North America less important in Japan's trade.⁴⁷

The implied terms of trade changes are not obvious *a priori*. Japanese exporters may have faced downward price pressure in the course of trade re-orientation, but China's goods (including its exports to Japan) are priced quite competitively in world markets (Schott 2006). In light of the dramatic change in trade patterns, one must be cautious in interpreting movements in aggregate export or import price indexes, as emphasized by Weinstein and Broda (2009). One must also question even more strongly any identification of export prices with consumer prices for tradable goods. Eichengreen, Rhee, and Tong (2007) conclude that on balance, China's export growth has had more important consequences important for low-income Asian countries than for higher-income Asian countries such as Japan.

There is another important channel through which China's torrid growth through mid-2008 affected Japan's overall terms of trade: by pushing up global commodity prices, notably the price of energy.

⁴⁷ Again, see Gaulier, Lemoine, and Ünal-Kesenci (2007).

Conclusion

The recent history of the yen suggests prolonged departures from longer-run trends, especially with respect to the U.S. dollar. These departures cannot be explained reliably even after the fact, but they appear to be related to macroeconomic policy actions, both in Japan and abroad, and to market expectations of future policies.

In Japan's economic history after the generation and collapse of the great asset price bubble, the yen's strong real appreciation in 1990-95 stands out as a pivotal episode. From the point of view of the Harrod-Balassa-Samuelson theory, prior sectoral growth trends changed around this time, and it is doubtful that foreign exchange market participants were able to foresee these structural shifts. Against the United States, relative tradables productivity growth actually went into decline, whereas against Germany it leveled off, as Figures 12a and 12b show. To the extent that foreign exchange markets were mistakenly expecting a return to previous growth trends, the yen's expected future real exchange rate could have been artificially high. Short-term monetary developments may have reinforced the latter stages of this appreciation, and trade tensions with the United States certainly played a role, as discussed above. In any case, the strong yen appreciation helped propel the Japanese economy into stagnation and deflation.

The yen's trend depreciation since early 1995 is more easily justifiable in terms of the underlying evolution of sectoral productivity growth and of overall growth in Japan and its trading partners. Japan's terms of trade have declined along with the yen's real exchange rate, and have contributed to the latter depreciation trend. Real yen depreciation after 1995 has to some degree bolstered the economy through export promotion, though

renewed trade friction with the United States remains a threat. The yen's sharp appreciation late in 2008 in the midst of the global financial crisis, coupled with the collapse of the Asian and American markets for Japanese exports, has once again thrown Japan into deep recession.

References

Ahearne, Alan, and others. "Preventing Deflation: Lessons from Japan's Experience in the 1990s." International Finance Discussion Papers 729, Board of Governors of the Federal Reserve System, June 2002.

Alexius, Annika and Peter Sellin. "Exchange Rates and Long-Term Bonds." Mimeo, Uppsala University and Sveriges Riksbank, April 2002.

Amano, Robert A. and Simon van Norden. "Exchange Rates and Oil Prices." *Review of International Economics* 6 (November 1998): 683-94.

Amiti, Mary and Caroline Freund. "An Anatomy of China's Export Growth." In Robert Feenstra and Shang-Jin Wei, eds., *China's Growing Role in World Trade*. Chicago: University of Chicago Press, 2009, forthcoming.

Asea, Patrick K. and Enrique G. Mendoza. "The Balassa-Samuelson Model: A General Equilibrium Appraisal." *Review of International Economics* 2 (October 1994): 244-67.

Atkeson, Andrew and Ariel Burstein. "Pricing-to-Market, Trade Costs, and International Relative Prices." *American Economic Review* 98 (December 2008): 1998-2031.

Auerbach, Alan J. and Maurice Obstfeld. "The Case for Open-Market Purchases in a Liquidity Trap." *American Economic Review* 95 (March 2005): 110-37.

Bank of Japan. "Minutes of the Monetary Policy Meeting on March 8 and 9, 2006." *Bank of Japan Quarterly Bulletin* 14 (no. 2, 2006).

Basu, Susanto. "Procyclical Productivity: Increasing Returns or Cyclical Utilization?" *Quarterly Journal of Economics* 106 (August 1996): 719-51.

Basu, Susanto and John Fernald. "Why is Productivity Procyclical? Why Do We Care?" In *New Developments in Productivity Analysis*, edited by Charles R. Hulten, Edwin R. Dean, and Michael J. Harper. Chicago: University of Chicago Press, 2001.

Burstein, Ariel and Nir Jaimovich. "Understanding Movements in Aggregate and

Product-Level Real-Exchange Rates.” Mimeo, UCLA and Stanford University, November 2008.

Caballero, Ricardo J., Takeo Hoshi, and Anil K. Kashyap. “Zombie Lending and Depressed Restructuring in Japan.” *American Economic Review* 98 (December 2008): 1943-77.

Canzoneri, Matthew B., Robert E. Cumby, and Behzad Diba. “Relative Labor Productivity and the Real Exchange Rate in the Long Run: Evidence for a Panel of OECD Countries.” *Journal of International Economics* 47 (April 1999): 245-66.

Cargill, Thomas F., Michael M. Hutchison, and Takatoshi Ito. *Financial Policy and Central Banking in Japan*. Cambridge, MA: MIT Press, 2000.

Cashin, Paul, Luis F. Céspedes, and Ratna Sahay. “Commodity Currencies and the Real Exchange Rate.” *Journal of Development Economics* 75 (October 2004): 239-68.

Chen, Yu-chin and Kenneth Rogoff. “Commodity Currencies.” *Journal of International Economics* 60 (May 2003): 133-60.

Chinn, Menzie. “The Usual Suspects? Productivity and Demand Shocks and Asia-Pacific Real Exchange Rates.” *Review of International Economics* 8 (February 2000): 20-43.

Chinn, Menzie. “The (Partial) Rehabilitation of Interest Rate Parity in the Floating Rate Era: Longer Horizons, Alternative Expectations, and Emerging Markets.” *Journal of International Money and Finance* 25 (February 2006): 7-21.

Choudhri, Ehsan U. and Mohsin S. Khan. “Real Exchange Rates in Developing Countries: Are Balassa-Samuelson Effects Present?” *International Monetary Fund Staff Papers* 52 (no. 3, 2005): 387-409.

Clarida, Richard H. and Daniel Waldman. “Is Bad News about Inflation Good News for the Exchange Rate? And, If So, Can That Tell Us Anything about the Conduct of Monetary Policy?” In John Y. Campbell, ed., *Asset Prices and Monetary Policy*. Chicago: University of Chicago Press, 2008, pp. 371-92.

Coleman, Wilbur John, II. “Accommodating Emerging Giants.” Mimeo, Duke University, November 2007.

De Gregorio, José, Alberto Giovannini, and Holger C. Wolf. “International Evidence on Tradables and Nontradables Inflation.” *European Economic Review* 38 (June 1994): 1225-44.

Dekle, Robert and Kyoji Fukao. “The Japan-U.S. Exchange Rate, Productivity, and the Competitiveness of Japanese Industries.” Mimeo, USC and Hitotsubashi University, November 2008.

DeLoach, Stephen B. "Do Relative Prices of Non-Traded Goods Determine Long-Run Real Exchange Rates?" *Canadian Journal of Economics* 30 (November 1997): 891-909.

Devereux, Michael B. "Real Exchange Rate Trends and Growth: A Model of East Asia." *Review of International Economics* 7 (August 1999): 509-21.

Dornbusch, Rudiger. "Exchange Rates and Prices." *American Economic Review* 77 (March 1987): 93-106.

Drine, Imed and Christophe Rault. "Does the Balassa-Samuelson Hypothesis Hold for Asian Countries? An Empirical Analysis Using Panel Cointegration Tests." Mimeo, Sorbonne and Evry Universities, 2003.

Eichengreen Barry, Yeongseop Rhee, and Hui Tong. "China and the Exports of Other Asian Countries." *Review of World Economics* 143 (2007): 201-26.

Engel, Charles. "Accounting for U.S. Real Exchange Rate Changes." *Journal of Political Economy* 107 (June 1999): 507-38.

Findlay, Ronald E. and Carlos Alfredo Rodríguez. "Intermediate Imports and Macroeconomic Policy under Flexible Exchange Rates." *Canadian Journal of Economics* 10 (May 1977): 208-17.

Gaulier, Guillaume, Françoise Lemoine, and Deniz Ünal-Kesenci. "China's Emergence and the Reorganisation of Trade Flows in Asia." *China Economic Review* 18 (September 2007): 209-43.

Hamada, Koichi and Yasushi Okada. "Monetary and International Factors Behind Japan's Lost Decade: From the Plaza Accord to the Great Intervention." Mimeo, Yale University and ESRI, Cabinet Office of Japan, December 2007. *Journal of the Japanese and International Economies*, forthcoming.

Hayashi, Fumio and Edward C. Prescott. "The 1990s in Japan: A Lost Decade." *Review of Economic Dynamics* 5 (January 2002): 206-35.

Hoshi, Takeo and Anil K. Kashyap. "Japan's Financial Crisis and Economic Stagnation." *Journal of Economic Perspectives* 18 (Winter 2004): 3-26.

Hsieh, David A. "The Determination of the Real Exchange Rate: The Productivity Approach." *Journal of International Economics* 12 (May 1982): 355-62.

