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CAPITAL CONTROLS AND COVERED INTEREST PARITY

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ABSTRACT

This paper examines covered interest parity between Yen-denominated and dollar-denominated assets: Euro-yen and Euro-dollar three month deposit rates, and the representative and comparable three-month interest rates in Japan and in the U.S. An objective of this paper is to single out the portion of deviations from covered interest parity that is caused by capital controls imposed by the Japanese authority. To that end, new measures of one-way arbitrage gain are defined taking into account transactions costs associated with the bid-ask spread of exchange rates and the transactions tax on repurchase agreements, Gensaki, in Japan. According to our measure, covered interest parity has been holding, as theory predicts, in the Euro market since 1977. The Euro-Yen market must have been thin to have caused violations to parity in 1975 and 1976. Capital controls imposed by the Japanese Government are detected by one-way arbitrage measures between Gensaki in Japan and Euro-Dollar deposits between 1975 and 1980. After a new law was enacted in December 1980 which lifted most capital controls, covered interest parity has been holding between Gensaki and dollar-denominated assets.

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I. INTRODUCTION

Covered interest arbitrage must equalize net yields of assets denominated in different currencies taking into account the currency appreciation (or depreciation) expressed in the forward-spot spread. Since simultaneous transactions in the spot and forward markets eliminate any risks in the exchange rate fluctuations, covered interest parity is expected to hold in a theoretical model with perfect capital mobility all the time. However, it is not so straightforward to establish covered interest parity empirically.[1] Deviations observed in data can be attributed to one of the following reasons: (i) transactions costs associated with information gathering and processing, brokerage fees and commissions, and taxes on transactions; (ii) differences in treatment of income taxes on yields from assets in different currency denominations; (iii) capital controls in place on movement of short-term investments; (iv) default risk of an asset and political (country) risk of future capital controls; and (v) errors in (observed) variables.

An objective of this paper is to single out the portion of deviations from covered interest parity that is caused by capital controls imposed by the Japanese authority. To that end, data are carefully selected to avoid the problem of timing and errors in observations. Monthly data are cross-checked with daily data, when possible, in order to make sure that they are on the "end of month" basis. Transactions costs associated with the bid-ask spread and the transactions tax on repurchase agreements in Japan are taken into account.[2] Political risks due to the fear of future capital controls are discussed but not explicitly analyzed in this paper. This is not a serious problem, because the capital controls of Japan in the 1970's are being lifted one by one as explained in the next section.[3] Thus, we interpret any significant deviations from parity as evident that capital controls already in place became binding.

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Covered interest parity is examined for various pairs of on-shore and off-shore assets denominated in Yen and in U.S. dollars: Euro-Yen and Euro-Dollar three month deposit rates and the representative and comparable three-month interest rates in Japan and in the U.S. In section 3, we define and examine these measures of arbitrage gains in the traditional way, without taking into account transactions costs. Section 4 is devoted to developing new measures of one-way arbitrage gains net of transactions costs consisting of the bid-ask spread of exchange rates and the transactions tax. Positive entries of a measure are interpreted as deviations from parity due to capital controls. The measure which takes into account transactions costs in one direction is related to the theoretical concept of "one-way arbitrage" in Deardorff (1979).

A few comments on closely related works are in order. Otani and Tiwari (1981) and Otani (1982) examined capital controls and covered interest parity between Yen-denominated and dollar-denominated assets. Both works used daily data from 1978 to March 1981. They examined the difference between three-month Gensaki, which are repurchase agreements in Japan, and three-month Euro-Yen deposit rates. They found that the Gensaki rate was higher than the Euro-Yen rate from the beginning of 1978 to March of 1979, and that the reverse was true in the first quarter of 1980. The authors explained these deviations by episodes of capital controls by the Japanese Government. There are several differences between their papers and this one. First, by using monthly data we have documented a longer time series by various measures for apparent arbitrage gains from 1975 to April 1983 (and in the case of TEGATA, the Bill Discount rate, from 1972 to 1982). Second, taking into account the bid-ask spread of exchange rates and transaction taxes on Gensaki arrangements, we created a measure which picks up the deviation from parity due to capital controls net of obvious transactions costs.[4]

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II. A BRIEF HISTORY OF JAPANESE CAPITAL CONTROLS

Deregulation of Japanese capital controls came in several steps during the 1970's and was completed by the new Foreign Exchange and Foreign Trade Control Law in December 1980. Before 1974, most short-term capital flows in and out of Japan were in general restricted. No Japanese security companies could buy foreign bonds and no foreign companies could buy Japanese securities. However, subsequent fluctuations in the Yen were accompanied by deregulation of capital controls. When the Yen was depreciating quickly, deregulation to encourage inflows of capital took place, and when the Yen was rapidly appreciating, deregulation to encourage outflows of capital was introduced.[5] For example, in the wake of Yen depreciation, short-term government securities became available to non-residents in August 1974, although their interest rate was (and still is) fixed at a level lower than the market rate. In an attempt to stop a long process of Yen appreciation in 1977, Japanese security firms and others (with security firms' intermediation) were allowed acquire foreign securities. After hitting an all-time high in late 1978, the Yen depreciated rapidly in 1979. In that year, it became possible for foreign companies to purchase any Japanese securities in February and to trade repurchase agreements in May. In December 1980, the new law became effective. Under the new law, capital flows in and out of Japan are free with a few exceptions.[6] Investing in foreign securities is allowed to anybody without a security firm's intermediation; foreign loans need only prior reporting; non-residents can purchase and sell Japanese securities without any licensing; non-residents can issue bonds in Japan with prior reporting; and Japanese residents can open deposit accounts denominated in foreign currencies with market-determined interest rates.

