BANCA D'ITALIA

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COOPERATION IN MANAGING THE DOLLAR (1985-87): INTERVENTIONS IN FOREIGN EXCHANGE MARKETS AND INTEREST RATES

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Contents

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1. Introduction[1]

In this paper we study the experience of cooperation between the United States, Japan and Germany in managing the dollar in 1985-87. The basic facts, with emphasis on the role played by the different policy tools (interventions in foreign exchange markets, monetary and fiscal policies) are reviewed in Section 2. In Section 3 we discuss the channels of monetary-financial interaction between countries participating in a managed exchange rate system, based on the model presented in the Appendix. In particular, we show that interest rate differentials (short and long-term) across countries and their maturity structure within countries may depend (together with many other factors) on intervention policies in foreign exchange markets (that is, on the degree to which market trends are "resisted") and the degree of sterilization of interventions. This result could be relevant for establishing a connection between exchange rate management under the Louvre accord and the steep rise in long-term interest rates in the US that "detonated" the October 1987 stock-market crash. We then present empirical evidence on intervention policies (Section 4), monetary policies and sterilization (Section 5), interest rates (Section 6) in the period under review; the critical relationships identified by the model are examined in some detail, with various quantitative techniques, to see whether actual developments lend any support to the propositions derived from the model. Our conclusions are summarized in Section 7.

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1. The authors are grateful to Alessandro Giustiniani for help in developing the model in the Appendix, and to William Branson for useful comments. The usual disclaimers apply.

2. Return to cooperation

The period 1985-87 marked the return to cooperation by the United States and the other major industrial countries in exchange rate management (Chart 1), in the (narrow) sense that: (i) on various occasions these countries took, and announced publicly, a common "view" on the desirable range or direction or pace of change of the key exchange rates (dollar-DM and dollar-yen); (ii) they intervened increasingly actively in foreign exchange markets, in a number of cases jointly, to achieve these goals; (iii) they recognized increasingly the resulting constraints for their domestic policies and to an extent changed these policies accordingly.

It is useful, to start with, to stress what this return to cooperation was not. The US policy of neglect of the dollar exchange rate was abandoned because of the protectionist pressures generated by the high dollar. Meanwhile, a consensus had emerged that exchange rate "misalignment" was due principally to the divergent mixes of monetary and fiscal policies followed in the US, Germany and Japan during the phase of disinflation.[2] Accordingly, much emphasis was placed, in the recipes for adjustment, on the need for fiscal policy changes (restraint in the US, stimulus in Japan and Germany). Monetary policy was to remain geared to the objective of price stability. Interventions in foreign exchange markets were assigned a subsidiary role on grounds that they would be ineffective in countering market trends if they were sterilized, and would otherwise come soon to conflict with domestic monetary objectives.[3]

At the official level the exchange rate regime was not

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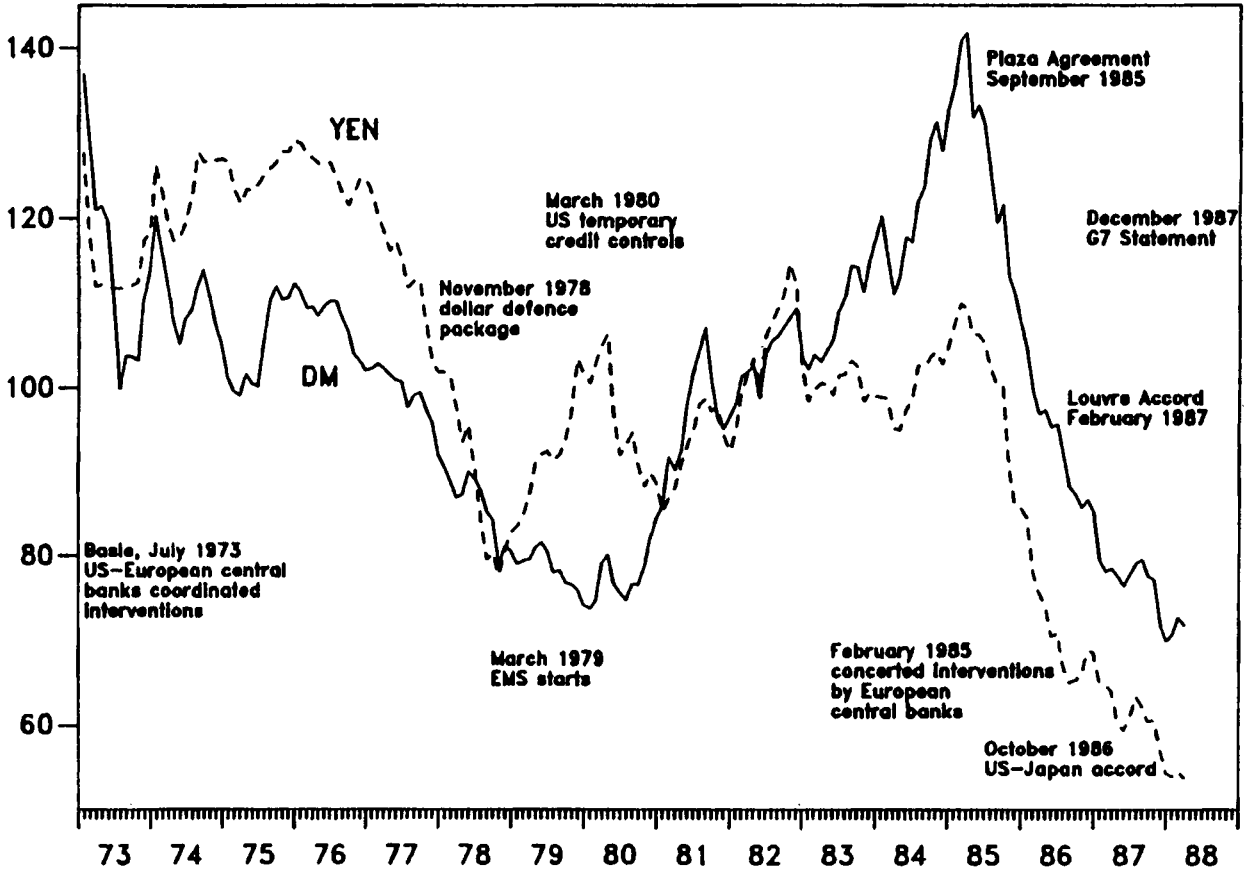
2. A forceful presentation of this view is in Marris (1985); the analytics are more fully discussed in Branson (1985) and Krugman (1988). This view found official sanction, as a basis for restored cooperation in exchange rate management, in the June 1985 Report on the functioning of the international monetary system of the Group of Ten Deputies.

3. See Jurgensen Report (1983).

Chart 1

PRICE OF THE DOLLAR IN TERMS OF YEN AND DM (*)



(*) index number with base=average of the whole period

in itself called into question. International institutions and Working groups (G-10, G-7, G-5) concentrated their efforts on setting up multilateral surveillance procedures -- based on joint monitoring of "objective" indicators -- to bring about greater "international consistency" of national policies and policy-mixes.[4] Altogether, the image of cooperation presented to the public was one of fully-fledged coordination of domestic policy objectives (growth, inflation, external balance) and instruments (monetary, fiscal and structural policies).[5] The exchange rate was apparently confined to backstage either because its level would be determined by "fundamentals" or, more simply, because it was not considered appropriate to let the public know the precise content of agreements in this area.

The reality of cooperation was different. Three phases can be identified in the period under review. During the first one, in 1985, the authorities of the industrial countries aimed at bringing the dollar down. Substantial interventions by the European central banks, with some assistance from the Federal Reserve (Chart 2), took place in February to accelerate a turnaround in market sentiment that appeared under way. However, following action by the Federal Reserve to halt the decline in short-term rates in the third quarter, in September the dollar

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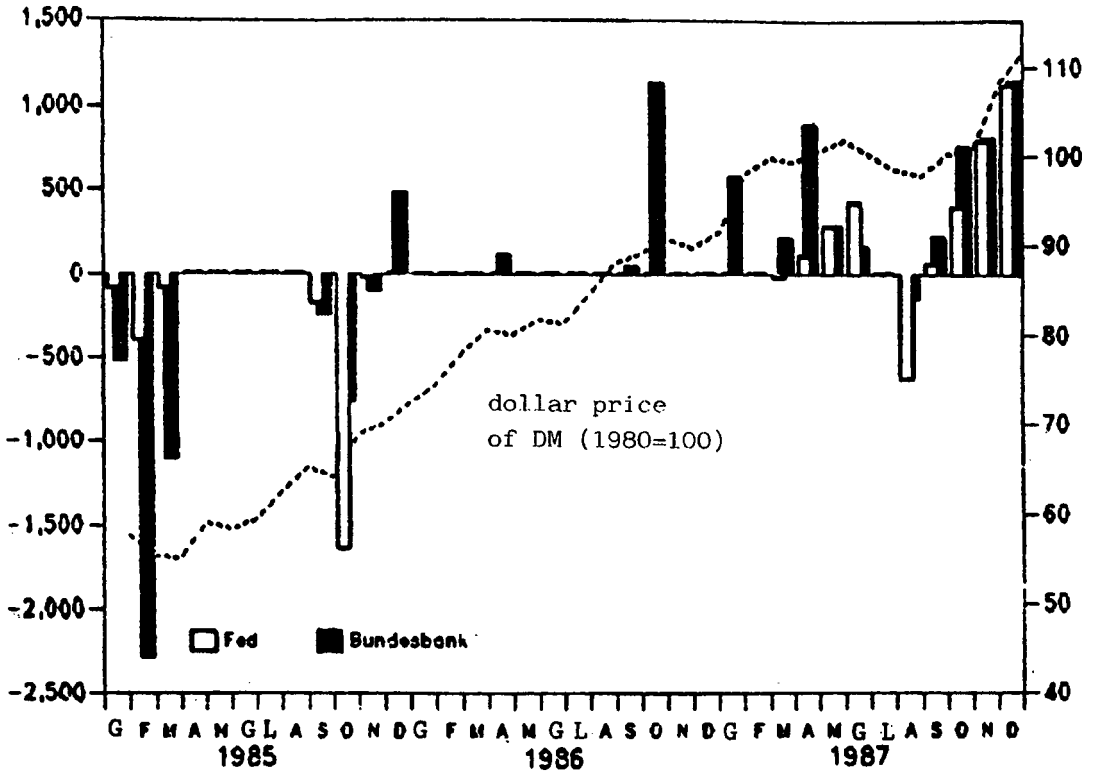
4. A formal endorsement of the indicators approach came with the Tokyo Economic Declaration of the Group of Seven (May 1986). The typical list of indicators would include growth (GDP and domestic demand), inflation, external balance, fiscal balance, monetary aggregates, interest rates and exchange rates.

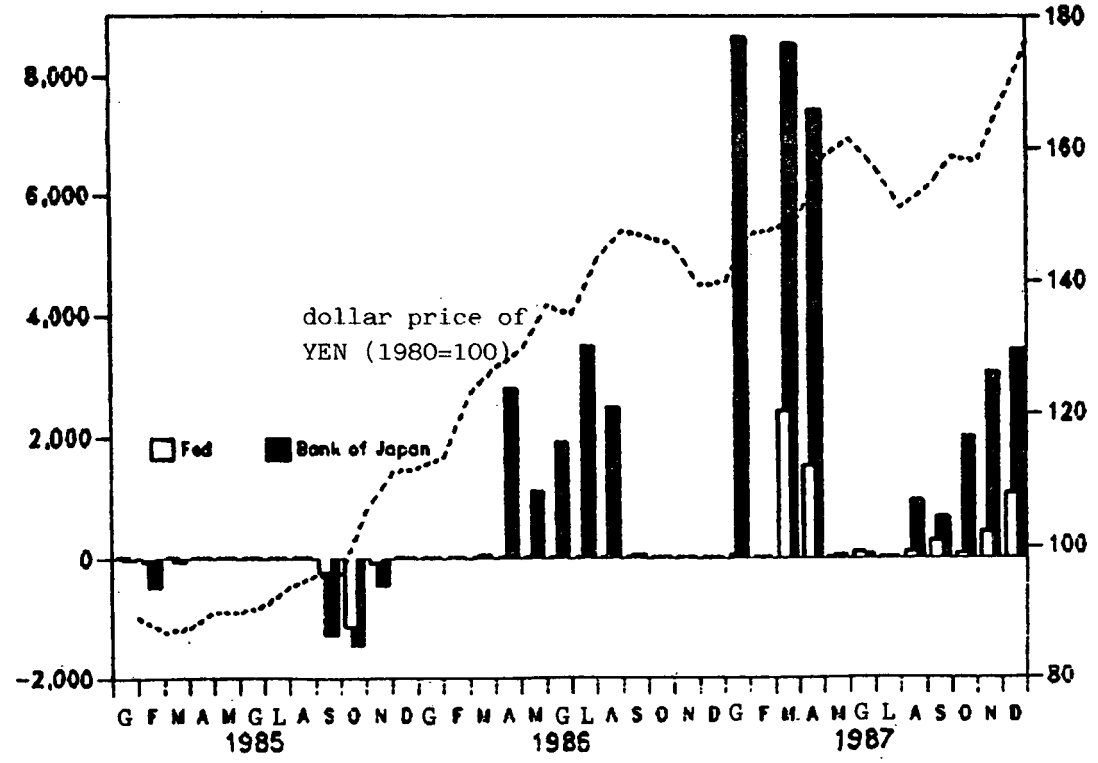
5. Coordination prevails when policy-makers in different countries agree on common objectives and together take joint policy decisions that differ from those they would have taken on their own. The game-theoretic approach to international policy coordination, cherished by academic economists, entails policy plans and policy rules that would apply far into the future and thus has contributed to a notion of coordination as a commitment binding participants together for a protracted period. Cooperation is a much looser concept that involves information exchanges, consultations, and possibly common assessments of the international economic picture and the external repercussions of national policies. Cf. Kenen (1987) and Dini (1988).

FOREIGN EXCHANGE INTERVENTIONS

DM Market



YEN Market



Note: Interventions: left-hand scale (US$ millions; positive sign= net purchases). Exchange rate: right-hand scale.