Ito, Takatoshi. "The Yen and the Japanese Economy, 2004." In C, Fred Bergsten and John Williamson, eds., *Dollar Adjustment: How Far? Against What?* Washington, DC: Institute for International Economics, 2004.

Ito, Takatoshi, Peter Isard, and Steven Symansky. "Economic Growth and Real Exchange Rate: An Overview of the Balassa-Samuelson Hypothesis in Asia." In Takatoshi Ito and Anne O. Krueger, eds., *Changes in Exchange Rates in Rapidly Developing Countries*. Chicago: University of Chicago Press, 1999.

Ito, Takatoshi and Frederic S. Mishkin. "Two Decades of Japanese Monetary Policy and the Deflation Problem." In Takatoshi Ito and Andrew K. Rose, eds., *Monetary Policy with Very Low Inflation in the Pacific Rim*. Chicago: University of Chicago Press, 2006, pp. 131-93.

Kakkar, Vikas. "The Relative Price of Nontraded Goods and Sectoral Total Factor Productivity: An Empirical Investigation." *Review of Economics and Statistics* 85 (May 2003): 444-52.

Kakkar, Vikas and Masao Ogaki. "Real Exchange Rates and Nontradables: A Relative Price Approach." *Journal of Empirical Finance* 6 (April 1999): 193-215.

Kakkar, Vikas and Isabel Yan. "Real Exchange Rates and Productivity: Evidence from Asia." Mimeo, City University of Hong Kong, November 2006.

Kohli, Ulrich and Jean-Marc Natal. "The Real Exchange Rate and the Structure of Aggregate Production." Mimeo, Swiss National Bank, October 2008.

Krugman, Paul R. "Pricing to Market when the Exchange Rate Changes." In Sven W. Arndt and J. David Richardson, eds., *Real-Financial Linkages among Open Economies*. Cambridge, MA: MIT Press, 1987.

Krugman, Paul R. "Differences in Income Elasticities and Trends in Real Exchange Rates." *European Economic Review* 33 (May 1989): 1031-54.

Kuttner, Kenneth N. and Adam S. Posen. "The Great Recession: Lessons for Macroeconomic Policy from Japan." *Brookings Papers on Economic Activity* 2 (2001): 93-185.

Lane, Philip R. "International Financial Integration and Japanese Economic Performance." Mimeo, Trinity College, Dublin, November 2008.

Lee, Jaewoo and Man Keung Tang. "Does Productivity Growth Appreciate the Real Exchange Rate?" *Review of International Economics* 15 (February 2007): 164-87.

Lee, Jaewoo, Gian Maria Milesi-Ferretti, Jonathan Ostry, Alessandro Prati, and Luca Antonio Ricci. *Exchange Rate Assessments: CGER Methodologies*. Occasional Paper 261, International Monetary Fund, 2008.

Marston, Richard C. "Real Exchange Rates and Productivity Growth in the United States and Japan." In Sven W. Arndt and J. David Richardson, eds., *Real-Financial Linkages among Open Economies*. Cambridge, MA: MIT Press, 1987.

McKinnon, Ronald I. and Kenichi Ohno. *Dollar and Yen: Resolving Economic Conflict between the United States and Japan*. Cambridge, MA: MIT Press, 1997.

Mori, Naruki, Shigenori Shiratsuka, and Hiroo Taguchi. "Policy Responses to the Post-Bubble Adjustments in Japan: A Tentative Review." *Monetary and Economic Studies* 19 (February 2001): 53-102.

Obstfeld, Maurice. "Model Trending Real Exchange Rates." Working Paper C93-011, Center for International and Development Economics Research, University of California, Berkeley, February 1993. URL: [elsa/berkeley/edu/~obstfeld/model.pdf](http://elsa.berkeley.edu/~obstfeld/model.pdf)

Obstfeld, Maurice and Kenneth Rogoff. *Foundations of International Macroeconomics*. Cambridge, MA: MIT Press, 1996.

Obstfeld, Maurice and Kenneth Rogoff. "The Unsustainable U.S. Current Account Position Revisited." In Richard H. Clarida, ed., *G7 Current Account Imbalances*. Chicago: University of Chicago Press, 2007, pp. 339-66.

Officer, Lawrence H. "The Productivity Bias in Purchasing Power Parity: An Econometric Investigation." *International Monetary Fund Staff Papers* 23 (November 1976): 545-79.

Okina, Kunio, Masaaki Shirakawa, and Shigenori Shiratsuka. "The Asset Bubble and Monetary Policy: Japan's Experience in the late 1980s and the Lessons." *Monetary and Economic Studies* 19 (February 2001): 395-450.

Okina, Kunio and Shigenori Shiratsuka. "Asset Price Bubbles, Price Stability, and Monetary Policy: Japan's Experience." *Monetary and Economic Studies* 20 (October 2002): 35-76.

Park, Sungwook and Masao Ogaki. "Long-Run Real Exchange Rate Changes and the Properties of the Variances of k -Differences." Mimeo, Bank of Korea and Ohio State University, December 2007.

Ricci, Luca Antonio, Gian Maria Milesi-Ferretti, and Jaewoo Lee. "Real Exchange Rates and Fundamentals: A Cross-Country Perspective." IMF Working Paper WP/08/13, Research Department, International Monetary Fund, January 2008.

Rogoff, Kenneth. "Traded Goods Consumption Smoothing and the Random Walk Behavior of the Real Exchange Rate." *Monetary and Economic Studies* 10 (1992): 1-29.

Sachs, Jeffrey D. "Energy and Growth under Flexible Exchange Rates: A Simulation Study." In Jagdeep S. Bhandari and Bluford H. Putnam, eds., *Economic Interdependence and Flexible Exchange Rates*. Cambridge, MA: MIT Press, 1983.

Schott, Peter K. "The Relative Sophistication of Chinese Exports." Working Paper 12173, National Bureau of Economic Research, April 2006.

Taylor, Alan M. and Mark P. Taylor. "The Purchasing Power Parity Debate." *Journal of Economic Perspectives* 18 (Autumn 2004): 135-58.

Thomas, Alastair and Alan King. "The Balassa-Samuelson Effect in Asia: Now You See It, Now You Don't." Mimeo, University of Otago, 2004.

Vecchi, Michela. "Increasing Returns, Labour Utilization, and Externalities: Procyclical Productivity in the United States and Japan." *Economica* 67 (May 2000): 229-44.

Wang, Zhi and Shang-Jin Wei. "What Accounts for the Rising Sophistication of China's Exports?" In Robert Feenstra and Shang-Jin Wei, eds., *China's Growing Role in World Trade*. Chicago: University of Chicago Press, 2009, forthcoming.

Weinstein, David and Christian Broda. "Exporting Deflation? Chinese Exports and Japanese Prices." In Robert Feenstra and Shang-Jin Wei, eds., *China's Growing Role in World Trade*. Chicago: University of Chicago Press, 2009, forthcoming.

Yoshikawa, Hiroshi. "On the Equilibrium Yen-Dollar Rate." *American Economic Review* 80 (June 1990): 576-83.

