Number 00-6

INFLATION, MONETARY TRANSPARENCY, AND G3 EXCHANGE RATE VOLATILITY

Kenneth N. Kuttner and Adam S. Posen

- July 2000 -

INFLATION, MONETARY TRANSPARENCY, AND G3 EXCHANGE RATE VOLATILITY

Kenneth N. Kuttner and Adam S. Posen

Short-term volatility in G3 bilateral exchange rates has been a fact of life since the beginning of the post-Bretton Woods float. It has been established, surprisingly, that this volatility is not only disproportionately large relative to the variation in relative macroeconomic fundamentals of Germany, Japan, and the United States, but is in fact largely unrelated to them.[1] The apparent disconnect between fundamentals and dollar-yen and dollar-euro exchange rate fluctuations has led to perennial complaints about persistent exchange rate "misalignments," and their real effects on the G3 (and other) economies, giving rise in turn to recurring proposals for government policies to limit this volatility.[2,3] The idea that volatility reflects nothing more than the (perhaps rational, certainly profit-seeking) behavior of foreign exchange traders seems to give justification for a policy response. Yet, the disjunction between macroeconomic expectations and the volatility seems to indicate as well that some deviation from domestic monetary policy goals would be necessary to intervene against exchange rate swings.[4]

In fact, as demonstrated to most observers' satisfaction in the instance of the ERM crises of 1992–1993, in a world of free movement of capital and domestic monetary policy autonomy (for the

---

[1] This result began to be established with the seminal paper of Meese and Rogoff (1983); later work extending and confirming this result includes Baxter and Stockman (1989), Flood and Rose (1995), and Flood and Rose (1999). Note that this characterization applies to *short-term* volatility between the G3 currencies—evidence exists that medium- to long-term trends in these exchange rates, and even the short-run volatility of exchange rates for high-inflation countries, do correspond to a significant degree to macroeconomic fundamentals.

[2] "Misalignments" might be characterized as resulting from exchange rate movements not warranted by changes in the underlying macroeconomic fundamentals. The analysis in this paper does not emphasize this distinction, however, but focuses on exchange rate volatility broadly defined.

[3] Volcker (1998) and Williamson (1998) are two recent well-argued examples.

[4] Of course, a policy intervention could also be targeted at the micro-level, in terms of regulating exchange market behavior, but few of these proposals tend to go in that direction. Moreover, the number of viable proposals for governments to effectively and beneficially regulate exchange rate trading appears for the moment to be limited.

G3 at least), exchange rate commitments cannot be maintained without sacrifice of one or the other.[5] In other words, if there are no capital controls, when an exchange rate commitment comes under attack, monetary policy must move in the opposite direction from that usually mandated by domestic inflation and output concerns in order to support the peg.[6] This is because of a limited number of degrees of freedom for economic policymakers. Contrary to the expectations of Friedman (1953) and Johnson (1969) prior to the advent of floating rates, it appears that domestically responsible monetary policy may be destabilizing for exchange rates.

Yet, the movement toward greater transparency in monetary policymaking in recent years may partially reconcile Friedman's and Johnson's instincts that a more disciplined monetary policy should diminish exchange rate volatility with the apparent reality that macroeconomic fundamentals do not drive exchange rates in the short run. If transparency can be increased by central banks, either through institutional developments or through being more systematic in policymaking, without altering the fundamental monetary policy capabilities or decisions, this may give central banks an additional degree of freedom with which to work. Since it is at least arguable that transparency may enhance the flexibility as well as the credibility of monetary policy by providing a better nominal anchor for inflation expectations, it is worth exploring whether use of this additional policy option (more a structure than an instrument) might have a meaningful effect on exchange rate volatility.[7]

Our paper assesses this possibility by posing two questions: first, to what extent do domestic inflation and interest rate surprises—fluctuations unexplained by past history and the systematic response of policy—contribute to short-run volatility in G3 exchange rates?[8] These are precisely the

---

[5] See Krugman (1998) or Clarida (1999) for a review of the "impossible trinity" assessment.

[6] There is no reason for an exchange rate commitment to come under attack when the move required to support the peg is in the same direction as intended monetary policy, e.g., when inflation is rising and the currency is under stress, an interest rate rise is credible. It is when the economy is slowing and the currency is going to the weak edge of the zone (e.g., UK or Sweden in fall 1992) that the peg comes under attack, and the attack itself generally worsens the conflict between goals.

[7] See King (1997), Laubach and Posen (1997), Bernanke, et al (1999), and Kuttner and Posen (1999) for a combination of theoretical, historical, and econometric arguments to this effect.

[8] Clarida and Gali (1994) and Eichenbaum and Evans (1995), among others, also assess various shocks' contributions to exchange rate fluctuations. Their focus, however, is on the contribution of unsystematic monetary policy shocks, while ours is on inflation shocks, and the effects of policy's systematic

type of shocks which should diminish in frequency and effect as monetary transparency increases, if the hypothesized relationship between transparency and inflation expectations holds. Second, to what extent do variations over time in American, German, and Japanese monetary transparency actually match up with the timing of these shocks and the magnitude of their impact? Taken together, the empirical estimates in answer to these questions should give some sense of whether increased transparency in the G3 central banks would diminish exchange rate volatility.

The paper is structured as follows. In section 1, we set out a simple model of the implications of different monetary regimes (discretionary, anti-inflationary conservative, and transparent "optimal state contingent rule" [OSCR] following) for the response of inflation, interest rates, and exchange rates to shocks.[9] In section 2, we develop an operational measure of central bank transparency, and apply it to the history of the Bank of Japan (BoJ), the Bundesbank, and the Federal Reserve in the period 1975–1998, finding significant shifts in institutional transparency for the Federal Reserve and for the BoJ in the late 1980s. In section 3, we estimate structural VAR (trivariate vector autoregression) models of relative interest rates, inflation rates, and exchange rates for deutsche mark-yen and deutsche mark-dollar, and conduct a number of analyses, including both comparing impulse response functions before and after the shifts in transparency, and interpreting historical decompositions for evidence of the exchange rate impact of smaller deviations from systematic monetary policy. Section 4 concludes with an assessment of the importance of domestic inflation and interest rate shocks to G3 exchange rate volatility, and the likelihood of increases in central bank transparency to diminish those shocks.

A SIMPLE MODEL OF INFLATION, EXCHANGE RATES,
AND MONETARY POLICY

In understanding the macroeconomic sources of exchange rate volatility, useful starting points are the familiar principles of purchasing power parity (PPP) and uncovered interest rate parity (UIP). The

---

response to those shocks.

[9] This model modifies Kuttner and Posen's (1999) application of Svensson (1997) by replacing the long-term interest rate and bond market with long-run PPP and an uncovered interest-rate parity (UIP) condition. See section 1 below.

latter is a difference equation linking the change in the exchange rate and the gap between foreign and domestic interest rates:

$$E_t \Delta e_{t+1} = i_t^* - i_t ,$$

where e is the log of the exchange rate (defined as the foreign currency units per domestic currency unit), and I^* and I are the foreign and domestic interest rates. The UIP condition can be solved forward to yield:

$$e_t = E_t \sum_{j=0}^{\infty} (i_{t+j} - i_{t+j}^*) + \bar{e} ,$$

which expresses the exchange rate at time t as the sum of current and expected future interest rate differentials, plus the long-run equilibrium exchange rate, $\bar{e}$. Domestic interest rates in excess of the foreign are associated with a high—but falling—exchange rate.

While interest rate differentials govern short-run exchange rate dynamics, the (log) ratio of foreign to domestic price levels pin down the long-run exchange rate, $\bar{e}$, via PPP:

$$\bar{e} = \lim_{j \to \infty} E_t (p_{t+j}^* - p_{t+j}) ,$$

where p^* and p are the logs of the foreign and domestic price levels. The condition can also be expressed in terms of the sum of expected future inflation rates:

$$\bar{e} = p_{t-1}^* - p_{t-1} + E_t \sum_{j=0}^{\infty} (\pi_{t+j}^* - \pi_{t+j}) .$$

The PPP and UIP conditions by themselves obviously do not represent a complete macroeconomic model. But even without closing the model, the two conditions suggest a tradeoff between short-run and long-run exchange stabilization.

To see this, imagine an economy subject to supply shocks—events that presented the central bank with a tradeoff between output and inflation stabilization. A vigorous policy reaction will reduce the shocks' impact on the price level, mitigating their long-run effect on the exchange rate. But such a policy will create larger interest rate differentials, which, in the near term, will generate exchange rate volatility. A more accommodative policy response, on the other hand, reduces short-run interest-rate induced volatility, but at the expense of destabilizing the long-run value of the

exchange rate. Either way, inflation shocks generate exchange rate volatility; how much will depend, of course, on the specifics of the macro model.

One way to close the model is to append the PPP and UIP relations to the model of Svensson (1997), as extended by Kuttner and Posen (1999). This model is far too stylized to think about directly estimating. It nonetheless illustrates the theoretical reasoning behind a role for central bank transparency in minimizing the effects of inflation shocks on the exchange rate.

In Svensson's model, the policymaker chooses inflation to minimize the discounted sum of single-period loss functions of the form,

$$L_t = \pi_t^2 + \lambda(y_t - y^*)^2 \, ,$$

subject to an aggregate supply relation given by

$$y_t = \rho y_{t-1} + \alpha(\pi_t - \pi_t^e) + \epsilon_t \, ,$$

where y is the output gap, π is inflation, and λ is the relative weight on output versus inflation stabilization. Persistence is introduced through the ρy_{t-1} term in the supply equation. Solving the minimization problem yields policy rules giving inflation as a function of expected inflation, the lagged output gap, and the supply shock, ϵ. An IS equation,

$$y_t = \delta(i_{1,t} - E_t \pi_{t+1} - r^*) \, ,$$

is then used to determine the corresponding path of interest rates.

Under discretion, the monetary authority accommodates supply shocks by allowing them to affect inflation: $\pi_t - E_{t-1}\pi_t = -b\epsilon_t$. Not surprisingly, a higher weight on output stabilization implies a more accommodative policy, which in this context means a larger value of b. Expected inflation itself obeys $E_t\pi_{t+1} = a - cy_t$; if the central bank targets a nonzero output gap, inflation will contain a constant inflation bias, a; output gap fluctuations also create a state contingent inflation bias, cy_t. The higher the weight on output stabilization, the larger are a and c.

Having derived the behavior of inflation, it is straightforward to use the IS equation, and the interest rate parity and purchasing power parity relationships to solve for the response of the exchange rate under discretion. The response of the nominal exchange rate at time $t+j$ to an ϵ equal to -1 at time t (i.e., a unit adverse supply shock) is given by:

$$e_{t+j} = -(\delta^{-1} - c)(1 - \alpha b)(1 - \rho)^{-1}\rho^j - [b + c(1 - \alpha b)(1 - \rho)^{-1}]$$

The first term, which comes from the interest rate differential, tends to increase the exchange rate, reflecting the increase in domestic interest rates used to combat inflation. The second term captures the shock's long-run effect on the price level. The net effect could go either way in a given period, depending on the strength of the initial policy response versus the long-run price-level implications. Over time, however, the interest rate effects die out, so in the long run, an adverse supply shock leads to a depreciation.

This exchange rate response is characterized by the tradeoff between short-run and long-run exchange rate stabilization alluded to earlier. As λ, the weight on output stabilization falls (the central bank becomes more "conservative"), b and c (the central bank's degree of accommodation) shrink. This reduces the supply shocks' effect on the long-run exchange rate, because the disinflation is greater and faster, but increases the short-run volatility through increasing the interest rate differential. In the limiting case of $\lambda=0$ (the "inflation nutter"), there is no long-run effect, but the short-run effect is maximized.