The series of important deregulations mentioned above is expected to make

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conditions of covered interest parity involving the Tokyo market (GAIN measures 2, 4, and 5, which will be defined in the next section) show a convergence toward zero. Considering the capital controls in place before 1974, it would not be surprising to find unexploited profit opportunities before 1974. The band of deviations from parity should diminish between 1974 and 1980, and should be at a minimum after 1980. Since the U.S. did not have notable capital controls after the 1970's, any arbitrage GAIN measures involving the U.S. market should not show much deviation. The interest parity in the Euro market (GAIN 1) should provide a benchmark for how much deviation is "normal." When we consider the bid-ask spread to single out deviations caused by capital controls, one-way arbitrage gains should not be observed after December 1980. One can ask the question whether the new law has actually made any differences. It may have been the case that deregulation for the Japanese investors in 1977 and for the non-residents in 1979 was significant enough so that parity was already holding at the time the new law was introduced; or perhaps the new law only paid lip service to deregulation and included some unwritten barriers. The following sections of this paper will confirm or refute the above conjectures and answer the above-mentioned question.

III. ARBITRAGE GAINS: A TRADITIONAL APPROACH

Several measures of hypothetical arbitrage gains are defined between EUROY, the three-month Euro-Yen deposit rate in London; EUROD, the three-month Euro-Dollar deposit rate in London; RJA, the three-month repurchase agreement (Gensaki) rate in Tokyo; and RUS, the prime industrial paper rate in the U.S.[7] Measures GAIN1 through GAIN4 represent net arbitrage gains by investing in assets denominated in dollars rather than in assets denominated in Yen. Formally,

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$$GAIN\# = (1 + R\$) \frac{F}{S} - (1 + RY)$$

where F is the three-month forward exchange rate measured in Yen per dollar; S is the spot exchange rate measured in Yen per dollar; R\$ is the interest rate on the dollar-denominated asset, i.e., EUROD or RUS; RY is the interest rate for a Yen-denominated asset, i.e., EUROY or RJA. For

$$\# = \quad 1, \quad 2, \quad 3, \quad 4,$$

we substitute

$$R\$ = EUROD, \ EUROD, \ RUS, \quad RUS,$$

$$RY = EUROY, \ RJA, \quad EUROY, \ RJA,$$

respectively. Note that all the GAIN measures in this paper are expressed in simple annual yields.

Covered interest parity is supposed to hold almost by definition in the Euro currency market. The transactions costs are minimal and there is little time lag in trading and recording. The interbank deposits in different currencies bear similar and comparable risks. As the Euro-Yen market has become more active, covered interest parity should be confirmed by data without even minor exceptions. One source of deviations may be observation errors of exchange rates and timing of measurements. On the other hand, covered arbitrage operations from assets in Tokyo to Euro-dollar deposits or vice versa may be subject to various kinds of capital controls of the Japanese Government. Therefore, GAIN2 would measure deviations from parity due to capital controls. There is another way of looking at this effect. Taking the difference between GAIN2 and GAIN1, we have another measure of deviation associated with capital controls.

$$GAIN5 \equiv GAIN2 - GAIN1$$

$$= EUROY - RJA$$

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On the one hand, GAIN5 is better than GAIN2 as a measure of capital controls if there are substantial transactions costs with respect to spot and forward foreign exchange, and also if there are measurement errors in exchange rates.[8] On the other hand, GAIN2 would represent deviations due to capital controls more accurately than GAIN5 if the Euro-Yen market is not well developed. The mere fact that the Euro-Yen deposit rate was not available before 1975 suggests that it might be only recently that GAIN5 has become a reliable measure. We will consider both GAIN2 and GAIN5 as candidates for a measure of capital controls. Similarly, a measure of the U.S. capital controls is created by taking the difference between GAIN3 and GAIN1:

GAIN6 ≡ GAIN1 - GAIN3

= EUROD - RUS

In the existing literature, some of the above measures are used to show or to refute covered interest parity. Either positive or negative entries mean violations to covered interestparity in the strict sense. However, parity is said to be holding if the deviation is within a "band of neutrality." It is an immediate question of what determines this band. A relationship between the above measures of gains from arbitrage is schematically explained in Figure 1.

INSERT FIGURE 1 ABOUT HERE

Summary statistics of each gain measure are presented in Table 1. Since the capital controls in Japan were significantly relaxed in December 1980, statistics are calculated for sub-periods before and after December 1980 as well as for the entire period from 1975 to 1983.

INSERT TABLE 1 ABOUT HERE

Since transactions costs are minimal and there are no capital controls in the

Euro markets, large deviations from parity in measure GAIN1 are due to a thin market or observational errors. Variability represented by standard deviations of GAIN1 is reduced after December 1980 to a level less than a half of what it was between 1975 and December 1980. This may be due to the increase in capital flows after the 1980 deregulation and the resulting expansion of the Euro-Yen market. Compared to the decrease in variability of GAIN1, changes in standard deviations of GAIN2 and GAIN5 over the two sub-periods are drastic: they are reduced by 90 %. For the period after December 1980, standard deviations of GAIN2 and GAIN1 are very close to 0.25, and those of GAIN3 and GAIN4 are equal at 0.466. This suggests that deviations from parity were because of capital controls before the new law came into effect in December 1980. However, parity has been holding closely since 1981. The large standard deviations of GAIN2 and GAIN5 before December 1980 do not tell us which way the deviations were directed. Means of GAIN measures 2 through 5 show that investing in Yen-denominated assets were on average more profitable than otherwise by a slight margin, but standard deviations are too large to conclude this with confidence. A plot of a gain measure should be examined to determine whether deviations from parity are just random or are serially correlated. Figure 2 shows how GAIN5 changes over time.

INSERT FIGURE 2 ABOUT HERE

Most of the time before the middle of 1979, deviations from parity were in a direction such that there were potential arbitrage gains toward Yen-denominated assets. That was particularly true in the beginning of 1975 and in all of 1978. As explained in section 2, the purchase of Gensaki was allowed in May 1979, and other restrictions were lifted in December 1980. It can be seen from Figure 2 and Table 1 that these deregulations seems to have established covered interest parity between Gensaki and dollar-denominated

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assets. However, this remains a conjecture until we separate deviations
due to capital controls from those due to transactions costs. In the next
section, we will propose new measure of "one-way" arbitrage gain which is more
explicit than the idea of a band of neutrality.