Figure 1: Yen real exchange rate and Japan's growth

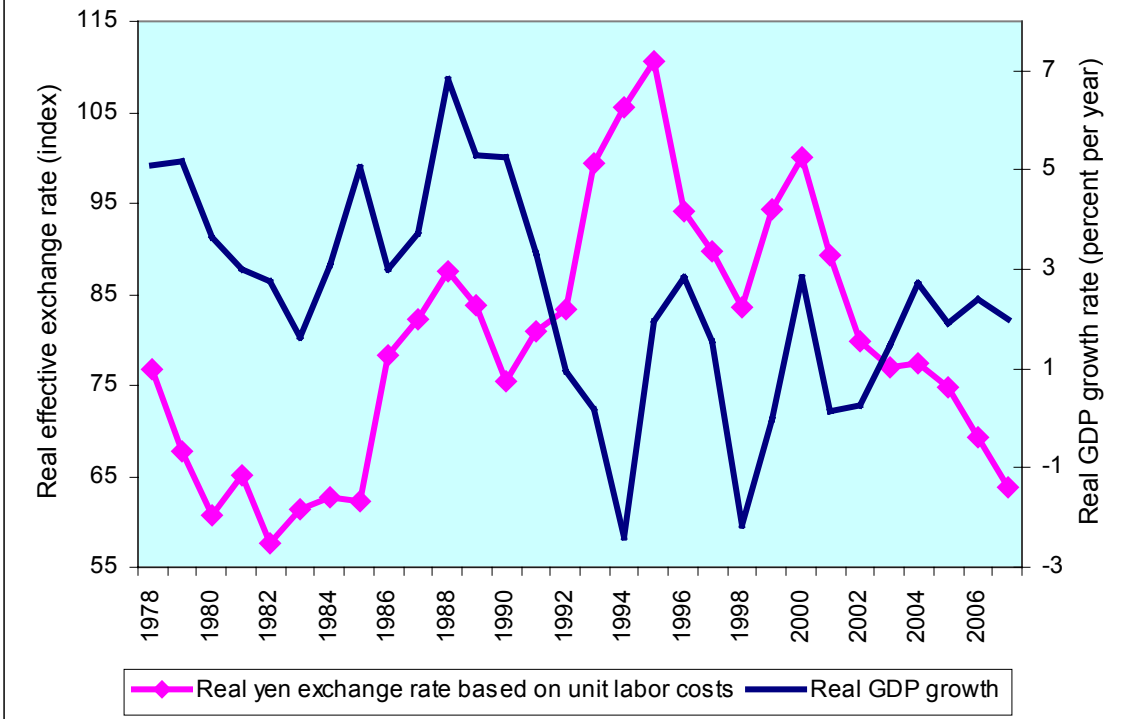


Figure 2: Yen/dollar nominal and real exchange rates

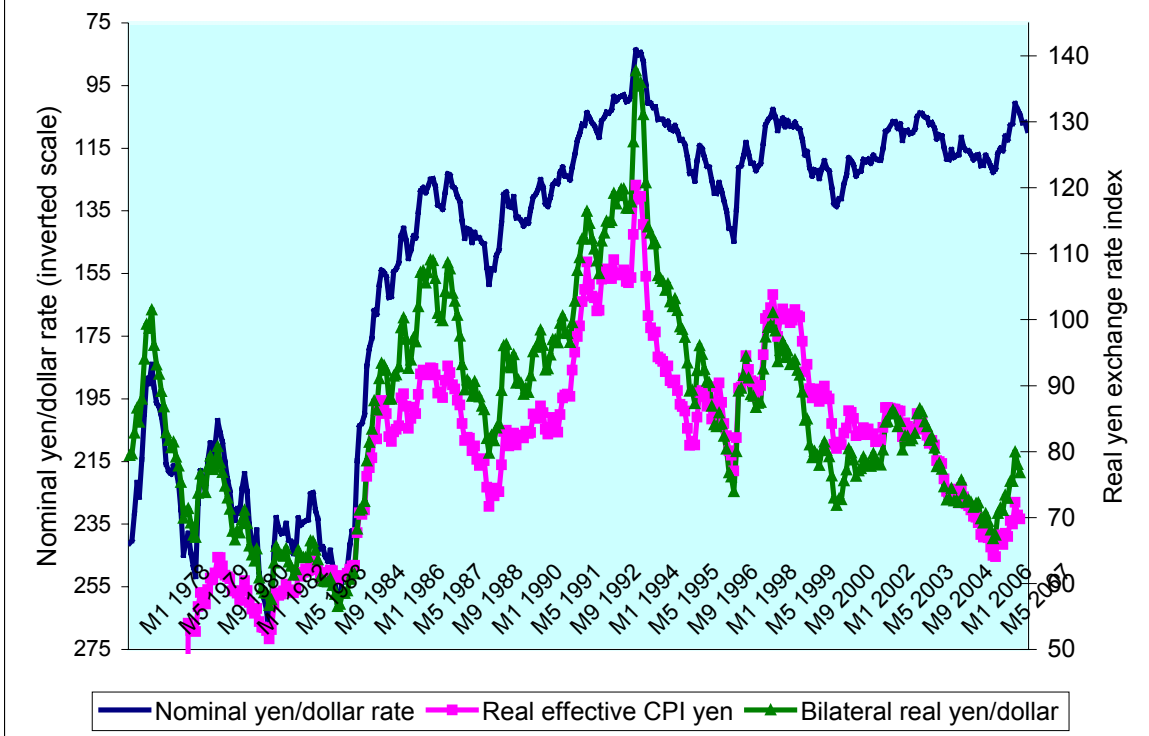


Figure 3: Japan nominal short-term interest rate

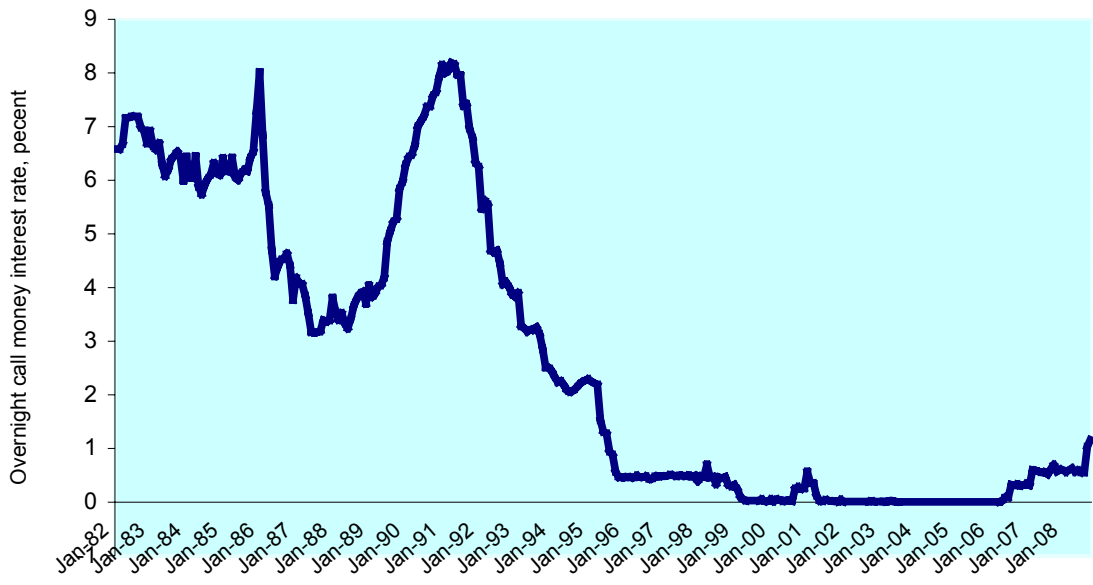
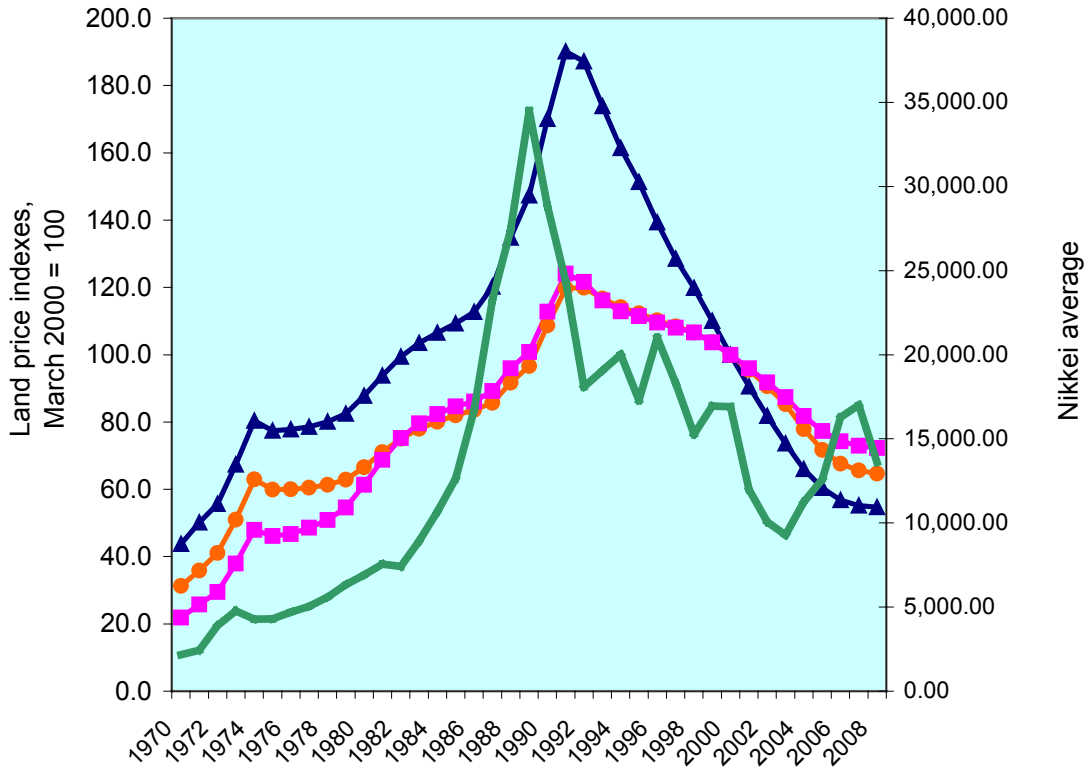


Figure 4: Land and stock-market prices



Sources: Real Estate Institute of Japan and Global Financial Data. Land-price indexes cover Tokyo, Osaka, Kobe, Yokohama, Nagoya, and Kyoto.