If the central bank can commit to a constant rate of *expected* inflation, the inflation bias problems associated with discretion disappear. King (1997) refers to this as the "optimal state-contingent rule," and argues that a properly-implemented inflation targeting policy can move the monetary authority in this direction. The central bank is believed to anchor inflation expectations, and so is not punished for its deviations.

In this case, the monetary authority creates inflation *only* in the period of the shock: $\pi_t - E_{t-1}\pi_t = -b^*\epsilon_t.$[10] The response of the nominal exchange rate to a unit adverse supply shock would then be:

$$e_{t+j} = -\delta^{-1}(1 - \alpha b^*)(1 - \rho)^{-1}\rho^j - b^*$$

---

[10] For the same set of parameters, b^*, the OSCR-following central bank's response to the shock, will be less than the b under discretion, an effect referred to "stabilization bias." See Svensson (1997).

The main difference between this exchange rate response and that under discretion is the lack of terms involving the coefficient describing the degree of state-contingent inflation bias, c. The lack of these terms means that the long-run effect of a supply shock on the price level and the PPP exchange rate is smaller. Furthermore, the absence of an inflation premium in the nominal interest rate implies smaller interest rate differentials, and attenuated short-run exchange rate volatility.

To summarize, when faced with supply shocks that entail a tradeoff between output and inflation stabilization, central banks can differ in their response to those shocks, and in the markets' response to them. Compared to the pure discretionary case, a "conservative" monetary policy can stabilize inflation and the long-run nominal exchange rate, but at the expense of introducing greater short-term volatility into the nominal (and real) exchange rate. In the limiting "inflation nutter" case (of no weight on output stabilization goals), inflation shocks have no long-run effect on inflation or even the nominal exchange rate, but maximum short-run effect on the volatility of the exchange rate. Following the OSCR through transparently anchoring inflation expectations, however, produces a more stable exchange rate in both the short- and long-run relative to a discretionary policy.

A FUNCTIONAL MEASURE OF TRANSPARENCY
IN THE G3 CENTRAL BANKS

While the path to central bank conservatism is well known (and increasingly well trod), the means to the OSCR is less widely recognized. As asserted in King (1997), a transparent monetary policy—interpreted in practice as inflation targeting—grants the central bank the credibility and flexibility characterizing the OSCR. Transparency has become a central bank watchword in recent years, and it is not disingenuous to claim that most people know it when they see it practiced.[11] Designing a more objectively reproducible measure of monetary transparency, however, requires a bit more rigor in classification. Following the discussion in Posen (1999), it is possible to characterize the elements of monetary transparency as they relate to parts of the central bank's

---

[11] Arguments for the benefits of transparency, in terms of movement towards the OSCR and therefore to a better outcome of the central bank's time-inconsistency dilemma on average and in response to supply shocks, are given in the preceding section and in Kuttner and Posen (1999). For broader discussions of the merits of transparency, in terms of democratic legitimacy, reduced market uncertainty, and improved central bank behavior, see *inter alia* King (1997), Blinder (1998), and Bernanke, et al (1999).

optimal control problem for monetary policy. In this view, a central bank has a preference (weighting losses over various macroeconomic goals), a model of the economy and of the effects of monetary policy (through an intermediate target) on that economy, a forecast of what will occur to the economy (with uncertain lags and shocks), and a record of what the monetary policy choice and the realization of shocks were last period. For the public and the markets, this means there are four potential areas of revelation for the central bank: its goal, its target, its forecast, and the outcome of its policies.

In theory, if the public and markets are given three or even two of these, and we assume markets have equivalent information to the central bank about the economy, and that the central bank engages in optimizing behavior, the remainder can be derived. In practice, however, such backwards induction is unlikely to be successfully undertaken, or fully trusted by those who undertake it. Thus, there is room for the central bank to disclose (make transparent) its views on each aspect of the control problem. For such transparency to work, the central bank has to not only announce these as numbers, but provide sufficient explanation to grant understanding of the numbers' significance.[12] So this gives us four potential disclosures with which, by whether or not they are provided, to evaluate central banks' transparency:

- A public numerical long-run goal for monetary policy;
- An *Inflation Report* or similar document describing the bank's model of the economy, estimate of the likely effect of monetary policy changes, and updates thereof;
- The central bank's forecast of the goal variable, including an explicit statement of the instrument setting underlying that forecast (e.g., unchanged interest rates);
- An *ex post* evaluation of what monetary policy moves were made in the past, what shocks were realized, and what outcome for the goal variable resulted.

These criteria make up what we will call *institutional transparency*. We do not create here an index of transparency, allowing for degrees of openness on each criterion and a means of aggregating them,

---

[12] As Friedman (1997) states, "Central bank purchases and sales of securities, the resulting changes in bank reserves, and fluctuations in the relevant short-term interest rate are all known data not long after the fact. But few central banks make clear - genuinely clear - just why they have chosen the actions they have taken." Similarly, Bomfim and Reinhart (2000) distinguish between announcements of monetary policy decisions in general and those which explain as well why the move was made.

like those indices for central bank independence.[13] Clearly, though, there is room for making some ordinal assessment on each criterion rather than just checking yes/no—a central bank can have a clear mandate for price stability, without a numerical target, and still be more transparent than a central bank with a mandate containing multiple competing goals;[14] a central bank can put greater or lesser emphasis on public explanation and consistency of presentation in its publications, rather than being limited to either simply printing backward-looking numbers or giving a full *Inflation Report*-type of document.

Of course, in reality, even a fully transparent central bank with an explicit long-run goal is likely to have multiple policy goals in the short run. Responsible central banks will not follow a simple policy rule as in the idealized optimal control literature, especially when large shocks occur with some frequency. As argued in Kuttner and Posen (1999), the key issue for monetary transparency in a world of unexpected economic shocks is the ability to anchor expectations when policy deviates from its normal response to those shocks (e.g., where inflation is the long-run goal, for there to be limited pass-through to inflation expectations when the central bank accommodates an adverse supply shock).[15] In practical terms, when a central bank does something contrary to expectations, is that action acknowledged and explained to the public and to markets? We term the degree of commitment to this type of explanation *transparency in discretion*. To operationalize this measure, one can assess whether a central bank issues a public explanation when it deviates significantly from a reaction function (for example, a "Taylor rule") estimated on its past behavior, and whether it acknowledges that there was a conscious deviation from systematic policy.

---

[13] We are currently at work on creating such an index for the major OECD central banks in recent decades, and exploring its explanatory power for different countries' proclivities to inflation scares (a la Goodfriend (1983)) and to overreact to monetary accommodation of shocks.

[14] See Svensson's (2000) discussion of the mandate and goal of the European Central Bank as an example of just this kind of assessment.

[15] Our working assumption is that transparency enhances flexibility, in the sense that a central bank which explains its deviations from its pattern is better able to get away with exercising discretion, and Kuttner and Posen (1999) provides some evidence to this effect. Faust and Svensson (1998) address much the same issue and definition of transparency from a theoretical perspective—"Increased transparency (smaller unobserved noise) improves the precision of private sector inference about central bank goals, and makes the bank's reputation and the private sector's inflation expectations more consistent"—and come to the opposite conclusion. We intend to employ our (in progress) index of transparency to test this empirically.

It is likely that a central bank with high institutional transparency will have no choice but eventually to offer a great deal of transparency in discretion as well—otherwise, its forecast competence and/or its commitment to its goals would come into question. For central banks which do not have in place the full apparatus of institutional transparency, however, it is conceivable that they could still wish to maintain a reputation for systematically opposing certain outcomes (e.g., demand-driven increases in inflation), and so they might display transparency in discretion without much institutional transparency. Moreover, the fact that central banks would find it difficult to simultaneously be institutionally transparent and be opaque in discretion, i.e., repeatedly deviate from systematic policy without explanation, does not imply that the resolution is immediate or in what manner the tension is likely to be resolved.[16] The relationship between accountability, independence, and transparency merits further research.[17] For purposes of this paper, we can and do distinguish between these two aspects of transparency in our empirical investigations, with changes in institutional transparency defining structural breaks in central bank behavior, and transparency in discretion relating to the market response to specific incidents in a central bank's timeline.

Applying these functional measurements of monetary transparency to the G3 central banks gives interesting results, though it should be noted that comparisons of institutional transparency "levels" across countries are a large degree judgmental on our ordinal scale (the sign of changes in institutional transparency within a country over time are easier to ascertain). Getting more than a broad sense of the degree of a central bank's transparency in discretion, however, is not possible without a baseline for that bank's systematic response function; initial estimates of those are given in our empirical work below.

---

[16] As we will argue below, this is relevant for the BoJ in the 1990s, which increased its institutional transparency with the passage of the new BoJ Law in 1998, but repeatedly deviated from systematic policy without explanation in the face of shocks.

[17] One paper which begins to tackle these issues is Briault, Haldane, and King (1997). In that paper, the authors create an index of central bank accountability, and establish a negative relationship between that index and goal independence for central banks. Their index combines measures of legal accountability and transparency, only one of which is in common with our criteria (publication of an inflation report). We prefer to focus solely on transparency as the direct means of accountability to the public and markets; see also Kohn's (1997) and Koenig's (1997) discussions of that index.

The Bundesbank was extremely stable in institutional transparency over the period 1975–1998.[18] From the time of the first monetary target, the Bundesbank annually announced the inflation goal (usually, but importantly not always, 2 percent) which underlay its quantity equation derivation of the year's monetary targets. Moreover, on several occasions when meeting the monetary target would have come into conflict with meeting the inflation goal, the inflation goal was pursued first and was publicly acknowledged to have been. On the two occasions when inflation was deemed likely to diverge noticeably from the goal for an extended period—following the 1979 oil shock, and after German monetary unification in 1990—the Bundesbank used its definition of "price stability" to point to a public long-run target. In terms of reporting, the Bundesbank was consistent in producing a *Monthly Report* which amassed a great deal of information beyond simply tracking the monetary aggregates, along with explanatory articles about issues in the German economy. The *Report* gave general indications of the likely direction of monetary policy, as fiscal, external, and labor market developments unfolded, but did not ever give strict forecasts for inflation. The Bundesbank did, however, publish its model of the economy in complete but highly technical form. Finally on the matter of *ex post* evaluation, the Bundesbank was scrupulously transparent, using the occasion of the annual setting of monetary growth targets to track not only how well it did in meeting those intermediate targets, but also in meeting the inflation goal, and explaining deviations from the targets in terms of specific shocks.

In terms of transparency in discretion, the Bundesbank's record is also consistent. To illustrate from the two major instances of potential inflationary pressures mentioned, in the episode of the second oil shock, the Bundesbank made clear that it would be more gradual than usual in disinflating, and even gave a path for the intended rate of deflation (moving its "Unavoidable Rate of Inflation" up to 4 percent in 1980 and bringing it down slowly until declaring victory in 1986). In the instance of monetary unification, the Bundesbank made clear that it was primarily concerned with inflation pass-through, and had to essentially ignore initial money demand shocks, and (perhaps as a result) found that neither was as large as expected.

---

[18] Laubach and Posen (1997) goes through the Bundesbank's institutional framework in detail. Neumann (1997) comes to many of the same conclusions in more summary form.