IV. ARBITRAGE GAINS DUE TO CAPITAL CONTROLS

In this section, we define measures for arbitrage gain taking into
account explicitly the bid-ask spread for the exchange rates and the
transactions tax for the Gensaki asset. The exchange rate available to a
seller of Yen is not the same as the one to a buyer. Therefore, a measure of
interest arbitrage gain should involve different exchange rates depending on
the direction of a flow of funds. Covered interest parity implies that there
are no gains of arbitrage in either direction, which show up as non-positive
entries for the two one-way gain measures involving the same assets. The
transactions tax for Gensaki depends on the instrument and on who is trading.
The loss on the annualized yield of Gensaki arrangements between a security
company and a client with Government bonds as an instrument is estimated to be
0.16 %, as explained in Ito (1983). Therefore, the yield for RJA should be
reduced by 0.16.

Let us denote the "ask" rate of spot and forward exchange rates by SA and
FA, respectively. Then our new measures of arbitrage gains are defined in two
directions. The arbitrage gain of a dollar-denominated asset over Yen-
denominated asset has a suffix A after the number of the gain measure, and
a gain measure in the reverse direction has a suffix B:

$$\text{GAIN\#A} = (1 + R\$) \frac{FA}{S} - (1 + RY)$$

$$\text{GAIN\#B} = (1 + RY)\ \frac{SA}{F}\ -\ (1 + R\$)$$

where for # = 1,   2,   3,   4

we substitute

   R\$ = EUROD, EUROD,   RUS,   RUS

   RY = EUROY, RJA-0.16, EUROY, RJA-0.16.

For example, GAIN2B measures whether an economic agent in the Euro market currently holding three-month Euro-dollar deposits would rather invest in three-month Gensaki in Tokyo. Since GAIN5 and GAIN6 are gain measures which do not involve transactions costs of foreign exchange, they are the same as in the last section. "One-way" covered interest parity implies that any GAIN measure should be non-positive all the time.[9] Summary statistics of one-way GAIN measures are presented in TABLE 2. The asset originally held is described in each row. An alternative asset by covered arbitrage operations is described in each column. In each box are means and standard deviations for the periods before and after the new law of 1980. Theory predicts that a gain measure is non-positive not only on average but also in each entry. TABLE 3 lists the number of positive entries for each series in each year after 1975.

INSERT TABLES 2 AND 3 ABOUT HERE

It is just as theory predicts that two "one-way" gain measures in the Euro-market, GAIN1A and GAIN1B, stay negative after 1977 with few exceptions. The means of these measures, therefore, are negative. Standard deviations become smaller, indicating that any factors affecting covered interest parity have become stable. For example, transactions costs other than the bid-ask spread have become uniform for all participants in the Euro-Yen market due to

the market's expansion. Major violations to parity and a large swing in 1976 suggest that the Euro Yen market was thin at that time.

Gain measures between Euro-Dollars and Gensaki, GAIN2A and GAIN2B, show a different picture. The number of positive entries and means of GAIN2B before 1979 suggest that there were substantial unexploited profit opportunities from the Euro market toward the Gensaki asset. This was due to the capital controls in place then in Japan, in particular a barrier to inflows of capital. As explained in section 2, purchase of Gensaki by non-residents was prohibited until May 1979. Non-residents could only invest in other securities, such as treasury bills, which had interest rates "fixed" lower than the Gensaki rate before May 1979; the Gensaki market had been the only open market with a flexible interest rate.[10] Therefore, potential profit opportunities shown above reflect both capital controls in terms of prohibiting non-residents from purchasing Gensaki and the low interest rate policy affecting yields on alternative assets. Positive entries of GAIN2A persisted until the end of 1980. This suggests that deregulation of outflows of capital in 1977 was not enough to establish parity, and that it was the new law of 1980 which made parity hold. In order to see how lifting the capital controls affected the measure, GAIN2A and GAIN2B are plotted in Figure 2. The decline in standard deviations and non-positive movements of both GAIN2A and GAIN2B after 1980 are seen in Figure 3.

INSERT FIGURE 3 ABOUT HERE

Unlike the success in measuring deviations from parity associated with capital controls of Japan, gain measures involving American domestic assets do not behave as theory predicts. Violations to covered interest parity are evident in GAIN3B and GAIN4B; U.S. asset holders would have been better off investing in Euro-Yen or Gensaki, according to these numbers. There are two

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possible reasons for this anomaly. First, prime industrial paper in the U.S., used for the representative short-term interest rate in the Morgan Guarantee data bank, may not be the appropriate domestic instrument for studying covered interest arbitrage. However, the Gensaki rate, which is listed as the representative short-term rate in the same source, is appropriate for Japan. Second, additional transactions costs or default risk in connection with international debt crisis may be responsible for the deviations. See Kreicher (1982) for discussion of default risk and balance sheet constraints to explain apparent deviations in the GAIN6 measure using the CD rate as domestic interest rate.

V.   EXTENSIONS OF THE ANALYSIS

In this section, we extend our analysis from previous sections in two directions. First, we would like to confirm that the new measures of one-way arbitrage gains are useful in daily data, too. Since the measures developed in the preceding section predict non-positive entries all the time, covered interest arbitrage is tested better in finer frequencies. Second, the sample period is extended to include the early 70's. Between 1971 and 1974, just after the demise of the Bretton-Woods regime, the Japanese government tried to avoid a rapid appreciation of Yen and kept strong capital controls. It is of great interest to see whether covered interest arbitrage was holding during these turbulent years.

V.1 Arbitrage Gain Measures with Daily Data

Daily (weekdays excluding bank holidays) data are available to calculate GAIN1A and GAIN1B after 1978. The number of violations to parity, i.e., positive entries, and means and standard deviations of GAIN1A and GAIN1B are reported in the first two columns of Table 4.[11]

Examining the table and figures, we realize that although all reported means are negative, one of the two GAIN measures has more than one-tenth of its entries violating parity every year between 1978 and 1982. However, standard deviations have been decreasing so that in the first half of 1983 there are no violations to parity. Since the Euro market has expanded, the covered interest parity between the Euro Yen and Dollar markets is now holding as theory predicts. This is shown in the non-positive one-way arbitrage gain measures. Plots of daily data are available in Ito (1983) for GAIN1A and GAIN1B and in Otani (1982) for Gensaki and EUROY showing GAIN5 as their differences.