Figure 5: Japan and US Core CPI Inflation

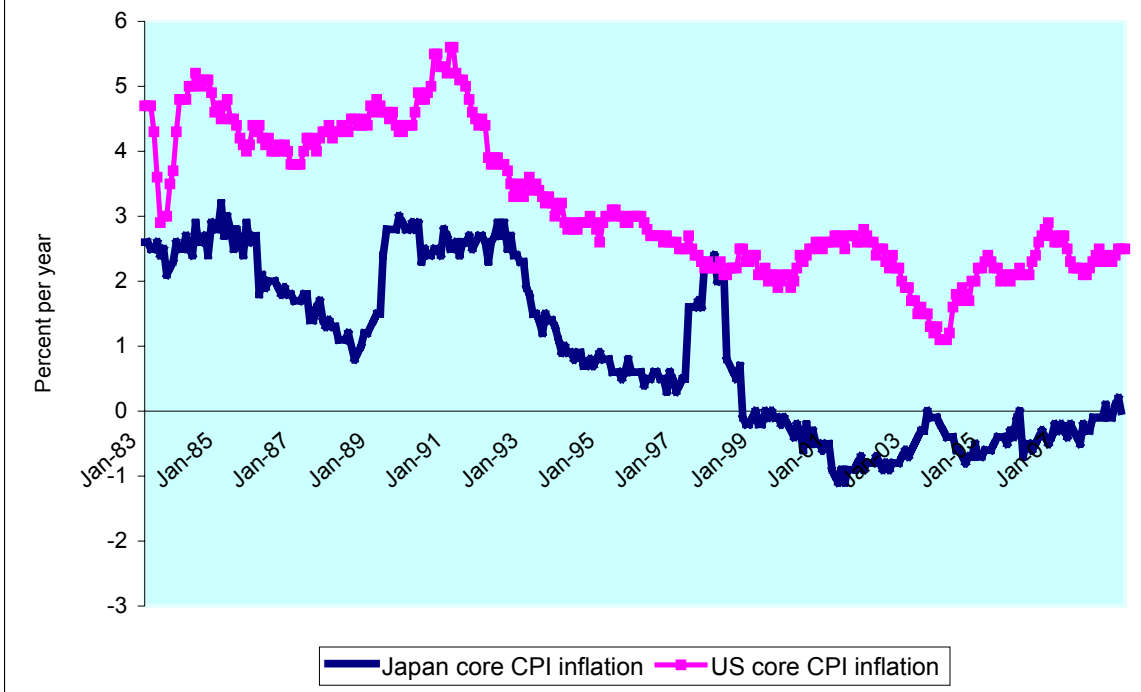


Figure 6: Japan less US real long-term interest differential and real exchange rate

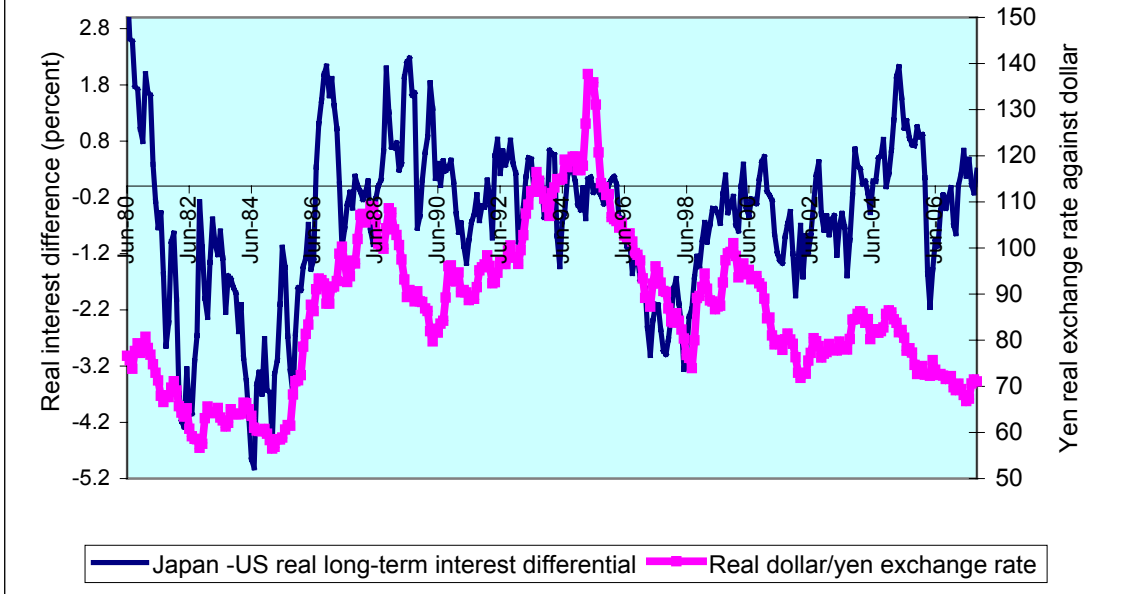


Figure 7: Japan less Germany real long-term interest differential and real exchange rate