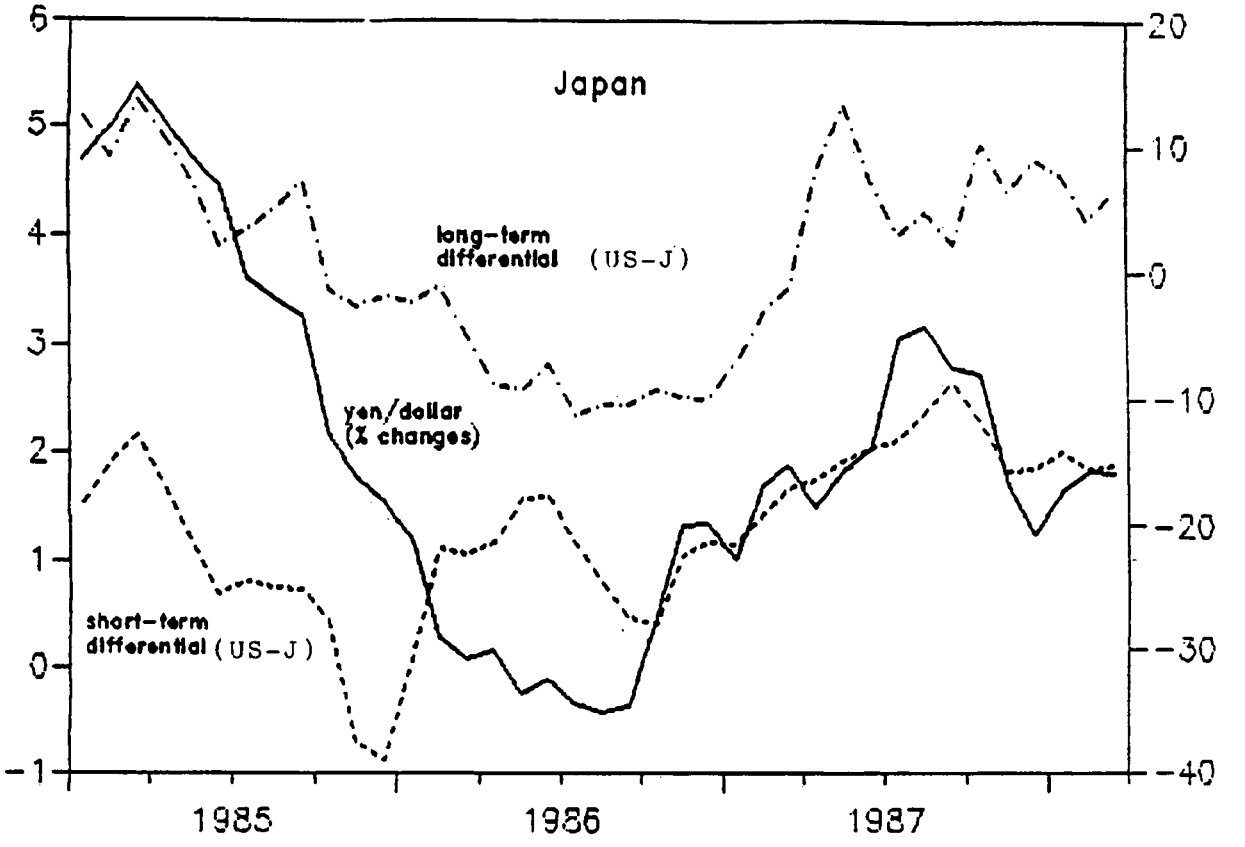
started to rise again. This prompted the authorities of the G-5 to sit together -- at the Plaza Hotel, in New York -- and agree on a joint announcement to the effect that "...in view of the present and prospective changes in fundamentals, some further orderly appreciation of the main non-dollar currencies against the dollar is desirable. They (i.e., the Ministers and Governors) stand ready to cooperate more closely to encourage this when to do so would be helpful" (G-5 Communiqué of September 22, 1985, para. 18). While registering national policy objectives and intentions, the Plaza communiqué did not involve commitments to change current domestic policies, that were judged already to "provide a sound basis for continued and more balanced expansion with low inflation ... (and) ... for redressing the ... external imbalances that have developed".

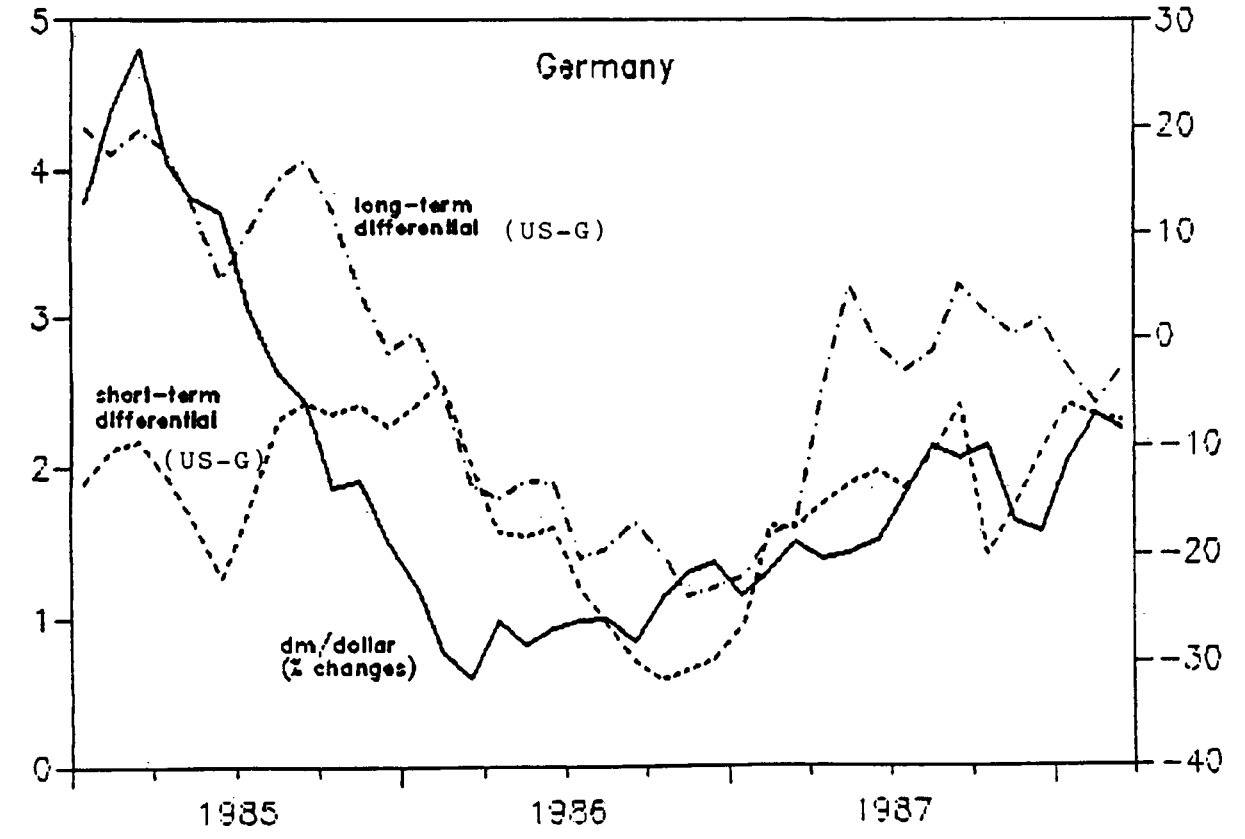
Substantial interventions in foreign exchange markets were carried out (jointly) only in late September and October (Chart 2); the Bank of Japan pushed up, sharply but temporarily, short-term rates, while little change in monetary conditions took place in either the US or Germany until early 1986. As for fiscal policies, measures of moderate restraint were already being enacted in the US (where in 1985 the federal government deficit reached 5.3 per cent of GNP). Expansionary measures were announced in Japan and were under discussion in Germany as part of the tax reform; the actual impact turned out to be negligible, and fiscal balances actually improved in 1986 in both countries. The depreciation of the dollar accelerated in early 1986 (Chart 3).

The second phase, lasting through 1986, saw a market-led depreciation of the dollar, with the Bank of Japan intervening to slow the rise of the yen in the central part of the year, and the Bundesbank and the Federal Reserve hardly intervening at all. Monetary policies were progressively eased in the US and abroad after the first quarter, and interest rate differentials moved against the dollar. The drop in the oil price, in early 1986, and (outside the US) the depreciation of the dollar had contributed to reducing fears of inflation and to tilting priorities in favour of growth. Measures to increase public spending and stimulate

Chart 3

INTEREST RATE DIFFERENTIALS AND EXCHANGE RATE CHANGES VIS-A-VIS THE UNITED STATES





Note: Interest rate differential: left-hand scale.
Exchange rate changes: right-hand scale.

domestic demand were approved by the Japanese Diet in November that, however, fell short of previous announcements by the government; steps to reduce the federal deficit were adopted in the US under the Balanced Budget (Gramm-Rudman-Hollings) Act; the German authorities continued to stick to their public deficit reduction objectives and to overly optimistic forecasts of domestic demand growth. Meanwhile, trade imbalances between the three major countries were growing larger in volume, and even more in dollar terms, owing to the depreciation of the US currency.

In November the Ministers of the Treasury of the US and Japan issued a joint statement that, after describing policies that were already in place in their countries, "expressed their mutual understanding that ... the exchange rate realignment achieved between the yen and the dollar since the Plaza agreement is now broadly consistent with the present underlying fundamentals, and reaffirmed their willingness to cooperate on exchange market issues". The changed attitude on the dollar was signalled by half-a-point cut in Japan's discount rate. This statement marked the transition to the third phase, that lasted through 1987 and was characterized by growing resistance to dollar depreciation and, at the same time, by increasing conflict between domestic and external objectives of monetary policies.

When the dollar fell sharply, in January 1987, the Bank of Japan intervened heavily; the Bundesbank helped with some interventions and joined in easing monetary conditions. With the Louvre Accord the authorities of the Group of Six[6] agreed that "the substantial exchange rate changes since the Plaza have now brought their currencies within ranges broadly consistent with underlying economic fundamentals and agreed to cooperate closely to foster stability of exchange rates around current levels". (Louvre Communiqué of February 22, 1987, para. 10). The communiqué also contained, once again, a detailed statement of policy actions

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6. The Group of Seven minus Italy, whose delegation did not take part in the meeting on grounds that all the relevant decisions had already been agreed upon by the Group of Five (US, UK, Japan, Germany and France).

already implemented (para. 7), as well as fresh promises to strengthen mutual surveillance over national economic policies (para. 9). In practice the Accord was a "holding operation" to stabilize exchange rates based on the belief: (i) that substantial improvement in real trade imbalances was already implicit in exchange rate and policy adjustments since the Plaza that required time to become visible; and (ii) that there was a risk of exchange rate overshooting that could rekindle inflation in the US and depress growth elsewhere.

Joint interventions in foreign exchange markets were substantial in March and April but tapered off in May; short-term rates continued to decline gently in Japan and Germany through the second quarter, and short-term differentials widened in favour of the dollar. Long-term rates, on the other hand, were coming down in the US and were rising in Japan and Germany, increasingly so as the stabilization operation gained credibility and the long-term capital flows towards the US accelerated.

In May the Japanese government approved strong stimulative fiscal measures; meanwhile the US federal deficit was improving more rapidly than originally envisaged. Neither development, however, was fully appreciated at that time, and there was growing disillusion with fiscal policy commitments undertaken in international fora. Monetary aggregates, on the other hand, were expanding rapidly, well beyond targeted growth rates, both in Germany and Japan, raising fears of monetary tightening; monetary restraint was also expected or feared in the US as a result of the need to support the dollar. And, indeed, during the summer monetary policy turned restrictive (albeit gently) in all the three countries; long-rates rose sharply, particularly in the US, as the markets saw their fears coming true.

Meanwhile, pressure was building up in foreign exchange markets, fuelled by bad trade balance figures and by the perception that interest rates were now less likely to respond to international considerations. At the end of September a new G-7 Communiqué failed to dispel mounting concern on the implementation

of domestic fiscal policy commitments.

On October 19, the US stock market fell by 23 per cent, all the main world stock markets followed suit in the ensuing days. Shortly afterwards, the Louvre Accord was suspended, as interest rates were pushed down aggressively by the Federal Reserve to circumscribe damage to the financial system. During the last two months of the year the dollar depreciated by some ten per cent despite substantial interventions; it was eventually stabilized around the turn of the year, partly thanks to joint interventions, partly because the descent of the dollar had made the new exchange rates more credible.

On the whole, the process of international cooperation has been much more in the nature of "regime preserving"[7] or crisis management operations than of coordination of national policies; its burden has fallen mostly on intervention and, increasingly, on monetary policies; policy commitments in other areas have reflected more often than not actions and intentions that had already been decided or responded anyway to domestic requirements. Fiscal policies, in particular, did move in the right direction in the period under review, but only in Japan in May 1987 visibly as a direct consequence of external objectives bending national priorities. Over time, the credibility of public announcements was damaged by failure to live up to the image of fully-fledged coordination that had been created in the public opinion. This has contributed to bringing about a less sanguine and more realistic view of international cooperation, both in the official and the academic world[8]; that, however, is a development of 1988, out of the range of observation of this paper.

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7. Cf. P. Kenen (1987), Fischer (1987) and Dini (1988).

8. A very influential voice in this direction has been that of Feldstein (1987).

3. The main channels of monetary interaction

In this section the channels of monetary interaction between countries participating in an exchange-rate arrangement are discussed based on a simple two-country, portfolio model so as to place in proper context the evidence presented in the ensuing sections.

The model (cfr. the Appendix) describes the financial sectors of two countries ("domestic" and "foreign"), made up in each case by markets for three assets, monetary base ("money", M), bills (B) and long-term securities (S). The demands (by residents and non-residents) for these assets are a function of wealth (domestic and foreign), the vector of returns, the expected change in the exchange rate and a vector of real exogenous variables. The assets are gross-substitutes (own-yield coefficents are positive and substitute-asset yield coefficients are negative, when non-zero); an expected appreciation of one country's currency increases the demand for assets denominated in that currency[9].