One may propose to consider a variant of the one-way arbitrage gain. In addition to using the bid-ask spread for the exchange rates, the bid-ask spread for three-month deposit rates could be used. Consider an arbitrage operation of borrowing the Euro-Yen at the ask rate and investing in the Euro-Dollar at the bid rate. The GAIN1A measure is modified by replacing the Euro-yen and Euro-dollar rates when used as the origins of arbitrage by their ask rates denoted by EUROYA and EURODA, respectively. Kreicher (1982) used the bid-ask spead of Euro-Dollar deposit rates in his calculation of one-way arbitrage gains between the Euro-Dollar and CD rates in the U.S., which are similar to GAIN6 of our definition. Our modified gain measures are defined as follows:

$$GAIN1AA = (1 + EUROD) \frac{FA}{S} - (1 + EUROYA)$$

$$GAIN1BB = (1 + EUROY) \frac{SA}{F} - (1 + EURODA)$$

The number of violations to parity and means and standard deviations of these modified GAIN measures are shown in the third and fourth columns of Table 4. According to the modified measures, covered interest arbitrage has been holding more than 95 % of the time since 1981, and the accuracy is improving over time. One problem with these measures is that since the mean is significantly different from zero, the modified measure is probably too strong in the sense that the marginal arbitrageurs in the market are not agents who issue the deposit certificates.

V.2 Experience in the Early 1970's

The end-of-month Gensaki series dates back only to 1975. In order to investigate covered interest parity during the turbulent years of the early 1970's, a substitute for the Gensaki rate is sought. A natural candidate is the (interbank) Bill Discount ("Tegata") rate with a maturity of two to three months.[12] The Tegata rate differs from the Gensaki rate in three respects: (i) the series is taken as "average over the month" as opposed to the "end of the month"; (ii) the interbank market is closed to nonresident investors (except foreign banks); (iii) the maturity of the instrument is classified as "two to three months" (and it is "two months" since October 1980). With these changes in mind, let us construct the modified gain measures, GAIN2T and GAIN4T, replacing RJA (Gensaki) by TEGATA in the definitions of GAIN2 and GAIN4, respectively. Figure 4 illustrates the fluctuations in GAIN2T between 1972 and 1982; and GAIN4T which is not shown here looks very similar to GAIN2T. How closely the Tegata rate is related to the Gensaki rate can be understood by comparing movements of GAIN2 and GAIN2T between 1975 and 1982. The modified series is quite comparable with the original series for that period in terms of direction of movements and the amplitude of fluctuations.

Let us focus on the modified measure between 1972 and 1974. This period
is characterized by fluctuations with amplitudes much wider than in later
periods. For example, in December 1973, GAIN2T became 30%. In that month
Tegata was 11.192% and EUROD was 10.13 %, while the spot rate was Y280/$ and
the forward rate was Y320/$. This is in contrast to the case in February
1973, when GAIN2T was below -10%. The Japanese interest rates were determined
quite independently from the forward premium (expected depreciation of Yen,
i.e., S < F) and the Euro-dollar interest rate. Most of these fluctuations in
GAIN2T can be attributed to the fluctuations in the forward premium or
discount, with comparable interest rates. These are sufficient evidence that
in the early 1970's, the Japanese capital market was isolated from the rest of
the world, as conjectured in Section 2. Any unexploited gains from arbitrage
in these periods were due to capital controls which made Japanese instruments
unavailable to non-residents and placed strong restrictions on the acquisition
of foreign securities by the Japanese.

VI. CONCLUDING REMARKS

This paper examines covered interest parity between Yen-denominated and
dollar-denominated assets. We propose a measure of one-way arbitrage gain
which singles out the deviations from parity due to capital controls.
According to our measure, covered interest parity has been holding, as theory
predicts, in the Euro market since 1977. The Euro-Yen market must have been
thin to have caused violations to parity in 1975 and 1976. Since 1977, the
standard deviations of the measure have been reduced gradually. This is

confirmed in daily data as well as monthly data.

In order to consider capital controls imposed by the Japanese Government, measures of one-way arbitrage gains between the Gensaki and Euro-dollar assets are examined from 1975 to 1983. The measure shows apparent unexploited arbitrage gains between 1975 and 1978. In particular, strong arbitrage gains existed in 1978 in the direction from Euro-Dollars to Gensaki. This is caused both by capital controls, in that non-residents were not allowed to purchase Gensaki, and by the low interest rate policy, in that assets available to non-residents had interest rates lower than the market (Gensaki) rate. After Gensaki became available to non-residents in May 1979 and the new Foreign Exchange Law became effective in December 1980, one-way arbitrage gains have almost disappeared, showing that these institutional changes were successful in establishing smooth short-term capital flows in and out of Japan.

Using the Tegata rate, a measure of arbitrage gain is extended back to 1972. The large fluctuations of the measure from 1973 to 1974 are due to very strict capital controls before 1974.

To sum up, we found in this paper that Japanese capital controls in place caused deviations from covered interest parity during 1972 to 1979. Gradual deregulation of capital controls from 1975 to 1980 contributed to smaller standard deviations in measures of arbitrage gains. Allowing non-residents to purchase Gensaki in May 1979 and the across-the-board deregulation of capital flows in December 1980 made significant changes in the behavior of measures of one-way arbitrage gains. Since January 1981, we have seldom observed positive unexploited arbitrage left in the market.

FOOTNOTES

1.   See Aliber (1973) for classifying different reasons for deviations from covered interest rate parity; these are reproduced below with modifications. Frenkel and Levich (1975,   1977, 1981) measured transactions costs by triangular arbitrage between different currencies. Frankel (1982) and Claasen and Wyplosz (1982) focused on the Franc with an emphasis on political risks and Otani and Tiwari (1981) and Otani (1982) demonstrated deviations from parity involving the Yen caused by capital controls for 1978-1982. Dooley and Isard (1980) explained deviations in foreign and domestic Mark-based interest rates by variables associated with political risks.