In the case of the Federal Reserve, measurement of institutional transparency shows an accelerating trend toward greater openness from 1975 through the present.[19] The Federal Reserve has never set a public numerical long-run goal for policy, but the recent trent has been towards greater clarity in objective-setting. From explicit pledges of loyalty to the potentially contradictory goals of its Humphrey-Hawkins mandate in 1978; an implied interest in counter-inflationary policies signaled but not specified by monetary targeting through 1985, to an explicit statement by Chairman Greenspan in Humphrey-Hawkins testimony in July 1988 (restated in February 1989) that the sole long-run goal of monetary policy should be price stability; and the abandonment ("downgrading") of monetary aggregates in 1993 for the reason that they do not contribute to tracking inflation, the Federal Reserve finally heeded calls by Chairman Greenspan starting in 1995 for a change in the Federal Reserve's mandate to one solely focused upon "price stability." The point for institutional transparency is not the increasing emphasis on inflation *per se*, but the increasing clarity and consistency with which that emphasis was made, especially beginning in July 1988.

The Federal Reserve Board and the 12 Reserve Banks publish an abundance of materials, including research papers, the "Beige Book" assessing regional economic developments, the "Green Book" showing with a five-year lag the Board staff's national forecast, and the *Federal Reserve Bulletin*. Unlike an *Inflation Report*-type document, however, no publication exists to summarize the macroeconomic outlook guiding policy. The *Bulletin* consists mainly of retrospective numbers in great density; and the "Green Book" forecasts cannot be interpreted either as policy goals, or as representing the consensus of the Federal Open Market Committee (FOMC) members—and in any case, the five-year publication lag renders the forecasts irrelevant for the evaluation of current policy. On this score, little has changed since the 1970s. Starting in February 1994, however, the FOMC began announcing changes in the Federal funds target, instead of requiring market participants to draw inferences from the Desk's open market operations. These announcements are also accompanied by a brief statement of the rationale for the move. While discount rate changes had always been announced with press releases, they too began to be accompanied by explanatory statements.

---

[19] This paragraph draws on Blinder (1998), Friedman (1997), Bomfim and Reinhart (2000), and the authors' own reading of Federal Reserve Chairman's testimony before Congress.

It is in terms of *ex post* evaluation of shocks and outcomes that the Federal Reserve remains least transparent. While the Chairman does report twice yearly to Congress ahead of the Humphrey-Hawkins hearings, and is in that sense formally accountable, policy's contribution to macroeconomic performance *vis à vis* that of exogenous shocks is not assessed. The lack of an explicit goal with which to benchmark performance makes such an assessment all the more difficult. Similarly, the Federal Reserve has often deviated from its "normal" response to macroeconomic developments (specified, e.g., by a "Taylor rule" or similar reaction function) without articulating the rationale for the deviation. In the aftermath of the October 1987 stock market crash, the Federal Reserve *did* make clear immediately what it would do and why; but other financial problems (e.g., the "headwinds" of 1991–93) were addressed without a clear statement of what was being tracked. The use of monetary targets from 1979–85 has been widely recognized (both at the time, and even more clearly since) as a means of signaling a general commitment to disinflation, but the failure to follow them strictly (especially after the first three years or so) left the impression that considerable discretion remained.

The BoJ pursued a "money focused" monetary policy from 1975 to 1985 (see Cargill, Hutchison and Ito (1997) and Ueda (1997) for details). This meant pursuing a generally stable declining trend in broad money growth, with clear reference to this objective—although not to specific annual monetary targets, just quarterly "forecasts" (starting in July 1978)—and explicit mention that the stability of the financial system was the other main pursuit of policy. During the period from the Plaza Accord in 1985 to the Louvre Accord in 1987, much the same approach was taken, except explicit target zones for the yen-dollar rate substituted for money growth. (Prior to that, it is difficult to discern a consistent major role for exchange rates in Japanese monetary policy, though there certainly were occasional interventions.) After April 1987, and the G-7 agreements at that time, monetary policy appears to have shifted between various goals, without a clearly-articulated rationale for those shifts. For a time, the proximate and stated goals were domestic demand growth linked with a decline in the value of the dollar, but these were replaced by a focus on asset prices starting in June 1989, a shift which was confirmed by the incoming BoJ Governor

Mieno in December 1989. After the bubble burst, the BoJ gradually switched to a limited reflationary strategy, followed by direct efforts to keep the payment system afloat in 1996–1998.[20]

In terms of the second criterion for institutional transparency, the publication of a regularly updated description of the Bank's model of the economy and estimates of the effect of monetary policy, the BoJ was similar to the Federal Reserve during the period examined. The BoJ did issue monthly reports of data on Japanese economic conditions, but stopped short of making specific forecasts. Changes in the monetary transmission mechanism were alluded to (*e.g.*, that the collapse of the banking system in the 1990s undermined the effects of expansionary policy), but not quantified. There is no regular mechanism for reporting forecasts of macroeconomic variables such as inflation, and the goals and even their relative priority remain unspecified. *Ex post* evaluations were unstructured, and unlike the Federal Reserve, there was no commitment to report to the Diet on its performance. This had some logic so long as the Ministry of Finance (MoF) officially controlled policy, but MoF representatives were not held publicly accountable on a regular basis for monetary performance either.

As indicated by the discussion of the shifting goals of Japanese monetary policy in the 1990s, transparency in discretion was somewhat lacking. Bernanke and Gertler (1999) and Jinushi, Kuroki, and Miyao (2000) both document several periods in which the BoJ diverged from the rather steady pattern of systematic policy established from 1975–87. While the Bank's activities in 1997 and 1998 to buy commercial paper, keep the discount rate low, and the like, were well and explicitly explained as responses to the financial crisis (as was the government's failure to respond until October 1998), other instances were less clear. In particular, the slow pace of easing policy from 1992–95, and to a lesser degree the slow rise in interest rates in 1990–91, were only clear in direction: the pace, intermediate target or path to the goal, and the assessment of the effects of shocks were left

---

[20]See Bernanke and Gertler (1999) and Jinushi, Kuroki and Miyao (2000) for detailed assessments of the changes in, and unsystematic behavior of, BoJ monetary policy in the 1990s. Starting in January 1998, essentially beyond the end of our data set for this paper's analyses, the BoJ did increase its institutional transparency in line with its impending independence. Despite a clarification of mandate—to price stability in the long-run, with concern for financial stability as required—and new efforts to release minutes and other information, a lack of transparency in discretion has beset Japanese monetary policy since mid-1998. See Mikitani and Posen, eds., (2000) for details.

unspecified. This would lead one to expect increasing volatility in Japanese interest rate responses in the 1990s, which would in turn create additional exchange rate volatility.

QUANTIFYING THE MACROECONOMIC SOURCES
OF EXCHANGE RATE VOLATILITY

It is worth beginning with an interesting stylized fact. The yen-dollar exchange rate has consistently shown significantly greater volatility than either of the other bilateral G3 exchange rates [see, e.g., Clarida (1999)]. On any standard explanations of exchange rate volatility, this is an anomaly. Macroeconomic differences between Japan and the United States, even if they were more unstable than those between Germany and the United States or Germany and Japan (which is by no means clear for the entire period), should not be the source of greater short-run volatility, given the literature's demonstrated unimportance of fundamentals. Both the United States and Japan had rising inflation in the 1970s, and declining inflation in the 1990s, relative to Germany's stable inflation rate, so the convergence on low inflation does not explain the pattern either. The market microstructures in terms of forex traders' incentives, information, liquidity, regulation, technology, and so on, which are usually considered the primary underlying cause of exchange rate volatility, are *identical* across the G3 bilateral rates; the same firms, if not precisely the same traders, are dealing in all three currencies simultaneously.

By taking monetary transparency into account, however, there seems to be a way of making sense of this pattern: as argued in the previous section, the Bundesbank consistently exhibited greater institutional transparency than either the BoJ or the Federal Reserve since 1975. This would be consistent with there being smaller reactions of inflation expectations and interest rates to inflation surprises originating in the deutsche mark-zone. When one considers the additional fact that all three central banks pursued Tayloresque reaction functions over the 1975–1998 period (see Clarida, Galí and Gertler (2000) and table 2 below), and that this relative ranking of bilateral average volatility even holds including German unification, the ERM crisis, and their aftermath, it is more striking that

the one apparent difference in monetary practice—the expectation anchoring effects of transparency—is consistent with this pattern.[21]

This gives us two reasons for focusing our empirical investigations on the deutsche mark-yen and deutsche mark-dollar exchange rates (and not the yen-dollar): First, since the Bundesbank's institutional transparency is essentially invariant over the 1975–1998 time period, but both the Federal Reserve's and the BoJ's transparency shift markedly, this lets us track the effect of changes in transparency. Second, since it is the deutsche mark cross-rates which were the subject of less direct political pressure over the period, studying the deutsche mark rates makes it more difficult to ascribe the influence of changes in transparency to an additional (unmeasured in this paper) source of shocks.

Figure 1 displays two measures of exchange rate volatility since 1976 for the deutsche mark-bilateral rates. The solid line in each panel is the standard deviation (in percent) of monthly exchange rate changes, computed over a moving 24-month window. (The exchange rates are from the first business day of each month.) The dashed line is similar, but rather than weighting each observation equally within a fixed window, they decline geometrically and the sample expands: the weight on observation $t-I$ is 0.9^i, normalized so that the sum of the weights equals unity.

Both measures tell identical stories. The volatility of the deutsche mark-dollar exchange rate has gradually declined by about one-quarter, from its peak of over 4 percent (standard deviation of monthly changes) to around 3 percent by 1994, where it has remained ever since. This is consistent with the measurement of increasing institutional transparency from Burns to Volcker to Greenspan, culminating in the additions to the Federal Reserve's institutional transparency in 1994. While the dollar has become more stable in recent years, the yen seems to have become quite a bit more volatile. From its peak near 5 percent in the late 1970s, the volatility of the deutsche mark-yen exchange rate declined to a nadir of around 2 percent in 1989. It subsequently increased to 3 percent, and surged to over 5 percent in 1998 as the yen appreciated sharply. This is also consistent with the measurement of decreasing transparency by the BoJ since 1987, after the Louvre Accord, and the increasing uncertainty about the priorities of the BoJ in responding to the challenges of the 1990s.

---

[21] Laubach and Posen (1997) discuss the ability of the Bundesbank to anchor expectations even during reunification and the German monetary unification which followed.

Beyond the overall pattern, it is essential to ask to what extent do these changes in exchange rate volatility have roots in domestic inflation and interest rate surprises. These are the shocks whose prevalence and effects should relate to transparency, if transparency matters. If these shocks are important sources of volatility, the next question is whether the changes in the frequency and effect of these surprises sensibly track the trends in central bank transparency in detail, as they do in broad brush. Those are the questions we try to address in our econometric investigations of macroeconomic shocks and monetary policy as sources of exchange rate volatility.

Our main focus is on the effect of inflation shocks: how the exchange rate responds when inflation comes in higher than expected, taking systematic monetary policy response into account (and assuming that the markets and public do the same).[22] As discussed in section 1 above, for a more transparent central bank, the central bank's and the market's responses to an inflation shock should look more like the OSCR model, with lower inflation persistence, smaller inflation and exchange rate effects from a given inflation shock, and a smaller accompanying rise of interest rates. A second question is the extent to which fluctuations in relative interest rates unrelated to inflation differentials can account for exchange rate movements. The size of the interest rate response is a noisy measure of markets' trust in the central bank's long-run commitment to its goal [see Kuttner and Posen (1999)]. To answer both of these questions, it is useful to distinguish between inflation's long-run effect on the nominal exchange rate (via PPP), and its short-run effect from the interest rate differentials produced by the policy response to inflation.

The framework used for the analysis is a VAR involving the bilateral exchange rate (deutsche mark versus dollar or yen), the inflation differential (US or Japanese CPI inflation relative to West German), and the interest rate differential (the Federal Reserve funds or Gensaki rates relative to the German repo rate). The exchange rate is entered as a log difference, and cointegration between the exchange rate and relative price levels is not imposed; consequently, the real exchange rate not assumed to be stationary. To examine possible changes in the degree of monetary transparency and the hypothesized resulting changes in inflation dynamics, the model is estimated separately over two roughly equal periods, with the breakpoints in April 1987 for Japan and in July 1988 for the United

---

[22] Which means that the emphasis here is on the systematic component of monetary policy, rather than on monetary policy "shocks" as in Eichenbaum and Evans (1995) or Faust and Rogers (2000).