The total supply of securities is exogenously fixed; the supply of bills is also fixed but the central bank can alter the quantity in the hands of the private sector with open market operations. Money supply in each country is the sum of a foreign and a domestic component of creation. The central banks of the two countries intervene in the foreign exchange market to limit the divergence between desired and current exchange rate level; the change in the foreign component is determined by the total interventions of the two central banks; by definition (the model is "closed") an increase in one country's foreign component of money supply entails a corresponding decrease in the second country. This is a first, direct source of monetary interaction.

The monetary base effects of interventions can be "sterilized", in each country, with open-market operations in the

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9. A number of restrictions on the matrix of substitution coefficients are introduced to make the model more manageable (without loss of generality); see the Appendix.

bills market. Thus, money creation through the domestic channel is described by central banks reaction functions that include, among their arguments, domestic policy objectives (growth, inflation) and the foreign component of the base; these functions also determine the supply of bills (domestic and foreign) to the public (residents and non-residents).

The model can be written in compact form in five independent market clearing equations (the sixth market is cleared by Walras'law) that determine four interest rates and the exchange rate level as a function of exchange rate expectations and the other exogenous variables.

Thanks to the hypothesis of symmetric responses (by residents and non-residents) to interest rate changes, the comparative statics of the model (linearized around equilibrium) can be decomposed into an <u>average</u> and a <u>difference</u> component of interest rate multipliers with respect to a change in exchange rate expectations.[10]

The model displays a number of interesting properties, that make the picture of monetary interactions more complex (but also complete). Taking differential effect first, one finds that:

(i) when exchange rates are "managed", if interventions are not sterilized, an expected depreciation of one country's currency raises interest differentials on all maturities in favour of that country; this is a standard result;

(ii) to the extent that interventions are sterilized, the short-term interest differential changes less (at the limit, with full sterilization, it does not change) in response to a change in expected depreciation; however, the long-term differential still increases. This effect is larger, the higher the "rigidity" of the central banks' intervention policies in foreign exchange

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10. This is an application to comparative statics of the technique developed by Aoki (1981) for dynamic analysis.

markets[11] (and of course, for given other conditions -- with the mobility of long-term capital). The resulting increase in the "steepness" of the yield curve will be larger, the higher the sterilization coefficient. This second property is also rather intuitive, and yet is usually not recognized, perhaps because the bond market is seldom explicitly modeled.

A third interesting property emerges from the "averages" comparative statics. When the sterilization coefficients in the money supply reaction functions of the two central banks are equal, the average interest rate level does not change in response to an expected exchange rate depreciation. However, with less-than-full sterilization, the average short and long-term interest rates always rise if the sterilization coefficients of the "domestic" country (whose currency is expected to depreciate) is lower than that of the "foreign" country.[12]

What is happening here is that the "foreign" country is effectively setting a floor not only to its own, but also to the world's interest rate structure; since the increase in the interest rate differential cannot spread symmetrically in the two countries, a tightening of aggregate monetary conditions (higher average interest rates) is brought about.

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11. Higher "rigidity" means that the exchange rate is allowed to move less under market pressure; the "rigidity" is maximum when the exchange rate is fixed.

12. A particular case of this property is the "reserve currency" case as stated in Marston (1980), p. 76-77.

4. Intervention policies

Very seldom, since the transition to floating exchange rates, did the leading countries' central banks admit the existence of a target-level for the exchange rates of their currency (bilateral or effective). The stated purposes of intervention have included the maintenance of orderly market conditions ("smoothing") and, on occasion, the "breaking" of destabilizing market behavior.[13]

1985-87 were no exception in this regard.[14] In practice, however, the Plaza agreement involved a joint decision to encourage depreciation of the dollar, and a joint decision that depreciation had gone far enough was reached between November 1986

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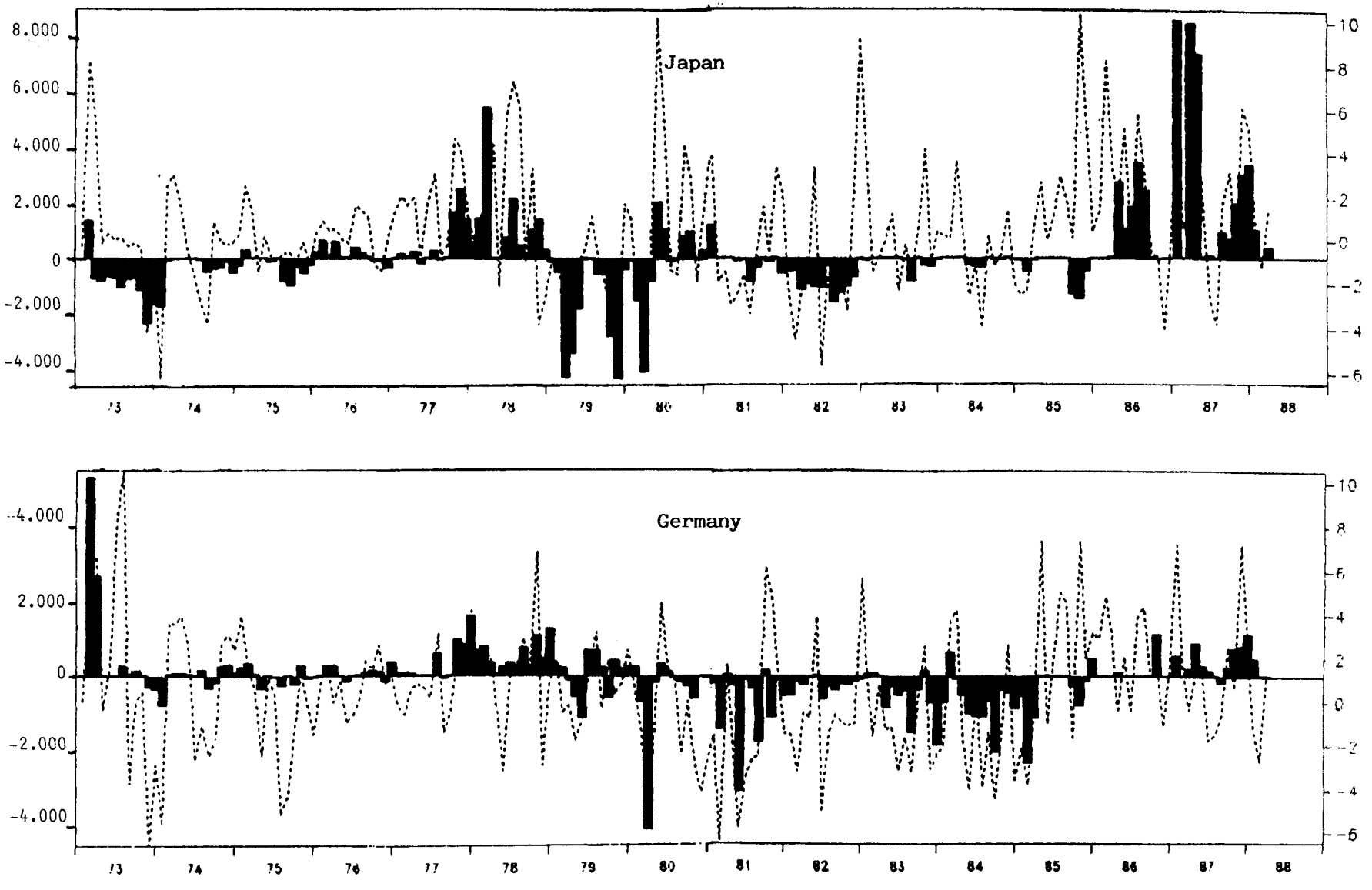
13. During the floating years the US Treasury was "interventionist" when the dollar was weak, most active in 1977-79; an explicit policy of non-intervention was adhered to between 1981 and the beginning of 1985. With the exception of the Carter years (1977-79), the Federal Reserve's operations aimed at "giving signals" in special circumstances rather than offering continuous guidance to the market. The presence of the Bank of Japan and the Bundesbank in the foreign exchange markets was more continuous, on both sides of the market (Chart 4), leading in the end to much larger numbers. On average intervention rates are much higher (more than double) for Japan than Germany. The Bank of Japan appears to have been more active during dollar depreciations and the Bundesbank during dollar appreciations. In the 1977-79 period (dollar depreciation), for istance, the former central bank intervened on average at a monthly rate of about $ 1,075 million, as against 435 millions of interventions by the latter; in 1981-84 period (dollar appreciation) the Bundesbank intervened at a monthly rate round 570 million dollars and the Bank of Japan at a 310 million rate.

14. For a semi-official description of leading countries' exchange rate policies see Smith-Madigan (1988), Dudler (1988), Masunaga (1988). This last author carries the notion of smoothing quite far, arguing that "when external surpluses are already very large...there will be a great deflationary effect if we try to bring exchange rates to levels that could eliminate surpluses within a short period", and therefore "...first of all the role of intervention policy would be to allow market trends to take their own course ...stemming at the same time any disruptive or too quick movements". (p.134).

INTERVENTIONS AND EXCHANGE RATE CHANGES



Interventions: left-hand scale (US $ millions; positive sign-net purchases of dollars)

Monthly percentage changes of $/DM and $/YEN exchange rate: left-hand scale

(US-Japan) and February 1987 (G-6). The Louvre Accord entailed de facto (although not formally announced) limits on the permissible range of variation of the dollar vis-à-vis the two other key currencies. Against the background of these broad objectives, interventions were typically "leaning into the wind", with the major exception of the post-Plaza operations. In the presence of strong market pressures, in some occasions a response of strong-announcement-cum-joint-intervention was adopted to "break" market trends (as in February 1987); in most instances, however, rigid pegging of exchange rates was avoided.[15] Flexible intervention policies were increasingly accompanied by supportive (sometimes joint) changes in money market conditions (see following section).

During the period not only Japan and Germany but also the US intervened more frequently and for increasing amounts (notably in 1987): average monthly interventions in 1985-87 were around 350 million dollars for the US and Germany, and 1,400 dollar millions for Japan; they were respectively about 800, 400, and 2,900 million dollars in 1987. The Bank of Japan was most active in resisting depreciations and participated with enormous purchases of dollars in the joint operations. The Bundesbank's pattern of intervention appears more balanced, with the largest operations observed when the goal was to push the dollar down (in 1985). As for the Federal Reserve (that intervenes under the instructions of the Treasury), increasing activism went along with a shifting focus from the DM to the yen as "pivotal" rate; however, its relative role, in terms of shares of total interventions, was bigger in the DM than in the yen market (Chart 2).

We have tried to ascertain whether the intervention

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15. Joint interventions were resorted to in four occasions (Chart 2), twice in 1985 (February and September-October) to consolidate the turnaround of the dollar, twice in 1987 (March-April, after the Louvre, and after the stock-market crash of October) to break downward pressure on the dollar.

policies of 1985-87 entailed a departure from past practices[16] by estimating intervention reaction functions. The Fed does not publish the (monthly) time series of interventions (and these cannot be meaningfully approximated by published data on its foreign official position); therefore, we restricted the exercise to Japan and Germany.

The model of central bank behaviour, following Artus (1976) and Black (1980), is as follows:

$$(4.1)\quad INT = a_0 (S - S^*) + a_1 \Delta\% S + a_2 TB + u \qquad a_0, a_1, a_2 > 0$$

$$(4.2)\quad S^* = b_0 + b_1 (P_f/P_{us} - 1) \qquad b_0, b_1 > 0$$

Interventions (purchases of dollars) increase with positive divergences of the exchange rate (dollars per foreign currency) from the target (S^*), the (percentage) rate of change of S (to measure the resistance or "leaning against the wind" behaviour), the trade balance (TB); u is an error term (normally and independently distributed). The TB variable is included since in the short-term, with the central bank managing both the exchange rate and the money market interest rate, changes in the trade balance will in general be offset less-than-fully by private capital flows, and will thus lead to interventions without this necessarily implying a change in the target-exchange rate. The target exchange rate S^* moves around a constant (b_0) with relative (wholesale) price changes (foreign/US). The estimating equation is obtained by sustituting (4.2) into (4.1):

$$(4.3)\quad INT = -a_0 b_0 + a_0 S - a_0 b_1 (P_f/P_{us} - 1) + a_1 \Delta\% S + a_2 TB + u$$

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16. Regardless of whether they were successful or not. An influential voice arguing indeed they were not is Feldstein (1986).

Equation (4.1) may involve problems of simultaneity, since -- to the extent that interventions are effective -- one may also expect that:

$$(4.4)\quad \Delta\%S = \alpha_0 + \alpha_1 \, INT + v, \qquad \alpha_1 < 0$$

The negative correlation between $\Delta\%S$ and INT through equation (4.4) may thus impart a downward bias to the estimated coefficient a_1 obtained with OLS. Therefore, equation (4.3) was estimated (in the specifications without dummies) both with OLS and with instrumental variable methods to account for simultaneity on $\Delta\%S$.

Estimation results are presented in Table 1 for the periods 1973-87 and 1973-84 (monthly data); the "leaning" coefficient (a_1) has also been allowed to vary in periods of sustained appreciation of the dollar;[17] the "basic equations" have been estimated with OLS and instrumental variables (IV).[18] Dummy variables have been inserted for the three episodes of large concerted interventions in November 1978 (Carter), September 1985 (Plaza) and February 1987 (Louvre). The equations' fit is fairly good and the residuals show little autocorrelation; all coefficients have the right sign and are significant. As expected, the estimate of the a_1 coefficient of $\Delta\%S$ increases with instrumental variables; the other properties of the equation do not change significantly.

For the whole period, a large share of explained variance (some 40%) is accounted for by the leaning variable for both Japan and Germany; the coefficient for Germany is always smaller than that of Japan (91 billion dollars against 190 per

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17. The variable DUM takes value = 1 in the period 1980-3 to 1985-2.

18. The following variables were used as instruments: the exogenous variables in equation (4.3) and, in addition, two lagged values of $\Delta\%S$, and the contemporaneous and lagged values of changes in interest rate differentials vis-à-vis the United States (cfr. also Artus 1976).