2.   This paper ignores deviations due to differences in taxation of corporate income from different sources.   Makin (1983) discusses the issue in a theoretical model but he considers purchasing power parity rather than covered interest parity.

3.   The Japanese deregulation of capital controls is in contrast to that in France which is described in Frankel (1982).   Strictly speaking, we cannot reject an alternative interpretation that the deviations result from the combination of capital controls already in place with a fear of the imposition of additional capital controls.

4.   Otani and Tiwari (1981) use a definition of transactions costs which is broader than ours. Their transactions costs include "not only brokerage fees but also costs in terms of taxes, search time, political risks, and ways in which market participants need to maneuver around any capital controls."

5.   However, there were a few occasions when controls were tightend, only to be deregulated shortly. See Otani (1981; Appendix) for details.

6. The law specifies various conditions under which controls can be reimposed: a dangerously unstable Yen; a threat to domestic capital markets, monetary policy, or balance of payments; a substantial threat to a domestic industry; or the inability of Japan to meet international agreements.

7. See appendices for the reasons we select these data and sources and definitions of data.

8. Most of the studies of interest rate parity use the difference between the on-shore and off-shore interest rates. Otani and Tiwari (1981) compared Euro-Yen and Gensaki rates. Claassen and Wyplosz (1982) studied the difference between the domestic Franc and Euro-Franc rates. It was the German Mark in Frankfurt and Zurich on which Dooley and Isard (1980) focused.

9. Although the name of "one-way" arbitrage is adopted from Deardorff, our definition is slightly different from his. We mean by one-way arbitrage a one-directional arbitrage between three-month assets denominated in home currency and an a set of operations consisting of selling home currency in the spot market, investing in foreign assets, and buying home currency in the forward market. Deardorff considered an arbitrage between buying foreign currency in the spot market and a set of operations consisting of investing (lending) in an asset denominated in home currency, selling home currency in the forward market, and selling short (borrowing) a foreign asset. Since both usages express the same phenomenon, covered interest arbitrage, our modified usage is appropriate.

10. For details, see Ito (1983).

11.   Observations which produce gain measures with more than 10 standard deviations from the mean of the respective sub-period are "trimmed." They are 1977:189, 1982:70, and 1983:115, where the dates are the number of weekdays.

12.   See Ito (1983) for the reason why the treasury bill rate (in Japan) cannot serve for the purpose here, and for characteristics of the Bill Discount rate, including a figure which illustrates how closely the Bill Discount rate has moved with the Gensaki rate.