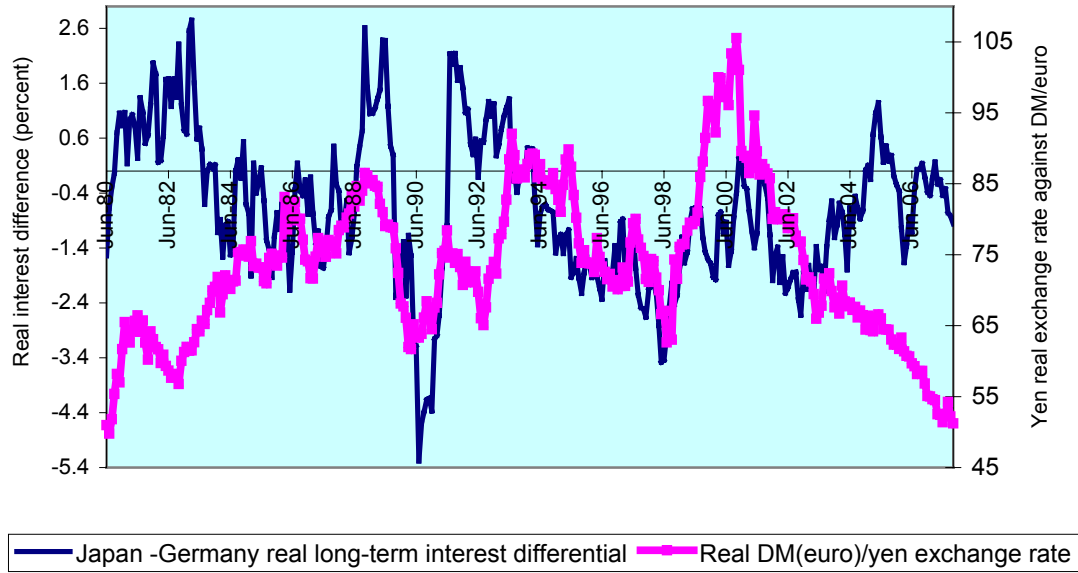


Figure 8: Dollar nominal short-term interest rate

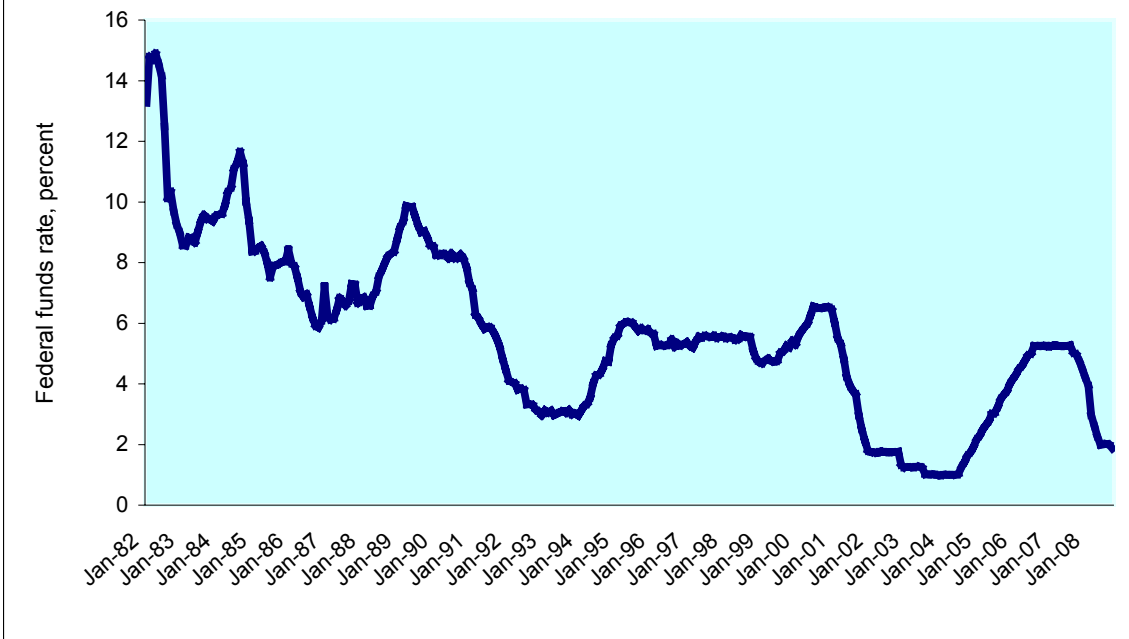


Figure 9: Japan and U.S. real GDP growth rates

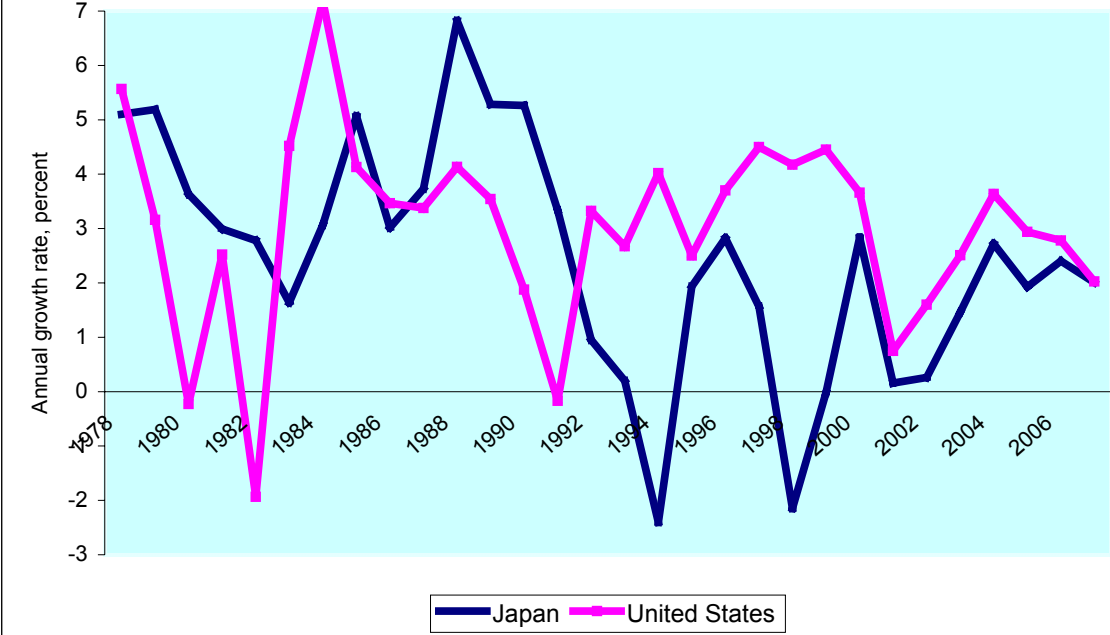


Figure 10a: Japan tradables

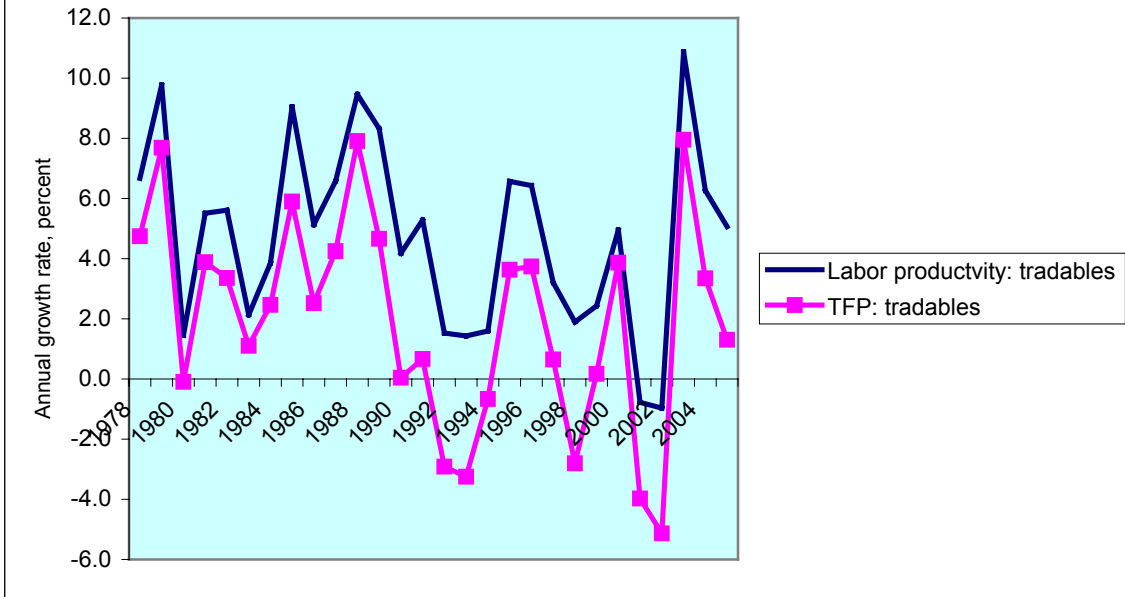


Figure 10b: Japan nontradables

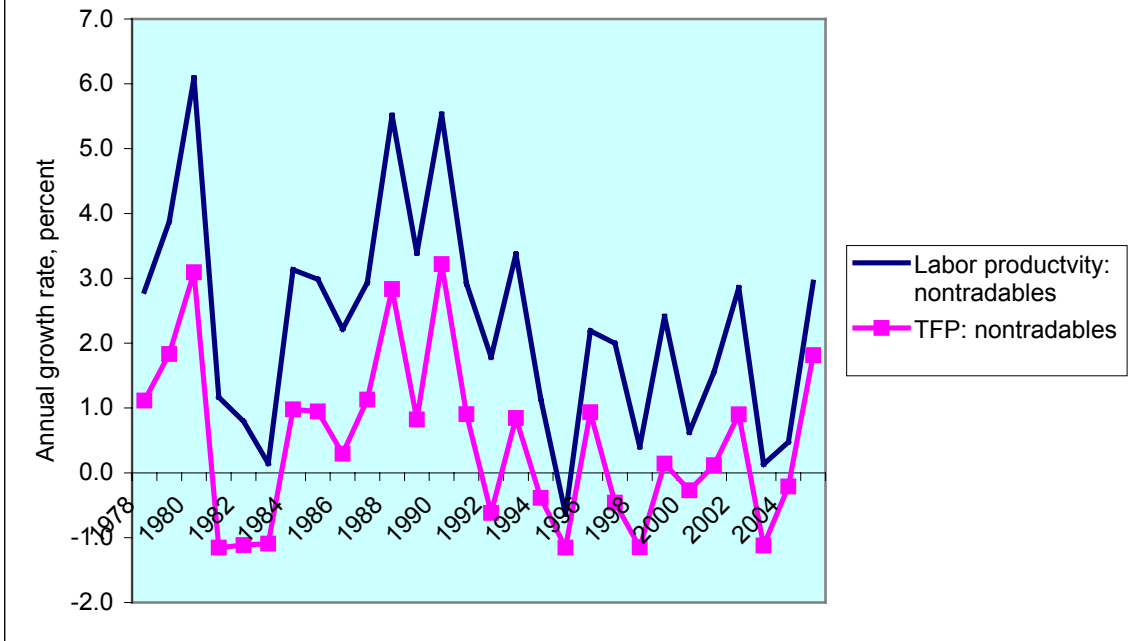


Figure 10c: United States tradables

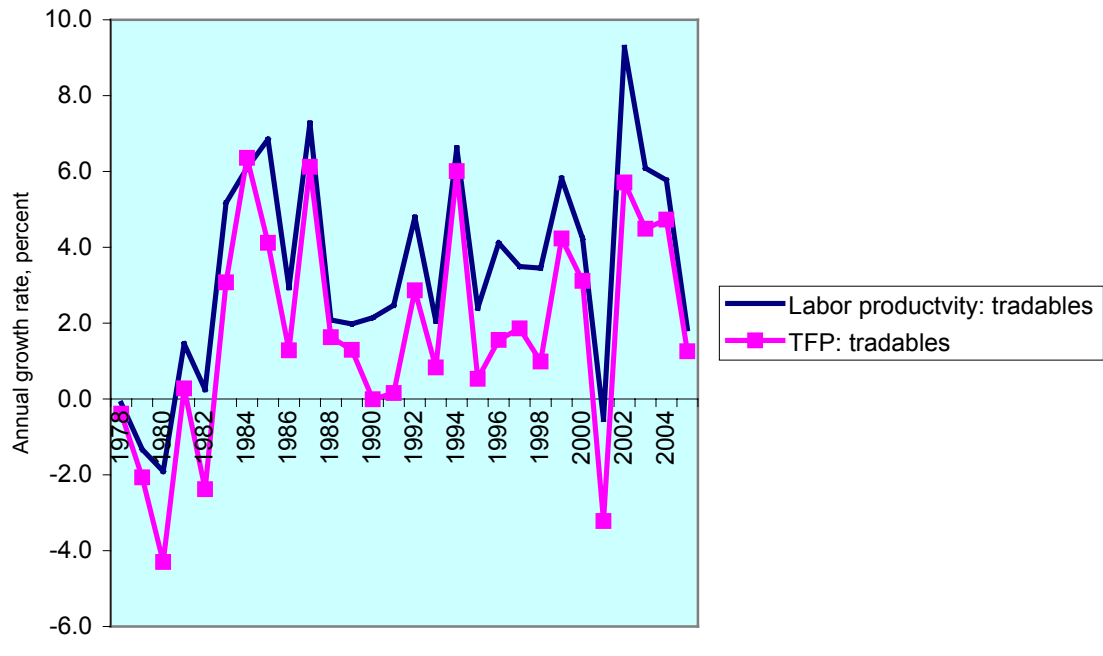