States, as suggested by the institutional transparency changes discussed above.[23] For both pairs of countries, nine lags of monthly data from 1976 through 1998 are used in the estimation.[24]

Identifying the model and extracting well-defined inflation and interest rate "shocks" requires three assumptions. One corresponds to a version of the PPP condition: inflation shocks are assumed to have no long-run effect on the real exchange rate, i.e., that inflation shocks have the same effect on the price level differential and on the nominal exchange rate in the long run. The second restriction is that shocks to the interest rate differential also have no long-run effect on the real exchange rate. The third identifying assumption is simply that shocks to the interest rate differential have no contemporaneous (within the month) effect on the inflation differential.

Having specified the statistical model, there are two ways to draw out its implications for the behavior of the exchange rate. One is to invert the autoregression and compute the impulse response functions from the moving average representation in the usual way. This can be used to look for changes in the response of monetary policy and exchange rates to inflation shocks before and after break points in institutional transparency. By matching up the patterns of these shifts in impulse response functions with the predictions of our model in section 1, this is the first of our investigations.

This procedure, however, does not take advantage of the fact that the VAR can also be used to generate a forecast of future inflation and interest rate differentials which, according to purchasing power and uncovered interest rate parity, determine the exchange rate. The second procedure, then, is essentially to plug those forecasts into the solved-forward UIP relationship to determine the response of the exchange rate, constrained to satisfy the interest rate parity condition (and the

---

[23] It is possible to argue for breaks in transparency for the BoJ in June 1989 (when interest rates began to rise to prick the bubble), and for the Federal Reserve in February 1989 (when Greenspan reiterated his definition of the price-stability goal in congressional hearings, and this was picked up by the major press), rather than these dates. As one would expect, this makes little difference to the results, especially for the United States, and the break points used in our investigations are statistically significant as they are.

[24] Estimation ends in 1998:12 to avoid any possible break associated with Germany's adoption of the euro in 1999.

homogeneity implied by PPP).[25] As a complement to these historical decompositions, we also estimate policy reaction functions to look for shifts in central bank preferences, and identify deviations from the central bank's systematic response to macroeconomic conditions. We report the results from both methods for each country, first for the United States, then for Japan, below.

United States

Figure 2 displays the basic data on the deutsche mark-dollar bilateral rate, and the other components of the VAR. Looking at the bottom panel, the trend in the two countries' relative price levels matches up well with the general downward trend in the value of the dollar since 1972, indicating that our long-run restrictions are plausible. **Figure 3** shows the estimated response of US inflation, interest rates, and exchange rates to an inflation shock of 1 percent. As suggested by the discussion above, a plausible breakpoint for the analysis is July 1988, when Alan Greenspan's testimony signaled a heightened clarity of focus on price stability. The top left panel of figure 3 shows that before 1988, the effects of shocks to the US/German inflation differential died out very gradually. These effects, cumulated over a period of years, had large implications for relative price levels. As shown in the next panel down, the interest rate differential did not, however, rise as much as inflation, resulting in a fall in the *real* rate in the United States, relative to Germany, after an inflation shock in the United States relative to Germany.

This apparently accommodative monetary policy response in the United States prior to July 1988, similar to that of the discretionary case in our model, is reflected in the behavior of the exchange rate, shown in the bottom left panel of figure 3. The dotted line shows the nominal exchange rate movement corresponding to the inflation shock's long-run effect on relative prices, which in this case is roughly 0.4 percent lower. The dashed line shows the path of the exchange rate constrained to satisfy UIP; after falling sharply in the in the month of the shock, it declines gradually towards the level implied by PPP. The unconstrained response, given by the dashed line, falls by a comparable amount on impact, but it subsequently overshoots by about 0.3 percent before converging (by assumption) to its PPP level.

---

[25] The restrictions implied by UIP are testable, although we do not perform those tests here. In Clarida and Galí (1994), the restrictions are rejected.

Things look very different after July 1988. As shown in the top right-hand panel, US inflation shocks now die out immediately, and have virtually no implications for future inflation. The response of the interest rate differential is mild, showing only a very small increase in the real rate. And, as expected given the small response of relative price levels and interest rates, inflation shocks' effect on the exchange rate is minimal (and there is much less overshooting as well). This pattern of less pass-through of inflation shocks and lower persistence is consistent in terms of our model with a move by the Federal Reserve towards the OSCR through increasing transparency.

The top panel of **figure 4** shows how inflation shocks have contributed historically to fluctuations in the nominal deutsche mark-dollar exchange rate. The July 1988 breakpoint is indicated by a vertical line. In the pre-1988 period, inflation shocks' contribution is large: in the unconstrained series shown as the dashed line, a large share of the 1976–80 depreciation and the 1980–85 appreciation are attributable to inflation disturbances.[26] (As always, much of the 1980–85 appreciation is *not* explained, however.) The dotted line shows the path of the exchange rate implied by inflation shocks' effect on expected future inflation and interest rate differentials, constrained to satisfy the UIP condition.[27] This shows the same qualitative pattern as the unconstrained series, albeit with a smaller magnitude. After 1988, neither method attributes any significant exchange rate variation to inflation shocks. This pattern is confirmed by the variance decompositions displayed in the top panel of table 1. In the early part of the sample, interest rate shocks account for as much as 20 percent of the nominal exchange rate variance; after 1988, they contribute a trivial 3 percent of the variance. ("Own" shocks to the exchange rate account for nearly all of the exchange rate variation.)

The bottom panel of figure 4 traces out the effects of fluctuations in the interest rate differential unrelated to inflation or exchange rate movements. These may represent either the normal policy response to macroeconomic factors not present in the VAR, or unsystematic deviations of policy from "normal" behavior. The unconstrained decomposition, again shown as a dashed line, attributes very little of the variation in the exchange rate to interest rate differentials, and

---

[26] This is just the standard historical decomposition of the nominal exchange rate in terms of past inflation shocks; see Doan (1992), 14-116.

[27] This series is related to a multivariate Beveridge-Nelson decomposition.

this is confirmed by the variance decompositions in the top panel of table 1. The decomposition based on UIP, on the other hand, associates a certain amount of the dollar's weakness to (predictably) lower interest rates in the United States vis à vis Germany in the early 1990s.

To understand whether differences in these responses can be traced to the behavior of monetary policy, it is useful to examine monetary policy reaction functions, like those studied by Clarida, Galí and Gertler (2000). The top panel of table 2 presents forward- and backward-looking versions of a reaction function for the United States, allowing for a change in the coefficients on inflation and output after July 1988. What is striking in these results is the lack of any significant difference in terms of the relative weight on output and inflation goals between the two periods. The inflation coefficient (which is significant only in the forward-looking specification) is nearly unchanged, and the coefficient on real output (detrended log industrial production) increases slightly.[28] Notice, however, that the standard error drops markedly, perhaps indicating more systematic policy in the second period. In any case, there is no evidence to suggest that the more subdued response of inflation and the nominal exchange rate to inflation shocks was obtained by an increase in conservatism. A decline in inflation persistence (an increase in the anchoring of inflation expectations) without a change in monetary policy goals is likely attributable to an increase in transparency - this is the potential additional degree of freedom for policymakers hypothesized about in our introduction.

Japan

As with the United States, **figure 5** displays the basic data used in the VAR. Unlike in the case of the dollar, the yen's appreciation against the deutsche mark since 1980 appears largely unrelated to changes in the two countries' relative price levels. **Figure 6** shows the response of inflation, interest rates, and the exchange rate to shocks to the Japanese–German inflation differential. The upper left-hand panel shows that prior to April 1987, shocks to the inflation differential displayed a fair amount of persistence (albeit not as much as the persistence of shocks to the United States–German differential). Nominal interest rates responded relatively gradually

---

[28] The results in Clarida, *et al's* own investigations suggest that the inflation coefficient would probably be smaller in the 1976–79 portion of the sample, however.

(center-left panel), leading to a near-term decline in the real rate, followed by an increase after about six months. The unconstrained response of the nominal exchange rate (bottom-left panel) overshoots its PPP level somewhat, before appreciating; the path constrained by UIP shows an immediate decline followed by a further depreciation towards the PPP level.

As in the United States, there is much less persistence in the Japanese inflation differential after the breakpoint in the late-1980s; in fact, there is some tendency in the latter period for shocks to reverse themselves (top-right panel). In line with our model in section 1, this could be the result of either increased conservatism or transparency (movement towards the OSCR). Despite the more muted behavior of inflation, the response of nominal rates is broadly similar across the two periods: somewhat smaller in magnitude in the latter period, but more prolonged (center-right panel). The result is a more pronounced increase in the real rate post-April 1987, consistent with the movement towards conservatism in our model. The exchange rate path (lower-right panel) is just what one would expect in light of the more aggressive response to inflation: in the unconstrained estimate, the nominal exchange rate actually *appreciates* initially in the face of an inflation shock, before declining to the level implied by PPP. The path constrained by UIP does not show an appreciation, but the increase in interest rates staves off the depreciation for a period of several months. This is the sort of volatility tradeoff of short-term exchange rate volatility versus long-term inflation volatility predicted for an increase in conservatism by our model.

Turning to the historical decompositions, the top panel of **figure 7** displays the contribution of inflation shocks to nominal deutsche mark-yen exchange rate fluctuations. Only in the mid- to late-1970s do inflation shocks contribute tangibly to the yen's fluctuations, accounting for some of the yen's gradual downward trend prior to 1980. Except for this episode, Japanese and German inflation rates remained close to one another, so it is no surprise that shocks to the inflation differential should have played a small role. Nonetheless, as shown in the bottom panel of table 1, overall inflation shocks did account for as much as 18 percent of the nominal exchange rate variance in the pre-April 1987 portion of the sample.

There is somewhat more variation in the interest rate differential, and shocks to it account for a surprising amount of the movements in the deutsche mark-yen exchange rate post-1987. In the unconstrained estimate, rising rates in the late 1980s are associated with a rising yen, and falling

rates in the early 1990s with the yen's subsequent decline. As shown in table 1, shocks to the interest rate differential account for 10 percent of the nominal exchange rate variance at a 12-month horizon.[29] In this latter portion of the sample, the exchange rate appears to be unusually sensitive to interest rate shocks: A 1 percent shock to the differential generates a peak response of over 6.5 percent, far in excess of the 1.3 percent or so that would be consistent with uncovered interest rate parity, given the shock's impact on future interest rate differentials. This sizable magnitude might be attributable to the decline in discretionary transparency, as BoJ monetary policy became less systematic in the face of the challenges of the 1990s; given the limited room for maneuver of the Japanese near-zero instrument interest rate, every monetary policy move was scrutinized for its uncertain implications for exchange rate levels.

Finally, to better understand the factors affecting Japanese interest rates, we examine an estimated reaction function for the BoJ, displayed in the bottom panel of table 2. The results confirm a distinct shift in the conduct of monetary policy in the late 1980s. Prior to 1987, the BoJ's emphasis seems to have been on real activity: The coefficient on detrended output is large and significant, while even in the forward-looking specification, the coefficient on inflation is small, and has the wrong sign. After 1987, the inflation coefficient is large (implying a two- or three-to-one response of the interest rate), and the coefficient on IP is insignificant[30]. Both coefficients' changes are statistically significant at the 5 percent level. In short, counter-inflationary conservatism markedly increased in Japanese monetary policy in the 1990s, and this added to short-run exchange rate volatility.