FIGURE 1
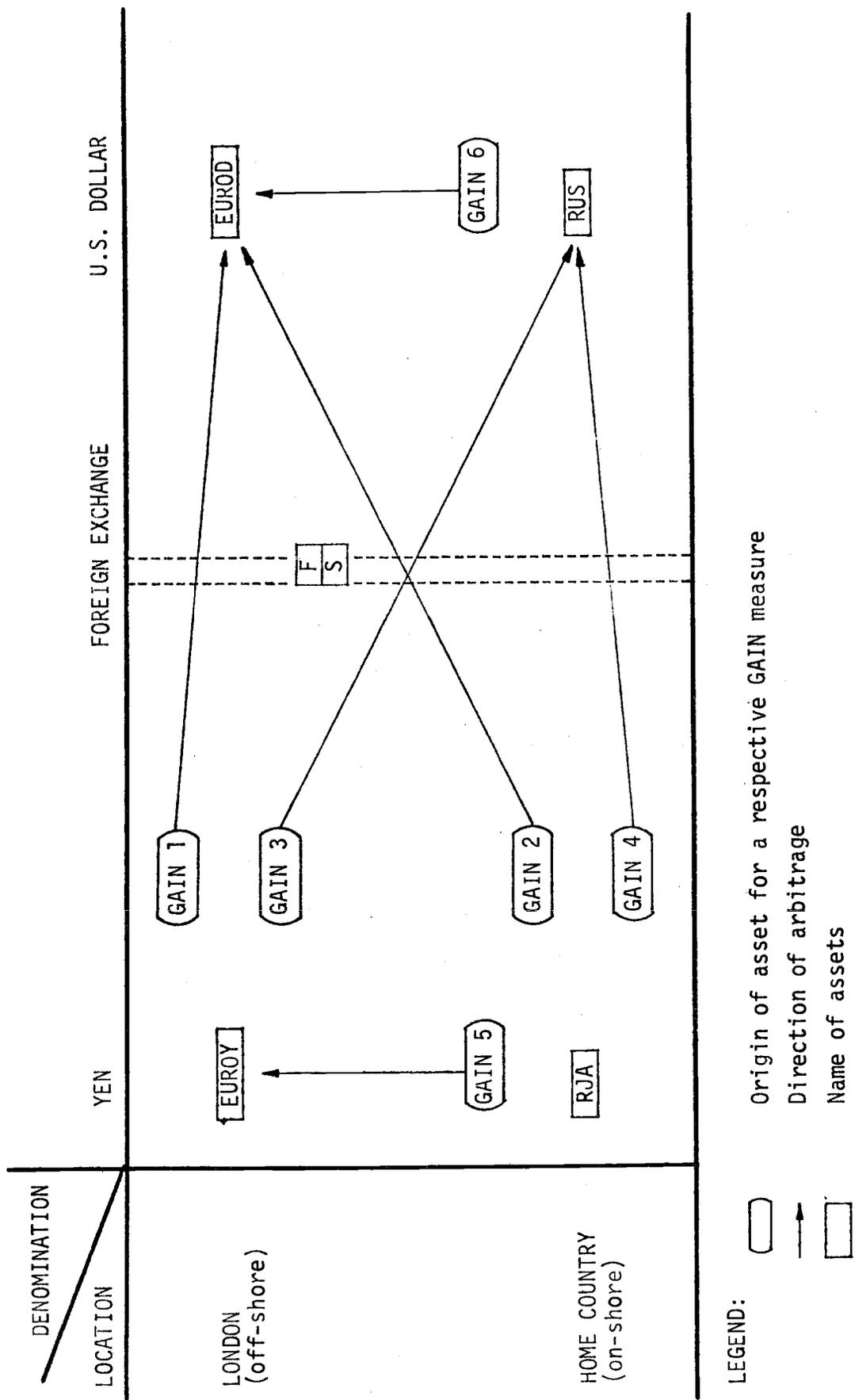
FIGURE 2

GAINS
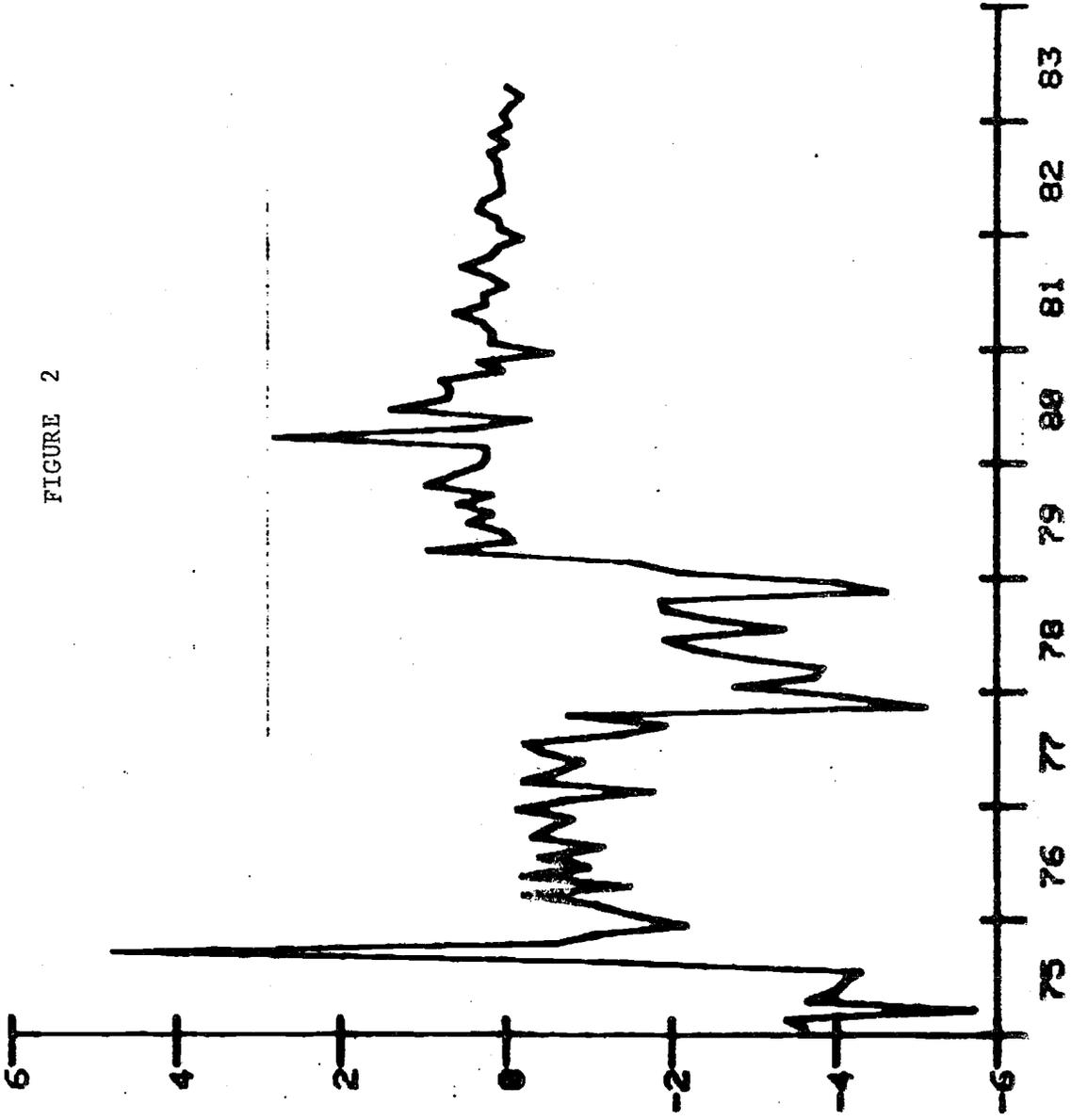
FIGURE 3