Figure 10d: United States nontradables

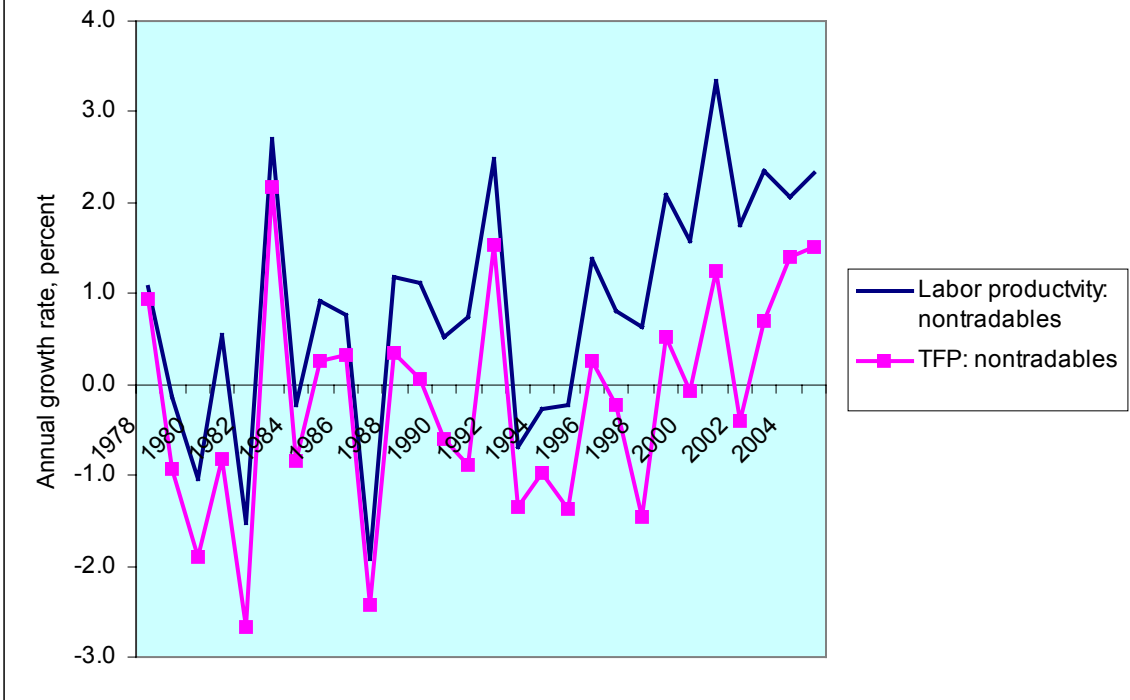


Figure 10e: Germany tradables

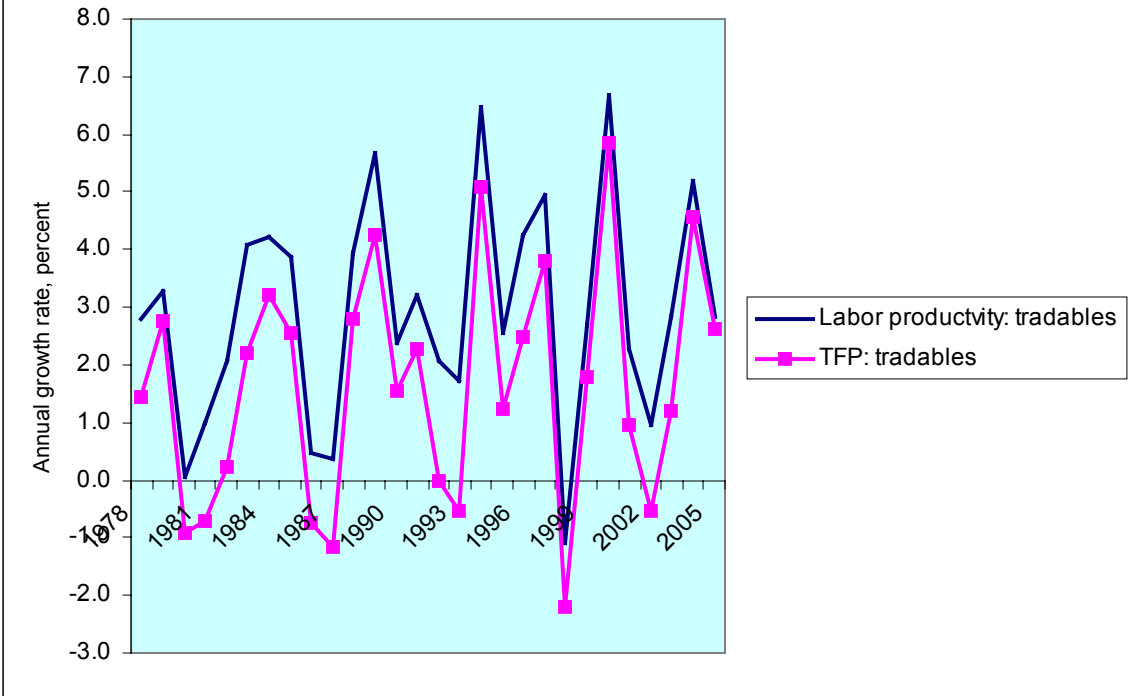


Figure 10f: Germany nontradables

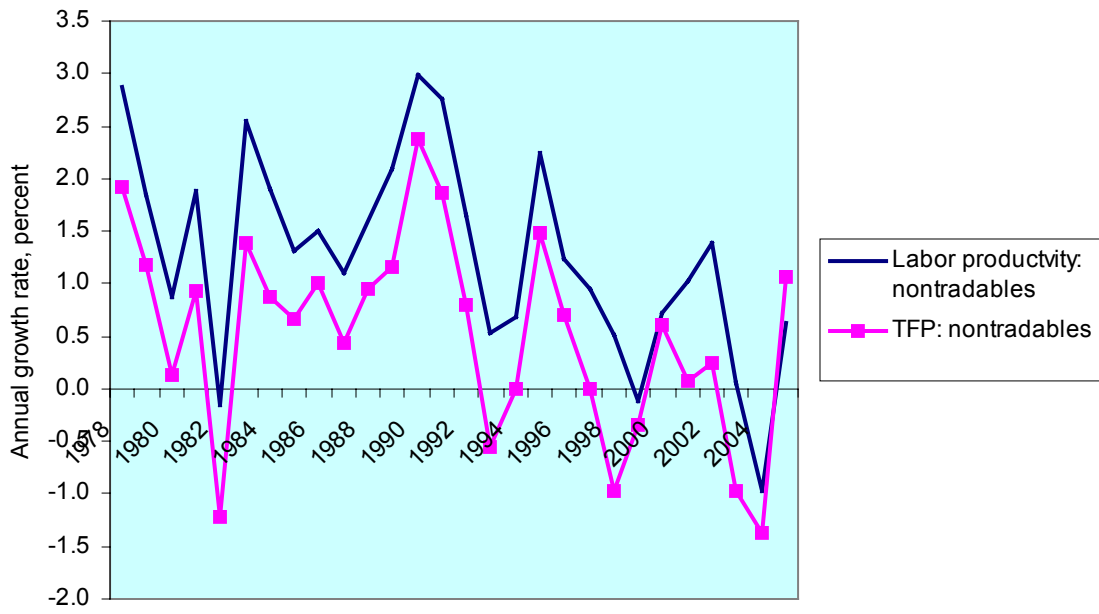


Figure 11a: Bilateral Japan/US productivity growth comparison and real exchange rate change

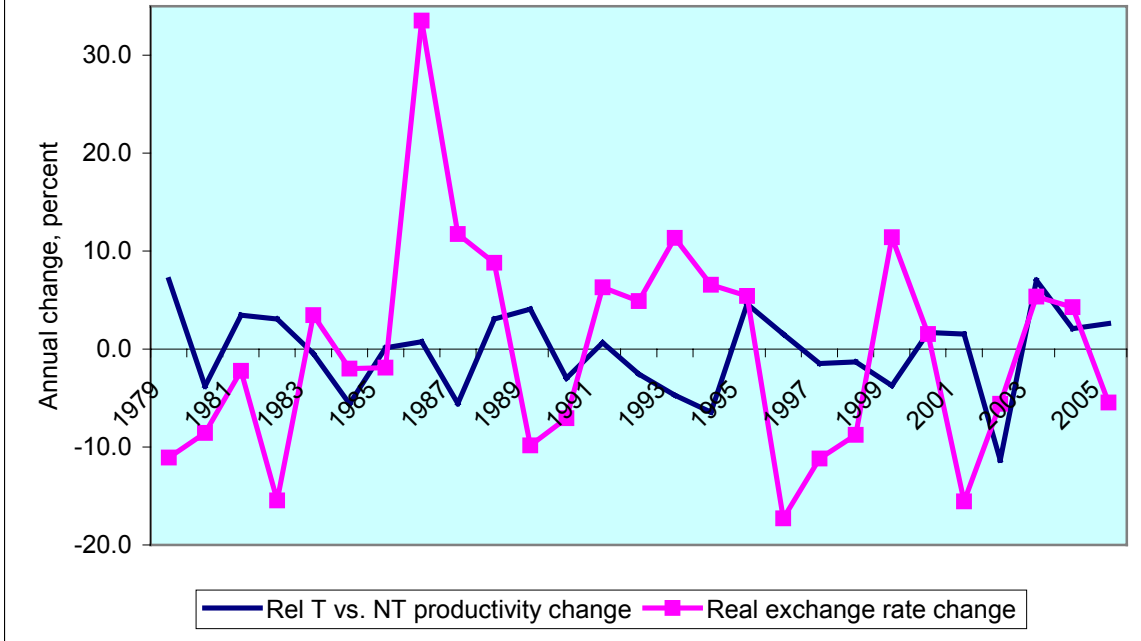


Figure 11b: Bilateral Japan/Germany productivity growth comparison and real exchange rate change