INTERVENTION REACTION FUNCTIONS
(OLS estimates (*); monthly data)

Table 1

EQ. NR.	ESTIM. PERIOD FROM 1973-4 TO:	INDEPENDENT VARIABLES									TESTS STATISTICS	
		CONSTANT	RELATIVE WHOLESALE PRICES	TRADE BALANCE	EXCHANGE RATE (1)	Δ% EXCH. RATE	Δ% EXCH. RATE*DUM (2)	CARTER (3)	PLAZA (4)	LOUVRE (5)	R^2C	DW
						GERMANY						
(1)	1987-12	-1798.6	1798.3	64.33	3044.9	90.83					0.41	1.83
		(-6.55)	(5.24)	(2.22)	(5.18)	(6.57)						
(1-IV)	"	-1413.1	1479	17.96	2603.8	169.44					0.30	1.83
		(-4.28)	(3.12)	(0.44)	(3.77)	(3.46)						
(2)	"	-1666.5	1614.1	64.62	2897.5	55.85	98.56				0.45	1.78
		(-6.21)	(4.79)	(2.31)	(5.08)	(3.34)	(3.50)					
(3)	"	-1558.4	1555.2	61.63	2664.2	66.32	89.30	490.88	-1008.3	256.32	0.45	1.81
		(-5.73)	(4.63)	(2.15)	(4.61)	(3.85)	(3.15)	(0.99)	(-1.99)	(0.71)		
(4)	1984-12	-1821.2	1660.3	120.36	3000.2	100.24					0.39	1.82
		(-4.33)	(4.35)	(1.52)	(3.73)	(5.91)						
(4-IV)	"	-1267.1	1378.6	54.99	2225.6	155.98					0.34	1.78
		(-2.21)	(2.58)	(0.55)	(2.09)	(3.08)						
(5)	"	-1734.9	1585.0	104.84	2942.2	64.59	81.36				0.42	1.79
		(-4.19)	(4.22)	(1.35)	(3.73)	(2.97)	(2.54)					
						JAPAN						
(1)	1987-12	-3279.9	3658.4	152.48	7055.4	189.34					0.39	1.68
		(-4.69)	(3.35)	(2.80)	(4.21)	(5.68)						
(1-IV)	"	-3715.4	3148.7	150.74	6974.8	198.9					0.39	1.69
		(-4.24)	(3.08)	(2.63)	(3.78)	(2.03)						
(2)	"	-3368.5	3646.6	127.75	7290.2	238.55	-127.66				0.40	1.69
		(-4.84)	(3.36)	(2.30)	(4.37)	(5.62)	(-1.85)					
(3)	"	-2251.9	2512.9	95.82	4654.0	285.52	-167.81	2342.20	-4356.7	5859.90	0.59	1.85
		(-3.83)	(2.78)	(2.08)	(3.30)	(7.60)	(-2.88)	(2.28)	(-4.06)	(7.85)		
(4)	1984-12	-2675.5	3378.1	246.67	5533.9	201.28					0.40	1.50
		(-3.12)	(3.45)	(4.27)	(2.72)	(7.23)						
(4-IV)	"	-2307.1	2243.8	218.9	3881.4	294.0					0.35	1.65
		(-1.97)	(2.17)	(3.43)	(1.57)	(3.83)						
(5)	"	-2486.6	2975.2	195.61	5150.3	283.38	-151.39				0.42	1.55
		(-2.96)	(3.08)	(3.29)	(2.58)	(7.01)	(-2.74)					

(*) instrumental variable (IV) method when indicated.
Data source: IMF IFS and national sources.
The t-statistics are shown in parentheses. (1) Dollars for 1 DM and 100 yen. (2) DUM is a dummy variable taking value = 1 from 1980-3 to 1985-2 (period of appreciating dollar). (3) Dummy for Carter's November 1978 dollar support package. (4) Dummy for the Plaza coordinated intervention (October 1985). (5) Dummy for the coordinated interventions of March and April 1987 (after the Louvre Accord of February).

percentage point change in the dollar exchange rate with OLS estimates, 160 against 191 with IV estimates). The estimates provide evidence (equations 3 and 5) of an asymmetric behaviour during dollar depreciations and appreciations; this asymmetry entails stronger resistance to appreciation of its currency by the Bank of Japan and stronger resistance to depreciation of its currency by the Bundesbank; the asymmetry is more pronounced for the former central bank.[19]

Each percentage-point deviation of S from S^* has resulted, on sample average (based on equations 1-IV), in monthly interventions of some 150 million dollars by the Bundesbank and 400 million dollars by the Bank of Japan. Using equations (4.2), the implicit target-exchange rates are as follows:

$$(4.5) \quad S^*_g = 54.3 - 56.8 \, (P_g/P_{us} - 1)$$

$$(4.6) \quad S^*_j = 53.3 - 45.1 \, (P_j/P_{us} - 1)$$

The average target-rates over the whole sample-period 1973-87 thus are US$1 = DM 1.84 and US$1= YEN 187.6.[20] The actual exchange rates and the estimated-target rates for the two currencies are represented in Chart 5.

The trade balance variable is significant, albeit not very strongly, for both countries, more so in the case of Japan (it loses significance with IV in the case of Germany).

The coefficients of the dummies for concerted operations reflect the large participation of Japan in concerted operations,

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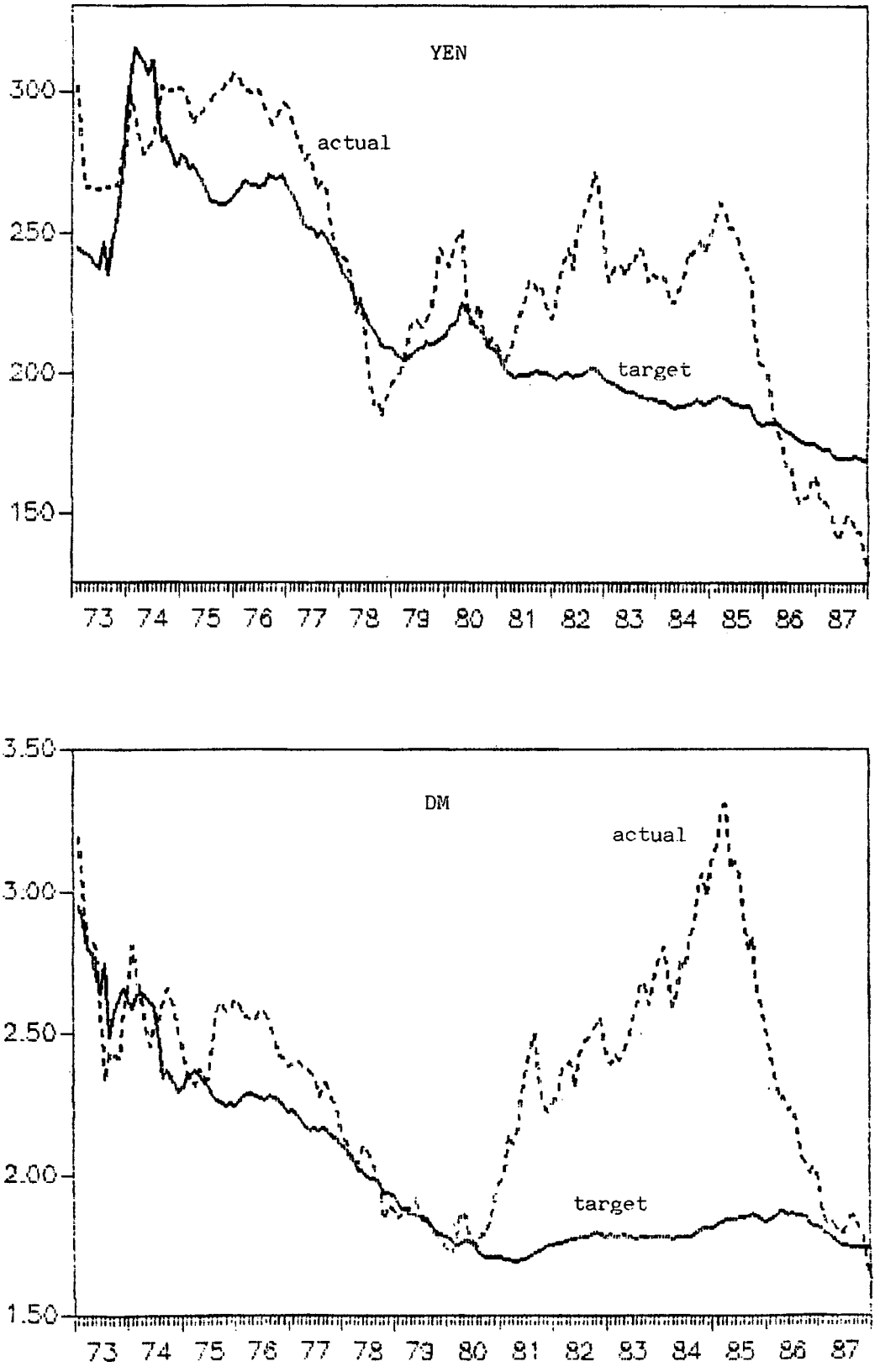
19. This result is confirmed by the results of (three years) rolling regressions, run through 1973-87, that show larger short-term changes in the Bank of Japan's leaning coefficients (see Chart 6). Japan thus emerges as both more "activist" (larger interventions) and more concerned about dollar depreciations.

20. Our result for Germany is strikingly similar to that obtained by Artus (1976) from estimation over the period April 1973-July 1975.

Chart 5

ACTUAL AND TARGET EXCHANGE RATES (1)



(1) Exchange rates are expressed in units of foreign currency per dollar. Target exchange rates are those implicit in equation 2 of table 1 (computed using equation (4.2) in the text).

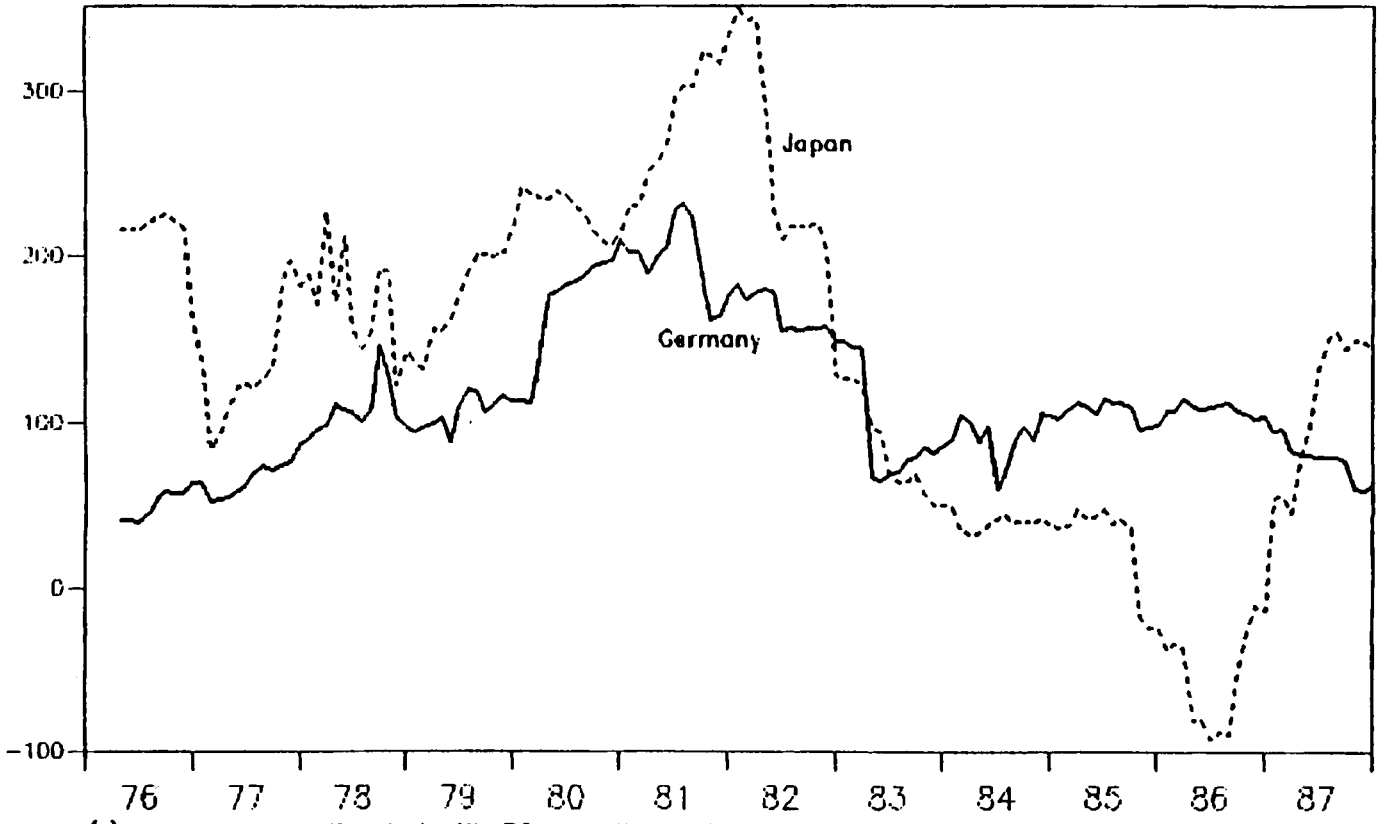
and that more modest of Germany (with the exception of the Plaza). They also indicate a greater resistance by the Bank of Japan to divergences of the exchange rate from its target-level. In this regard it is interesting to note (Chart 5) that increased resistance to dollar depreciation since late 1986 did correspond to the actual rate falling below the target; the same happened only much later, after mid-1987, for the DM. While our estimate of the equilibrium DM rate may be biased downward, this result is consistent with the lower resistance to depreciation offered by the Bundesbank.

We performed stability tests (Chow and Hendry tests) on our estimated equations to see whether significant differences of behaviour emerge in 1985-87 and in 1986-87 (since the Plaza events are in many ways very "special"): we did not find evidence of instability in the case of Germany, but could not reject that possibility for Japan. Indeed, in this case a large increase is observed in the exchange-rate level coefficient (and, less, in the constant). The estimated "leaning" coefficients, on the other hand, appear fairly stable for both countries.