---

[29] The share peaks at 14 percent at the 24-month horizon. Shocks to the interest rate differential actually contribute slightly more to the nominal exchange rate variance pre-1987 at the shorter 1–6 month horizon, presumably due to the high-frequency volatility of short-term interest rates.

[30] Jinushi, Kuroki, and Miyao (2000) find a similarly timed break in the BoJ's response function in 1987, and a similar move towards more strict pursuit of inflation goals.

WOULD INCREASED TRANSPARENCY MEANINGFULLY
DIMINISH G3 EXCHANGE VOLATILITY?

The premise of this paper's investigations was that differences in transparency of monetary policy within the G3 could explain part of the variation over time in short-run exchange rate volatility. As set out in the model of section 1, a central bank which increases its transparency of monetary policy making can be thought of as moving from discretion towards the OSCR, thereby better anchoring inflation expectations, and decreasing its need to be aggressive in response to inflation surprises. Working from a standard model of central bank goals under time-inconsistency, following Svensson (1997) and Kuttner and Posen (1999), but adding a short-run UIP condition, and long-run PPP, it becomes clear that movements from discretion towards the OSCR will diminish exchange rate volatility, while increases in conservatism (i.e., the relative weight on inflation goals) without compensating increases in transparency will increase that short-run volatility.

Using a measure of institutional transparency for central banks developed in section 2, it was established that the Bundesbank was consistently, and noticeably though not fully, transparent for the duration of its post-Bretton Woods lifetime (1975–1998). The Federal Reserve significantly increased transparency with a clarification of its goals in 1988, and showed a trend towards greater openness from that date forward, including the explicit abandonment of monetary targets in 1993 and the addition of explanations to interest rate announcements in 1994. The BoJ moved in the opposite direction, cycling between multiple goals starting in 1987, with diminishing clarity over time.[31] These trends, and the stability of the Bundesbank's framework, allowed us to examine the behavior of deutsche mark-yen and deutsche mark-dollar nominal exchange rates for evidence of transparencies impact in line with the predictions of the model.

Both in the broad and the specific, our investigations support the belief that monetary transparency matters for exchange rate volatility. Broadly speaking, this characterization of the G3 central banks' transparency provides a means of explaining the previously anomalous pattern that yen-dollar exchange rate volatility was consistently higher than either of the deutsche mark bilateral

---

[31] The new BoJ Act of 1998, and the BoJ's preparations for operational independence, did increase institutional dependency on two of our four criteria, but this takes place at the very end of our sample period (and arguably was accompanied by a decrease in transparency in discretion).

rates in the G3, despite one unified market for all three currencies. More specifically linking to the predictions of our model, the deutsche mark-dollar exchange rate showed diminishing volatility over time in line with the increase in the Federal Reserve's transparency. Most tellingly, US inflation persistence declined significantly after 1988, despite stability before and after 1988 in the relative weights on inflation and output goals in an estimated Federal Reserve response function. This is consistent with a view of the Federal Reserve as a central bank moving from discretion towards the OSCR through increasing transparency. Marked changes in the impulse response functions of inflation, interest rates, and exchange rates after 1988 in the United States also fit the picture of what should happen for a central bank moving towards the OSCR without an increase in conservatism.[32]

In the case of Japan, there is ample evidence of an increase in counter-inflationary conservatism—while inflation persistence declines after 1987, the weight on inflation goals in an estimated Taylor rule significantly increased, and the impulse response functions for interest rates, et al, look like those of a central bank moving towards being an "inflation nutter" [in the sense of King (1997)]. Also, the volatility of the deutsche mark-yen exchange rate steadily rises from 1987 onwards, consistent with a more aggressive pursuit of price stability at the expense of short-run exchange rate volatility. The role of inflation shocks in explaining movements in the variation of exchange rates falls for both the BoJ and the Federal Reserve after their respective late-1980s breakpoint, but only in Japan is this accompanied by an increase in the explanatory power of interest rate shocks (their explanatory power declines for the deutsche mark-dollar post 1988), again consistent with the interpretation of the Federal Reserve moving towards the OSCR while the BoJ moved toward greater conservatism.

So, in practice as well as in prospect, increasing monetary transparency does offer an additional degree of freedom with which the G3 central banks can address short-run exchange rate volatility. As exemplified by the shift in the Federal Reserve transparency after 1988, without an increase in conservatism—and the Federal Reserve and the markets' response to inflation surprises after that—it is not necessary to change a central bank's macroeconomic priorities in order to better anchor expectations, and thereby diminish exchange rate volatility. In fact, for reasonable parameter

---

[32] Future work using monte-carlo methods will give us standard error bands on the impulse response functions, allowing us to assess whether these changes are statistically significant.

values, transparency enhancement is more likely to be win-win than increasing conservatism, decreasing both inflation persistence and forex volatility. As illustrated by the experience of the BoJ after 1987, increasing conservatism is more likely to trade a drop in inflation persistence for an increase in exchange rate volatility. Transparency is independent of the "impossible trinity" tradeoff usually cited as a reason for the inability or unwillingness of major central banks to respond to volatility, as well as of the "fundamentals" which do not determine exchange rates (except to the extent that increased transparency improves inflation performance).

The magnitude of the impact of increased monetary transparency on G3 exchange rate volatility, however, remains open to question. There is no quantitative, cardinal, metric for transparency, and so no way of knowing how much stability is bought for a given increase. In the case of the United States, while there is certainly room for additional clarity, given the marked increases in the Federal Reserve's institutional transparency in 1988 and 1993–94, it is not evident how much the additional efforts will "buy" in terms of exchange rate stability. If the entire decline in deutsche mark-dollar volatility after 1988 were to be attributed to the Federal Reserve's increase in transparency—a binding but not outrageous upper-bound—over 1 percent of the initial 4 percent monthly standard deviation of would have been taken away by the efforts. A similar attribution for the rise in deutsche mark-yen volatility gives an upper bound of over 2 percent, but given the Japanese economic crisis, it is much less credible that the only major shift in policy or forex environment was the shift in BoJ transparency and preferences. Taking only half that amount as the effect of transparency, however, puts us back at the same estimate as that for the deutsche mark-dollar. The average amount by which the yen-dollar volatility exceeds either of the deutsche mark bilateral rates—which could be interpreted largely as the Bundesbank's relative transparency bonus, since there are no significant differences from the other two central banks in central bank independence or in monetary response functions for much of the period, let alone in structure of the foreign exchange markets—is also of a similar order of magnitude.

If these ballpark but consistent estimates of the benefits of transparency were correct, that would still leave more than two-thirds of the present monthly volatility, which would still swamp (and be unrelated to) the movement in underlying macroeconomic fundamentals. The problem of G3 exchange rate volatility would not go away, nor should it so long as financial markets'

26

microstructure is the source of it (see Rogoff 1999). Yet, assuming that part of the dislike for exchange rate volatility is generated by its extreme magnitudes, removing 20–30% of it would be significant for emerging markets and international businesses—especially since the means for so doing, increasing monetary transparency, increases political legitimacy without economic cost, and adds potentially significant economic benefits (such as diminished inflation persistence and pass-through).

Meanwhile, were all three of the G3 central banks to maximize their institutional transparency, say by moving to explicit inflation targeting frameworks in today's believed best practice for openness, there is likely to be even greater demand for transparency in discretion. The major central banks' explanations of deviations from systematic policy would no longer be compared against just their own published goals, forecasts and explanations, but also those of their peers. While this framework thankfully would not constitute a fixed rule, such an institutionalization of transparency would seem to bode well for more disciplined, better understood, monetary policy. This disciplining of discretion might in turn imply still further decreases in exchange rate volatility beyond those to be expected from each of the G3 central banks becoming more transparent on their own.

REFERENCES

Baxter, Marianne and Alan Stockman. 1989. Business Cycles and the Exchange-Rate System, *Journal of Monetary Economics*.

Bernanke, Ben. 2000. Japanese Monetary Policy: A Case of Self-Induced Paralysis? In Mikitani and Posen, eds.

Bernanke, Ben, et al. 1999. *Inflation Targeting: Lessons from the International Experience*. Princeton University Press.

Bernanke, Ben and Mark Gertler. 1999. Monetary Policy and Asset Price Bubbles mimeo, FRBKC Jackson Hole Conference, August.

Blinder, Alan. 1998. *Central Banking in Theory and Practice*, Cambridge: MIT Press.

Bomfim, Antulio and Vincent Reinhart. 2000. Making News: Financial Market Effects of Federal Reserve Disclosure Practices mimeo, Federal Reserve Board.

Briault, Clive, Andrew Haldane, and Mervyn King. 1997. Independence and Accountability, in Kuroda ed.

Cargill, Thomas, Takatoshi Ito, and Michael Hutchison. 1997. *The Political Economy of Japanese Monetary Policy*, Cambridge: MIT Press.

Clarida, Richard. 1999. *G3 Exchange Rate Relationships: A Recap of the Record and A Review of Proposals for Change.* NBER Working Paper 7434, December.

Clarida, Richard, and Jordi Galí. 1994. Sources of real exchange-rate fluctuations: How important are nominal shocks? *Carnegie-Rochester Conference Volume on Public Policy* 41, 1–56.

Clarida, Richard, Jordi Galí and Mark Gertler. 2000. Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory, *Quarterly Journal of Economics* 115 (1), February, 147–180.

Doan, Thomas. *Rats User's Manual version 4*, Evanston: Estima.

Eichenbaum, Martin and Charles Evans, Some Empirical Evidence on the Effects of Shocks to monetary Policy on Exchange Rates, *Quarterly Journal of Economics* 110, 975–1010.

Faust, Jon and John Rogers, Monetary Policy's Role in Exchange Rate Behavior mimeo, Board of Governors of the Federal Reserve System.

Flood, Robert, and Andrew Rose. 1995. Fixing Exchange Rates: A Virtual Quest for Fundamentals, *Journal of Monetary Economics*.

Flood, Robert and Andrew Rose. 1999. Understanding Exchange Rate Volatility Without the Contrivance of Macroeconomics, *Economic Journal*, November.

Frankel, Jeffrey and Andrew Rose. 1995. Empirical Research on Nominal Exchange Rates, *Handbook of International Economics* 3. Amsterdam: Elsevier.

Friedman, Benjamin. 1997. *The Rise and Fall of Monetary Targets for US Monetary Policy*, in Kuroda, ed.

Jinushi, Toshiki, Yoshihiro Kuroki, and Ryuzo Miyao. 2000. Monetary Policy in Japan Since the Late 1980s: Delayed Policy Actions and Some Explanations. In Mikitani and Posen, eds.

King, Mervyn. 1997. Changes in UK Monetary Policy: Rules and Discretion in Practice, *Journal of Monetary Economics* 39, 81–87.

Krugman, Paul. 1998. The Eternal Triangle mimeo, MIT

Kuroda, Iwao, ed. 1997. *Towards More Effective Monetary Policy*. New York: St. Martin's Press

Kuttner, Kenneth N. and Adam S. Posen. *Does Talk Matter After All? Inflation Targeting and Central Bank Behavior*. Federal Reserve Bank of New York Staff Report 88.

Laubach, Thomas and Adam Posen. 1997. Disciplined Discretion: Monetary Targeting in Germany and Switzerland, *Princeton Essays in International Finance*, December.

Meese, R and Kenneth Rogoff. 1983. Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample? *Journal of International Economics*, February.

Mikitani, Ryoichi and Adam Posen, eds. 2000. *The Japanese Financial Crisis and Its Parallels With US Experience*, Washington: Institute for International Economics (forthcoming July).

Neumann, Manfred J. M. 1997. Monetary Targeting in Germany. In Kuroda, ed.