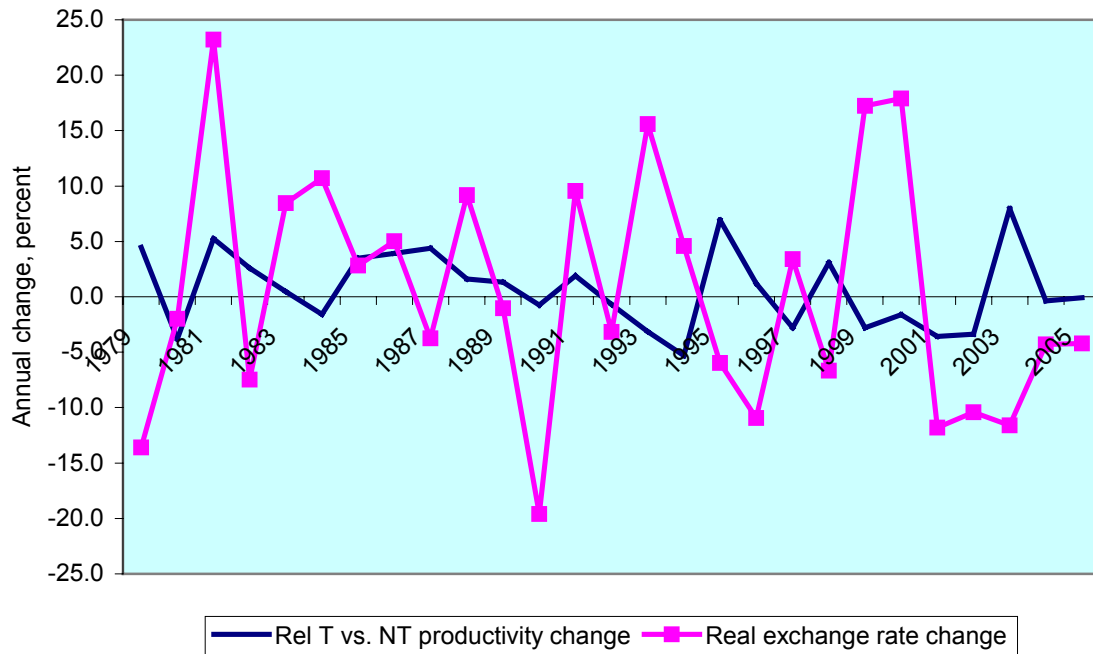


Figure 12a: Bilateral Japan/US productivity comparison and real exchange rate: Levels

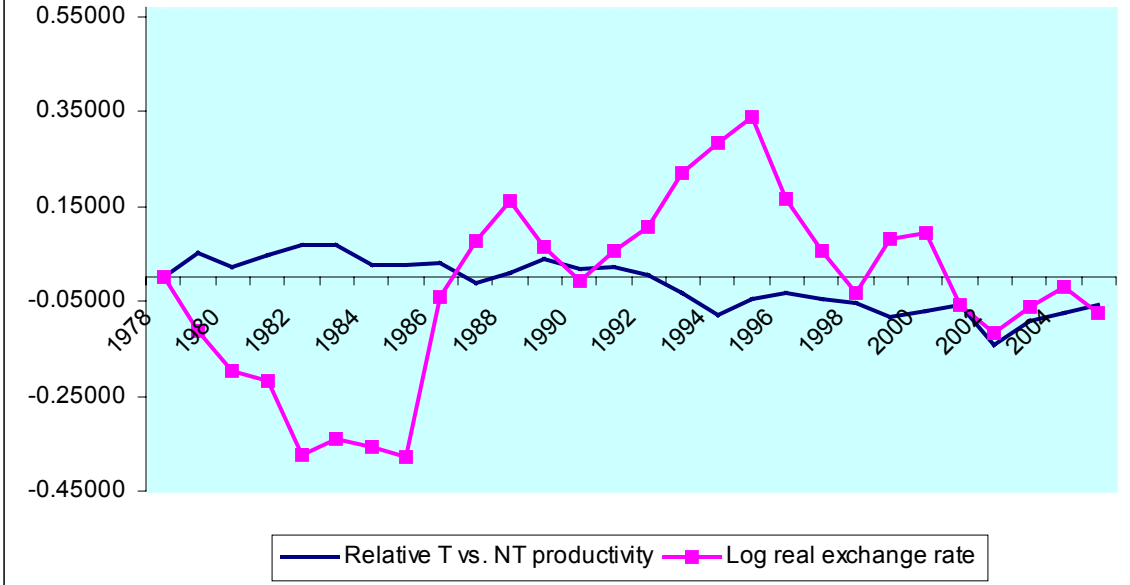


Figure 12b: Bilateral Japan/Germany productivity comparison and real exchange rate: Levels