We have further estimated three-years rolling regressions with terminal date from 1975-12 to 1987-12 (in the "basic" form of equations (1) in table 1) and have represented in Chart 6 the leaning coefficients thus obtained: as can be seen, a moderate increase is observed for Germany in 1984-85, and a decline thereafter, while a strong increase (from a low point) is observed for Japan after mid-1986.

Altogether, we do find evidence of increased "rigidity" of exchange rate policies for Japan from mid-1986 onwards; we do not find similar evidence for Germany. However, both countries as well as the United States did intervene more actively in 1987 to resist dollar depreciation; interventions were strong in the weeks that preceded the stock-market crash of October (Chart 2).

INTERVENTION REACTION FUNCTION
"leaning" coefficients from rolling regressions (*)



(*) coefficients estimated with 36-months rolling regressions from 1973 to 1987 (data refer to the end of the moving three-years period)

5. Interventions and domestic monetary conditions

The monetary policy operating procedures of the three countries under consideration, all involve control of a total base or bank reserve aggregate, which in principle entails routine sterilization in the money market of any effects of interventions on base creation[21]. This is in fact systematic practice in the United States, where interventions by the Fed represent a negligible part of base creation; dollar balances purchased (sold) by foreign central banks are usually reinvested in (withdrawn from) US financial markets, so that sterilization is automatic.

In Japan and Germany, on the other hand, foreign exchange flows and interventions are relatively more important, and the foreign component of the base more readily reflects possible "pressures" of external origin on monetary policy. The monetary authorities in these countries maintain that they follow a policy of "almost complete" sterilization, deviating from this course of action only temporarily and in response to specific policy considerations. In practice, both Dudler (1988) and Masunaga (1988) recognize that in a number of cases exchange rate considerations -- notably in periods of pressure -- did lead to a changed course of monetary policy, more or less protracted depending on the nature of the disturbance (although both authors stress that this is the result of discretionary decisions and not of any technical problem of sterilization).

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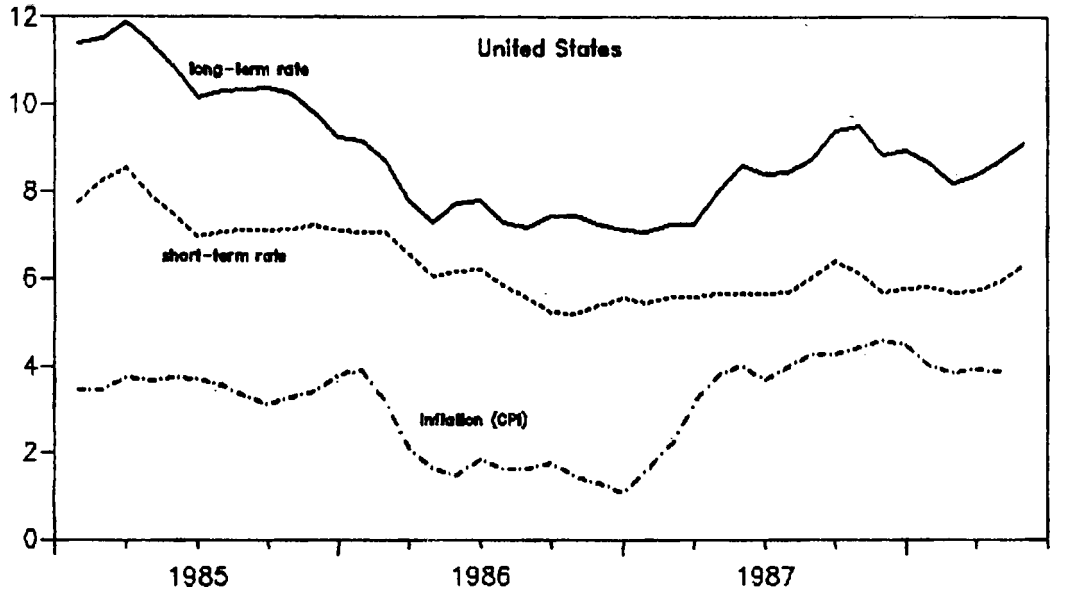
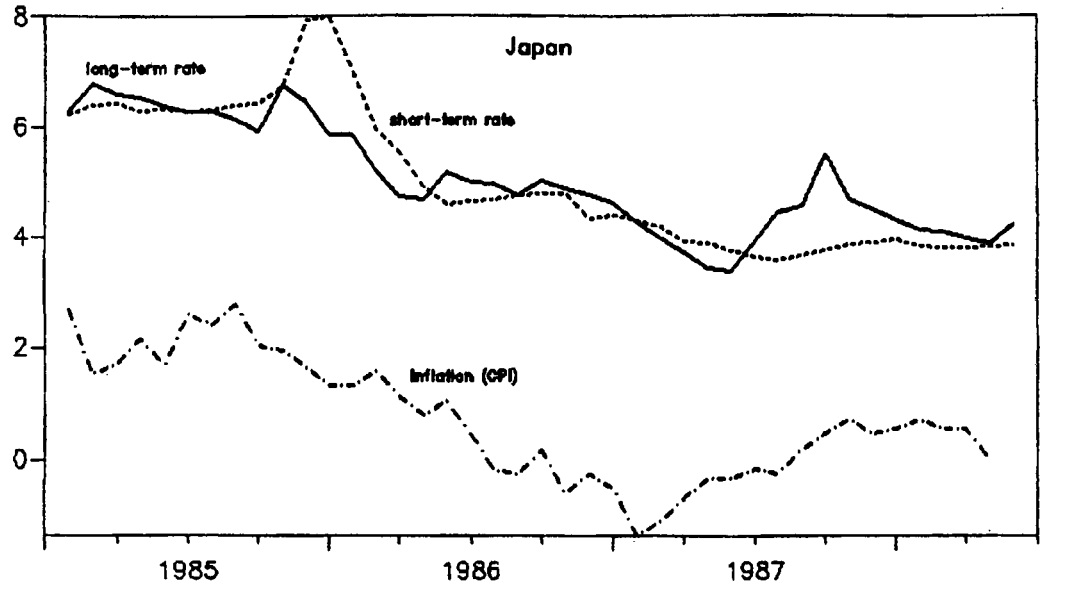
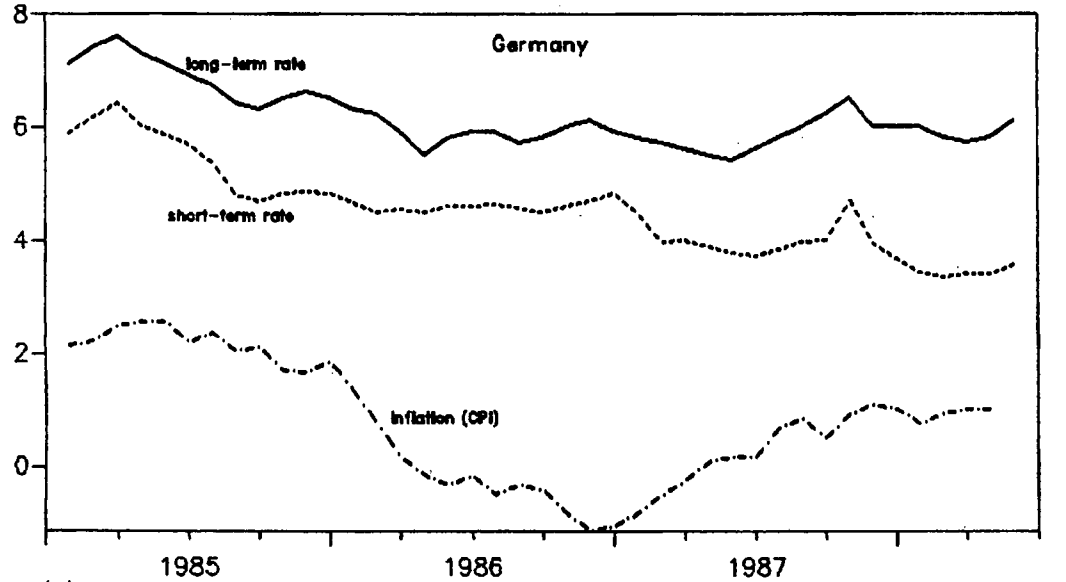
21. See Mastropasqua - Micossi - Rinaldi (1988). Interventions in foreign exchange markets have a direct impact on the foreign component of monetary base creation only if they are not carried out with foreign currency balances held with the international banking system,; this effect can be "sterilized" with offsetting operations in foreign currencies (swaps with commercial banks, loans, etc. channeled outside the "cash" foreign exchange market) or, more frequently, in the domestic money market.

Chart 7

INTEREST RATES (*) AND INFLATION







(*) US, 10-year Treasury Bonds and 3-month Treasury Bills; Japan, long-term Government bonds and 2-month Commercial Bills; Germany, long-term Government bonds and 3-month loans.
Inflation: twelve-month percentage changes in CPI.

Table 2 reports interventions[22] and the foreign, domestic and total base creation in reference periods as (percentage) ratios to monetary base stock at the beginning of the period, so as to highlight the contributions to base growth in 1985-87. In 1985 both Germany and Japan were keeping monetary reins rather tight, while the US was easing monetary policy; in 1986 the three countries were all easing (with interest rate differentials moving against the dollar - Chart 3). In both years there was in fact no conflict between domestic and external objectives of monetary policy; interventions either contributed to monetary base creation in the desired direction or were sterilized without much difficulty. The story is different in 1987: dollar interventions, very substantial, were sterilized by the US (where, however, bank reserves and monetary aggregates were slowing down growth), but were increasingly reflected in base and money supply growth in Japan, and, to a lesser extent, also in Germany (notably in the fourth quarter).

Up until early 1987, in a number of cases interest rates (Chart 7) were changed for exchange rate reasons[23]; afterwards the three countries started increasingly to go each on its own. Since the spring the desire to slow money supply was mirrored in a creeping-up of short-term rates; US long-term rates anticipated this upward movement, pushed-up by the apparent acceleration of

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22. For the US, total interventions in dollars, as estimated by the OECD and the BIS, by the main world central banks; for Germany, INT_{EMS} includes DM interventions that affect Germany's monetary base by other EMS central banks.

23. Both Japan and Germany raised their money market interest rates in the weeks following the Plaza, and lowered them subsequently once the dounward trend in the dollar was established (Chart 7). In March 1986 interest rates were lowered jointly by the US, Japan and Germany; from this moment onward the US was leading in a general relaxation of monetary policy, after the fall (in January) in the oil prices had dampened inflation fears. The October 1986 US-Japan accord to halt the decline of the dollar was marked by the Bank of Japan lowering interest rates; both Japan and Germany lowered their discount rates at the time of the Louvre Accord (February 1987).

Table 2

MONETARY BASE CREATION: DOMESTIC AND EXTERNAL COMPONENT

AND TOTAL INTERVENTIONS (1)

Period:	GERMANY					JAPAN				UNITED STATES			
	$INT_{\$}$	INT_{EMS}	ΔNFA (2)	ΔDC	ΔBM	INT	ΔNFA (2)	ΔDC	ΔBM	INT	ΔNFA	ΔDC	ΔBM
1985	-9.4	-0.1	-2.4	6.2	3.8	-2.9	1.4	2.4	3.7	8.8	4.1	5.8	9.9
1986	1.4	-4.6	-0.6	6.2	5.6	6.6	3.0	5.2	8.1	-8.2	2.4	12.5	14.9
1987	5.3	9.4	18.6	-10.6	8.0	15.9	16.0	-7.2	8.7	-42.4	-1.0	5.5	4.5
1985 IQ	-7.6	-0.1	-5.4	-1.5	-6.9	-0.5	1.0	-11.9	-10.9	-4.7	0.0	-0.1	-0.1
IIQ	0.0	0.0	2.5	-0.6	1.9	0.0	1.0	3.4	4.5	1.5	0.5	2.9	3.4
IIIQ	-0.4	0.0	1.7	-0.1	1.6	-1.1	0.7	-7.1	-6.4	-0.9	1.0	1.4	2.4
IVQ	-1.6	0.0	-0.9	8.7	7.8	-1.6	-1.4	20.4	19.0	-4.5	2.4	1.6	4.0
1986 IQ	0.0	0.0	-3.0	2.0	-1.0	0.0	-0.7	-8.2	-8.9	1.8	0.8	-1.2	-0.4
IIQ	0.1	-5.7	-1.6	1.0	-0.6	3.7	5.1	-0.1	5.0	-4.8	0.8	2.5	3.3
IIIQ	0.0	1.3	3.7	-7.4	-3.7	3.3	-1.0	-7.1	-8.1	-5.0	0.7	2.6	3.3
IVQ	1.3	-0.3	0.3	11.1	11.4	0.0	0.0	23.0	23.0	0.1	0.1	8.0	8.1
1987 IQ	0.5	4.6	8.1	-9.9	-1.8	8.2	5.2	-11.3	-6.1	-13.4	0.2	-3.4	-3.2
IIQ	1.0	-0.4	2.3	-0.9	1.4	3.6	6.7	-2.9	3.8	-14.4	-1.6	2.1	0.5
IIIQ	-0.6	0.0	-0.3	-0.7	-1.0	0.8	-0.1	-3.3	-3.4	-3.8	0.1	2.4	2.5
IVQ	4.4	5.3	8.7	0.9	9.6	3.8	4.8	10.7	15.5	-11.4	0.3	4.5	4.8

Source: BIS, IMF

INT: total net official sales of the national currency; for Germany, the figures refer to interventions affecting the net external position of the Bundesbank, respectively on the DM/dollar market ($INT_{\$}$) and in EMS currencies (INT_{EMS}). ΔNFA: change in net foreign assets of the monetary authorities; ΔBM: change in monetary

inflation and the worsening climate of expectations on the dollar.