Obstfeld, Maurice and Kenneth Rogoff. 1995. The Mirage of Fixed Exchange Rates, *Journal of Economic Perspectives*, Fall 1995.

Posen, Adam. 1999. No Monetary Masquerades for the ECB. In *The European Central Bank: How Accountable? How Decentralized?,* ed. Ellen Meade. American Institute for Contemporary German Studies.

Rogoff, Kenneth. 1999. Monetary Models of Dollar/Yen/Euro Nominal Exchange Rates: Dead or Undead? *Economic Journal*, November.

Svensson, Lars. 1997. Optimal Inflation Contracts, 'Conservative' Central Banks, and Linear Inflation Contracts, *American Economic Review* 87, 98–114.

Ueda, Kazuo. 1997. Japanese Monetary Policy, Rules or Discretion? A Reconsideration. In Kuroda, ed.

Volcker, Paul. 1995. The Quest for Exchange Rate Stability mimeo, Institute for International Economics.

Williamson, John. 1998.Crawling Bands or Monitoring Bands, *International Finance*, September.

Figure 1

Exchange rate volatility
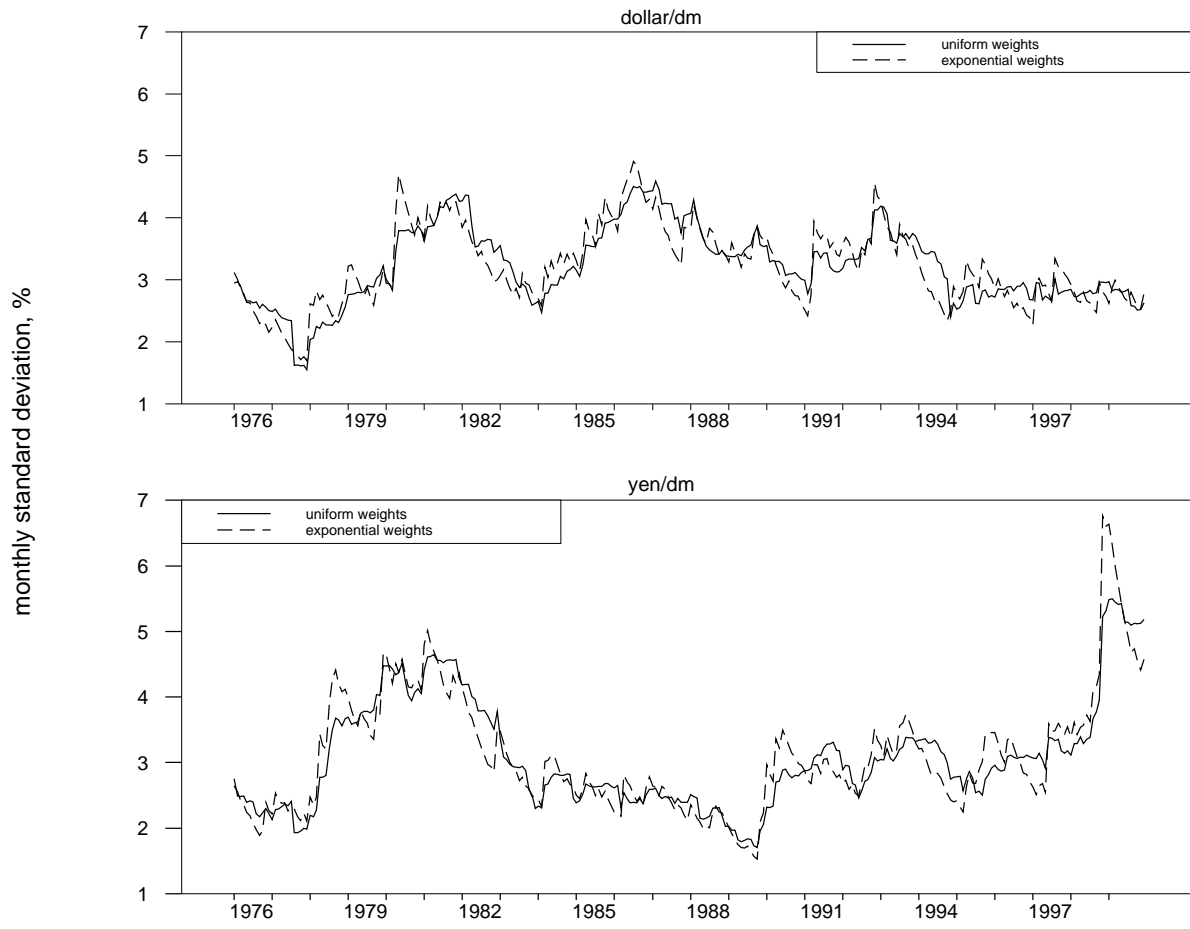
Figure 2

US and German data

Inflation
12-month change in CPI

Interest rates
Fed funds, call money rates

Log nominal exchange rate
and cumulative inflation differential
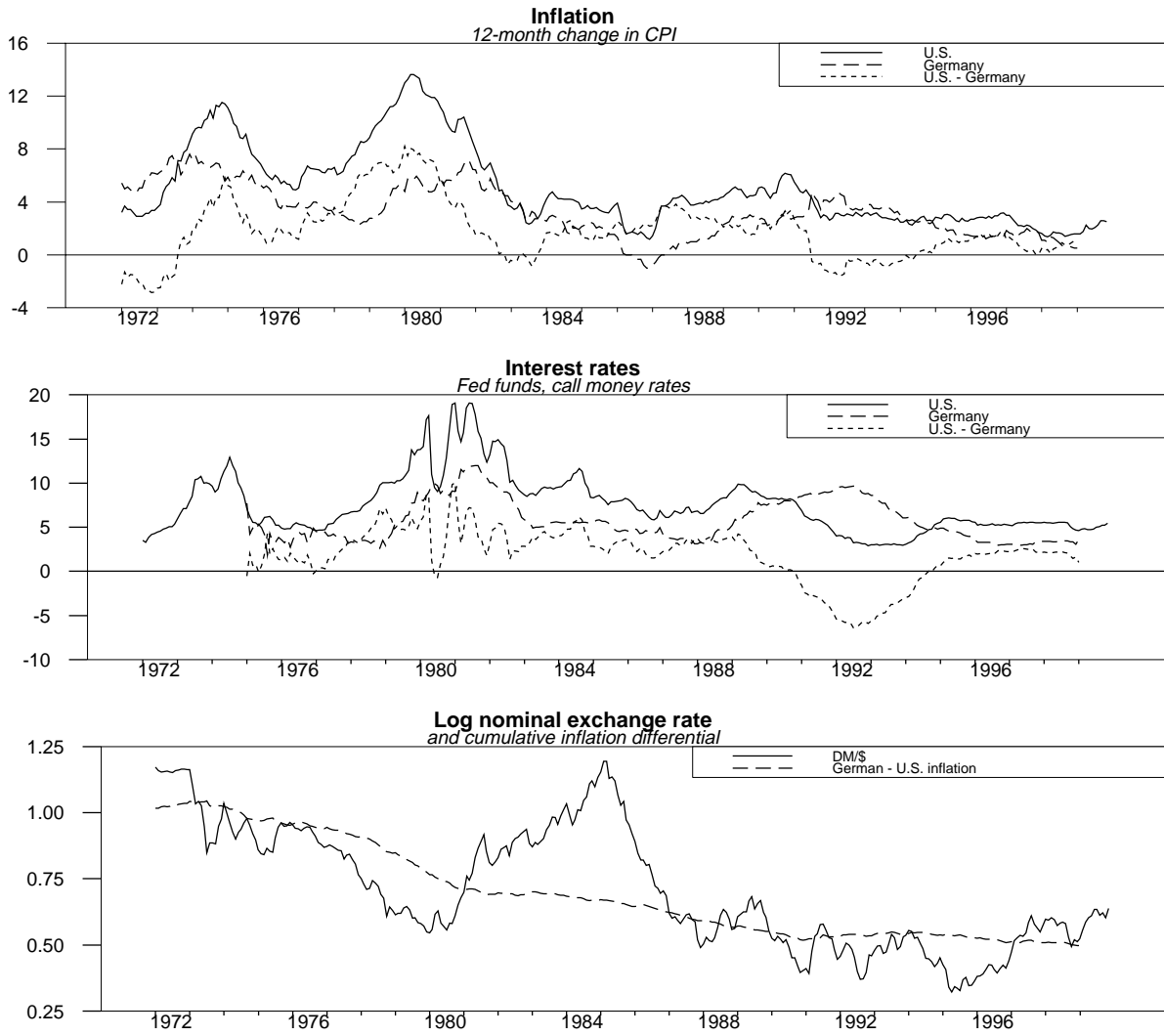
Figure 3

Response of interest rate and exchange rate to a 1 percent inflation shock, the United States
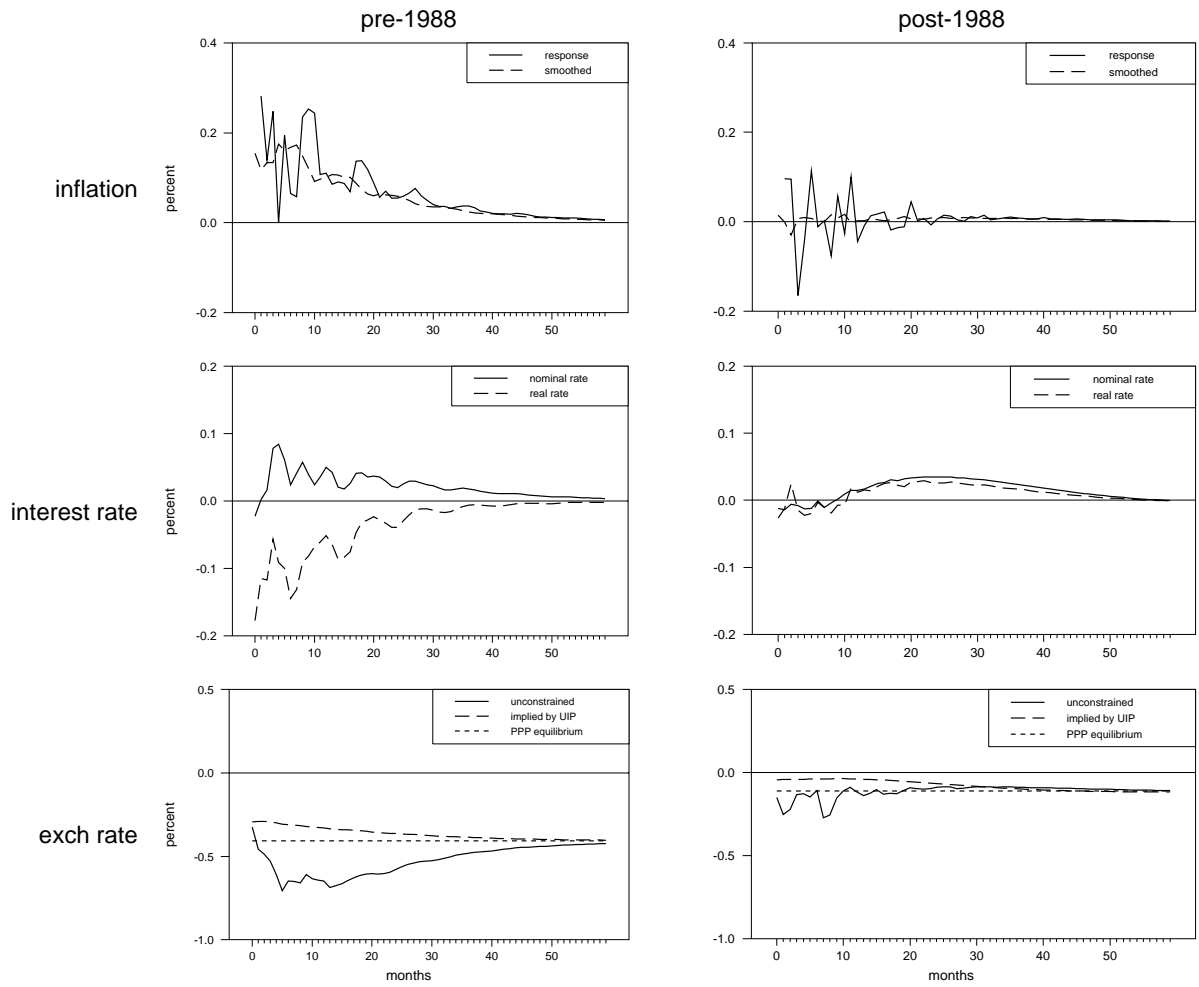
Figure 4