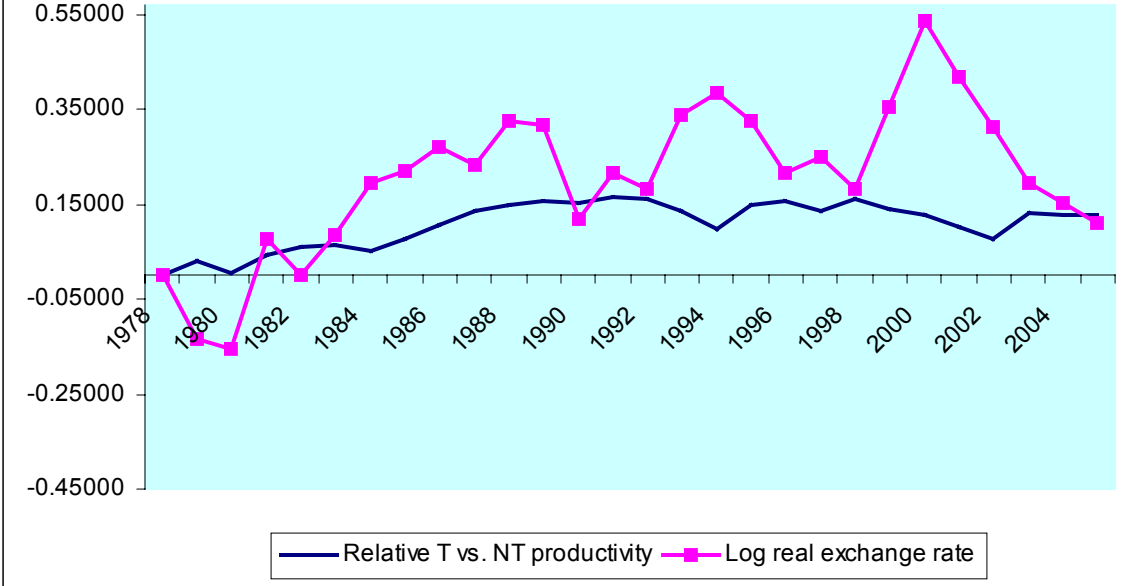


Figure 13: Real exchange rate vs. economy-wide productivity ratios

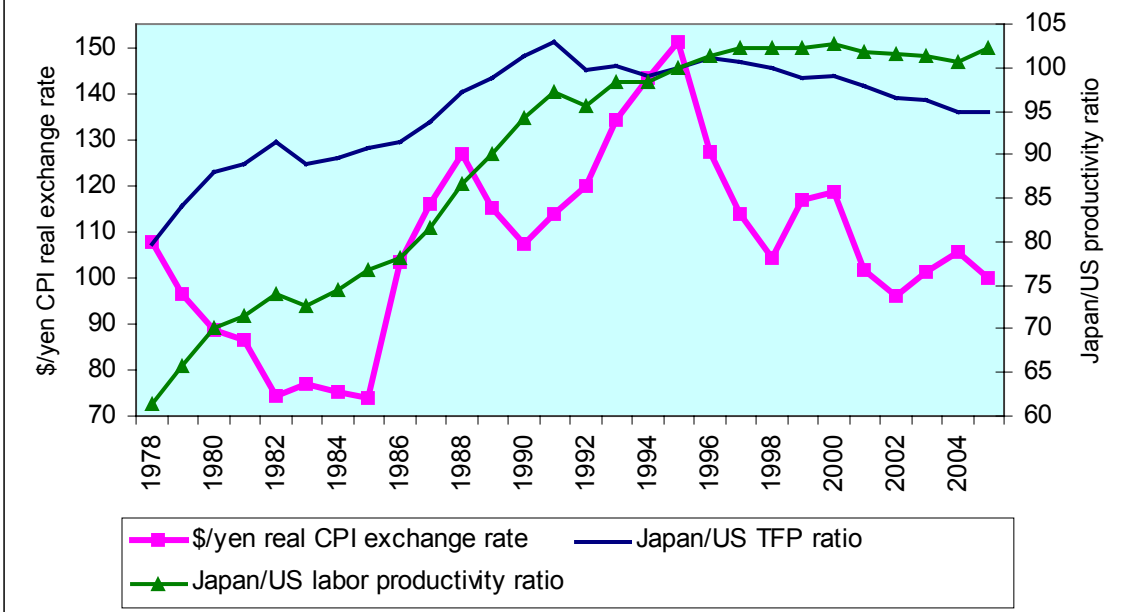


Figure 14: Real yen exchange rate and Japan's terms of trade

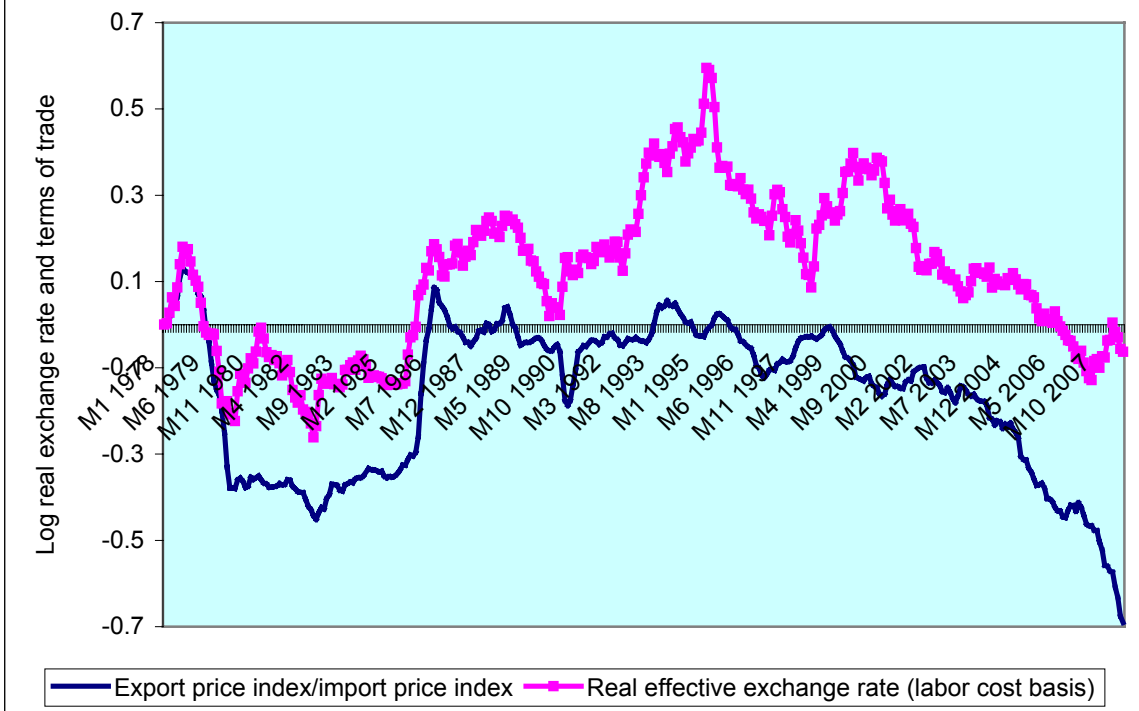


Figure 15a: Bilateral Japan/US terms of trade adjustment and composite simulated real exchange rate: Levels

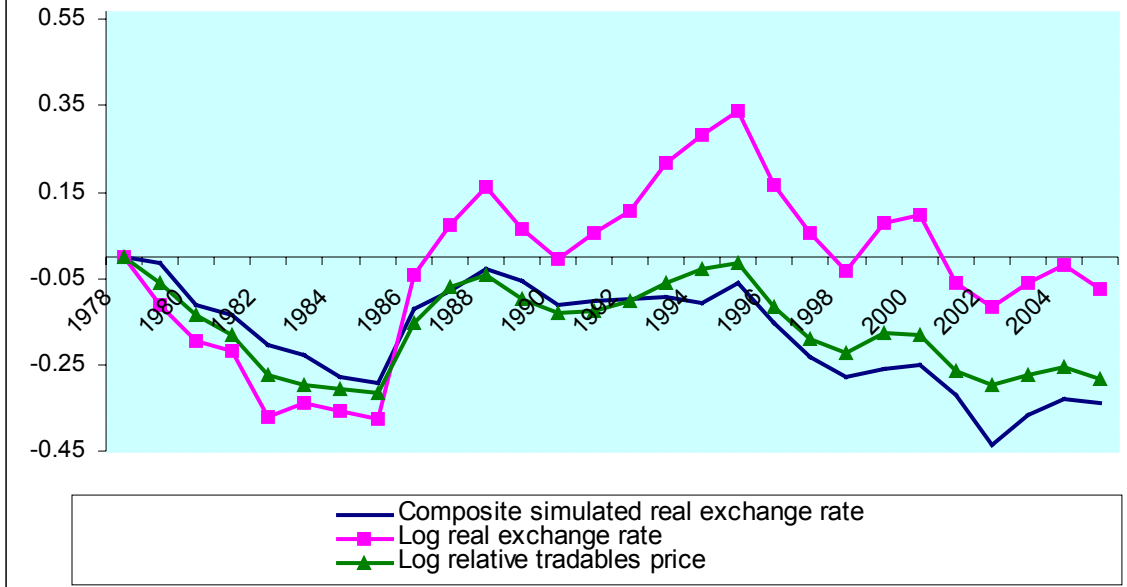


Figure 15b: Bilateral Japan/Germany terms of trade adjustment and composite simulated real exchange rate: Levels

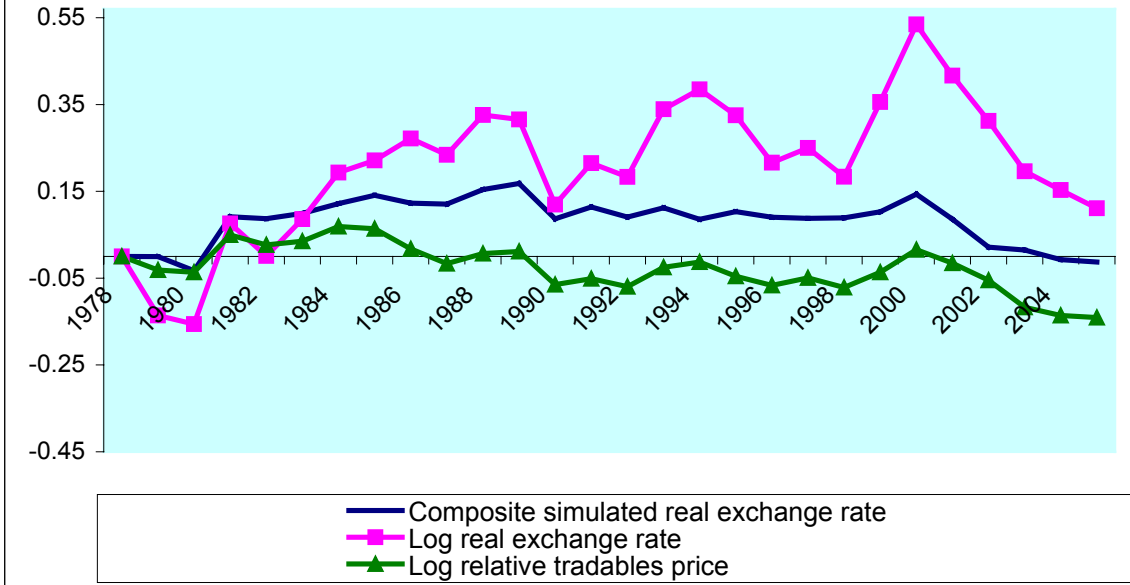


Figure 16: Oil prices and the yen's real exchange rate

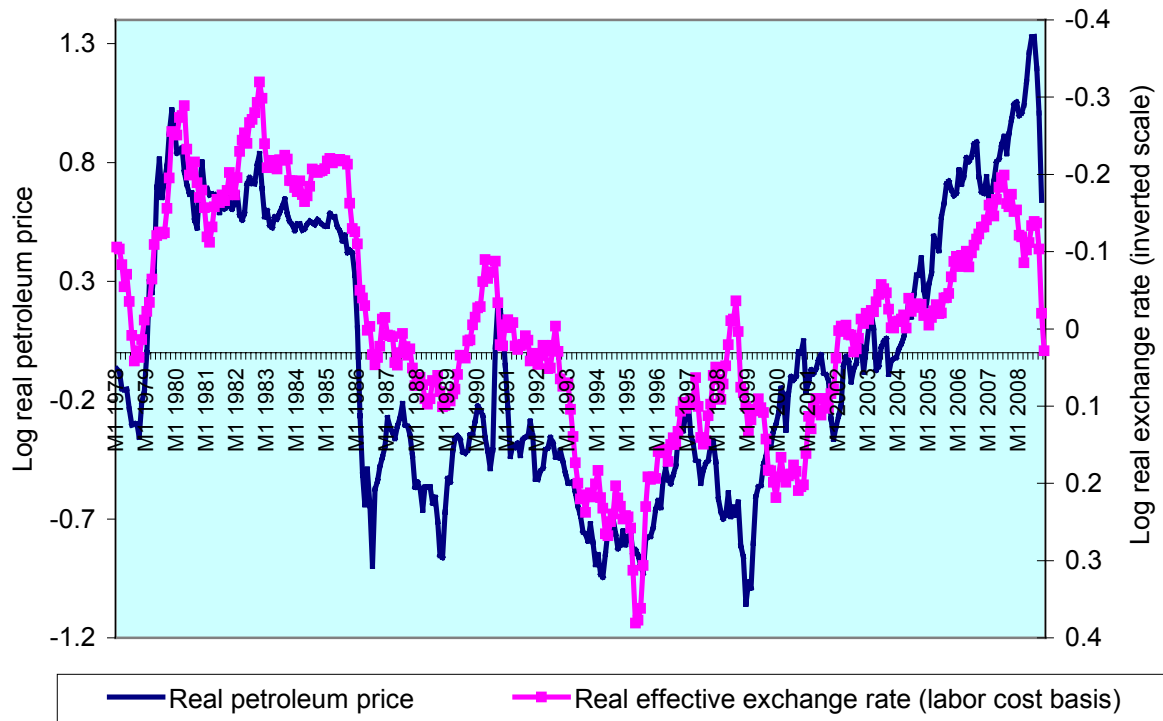


Figure 17: Real effective exchange rate, overall terms of trade, and ex-oil terms of trade