Further insight on central bank behaviour was sought through the estimation of monetary policy reaction functions relating the domestic component of monetary base creation to the foreign component and to domestic policy objectives, as in Obstfeld (1983), Herring-Marston (1977) and Artus (1976):

$$(5.1) \qquad \frac{\Delta DC}{BM_{-1}} = a_0 + a_1 \frac{\Delta NFA}{BM_{-1}} + a_2\, INFLT + a_3\, INFLR + a_4 GAP + \varepsilon$$

where ΔDC is the change in domestic assets of the central bank, ΔNFA is the change in its net foreign assets, INFLT and INFLR are, respectively, the trend and residual component of consumer price inflation, GAP is the output gap. The sterilization coefficient a_1 should lie between 0 (no sterilization) and -1 (full sterilization). The equations were estimated over the period 1973-1987, with monthly and quarterly data, both with OLS and with instrumental variable methods, to adjust for simultaneity in the base foreign component.

No meaningful results were obtained for the foreign component of base creation in the United States (and, hence, no results are presented), while the estimates are reasonably satisfactory for Japan and Germany (Tables 3 and 4).[24] Sterilization coefficients are close to (and not significantly different from) one for Japan, and somewhat lower for Germany

24. Our results, for Germany, in particular, are broadly in line with those obtained for the period 1979-1987 by Mastropasqua - Micossi - Rinaldi (1988), for 1973-75 by Artus (1976), and for 1960-1971 by Herring-Marston (1977). For Japan, most estimates indicate sterilization coefficients greater than 1 during the 60s and 70s. See Laney-Willet (1982) for a survey of the main empirical results for sterilization coefficients in the industrial countries.

Table 3

GERMANY

DOMESTIC CREDIT REACTION FUNCTIONS (1)

dependent variable: $\Delta DC/BM_{-1}$

EQ. NR.	estimation period	estim. method	Const.	$\frac{\Delta NFA}{BM_{-1}}$ (2)	Infl. (trend) (2)	Infl. (resid.) (2)	Output gap (3)	R^2C	DW	ρ
1	1973 IQ - 1987 IVQ	OLS	1.05	-0.68	0.07	-1.59	0.07	0.55	2.24	--
			(1.69)	(-8.58)	(0.12)	(-2.53)	(0.92)			--
2	"	IV	0.79	-0.45	0.20	-1.24	0.04	0.47	2.27	--
			(1.15)	(-2.61)	(0.31)	(-1.74)	(0.54)			--
3	1976 IQ - 1987 IVQ	OLS	1.15	-0.78	0.04	-1.61	0.05	0.61	2.14	--
			(1.77)	(-8.62)	(0.06)	(-2.45)	(0.57)			--
4	"	IV	0.91	-0.60	0.21	-1.35	0.07	0.58	2.07	--
			(1.30)	(-3.71)	(0.28)	(-1.90)	(0.71)			--
5	1976 IQ - 1984 IVQ	OLS	1.88	-0.79	-0.65	-2.09	0.09	0.61	1.81	--
			(1.14)	(-7.35)	(-0.41)	(-2.60)	(0.81)			--
6	"	IV	1.96	-0.66	0.78	-1.93	0.11	0.59	1.73	--
			(1.17)	(-3.44)	(0.47)	(-2.29)	(0.93)			--
7	1973,4 - 1987, 12	OLS	0.52	-0.79	-0.33	-1.20	0.07	0.41	2.23	-0.49
			(1.72)	(-9.45)	(-0.37)	(-1.70)	(0.67)			(-7.50)

Source: BIS, IMF.
BM: monetary base; ΔNFA: change in the net foreign assets less valuation adjustment; ΔDC: ΔBM - ΔNFA. (1) Equations 1 to 6 are estimated with quarterly data, equation 7 with monthly data, with OLS and instrumental variable (IV) method when indicated; variables seasonally adjusted with X11 (additive seasonality); t-values in parentheses. (2) Inflation: (quadratic) trend component and residual component (resid.), measured on consumer prices. (3) Percentage deviation from (linear) trend of industrial production.

Table 4

JAPAN

DOMESTIC CREDIT REACTION FUNCTIONS (1)

dependent variable: $\Delta DC/BM_{-1}$

EQ. NR.	estimation period	estim. method	Const.	$\frac{\Delta NFA}{BM_{-1}}$ (2)	Infl. (trend) (2)	Infl. (resid.) (2)	Output gap (3)	R^2c	DW
1	1973 IQ - 1987 IVQ	OLS	1.25 (3.91)	-0.97 (-13.60)	0.77 (4.65)	-0.56 (-2.48)	0.23 (5.60)	0.87	1.78
2	"	IV	1.23 (3.52)	-0.95 (-5.91)	0.78 (4.32)	-0.57 (-2.48)	0.23 (4.88)	0.87	1.79
3	1973 IQ - 1984 IVQ	OLS	1.32 (3.29)	-1.00 (-12.54)	0.73 (3.94)	-0.61 (-2.62)	0.24 (5.62)	0.88	1.89
4	"	IV	1.31 (3.22)	-0.92 (-5.37)	0.75 (3.93)	-0.62 (-2.64)	0.26 (4.94)	0.88	1.91
5	1973,4 - 1987,12	OLS	0.60 (3.40)	-0.85 (-12.35)	0.71 (2.52)	-0.06 (-0.28)	0.05 (2.36)	0.52	2.41

Source: BIS, IMF.
BM: monetary base; ΔNFA: change in the net foreign assets less valuation adjustment; ΔDC: ΔBM - ΔNFA. (1) Equations 1 to 4 are estimated with quarterly data, equation 5 with monthly data, with OLS and instrumental variable (IV) method when indicated; variables seasonally adjusted with X11 (additive seasonality); t-values in parentheses. (2) Inflation: (quadratic) trend component and residual component (resid.), measured on consumer prices. (3) Percentage deviation from (linear) trend of industrial production.

(significantly different from 1).[25] The inflation effect in both countries confirms the role played by this variable in the decision to relax monetary policy in 1986 (when INFLR was negative).

Stability tests were performed on the monthly data equations to check for possible structural "breaks" in 1985-87 or, within this period, in 1986-87. The results do not lend support to the hypothesis of structural break, particularly in the case of Japan (the Chow test for Germany is slightly above the 95% confidence interval for 1986-87).

Out of sample simulation over 1985-87 of the equations estimated for 1973-1984 shows an underprediction of domestic base growth (that is, reduced sterilization) for both countries in 1986 (when Germany did not intervene very much) and for Germany in 1987, and an overprediction for Japan in this latter year (that is, Japan sterilized more than expected). Some short-run oscillations in sterilization coefficients are confirmed by the estimates from three-years rolling regressions (Chart 8). As may be noted, for both countries sterilization coefficients are below sample average in 1985-87, but close to or above average in 1987. Germany's coefficient shows wider oscillations (greater short-term flexibility), with a drop in 1985-86 (external and domestic objectives coincided) and a recovery at the beginning of 1987.[26]

All in all, our results confirm flexibility in sterilization behaviour in the short-run and a tendency to revert to "normal" behaviour over longer periods. Once again, however,

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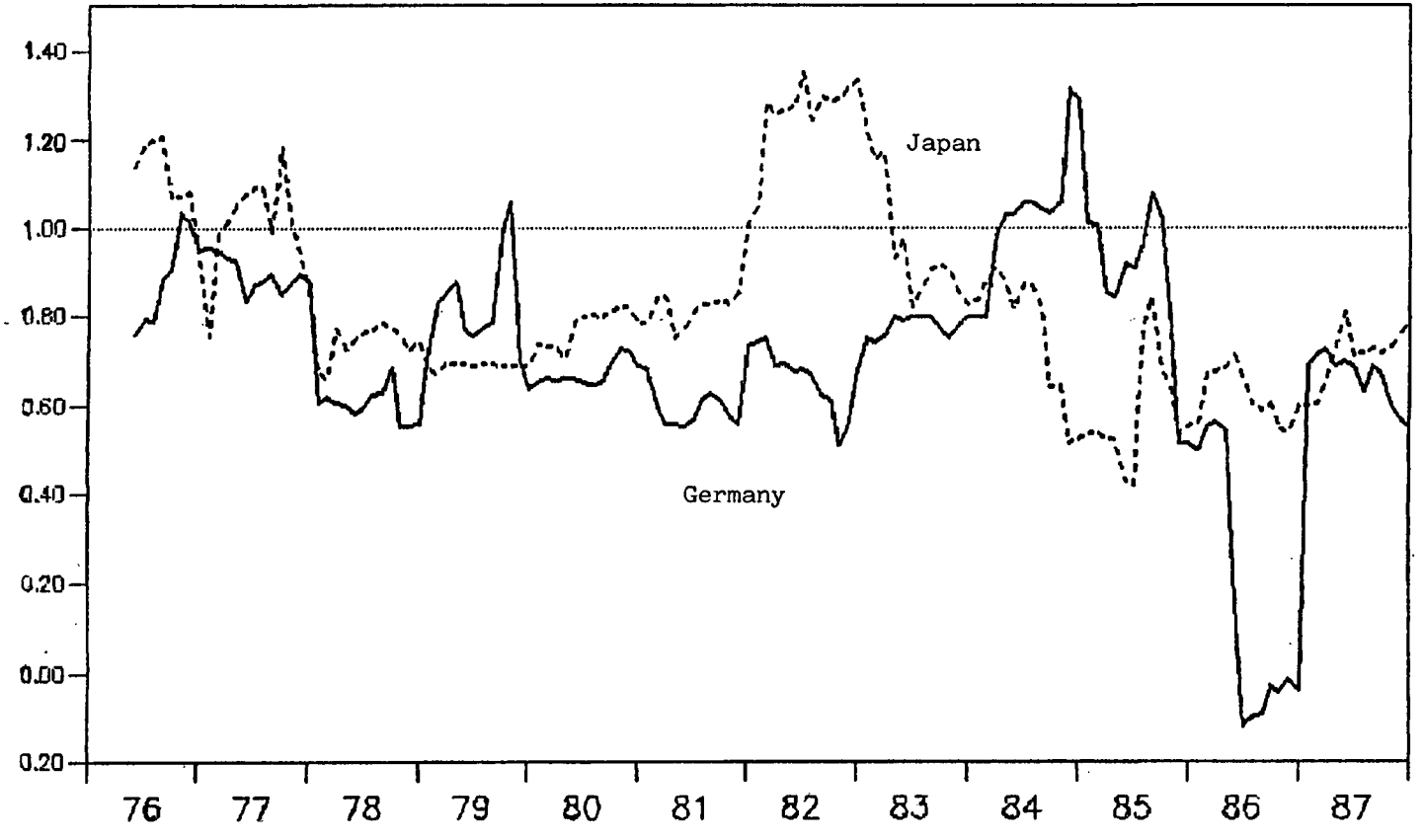
25. As for the policy variables, in the German case only the residual component of inflation is significant, with the expected negative sign, indicating a monetary policy mainly aimed at contrasting inflation accelerations. For Japan, the three policy variables are generally all significant. The signs seem to indicate that monetary policy accomodates variations in output and in the trend component of inflation, while contrasting inflation accelerations.

26. For Germany, the pattern shown in Chart 8 is consistent with the identification made by Dudler(1988) of episodes of less-than-full sterilization for external reasons, that is 1977-78, 1981, 1986-87.

Chart 8

DOMESTIC CREDIT REACTION FUNCTION
sterilization coefficients from rolling regressions (*)



(*) coefficients estimated with 36-months rolling regressions from 1973 to 1987 (data refer to the end of the moving three-year period)

1987 stands out as a case when increased pressure on money supply from the foreign component was matched by increased resistance to let domestic money market interest rates adjust downwards (in fact, after mid-year a rise took place).

6. Interest rate differentials and maturity structure

We have suggested, with the help of the model sketched in Section 3, that changes in exchange rate expectations may influence differently interest rate differentials across countries, and their maturity structure within countries, depending, among other things, on interventions (degree of resistance) in foreign exchange markets and the degree of sterilization of their monetary effects.

Two sets of propositions are involved here. First, interest rate parity is an equilibrium condition; as such it cannot identify causation chains, and is consistent with different observed dynamic relationship between interest rate differentials across currencies and exchange rate changes. Indeed during 1985-87 we observe interest rate differentials (dollar minus foreign) sometimes shrinking and sometimes widening in the presence of dollar depreciations. The former case implies that the exchange rate is moving to reduce expected depreciation[27], the second that actual changes in the exchange rate are lagging behind expected depreciation (we assume that changes in any risk premium or discount on the three currencies played a minor role in observed changes in differentials).

Second, as shown in our model, interventions in foreign exchange markets shift more of the burden of adjustment of any emerging portfolio disequilibrium (due to a change in exchange rate expectations) onto interest rate differentials, increasingly with increasing resistance to exchange market trends;

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27. A similar distinction is that made in McKinnon (1988), if one relates expected depreciation to inflation expectations.

sterilization, in turn, shifts more of the burden of adjustment onto the long-term end of the market; and, finally, if the country whose currency comes under upward pressure sets a floor to domestic (short-term) interest rates, even more of the burden of adjustment falls on interest rates in the country whose currency is depreciating.

Some elements consistent with these two sets of propositions can be recognized in observed developments in 1985-87. First, long term differentials were higher in 1985, up until the Plaza, when a large depreciation was discounted by private agents but uncertainty as to the actual course of monetary policy in the US (would it accomodate the depreciation or not?), kept the dollar from falling more than it did (Chart 3 and Table 5). They went down consistently from the last quarter of 1985 through most of 1986, when a market led depreciation was restoring portfolio equilibrium; they went up again in 1987, as confidence in the Louvre Accord was faltering.

The observed pattern of net capital flows (Table 5) could also be related to changing expectations on the dollar (the alternative explanation of a rising risk premium on this currency is also plausible, and would not change the substance of the argument). The slowdown of net inflows in the US from Japan corresponds to a "bump" along the interest-differential declining trend in the fourth quarter of 1986, and to a sharp widening of the differential in the third quarter of 1987. The phenomenon is less clear vis-à-vis Germany, where aggregate flows are the result of bilateral movements of opposite sign with other European countries; however, rising outflows do coincide with declining long-term differentials through 1986, and declining outflows from Germany with rising differentials vis-à-vis the US in the first and second quarter of 1987.