Contribution of inflation and interest rate shocks to nominal exchange rate fluctuations, the United States

contribution of inflation shocks

contribution of interest rate shocks

percent deviation from trend
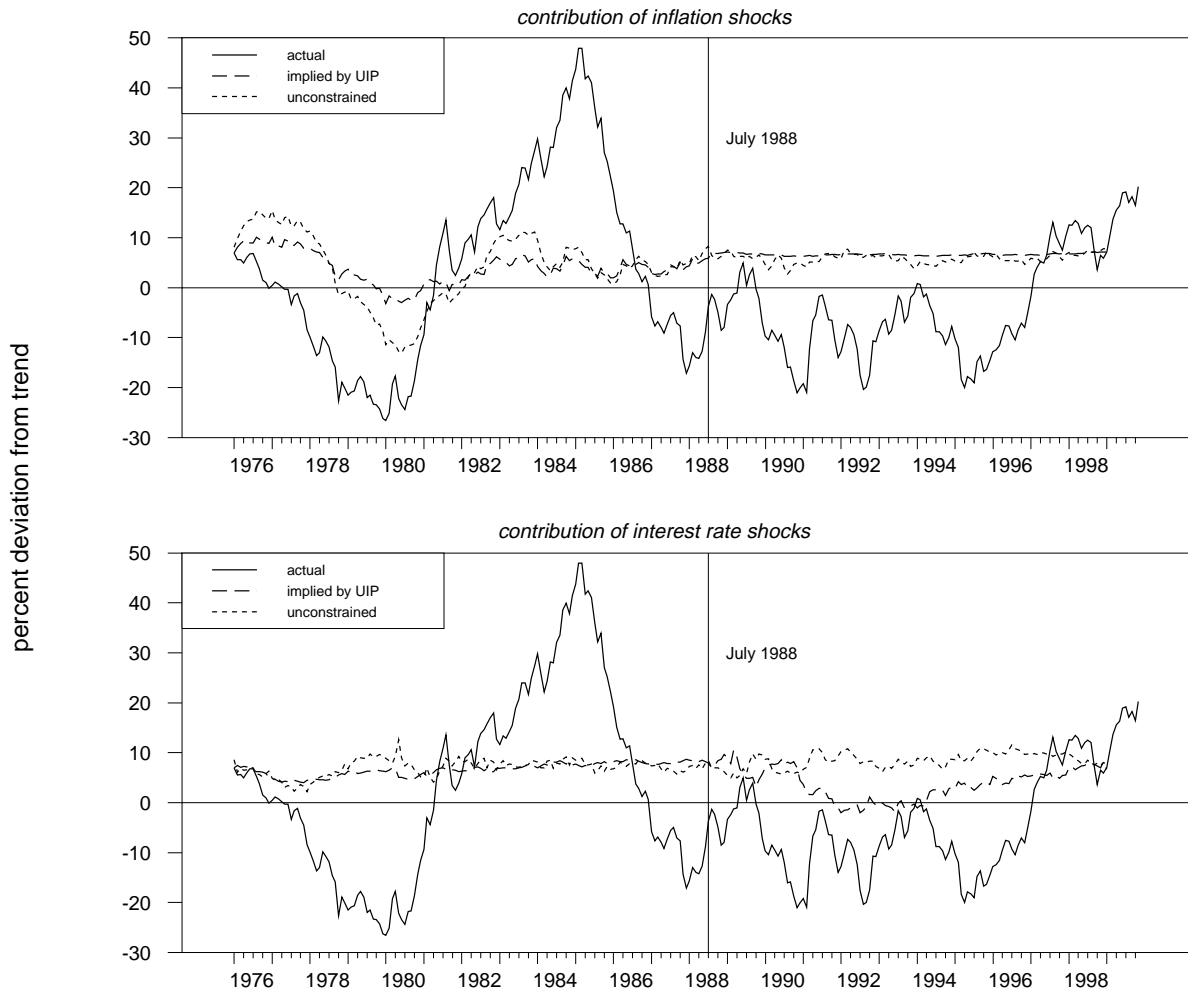
Figure 5

Japanese and German data

Inflation
12-month change in CPI

———	Japan
– – –	Germany
·······	Japan - Germany

Interest rates
Gensaki, call money rates

———	Japan
– – –	Germany
·······	Japan - Germany

Log nominal exchange rate
and cumulative inflation differential

———	DM/Yen
– – –	German - Japanese inflation

35
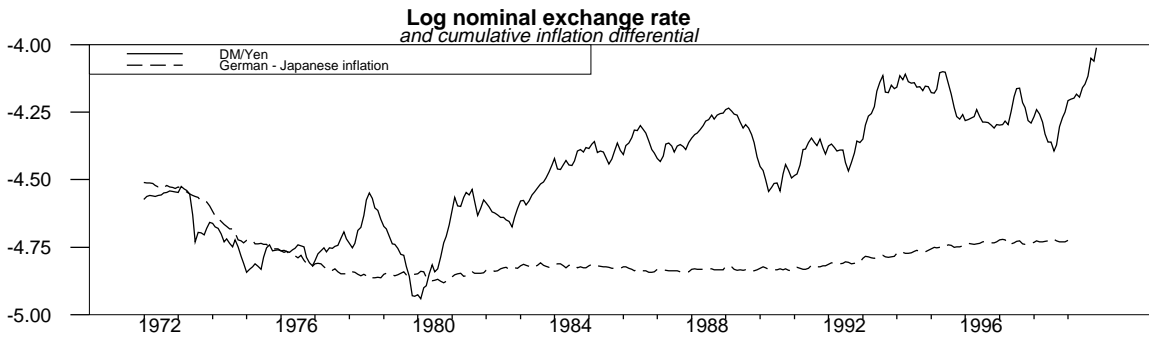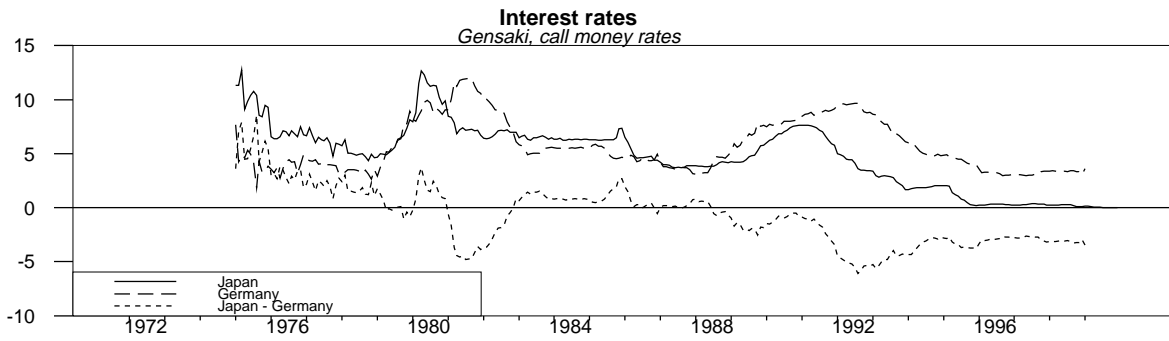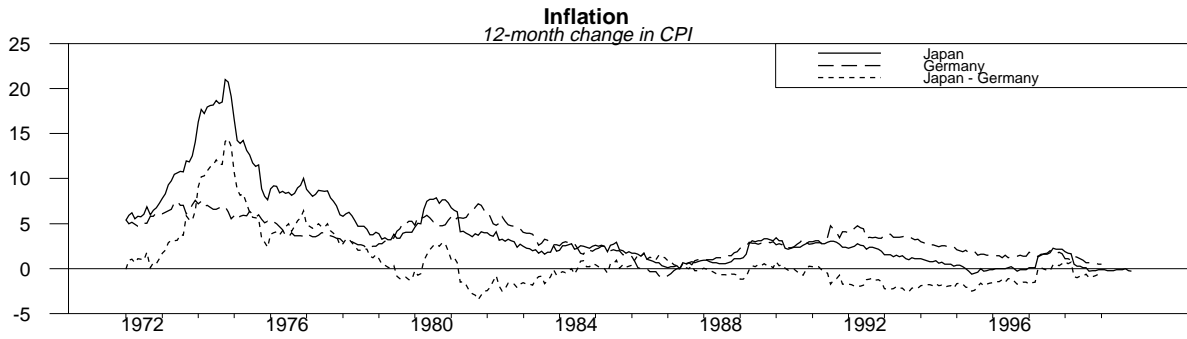
Figure 6

Response of interest rate and exchange rate to a 1 percent inflation shock, Japan
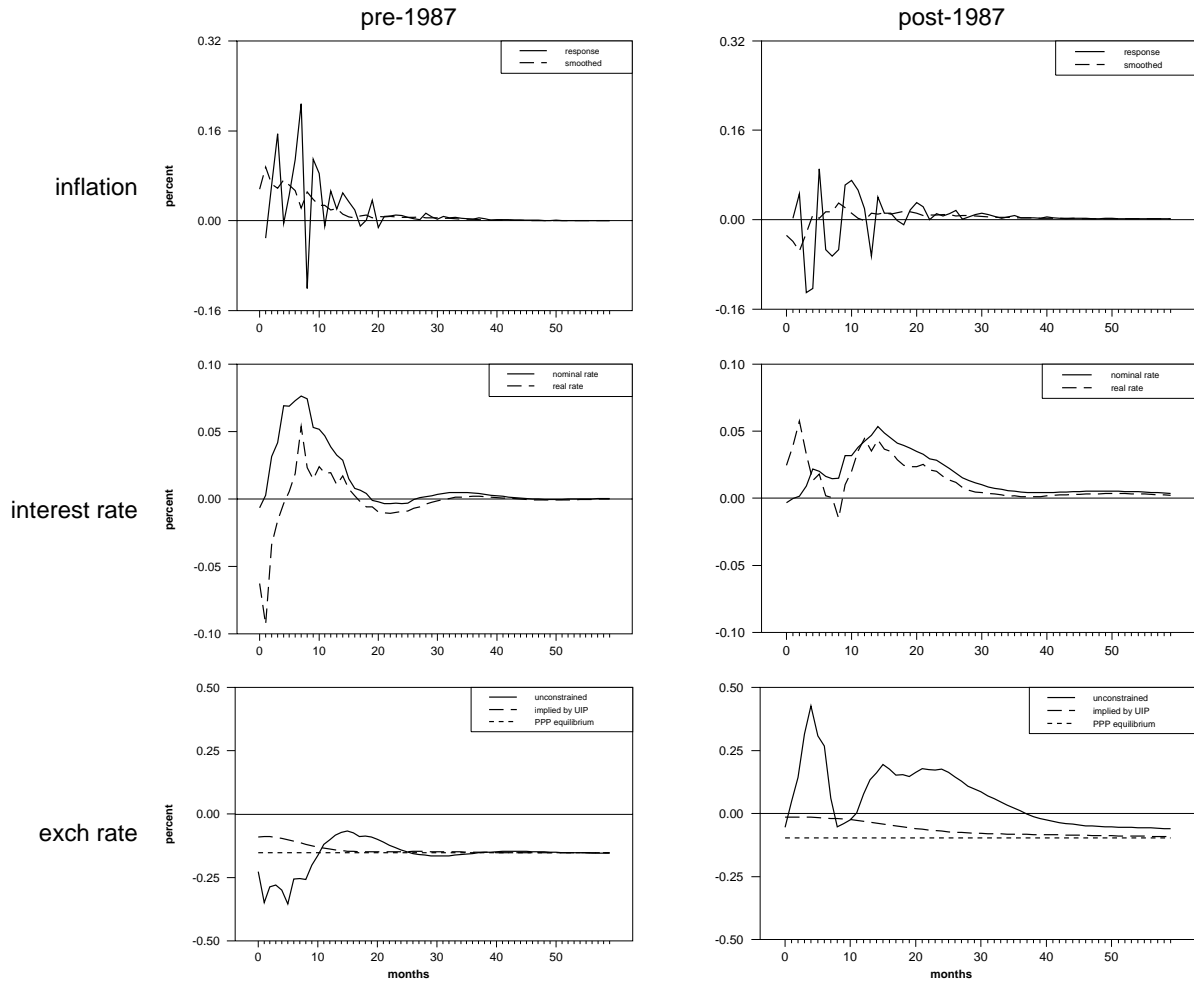
Figure 7