GAIN2A
GAIN2B
ZERO
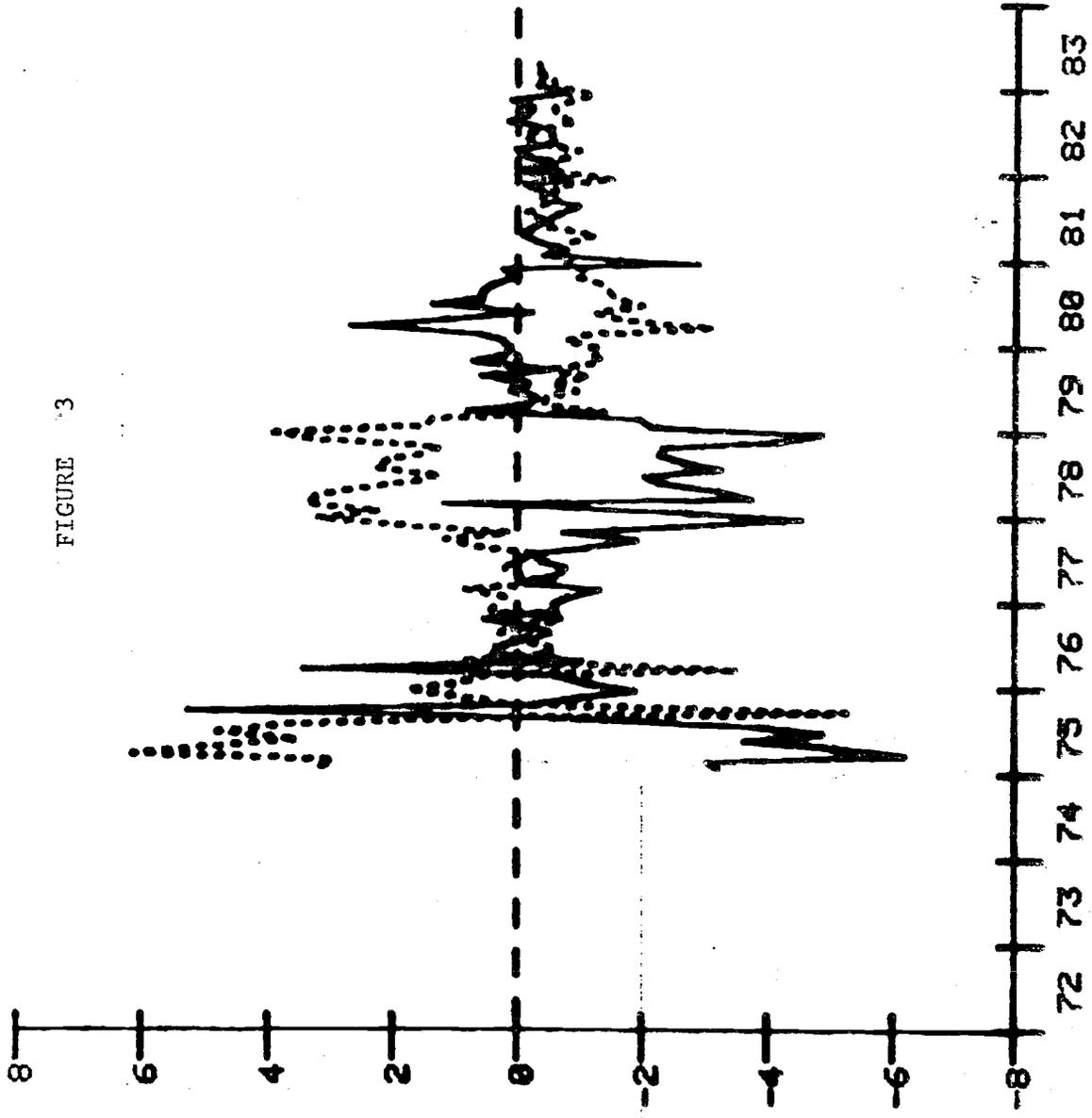
FIGURE 4
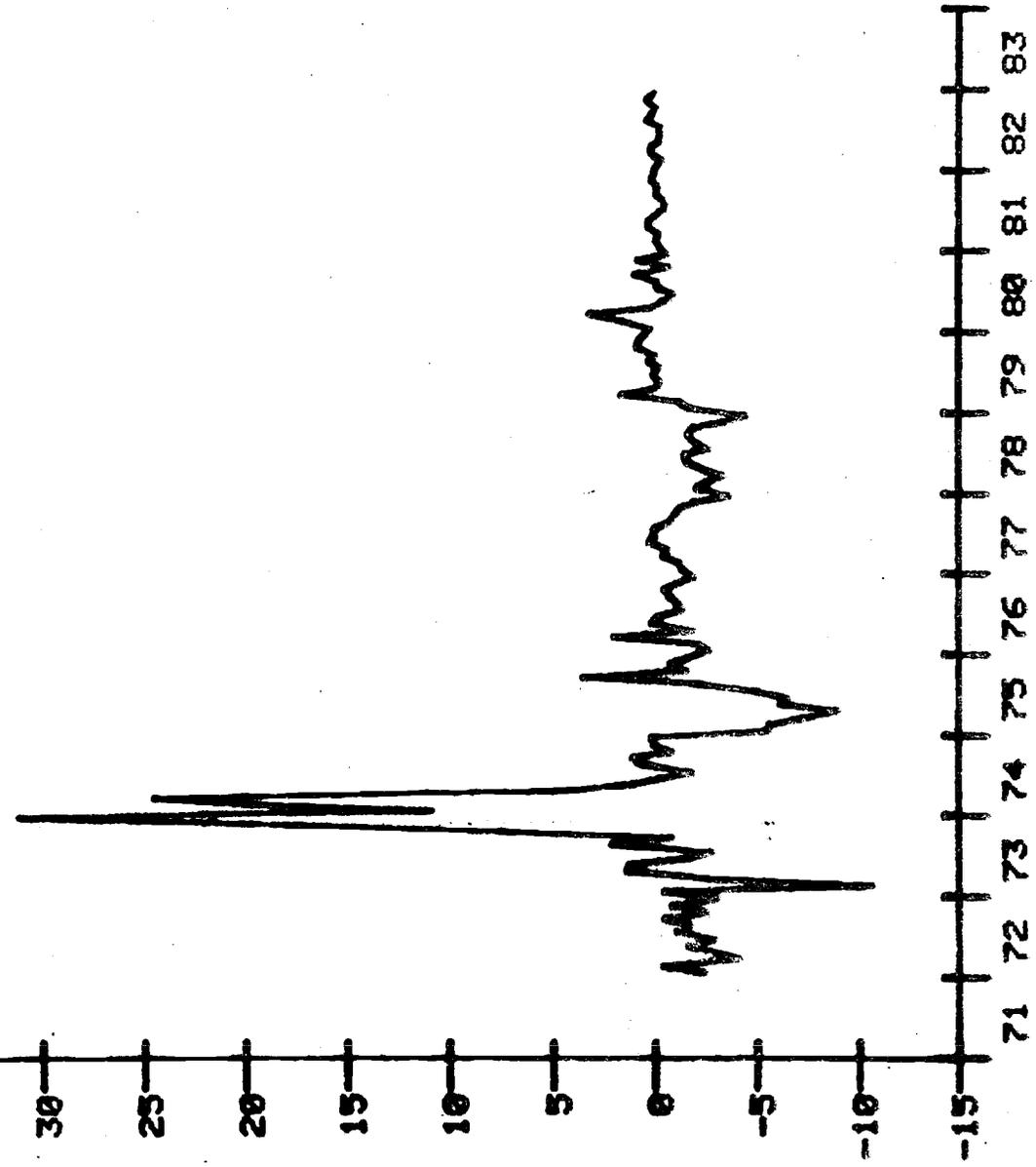
TABLE 1