The behaviour of short-term interest differentials is somewhat different (Chart 3), notably in the case of Japan in 1985-86 (Japan raised its money market rates in the first half of 1986, after lowering them more pronouncedly in late 1985), and in the case of Germany in 1987 (when the Bundesbank moved its money

Table 5

CAPITAL MOVEMENTS AND INTEREST RATES (1)

Period		Capital movements (2)	Net transactions of the monetary authorities	Long minus short-term rate	Premium on dollar instruments (3) short	Premium on dollar instruments (3) long
			United States			
1985	IQ	34.5	10.8	3.4	...	...
	IIQ	22.8	-7.6	3.4	...	...
	IIIQ	30.0	-2.1	3.2	...	...
	IVQ	34.9	4.6	2.6	...	...
1986	IQ	28.0	-2.0	1.7	...	...
	IIQ	20.0	-14.7	1.5	...	...
	IIIQ	25.4	-14.8	1.8	...	...
	IVQ	34.7	-1.7	1.9	...	...
1987	IQ	16.1	-17.3	1.7	...	...
	IIQ	27.1	-15.0	2.7	...	...
	IIIQ	47.5	-0.8	2.8	...	...
	IVQ	13.3	-23.6	3.3	...	...
			Japan			
1985	IQ	-6.6	0.1	0.2	1.9	5.0
	IIQ	-12.3	0.9	0.1	1.2	4.4
	IIIQ	-13.5	-0.4	-0.3	0.8	4.2
	IVQ	-16.6	-0.5	-1.2	-0.4	3.4
1986	IQ	-11.5	1.2	-1.0	0.7	3.3
	IIQ	-17.4	5.7	0.2	1.4	2.7
	IIIQ	-17.1	7.3	3.2	0.8	2.4
	IVQ	-25.0	0.6	0.3	0.9	2.5
1987	IQ	-5.1	15.8	-0.1	1.4	3.2
	IIQ	-11.9	10.8	-0.2	1.9	4.8
	IIIQ	-18.3	2.8	1.2	2.3	4.0
	IVQ	-12.7	9.3	0.6	1.9	4.6
			Germany			
1985	IQ	-6.2	-3.9	1.2	2.1	4.2
	IIQ	-1.6	1.7	1.3	1.6	3.7
	IIIQ	-1.1	1.9	1.5	2.2	3.8
	IVQ	-7.0	1.2	1.7	2.3	3.2
1986	IQ	-6.8	0.8	1.6	2.3	2.4
	IIQ	-12.3	-3.9	1.2	1.6	1.8
	IIIQ	-6.1	3.3	1.2	1.0	1.5
	IVQ	-12.9	1.3	1.3	0.7	1.3
1987	IQ	-4.1	7.3	1.5	1.3	1.5
	IIQ	-9.1	1.6	1.7	1.8	2.8
	IIIQ	-9.9	-2.2	2.0	2.1	2.9
	IVQ	-1.9	13.6	2.0	1.7	3.0

Source: BIS, IMF.
(1) US: 10-year Treasury Bond yields and 3-month Treasury Bill rates; Japan: long-term Government bond yields and 2-month Commercial Bills rates; Germany: long-term Government bond yields and 3-month loans. (2) Including errors and omissions. Billions of US dollars. (3) US rates minus corresponding rates in Japan and Germany, in percent.

market rates more actively): these differences signal the attitude of monetary policies relative to changing exchange rate expectations.

As it was mentioned, resistance to exchange rate depreciation really starts at end 1986 - early 1987. In the first half of this year short- (and long-) term interest rates moved consistently with the objective of supporting the dollar (in line with the symmetric widening- or shrinking-case of our model). In the summer and early autumn, however, short-term interest rates were creeping up everywhere while exchange rate expectations were turning again against the dollar; the two foreign countries were "setting a floor" to the world interest rate structure, thus shifting more of the burden of monetary adjustment into US markets. The steepening yield curve in the US seems to imply -- in terms of our model -- that the Fed was moderating the rise in short-term interest rates relative to what would have been required by portfolio balance[28].

The cross-correlations in table 6 present further rough evidence of the above. During the period 1985-87, the correlation between long and short term rate differentials is lower than that observed for the previous floating-rate period 1973-84. In 1985-86, a positive correlation was observed between interest rate differentials and the exchange rate, particularly strong for long-term rates (0.95 for Germany, 0.96 for Japan). In 1987, the correlation is negative (the expected depreciation is resisted, not necessarily with success); in absolute terms long-term rates are more strongly correlated with exchange rates than short rates.

We further tried to investigate with time series (VAR)

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28. According to the OECD, "over this period, given the efforts of the authorities to stabilize exchange rates at the then-current level, practically all the financial adjustment took place in terms of a change in long-term interest rates and differentials" (OECD 1987, p. 76). On long-term rates as an emerging constraint to monetary policy, see the considerations in BIS (1988), Ch. VI.

Table 6

CROSS-CORRELATION COEFFICIENTS BETWEEN LONG- AND SHORT-TERM INTEREST RATE DIFFERENTIALS VIS-A-VIS THE US DOLLAR AND THE EXCHANGE RATE (1)
(monthly data)

Correlations between:	1973,1-1984,12	1985,1-1987,12	1985,1-1986,12	1987,1-1987,12
Germany				
Long-term differential and exchange rate	-0.26	0.68	0.95	-0.43
Short-term differential and exchange rate	-0.30	0.30	0.55	-0.29
Long and Short term differentials	0.78	0.69	0.70	0.72
Japan				
Long-term differential and exchange rate	-0.71	0.34	0.96	-0.73
Short-term differential and exchange rate	-0.76	-0.28	0.37	-0.45
Long and Short term differentials	0.80	0.58	0.48	0.57

Source: BIS.
(1) Interest rate differentials: US rate less foreign rate; exchange rate: DM/$ and Yen/$.

techniques the interactions predicted by our model[29].

The results, presented in Table 7 (for the period 1983-87), are not very satisfactory. They do show that long and short interest differentials are generally dependent on the exchange rate, with the notable exception of Japan's short-term rates[30]; the exchange rate, on the contrary, follows mainly an autoregressive process, in accordance with standard empirical findings on the subject. Long-term interest-rate differentials seem to contribute somewhat to the explanation of the yen/dollar exchange rate[31].

With monthly data we were not able to analyse separately the 1985,86, and 87 periods, as would be required to find formal evidence of our theses. We estimated separately the VAR model over 1985-87; the results, however, are inconclusive due to the limited number of degrees of freedom and hence low significance levels. Further research using higher frequency data is required. Keeping this caveat in mind, the impulse-response functions derived from the estimated VAR models over the two periods 1973-84 and 1985-88 were calculated; some of their characteristics are shown in

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29. The reduced form of the model can be represented in general form by a three-variable vector autoregression including long-term differentials, short-term differentials and the exchange rate; relative monetary conditions are included as exogenous, lagged variables. If we assume that exchange rate expectations are a function of past exchange rates, their effect in the model can be captured by the lagged values of the latter variable (at least in part).

30. The statistical significance levels of Japan's long-term differential are just slightly below 95%.

31. A significant role of the term structure of interest rates in predicting movements in the (real) exchange rate is found by Boughton (1987). Unlike our results his estimates show a dependence of the exchange rate on long-term interest rates in Germany but not in Japan. Boughton's model assumes different processes of formation for long and short-term exchange rate expectations.

Table 7

VECTOR AUTOREGRESSIONS OF DOLLAR EXCHANGE RATE AND LONG-TERM AND SHORT-TERM INTEREST RATE DIFFERENTIALS VIS-À-VIS THE US (1)

(monthly data; 1973,6-1988,8)

Dep. var.	F_{EXC}	F_{LONG}	F_{SHORT}	Q(39)
	GERMANY			
EXC	3,57*	0,54	1,29	24,24
	(0,8)	(70,0)	(27,7)	
LONG	3,14*	4,8*	0,7*	36,72
	(1,6)	(0,2)	(0,6)	
SHORT	4,4*	2,9*	16,6*	20,26
	(0,2)	(2,2)	(0,0)	
	JAPAN			
EXC	10,8*	3,1*	2,0	30,6
	(0,0)	(4,9)	(13,6)	
LONG	2,8	2,8	2,7	34,9
	(6,3)	(6,6)	(6,9)	
SHORT	1,1	3,2*	9,2*	89,5
	(32,3)	(4,2)	(0,0)	

Source: BIS.

(1) Vector autoregression including long-term interest rate differential with the U.S. (LONG), short-term interest rate differential with the U.S. (SHORT) and the log of dollar exchange rate (EXC). The optimal lag lenght was chosen by an AIC criterion (4 for Germany, 2 for Japan). Exogenous variables are a constant term and two lagged values of relative money supplies, defined as log (M_{US}/M). All series were differenced to obtain stationarity. (2) The statistics F_z tests the null hypothesis that lagged values of the independent variable z do not affect the dependent variable. Significance levels (in percent) are reported in parentheses; an asterisk (*) indicates failure to reject the null hypothesis at 5 percent significance level.

Chart 9[32]. For both countries, a shock on the exchange rate has a lower effect on short-term differentials in the more recent period, while the effect on long-term differentials is somewhat stronger; this result is at least consistent with our interpretation of the facts.

7. Conclusions

The return to cooperation in managing the dollar between the United States, Japan and Germany in 1985-87 mainly involved joint announcements, interventions in foreign exchange markets and, to an extent, supporting changes in monetary policies. Fiscal policies did play some role, but much less than is envisaged in official statements and communiqués, with the exception of the expansionary package adopted by Japan in May 1987. Furthermore, cooperation did not live up to the image of fully-fledged coordination of macro-policies and policy-mixes advocated by international institutions and described by academic economists in their models. Rather, what prevailed was flexible "muddling through" with monetary instruments, and effective crisis management operations concentrated in short-time spans.

Through most of 1985 and 1986 national policy objectives were broadly consistent with the common goal of bringing about an orderly depreciation of the dollar, so that pursuit of the latter did not imply an important constraint on national policies. The story was different in 1987, when the desire to halt depreciation of the dollar came to conflict increasingly with domestic monetary policy objectives in Japan and Germany. Large interventions , the resulting pressure on monetary growth, actual and feared policy reactions to this pressure and their impact on long-term interest rates, eventually took their toll, possibly becoming an important factor in "detonating" the stock-market crash.

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32. Data for 1988, otherwise not considered in this paper, had to be included to gain degrees of freedom.

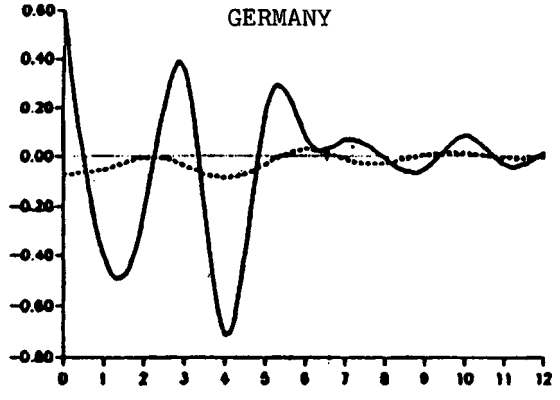
3-VARIABLE VECTOR AUTO-REGRESSION

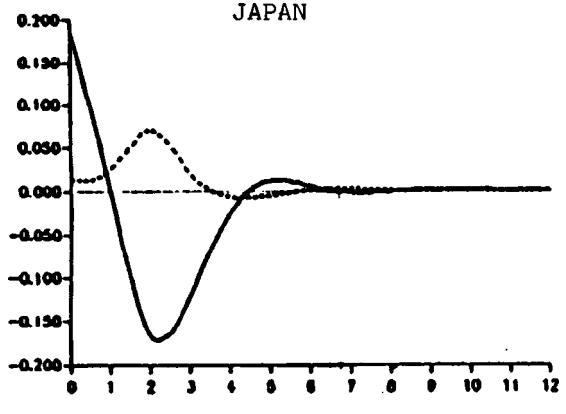
Responses to a shock on the exchange rate

Chart 9

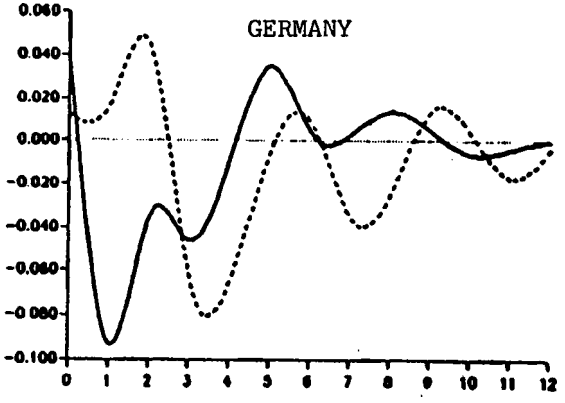
(— 73:6-84:12 ···85:1-88:7)

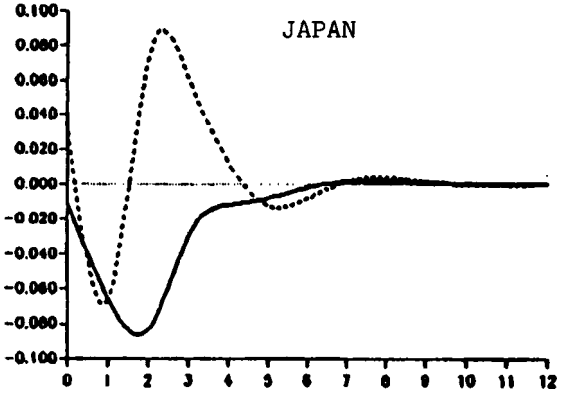
Short-term interest rate differential





Long-term interest rate differential





Horizontal axis: lag, in months. The scale on the vertical axis measures the response of the interest differential to one-standard deviation-shock in the log of the exchange rate. The impulse-response functions are derived from the VAR described in the footnote to table 7 , estimated over the indicated periods. Innovations were triangularized through a Choleski factorisation of their covariance matrix, in the order EXC-SHORT-LONG.

The general lesson seems to be that there is considerable leeway in the use of monetary instruments to accomodate diverging domestic and external requirements, but that after a point the inconsistency may show up (the inconsistency obviously arising from failure to act on the fiscal policy front).