Contribution of inflation and interest rate shocks to nominal exchange rate fluctuations, Japan

contribution of inflation shocks

contribution of interest rate shocks
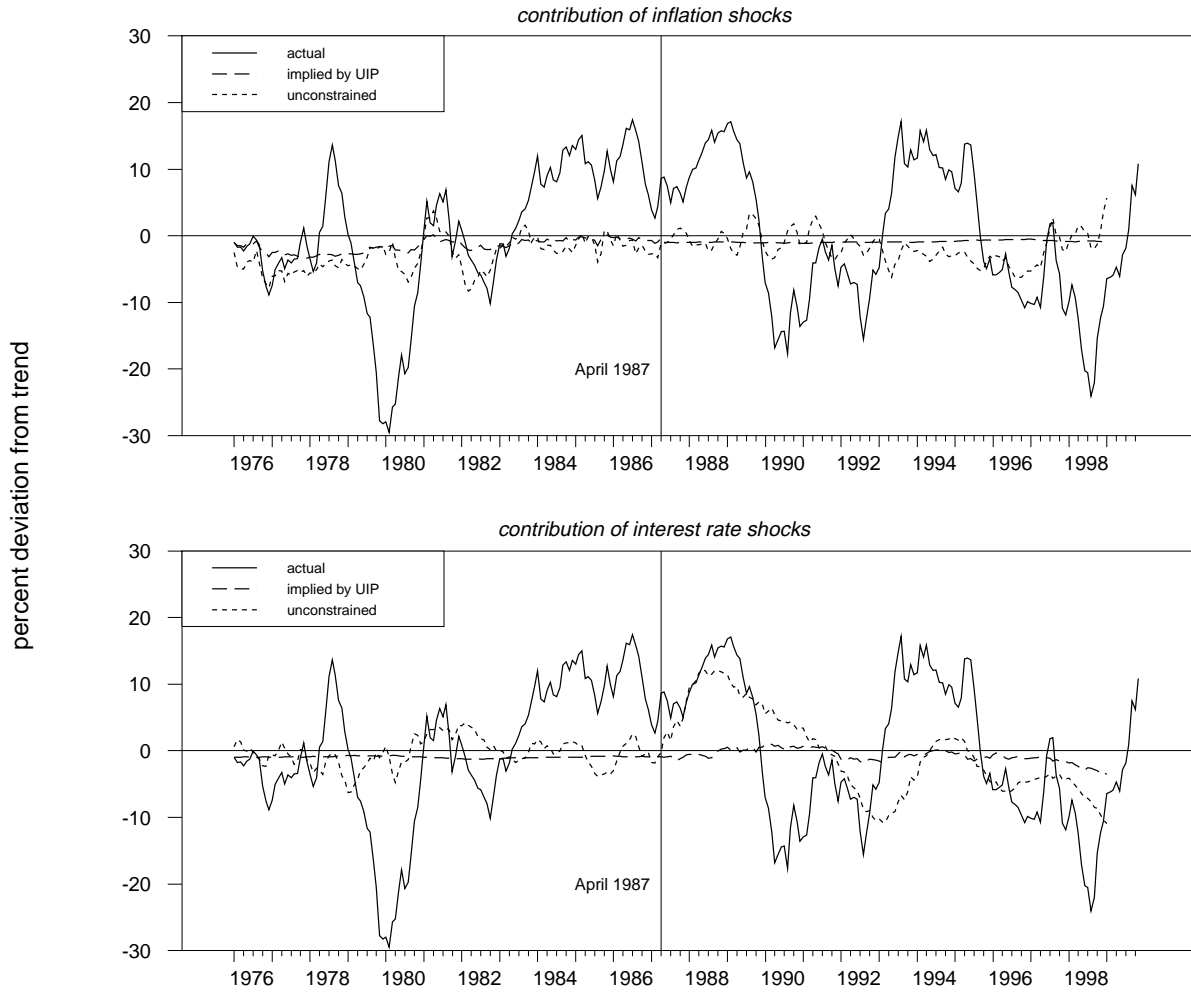
Table 1

Decomposition of Nominal Exchange Rate Variance

United States

	Percent of nominal exchange rate variance attributed to					
	Pre-1988			Post-1988		
Horizon, months	Inflation shocks	Interest rate shocks	Own shocks	Inflation shocks	Interest rate shocks	Own shocks
1	14	6	79	2	0	98
6	20	1	79	3	3	96
12	17	1	82	2	2	96
120	8	0	92	1	2	97

Japan

	Percent of nominal exchange rate variance attributed to					
	Pre-1987			Post-1987		
Horizon, months	Inflation shocks	Interest rate shocks	Own shocks	Inflation shocks	Interest rate shocks	Own shocks
1	18	16	66	0	4	96
6	14	12	74	5	4	91
12	9	6	85	3	10	88
120	4	3	93	0	2	98

Notes: variance decompositions are calculated from the trivariate vector autoregression described in the text, unconstrained by the UIP condition.

Table 2

Estimated Monetary Policy Reaction Functions

United States

Specification	r_{t-1}	Pre-1988		Post-1988		Change		Standard error	
		Inflation	IP	Inflation	IP	Inflation	IP	Pre-88	Post-88
Backward	0.94	0.03	3.95	0.07	2.34	0.04	−1.61	0.94	0.18
	(0.02)	(0.03)	(1.56)	(0.07)	(1.57)	(0.06)	(2.35)		
Forward	0.95	0.08	0.45	0.08	2.29	0.01	1.84	0.96	0.18
	(0.02)	(0.02)	(1.55)	(0.05)	(0.95)	(0.12)	(1.06)		

Japan

Specification	r_{t-1}	Pre-1987		Post-1987		Change		Standard error	
		Inflation	IP	Inflation	IP	Inflation	IP	Pre-87	Post-87
Backward	0.96	−0.03	5.84	0.08	0.35	0.11	−5.49	0.50	0.17
	(0.01)	(0.01)	(1.08)	(0.04)	(0.86)	(0.04)	(1.36)		
Forward	0.93	−0.02	5.50	0.20	−1.35	0.22	−6.85	0.47	0.19
	(0.03)	(0.01)	(2.83)	(0.10)	(1.02)	(0.10)	(3.40)		

Notes: Numbers in parentheses are standard errors corrected for 11th-order serial correlation. The break date for the U.S. is July 1988, and for Japan it is April 1987. Data are monthly. The dependent variable for Japan is the 3-month Gensaki rate, for Germany it is the overnight call money rate. IP is detrended log industrial production; for Japan, the trend is allowed to change in January 1990. The inflation regressor in the "backward" specification is the lagged twelve-month inflation rate; in the "forward" specification, which is estimated via 2SLS, the regressor is the inflation rate over the coming twelve months. The instruments for the 2SLS regression consist of lagged inflation, IP, and the interest rate, and the same variables interacted with the post-breakpoint dummy.

WORKING PAPERS

No. 98-5.	Hiroko Ishii and Erika Wada, "Local Government Spending: Solving the Mystery of Japanese Fiscal Packages"
No. 98-6.	Marcus Noland, Sherman Robinson, and Zhi Wang, "The Global Economic Effects of the Japanese Crisis"
No. 99-1.	Marcus Noland, Sherman Robinson, and Tao Wang, "Rigorous Speculation: The Collapse and Revival of the North Korean Economy"
No. 99-2.	Marcus Noland, Sherman Robinson, and Tao Wang, "Famine in North Korea: Causes and Cures"
No. 99-3.	Marcus Noland, "Competition Policy and FDI: A Solution in Search of a Problem?"
No. 99-4.	Marcus Noland, Sherman Robinson, and Zhi Wang, "The Continuing Asian Financial Crisis: Global Adjustment and Trade"
No. 99-5.	Adam S. Posen, "Why EMU Is Irrelevant for the German Economy"
No. 99-6.	C. Fred Bergsten, "The Global Trading System and the Developing Countries in 2000"
No. 99-7.	Marcus Noland, Sherman Robinson, and Tao Wang, "Modeling Korean Unification"
No. 99-8.	Marcus Miller and Lei Zhang, "Sovereign Liquidity Crisis: The Strategic Case for a Payments Standstill"
No. 99-9.	C. Fred Bergsten, Olivier Davanne, and Pierre Jacquet, "The Case for Joint Management of Exchange Rate Flexibility"
No. 99-10.	Kenneth N. Kuttner and Adam S. Posen, "Does Talk Matter After All? Inflation Targeting and Central Bank Behavior"
No. 99-11.	Gary Clyde Hufbauer and Erika Wada, "Hazards and Precautions: Tales of International Finance"
No. 99-12.	Gary Clyde Hufbauer and Tony Warren, "The Globalization of Services: What Has Happened? What Are the Implications?"
No. 00-1.	Keith Maskus, "Regulatory Standards in the WTO: Comparing Intellectual Property Rights with Competition Policy, Environmental Protection, and Core Labor Standards"
No. 00-2.	Richard M. Goodman and John M. Frost, "International Economic Agreements and the Constitution"
No. 00-3.	Catherine L. Mann, "Electronic Commerce in Developing Countries: Issues for Domestic Policy and WTO Negotiations"
No. 00-4.	C. Fred Bergsten, "The New Asian Challenge"
No. 00-5.	Marcus Noland, "How the Sick Man Avoided Pneumonia: The Philippines in the Asian Financial Crisis"
No. 00-6.	Kenneth N. Kuttner and Adam S. Posen, "Inflation, Monetary Transparency, and G3 Exchange Rate Volatility"
No. 00-7.	Catherine L. Mann, "Transatlantic Issues in Electronic Commerce"
No. 00-8.	Morris Goldstein, " Strengthening the International Financial Architecture: Where Do We Stand?"

Working Papers are only available directly from the Institute (not from our international distributor or bookstores). Most appear in full form on our Web site at http://www.iie.com/catalog/wp/apecwp.htm. If you require a paper that is not available on the Web site, please contact us.

Working Papers
Tel: (202) 328-9000
Fax: (202) 328-5432
http://www.iie.com

Institute for International Economics
11 Dupont Circle, NW, Suite 620
Washington, DC 20036-1207