TRADITIONAL APPROACH: MONTHLY RESULT

	GAIN1	GAIN2	GAIN3	GAIN4	GAIN5	GIAN6
75:1 - 83:4						
AVERAGE	0.182	-0.635	-0.506	-1.323	-0.817	0.688
(STAND. DEV)	(0.574)	(1.764)	(0.766)	(1.709)	(1.720)	(0.444)
75:1 - 80:12						
AVERAGE	0.281	-0.906	-0.352	-1.539	-1.187	0.633
(STAND. DEV)	(0.631)	(2.009)	(0.803)	(1.951)	(1.899)	(0.442)
81:1 - 83:4						
AVERAGE	-0.073	0.062	-0.904	-0.768	0.135	0.831
(STAND. DEV)	(0.253)	(0.245)	(0.466)	(0.466)	(0.179)	(0.414)

TABLE-1

TABLE 2

Means and Standard Deviations of "One-Way" Arbitrage Gain Measures

to / from	EUROY	EUROD	RJA	RUS
EUROY Off-shore Yen		GAIN1A -0.067, -0.655 (0.722),(0.275)	-GAIN5	GAIN3A -0.699, -1.484 (0.910),(0,446)
EUROD Off-shore Dollar	GAIN1B -0.506, -0.319 (0.641),(0.360)		GAIN2B 0.531, -0.620 (2.033),(0.339)	-GAIN6
RJA On-shore Yen	GAIN5	GAIN2A -1.094, -0.360 (2.009),(0.275)		GAIN4A -1.726, -1.189 (1.967),(0.450)
RUS On-shore Dollar	GAIN3B 0.131, 0.525 (1.971),(0.536)	GAIN6	GAIN4B 1.168, 0.224 (1.971),(0.536)	

Each box consists of mean and standard deviations in brackets of a GAIN measure from 1975:1 to 1980:12 and ones from 1981:1 to 1983:4.

TABLE-2

TABLE 3

Numbers of Positive Entries of "One-Way" Arbitrage Gain Measures

Gain Meaure	1A	1B	2A	2B	3A	3B	4A	4B
75:1 - 75:12	8	4	1	11	1	11	1	11
76:1 - 76:12	11	1	4	6	8	4	3	9
77:1 - 77:12	3	0	0	9	2	4	0	11
78:1 - 78:12	1	0	0	12	0	8	0	12
79:1 - 79:12	0	0	6	2	0	10	1	5
80:1 - 80:12	2	0	9	0	0	10	2	5
81:1 - 81:12	0	3	0	0	0	10	0	8
82:1 - 82:12	0	1	3	0	0	11	0	9
83:1 - 83: 4	0	0	0	0	0	2	0	1

TABLE-3

TABLE 4

OF DAYS WHICH VIOLATE PARITY

YEAR	# OF OBS.	GAIN1A	GAIN1B	GAIN1AA	GAIN1BB
1978	256	60	35	15	25
1979	251	43	34	22	34
1980	252	36	7	12	3
1981	252	4	30	1	10
1982	252	3	31	0	9
1983	133	0	0	0	0

MEAN AND
(STANDARD DEVIATIONS)

WHOLE SAMPLE				
1978-1983	-0.41 (0.39)	-0.40 (0.40)	-0.68 (0.42)	-0.52 (0.42)

SUB-PERIODS				
1978-1980	-0.31 (0.45)	-0.48 (0.47)	-0.66 (0.49)	-0.61 (0.48)
1981-1983	-0.52 (0.25)	-0.30 (0.28)	-0.70 (0.31)	-0.43 (0.30)

TABLE-4

APPENDIX

The follwing data are provided by courtesy of Data Resources Inc. (DRI) and Morgan Guarantee Trust (MG).

EUROY, EUROD, RUS

Daily series by DRI; Monthly series by MG, World Financial Markets, with with additional observations of EUROY from its data bank.

RJA

Monthly series by MG, data bank. (Note that the series published in World Financial Markets has a discontinuity over the data source, which has to be corrected. See Ito (1983) for details.)

S, F

Daily series by DRI; Monthly series between 71:8 and 76:12 from IMF (ae3C158 and b3C158), and between 77:1 and 83:4 constructed from DRI daily series by picking the last business day of each month.

SA, FA

Daily series by DRI; Monthly series between 77:1 and 83:4 from DRI daily series by picking the last business day of each month, and between 75:1 to 76:12 by regressing SA (FA) on constant, time and S (F) and then estimating SA (FA) by extrapolation.

Further notes on the data are in order. First, it is difficult to find an alternative source for the Gensaki rate with a maturity of three months. A series for Gensaki in OECD, Main Economic Indicators, is unfortunately not an "end of month" series, contrary to its caption. The end-of-month series for three-month Gensaki is available from Bank of Japan, Annual Economic Statistics, only after 1977. The monthly data we used were cross-checked

against daily series published in newspapers in Japan for 1980-82 without detecting any major deviations.

Second, an alternative interest rate in Japan is not available. The Tegata rate as explained in section VI is an interbank rate. However, the series for a two-month instrument is available only as daily averages and has been regulated in a sense until 1979. The CD rate, which is free from regulation, is available only since May 1979. The treasury bill rate with a maturity of 60 days is heavily regulated. It is well below the official discount rate and the rate is changed only when the official discount rate is changed. Most of the treasury bills are simply bought out by the Bank of Japan and do not circulate in the open market. Since the treasury bill rate in Japan does not represent the short-term money market rate, it is inappropriate to use it in a study of covered interest rate parity such as one by Frenkel and Levich (1981). For a detailed description of interest rates in Japan, see Ito (1983).

Third, we decided not to use the IMF monthly series of exchange rates after 1977, because cross-checking with daily data available from DRI revealed that the IMF series failed to pick up the last business day of the month. The IMF series deviates from ours by about 2 Yen per dollar for the spot exchange rates in April 1979 and January 1982, partly because of high volatility in the rate toward the ends of those months. Using IMF data would not establish diminishing standard deviations of the gain measure even between the Euro-Yen and Euro-dollar rates.

Fourth, the Euro deposit rates provided by MG are cross-checked against daily series available from DRI. The discrepancy is minimal and the problem mentioned above about the spot exchange rates does not happen for the deposit rates.

APPENDIX 2

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