The traumatic suspension of cooperation in October 1987 also seems to point to another conclusion. Non-intervention and pure floating had been abandoned because of emerging imbalances in international trade. A consensus then developed that exchange rates cannot be left by themselves and need to be managed. After the return to cooperation, however, there is ground to argue that central banks may have overdone it, falling into the opposite sin of an excess of intervention both in the foreign exchange and the domestic money market, simply because it is very difficult to determine when precisely to stop intervening under growing market pressures.

As long as there is an underlying "fundamental" disequilibrium (in external balances or fiscal policies) the possibility of making similar mistakes is a risk inherent in any cooperative arrangement to manage exchange rates.

APPENDIX

The model describes the financial sectors of two countries, with three assets for each country: (base) money (M), bills (B), long-term securities (S) (an asterisk denotes foreign country variables)[33]. Private agents in the two countries are assumed to respond symmetrically to interest rate changes; however, the central banks' reaction functions may differ.

We first examine the supply functions. The central banks of the two countries intervene in the foreign exchange markets by purchasing or selling their currency in exchange for the other country's currency, to limit the discrepancy between the targeted exchange rate, $\hat{e}$, common to the two contries, and its current level e (defined as the price of the "foreign" currency; INT, INT^* represent purchases of the "foreign" currency):

$$(A.1) \quad INT = b(\hat{e} - e) \qquad b > 0$$

$$INT^* = b^*(\hat{e} - e) \qquad b^* > 0$$

When b (or b^*) $\to \infty$, we are in a fixed exchange rate regime. The foreign component (FC) of the money supply in the two

33. The model determines a short-run equilibrium, in line with the approach followed by most portfolio models of the exchange rate; e.g., see the one-country models in Kouri (1980), Branson-Halttunen-Masson (1980) and the two-country model in Marston (1980); see also the survey in Murphy-Van Duyne (1980). These models usually consider only one kind of domestic securities; an exception is represented by Argy and Murray (1985), who analyze the effects of sterilization in a one-country model with money, bonds, shares and foreign securities; they assume fixed exchange rates.

countries is given by:[34]

(A.2) $FC = FC_0 + INT + INT^*$

$$FC^* = FC_0^* - (INT + INT^*)$$

Each country's central bank can carry out open market operations to sterilize the effects of interventions on the supply of domestic money (monetary base), so that the domestic component of money supply takes the form:

(A.3) $DC = DC_0 - c\,(FC - FC_0)$

$$DC^* = DC_0^* - c^*(FC^* - FC_0^*)$$

where c and c^* are the sterilization coefficients (with values $1 \geq (c, c^*) \geq 0$). The (base) money supply functions in the two countries are then obtained as the sum of the domestic and foreign components (setting $M_0 = FC_0 + DC_0$):

(A.4) $M = M_0 + (b+b^*)(1-c)(\hat{e}-e)$

$$M^* = M_0^* - (b+b^*)(1-c^*)(\hat{e}-e)$$

The total supply of bills in the two countries is taken as exogenous (and constant), B_0 and B_0^*. However, since open market operations entail changes of opposite sign in the supply of bills to the market, that is thus obtained, in each country, as:

(A.5) $B = B_0^* + c(b+b^*)(\hat{e}-e)$

---

34. Valuation problems are avoided by restricting the analysis to a neighborhood of equilibrium (where by definition e=1).

$$B^* = B^*_0 - c^*(b+b^*)(\hat{e}-e)$$

The supply of long-term securities is assumed exogenous and constant in both countries (S and S^*).

We now turn to the demand functions for money (M_d, M_d^*), bills (B_d, B_d^*), long-term securities (S_d, S_d^*). Measured in country one's currency, they take the general form:

$$(A.6) \qquad A_d = A\,(W,\ eW^*,\ r,\ r^*,\ \rho,\ \rho^*,\ \varepsilon)$$

where:

$$(A.7) \qquad \varepsilon \equiv \frac{e-e_{exp}}{e},$$

W,W* represent wealth in the two countries, and satisfy

$$(A.8) \qquad W+eW^* \equiv S+B+M+e(S^*+B^*+M^*),$$

and r is the interest rate on bills, ρ the yield on securities, $\hat{e}$ the targeted exchange rate (policy objective common to the two countries), and e_{exp} the (exogenously)[35] expected exchange rate. The demand for each asset depends positively on the differential between own and alternative

35. The exogeneity of exchange rate expectations is based on the hypothesis that they are determined in the "real" sector, on the basis of "fundamental" variables (current account balance and fiscal policy).

asset yields[36]. This implies[37]:

(A.9) M_r, B_ρ, S_r, B_{r*}, $S_{\rho*} < 0$; B_r, $S_\rho > 0$; B_ε, $S_\varepsilon > 0$

(A.10) $B_r = -(M_r + B_\rho + B_{r*})$; $S_\rho = -(S_r + S_{\rho*})$

Furthermore the assumption of <u>symmetry</u> implies[38]:

(A.11) $A_i = A^*_{i*}$ for A = S, B, M

$A_{i*} = A^*_i$ i = r, ρ

A number of restrictions have been imposed on the partial derivatives of (A.6) so as to make the model more manageable. In particular:

(i) in the demand for money, in each country, only the yield on bills has non-zero coefficient (this implies

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36. When $c=c^*$, this is a sufficient condition for stability. (For an analysis of stability conditions in a two-country, short-run portfolio balance model see Cadsby 1987). The yield differentials vis-a-vis foreign assets are defined as $(\rho-\rho^*+\varepsilon)$ and $(r-r^*+\varepsilon)$; hence it is also $-B_{r*}=B_\varepsilon$ and $-S_{\rho*}=S_\varepsilon$. Yield differentials vis-a-vis money are simply defined as r, ρ.

37. For simplicity, in (A.10) we omitted the coefficients that are set equal to zero by (A.12) and (A.13).

38. In what follows, A_i indicates the partial derivative of the demand function for A with respect to argument i.

no currency substitution)[39];

(A.12) $M_{\rho} = M_{\rho*} = M_{r*} = M_{\varepsilon} = 0$

(ii) in each country domestic bills are a substitute for domestic money, domestic securities and foreign bills, but not for foreign securities;

(iii) similarly, in each country domestic securities are subsitutes for foreign securities, and domestic bills, but not for foreign bills; (ii) and (iii) imply[40]:

(A.13) $S_{r*} = B_{\rho*} = 0; \quad S_{\varepsilon} = -S^*_{\varepsilon}: \quad B_{\varepsilon} = -B^*_{\varepsilon}$

(iv) wealth effects on asset excess demand functions due to exchange rate changes are set equal to zero[41].

Finally, from the definition of wealth (A.8) and the budget constraint

(A.14) $M_d + S_d + B_d + e(M^*_d + S^*_d + B^*_d) = W_T$,

considering (A.13), and assuming e=1, we get the following restrictions:

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39. Without this assumption, the effect of Δe_{exp} on the rate of interest on bills would be ambiguous (Argy-Murray, (1985)); in this case, however, the rationality of a sterilization policy as defined in (A.3) would be doubtful.

40. Assumption (A.13) could be relaxed without prejudice to the results, provided that the elasticity of substitution is larger between domestic bonds and domestic securities than between domestic bonds and foreign securities: $|S_r| > |S_{r*}|$, $|B_{\rho}| > |B_{\rho*}|$.

41. This amounts to assume that wealth effects on asset demands are offset by "valuation" effects on asset supplies.

(A.15) $S_\rho + B_\rho + S^*_\rho = 0 \; ; \; M_r + S_r + B_r + B^*_r = 0$

The model is completed by six market-clearing conditions (demand=supply).

Through appropriate substitutions and by linearizing around equilibrium (where we assume $e = e_{exp} = 1$), we get the following six-equation model in compact form (where variables represent deviations from the equilibrium level):

Country 1:

(A.16) $M_r r - M_0 - (b+b^*)(1-c)(\hat{e}-e) = 0$

(A.17) $S - S_r r - S_\rho \rho - S_{\rho^*} \rho^* - S_\varepsilon (e-e_{exp}) = 0$

(A.18) $B_0 - B_r r - B_\rho \rho - B_{r^*} r^* - B_\varepsilon (e-e_{exp}) + (b+b^*)c(\hat{e}-e) = 0$

Country 2:

(A.19) $M_r r^* - M^*_0 + (b+b^*)(1-c^*)(\hat{e}-e) = 0$

(A.20) $S^* - S_r r^* - S_\rho \rho^* - S\rho^* \rho + S_\varepsilon (e-e_{exp}) = 0$

(A.21) $B^*_0 - B_r r^* - B_\rho \rho^* - B_r r^* + B_\varepsilon (e-e_{exp}) - (b+b^*)c^*(\hat{e}-e) = 0$

Solution of the model: differences

By subtracting each of country two equations from the corresponding country one equations[42], we obtain a

42. Valuations problems are again avoided through linearization of the model around e=1.

three-equation system determining two interest rate differentials ($\tilde{r}$, $\tilde{\rho}$) and the exchange rate (e) as a function of relative asset supplies, the exchange rate level, the exchange rate target and the intervention parameters (we define $\tilde{x} = x - x^*$):

$$(A.22) \quad M_r\tilde{r} - \tilde{M}_0 - k(\hat{e}-e) = 0$$

$$(A.23) \quad \tilde{S} - S_r\tilde{r} - (S_\rho - S_{\rho^*})\tilde{\rho} - S_e\,(e-e_{exp}) = 0$$

$$(A.24) \quad \tilde{B} - (B_r - B_{r^*})\tilde{r} - B_\rho\tilde{\rho} - B_e\,(e-e_{exp}) + w(\hat{e}-e) = 0$$

where

$$(A.25) \quad S_e = 2S_\varepsilon > 0$$

$$B_e = 2B_\varepsilon > 0$$

$$k = (b+b^*)(2-c-c^*)$$

$$w = (b+b^*)(c+c^*)^{43}$$

Solution of the comparative statics system yields the following multipliers:

$$(A.26) \quad d\tilde{r} = \frac{k\Phi}{\Delta}\, d\,(e_{exp}-\hat{e})$$

$$(A.27) \quad d\tilde{\rho} = \frac{k\Phi - 2(b+b^*)M_r S_e}{\Delta}\, d\,(e_{exp}-\hat{e})$$

---

43. k measures the effect of an exchange rate variation on relative money supply (through non-sterilized interventions); w measures the effect of an exchange rate variation on relative supply of bills (through sterilized interventions).

$$(A.28)\quad de = \frac{-M_r\Phi}{\Delta}\, de_{exp} + \left(1 - \frac{-M_r\Phi}{\Delta}\right) d\hat{e}$$

where:

$$\Delta \equiv -2(b+b^*)M_r(S_\rho - S_{\rho^*}) + (k-M_r)\Phi > 0$$

$$\Phi \equiv (S_\rho - S_{\rho^*})B_e - S_e B_\rho > 0 \qquad \text{(by A.9)}$$

Note that (A.26) and (A.27) imply that interest rate differentials are influenced by the discrepancy between market expectations and the monetary authorities' exchange rate target; while (A.28) implies that, in a neighborhood of equilibrium, the actual exchange rate is a weighted average of its targeted and expected value.

It is immediate to see that an expected increase in e_{exp} (depreciation of first country's currency) will in general lead to an increase in its interest rates relative to those of the second country. Short-term differentials will not change if interventions are fully sterilized ($k = 0$ since $c = c^* = 1$)[44]; in this case, however, long-term differentials in favour of the country whose currency is depreciating will still increase[45]. The increase in interest rates in the country whose currency is coming under pressure will be larger, the

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44. In the presence of wealth effects of exchange rate changes and less-than-fully-fixed exchange rates, interest rates differentials will always show some change.

45. The multiplier in (A.27) has a positive sign even if $k=0$. This implies that the "slope" of the yield curve (represented by $\rho-r$) is increasing in the first country. This latter effect will be greater, the greater the sterilization coefficients (Δ decreases).

more rapid is the defence of the exchange rate (that is, the larger is $b+b^*$); for $b+b^* \to \infty$, and $k=0$ the impact of worsened exchange rate expectations will be wholly discharged on long term interest rate differentials (in this case, $d\tilde{\rho}/de_{exp} = Se/(S_\rho - S_\rho{}^*)$). For given other conditions, such effect will obviously increase with the international mobility of long-term capital[46].

Solution of the model : averages

By adding equations (A.16) to (A.19), (A.17) to (A.20), (A.18) to (A.21), and then dividing by two, we obtain a two equation system (the third equation is redundant by Walras' Law) which determines the average return on bills and securities (a bar over a variable indicates its average):

$$(A.29) \quad M_r \bar{r} - \bar{M}_0 - \gamma (\hat{e} - e) = 0$$

$$(A.30) \quad \bar{S} - S_r \bar{r} - (S_\rho + S_{\rho^*}) \bar{\rho} = 0$$

where

$$\gamma \equiv \frac{1}{2} - (b + b^*)(c^* - c)$$

46. By (A.10), $S_e/(S_\rho - S_\rho{}^*) = 1 + S_r/(S_e - S_r)$; it has a value between 0 and 1, tending to 1 if $S_e \to \infty$.

From (A.29)-(A.30), using the expression (A.28) for de, (and considering that $S_\rho + S_{\rho^*} = -S_r$ by A.10), we get the comparative statics multipliers for the average levels of the interest rates:

$$(A.31) \qquad d\bar{r} = d\bar{\rho} = \gamma \frac{\Phi}{\Delta} \, d\,(e_{exp} - \hat{e})$$

Two properties of the model can be derived from these solutions. First, it can be seen that if $c = c^*$, that is if the sterilization behaviour of the two countries is similar, $\gamma = 0$ and the average interest rate level does not change in response to an increase in e_{exp}. If however $c \neq c^*$,

$$\frac{d\bar{\rho}}{d(e_{exp}-\hat{e})} \;,\; \frac{d\bar{r}}{d(e_{exp}-\hat{e})} > 0 \quad \text{if} \quad \gamma > 0$$

In other words, differently sterilized interventions by the countries can lead to a change in aggregate (as opposed to relative) monetary (short-term) and financial (long-term) condition. Increasing restriction prevails, in particular, if the country whose currency is coming under downward pressure sterilized less than the other one, and decreasing restriction in the opposite case.

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